CLIMATE ACTION PLAN

Munshiganj Municipality

Munshiganj, Bangladesh

2026



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CLIMATE ACTION PLAN

Munshiganj Municipality, Munshiganj, Bangladesh

2026



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LIST OF ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
CAP	Climate Action Plan
CCDR	Country Climate and Development Report
CEO	Chief Executive Officer
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
DDM	Department of Disaster Management
DEM	Digital Elevation Model
DPHE	Department of Public Health Engineering
EM-DAT	Emergency Events Database / International Disaster Database
FVI	Flood Vulnerability Index
GBM	Ganges–Brahmaputra–Meghna
GDP	Gross Domestic Product
GEE	Google Earth Engine
GIS	Geographic Information System
HIGS	Hazard, Infrastructure and Urban Services, Governance, and Socio-economic Vulnerability
IPCC	Intergovernmental Panel on Climate Change
IUGIP	Integrated Urban Development and Infrastructure Improvement Project
LGED	Local Government Engineering Department
LLA	Locally Led Adaptation
LP Gas	Liquefied Petroleum Gas
LST	Land Surface Temperature
LULC	Land Use and Land Cover
MCPP	Mujib Climate Prosperity Plan
MoEFCC	Ministry of Environment, Forest and Climate Change
NASA	National Aeronautics and Space Administration
NDC	Nationally Determined Contribution
NDC 3.0	Bangladesh's Third Nationally Determined Contribution
R813	Muktarpur Bridge–Munshiganj Road regional route designation
RCC	Reinforced Cement Concrete
REB	Rural Electrification Board
RHD	Roads and Highways Department
SEVI	Socio-economic Vulnerability Index
SRTM	Shuttle Radar Topography Mission
SWM	Solid Waste Management
TLCC	Town Level Coordination Committee
UNDRR	United Nations Office for Disaster Risk Reduction
USGS	United States Geological Survey
WASH	Water, Sanitation and Hygiene
WMO	World Meteorological Organization

GLOSSARY

Adaptation: The process of adjusting people, infrastructure, ecosystems, institutions, and services to current and expected climate impacts in order to reduce vulnerability and strengthen resilience.

Blue-Green Water Network: An interconnected system of rivers, canals, wetlands, ponds, drainage channels, retention areas, green spaces, and related natural or engineered features that collectively support urban water management and climate resilience.

Canal/Khal: A natural or modified water channel that conveys, stores, or drains water and forms part of the municipal water and drainage network.

Climate Action Plan (CAP): A municipal planning document that translates climate risk assessment into prioritized actions for climate adaptation, mitigation, resilient infrastructure, improved services, and sustainable urban development.

Climate Resilience: The capacity of a community, infrastructure system, ecosystem, or institution to anticipate, absorb, withstand, recover from, and adapt to climate-related shocks and stresses.

Climate Risk: The potential for adverse consequences arising from the interaction of climate-related hazards with exposed people, infrastructure, ecosystems, and livelihoods, considering their vulnerability.

Community Consultation: A participatory process through which residents and local stakeholders provide information, experiences, concerns, and priorities to inform planning and decision-making.

Digital Elevation Model (DEM): A digital representation of ground elevation used to understand terrain, slope, drainage direction, and flood-related conditions.

Drainage Outfall: A point or location where water from a drain or drainage network discharges into a canal, river, pond, wetland, or other receiving water body.

Flood Vulnerability: The degree to which people, infrastructure, services, and ecosystems are susceptible to adverse effects from flooding, considering exposure, sensitivity, and capacity to cope or adapt.

Heat Stress: The physiological and environmental stress caused by high temperatures, often intensified in urban areas by dense built-up surfaces and limited vegetation.

HIGS Framework: A ward-level climate vulnerability assessment framework used in the CAP that considers Hazard, Infrastructure and Urban Services, Governance, and Socio-economic vulnerability.

Land Surface Temperature (LST): The temperature of the Earth's land surface, commonly estimated from satellite thermal data and used to identify areas experiencing higher surface heat.

Land Use and Land Cover (LULC): The classification and spatial distribution of land uses and physical land-cover types such as built-up areas, vegetation, agriculture, bare land, and water bodies.

Min–Max Normalization: A data-processing method that converts indicator values to a common scale, in this CAP generally from 0 to 1, so that different indicators can be combined for vulnerability assessment.

Nature-Based Solutions: Actions that use or strengthen natural processes and ecosystems to address societal challenges such as flooding, heat, water pollution, and drainage while providing environmental and social benefits.

Overlay Analysis: A GIS-based method in which multiple spatial datasets are combined to identify areas where different environmental or climate-risk factors overlap.

Retention Area / Retention Pond: A designated natural or constructed area that temporarily stores excess stormwater and helps reduce flood peaks and waterlogging.

Socio-economic Vulnerability Index (SEVI): A composite ward-level index used in the CAP to assess differences in vulnerability using indicators including population, density, literacy, vulnerable population, housing condition, and unsafe sanitation.

Stormwater Drainage: The network of drains, channels, outfalls, and related infrastructure that collects and conveys rainfall runoff to receiving water bodies or other drainage systems.

Waterlogging: The temporary accumulation or prolonged stagnation of water in urban areas caused by rainfall, inadequate drainage capacity, siltation, blockage, low elevation, or restricted outfall connectivity.

Water Network: The interconnected system of rivers, canals, khals, ponds, wetlands, drainage channels, outfalls, and associated water-management infrastructure serving the municipality.

Vulnerability Assessment: A systematic assessment of the factors that make people, places, infrastructure, ecosystems, or services susceptible to climate hazards and their impacts.

Ward: An administrative and electoral division of a municipality. The Munshiganj CAP assesses climate vulnerability and prioritizes interventions at ward level.

Wetland: A land area that is permanently or seasonally saturated or covered by water and provides important functions such as water retention, drainage, habitat support, and ecological regulation.

Wetland Conservation: The protection and sustainable management of wetlands and water bodies to retain their ecological, hydrological, and climate-resilience functions.

Blue-Green Corridor: A connected spatial system linking water bodies and drainage features with vegetation and green spaces to improve ecological connectivity, stormwater management, and urban climate resilience.

Canal Desiltation: The removal of accumulated sediment, silt, waste, and other deposited materials from a canal or channel to restore its water-carrying and drainage capacity.

Encroachment: Unauthorized occupation, filling, narrowing, blockage, or conversion of canals, drainage corridors, wetlands, water bodies, or other protected/public spaces.

Resilient Infrastructure: Infrastructure planned, designed, constructed, and maintained to continue functioning under climate-related hazards and recover quickly after disruptive events.

EXECUTIVE SUMMARY

Munshiganj Municipality Climate Action Plan (CAP) provides an evidence-based framework for understanding and addressing the municipality's current and emerging climate risks. Located within a low-lying riverine and floodplain environment and influenced by the Dhaleshwari and Meghna river systems, Munshiganj is increasingly exposed to heavy rainfall, waterlogging, flooding, heat stress, thunderstorms, and associated impacts on infrastructure, water and sanitation services, housing, livelihoods, and the urban environment. The municipality's vulnerability is further shaped by rapid urbanization, pressure on drainage and water systems, solid-waste accumulation, degradation of canals and waterbodies, and uneven infrastructure and service provision across its nine wards.

The CAP was prepared through a participatory and multi-source assessment combining secondary data, GIS and satellite-based analysis, field observations, stakeholder consultations, and primary household-level information. A structured questionnaire survey covered 360 respondents, with 40 respondents from each of the nine wards. The assessment integrated spatial analysis of land use and land cover, land surface temperature, rainfall, and flood susceptibility with the HIGS framework, which evaluates Hazard, Infrastructure and Urban Services, Governance, and Socio-economic vulnerability at ward level. This approach allowed the plan to identify both physical climate-risk hotspots and areas where infrastructure and socio-economic conditions increase residents' capacity constraints.

The assessment demonstrates that climate vulnerability is unevenly distributed across Munshiganj Municipality. Wards 3, 7 and 8 are classified as highly vulnerable under the HIGS assessment, while Wards 1, 2, 4 and 9 fall within the moderate category and Wards 5 and 6 within the low category. Ward 3 records the highest overall HIGS score (2.82), driven particularly by high hazard and infrastructure vulnerability. Wards 7 and 8 are also highly vulnerable, with their vulnerability strongly influenced by physical exposure and socio-economic conditions. The satellite-based assessment additionally identifies Wards 7–9 as important physical vulnerability hotspots because of their flood susceptibility, river proximity, rainfall conditions, and elevated land surface temperature.

Among the assessed hazards, heatwave and heavy rainfall/waterlogging emerge as the most significant municipal-level concerns. Heavy rainfall and waterlogging are particularly severe in Ward 3, while heatwave vulnerability is highest in Wards 7 and 8. Approximately 68.97% of surveyed respondents reported experiencing waterlogging, highlighting the significance of drainage-related climate impacts. The infrastructure assessment further identifies sanitation and wastewater, solid waste management, and Internet and communication as the most vulnerable urban systems, followed by stormwater drainage and housing. The baseline assessment also identifies important service and infrastructure gaps. Only 22.84% of households use piped or tap water, while most households depend on tubewells. Although approximately 92.98% of households have improved or safe sanitation, wastewater disposal remains a concern, with some households discharging wastewater directly into canals and rivers. The municipality has no centralized fecal sludge management facility. Its drainage network is affected by blockage, siltation, vegetation, and inadequate outfall connectivity, contributing to recurring monsoon waterlogging. Solid-waste generation is approximately 41.9 tonnes per day, while collection capacity, waste segregation, recycling, and controlled disposal remain limited. Housing vulnerability is particularly pronounced in Wards 6–9, where kancha and jhupri structures constitute a substantial share of housing.

Based on the vulnerability assessment, the CAP establishes a set of ward-specific adaptation and resilience priorities. Ward 3 requires urgent attention to drainage capacity, flood protection, sanitation, water points, road accessibility, and emergency access. Wards 7 and 8 require integrated improvements in drainage, water and sanitation, housing, roads, waste management, emergency preparedness, and urban

greening. Wards 1–3 require strengthened sanitation and public toilet facilities, while Wards 2, 3 and 7 are identified for a pilot waste-segregation and Material Recovery Facility initiative. Across the municipality, drainage rehabilitation and desiltation, improved outfalls, flood-resilient water points, waste clearance, resilient roads, urban greening, early-warning systems, and climate-resilient sanitation are identified as important actions.

A central strategic intervention of the CAP is the Integrated Riverfront, Waterbody Conservation and Sustainable Tourism Development initiative. This intervention responds to the convergence of major vulnerabilities identified through the assessment: severe waterlogging and drainage constraints in the urban core, flood and heat exposure in Wards 7–9, degradation of canals and waterbodies, and increasing development pressure. The plan therefore proposes treating the municipality's rivers, canals, ponds, wetlands, drainage channels, and green spaces as an interconnected blue-green infrastructure system, rather than as isolated environmental features.

The proposed approach prioritizes water-system restoration before conventional riverfront development. Key measures include mapping and protecting waterbody boundaries, controlling encroachment, targeted canal re-excavation and desiltation, improving upstream drainage and downstream outfall connectivity, managing pollution and solid-waste dumping, and introducing nature-based solutions such as riparian vegetation, rain gardens, bio-retention areas, retention ponds, wetland restoration, permeable surfaces, and urban tree planting. These measures are intended to improve stormwater retention, reduce waterlogging and flood exposure, mitigate heat, improve water quality and biodiversity, and strengthen the municipality's ecological resilience.

The CAP also proposes integrating environmental restoration with heritage-sensitive and low-impact tourism development. Existing riverfront recreational facilities and restaurants can be improved and connected through public promenades, viewing areas, shaded spaces, improved ghats, and appropriate visitor facilities. Selected restored canal sections may support low-impact eco-tourism, walking and cycling routes, fishing, and community-based recreation. Heritage assets including Idrakpur Fort, Baba Adam Mosque, and Nagar Koshba can form part of a wider blue-green heritage tourism network. Tourism is considered a secondary co-benefit of climate adaptation, intended to improve public access, support local livelihoods, and strengthen incentives for long-term conservation of restored water systems.

Implementation is proposed through a phased and evidence-based approach. Immediate priorities include public/shared sanitation facilities in Wards 1–3, waste segregation and an MRF pilot in Wards 2, 3 and 7, drainage clearance and outfall improvement, flood-resilient water points, and pre-monsoon waste and drainage management. Medium- and longer-term priorities include climate-resilient drainage and roads, resilient sanitation and wastewater management, housing improvements, urban greening, communication and early-warning resilience, and the integrated riverfront, waterbody conservation and blue-green infrastructure programme, particularly in Wards 7–9.

Successful implementation will require strong municipal leadership, inter-agency coordination, community participation, dedicated financing, and clearly assigned responsibilities for operation and maintenance. Before major riverfront or waterbody interventions are implemented, detailed hydrological, topographic, environmental, geotechnical, engineering, land-ownership, and feasibility assessments should be undertaken. The CAP should also be treated as a living planning instrument and periodically updated as new climate, demographic, infrastructure, and environmental data become available.

Overall, the Munshiganj Climate Action Plan shifts the municipality's climate response from isolated infrastructure improvements toward an integrated, ward-focused and water-sensitive resilience strategy. By prioritizing drainage and waterlogging management, resilient water and sanitation services, improved waste management, climate-resilient infrastructure, urban greening, emergency preparedness, and restoration of the municipal water network, the CAP provides a practical pathway toward reducing climate risk while improving environmental quality, public space, local economic opportunities, and quality of life. Sustained implementation of these measures can help Munshiganj protect its natural water systems, strengthen essential municipal services, and move toward a safer, healthier, more inclusive, and climate-resilient urban future.



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01. INTRODUCTION: DEFINING THE CRISIS

1. INTRODUCTION: DEFINING THE CRISIS

1.1 Global Context: A Shared Climate Emergency

Climate change has become one of the most pressing global challenges of the twenty-first century, creating serious threats to ecosystems, economies, infrastructure, public health, livelihoods, and human well-being. The global climate system is changing rapidly due to increasing greenhouse gas emissions, unsustainable land-use practices, ecosystem degradation, and continued dependence on carbon-intensive development. These changes are already visible through rising temperatures, shifting rainfall patterns, more frequent and intense extreme weather events, ocean warming, sea-level rise, glacier melt, biodiversity loss, water insecurity, and growing stress on cities and settlements (IPCC, 2022; WMO, 2026).

According to the World Meteorological Organization (WMO), the year 2025 was about 1.43°C ± 0.13°C warmer than the 1850–1900 pre-industrial average, making it the second warmest year in the 176-year observational record (WMO, 2026). It clearly indicates how close the global climate system is moving toward dangerous levels of warming. The rise in global temperature is closely linked with the continuous increase in greenhouse gas concentrations. In 2024, the global atmospheric concentration of carbon dioxide reached 423.9 ± 0.2 parts per million, the largest annual increase in carbon dioxide concentration since 1957. As greenhouse gas concentrations rise, the Earth stores more heat, and this excess energy is distributed across the ocean, land, ice, and atmosphere. Around 91% of the excess heat is absorbed by the ocean, about 5% warms the land, nearly 3% contributes to melting ice, and around 1% warms the atmosphere (WMO, 2026). In 2025, global ocean heat content reached the highest level in the observational record (WMO, 2026). This has serious consequences for marine ecosystems, coastal settlements, fisheries, tropical cyclones, and global sea-level rise. Ocean warming also contributes to stronger storms, coral bleaching, biodiversity loss, and reduced ocean capacity to absorb carbon dioxide.

Additionally, global sea level is rising at an average rate of about 2.65 mm per year, while from 2012 to 2025 the rate increased to about 4.75 mm per year (WMO, 2026). Sea-level rise contributes to coastal flooding, salinity intrusion, erosion, groundwater contamination, damage to infrastructure, and loss of coastal ecosystems. For deltaic countries such as Bangladesh, sea-level rise also interacts with river systems, drainage congestion, floodplain dynamics, and urban waterlogging, creating complex and cascading risks.

Climate change impacts are not evenly distributed. The Intergovernmental Panel on Climate Change (IPCC) states that climate risk emerges from the interaction of three major factors: climate-related hazards, exposure, and vulnerability. Hazards such as floods, heatwaves, droughts, cyclones, heavy rainfall, and sea-level rise become more damaging when people, infrastructure, ecosystems, and livelihoods are exposed and when their capacity to cope or adapt is limited (IPCC, 2022). The IPCC also estimates that approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change. Vulnerability is especially high in areas affected by poverty, weak governance, limited access to basic services, ecosystem degradation, rapid urbanization, and dependence on climate-sensitive livelihoods (IPCC, 2022).

Recognizing the scale and urgency of the crisis, the international community has adopted several frameworks and commitments:

- **Paris Agreement (2015):** Committing countries to limit global temperature rise to well below 2°C, and preferably to 1.5°C.
- **Sendai Framework for Disaster Risk Reduction (2015–2030):** Promoting resilience-building and risk reduction across sectors.

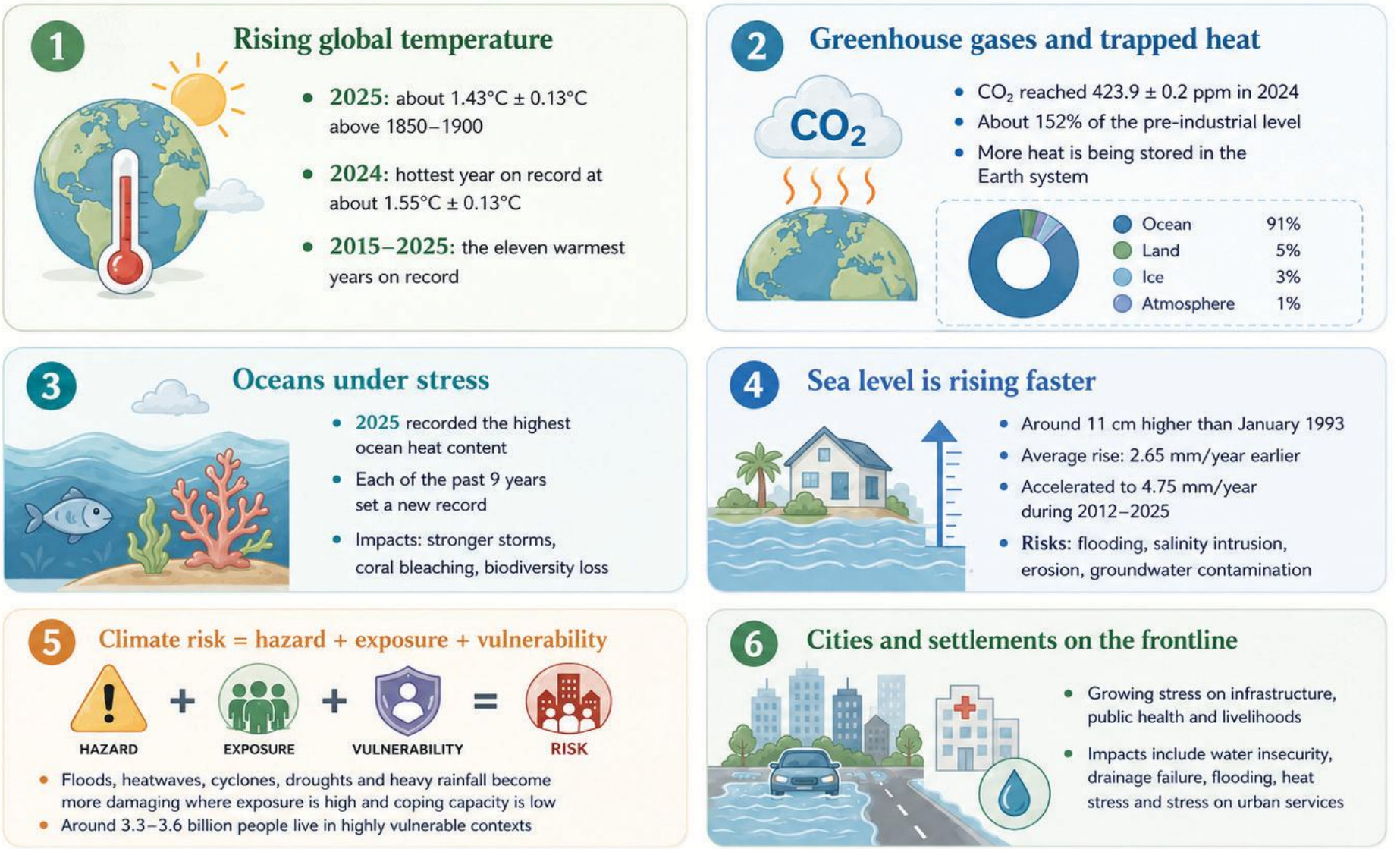


Figure 1: *Global Climate Change – Key Indicators and Risks*

Source: Data compiled fromIPCC, 2022; WMO, 2026.

- **Sustainable Development Goals (SDGs, 2015):** Mainstreaming climate action (Goal 13) across all development goals.
- **New Urban Agenda (2016):** A global framework to promote sustainable, inclusive, and resilient urban development aligned with SDG 11.

In response, global climate action must combine mitigation and adaptation. Mitigation focuses on reducing greenhouse gas emissions, while adaptation focuses on preparing societies, ecosystems, infrastructure, and institutions to cope with current and future climate impacts. International frameworks such as the Paris Agreement, the Sendai Framework for Disaster Risk Reduction, the Sustainable Development Goals, and the New Urban Agenda all emphasize the need for resilient, inclusive, and sustainable development. However, these global commitments must be translated into practical local actions, particularly at the municipal level, where climate impacts are directly experienced by communities. In this global context, municipal climate action must move beyond conventional infrastructure planning. Roads, drains, buildings, parks, water supply, sanitation, solid waste management, canals, wetlands, and riverfront spaces should be planned together as part of an integrated urban resilience system. For water-sensitive municipalities such as Munshiganj, the global climate emergency reinforces the urgent need to conserve and restore canals, wetlands, riverfront areas, ponds, drainage networks, and natural retention spaces. These systems can reduce flood and waterlogging risks, improve ecological balance, create public open spaces, enhance environmental quality, and strengthen long-term climate resilience.

1.2 National Context: Bangladesh's Rising Climate Risks

Bangladesh is widely recognized as one of the world's most climate-vulnerable countries due to its low-lying deltaic geography, dense population, extensive river network, and high dependence on climate-sensitive sectors. Situated within the Ganges–Brahmaputra–Meghna (GBM) Delta, the country is highly exposed to recurrent floods, cyclones, riverbank erosion, droughts, heatwaves, salinity intrusion, and waterlogging. Climate change is intensifying the frequency and severity of these hazards, posing significant risks to human settlements, infrastructure, agriculture, water resources, ecosystems, public health, and economic development (IPCC, 2022; Ministry of Environment, Forest and Climate Change [MoEFCC], 2022b).

Despite contributing less than 0.5% of global greenhouse gas emissions, Bangladesh bears a disproportionate share of climate impacts. According to the World Bank Country Climate and Development Report (CCDR), climate change could reduce the country's gross domestic product (GDP) by up to 9% by 2050 if adequate adaptation measures are not implemented. The report projects that climate impacts could substantially increase poverty, reduce agricultural productivity, damage infrastructure, and accelerate climate-induced migration, placing additional pressure on urban centers and municipal service delivery (World Bank, 2022).

Recent observations further demonstrate that climate risks are accelerating across Bangladesh. The World Meteorological Organization (WMO) reports that South Asia continues to experience above-average warming, increasingly frequent heatwaves, and more intense precipitation events, trends that are already affecting Bangladesh through recurrent flooding, prolonged heat stress, and greater climate variability (WMO, 2025). Similarly, disaster records maintained by the EM-DAT International Disaster Database show that floods, storms, cyclones, and other hydro-meteorological hazards remain the dominant disasters affecting Bangladesh, causing repeated losses to lives, livelihoods, infrastructure, and economic activities (CRED & UNDRR, 2025).

1.2.1 Bangladesh's Climate Risk Profile: Observed Climate Trends and Impacts

Bangladesh has experienced significant changes in temperature, precipitation, river hydrology, and the frequency of extreme weather events over recent decades. These changes are increasing risks to infrastructure, agriculture, water resources, ecosystems, public health, and urban development. Owing to its low-lying deltaic landscape, extensive river network, and high population density, the country remains highly vulnerable to climate-induced hazards. National and international assessments indicate that climate change will further intensify these risks, highlighting the need for climate-resilient planning and adaptation at all levels of government (MoEFCC, 2022b; IPCC, 2022; World Bank, 2022).

