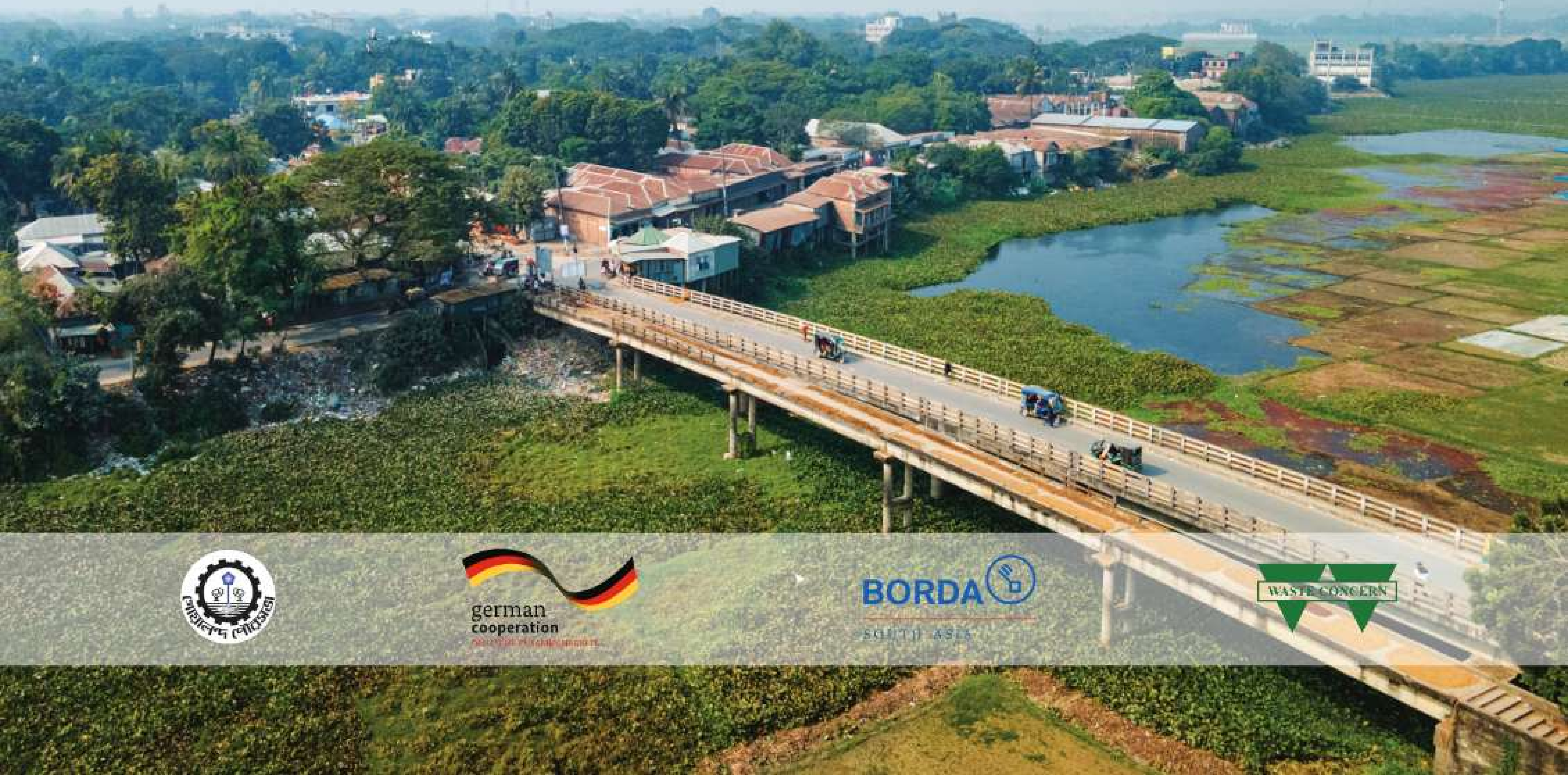
CLIMATE ACTION PLAN

Goalanda Municipality, Goalanda
Bangladesh
2025



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ACKNOWLEDGEMENT

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We also express our heartfelt appreciation to the residents of Goalanda Municipality, whose active participation as respondents in surveys and interviews provided invaluable local knowledge and perspectives. Their contributions have enriched thisplan by ensuring that it accurately reflects the community's aspirations and priorities.

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