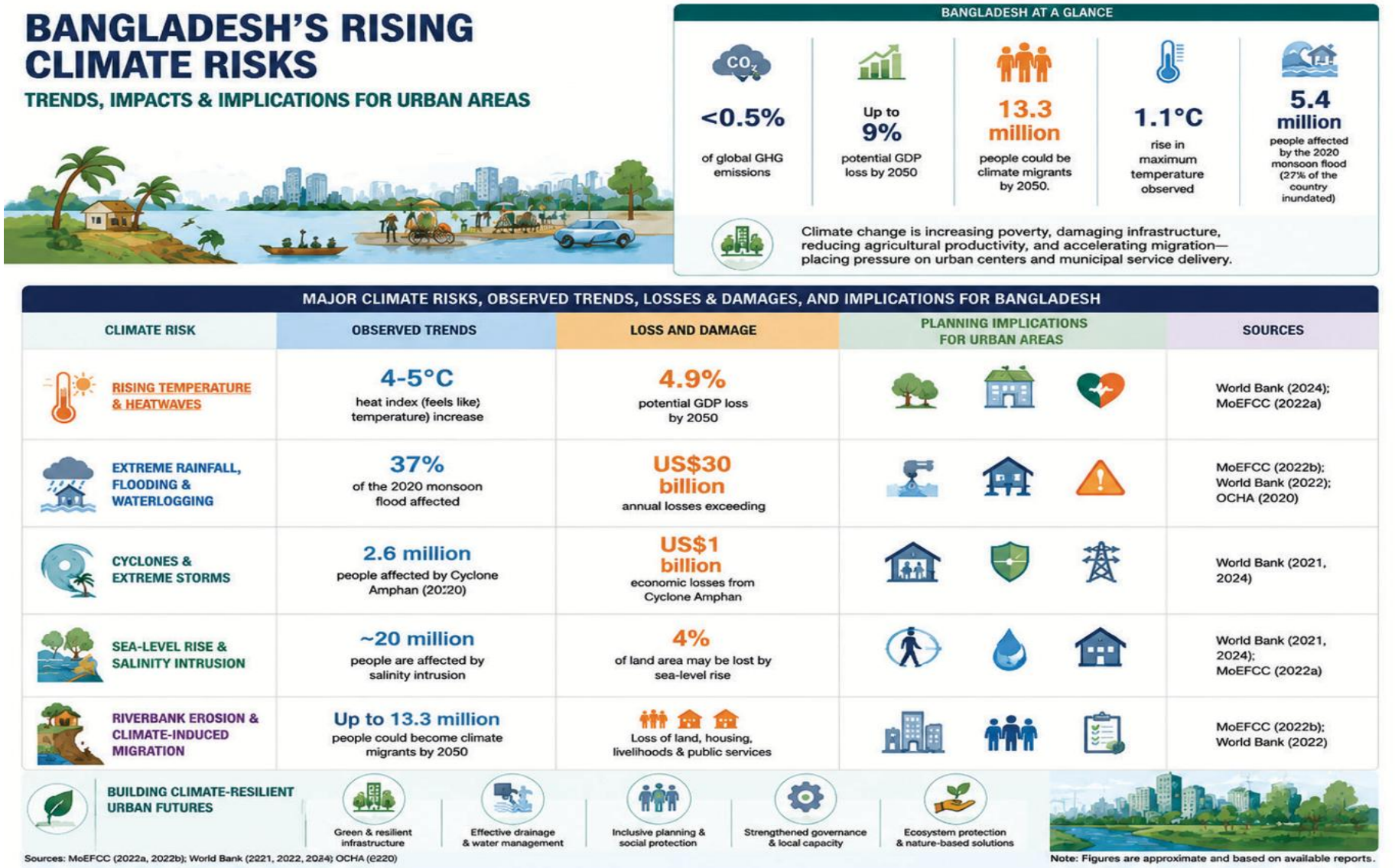


Figure 2: *Bangladesh's Climate Risks*

Table 1: Major Climate Risks, Observed Trends, Loss and Damage, and Implications for Bangladesh

Climate Risk	Observed Trends / Emerging Threats	Loss and Damage	Planning Implications for Urban Areas	Sources
Rising Temperature & Heatwaves	Maximum temperature has increased by 1.1°C, while the heat index ("feels like" temperature) has increased by 4.5°C. Heatwaves are becoming more frequent and prolonged, particularly in urban areas.	Heat stress alone could reduce GDP by 4.9% by 2030, resulting in annual losses exceeding US$30 billion, a 4.84% reduction in working hours, and the loss of approximately 3.83 million full-time jobs.	Urban heat action plans, green infrastructure, cool roofs, expansion of urban green spaces, and public health preparedness.	World Bank (2024); MoEFCC (2022a)
Extreme Rainfall, Flooding & Waterlogging	Heavy rainfall events have increased by approximately 12% since the 1980s; flooding has become more frequent and prolonged. The 2020 monsoon flood affected 5.4 million people and inundated 37% of Bangladesh.	Damage to settlements, roads, bridges, drainage, and public utilities; disruption of transport, commerce, education, healthcare. Severe floods could reduce national GDP by up to 9% under future climate scenarios.	Climate-resilient drainage, flood-resilient infrastructure, stormwater management, flood zoning, emergency preparedness.	MoEFCC (2022b); World Bank (2022); OCHA (2020)
Cyclones & Extreme Storms	Cyclones are intensifying due to rising sea surface temperatures. Cyclone Amphan (2020) affected 2.6 million people and caused losses exceeding US$130 million. Tropical cyclones currently cause average annual losses of approximately US$1 billion (~0.7% of GDP).	Damage to housing, coastal infrastructure, agriculture, power systems, livelihoods; prolonged disruption of economic activity.	Climate-resilient public infrastructure, disaster preparedness, emergency shelters, resilient utility services.	World Bank (2021, 2024)
Sea-Level Rise & Salinity Intrusion	Rising sea level and reduced river discharge continue to increase coastal salinity, shoreline erosion, and tidal flooding. Approximately 20 million people are affected by salinity intrusion.	Loss of agricultural productivity, freshwater scarcity, ecosystem degradation, declining food production, displacement of coastal populations. Sea-level rise may cause loss of 4% of land area, nearly 30% reduction in food production, and 1.49–3.02% annual GDP losses by 2031.	Increased migration to inland municipalities; greater demand for housing, water, sanitation, public services.	World Bank (2021, 2024); MoEFCC (2022a)
Riverbank Erosion & Climate-Induced Migration	River erosion, recurrent flooding, and declining agricultural productivity continue to displace rural populations. Up to 13.3 million people could become internal climate migrants by 2050.	Loss of land, housing, livelihoods, and public infrastructure; increasing pressure on urban settlements, employment, municipal services.	Climate-informed land-use planning, affordable housing, resilient infrastructure, inclusive urban development.	Rigaud et al. (2018); World Bank (2024)

Climate Risk	Observed Trends / Emerging Threats	Loss and Damage	Planning Implications for Urban Areas	Sources
Economic & Social Impacts	Climate change is increasingly affecting economic productivity, infrastructure, agriculture, and public health across Bangladesh.	Agricultural GDP could decline by nearly one-third by 2050. Climate adaptation investments of approximately US$12.5 billion (≈3% of GDP) required medium-term. Climate-related disasters may generate annual losses exceeding US$4 billion by 2030; habitat degradation and declining labour productivity could exceed US$50 billion annually.	Mainstream climate resilience into municipal investment, budgeting, infrastructure, service delivery.	World Bank (2024); MoEFCC (2022a)
Future Climate Risks	Climate projections indicate increasing frequency of compound climate events, heatwaves, flooding, extreme rainfall. Rising temperatures may increase lightning strikes by approximately 12% per 1°C increase.	By 2030, climate change could contribute to an additional 150,000 deaths annually and affect nearly 55 million people. Climate-related losses could reach 6.8% of GDP; more than 35 million people may be displaced by flooding by 2050.	Strengthen climate risk governance, resilient infrastructure, disaster preparedness, long-term adaptation planning.	MoEFCC (2022a); IPCC (2022); World Bank (2024)

1.2.2 Urban Climate Vulnerabilities in Bangladesh

Bangladesh's urbanization is proceeding faster than its urban infrastructure can absorb, and this mismatch is becoming one of the country's most consequential climate risk multipliers. By 2050, Bangladesh's urban population is projected to approach 50% by 2050 (World Bank, 2024). Much of this growth is occurring in secondary and district-level municipalities rather than in Dhaka alone, as improved road and bridge connectivity draws population and commercial activity outward from rural areas. This rapid and unplanned urban expansion is occurring on landscapes that were historically shaped by rivers, canals, floodplains, and wetlands, which traditionally absorbed monsoon rainfall and moderated flood peaks. As settlements and infrastructure encroach on these systems, cities face a worsening pattern of climate vulnerability, summarized in Table 2.

Table 2: Urban Climate Vulnerability Indicators in Bangladesh

Vulnerability Dimension	Key Statistic
Urbanization rate	Urban population accounts for approximately 40% of the total population (2023) and is growing at over 3% per year; projected to reach approximately 50% by 2050 (World Bank, 2024).
Floodplain exposure	Approximately 80% of Bangladesh's land area is floodplain; annual inundation affects 20–25% of national land area, rising above 60% in extreme years (Khan et al., 2024).
Wetland loss	Wetland loss of up to approximately 75% has been recorded over four decades in Bangladesh's large urban centers. The same trend is evident in smaller municipalities: Pabna Municipality, for instance, has lost approximately 50% of its wetlands since 1990, with its principal river, the Ichamoti, in continuing decline (World Bank, 2018).
Waterlogging	Urban areas experience recurring monsoon waterlogging, attributed to inadequate drainage capacity, siltation, and drainage encroachment (Rahaman et al., 2020). In Dhaka, approximately 35% of the metropolitan area is classified as highly or very highly vulnerable to waterlogging, with the south and south-western parts of the city being the most susceptible (Alam et al., 2023). In Khulna City, waterlogging has been recorded to inundate approximately 45% of paved roads, 77% of brick-soling roads, and 65% of unpaved roads at varying depths Rahman et al. (2009).
Scale of major flood events	The 2020 monsoon floods affected approximately 5.4 million people across 158 upazilas nationwide, leaving approximately 100,000 families waterlogged (Khan et al., 2024)
Urban heat index rise	The national heat index has risen by approximately 4.5°C, compared with a measured temperature rise of approximately 1.1°C (World Bank, 2024)
Pollution-linked mortality and GDP loss	Approximately 28% of deaths nationally are pollution-linked; environmental degradation is estimated to cost approximately 3.4% of GDP (approximately US$6.5 billion, 2015), affecting both large and small urban centers (World Bank, 2018)

1.3 National Strategies and Policy Responses to Climate Change

The Government of Bangladesh has taken proactive steps to address climate change through a comprehensive policy and planning framework, including:

Table 3: Key features of local-level climate action planning in Regulatory Frameworks of Bangladesh

National Documents	Key features of local-level climate action planning
National Urban Policy 2025	• Mandates climate-sensitive spatial planning for all urban areas, integrating flood risk, urban heat, climate-induced migration, and environmental sustainability into urban development planning. • Requires climate-resilient urban infrastructure through green infrastructure, renewable energy, energy-efficient buildings, and climate-adaptive roads, bridges, and utilities. • Promotes nature-based solutions, including urban greening, green corridors, urban forests, wetland conservation, and biodiversity protection to reduce climate risks and improve urban resilience. • Strengthens climate adaptation and disaster risk reduction through early warning systems, flood management, urban heat mitigation, and multi-hazard risk-sensitive spatial planning. • Establishes environmental and climate units in municipalities and promotes GIS-based planning, public participation, and performance monitoring for climate-resilient urban governance.
National Adaptation Plan of Bangladesh (2023-2050)	• Development of climate action plans for urban and peri-urban areas with an investment budget of BDT 4 billion, prioritizing resilience of vulnerable populations, including the urban poor and climate migrants. • Implementation of risk management measures for thunderstorms and lightning in high-risk areas. • Promotion of climate-resilient, inclusive (gender-, age-, and disability-sensitive) WASH technologies and facilities. • Enhancement of urban access to water, sanitation, and hygiene services to reduce exposure to flooding and waterborne diseases during extreme weather events.
Bangladesh Delta Plan 2100	• Recognizes urban areas as critical climate hotspots with an investment budget of USD 8 billion, particularly vulnerable to flooding, heat stress, and infrastructure strain due to rapid urbanization and climate change. • Appropriate action plan for removing waterlogging in urban areas • Categorization of wastes into e-waste, hospital wastes, and others, with separate, effective waste management plans. • Community engagement and local knowledge in developing and implementing climate adaptation strategies, ensuring that interventions are context-specific and inclusive. • Strengthening local governance and institutional frameworks to effectively plan, implement, and monitor climate adaptation measures in urban settings.

National Documents	Key features of local-level climate action planning
Mujib Climate Prosperity Plan (MCPP) 2022–2041	• Promotes locally led adaptation (LLA) by empowering communities with decision-making authority and long-term financial support. • Establishes a dedicated funding window for local adaptation through the Ministry of Local Government, Rural Development and Cooperatives in collaboration with the Ministry of Planning and Ministry of Finance. • Mainstreams climate change into local development planning to address poverty, inequality, and climate vulnerability simultaneously. • Prioritizes inclusive climate governance, ensuring preferential support for women, youth, persons with disabilities, and climate-displaced populations in local adaptation initiatives. • Integrates climate risk into national and local plans, promoting climate-resilient agriculture, infrastructure, and development pathways. • Encourages a whole-of-government and whole-of-society approach, involving local governments, civil society, academia, and the private sector in climate resilience planning and implementation. • Supports locally led adaptation hubs to strengthen resilience and reduce climate-induced displacement.
Bangladesh's Third Nationally Determined Contribution (NDC 3.0) 2025	• Integration of climate mitigation into city development plans, strengthening local government capacity for low-carbon urban planning, and aligning zoning, building codes, and infrastructure with emission reduction goals. • Implementation of integrated solid waste and fecal sludge management at the city level (establishment of 26 integrated landfills and resource recovery facilities and 6 sewage treatment plants) • Sustainable waste management practices, including source segregation, composting/anaerobic digestion, landfill gas capture, e-waste management; • workforce training, job creation through repair, reuse, and recycling hubs; and formalization of waste pickers with PPE, contracts, and health coverage.
Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009	• Mainstream climate change adaptation and disaster risk reduction into local development planning and sectoral activities. • Strengthen climate-resilient infrastructure, including urban drainage, flood protection, water supply, sanitation, and cyclone/flood-resilient public facilities. • Strengthen the institutional and technical capacity of local government institutions for climate change planning, implementation, and disaster management. • Promote community-based adaptation and participation of local communities in climate risk reduction and resilience-building initiatives. • Improve climate information, research, knowledge management, and early warning systems to support local decision-making and adaptation planning.
Perspective Plan of Bangladesh 2021-2041	• Green areas in Dhaka and major cities to reach 5–12 m^2 per capita, 100 % of cities flood-free with proper drainage, and PM 2.5 reduced from 86 µg/m^3 to 10 µg/m^3. • Emphasis on sustainable city planning, decentralized governance, and integration of geo-spatial data (e.g., urban heat-mapping and land-use zoning). • Urban development must integrate environmental management and climate resilience to reduce urban heat, flooding, and pollution.
8th Five-Year Plan of Bangladesh (2021–2025)	• By 2030, cities should adopt integrated urban policies focusing on resource efficiency, mitigation and adaptation to climate change, and disaster resilience, aligned with New Urban Agenda (NUA) and SDG-11. • Integrate climate change risk management into urban planning and governance. • Strengthen local institutions for urban climate and disaster risk management and build municipal–community partnerships to improve services and neighborhood resilience

1.4 Local Level Climate Action

National climate policies and strategic frameworks in Bangladesh have advanced considerably in recent years, yet a persistent gap remains at the point where these policies must actually take effect: the municipality. Towns and cities sit at the frontline of climate change, absorbing its impacts directly through recurring urban flooding, intensifying heat stress, strained infrastructure, and rising public health risks. Municipal institutions, however, are frequently constrained by limited technical capacity, thin budgets, and a shortage of localized data, which makes it difficult to convert national-level priorities into concrete, ground-level interventions.

A Municipal Climate Action Plan (MCAP) is designed to close this gap. By grounding planning in ward-level vulnerability assessments, it gives municipalities a structured, evidence-based way to identify where climate risks are concentrated, decide what to prioritize, and design interventions that respond to the needs that matter most locally. Beyond being a planning document, the MCAP functions as a living data source that feeds directly into master plans, local development plans, and municipal budget allocations.

Just as importantly, the MCAP is built around community engagement rather than imposed from above. Involving residents and local stakeholders in shaping the plan keeps it grounded in local realities and builds the buy-in needed for lasting implementation. By linking municipal action to national climate strategy, the MCAP strengthens institutional capacity, sharpens resource allocation, and moves cities toward resilient, low-carbon development.

1.5 Preparation of Municipal Climate Action Plan

The Climate Action Plan (CAP) for Munshiganj Municipality was developed through a structured and participatory process built on local data and direct engagement with residents. Municipal officials and community members, including groups often left out of planning processes, were involved at every stage to ensure the plan reflects real local priorities rather than assumptions made from a distance. Figure 3 illustrates the full cycle: the first four stages cover preparation of the plan, from local engagement through to selecting priority projects, while the remaining four stages carry it into implementation, financing, execution, and ongoing review. The preparation phase itself unfolds across five steps, described below and summarized visually in the figure 3.

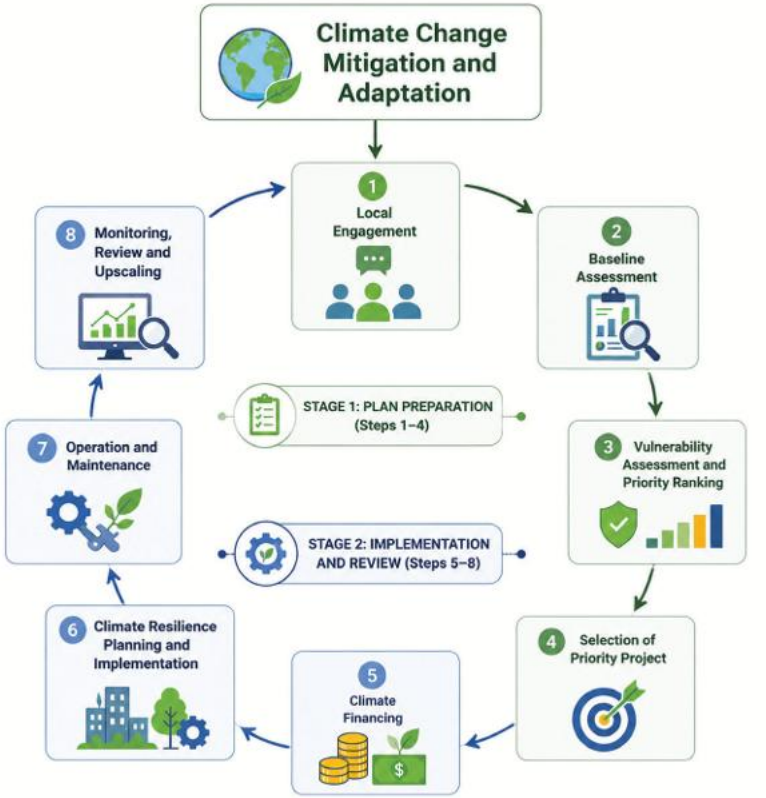


Figure 3: *Development of Local Level Climate Action Plan*

Step 1: Orientation with the Municipal Authority

The process began with an orientation session bringing together Munshiganj Municipal officials and Waste Concern to introduce the concept and purpose of the Climate Action Plan. The discussion connected climate risks at the national scale to their local consequences, making the case for coordinated local action, community involvement, and inclusive planning from the outset. It also set out the CAP's scope and objectives, laying the groundwork for the municipality's commitment and its technical partnership with Waste Concern going forward.

Step 2: Data Collection

A combination of secondary and primary data collection was used to build a complete picture of Munshiganj's climatic, environmental, and socio-economic conditions.

- **Secondary data:** drawn from institutional sources including the Munshiganj Municipality Master Plan, and BBS reports, supplemented with Landsat satellite imagery to track how land use and extreme weather patterns have shifted over time.
- **Primary data:** gathered through town-level stakeholder consultations that surfaced Munshiganj-specific climate concerns, followed by a structured questionnaire survey with 360 individual respondents across the nine wards of Munshiganj Municipality. An equal allocation method was applied, with 40 respondents selected from each ward, ensuring consistent ward-level representation.

Step 3: Data Analysis

The data collected was analyzed at both the ward and municipal level to understand current conditions, assessing how vulnerability varies across wards.

- **Vulnerability assessment from secondary data:** GIS-based analysis of satellite imagery revealed spatial patterns in extreme weather exposure and land use change, making it possible to compare risk levels across wards and identify where exposure is highest.
- **Vulnerability assessment from primary data:** community perceptions added a human dimension to the spatial findings. The assessment used the HIGS framework — covering Hazard, Infrastructure, Governance, and Socio-economic dimensions — adapted from the city-scale model originally developed by the Integrated Research and Action for Development (IRADe) and scaled down here to capture vulnerability at the ward level.

Step 4: Prioritizing Vulnerable Wards and Urban Systems

With the vulnerability findings in hand, wards and critical urban systems were ranked by their level of risk. This step turned the analysis into direction — clarifying where intervention is most urgently needed and which actions should come first, so that limited resources are channeled toward the communities and sectors facing the greatest exposure.

Step 5: Recommendations and the CAP Implementation Pathway

The final step translated community input and local analysis into a concrete set of recommendations spanning both mitigation and adaptation. Rather than restating national policy in the abstract, the CAP sets out actionable measures suited to Munshiganj's specific conditions, giving the municipality a practical route toward building climate resilience and embedding sustainable practices into everyday governance and service delivery.

1.6 Implication of Municipal Climate Action Plan

The Climate Action Plan gives Munshiganj Municipality a concrete, actionable roadmap for reducing climate vulnerability across all its wards. Because it combines ward-level vulnerability data with insights gathered directly from residents, the interventions it recommends are targeted and grounded in local evidence rather than generic assumptions — turning national climate policy into practical action on the ground.

Beyond the immediate interventions it recommends, the CAP strengthens the municipality's underlying capacity to plan, govern, and monitor its own climate response, while keeping the process inclusive enough that the most vulnerable residents remain protected rather than overlooked. By steering investment toward resilient infrastructure, disaster risk reduction, and improved urban services, it positions Munshiganj for sustainable, climate-resilient growth over the long term — and, in doing so, offers a working model that other municipalities can adapt for their own planning.

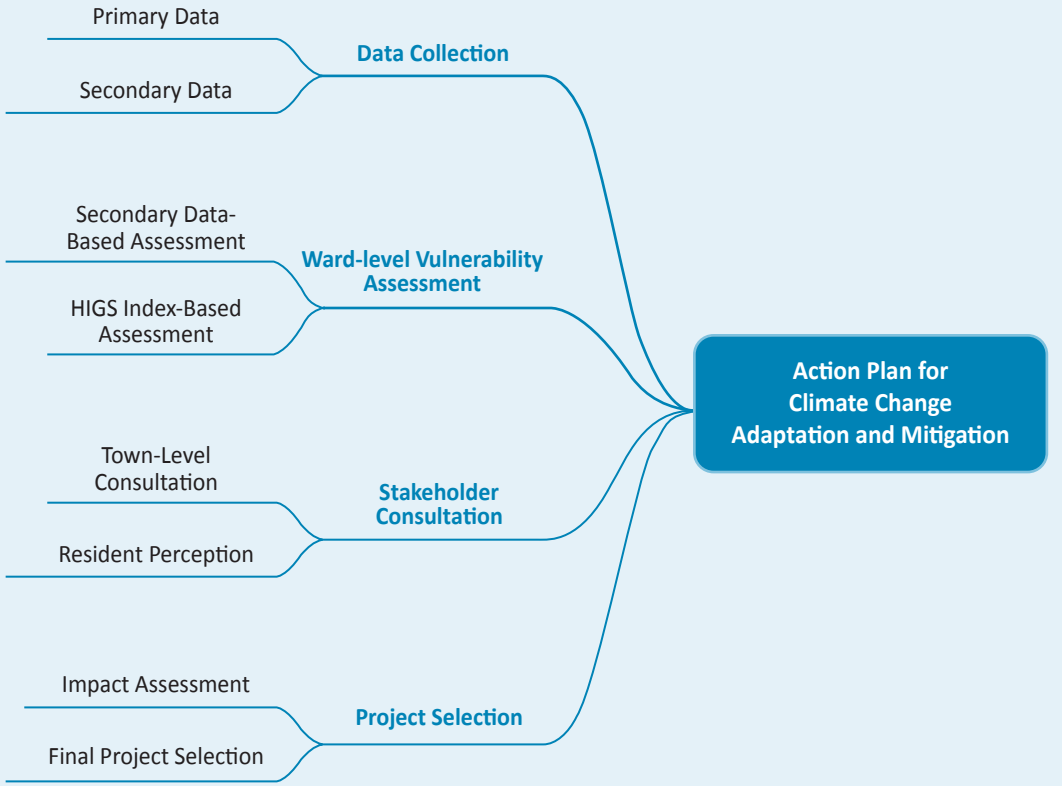


Figure 4: *Methodology of Climate Action Plan (CAP) Development*

02. PROFILE OF MUNSHIGANJ MUNICIPALITY

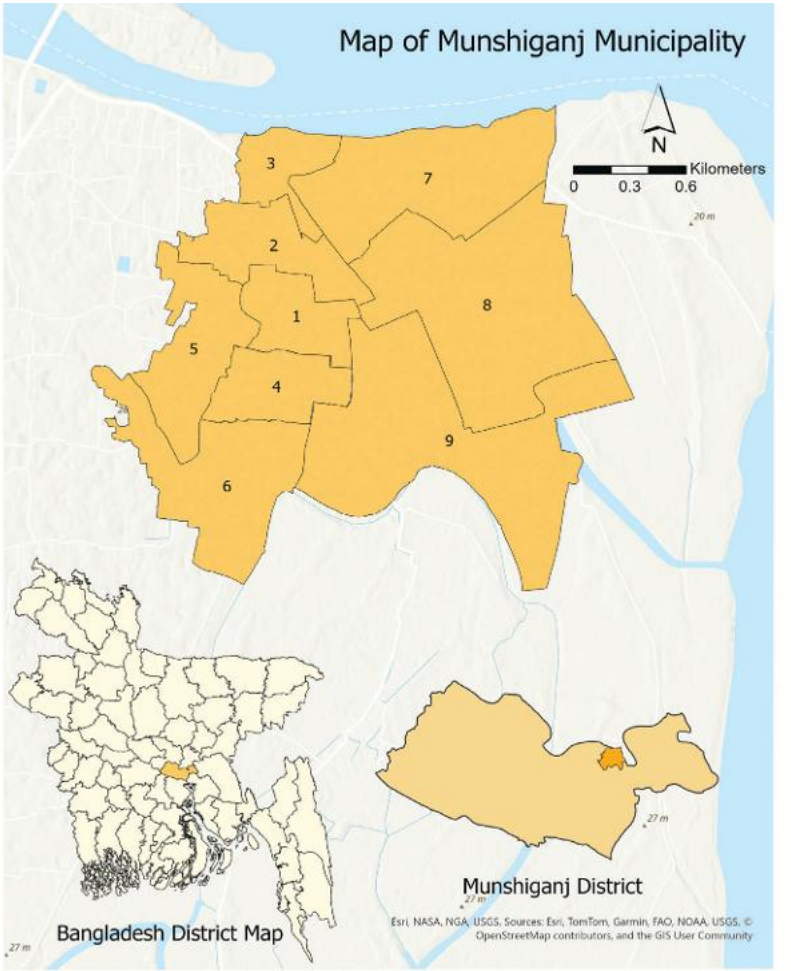
2.1 Establishment of the Municipality

Munshiganj Municipality is the administrative and urban centre of Munshiganj District, located in the historic Bikrampur region of central Bangladesh. This area was originally a village named Idrakpur; local tradition holds that during the Mughal period, an official named Munshi Haydar Hossain, who served as a faujdar (local administrator), was well regarded for his benevolence, and the village was subsequently renamed *Munshiganj* in his honour. Munshiganj was elevated to a thana and sub-division (Munshiganj Mohakuma) in 1945 for administrative convenience under British India, with the sub-division formally created in 1947 under Dhaka district. It was upgraded to a full district on 1 March 1984.

Munshiganj Municipality itself was established by gazette notification on 22 January 1972 as a Class B municipality comprising 3 wards. It was subsequently upgraded to a Class A municipality on 21 July 1993 and reorganised into 9 wards, the structure that continues today (Map 1).

2.2 Location, Area, and Boundary

Munshiganj Municipality lies between approximately 23°23′–23°35′ north latitude and 90°28′–90°35′ east longitude. It sits on the bank of the Meghna River, with the Dhaleshwari River forming part of its northern edge, and several smaller khals (canals) running through the town. The town is a flood-prone, low-lying floodplain area. The gazetted area of Munshiganj Municipality is 10.85 square kilometres. However, the IUGIP land-use survey calculated a planning area of 12.93 km² after excluding river-overlap areas.



Map 1: *Location Map of Munshiganj Municipality*

Munshiganj Municipality is bounded by the Dhaleshwari River along with Narayanganj Sadar, Bandar, and Sonargaon upazilas to the north. To the south, it is bordered by Mahakhali and Char Keowar unions, as well as Bhedarganj and Naria upazilas. The eastern boundary extends along the extended part of the Meghna River, adjacent to Gazaria and Matlab Uttar upazilas. To the west, the municipality is bounded by Panchsar union and the upazilas of Tongibari and Naria.

2.3 Administrative and Institutional Capacity

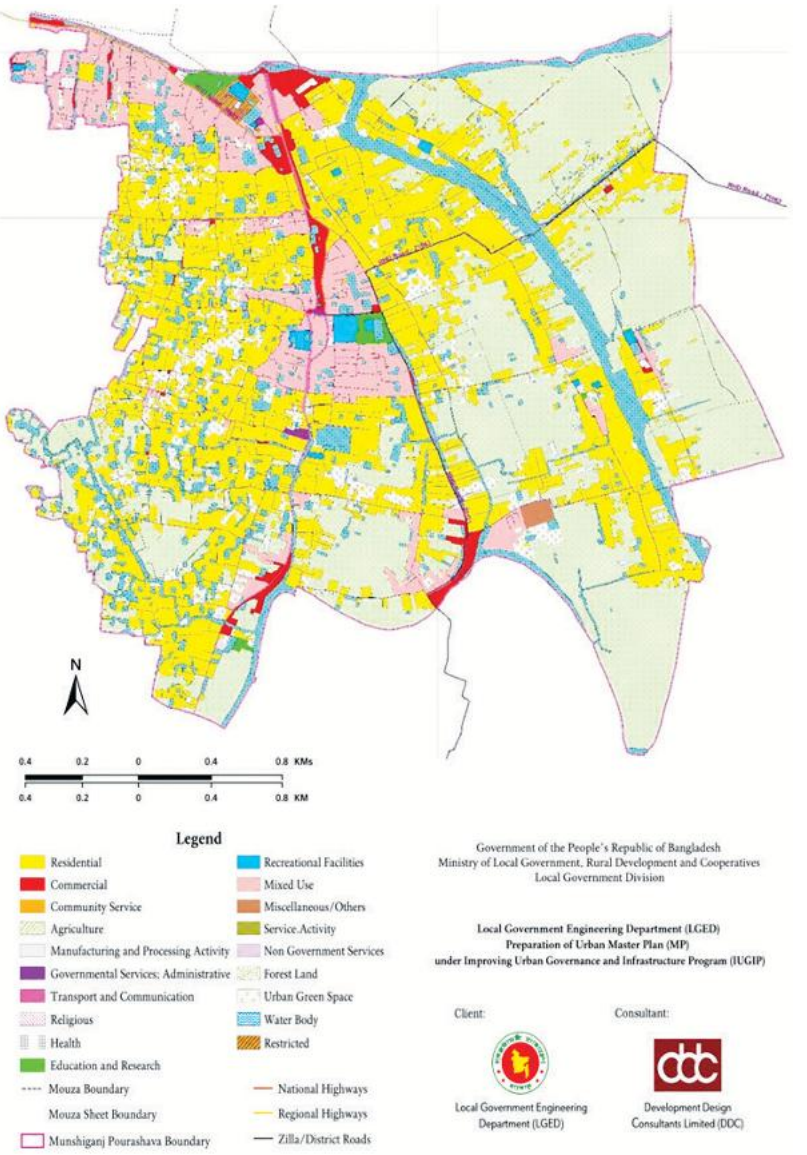
As an "A"-category Municipality under Section 72 of the Municipality Act 2009, Munshiganj has an approved organogram of 160 officers and staff across the Engineering, Administration, Health/Family Planning/Conservancy, Assessment, Tax Collection/Licensing and Water Supply sections; only 69 of these posts were filled as of the latest establishment record, leaving 91 vacancies. Key sanctioned/ filled positions include 1 Chief Executive Officer (vacant), 1 Secretary, 1 Executive Engineer, and conservancy staff comprising 77 conservancy (cleaning) labourers and 48 sweepers against the approved strength.

2.4 Transportation and Connectivity

2.4.1 Transportation System

Road Network: Munshiganj Municipality has a well-established road network consisting of approximately 123.60 km of roads. Based on road surface condition, the network is mainly categorized into pucca and semi-pucca roads. Around 49.43 km (39.99%) of roads are pucca, while 74.17 km (60.01%) are semi-pucca roads. Ward-wise road distribution shows variation in road availability and quality. The municipality has several important transport structures supporting road connectivity, including 12 pucca bridges, 30 pucca culverts, 24 RCC pipe culverts, and 2 wooden bridges. However, pedestrian facilities remain inadequate; dedicated footpath facilities are largely absent, creating challenges for pedestrian safety and urban mobility.

Waterway Transportation: Due to its riverine location, Munshiganj has significant potential for water-based transportation. The municipality is influenced by major



Map 2: *Land Use Map of Munshiganj Municipality*

waterways including the Dhaleshwari River and Dhaleshwari River Branch-1, along with numerous canals and water bodies. Munshiganj District has several launch and steamer terminals that provide connections through waterways. The district-level transportation system benefits from river routes connecting Dhaka and other regions. However, within the Municipality area, water transport facilities require further improvement for better integration with land-based transport networks.

Railway Transportation: Railway connectivity in Munshiganj Municipality is limited compared to road and water transport systems. The municipality does not have a major operational railway station within the urban area. Therefore, residents primarily depend on road and water-based transport for regional and inter-city travel.

2.4.2 National and Regional Connectivity

Munshiganj Municipality lies about 26 km south of Dhaka's Zero Point by direct road and roughly 43.2 km from Dhaka via the Bondor–Modonpur Highway (R113), a journey of about 1–2 hours. It is about 25.2 km from Narayanganj, 80.6 km from both Madaripur and Shariatpur, and 126.4 km from Faridpur. Frequent bus services connect Munshiganj to Dhaka's Gulistan, Sayedabad and Jatrabari every 10–15 minutes, and small launches operate between Munshiganj and Dhaka's Sadarghat. The major regional road connections include the Muktarpur Bridge–Munshiganj Road (RHD-R813) and the Loharpool–Munshiganj Road. The R813 road provides an important connection between Munshiganj and Dhaka through Muktarpur Bridge and links with R812, while Loharpool–Munshiganj Road connects the main urban area with the regional road network.



2.5 Land Use Pattern

According to the Existing Land Use Survey (2025) carried out for the Urban Master Plan under IUGIP, Munshiganj Municipality's land uses are classified into nineteen broad categories. Agriculture remains the single largest land use, covering 36.11 percent of the total municipal area, followed by Residential use at 31.31 percent. Water bodies occupy a substantial 11.57 percent of the Municipality, while Mixed Use (combined residential-commercial) accounts for 8.39 percent. Despite its status as a municipal/urban area, the overall land-use character remains predominantly rural-agricultural, reflecting a slow and still-ongoing rural-to-urban transition centered around the older urban core.

Table 4 presents the percentage share of key land-use categories (agriculture, residential, mixed use, open space, waterbodies, commercial, and transport) within the total area of each ward in Munshiganj Municipality. A clear core–periphery pattern emerges from the ward-wise land-use pattern. The oldest and most built-up wards — Ward 1 (41.0% mixed use), Ward 2 (53.4% residential), and Ward 3 (40.6% mixed use) — form compact commercial and administrative core, where agricultural land is at or near zero. Ward 4 and Ward 5 represent a transitional zone, remaining majority-residential (63.2% and 46.8%, respectively) while retaining meaningful shares of water bodies and open space. Wards 6 through 9, which together account for nearly 68 percent of the Municipality's total land area, remain agriculture-dominant, with agricultural land ranging from 34 to 57 percent. This indicates that urban growth is gradually expanding outward from the core toward these peri-urban wards.

Table 4: Ward-wise Land Use Percentage (Key Categories)

Ward	Agriculture (%)	Residential (%)	Mixed Use (%)	Open Space (%)	Waterbodies (%)	Commercial (%)	Transport (%)
1	–	26.8	41.1	7.1	8.9	–	5.4
2	3.3	53.8	15.4	7.7	8.8	3.3	6.6
3	–	16.4	40.9	6.4	14.5	7.3	7.3
4	4.8	63.5	1.6	6.3	17.5	–	4.8
5	15.3	46.9	–	18.4	16.3	–	3.1
6	33.6	34.2	3.4	6.2	17.8	2.1	2.1
7	53.4	28.4	–	2.3	13.1	–	1.7
8	52.3	29.9	–	1.9	9.5	–	1.5
9	57.5	20.2	–	5.6	7.3	1.4	1.7

Source: Calculated from Urban Master Plan, IUGIP, Munshiganj Municipality, 2025

2.6 Demographic Features

Munshiganj Municipality is divided into 9 wards (Map 1). According to Population and Housing Census 2022, Bangladesh Bureau of Statistics (BBS), this municipality has a total population of 93,120 across 22,491 households.

Population distribution across the municipality is markedly uneven, with a clear concentration of residents in the small, centrally located wards (1-3) and a more dispersed pattern in the larger, peripheral wards (7-9).

Ward 2 is the most densely populated ward, accounting for approximately 16.6 percent of the total 2022 population within only 4.6 percent of the total land area. Ward 1 shows a similarly high density per square kilometers. Both wards lie within the older urban core, which has been built up over a long period. In contrast, the larger peripheral wards—Wards 6 to 9—remain considerably less densely populated. This difference reflects the greater share of open and agricultural land still present in these wards, which have not yet undergone extensive urban development.

In terms of growth rate, Ward 4 recorded the highest annual growth rate (3.6 percent), followed by Ward 2 (3.3 percent) and Ward 6 (3.0 percent), while Ward 3 (1.2 percent) and Ward 7 (1.5 percent) recorded the lowest growth rates. This suggests that although the urban core continues to grow steadily, some peripheral wards—particularly Ward 6—are urbanizing relatively quickly despite their current low density. Finally, the population shows near gender balance, with a sex ratio of 99 males per 100 females (46,303 males and 46,815 females in 2022).

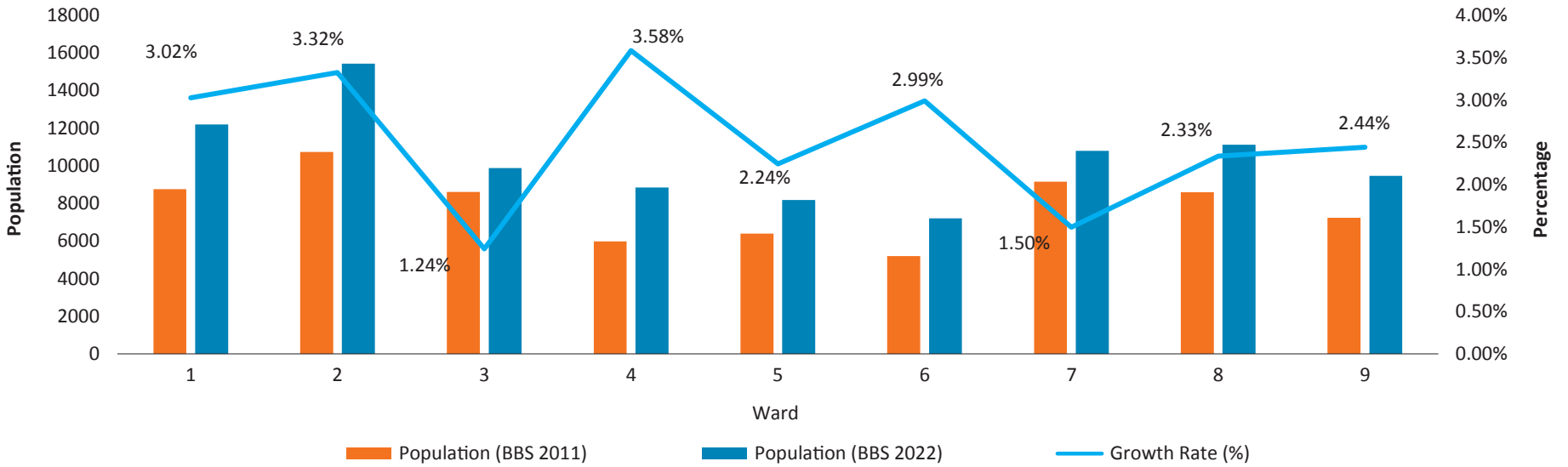


Figure 5: *Ward-wise Population Distribution and Growth Rate*

2.7 Socio-economic Characteristics

2.7.1 Employment

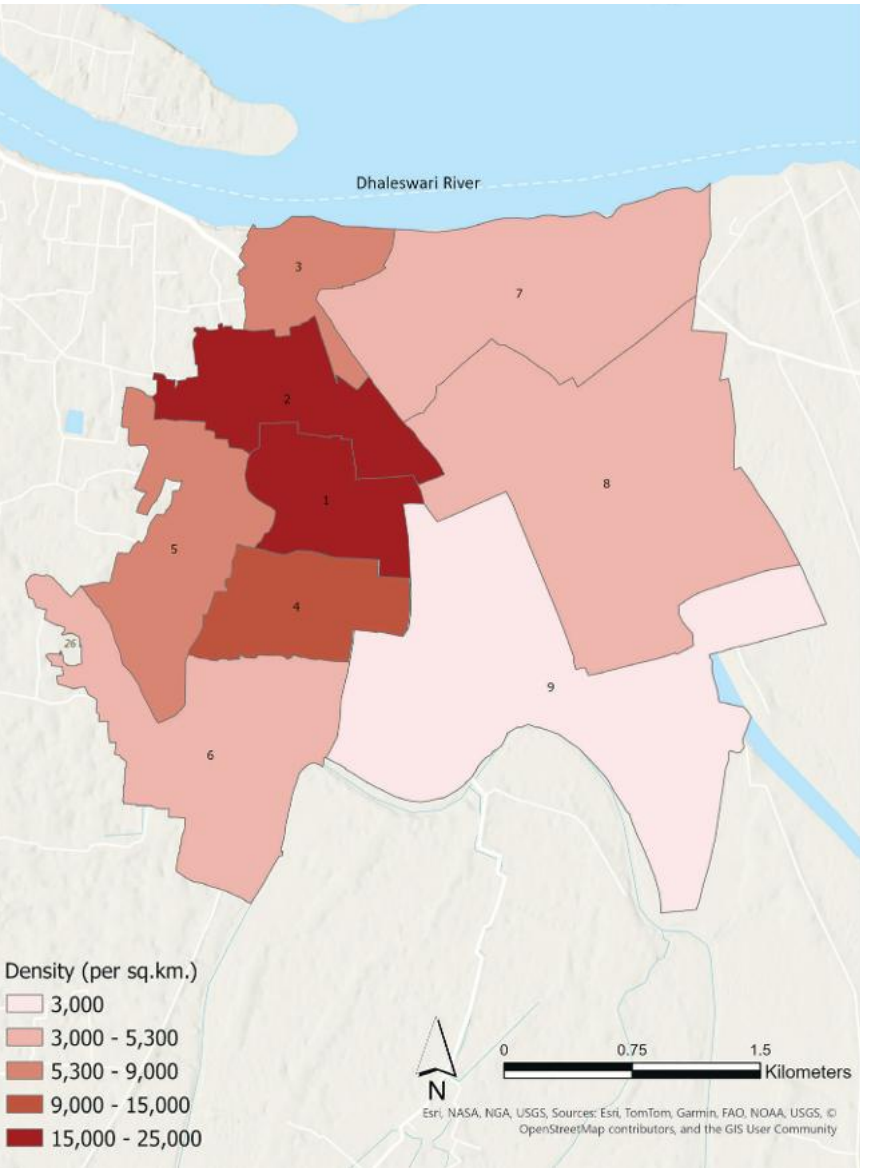
According to Population and Housing Census, BBS, 2022, approximately 31.2 percent of Munshiganj Municipality's population aged 5 years and above (26,533 of roughly 85,000 persons) is employed, while about 37.7 percent (35,109 persons) are not engaged in any work, including students, homemakers, and dependents — indicating a sizable inactive group. Among the employed, the service sector dominates (81.76%, 21,694 persons), followed by industry (10.50%, 2,786 persons) and agriculture (7.74%, 2,053 persons). At the ward level, the service sector remains dominant throughout, though its share varies from 70.88 percent (Ward 8) to 86.88 percent (Ward 4). Agricultural employment, though marginal overall, is comparatively higher in the peripheral Wards 8 (21.49%) and 9 (14.82%), consistent with their more rural land-use character.

2.7.2 Literacy

The literacy rate among the population aged 7 years and above was 81.82% in Munshiganj Municipality. Ward 2 recorded the highest literacy rate at 91.67%, while Ward 8 recorded the lowest at 70.67% (BBS, Population and Housing Census 2022).

2.7.3 Poverty

Based on the World Bank's international poverty line of US$3.00 per person per day (approximately equivalent to a monthly household income of less than BDT 10,000), findings from Socio-economic Survey, Urban Master Plan 2025, IUGIP, indicate that 1.33 percent of households in Munshiganj Municipality fall below this threshold. This represents a relatively favorable outcome in comparison with the incidence of poverty recorded in numerous other municipalities across Bangladesh.



Map 3: *Population Density Map of Munshiganj Municipality*

2.8 Local Government Bodies

Functions and Responsibilities: Under the Local Government (Municipality) Act, 2009, Munshiganj Municipality (A class municipality) is responsible for core municipal services — road network, water supply and sewerage, solid waste management, tax assessment and collection, public health/sanitation, and civic registration. DPHE provides technical support for water supply and sanitation, and LGED supports road/drainage infrastructure, similar to the arrangement seen in other Municipalities.

Elected Personnel, Structure and Staff: The Municipal Council structure provides for 1 Mayor, 9 general ward councilors, and 3 reserved-seat (women) councilors — 13 elected members in total. The Chief Executive Officer (CEO)/Paura Nirbahi Officer serves as the administrative head under the Mayor.

As of late 2024, the Mayor was removed from office (order dated 18 August 2024) and an Administrator was appointed in his place; subsequently the ward councilors were also removed (26 September 2024). Following the Council's monthly meeting decision of October 2024, an inter-committee arrangement involving government officers was formed to support the Administrator in day-to-day functions, and the Town Level Coordination Committee, Ward Committees, and Standing Committees were all re-constituted in November 2024 under this arrangement.

Table 5: Organizational Structure of Munshiganj Municipality

Division	Key Saections	Sanctioned Posts	Filled	Vacant
General Administration Division	General, Accounts, Tax Assessment, Tax Collection/License, Municipal Bazar, Education & Culture	59	22	37
Engineering Division	Water Supply & Sewerage; Civil/ Electrical/Mechanical (Works)	68	30	38
Health, Family Planning & Sanitation Division	Sanitation, Health & Family Planning	33	17	16
Total		**160**	**69**	**91**

Committees: In line with the Local Government (Municipality) Act 2009, Munshiganj Municipality has one Town Level Coordination Committee (TLCC), 9 Ward Committees (WCs), and 14 Standing Committees (SCs) - 10 core statutory committees plus 4 additional committees formed under Section 55(2). All were re-constituted in November 2024.

Town Level Coordination Committee (TLCC)

The TLCC is chaired by the Administrator (currently the Deputy Director, Local Government, Munshiganj), with the CEO of the Municipality serving as Member Secretary. It has 40 members, drawn from:

Table 6: Town Level Coordination Committee (TLCC) of Munshiganj Municipality

Member Category	Approx. Representation
Chairperson	Administrator (Deputy Director, Local Government)
Government line-department officers (education, health, engineering/LGED/DPHE, women affairs, agriculture, public works, cooperatives, youth, fisheries, information, etc.)	18 members
Councilor-designated ward representatives (govt. officers acting on behalf of Wards 1–9)	9 members
Professional bodies / civil society / academia representatives	5 members
Low-income group representatives	7 members
Municipality officials (CEO, Executive Engineer, Accounts Officer, Town Planner, Assistant Engineers, Conservancy Inspector)	Members
Member Secretary	CEO, Munshiganj Municipality

Per its Terms of Reference, the TLCC is tasked with promoting citizen participation in planning, overseeing overall development-plan progress, discussing tax assessment/collection, reviewing service delivery, and monitoring the work of Standing Committees; it is required to meet once every three months.

Ward Committees (WCs)

There are 9 Ward Committees (Wards 1–9), each with 9 members. Under the current administrator-led arrangement, each WC is chaired by a designated government officer (rather than an elected Ward Councilor, since councilors have been removed), with a Municipality Assistant Engineer typically serving as Member Secretary.

Each WC's members are drawn from urban poor representatives, civil society representatives, and professional-body representatives (2 each), alongside the chair and member-secretary. Their ToR covers reviewing ward-level infrastructure/development progress, birth-death registration, streetlighting and water-source planning, sanitation and tree-plantation awareness, social safety-net beneficiary lists, and disaster response support — with a mandate to convene at least once every three months, ideally inviting approximately 150 local notables to discuss ward performance.

Standing Committees (SCs)

Ten core Standing Committees are constituted under Section 55(1) of the Act, each for a two-and-a-half-year term:

Table 7: Standing Committees (SCs) of Munshiganj Municipality

Standing Committee	Chairperson	Member Secretary
(a) Establishment & Finance	District Primary Education Officer	CEO
(b) Tax Assessment & Collection	District Education Officer	CEO
(c) Accounts & Audit	District Education Officer	Accounts Officer
(d) Town Planning, Civic Services & Development	Executive Engineer, Public Works	Town Planner
(e) Law & Order and Public Safety	Administrator (Dy. Director, Local Govt.)	CEO

Standing Committee	Chairperson	Member Secretary
(f) Communication & Physical Infrastructure	Executive Engineer, LGED	Executive Engineer, Municipality
(g) Women & Children's Affairs	Dy. Director, Women Affairs	Town Planner
(h) Fisheries & Livestock	Dy. Director, Agriculture Extension	Sanitary Inspector
(i) Information & Culture	District Primary Education Officer	Office Assistant
(j) Market Price Monitoring & Control	Dy. Director, Agriculture Extension	Sanitary Inspector

Additional Committee	Chairperson	Member Secretary
(a) Health, Water & Sanitation	Executive Engineer, DPHE	Civil Surgeon
(b) Poverty Alleviation & Slum Development	Dy. Director, Women Affairs	Town Planner
(c) Waste Disposal & Transfer	Civil Surgeon	Conservancy Inspector
(d) Disaster Management	Civil Surgeon	Assistant Engineer

2.9 Baseline Condition

2.9.1 Water Supply

Munshiganj Municipality does not have a comprehensive piped water supply network covering all households; the majority of residents depend on their own house pumps and tubewells. Access to piped supply varies considerably by ward.

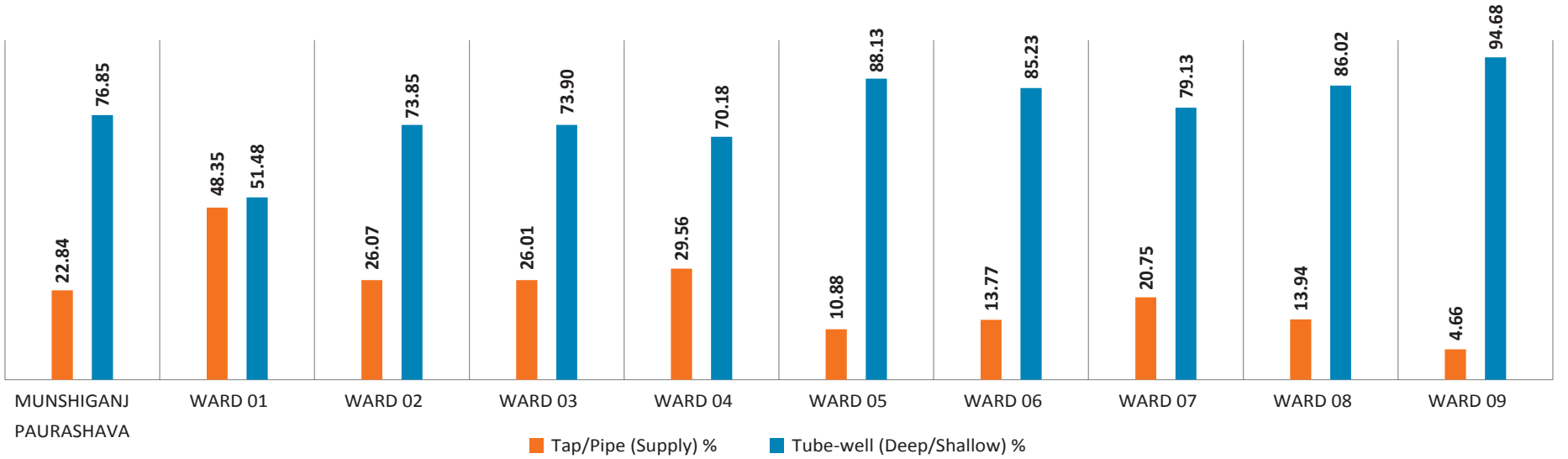


Figure 6: *Ward-wise Water Supply Source (% of Households)*

Across the municipality as a whole, only 22.84 percent of households use tap or pipe supply, while 76.85 percent depend on tubewells. Ward 01 stands out with the highest reliance on piped water at 48.35 percent, whereas Ward 09 is almost entirely dependent on tubewells, with piped supply reaching only 4.66 percent of households. Wards 05, 06, and 08 similarly show heavy tubewell dependence (above 85 percent each), underscoring the uneven distribution of the municipality's limited piped network and the continued reliance on private and hand tubewells across most of the town.

2.9.2 Sanitation and Wastewater

Sanitation: Sanitation coverage in Munshiganj Municipality is comparatively high, although notable differences exist among wards. According to BBS Census 2022 data, 83.03% of households use flushing or pouring-water systems with safe disposal, while 9.95% use slab, ventilated improved, or composting latrines. Combining these categories, 92.98% of households have improved or safe sanitation. Unsafe flushing systems and pit latrines without slabs account for 6.90%, while hanging latrines and open defecation or absence of a latrine account for only 0.13%. Open defecation alone is reported for 0.02% of households, indicating that it is negligible across the municipality.

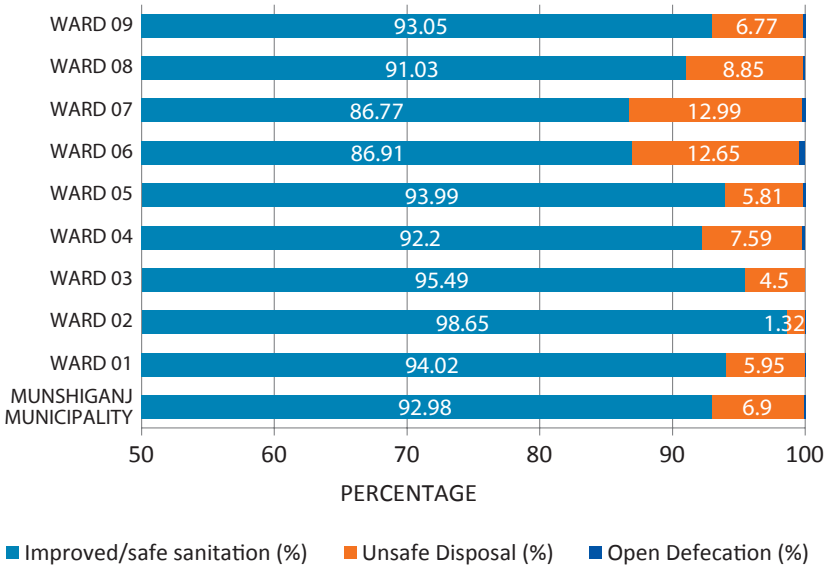


Figure 7: *Ward-wise Sanitation and Waste Disposal Status*

Figure 7 presents three combined categories. "Improved/Safe Sanitation" combines safe flushing or pouring-water systems with slab, ventilated improved, and composting latrines. "Unsafe Sanitation Disposal" combines unsafe flushing or pouring-water systems with pit latrines without slabs. The final category combines hanging latrines with open defecation or absence of a latrine.

At the ward level, Ward 2 has the highest improved or safe sanitation coverage at 98.65%, followed by Ward 5 at 93.99% and Ward 1 at 94.02%. Ward 7 records the lowest coverage at 86.77%, followed by Ward 6 at 86.91%. Unsafe sanitation disposal is highest in Ward 7 at 12.99% and Ward 6 at 12.65%. Ward 6 also records the highest combined proportion of hanging latrines and open defecation or no-latrine cases at 0.43%. However, open defecation alone remains extremely low, reaching its highest ward-level value of only 0.12% in Ward 6 (BBS, Table C-16, 2022).

Public Toilet: public toilet provision remains a significant deficiency across the municipality. Although municipal records enumerate three public toilets, those are in poor condition and not properly functional.

Wastewater: Septic tanks constitute the predominant method of household waste disposal, employed by 61.6 percent of households, followed by disposal into designated pits or holes (18.6 percent). A meaningful proportion of households, however, continue to discharge waste directly into adjacent canals (9.3 percent) or rivers (7.5 percent), indicating that a portion of household waste bypasses on-site treatment altogether (Draft Urban Master Plan Survey Report (IUGIP), 2025).

Munshiganj Municipality currently has no centralized fecal sludge management facility either operational or planned. Consequently, the treatment and disposal of septic and pit waste remain confined to household-level, largely manual practices, with no institutional mechanism in place for the safe, centralized processing of sludge — underscoring a key infrastructure gap for future intervention.

2.9.3 Drainage

Munshiganj Municipality's drainage network totals approximately 32 km of primary/secondary/tertiary pucca drains, along with the same 14 km of RCC pipe drains and 2 km of earthen drains. The drainage pattern of Munshiganj Municipality shows a mixed dependency on both formal and natural drainage systems. Drains are the most common drainage outlet (27.42%), followed by canals (24.98%) and ponds (19.73%) (Figure 8). Ward 2 has the highest reliance on formal drains, while wards such as Ward 6, Ward 8, and Ward 9 show greater dependence on natural drainage pathways, increasing their vulnerability to waterlogging (Figure 9). The uneven distribution of drainage facilities indicates the need for improved drainage infrastructure, particularly in wards with limited formal drainage coverage. The existing condition of drains is poor and inlets are blocked by solid waste, silt, and vegetation; As a result, waterlogging remains a recurring problem during the monsoon season (May–October).

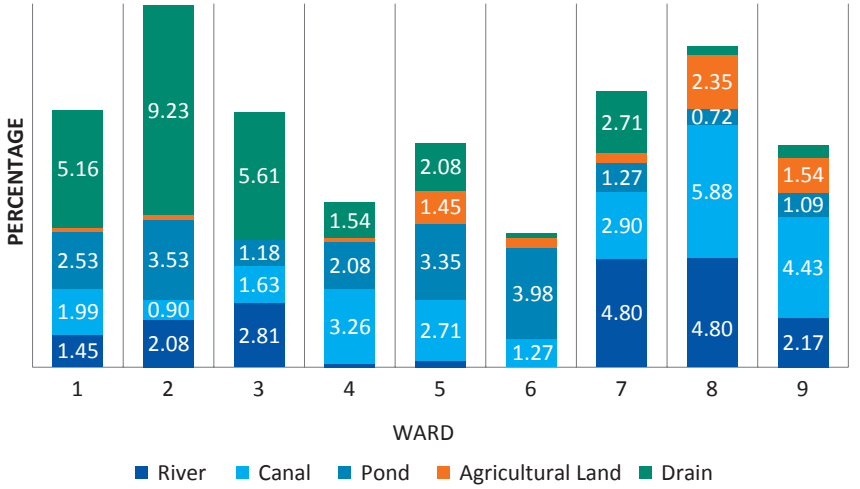


Figure 8: *Ward-wise Drainage Disposal in Municipality*

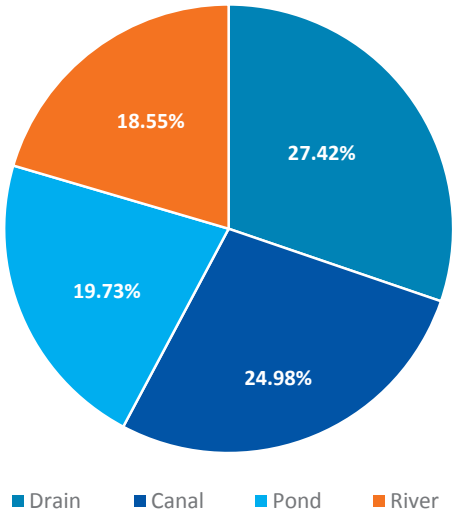


Figure 9: *Drainage Disposal at Municipality Level*

2.9.4 Solid Waste Management

Munshiganj Municipality generates approximately 41.9 tonnes of solid waste per day (≈15,290 tonnes/year). The existing waste management system remains under development, with partial household collection coverage and continued dependence on open dumping, roadside disposal, and low-lying areas due to limited collection capacity. Although door-to-door collection has been introduced in some wards, irregular schedules, limited manpower, and insufficient vehicles restrict effective service delivery. The municipality operates a sanitary landfill at Baradi, but waste segregation, recycling, and controlled disposal practices remain limited.

2.9.5 Housing Structure

The housing condition of Munshiganj Municipality shows significant variation across wards. Overall, 44.00% of houses are pucca, 12.25% are semi-pucca, and 43.74% are kancha or jhupri structures, indicating a considerable proportion of households living in relatively vulnerable housing conditions.

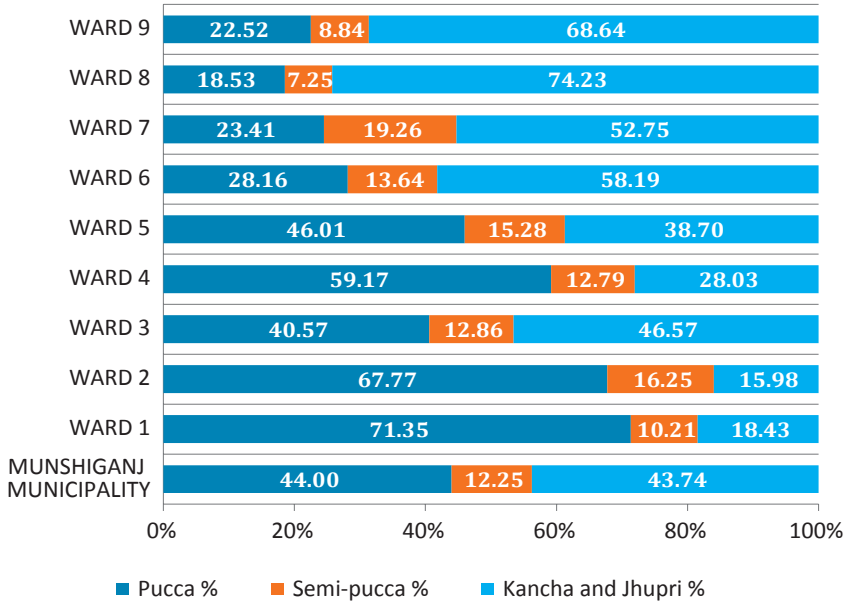


Figure 10: *Distribution of Housing Structures*

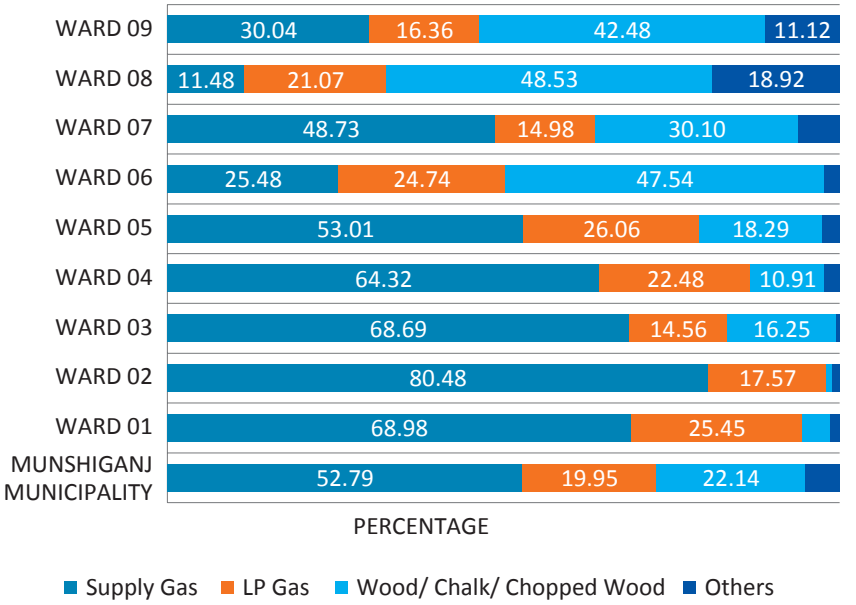


Figure 11: *Types of Cooking Fuel Used across the Municipality*

Ward-wise analysis reveals that Ward 01 (71.35%) and Ward 02 (67.77%) have the highest proportion of pucca houses, reflecting comparatively better housing quality and urban development. In contrast, Ward 08 and Ward 09 have the lowest share of pucca structures (18.53% and 22.52%, respectively) and the highest proportion of kancha/jhupri houses (74.23% and 68.64%), indicating greater housing vulnerability. Other wards such as Ward 06 and Ward 07 also show poor housing conditions, with more than half of the houses classified as kancha/jhupri (58.19% and 52.75%). The higher concentration of temporary and semi-permanent structures in these areas may increase residents' exposure to climate-related hazards such as flooding, waterlogging, storms, and extreme weather events due to lower structural resilience.

2.9.6 Cooking Fuel

Cooking fuel use in Munshiganj Municipality is mainly dominated by supply gas (52.79%), followed by wood-based fuel (22.14%) and LP gas (19.95%). Ward-wise, Ward 2 has the highest access to supply gas (80.48%), while Ward 8 and Ward 6 rely more on wood-based fuels (48.53% and 47.54%). The continued dependence on biomass fuels in some wards indicates disparities in clean energy access and potential indoor air pollution risks.

03. METHODOLOGY OF CLIMATE VULNERABILITY ASSESSMENT OF MUNSHIGANJ MUNICIPALITY

The methodology for assessing municipal vulnerability under this Climate Action Plan follows two primary approaches. One approach focuses on quantitative assessment of hazard vulnerability using satellite data, and the other focuses on qualitative assessment of hazard vulnerability based on questionnaire survey.

3.1 Vulnerability Assessment Using Secondary Sources

A comprehensive climate vulnerability assessment was conducted for Munshiganj Municipality using secondary spatial datasets, satellite imagery, and GIS-based analysis. The assessment focused on identifying areas exposed to climate-related risks by analyzing key environmental indicators, including land use and land cover change, land surface temperature, rainfall variation, and flood vulnerability.

The assessment was conducted using Google Earth Engine (GEE) and GIS-based spatial analysis techniques. Satellite imagery and environmental datasets were collected from globally recognized sources, including USGS Landsat,

Copernicus Sentinel-2, CHIRPS rainfall dataset, NASA SRTM Digital Elevation Model (DEM), and OpenLandMap soil dataset.

The analysis provides a spatial understanding of climate exposure and supports the identification of priority areas for climate adaptation interventions within Munshiganj Municipality.

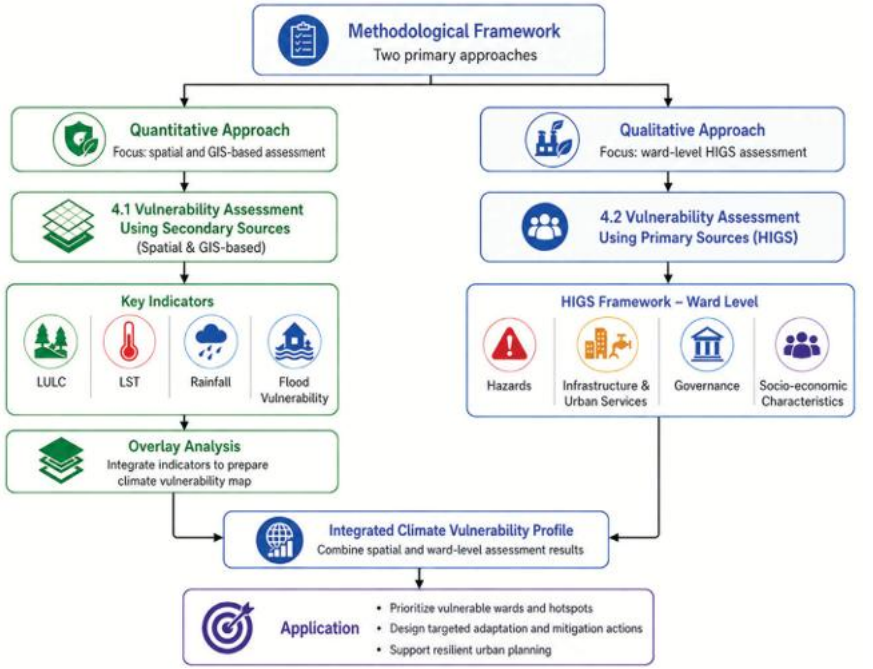


Figure 12: *Methodology of Climate Vulnerability Assessment*

3.1.1 Overlay Analysis of Vulnerability Assessment

Climate vulnerability in urban areas is influenced by multiple interacting environmental factors. Therefore, an overlay-based assessment approach was adopted to identify areas experiencing higher exposure to climate risks.

Four major environmental indicators were considered:

- Land Use and Land Cover (LULC)
- Land Surface Temperature (LST)
- Rainfall Pattern
- Flood Vulnerability

These indicators provide a comprehensive understanding of urban expansion, environmental degradation, rainfall variability, and flood exposure within the municipality.

3.1.1.1 Land Cover Classification and Land Use Change

Land Use and Land Cover (LULC) classification was conducted to understand changes in natural and built environments of Munshiganj Municipality. Changes in vegetation cover, water bodies, built-up areas, and bare land influence climate vulnerability by affecting surface temperature, drainage conditions, and urban heat exposure.

Year	Dataset	Source	Resolution
1995	Landsat 5 TM Surface Reflectance	USGS Landsat Archive	30 m
2025	Sentinel-2 MSI Surface Reflectance	Copernicus Sentinel Programme	10 m

Using GIS-based satellite image analysis, LULC maps were prepared for 1995 and 2025 to identify major land transformation patterns within the municipality.

3.1.1.2 Land Surface Temperature Map

Increasing temperature is one of the major impacts of climate change, creating heat stress and affecting urban comfort. Land Surface Temperature (LST) mapping was conducted to identify spatial variation of surface temperature within Munshiganj Municipality.

Year	Dataset	Source
1995	Landsat 5 Thermal Band	USGS Landsat Archive
2025	Landsat 8 Thermal Band	USGS Landsat Archive

Satellite-derived thermal data were used to prepare LST maps for different periods and identify areas exposed to higher heat intensity.

3.1.1.3 Rainfall Map

Dataset	Source	Period
CHIRPS Daily Rainfall	Climate Hazards Group (CHG), UCSB	2015–2025

Changes in rainfall patterns and increasing intensity of rainfall events contribute to flooding and waterlogging problems in urban areas. Therefore, rainfall analysis was conducted to understand spatial variation of rainfall conditions in Munshiganj Municipality. Annual rainfall trend was analysed using BMD data for 2005–2024, while spatial rainfall classification was derived from CHIRPS data for 2015–2025.

3.1.1.4 Flood Risk Map

Parameter	Source
Elevation (DEM)	NASA SRTM DEM
Slope	Derived from DEM
Rainfall	CHIRPS Dataset
Land Use/Land Cover	Satellite Image Classification
Distance from River	River Network Data
Soil Condition	OpenLandMap Soil Dataset

Flooding is one of the major climate hazards affecting Munshiganj due to its low-lying floodplain characteristics and proximity to major river systems. A GIS-based flood

risk assessment was conducted by integrating topographic, hydrological, climatic, and land surface characteristics.

Data were analyzed using Google Earth Engine. Areas with lower elevation, gentle slope, higher rainfall exposure, and close proximity to water bodies were considered more vulnerable to flooding. A weighted overlay approach was applied to combine different flood-related indicators and prepare the flood risk map.

Flood Vulnerability Index (FVI); Each parameter was reclassified into three risk levels: Low = 1, Moderate = 2, High = 3

The Flood Vulnerability Index was calculated as:

FVI = 0.25 (DEM) + 0.20 (Distance from River) + 0.20 (Rainfall) + 0.15 (Slope) + 0.12 (LULC) + 0.08 (Soil)

3.1.1.5 Climate Vulnerability Map Preparation Using Satellite Data

To identify areas facing multiple climate stresses, an overlay analysis was conducted by integrating LULC, LST, rainfall, and flood vulnerability information. This approach helped identify climate-sensitive areas where multiple risks overlap, such as: high surface temperature, reduced vegetation coverage. intense rainfall exposure, flood susceptibility. The findings provide a scientific basis for prioritizing climate adaptation interventions, including flood management, drainage improvement, heat reduction, and green infrastructure development.

3.2 Vulnerability Assessment Using Primary Sources (HIGS)

In addition to spatial analysis, a ward-level vulnerability assessment was conducted using the Hazard, Infrastructure and Urban Services, Governance, and Socio-economic (HIGS) framework.

The HIGS framework provides a localized understanding of climate vulnerability by assessing differences among wards in terms of hazard exposure, service availability, governance capacity, and community characteristics.

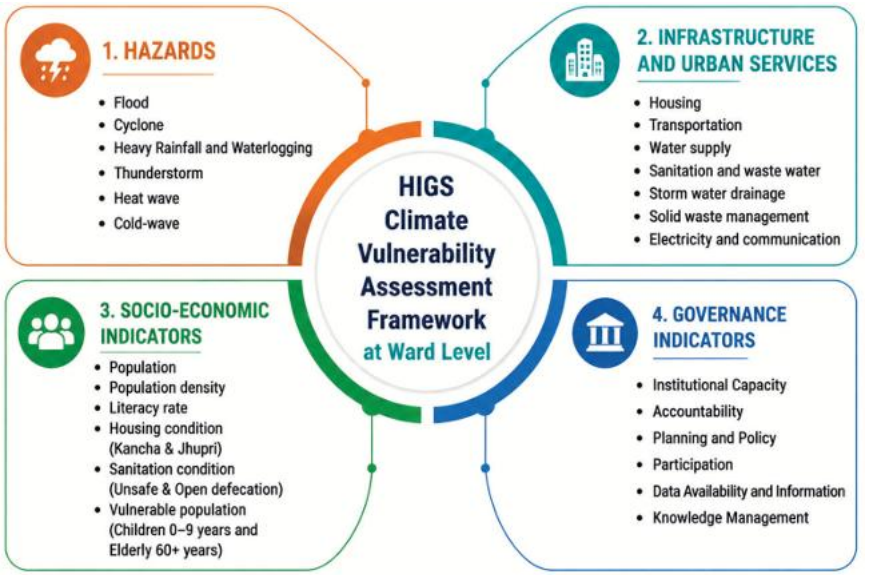


Figure 13: *Components of HIGS Framework*

3.2.1 Development of HIGS Framework for Climate Vulnerability Assessment at Ward Level

Climate impacts and vulnerability are not evenly distributed across a municipality. Different wards experience different levels of exposure and adaptive capacity depending on their physical conditions, infrastructure availability, and socio-economic characteristics.

Therefore, the HIGS framework was applied at the ward level to identify specific vulnerabilities and support targeted climate adaptation planning.

The framework consists of four major dimensions: Hazards, Infrastructure and Urban Services, Governance and Socio-economic Characteristics.

3.2.1.1 Hazards

The hazard dimension evaluates climate-related risks affecting Munshiganj Municipality. Based on national climate trends and local conditions, the selected hazards include: flood, heavy rainfall and waterlogging, heatwave, coldwave, thunderstorm, cyclone for hazard vulnerability index assessment.

These hazards were selected due to their increasing frequency and impact on urban settlements, infrastructure, and community well-being. Ward-level hazard assessment helps identify areas requiring specific adaptation measures, such as improved drainage, flood protection, heat reduction strategies, and emergency preparedness.

3.2.1.2 Infrastructure and Urban Services

The infrastructure and urban services dimension evaluates the capacity of essential municipal systems to withstand climate impacts. The Infrastructure and Urban Services Index assessment includes: housing condition, transportation, water supply, sanitation and wastewater management, stormwater drainage, solid waste management, internet and communication. Differences in service availability among wards influence their ability to cope with climate hazards. Wards with inadequate infrastructure and limited services require priority attention for resilience improvement.

3.2.1.3 Governance

Governance plays an important role in effective climate adaptation planning. This dimension assesses institutional capacity, planning practices, community participation, and availability of climate-related information. Effective governance ensures proper implementation of adaptation measures, coordination among agencies, and efficient allocation of resources to vulnerable areas.

3.2.1.4 Socio-economic characteristics

The socio-economic dimension of climate vulnerability assessment evaluates the capacity of communities to cope with, respond to, and recover from climate-related hazards. Socio-economic conditions influence the level of exposure and adaptive capacity of different wards within the municipality. For Munshiganj Municipality, a Socio-economic Vulnerability Index was developed at the ward level to identify spatial variations in community vulnerability. The assessment considered key socio-economic indicators related to population characteristics, housing conditions, sanitation status, literacy level, and vulnerable population groups. The indicators were selected based on their relationship with climate resilience. For example, densely populated areas may experience greater pressure on urban services during hazards, while poor housing conditions and unsafe sanitation increase vulnerability during flooding and waterlogging events.

Table 8: Selected Indicators for Socio-economic Vulnerability Assessment

Ward	Population (2022)	Density 2022 (per sq. km.)	Literacy rate (15 Years +)	Vulnerable Population (Children age 0-9 + Old age 60+)	Kancha and Jhupri (%)	Unsafe Disposal + Open Defecation (%)
1	12191	23534.02212	89.91%	2,968	18.43	5.98
2	15429	25081.93204	91.67%	3,892	15.98	1.35
3	9881	6995.878655	76.60%	2,565	46.57	4.5
4	8850	14978.11672	89.02%	2,397	28.03	7.79
5	8186	9030.057538	85.96%	2,221	38.70	6.02
6	7206	5299.339899	83.19%	1,947	58.19	13.08
7	10800	4878.690018	73.79%	2,964	52.75	13.22
8	11115	4238.393323	70.67%	3,130	74.23	8.97
9	9462	2982.178787	71.07%	2,683	68.64	6.95

3.2.2 Normalization and Calculation of the HIGS Index

The Hazard (H), Infrastructure and Urban Services (I), and Socio-economic (S) dimensions were normalized to a common scale ranging from 0 to 1 using min–max normalization. A value of 0 represents the lowest relative vulnerability, while 1 represents the highest.

For indicators where a higher value indicates greater vulnerability, the following formula was used:

Normalized value = (Ward value − Minimum ward value) / (Maximum ward value − Minimum ward value)

Literacy was reverse-normalized because a higher literacy rate indicates lower vulnerability:

Normalized literacy vulnerability = (Maximum literacy rate − Ward literacy rate) / (Maximum literacy rate − Minimum literacy rate)

The normalized socio-economic indicators—population, population density, literacy, vulnerable population, housing condition, and unsafe sanitation disposal—were assigned equal weights. The Socio-economic Vulnerability Index was calculated as:

S = (Population + Density + Literacy + Vulnerable Population + Housing Condition + Unsafe Sanitation Disposal) / 6

Because quantitative ward-level governance data were unavailable, a uniform Governance Index was assigned to every ward: G = 1

The final ward-level HIGS Index was calculated as:

HIGS = H + I + G + S

Higher HIGS scores indicate greater relative climate vulnerability. The final scores were classified into low, moderate, and high vulnerability categories using the Jenks natural-breaks method.





04. VULNERABILITY PROFILE ANALYSIS

4.1 Ward Climate Vulnerability Profile of Munshiganj Municipality Using Secondary Sources

4.1.1 Land Use and Land Cover Change

The LULC maps show a clear expansion of built-up areas between 1995 and 2025. At the municipal level, built-up land increased from 5.41% to 8.82%, representing a 63.6% increase, while vegetation, water bodies and bare land declined slightly.

At the ward level, the strongest concentration and expansion of built-up land is visible in Wards 1, 2, 3 and 4, which form the established urban core. Ward 2 and Ward 3 show particularly dense development along the major road corridors, while built-up areas have also become more scattered in Wards 5 and 9 by 2025. In contrast, Wards 7, 8 and 9 remain comparatively open and agriculture-dominated, although scattered development is becoming visible. Ward 6 retains relatively extensive vegetation, while vegetation is also concentrated along canals, homesteads and field boundaries in Wards 7–9. The pattern reflects the gradual outward expansion of the municipality from the established western and central urban areas toward the agricultural eastern and southern wards. The existing land-use survey similarly identifies Wards 1–4 as the urban core, Wards 5–6 as transitional areas and Wards 7–9 as predominantly agricultural peri-urban areas.

Table 9: Change in Land Cover Classes from 1995 to 2025

LULC Class	% 1995	% 2025	Rate of Change (%)	Trend
Water body	3.48%	3.40%	-1.9%	▼ Dec.
Vegetation	29.96%	28.99%	-2.8%	▼ Dec.
Built-up	5.41%	8.82%	+63.6%	▼ Inc.
Bare land	61.15%	58.79%	-3.4%	▼ Dec.

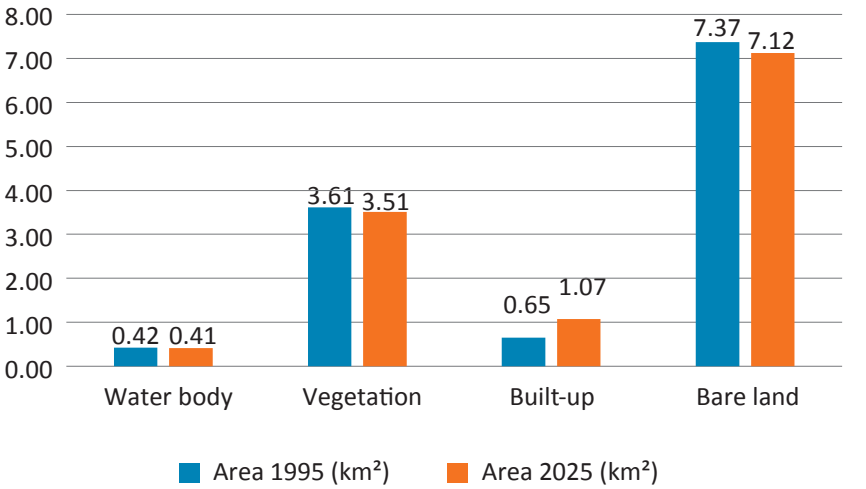
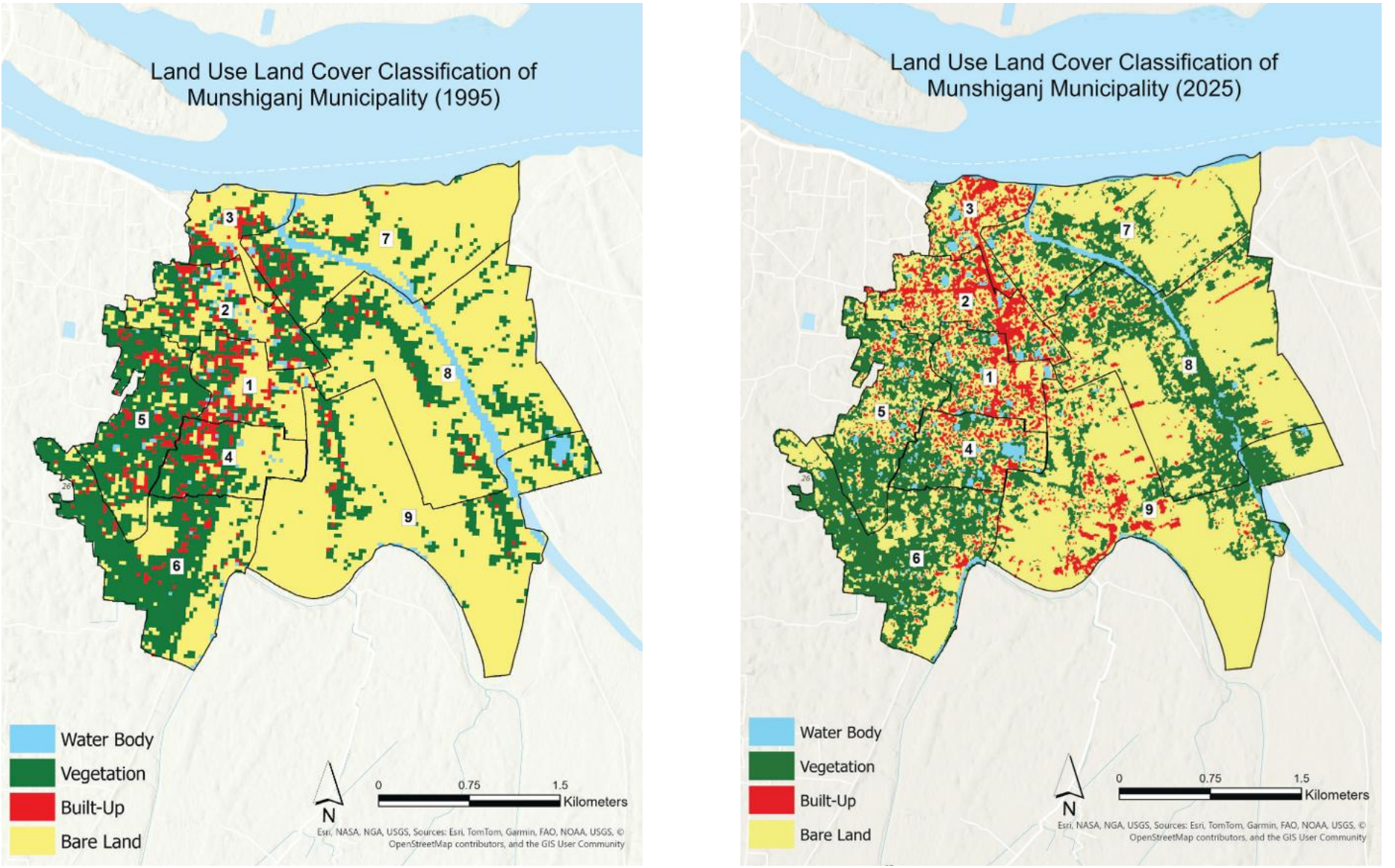


Figure 14: *Change in Land Cover Classes from 1995 to 2025*



Map 4: *Land Use Land Cover Change of Munshiganj Municipality from 1995 to 2025*

4.1.2 Land Surface Temperature (LST)

The LST analysis shows a clear increase in surface temperature between 1995 and 2025. The highest temperature class increased from approximately 35–36.5°C in 1995 to 36–39°C in 2025, indicating an increase of about 3°C in the peak LST range.

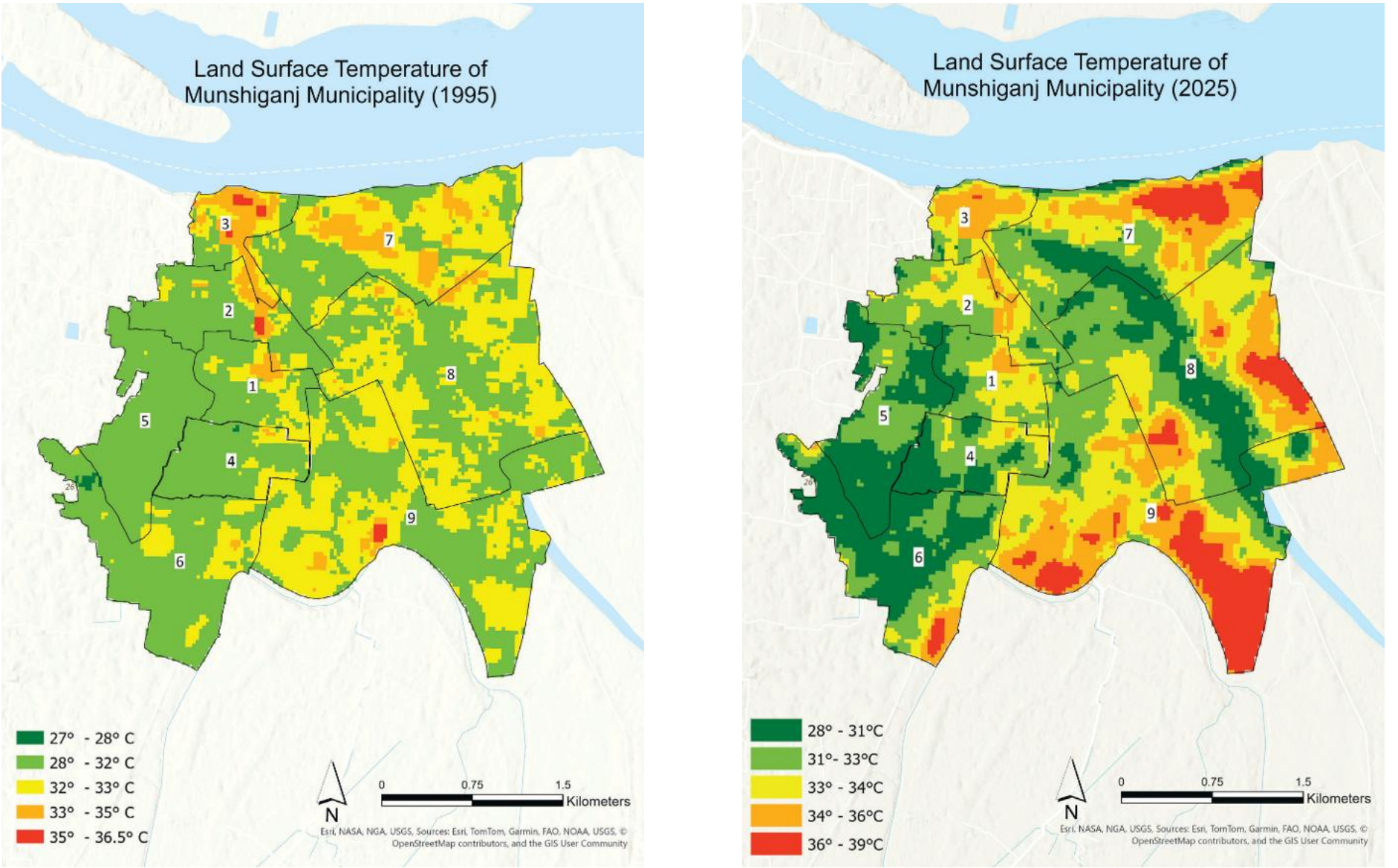
In 2025, the highest LST is concentrated mainly in Wards 7, 8 and 9, while localized high-temperature areas are also visible in Ward 3. In contrast, Wards 5 and 6 remain comparatively cooler, with large areas falling within approximately 28–33°C. Wards 1, 2 and 4 generally show moderate surface temperatures. The pattern indicates that high LST in Munshiganj is not controlled by built-up density alone.

Although Wards 7–9 are less densely built-up and are located closer to rivers, they are predominantly agricultural. Munshiganj Municipality follows a diverse seasonal cropping pattern dominated by vegetables, potato, Aman rice and Boro rice. April represents an important transition period, when potato and Boro fields are often harvested or recently harvested and some vegetable plots have relatively low canopy cover. Consequently, extensive agricultural areas may temporarily consist of exposed, dry or stubbled soil, particularly in the agriculture-dominated Wards 7–9. These seasonal surface conditions can produce relatively high land surface temperatures despite the lower built-up density of these wards.

The cooling influence of rivers also appears to be relatively localized. In Ward 8, for example, cooler conditions are visible along the canal and vegetated corridor, while higher temperatures occur farther away over open agricultural surfaces. Similarly, the hotter zones in Ward 7 are concentrated mainly toward the northern and northeastern agricultural areas, whereas Ward 9 shows extensive high-temperature patches across its southern and eastern agricultural land.

Heat vulnerability reflects more than one land-surface mechanism. Impervious development and limited vegetation can intensify heat in the urban core, while the comparatively high pre-monsoon LST in Wards 7–9 is more strongly associated with exposed, harvested, fallow or sparsely vegetated agricultural surfaces. Conversely, the relatively lower LST in Wards 5 and 6 corresponds with their greater vegetation cover, which provides more shading and evapotranspirative cooling.





Map 5: *Land Surface Temperature (LST) Comparison between 1995 and 2025*

4.1.3 Rainfall Variation

Rainfall varies considerably from year to year (Figure 15), with distinct wet and dry periods and no uniform long-term trend. The sharp fluctuations indicate increasing importance of managing both intense rainfall and seasonal waterlogging risks.

Across Munshiganj Municipality, rainfall range varies from approximately 2,166 to 2,197 mm. The lowest rainfall class, around 2,166–2,175 mm, is concentrated mainly in Wards 5 and 6, with parts of Wards 1–4 also falling within the lower range. Rainfall gradually increases toward the east. Wards 7, 8 and 9 receive comparatively higher rainfall, with Ward 8 and the eastern parts of Wards 7 and 9 showing the highest values of approximately 2,185–2,197 mm.

Although the absolute difference across the municipality is not large, this spatial gradient becomes important when combined with low elevation, proximity to rivers and poor drainage.

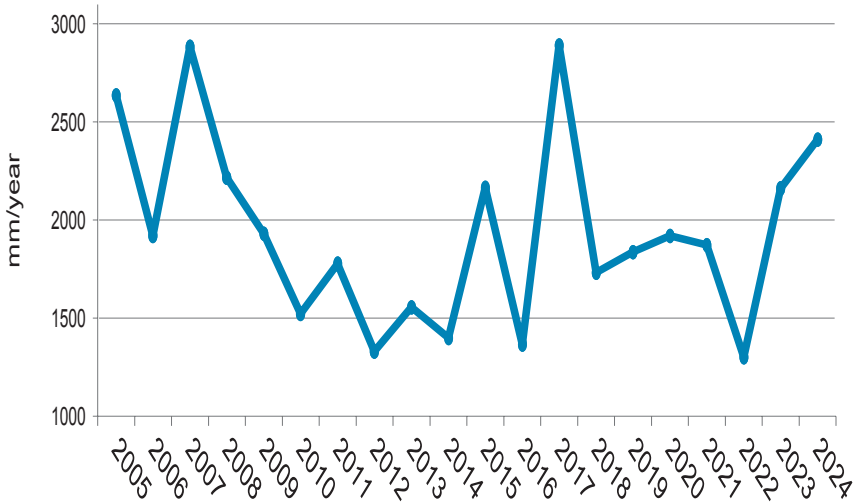
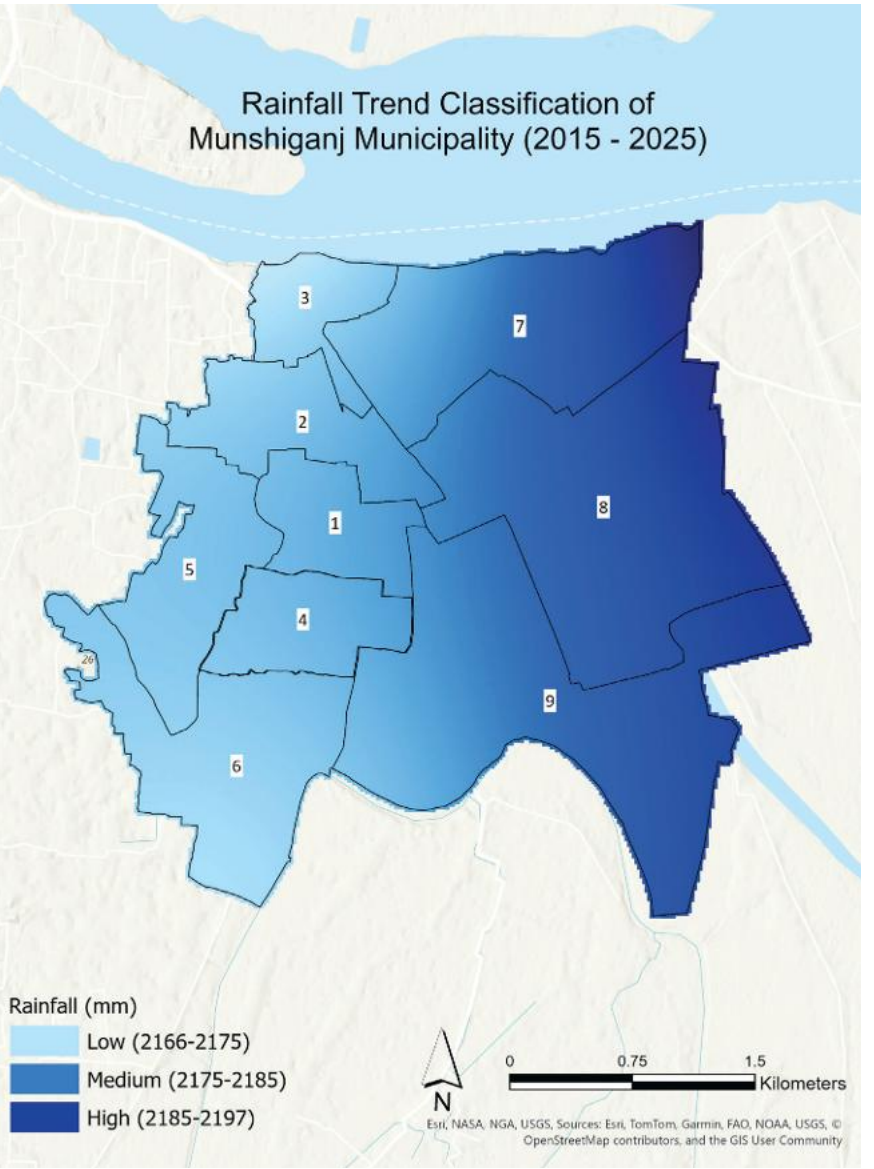


Figure 15: *Annual Rainfall Trend from 2005 to 2024*

Source: BMD



Map 6: *10 Years Rainfall Trend (2015 - 2025) of Munshiganj Municipality*

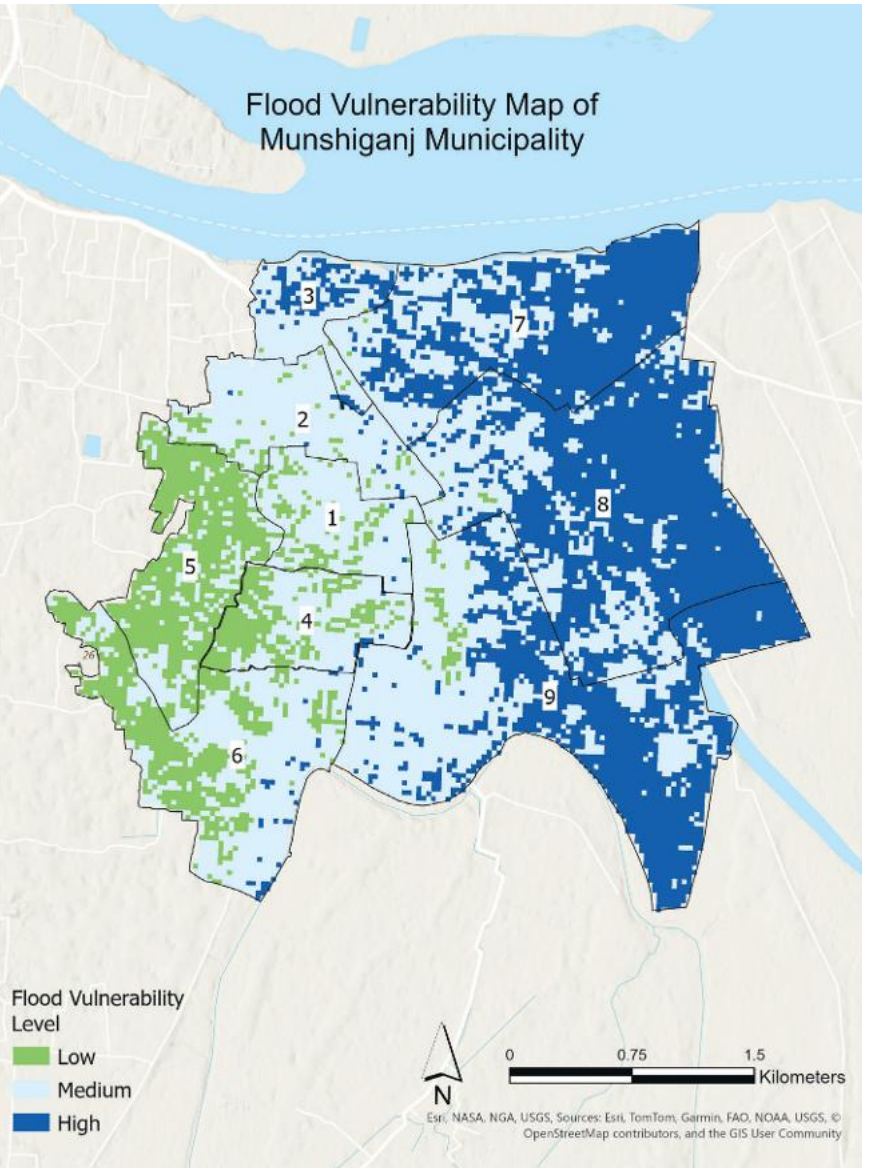
4.1.4 Flood Risk

The Flood Vulnerability Map of Munshiganj Municipality shows a pronounced west-to-east gradient in flood exposure across the municipality.

The eastern and southeastern wards — Ward 7, Ward 8 and Ward 9 — are classified as high flood vulnerability zones. This pattern is consistent with the physical setting of these wards: they occupy the low-lying, peri-urban floodplain closest to the Meghna River, fall within the higher end of the municipality's rainfall gradient (approximately 2,185–2,197 mm), and retain the lowest built-up density and highest share of exposed agricultural land, all of which reduce natural resistance to inundation.

The central wards — Ward 1, Ward 2, Ward 3 (southern portion) and Ward 4 — fall predominantly into the medium vulnerability class. These wards form the older, more built-up urban core, where higher elevation and denser road/drainage infrastructure moderate direct river-flood exposure, though localized medium- and even isolated high-risk pockets remain, particularly along Ward 3's eastern boundary near the canal branch connecting to the Dhaleshwari River.

The western wards — Ward 5 and Ward 6 — show the lowest flood vulnerability in the municipality, with low-risk pixels dominating both wards. This corresponds to their comparatively higher ground elevation, lower rainfall exposure (2,166–2,175 mm), and greater distance from the Meghna and Dhaleshwari river systems.



Map 7: *Flood Vulnerability Map of Munshiganj Municipality*

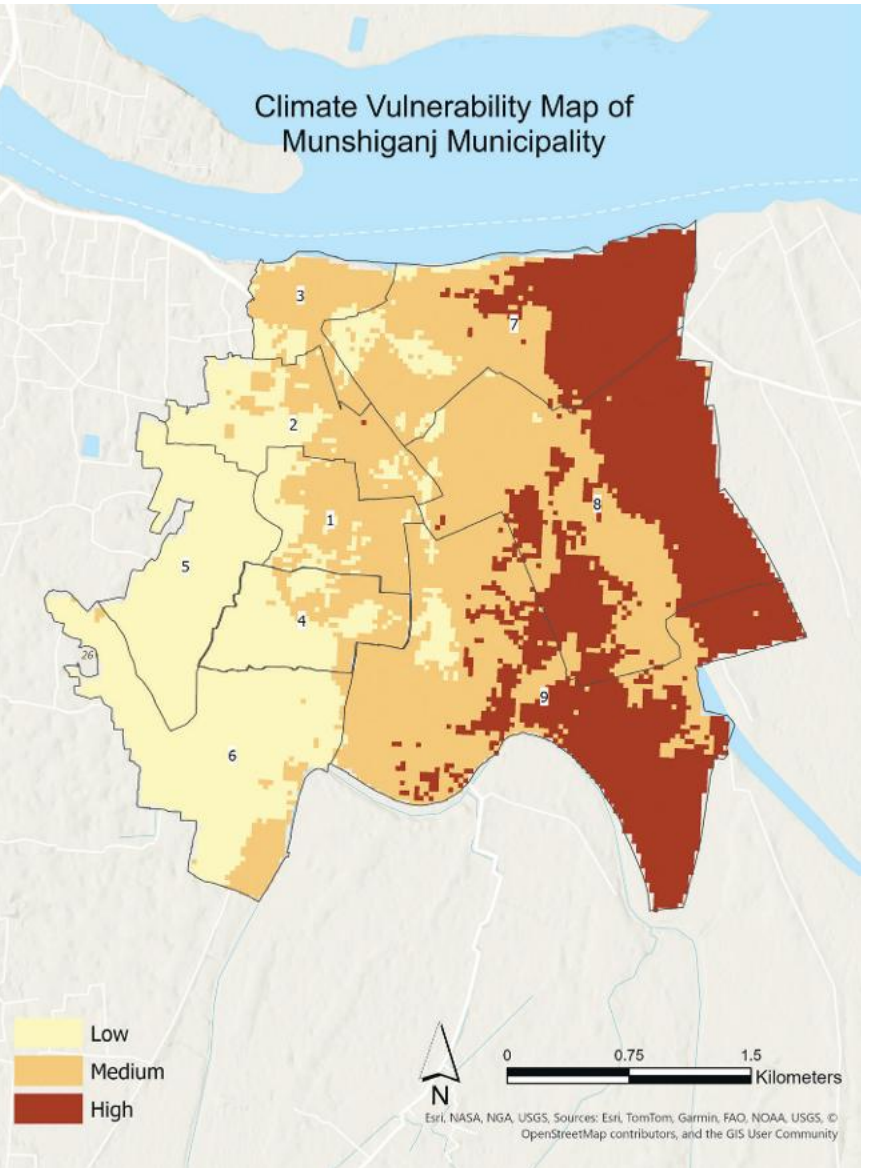
4.1.5 Climate Vulnerability Assessment

To capture the combined effect of multiple climate stressors, an overlay analysis integrating Land Use/Land Cover, Land Surface Temperature, rainfall pattern and the Flood Vulnerability Index was conducted for Munshiganj Municipality.

The result shows a similarly clear spatial gradient. Ward 7, Ward 8 and the greater part of Ward 9 are classified as high climate vulnerability, forming a large, contiguous high-risk zone along the eastern and southeastern edge of the municipality, coinciding with the Meghna River corridor. This is the combined product of the highest flood exposure, comparatively higher pre-monsoon land surface temperature (linked to exposed, harvested or fallow agricultural surfaces, as discussed in Section 4.1.2), and the upper end of the municipal rainfall range identified in these wards.

Ward 1, Ward 2, Ward 3 and Ward 4 — the established urban core and its immediate transition zone — fall into the medium vulnerability category. Here, moderate LST, medium flood risk and mid-range rainfall combine with denser built-up land use to produce an intermediate overlay score.

Ward 5 and Ward 6, in the west, register the lowest overlay scores in the municipality, consistent with their lower flood exposure, higher retained vegetation cover, and comparatively lower LST and rainfall values documented in the preceding subsections.



Map 8: *Climate Vulnerability Map of Munshiganj Municipality Overlaying Satellite Data*

4.2 Ward Climate Vulnerability Profile of Munshiganj Municipality Using Primary Sources

The ward-level climate vulnerability of Munshiganj Municipality was assessed using the HIGS framework, integrating four dimensions: Hazards (H), Infrastructure and Urban Services (I), Governance (G), and Socio-economic Vulnerability (S).

Hazard and infrastructure vulnerability were estimated from questionnaire responses considering both the frequency of hazards and the intensity of their impacts. Higher values indicate greater vulnerability. Frequency and intensity were weighted as follows.

Dimension	Category	Weight
Frequency	<3 times/year	0.25
	3–5 times/year	0.50
	5–7 times/year	0.75
	>7 times/year	1.00
Intensity	Low impact	0.33
	Medium impact	0.66
	High impact	1.00

The Hazard Vulnerability Index (H) reflects the combined frequency and intensity of each hazard across affected urban systems, while the Infrastructure Vulnerability Index (I) represents the cumulative impact of all hazards on each infrastructure type.Socio-economic indicators were normalized to a 0–1 scale using Min–Max normalization. Because ward-specific quantitative governance indicators were unavailable, a uniform Governance Index (G) = 1 was applied to all wards, consistent with the reference HIGS methodology.

The final index was calculated as:

$HIGS_v = H_v + I_v + G_v + S_v$

where higher values indicate greater overall climate vulnerability.

4.2.1 Hazard Vulnerability Profile of Munshiganj Municipality

The hazard assessment covers cyclone, flood, heavy rainfall and waterlogging, thunderstorm, heatwave and coldwave. Among these, the municipality demonstrates the highest vulnerability to heatwaves, with a score of 23.61, followed by heavy rainfall and waterlogging, with a vulnerability score of 22.98. Thunderstorms pose a moderate vulnerability level at 18.59, while coldwaves show a relatively lower score of 17.09. The municipality is least vulnerable to cyclones (11.50) and floods (10.55). Cyclone vulnerability is comparatively low because Munshiganj is outside the direct coastal storm-surge zone. Municipality-wide questionnaire-reported flood impacts are also comparatively lower than several other hazards; however, the GIS assessment identifies substantial physical riverine and floodplain exposure in Wards 7–9. Heat vulnerability reflects multiple land-surface conditions. Impervious development and limited vegetation may intensify heat within the urban core, while the comparatively high pre-monsoon LST in Wards 7–9 is more strongly associated with exposed, harvested, fallow or sparsely vegetated agricultural surfaces.

Table 10: Hazard Vulnerability Index

Hazard Vulnerability of Munshiganj Municipality									
Ward No.	1	2	3	4	5	6	7	8	9
Cyclone	1.11	1.05	1.16	1.12	1.16	1.25	1.22	1.81	1.62
Floods	1.19	0.89	1.11	1.26	0.89	0.89	1.54	1.49	1.29
Heavy Rainfall and Waterlogging	2.58	2.64	3.76	2.26	2.03	2.18	2.85	2.21	2.49
ThunderStorm	2.28	3.29	2.86	1.97	2.32	1.41	1.54	0.99	1.93
Heatwave	1.94	1.93	3.05	2.73	2.19	1.91	3.51	3.45	2.89
Coldwave	0.82	0.84	2.33	1.74	1.65	2.09	2.53	2.65	2.44

The cumulative multi-hazard scores show clear ward-level variation. Ward 3 has the highest overall hazard exposure (14.27), followed by Ward 7 (13.19), Ward 9 (12.66), and Ward 8 (12.60). Ward 1 records the lowest cumulative score at 9.92.

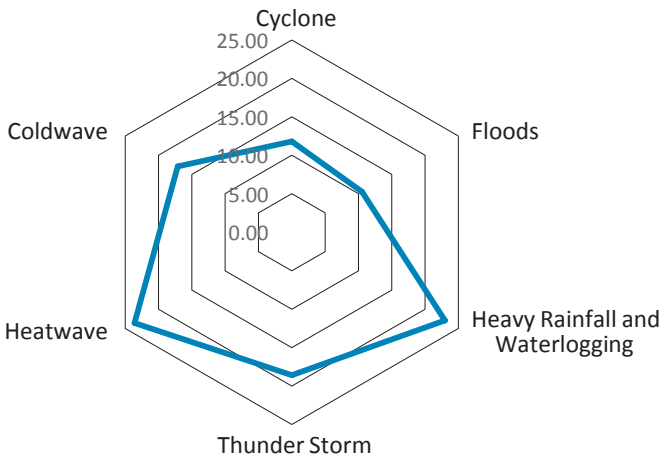


Figure 16: *Hazard Vulnerability in Munshiganj Municipality*

At the municipality level, heatwave is the dominant hazard, followed by heavy rainfall and waterlogging. Thunderstorms and coldwaves represent moderate concerns, while cyclone and flood have comparatively lower questionnaire-based scores.

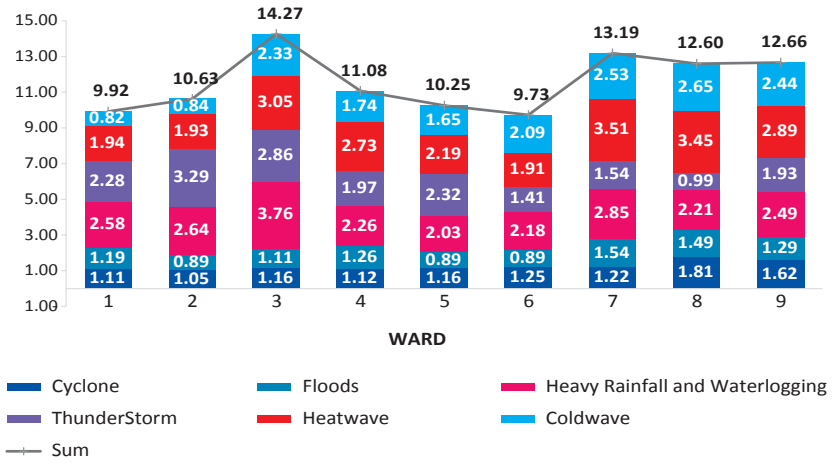


Figure 17: *Ward-Level Exposure to Hazards*

4.2.1.1 Cyclone

Cyclone vulnerability is comparatively moderate across Munshiganj. Ward 8 records the highest score (1.81), followed by Wards 9 and 6. Although Munshiganj is inland, cyclonic systems can still cause strong winds, intense rainfall, infrastructure damage and service disruption. Therefore, cyclone vulnerability mainly reflects secondary impacts rather than direct coastal storm-surge exposure.

4.2.1.2 Flood

Flood vulnerability is highest in Ward 7 (1.54), followed by Ward 8 (1.49) and Ward 9 (1.29).

This pattern corresponds well with Munshiganj's physical setting. Wards 7–9 occupy the eastern and peri-urban floodplain and are comparatively close to surrounding river systems. The municipality itself is characterized by a flat, low-lying deltaic floodplain and shallow groundwater conditions, increasing sensitivity to inundation and slow drainage.

The HIGS assessment indicates comparatively lower municipality-wide respondent-reported flood impacts. However, the GIS and satellite-based assessment identify substantial physical flood susceptibility in Wards 7–9 because of their low elevation, proximity to rivers and canals, and floodplain characteristics. These findings are complementary rather than contradictory. The HIGS scores reflect respondents' experiences and perceived impacts during the survey period, whereas the spatial assessment represents the underlying physical conditions that may produce flooding. Therefore, although reported flood impacts are comparatively lower at the municipal level, Wards 7–9 remain important physical flood-exposure hotspots requiring targeted flood-risk reduction measures.

4.2.1.3 Heavy Rainfall and Waterlogging

Heavy rainfall and waterlogging are among the most important hazards in the municipality. Ward 3 records the highest vulnerability (3.76), followed by Ward 7 (2.85), Ward 2 (2.64), Ward 1 (2.58) and Ward 9 (2.49).

Ward 3's high vulnerability may be associated with its relatively developed urban character, where impervious surfaces and drainage pressure can intensify water accumulation. In the peripheral wards, low-lying terrain and limited drainage outlets can also prolong waterlogging.

This is consistent with the broader municipal assessment, where 68.97% of surveyed respondents reported waterlogging.

4.2.1.4 Thunderstorm

Thunderstorm vulnerability is highest in Ward 2 (3.29) and Ward 3 (2.86). Ward 8 shows the lowest score at 0.99.

Thunderstorms can cause sudden disruption through strong winds, lightning, rainfall, falling trees and interruptions to internet and communication services. Differences among wards therefore reflect variations in infrastructure exposure and reported impact intensity.

4.2.1.5 Heatwave

Heatwave emerges as the most significant hazard at the municipal level. The highest scores occur in Ward 7 (3.51) and Ward 8 (3.45), followed by Ward 3 (3.05).

The high scores in Wards 7–9 are consistent with the spatial LST assessment, where pre-monsoon agricultural surfaces can become strongly heated when fields are harvested, fallow, stubbled or have limited vegetation cover.

However, the HIGS heatwave index should not be interpreted as an LST measure alone. It reflects reported impacts on people and infrastructure, meaning housing condition, access to shade, livelihood exposure and service conditions can also influence ward-level heat vulnerability.

4.2.1.6 Coldwave

Coldwave vulnerability is highest in Ward 8 (2.65), followed by Ward 7 (2.53), Ward 9 (2.44) and Ward 3 (2.33). The relatively higher scores in Wards 7–9 may be associated with weaker housing conditions and greater exposure of vulnerable households. Cold periods can particularly affect children, elderly residents and households living in less protective structures.

Table 11: Infrastructure and Urban System Vulnerability Index

Infrastructure Vulnerability of Munshiganj Municipality									
Ward No	1	2	3	4	5	6	7	8	9
Housing	1.35	1.40	1.42	1.45	1.23	1.55	1.61	1.81	1.93
Transportation	1.64	1.40	1.50	1.39	1.28	1.33	1.33	1.22	1.19
Water Supply	1.69	1.38	1.84	1.46	1.69	1.52	1.39	1.15	1.05
Sanitation and Wastewater	1.82	2.07	2.24	1.64	1.55	1.56	1.56	1.52	1.48
Stormwater Drainage	1.67	1.81	2.13	1.54	1.51	1.47	1.40	1.20	1.40
Solid Waste Management	1.69	1.61	2.20	1.67	1.72	1.50	1.68	1.75	1.58
Internet and Communication	1.60	1.54	1.62	1.78	1.66	1.64	1.50	1.68	1.74

4.2.2 Infrastructure and Urban Systems Vulnerability Profile of Munshiganj Municipality

The table illustrates the infrastructure and urban system vulnerability of Munshiganj Municipality across seven sectors. All seven systems show comparable vulnerability scores, indicating that each faces broadly similar risk from hazards. Sanitation and Wastewater is the most vulnerable sector, with a score of 15.44, followed closely by Solid Waste Management (15.40) and Internet and Communication (14.76). Stormwater Drainage (14.12) and Housing (13.75) also show notable vulnerability, while Water Supply (13.17) and Transportation (12.28) are

comparatively the most resilient sectors. The elevated vulnerability in sanitation, solid waste, and drainage reflects the municipality's struggle with inadequate wastewater and waste management systems, which is critical given its high exposure to heavy rainfall and waterlogging. Urban system components are grouped into Non-WASH

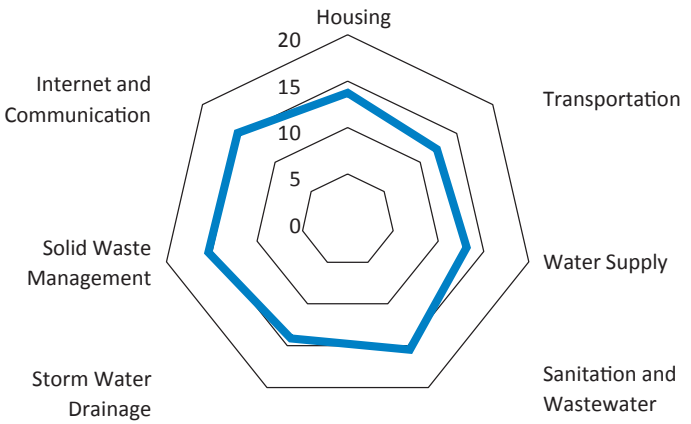


Figure 18: *Infrastructure Vulnerability in Munshiganj Municipality*

systems — housing, transportation, and internet and communication — and WASH systems, comprising water supply, sanitation and wastewater, stormwater drainage, and solid waste management.

Non-WASH Urban System: Among the Non-WASH systems, Ward 9 (4.86 combined) and Ward 8 (4.71) show the highest vulnerability, driven primarily by poor housing conditions, which score 1.93 and 1.81 respectively — the two highest housing vulnerability scores in the municipality. This is consistent with weaker construction quality and lower-income settlement patterns in these wards, and it aligns closely with their high socio-economic vulnerability and heat/cold exposure discussed further below. Ward 1 records the highest transportation vulnerability (1.64), while Ward 4 is most vulnerable in internet and communication (1.78); Ward 5 shows the strongest overall Non-WASH performance.

WASH Urban System: WASH systems constitute the most vulnerable component of Munshiganj Municipality's infrastructure. Among the seven infrastructure and urban system sectors assessed, Sanitation and Wastewater (15.44) and Solid Waste Management (15.40) record the highest cumulative vulnerability scores across the municipality, exceeding all other sectors, including stormwater drainage and water supply.

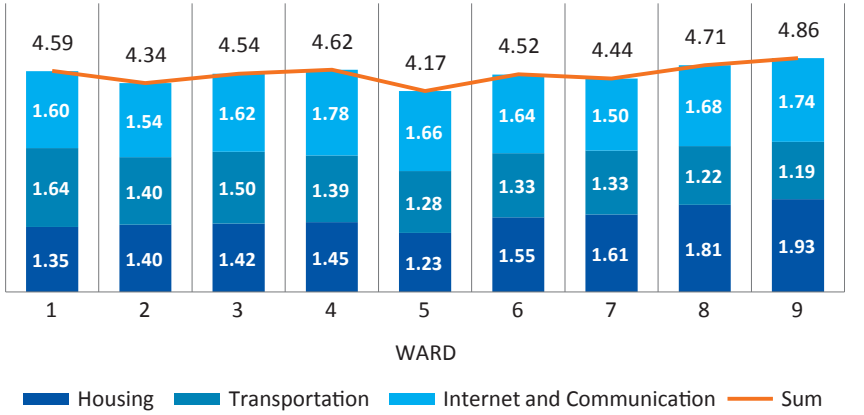


Figure 19: *Non-WASH Urban Systems Vulnerability of Wards*

Sanitation and wastewater vulnerability in Munshiganj is not evenly distributed but is instead specifically concentrated in ward 1 (1.82), ward 2 (2.07), and ward 3 (2.24), which record the three highest scores in the municipality.

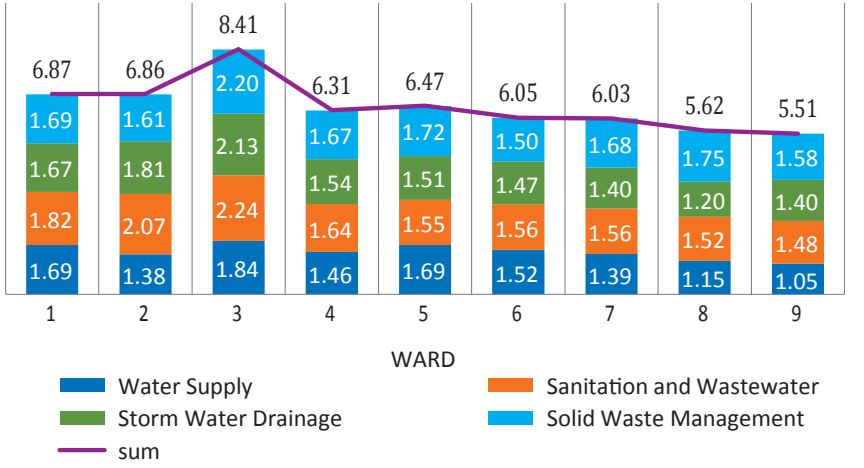


Figure 20: *WASH Urban Systems Vulnerability of Wards*

Notably, the same wards also record elevated stormwater drainage vulnerability, suggesting a compounding relationship between the two systems: where sewerage and drainage infrastructure are both inadequate, heavy rainfall events are more likely to result not only in surface flooding but also in cross-contamination between wastewater and drainage systems, thereby elevating public health risk during hazard events.

Ward 3 represents the most severe case within the WASH assessment, recording the highest vulnerability across all four WASH sectors simultaneously — water supply (1.84), sanitation and wastewater (2.24), stormwater drainage (2.13), and solid waste management (2.20) — for a combined WASH vulnerability score of 8.41.

Wards 1 and 2, while also exhibiting high sanitation and drainage vulnerability, differ from Ward 3 in that their solid waste management scores remain at or near the municipal average. This distinction indicates that the vulnerability in Wards 1 and 2 is concentrated specifically within the sewerage and drainage network, rather than in waste collection service delivery. Such a pattern is typically associated with older, more established areas of a municipality, where sewerage infrastructure was constructed prior to current population densities and is comparatively difficult and costly to retrofit.

Solid waste management vulnerability follows a distinct spatial pattern. Beyond Ward 3, the next most vulnerable wards are Ward 8 (1.75) and Ward 5 (1.72). This suggests that solid waste vulnerability is governed by a different set of drivers than sanitation vulnerability — most plausibly related to accessibility constraints, such as narrow street networks or distance from collection points, rather than the ageing sewerage infrastructure implicated in the sanitation findings.

Taken together, these findings identify sanitation and wastewater management, together with stormwater drainage, in Wards 1, 2, and 3 as the most urgent WASH intervention priorities for Munshiganj Municipality.

4.2.3 Governance Vulnerability Profile of Munshiganj Municipality

No ward-level climate governance data were available for Munshiganj, so a uniform Governance Vulnerability Index of 1 was assigned to all wards. This does not imply that governance capacity is equally weak everywhere, but rather that no differentiated ward-level dataset currently exists to distinguish between wards.

The institutional records reviewed for Munshiganj do allow some of the underlying governance gaps to be characterized more specifically because the municipality is currently in an unusual transitional state of governance.

Table 12: Summary of Identified Governance Gaps in Munshiganj Municipality

Governance Dimension	Detailed Findings	Status Summary
Elected leadership	Munshiganj Municipality has been without an elected Mayor since 18 August 2024 and without elected Ward Councilors since 26 September 2024, both removed by order of the Local Government Division. An Administrator (currently the Deputy Director, Local Government, Munshiganj) has since been appointed to exercise the Mayor's functions, supported by an inter-committee arrangement of government officers formed following the Council's October 2024 meeting.	Vacant since Aug–Sep 2024; Administrator + government-officer committees in place instead
Ward-level disaster management structure	Disaster-related responsibilities are formally assigned to a Standing Committee on Disaster Management (constituted under Section 55(2) as an additional Standing Committee, chaired by the Civil Surgeon) and referenced as a secondary function within the Ward Committees' Terms of Reference (taking emergency action during epidemics and natural disasters). No ward possesses its own dedicated disaster management committee, and the municipal-level committee's ToR is oriented toward post-event coordination — early warning dissemination, emergency response, and rehabilitation — rather than proactive, ward-differentiated risk reduction planning.	Not present; disaster duties folded into general Ward Committee ToR and one municipal-level Standing Committee
Ring-fenced climate/ disaster resilience budget	No line item or dedicated fund for climate resilience or disaster risk reduction activities was identified in the institutional documents reviewed. The Establishment & Finance Standing Committee's ToR covers general revenue planning and budget preparation but does not reference a climate- or resilience-specific allocation.	Not identified in reviewed documents
Regulatory enforcement capacity (staffing gaps)	The Engineering Division — responsible for infrastructure, drainage, and civil works enforcement — has the highest staff vacancy rate in the organogram (35 of 52 sanctioned Engineering-section posts vacant, i.e. 67%), and the municipality overall operates at 43% of sanctioned staff strength (69 filled of 160 sanctioned posts). This directly constrains the Town Planning, Civic Services & Development Standing Committee's stated mandate to ensure "proper application of Municipality law in infrastructure and civic service development" (ToR item ঘ.১.ঙ), including building code enforcement.	Constrained — Engineering Division 67% vacant; overall staffing at 43% of sanctioned strength
Public/private climate-risk data-sharing platforms	The TLCC's Terms of Reference nominally include informing citizens and building awareness in the planning process (ToR item ১), but the committee meets only quarterly, is chaired by a government official rather than an elected Mayor during the current period, and no dedicated public-facing climate-risk information platform or citizen feedback channel is referenced in the available records.	Not identified; TLCC citizen engagement limited to quarterly meetings

4.2.4 Socio-economic Vulnerability Profile of Munshiganj Municipality

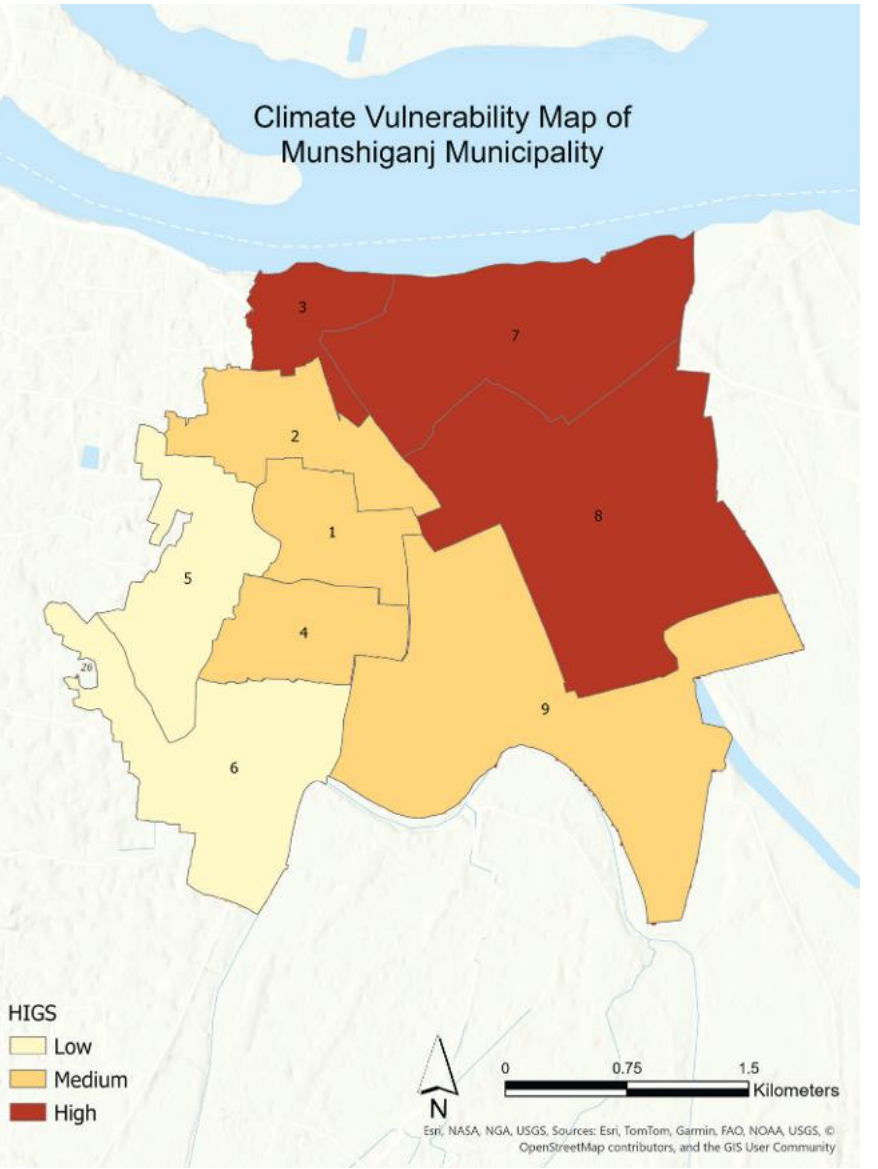
Table 13: Socio-economic Vulnerability Index

Socio-economic Vulnerability Index of Munshiganj Municipality									
Ward No	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Population	0.61	1.00	0.33	0.20	0.12	0.00	0.44	0.48	0.27
Density	0.93	1.00	0.18	0.54	0.27	0.10	0.09	0.06	0.00
Literacy	0.09	0.00	0.71	0.15	0.30	0.42	0.85	1.00	0.98
Vulnerable Population	0.52	1.00	0.32	0.23	0.14	0.00	0.52	0.61	0.38
Housing Condition	0.04	0.00	0.53	0.21	0.39	0.72	0.63	1.00	0.90
Unsafe Sanitation Disposal	0.39	0.00	0.27	0.54	0.39	0.99	1.00	0.64	0.47

The socio-economic indicators show different patterns of vulnerability across the municipality. Ward 8 records the highest literacy-related vulnerability, while Ward 8 and 9 have higher proportion of kancha and jhupri housing, followed by Wards 3 and 2. Unsafe sanitation vulnerability is highest in Ward 7, followed closely by Ward 6. These findings suggest that lower literacy, vulnerable housing, and inadequate sanitation affect different wards in different ways. Housing vulnerability may increase residents' exposure to heatwaves, coldwaves, flooding, and other climate hazards, while lower literacy and unsafe sanitation can limit adaptive capacity and increase health risks. Ward 5 and Ward 4 are the least socio-economically vulnerable wards in the municipality, reflecting comparatively stronger housing conditions, lower population pressure, and better sanitation access.

4.2.5 HIGS Climate Vulnerability Index

Based on natural breaks in the composite HIGS scores, Wards 3, 7, and 8, (HIGS ≥ 2.50) fall into the high vulnerability category, while Wards 1, 2, 4, and 9 (HIGS 2.13–2.4) fall into the moderate category, and Ward 5 (1.83) and 6 (2.02) are classified as low vulnerability.



Map 9: *Climate Vulnerability Map of Munshiganj Municipality Using HIGS Index*

Ward 3 leads the overall ranking with a HIGS score of 2.82, and the composition of this score represents that it is the only ward where both the Hazard dimension (0.66) and the infrastructure dimension (0.77) are simultaneously at their highest levels in the municipality. In other words, Ward 3's vulnerability is fundamentally a physical and engineering problem — a genuinely lower-lying, wetter location compounded by inadequate drainage and sanitation infrastructure that cannot cope with the hazard load it faces.

Wards 7, and 8 also reach the high category, but through a different combination of drivers such as hazard exposure — particularly heatwave and cold wave — and socio-economic vulnerability, which is the highest in these wards. Their underlying challenge is more about housing quality and the economic resilience of residents.

4.2.6 Comparison between the Satellite Vulnerability Map and HIGS Vulnerability Map

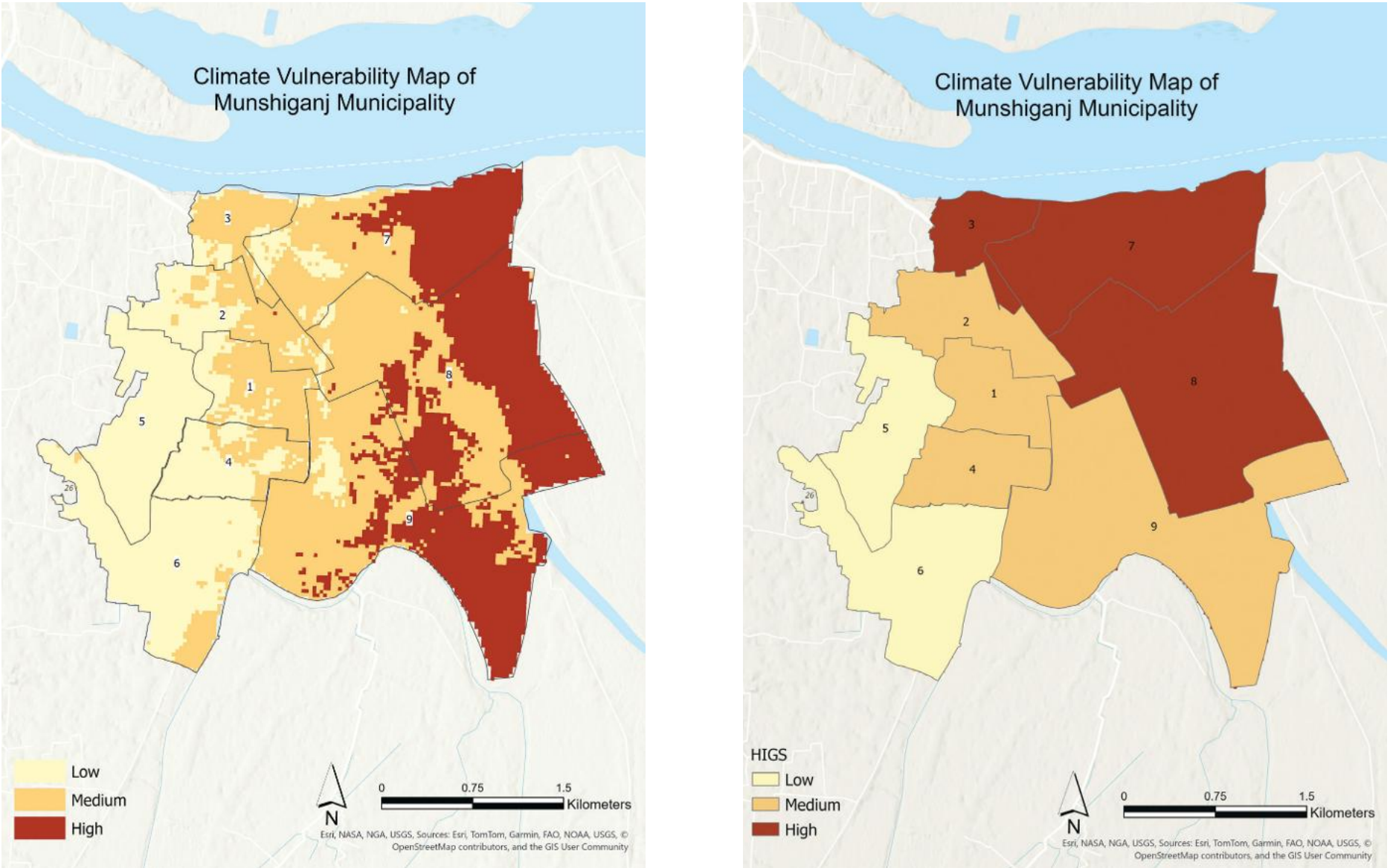
The satellite-based and HIGS assessments provide two complementary perspectives on climate vulnerability in Munshiganj Municipality. The satellite-based assessment primarily represents physical and environmental vulnerability, incorporating factors such as flood susceptibility, rainfall and LST, whereas the HIGS assessment incorporates community-reported hazard impacts, infrastructure and urban services, governance and socio-economic conditions.

Comparison of the two results shows meaningful but not complete spatial agreement. The satellite-based vulnerability map identifies Wards 7, 8 and 9, particularly the eastern and southeastern parts of the municipality, as the main areas of high physical vulnerability. This pattern is associated with their proximity to rivers, higher rainfall, flood susceptibility and comparatively high pre-monsoon LST.

The HIGS assessment also identifies Wards 7 and 8 among the most vulnerable wards, demonstrating a clear convergence between physical exposure and community-level vulnerability in these areas. These wards therefore represent important climate-vulnerability hotspots where environmental exposure coincides with socio-economic and service-related sensitivity.

However, some differences are also evident. Ward 3 has the highest HIGS score despite not being among the most extensive high-vulnerability areas in the satellite assessment. This is mainly because HIGS captures factors not represented directly by satellite data, including the strong reported impact of heavy rainfall and waterlogging and comparatively high infrastructure vulnerability. Conversely, Ward 9 shows substantial physical vulnerability in the satellite assessment but a lower HIGS score than Wards 3, 7 and 8, indicating that physical exposure alone does not determine overall vulnerability.

These differences should not be considered inconsistencies. Rather, they demonstrate the value of combining the two approaches. The satellite assessment identifies where physical climate stresses are concentrated, while HIGS identifies where those stresses interact with infrastructure weaknesses and socio-economic sensitivity.



Map 10: *Ward level Climate Vulnerability Assessment Using Primary and Secondary Data*

4.3 Climate Impact Assessment

The questionnaire survey assessed the impacts of climate-related hazards on seven major urban systems: housing, transportation, water supply, sanitation and wastewater, stormwater drainage, solid waste management, and internet and communication. The results indicate that climate hazards affect Munshiganj Municipality through multiple interconnected urban systems. Water contamination, drainage disruption, service interruptions, mobility constraints, health risks, and damage to infrastructure are among the key reported impacts. The findings highlight the importance of strengthening basic urban services, particularly drainage, water supply, sanitation, waste management, and critical utility systems, as part of climate-resilient municipal planning.

Table 14: Impacts on the Infrastructure and Urban Systems during Hazards

Urban System	Impact	Frequency
Housing	Disruption of utility services at the homestead	1157
	Increased costs for utilities	965
	Health risk from physical injuries or mental stress	889
	Loss of property and livestock	689
	Homestead damage and rebuilding costs	655
	Displacement of residents and temporary/permanent relocation	395
	Gender-based violence and safety	93
Urban System	**Impact**	**Frequency**
Transportation	Mobility and access challenges	874
	Health risk from physical injuries or mental stress	847
	Vehicle damage & repair/replacement costs	747
	Delay in emergency response & relief work	527
	Disruption of maintenance and operational activities	500
	Infrastructure damage & rebuilding costs	417
	Gender-based violence and safety	62

Urban System	Impact	Frequency
Water Supply	Increased demand for water supply	916
	Water contamination & related health risks	835
	Interruption of delivery services	693
	Disruption of maintenance and operational activities	664
	Water infrastructure damage & repair costs	330
	Flooding of water supply infrastructure	144
	Increased workload	70
Urban System	**Impact**	**Frequency**
Sanitation & Wastewater	Flooding of sanitation/wastewater facilities	973
	Exposure to untreated sewage/waste & related health risks	1141
	Water contamination & related health risks	1290
	Disruption of maintenance and operational activities	821
	Infrastructure damage & repair costs	620
	Increased workload	235
Urban System	**Impact**	**Frequency**
Stormwater Drainage	Water contamination & related health risks	1219
	Disruption of maintenance and operational activities	784
	Blockage & overflows of drainage	1346
	Drainage infrastructure damage & repair costs	801
	Increased workload	269

Urban System	Impact	Frequency
Solid Waste Management	Contamination & public health risks	1178
	Disruptions of waste collection & transportation	1066
	Blockage & overflows of waste disposal sites	1010
	Increased decomposition	1006
	Disruption of maintenance and operational activities	748
	Waste-management infrastructure damage & repair costs	504
	Disruption of treatment & recycling facilities	518
Urban System	**Impact**	**Frequency**
Internet & Communication	Disruption of internet/communication due to power outages	1502
	Internet service interruption & slowdown	1414
	Damage to communication towers/cables & service outages	1222
	Disruption in timely information & warnings	787
	Reduced emergency response communication	574
	Disruption of maintenance and operational activities	488

[Note: The survey covered 360 individual respondents, each of whom assessed six climate-related hazards, producing a maximum of 2,160 hazard-specific observations for each impact. Multiple impacts could be reported. Therefore, the values represent cumulative response frequencies rather than unique respondents]

Table 15: Ward-Level Impact Assessment of Hazards in Munshiganj Municipality

Ward	Key impacts on urban systems	Overall impact
Ward 1	Water contamination; maintenance/service disruption; drainage problems; power and communication interruptions; increased utility stress	Broad impact across WASH and utility systems
Ward 2	Water contamination; health and safety risks; drainage blockage/overflow; sanitation disruption; communication interruption	Strong storm-related infrastructure and public-health impacts
Ward 3	Severe water contamination; drainage blockage; sanitation risks; health impacts; internet and communication disruption	Multi-system vulnerability with strong water and drainage impacts
Ward 4	Service/maintenance disruption; water contamination; housing and mobility impacts; communication disruption; heat-related health stress	Significant storm, flood and heat impacts
Ward 5	Mobility/access problems; water contamination; waste collection disrupWion; utility and communication interruptions	Comparatively lower flood exposure but persistent service constraints
Ward 6	Water contamination; service disruption; drainage problems; loss of property/livestock; waste-management impacts; communication interruption	Strong flood and service-continuity concerns
Ward 7	Extensive service disruption; water contamination; health risks; housing and utility impacts; drainage, waste and communication disruption	Most widespread multi-sector impact
Ward 8	Drainage disruption; water contamination; health risks; housing and transport impacts; waste and communication disruption	Strong flood–rainfall–WASH vulnerability
Ward 9	Water contamination; drainage blockage/overflow; service disruption; mobility constraints; waste and communication impacts	Significant rainfall and storm-related impacts

05. WAYS FORWARD BASED ON CLIMATE VULNERABILITY

Table 16: Ward-Level Climate Adaptation and Resilience Actions

Ward	Key vulnerability	Recommended ways forward
1	Rainfall, water contamination, drainage and heat stress	Clean and rehabilitate drains; improve drainage outfalls; protect water sources; regular waste clearance; increase tree plantation and shaded areas; improve Internet reliability
2	Thunderstorm/lightning, rainfall and flood	Strengthen electrical infrastructure; install lightning protection at public facilities; establish early-warning dissemination; improve drains; raise vulnerable road sections; protect water points
3	Flood, heavy rainfall, water contamination and drainage	Upgrade drainage capacity; construct/widen critical drains; protect and raise water points; improve sanitation; strengthen flood protection; raise critical roads and ensure emergency access
4	Thunderstorm, flood and heat	Improve drainage and road crossings; strengthen Internet and lightning protection; introduce roadside/institutional tree plantation; improve shaded public spaces; promote heat-resilient buildings
5	Mobility, waste and drainage service gaps	Improve local drainage; ensure regular waste collection; provide strategically located waste bins; improve water-service reliability; expand tree plantation; maintain existing open/green areas
6	Flood, water contamination and service disruption	Improve drainage; install/extend water supply lines; flood-proof water points; establish early-warning mechanisms; strengthen Internet supply; maintain emergency food/water stocks
7	Highest multi-hazard and multi-system vulnerability	Implement integrated drainage, water, sanitation, SWM, housing, road, internet and communication improvements; establish emergency preparedness and shelter arrangements; expand green coverage
8	Flood, rainfall, drainage and WASH vulnerability	Improve drainage and flood outfalls; strengthen embankment/flood protection where technically justified; flood-resilient toilets and water points; improve waste collection; upgrade vulnerable houses and access roads; increase tree cover
9	Heavy rainfall, storm, drainage and emergency access	Construct/improve drains; improve road drainage and crossings; establish lightning protection; strengthen early-warning systems; develop/upgrade emergency shelter access; expand tree plantation



The proposed interventions translate the identified impacts into practical urban adaptation measures. The recommendations follow a phased approach: immediate service maintenance and preparedness, followed by infrastructure upgrading and longer-term climate-resilient urban development.

Based on the climate vulnerability assessment, hazard exposure analysis, infrastructure assessment, and ward-level findings presented in the preceding sections, a set of priority climate-action interventions has been identified for Munshiganj Municipality. To translate these findings into an implementable action framework, the proposed interventions are organized according to their target locations, primary climate hazards addressed, implementation priority, indicative cost level, responsible entities, and measurable key performance indicators (KPIs). The implementation matrix gives particular emphasis to interventions that respond directly to the highest ward-level vulnerabilities identified through the HIGS assessment and climate-impact analysis. Priority actions include immediate improvement of sanitation and public toilet facilities in Wards 1–3, development of a small-scale Material Recovery Facility (MRF) pilot in Wards 2, 3 and 7, and progressive implementation of integrated riverfront, waterbody conservation and blue-green infrastructure measures as a longer-term strategic intervention.

Table 17: Climate Action Implementation and Prioritization Matrix for Munshiganj Municipality

Intervention Component	Target Location (Priority Wards)	Primary Hazard	Cost Level	Lead Entity	Key Performance Indicator (KPI)
Public Toilet Construction & Shared Sanitation Facilities	Wards 1, 2, 3 **(Priority 1)**	Water Contamination / Waterborne Disease	Medium	Municipality / DPHE	Number of public/shared toilets constructed, upgraded or made climate-resilient
Waste Segregation & Small-Scale Material Recovery Facility (MRF) Pilot	Wards 2, 3, 7 **(Priority 2)**	Solid Waste / Water Pollution / Drainage Blockage	Medium	Municipality Conservancy Section / Private or Community Partners	Percentage of collected waste segregated and/or recovered through the pilot
Integrated Riverfront, Waterbody Conservation & Sustainable Tourism Development	Riverfront, canal and waterbody areas, especially Wards 7–9 **(Priority 3)**	Flooding / Waterlogging / Environmental Degradation	High	Municipality / LGED / Relevant Agencies / Private & Community Partners	Length/area of riverfront, canal and waterbody system restored or developed with blue-green infrastructure
Drainage Desilting, Clearing & Outfall Improvement	Wards 1, 3, 6, 7, 8, 9	Waterlogging / Heavy Rainfall	Low	Municipality Engineering Section / LGED	Kilometres of priority drains cleared or rehabilitated
Flood-Resilient Water Points & Water-Supply Protection	Wards 2, 3, 6, 7, 8	Water Contamination / Flooding	Low	Municipality / DPHE	Number of water points protected, raised or made flood-resilient
Pre-Monsoon Waste Clearance & Drainage Protection	Priority drainage/waste-service locations, especially Wards 1, 3, 5, 7, 8, 9	Waterlogging / Water Pollution	Low	Municipality Conservancy Section	Percentage of priority drains receiving documented pre-monsoon clearance
Climate-Resilient Drainage Upgrading	Wards 1, 3, 6, 7, 8, 9	Waterlogging / Heavy Rainfall	Medium	Municipality Engineering Section / LGED	Kilometres of drainage upgraded with improved capacity/outfalls
Climate-Resilient Roads & Mobility Improvement	Wards 2, 3, 6, 7, 8, 9	Flooding / Waterlogging	High	Municipality / LGED	Kilometres of roads upgraded with integrated drainage and resilient crossings
Flood-Resilient Sanitation & Wastewater Management	Wards 1, 2, 3, expanding to 7, 8	Water Contamination / Waterlogging	Medium	Municipality / DPHE	Number of households/public facilities receiving improved sanitation or wastewater services
Urban Greening & Heat-Mitigation	Wards 1, 3, 4, 7, 8	Heat Stress	Low	Municipality / Forest Department	Number of trees planted and/or area receiving added green/shaded coverage
Resilient Housing Improvement	Wards 3, 7, 8	Heat / Flooding / Structural Risk	High	Municipality / LGED / NGOs	Number of vulnerable houses upgraded with resilience measures
Internet, Communication & Early-Warning Resilience	Wards 2, 3, 4, 6, 7, 9	Thunderstorm / Extreme Weather	Medium	Municipality / REB or Power Utilities / DDM	Number of critical facilities with backup communication, power and/or warning systems



06. CLIMATE ADAPTATION INTERVENTION: INTEGRATED RIVERFRONT, WATERBODY CONSERVATION AND SUSTAINABLE TOURISM DEVELOPMENT

Munshiganj Municipality's rivers, canals, ponds and wetlands are not peripheral features of the urban area; they form an interconnected environmental, drainage, livelihood and cultural system through which several of the municipality's major climate vulnerabilities are expressed. This chapter therefore proposes an integrated intervention centred on riverfront development, canal and waterbody conservation, nature-based solutions, heritage conservation and sustainable tourism development.

6.1 Rationale: From Vulnerability Findings to Proposed Intervention

The rationale for prioritizing waterbody conservation and riverfront development emerges from the convergence of three independent components of the vulnerability assessment. First, heavy rainfall and waterlogging represent the most severe climate-related vulnerability identified through the HIGS method, with the highest hazard score concentrated in Ward 3. The infrastructure assessment independently identifies stormwater drainage and sanitation and wastewater as the weakest sectors, with particular

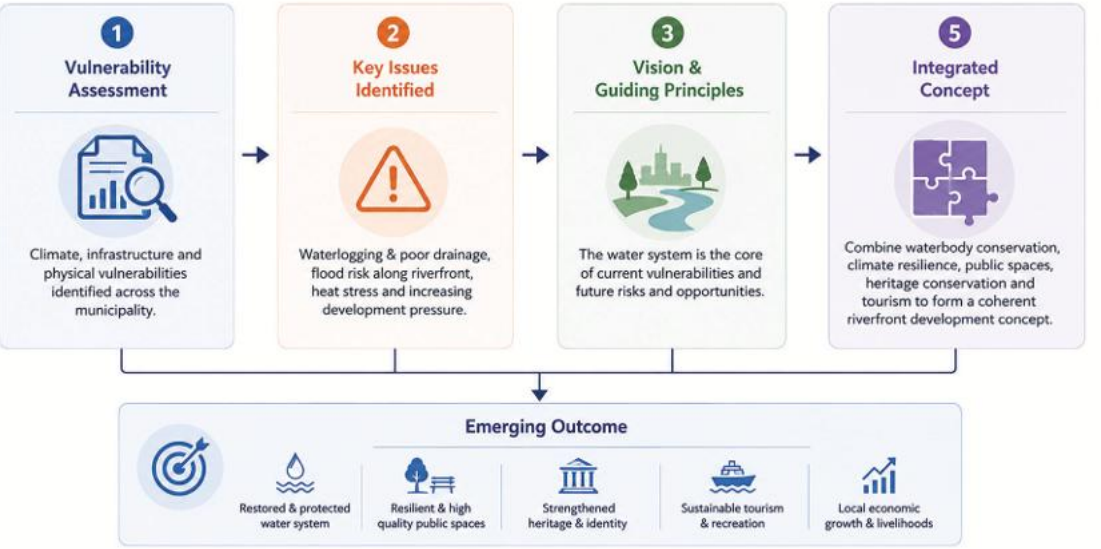


Figure 21: *Process from vulnerability assessment to riverfront and tourism development concept*

concentration in Wards 1, 2 and 3. These findings indicate that waterlogging is not solely a consequence of rainfall intensity but is also strongly associated with inadequate drainage capacity and constrained water conveyance.

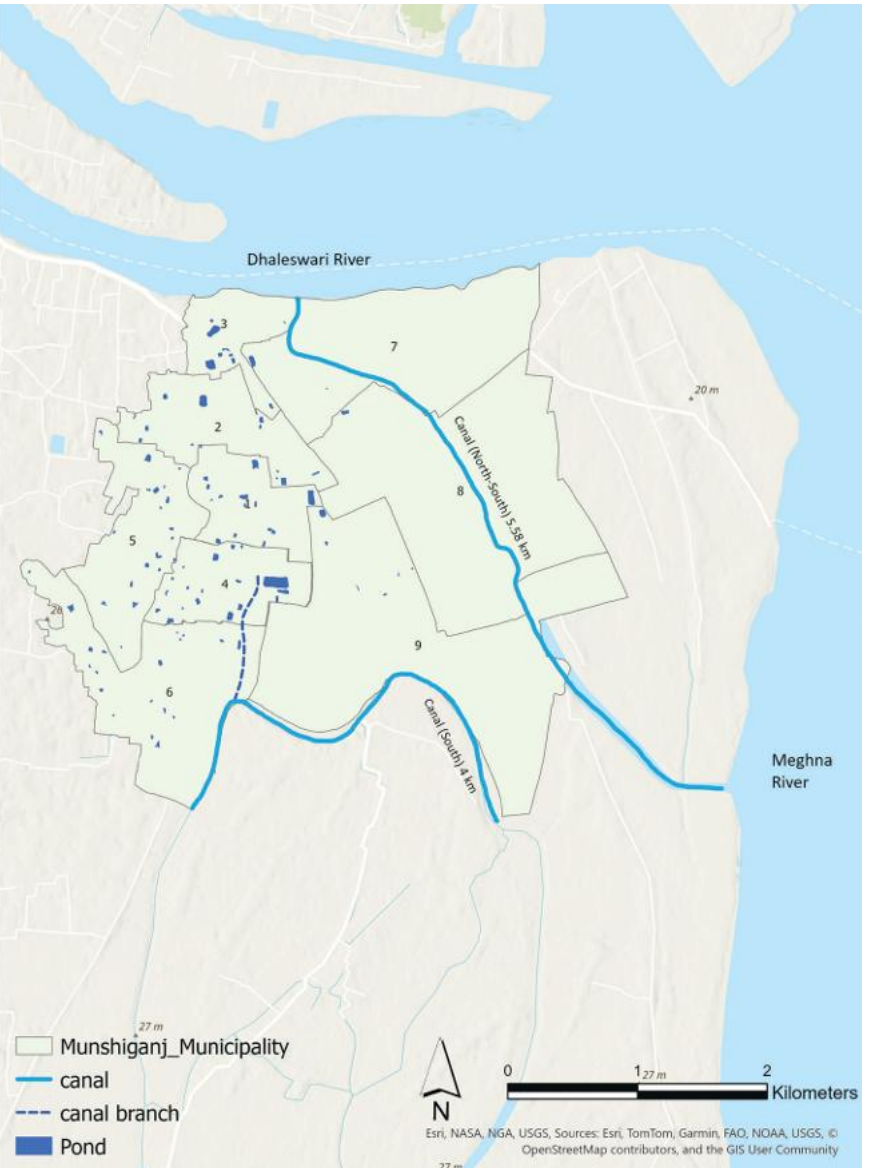
Second, the physical vulnerability assessment identifies another important cluster in Wards 7, 8 and 9, where flood susceptibility and elevated land surface temperature coincide with the municipality's riverfront and canal network. Field investigation independently confirms flood vulnerability in these wards.

Third, the municipality is entering a period of increasing development pressure associated with regional connectivity improvements, including bridge and regional highway constructions and associated transport infrastructures. Field consultation identifies Ward 7 as particularly exposed to the resulting increase in traffic and urban development pressure. Land currently characterized by agricultural or relatively undeveloped uses in the eastern and southeastern portions of the municipality may therefore experience substantial transformation.

The proposed concept is based on the principle that restoration of the water system should precede and guide public-space and tourism development. Rather than treating riverfront development as conventional beautification, the proposed approach seeks to create a climate-resilient blue-green corridor that improves drainage and flood resilience while providing public access, recreational opportunities, heritage experiences and local economic benefits.

6.2 Existing Water Network Profile of Munshiganj Municipality

Munshiganj Municipality is located within a highly dynamic riverine floodplain environment influenced by major surrounding rivers, including the Dhaleshwari, Meghna, Padma, and associated river channels. The municipality contains a significant number of surface water bodies, including rivers, canals, ponds, and ditches. These water systems historically played an important role in in maintaining natural drainage, stormwater conveyance, and connectivity between urban areas and surrounding river systems.



Map 11: *Existing Water Network Map of Munshiganj Municipality*

The canal branch originated from the Dhaleshwari River at the northern part flows through Ward Nos. 7, 8, and 9 before connecting with the Meghna River. The canal has a total length of approximately 5.58 km, of which 3.95 km lies within the municipal boundary. This canal, historically known as the Kalidas River, maintains connectivity with the Dhaleshwari–Meghna river system and serves as an important component of the local water network. Another canal branch (4 km) originates from the Meghna River on the southern side and flows adjacent to Ward 6. A small branch (1 km) from this canal is located in wards 6 and 4.

According to the Urban Master Plan (IUGIP, 2025), Munshiganj Municipality contains a total of 652 water bodies, including ponds, ditches, irrigation canals, khals, lakes, and borrow pits.

6.3 Existing Water Use Pattern and Socio-economic Functions of Canal Network

6.3.1 Canal as a Local Transport Corridor

Historically, the canal and connected river system played a significant role in local navigation and transportation. The canal network contains several boat landing points (Ghat) used for boat parking, boarding, and passenger movement, supporting small-scale water-based mobility and daily activities of local residents. Although the navigability of some sections has declined due to sedimentation and reduced water flow, the existing ghats continue to provide important access points for boat movement and community connectivity.

6.3.2 Domestic and Community Water Use

The canal and connected river systems have historically supported various household activities of nearby communities. Field observations indicate that despite pollution, households continue to use canal water for activities such as bathing, washing utensils, and other domestic purposes due to limited alternatives.

6.3.3 Livelihood and Socio-economic Importance

The canal network contributes to local livelihoods by supporting fishing activities and other water-dependent practices. The surrounding settlements maintain a close relationship with the canal system; however, declining water quality and reduced functionality have affected the economic and social benefits previously provided by these waterways.





Figure 22: *Existing Water Use Pattern and Socio-economic Functions of Canal Network*



Figure 23: *Traditional fishing activity along the canal/riverbank*

6.4 Existing Condition of the Canal

6.4.1 Current Flow Condition and Drainage Functionality

The present condition of several canal sections is characterized by low water flow, stagnant water pockets, and reduced circulation. Field observations indicate that the natural flow of the canal has declined compared to historical conditions, despite existing connections with nearby rivers. During the monsoon season, the canal plays an important role in receiving and conveying excess rainfall runoff. However, reduced flow capacity, channel narrowing, and obstruction caused by waste accumulation limit drainage performance. These conditions increase the risk of drainage congestion, prolonged water stagnation, and waterlogging in adjacent settlements.

6.4.2 Pollution and Environmental Degradation

Waste disposal, polythene accumulation, drainage discharge, and possible wastewater connections as key factors contributing to canal pollution (Figure 24). Due to deteriorating water quality and stagnant conditions, canal water is currently unsuitable for regular domestic use. The reduction in water quality has also affected the ecological value of the canal system and reduced its contribution to local water-based activities.

6.4.3 Sedimentation and Channel Capacity Reduction

Sedimentation is one of the major factors influencing the current condition of the canal system. Field observations and community feedback indicate that several water channels were historically wider, deeper, and more actively used for navigation and transportation. However, gradual sediment deposition and reduced flow have altered channel characteristics and reduced their water-carrying capacity (Figure 25). Existing area of canal (north-south) is only 0.0771 km^2 and the area of the canal on the southern side is only 0.11 km^2. The 1 km canal branch is almost encroached. The accumulation of sediments has contributed to reduced navigability, weaker river-canal interaction, and decreased efficiency of natural drainage functions.

6.4.4 Community Vulnerability and Climate Impacts

Settlements along the canal banks are directly affected by the declining condition of the water network. Communities experience challenges related to drainage congestion, stagnant water, pollution, and seasonal flooding. The presence of settlements along canal corridors increases human pressure on the water system through waste disposal, encroachment, and wastewater discharge. During monsoon periods, rising river levels and insufficient drainage capacity increase flood exposure. Field surveys indicate that flooding affects household activities and creates additional sanitation risks, particularly where wastewater mixes with floodwater.



Figure 24: *Drainage Outfall and Solid Waste Accumulation at Canal Edge*



Figure 25: *Canal encroachment and reduced waterway width associated with sedimentation, aquatic vegetation growth, and waste dumping.*

6.5 Restoration Potential and Adaptation Measures

Nature-based solutions and ecosystem-based approaches are increasingly recognized as essential tools for climate adaptation. The IPCC highlights that restoring wetlands and rivers, improving natural water retention, applying sustainable land-use planning, and strengthening green infrastructure can reduce flood risk and improve resilience (IPCC, 2022). Such measures also provide multiple co-benefits, including biodiversity conservation, groundwater recharge, heat reduction, improved air quality, public recreation, health benefits, and better quality of urban life. Therefore, canals, rivers, wetlands, ponds, floodplains, green buffers, parks, and open spaces should be treated not as unused or leftover land, but as critical climate-resilient infrastructure.

The existing canal network has significant potential to support climate-resilient urban drainage and water management in Munshiganj Municipality. However, improving its functionality requires integrated restoration measures, including canal re-excavation, removal of blockages, sediment management, pollution control, improvement of drainage connectivity, and regular maintenance. Restoring canal flow and protecting natural water corridors will enhance stormwater management capacity, reduce waterlogging risks, improve environmental quality, and strengthen the municipality's resilience against future climate impacts.

6.6 Policy and Legal Alignment

The proposed intervention is aligned with Bangladesh's water-resource, environmental, spatial-planning, climate-adaptation and tourism frameworks. The relevant instruments are summarized below in chronological order from latest to oldest.

Table 18: Relevant Policies and Legal Instruments Supporting the Proposed Intervention

Year	Policy / Legal Instrument	Relevance to the proposed intervention
2026	**Spatial Planning Act, 2026**	Provides the current framework for spatial planning and supports integration of environmental and water-resource considerations into development planning. It is particularly relevant to preventing incompatible development around waterbodies and guiding future riverfront growth. The Act was enacted on 8 April 2026.
2025	**National Urban Policy 2025**	Provides a contemporary framework for planned, inclusive, environmentally sustainable and climate-resilient urban development. It supports integrated urban planning, improved public spaces, environmental conservation, local governance and inclusive economic development.
2023	**National Adaptation Plan of Bangladesh 2023–2050**	Provides the national adaptation framework for reducing climate vulnerability. Its emphasis on climate-resilient cities, nature-based solutions, ecosystem protection and integration of adaptation into planning directly supports the proposed blue-green corridor and resilient riverfront.
2018	**Bangladesh Delta Plan 2100**	Provides the overarching long-term framework for integrated management of water, ecology, environment and land in the context of climate change and natural hazards. It directly supports flood resilience, drainage improvement, waterbody conservation and integrated river management.
2018	**Bangladesh Water Rules, 2018**	Provides implementation mechanisms under the Bangladesh Water Act and is relevant to water-resource interventions such as excavation, drainage improvement and management of water systems.

Year	Policy / Legal Instrument	Relevance to the proposed intervention
2013	**Bangladesh Water Act, 2013**	Provides the legal framework for protection, conservation and integrated management of water resources. It supports restoration and sustainable management of the municipal river and canal system.
2013	**National River Conservation Commission Act, 2013**	Establishes the framework for preventing river encroachment and pollution and supporting restoration of normal river flow and navigability. It is directly relevant to riverfront and river/canal connectivity.
2010	**National Tourism Policy, 2010**	Provides the policy basis for sustainable tourism, including eco-tourism, community participation, conservation of natural resources and preservation of cultural values. This directly supports the proposed heritage–river–canal tourism circuit.
2000	**Playgrounds, Open Spaces, Gardens and Natural Water Reservoirs Conservation Act, 2000**	Provides a key legal basis for protecting natural water reservoirs and preventing inappropriate conversion or alteration. It supports conservation and boundary protection of the municipality's ponds and other natural waterbodies.
1999	**National Water Policy, 1999**	Provides the national policy framework for water-resource management, including water for the environment, wetlands, fisheries, navigation, recreation and stakeholder participation.
1995	**Bangladesh Environment Conservation Act, 1995**	Provides the overarching framework for environmental conservation, pollution control, ecological protection and environmental clearance for relevant development activities.
1992	**Water Resources Planning Act, 1992**	Provides the institutional and planning basis for balanced development and use of water resources and supports integrated water-resource planning. The Ministry of Water Resources continues to list it within the national water-resource legal framework.

6.7 Proposed Integrated Riverfront Development Concept

Riverfront development is proposed as a climate-resilient public-realm and waterbody management intervention, rather than conventional beautification. The concept seeks to improve the environmental and recreational functions of the riverfront while strengthening its connection with the existing urban, heritage and tourism network.

The proposed riverfront, canal and tourism development should be guided by the following principles:

1. **Water-System First:** The hydrological and ecological functions of rivers, canals, ponds and wetlands should guide subsequent development.
2. **Protect Before Developing:** Waterbody boundaries, drainage corridors and ecologically sensitive areas should be identified and protected before new facilities are introduced.
3. **Climate-Resilient Design:** Riverfront facilities should account for seasonal water-level variation, flooding, erosion and projected climate risks.
4. **Nature-Based Development:** Vegetated edges, wetlands, permeable surfaces and green infrastructure should be prioritized over extensive hardscape.
5. **Public Accessibility:** The riverfront should provide safe and inclusive access through appropriate pedestrian, cycling and public-space connections.
6. **Build on Existing Tourism Assets:** Existing riverfront restaurants, tourism spots, ghats and recreational activities should be recognized, improved and integrated into the proposed network, rather than treated as separate or redundant facilities.

7. **Heritage-Sensitive Development:** New tourism facilities should complement the cultural and architectural character of heritage sites and avoid intrusive development.
8. **Low-Impact Tourism:** Tourism activities should remain within the ecological, hydraulic and social carrying capacity of the river and canal system.
9. **Local Economic Participation:** Local communities should have opportunities to participate in tourism-related employment, guiding, boat services, food, crafts and other small enterprises.
10. **Phased and Evidence-Based Implementation:** The concept should be refined through detailed feasibility studies, surveys, stakeholder consultation and technical assessments before implementation.
11. **Long-Term Operation and Maintenance:** Each public-space, waterbody and tourism facility should have clearly defined institutional responsibility for operation, maintenance and environmental management.

The proposed riverfront corridor may incorporate:

1. Ecological restoration and riverbank protection;
2. Flood buffering and green infrastructure;
3. Public open spaces and recreational facilities;
4. Pedestrian and cycling connectivity;
5. Improved boat stations and water-based mobility;
6. Heritage and cultural interpretation;
7. Tourism and visitor facilities;
8. Local economic activities; and
9. Climate-resilient development standards.

Importantly, existing riverfront tourism and recreational destinations, including riverside restaurants and visitor facilities, should be considered as part of the existing tourism base. The proposed intervention therefore focuses on improving their environmental performance, accessibility and connectivity and integrating them into a broader riverfront–heritage–canal tourism network.

The exact configuration, dimensions and structural treatment should be determined through detailed topographic, hydraulic, geotechnical and engineering studies.

6.7.1 Flood-Resilient Development Control

Future development within or adjacent to the proposed riverfront corridor should be guided by appropriate climate-resilient development controls, including:

1. Flood-resilient building standards;
2. Adequate drainage provision;
3. Appropriate finished-floor levels;
4. Protection of natural drainage paths;
5. Adequate wastewater and sanitation facilities;
6. Permeable surface provision;
7. Protection of waterbody boundaries; and
8. Appropriate setbacks and ecological buffers.

The specific standards and setbacks should be established through subsequent detailed planning, hydraulic and engineering assessments.

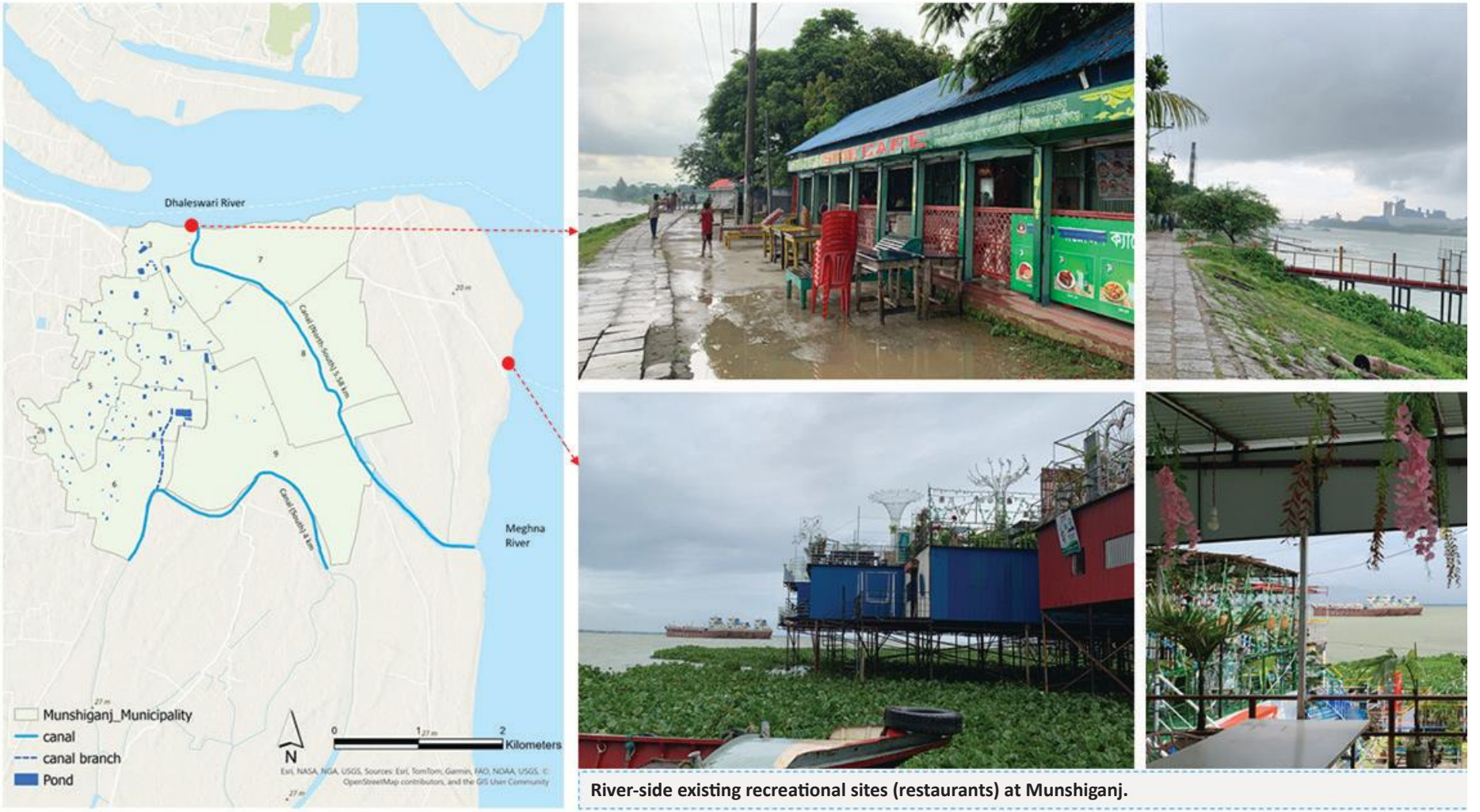


Figure 26: *Existing recreational sites at riverbanks*

6.7.2 Canal and Waterbody Conservation Strategy

The municipality's recorded waterbodies should be considered within spatial planning and development-control mechanisms to prevent further loss, encroachment and degradation.

Canal and waterbody restoration should be undertaken through a segment-based and condition-specific approach, recognizing that the physical and functional conditions of individual waterbodies vary across the municipality. The boundaries of priority canals and waterbodies should be surveyed, mapped and appropriately demarcated to prevent encroachment and unauthorized filling.

Re-excavation and desiltation should prioritize severely narrowed, blocked or poorly functioning sections of the canals, subject to hydraulic assessment.

Canal restoration should be accompanied by assessment of upstream drainage and downstream outfall conditions. Restoration of individual drains or canals without adequate receiving-water capacity may not provide the intended reduction in waterlogging.

Potential wastewater connections and pollution sources should be identified and appropriately managed. Solid-waste and polythene dumping along canals and waterbodies should be addressed through improved waste management, awareness and enforcement.

6.7.3 Nature-Based Solutions and Blue-Green Infrastructure

Nature-based solutions should form an integral component of the proposed riverfront and waterbody management strategy.

The proposed blue-green network would establish functional connections between:

River → Canal → Pond/Wetland → Drainage Network → Green/Open Space

Potential measures include: riparian vegetation; vegetated riverbank buffers; rain gardens; bio-retention areas; retention ponds; wetland restoration; permeable public spaces; urban tree planting; and ecological landscaping.

These measures can contribute to stormwater retention, runoff reduction, heat mitigation, biodiversity enhancement and improvement of the urban environment.

6.8 Integrated Heritage, Riverfront and Sustainable Tourism Development

Munshiganj's riverfront, canal network, heritage assets and existing tourism facilities provide an opportunity to establish an integrated heritage–river–canal tourism network. The tourism and recreational elements are secondary co-benefits intended to improve public access, support local livelihoods, connect heritage assets, and encourage long-term protection and maintenance of restored waterbodies.

6.8.1 Proposed Tourism Zones

Zone 1: Riverfront Tourism and Recreation Zone

The riverfront should consolidate and improve existing tourism and recreational activities, rather than replace them with entirely new commercial development.

Existing riverside restaurants and tourism spots can be connected with: riverfront promenade; viewing points; landscaped public spaces; seating and shaded areas; riverfront public amenities; improved ghats; floating pontoons; water-based recreational activities; and appropriate visitor facilities.

Zone 2: Canal Eco-Tourism Network

Following restoration, suitable canal sections may be considered for low-impact recreational and eco-tourism activities such as: canal cruises; small-scale boating; fishing activities; walking and cycling routes; viewing areas; and community-based recreation.

Any boating or water-based tourism activity should be subject to hydraulic, environmental, safety and carrying-capacity assessment.

Zone 3: Heritage Tourism Precinct – Idrakpur Fort

Idrakpur Fort may serve as a primary heritage tourism node, with potential emphasis on: heritage conservation; interpretation facilities; viewing areas; heritage plaza; local

craft and cultural activities; landscaped public space; and pedestrian connectivity to the wider tourism network.

Development should remain compatible with the heritage character and applicable conservation requirements.

Zone 4: Baba Adam Religious Heritage Zone

Baba Adam Mosque may function as a cultural and religious heritage node supported by: improved pedestrian access; visitor facilities; appropriate sanitation; landscaped areas; heritage interpretation; and locally managed cultural and commercial activities.

Development should respect the religious and cultural character of the site.

Zone 5: Nagar Koshba Heritage and Cultural Zone

Nagar Koshba may function as a heritage and cultural tourism node within the proposed Munshiganj Blue-Green Heritage Tourism Circuit. The zone should focus on conserving the heritage character of the site while improving its accessibility and connection with other heritage and riverfront destinations.

Development should remain low-impact and heritage-sensitive, avoiding inappropriate structures or activities that could compromise the historical character of Nagar Koshba.

Table 19: Proposed Integrated Riverfront and Tourism Zones

Zone	Primary Function	Potential Components	Climate/Environmental Function	Socio-economic Benefit
Zone 1: Riverfront Tourism and Recreation Zone	Public waterfront and recreation	Promenade, viewing areas, improved ghats, existing restaurants, shaded seating and public amenities	Flood buffering, riparian protection and heat mitigation	Recreation, tourism and local employment
Zone 2: Canal Eco-Tourism Network	Low-impact water-based recreation	Restored canals, boating, eco-trails, walking and cycling routes, fishing and viewing areas	Improved drainage, water retention, water quality and biodiversity	Boat services, guiding and small-enterprise opportunities
Zone 3: Idrakpur Fort Heritage Tourism Precinct	Heritage and cultural tourism	Heritage conservation, interpretation facilities, heritage plaza, landscaped public space and pedestrian connections	Heritage-sensitive landscaping, shade and permeable public spaces	Cultural preservation, tourism and local enterprise
Zone 4: Baba Adam Religious Heritage Zone	Religious and cultural tourism	Improved pedestrian access, visitor facilities, sanitation, landscaping and heritage interpretation	Green public space, shade and improved environmental quality	Religious tourism, cultural preservation and local business
Zone 5: Nagar Koshba Heritage and Cultural Zone	Heritage and cultural tourism	Heritage conservation, interpretation, improved access, public space and connection with the wider tourism network	Low-impact landscaping, vegetation protection and heat mitigation	Cultural tourism, heritage preservation and local enterprise



Figure 27: *Identified Location for Integrated Riverfront Tourism-Based Development*

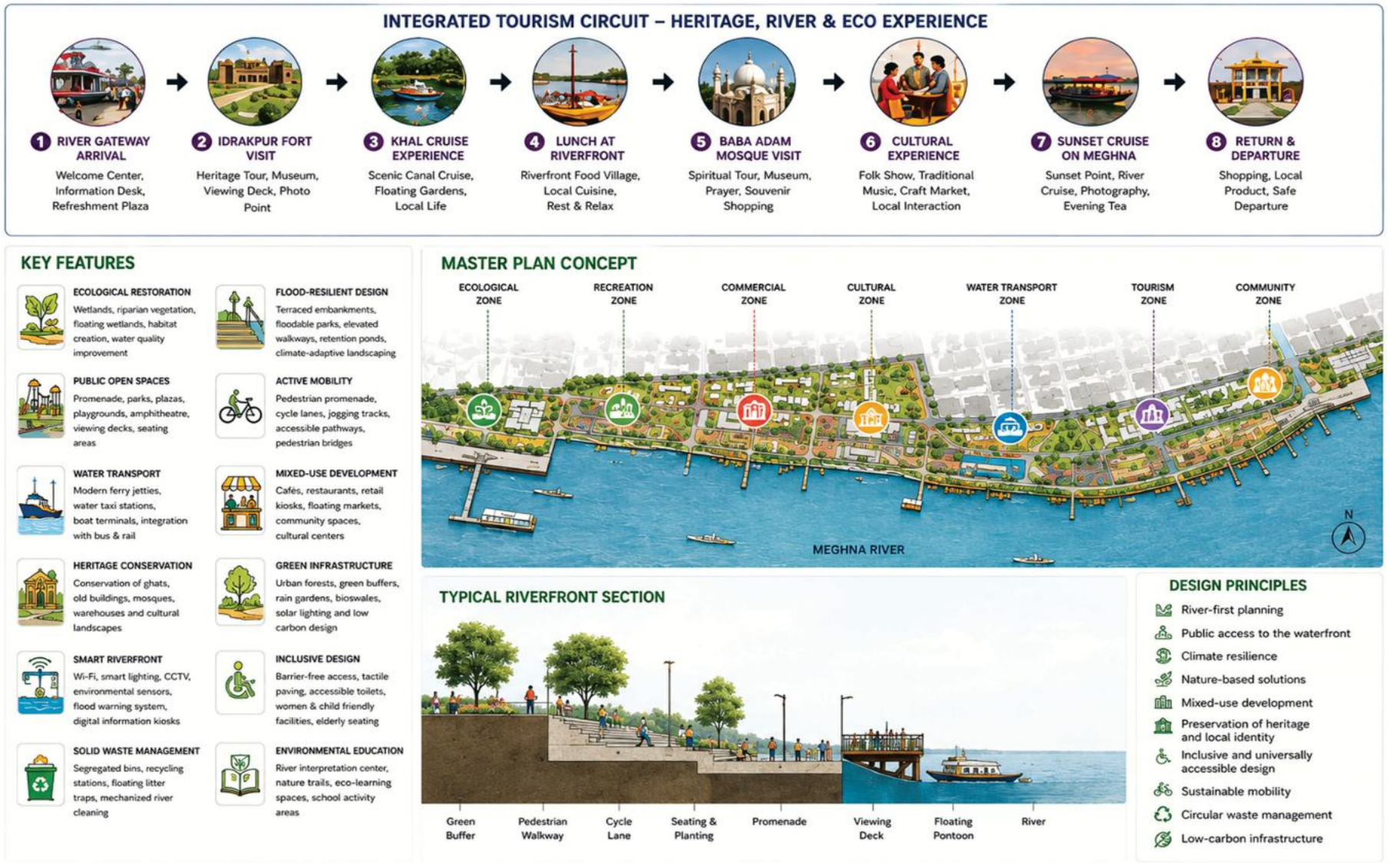


Figure 28: *Proposed Conceptual Framework for Riverfront Development*

6.9 Phased Implementation Strategy

The integrated riverfront intervention should be implemented progressively because detailed engineering, hydraulic, environmental, land, heritage, and financial assessments are required before major development. The three-phase strategy below provides an indicative framework for moving from planning and quick-win actions toward larger-scale riverfront development and long-term destination management.

The phases are intended to be sequential but adaptable. The exact alignment, configuration, dimensions, and structural treatment of the proposed riverfront facilities should be determined through detailed topographic, hydraulic, geotechnical, environmental, and engineering studies. The municipality should also establish clear responsibilities for operation and maintenance so that restored waterbodies, public spaces, tourism facilities, and ecological infrastructure remain functional over the long term.

Table 20: Phased Implementation Strategy for Integrated Riverfront Development

Phase	Period	Strategic Focus	Key Actions
Phase 1: Short Term	1–2 Years	Planning, Conservation and Quick Wins	Detailed planning and engineering/design; waterbody and riverbank assessment; priority dredging/desiltation where technically appropriate; heritage conservation initiatives; basic sanitation and public amenities; initial riverbank and blue-green improvements; quick-win public-space improvements; stakeholder and community engagement
Phase 2: Medium Term	3–5 Years	Riverfront Development, Canal Rehabilitation and Tourism Services	Development of priority riverfront stretches; canal/waterway rehabilitation; promenades and pedestrian connections; blue-green infrastructure; tourism and visitor facilities; improved ghats and recreational spaces; heritage-linked facilities; wayfinding and interpretation; waste and sanitation improvements; destination promotion
Phase 3: Long Term	5–10 Years	Major Infrastructure, Ecological Expansion and Smart Integration	Major riverfront infrastructure and attractions; expansion of ecological restoration and blue-green networks; smart riverfront management; digital tourism and information systems; integration with wider municipal mobility and infrastructure; expansion of tourism and cultural facilities where appropriate; destination branding and wider tourism promotion

6.10 Expected Climate, Environmental, Economic and Social Benefits

The integrated intervention is expected to produce multiple benefits simultaneously.

Climate Resilience

1. Reduced waterlogging in Ward 3 and surrounding areas.
2. Improved drainage and outfall connectivity.
3. Reduced flood exposure in Wards 7–9.
4. Increased temporary water retention.
5. Reduced heat exposure through green infrastructure.
6. Improved resilience to future development pressure.

Environmental Benefits

1. Restoration of canal and river ecological functions.
2. Protection of ponds and wetlands.
3. Improved water quality.
4. Reduced solid-waste pollution.
5. Increased vegetation and biodiversity.
6. Improved stormwater filtration and retention.

Economic Benefits

1. New tourism-related employment.
2. Local boat and transport services.
3. Growth of food and craft businesses.
4. Increased local entrepreneurship.
5. Increased value of appropriately managed public spaces.
6. Opportunities for community-based tourism.

Social Benefits

1. Improved public access to the river.
2. Additional recreational spaces.
3. Improved sanitation.
4. Safer waterfronts.
5. Preservation of cultural heritage.
6. Improved community identity and social interaction.

Mobility Benefits

1. Improved pedestrian and cycling connectivity.
2. Revitalized water-based mobility.
3. Better integration of ghats into the urban network.
4. Potential reduction of pressure on road-based mobility for selected local and tourism trips.

07. CONCLUSION

The Munshiganj Municipality Climate Action Plan provides an evidence-based framework for understanding and addressing climate risks at the municipal and ward levels. By combining GIS and satellite-based analysis with the HIGS assessment, field observations, stakeholder inputs, and socio-economic data, the CAP identifies heavy rainfall, waterlogging, heatwaves, and localized flooding as major concerns. It also demonstrates that climate vulnerability varies across wards because of differences in physical exposure, infrastructure, urban services, housing conditions, sanitation, and adaptive capacity.

The assessment identifies drainage and waterlogging management and flood-resilient water supply as the municipality's highest priorities. Climate-resilient sanitation and wastewater management, solid-waste management, resilient roads and housing, Internet and communication, urban greening, and emergency preparedness also require coordinated attention. Addressing these challenges will require integrated actions rather than isolated infrastructure projects.

The integrated water-network, waterbody conservation, and riverfront restoration intervention was selected for detailed development because it responds to several priorities simultaneously. Restoring canals, improving drainage and outfall connectivity, protecting ponds and wetlands, controlling encroachment and pollution, and introducing nature-based solutions can reduce waterlogging and flood risks while improving water quality, biodiversity, and environmental conditions. Heritage conservation, recreation, and sustainable tourism are proposed as secondary benefits that may support local livelihoods and encourage the long-term protection of restored waterbodies.

Effective implementation will require phased investment, clear institutional responsibilities, inter-agency coordination, community participation, and regular operation and maintenance. Detailed hydrological, environmental, engineering, land-ownership, and feasibility assessments should be completed before implementation. The CAP should also be reviewed periodically as new climate, demographic, and infrastructure data become available. Through coordinated implementation and sustained municipal commitment, Munshiganj can protect its natural water systems, improve essential services, reduce risks for vulnerable communities, and build a safer, healthier, and more climate-resilient urban future.



REFERENCES

1. Alam, R., Quayyum, Z., Moulds, S., Radia, M. A., Sara, H. H., Hasan, M. T., & Butler, A. (2023). *Dhaka city water logging hazards: Area identification and vulnerability assessment through GIS-remote sensing techniques*. Natural Hazards, 116(1), 925–950. https://doi.org/10.1007/s11069-023-05875-6

2. Bangladesh Bureau of Statistics. (2024). Population and housing census 2022: District report—Munshiganj. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. BBS Population and Housing Census

3. Bangladesh Bureau of Statistics. (2025). Population and housing census 2022: Community report—Munshiganj. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

4. Bangladesh Meteorological Department. (2022). Annual climate summary 2022. Ministry of Defence, Government of the People's Republic of Bangladesh.

5. Centre for Research on the Epidemiology of Disasters. (2025). EM-DAT: The international disaster database. Université catholique de Louvain. https://www.emdat.be

6. General Economics Division. (2018). Bangladesh Delta Plan 2100. Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.

7. General Economics Division. (2020). Making Vision 2041 a reality: Perspective Plan of Bangladesh 2021–2041. Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.

8. Government of the People's Republic of Bangladesh. (2009). Local Government (Municipality) Act, 2009. Legislative and Parliamentary Affairs Division, Ministry of Law, Justice and Parliamentary Affairs.

9. Government of the People's Republic of Bangladesh. (2026). Spatial Planning Act, 2026 (Act No. 31 of 2026). Bangladesh Code, Legislative and Parliamentary Affairs Division. Official legal text

10. Hasan, M. R., Hossain, M. T., Khan, L. A., & Afrin, S. (2018). *Seasonal water logging problem in an urban area of Bangladesh: A study on Pabna Municipality*. 1st National Conference on Water Resources Engineering, CUET.

11. Intergovernmental Panel on Climate Change. (2022). Climate change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009325844

12. Khan, N. S., Shawal, S., Hossain, M. A., Tasnim, N., Whitehead, P. G., & Rahman, M. (2024). Assessing flooding extent and potential exposure to river pollution from urbanizing peripheral rivers within Greater Dhaka watershed. Scientific Reports, 14, Article 29341. https://doi.org/10.1038/s41598-024-80063-4

13. Local Government Division. (2025). National Urban Policy 2025. Ministry of Local Government, Rural Development and Co-operatives, Government of the People's Republic of Bangladesh. The policy was formally approved on 1 January 2026. UNDP confirmation of approval

14. Local Government Engineering Department. (2025). Draft survey report for the preparation of the Urban Master Plan of Munshiganj Municipality. Integrated Urban Governance and Infrastructure Improvement Project (IUGIP), Government of the People's Republic of Bangladesh.

15. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh. (2009). Bangladesh climate change strategy and action plan 2009 (BCCSAP).

16. Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh. (2025). Nationally determined contribution (NDC): Updated submission.

17. Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh. (2022a). Mujib Climate Prosperity Plan 2022–2041. https://moef.portal.gov.bd/sites/default/files/files/moef.portal.gov.bd/publications/f6c2ae73_30eb_4174_9adb_022323da1f39/Mujib%20Climate%20Prosperity%20Plan%202022-2041.pdf.

18. Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh. (2022b). National adaptation plan of Bangladesh (2023–2050). https://faolex.fao.org/docs/pdf/BGD214817.pdf.

19. Munshiganj Municipality and Waste Concern. (2026). Field assessment and GPS-based mapping of canals, drainage outfalls and municipal waterbodies. Unpublished field-survey dataset.

20. Munshiganj Municipality and Waste Concern. (2026). Questionnaire survey for the preparation of the Munshiganj Municipality Climate Action Plan. Unpublished primary-survey dataset.

21. Rahaman, M. S., Hossain, N., Nurain, A., Sarker, P., & Ichihara, S. (2020). Investigation on causes and effects of waterlogging in the southern part of Bangladesh. *Management of Sustainable Development, 12*(2), 4–11. https://doi.org/10.54989/msd-2020-0006.

22. Rahman, M. M., Akteruzzaman, A. K. M., Khan, M. M. H., Jobber, A., & Rahman, M. M. (2009). Analysis of water logging problem and its environmental effects using GIS approaches in Khulna city of Bangladesh. *Journal of Socio Research Development, 6*(2), 572–577.

23. Rahman, M. M., Islam, A. R. M. T., Ahmed, B., & Islam, G. M. T. (2022). Urban heat stress and climate change impacts in Bangladesh. Climate Services, 28, Article 100329.

24. Rigaud, K. K., de Sherbinin, A., Jones, B., Bergmann, J., Clement, V., Ober, K., Schewe, J., Adamo, S., McCusker, B., Heuser, S., & Midgley, A. (2018). Groundswell: Preparing for internal climate migration. World Bank. https://doi.org/10.1596/29461.

25. World Bank. (2018). *Enhancing opportunities for clean and resilient growth in urban Bangladesh: Country environmental analysis*.

26. World Bank. (2021). Bangladesh: Cyclone Amphan rapid damage and needs assessment.

27. World Bank. (2022). Bangladesh country climate and development report. https://doi.org/10.1596/38241.

28. World Bank. (2024). Climate risk country profile: Bangladesh. https://climateknowledgeportal.worldbank.org/sites/default/files/country-profiles/16813-WB_Bangladesh%20Country%20Profile-WEB.pdf.

29. World Meteorological Organization. (2025). State of the climate in Asia 2024 (WMO-No. 1362).

30. World Meteorological Organization. (2026). State of the global climate 2025 (WMO-No. 1391). https://doi.org/10.59327/WMO/S/CRI/SOC/1.

ANNEX 1: WARD-WISE DATA TABLES

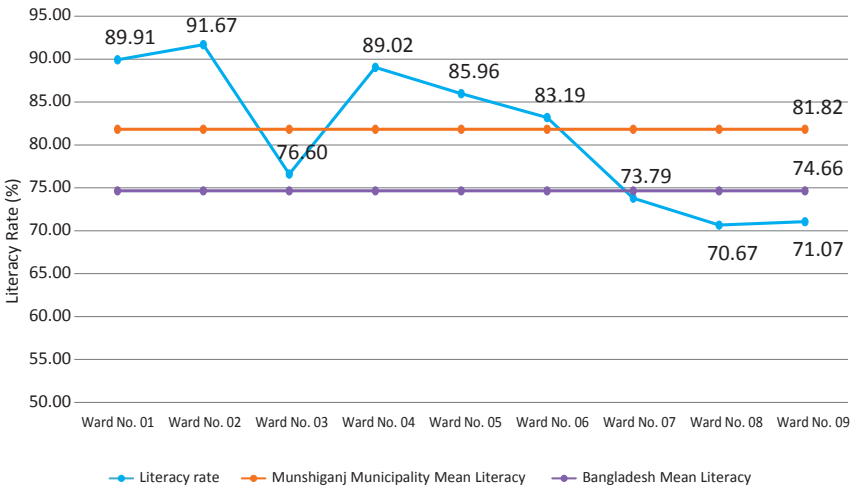


Figure A1: *Ward-wise Literacy Rate: National-level vs Munshiganj Municipality*

Source: *Population and Housing Census, BBS, 2022*

Table A1: Population and Density of Munshiganj Municipality

Ward	Population 2011	Population 2022	Density 2011 (per sq. km)	Density 2022 (per sq. km)	Change 2011-2022 (%)
01	8755	12191	16,902	23,535	39.2%
02	10729	15429	17,442	25,083	43.8%
03	8616	9881	6,100	6,996	14.7%
04	5986	8850	10,131	14,979	47.8%
05	6398	8186	7,058	9,030	27.9%
06	5196	7206	3,821	5,300	38.7%
07	9156	10800	4,136	4,879	18.0%
08	8601	11115	3,280	4,239	29.2%
09	7237	9462	2,281	2,982	30.7%

Source: *Population and Housing Census, BBS, 2022*

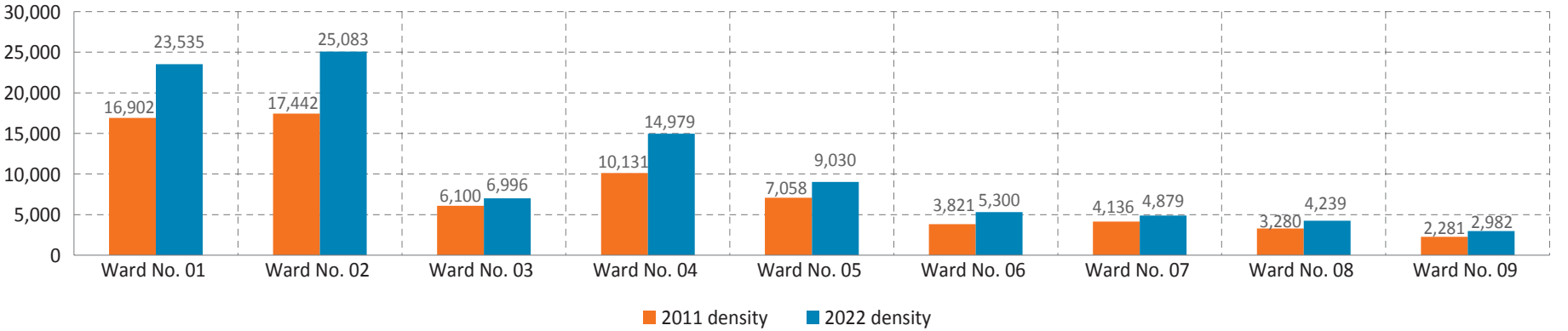


Figure A2: *Ward Wise Population Density of Munshiganj Municipality (2011 vs 2022)*

Table A2: Ward-Wise Employment Status

Area	Employed	Employed male	Employed female	Household work	HH work male	HH work female	Agriculture	Industry	Service	Employment rate
Munshiganj Municipality	**26,533**	**23,630**	**2,903**	**22,613**	**166**	**22,447**	**2,053**	**2,786**	**21,694**	**31.22**
Ward 01	3,494	3,112	382	2,694	13	2,681	153	382	2,959	30.90
Ward 02	4,429	3,758	671	3,694	17	3,677	115	507	3,807	31.20
Ward 03	3,264	2,869	395	2,404	8	2,396	15	455	2,794	36.42
Ward 04	2,081	1,839	242	1,910	12	1,898	67	206	1,808	25.62
Ward 05	2,151	1,905	246	2,038	13	2,025	146	226	1,779	28.92
Ward 06	2,033	1,845	188	1,842	17	1,825	196	230	1,607	30.87
Ward 07	3,302	2,922	380	2,506	26	2,480	285	197	2,820	33.87
Ward 08	3,290	3,049	241	2,987	36	2,951	707	251	2,332	32.75
Ward 09	2,489	2,331	158	2,538	24	2,514	369	332	1,788	28.99

Source: *Population and Housing Census, BBS, 2022*

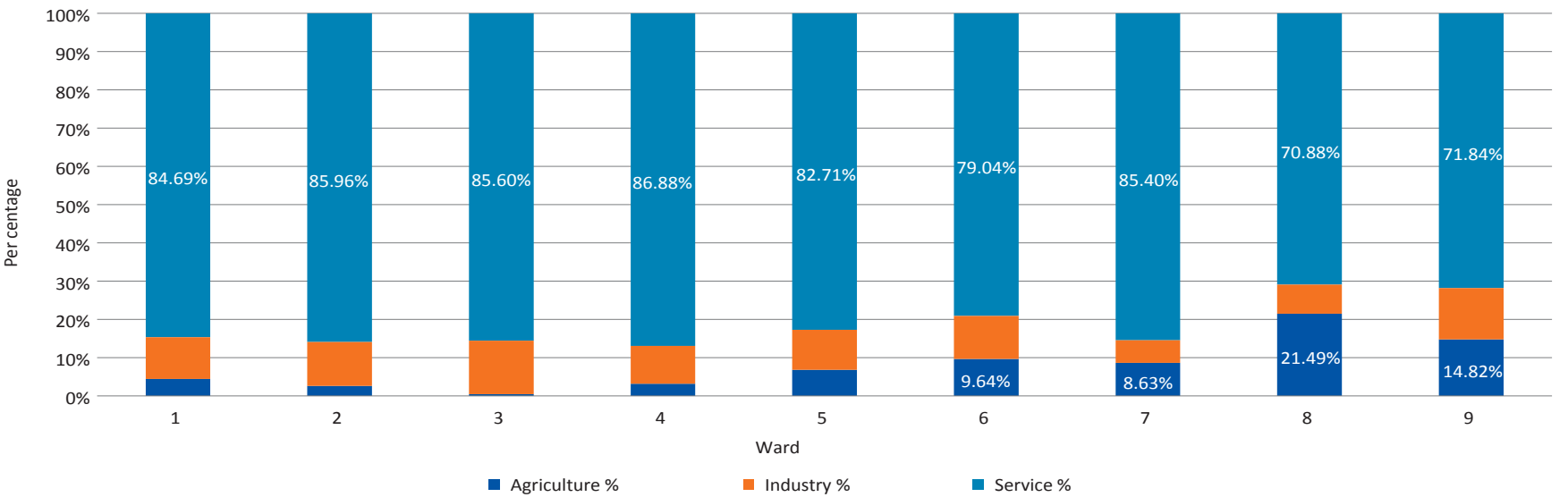


Figure A3: *Ward-wise Sectoral Distribution of Employment*

Table A3: Broad Land Use Category of Munshiganj Municipality

Land Use Category	Area (Sq. Km)	% of Total
Agriculture	4.669	36.11
Residential	4.048	31.31
Water Bodies	1.496	11.57
Mixed Use	1.085	8.39
Open Space	0.801	6.20
Transport	0.403	3.11
Commercial	0.189	1.46
Education	0.057	0.44
Recreational	0.069	0.53
Restricted Area	0.031	0.24
Graveyard	0.025	0.19
Miscellaneous	0.024	0.19
Industrial	0.010	0.07
Administrative	0.010	0.07
Health	0.008	0.06
Places of Worship	0.004	0.03
Heritage	0.001	0.01

Source: Urban Master Plan, IUGIP, Munshiganj Municipality, 2025



ANNEX 2: HERITAGE SITES UNDER RIVERFRONT DEVELOPMENT

Idrakpur Fort







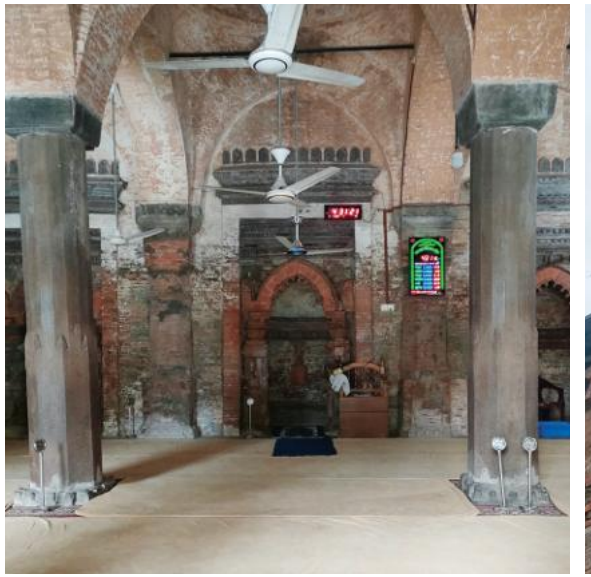




Baba Adam Mosque





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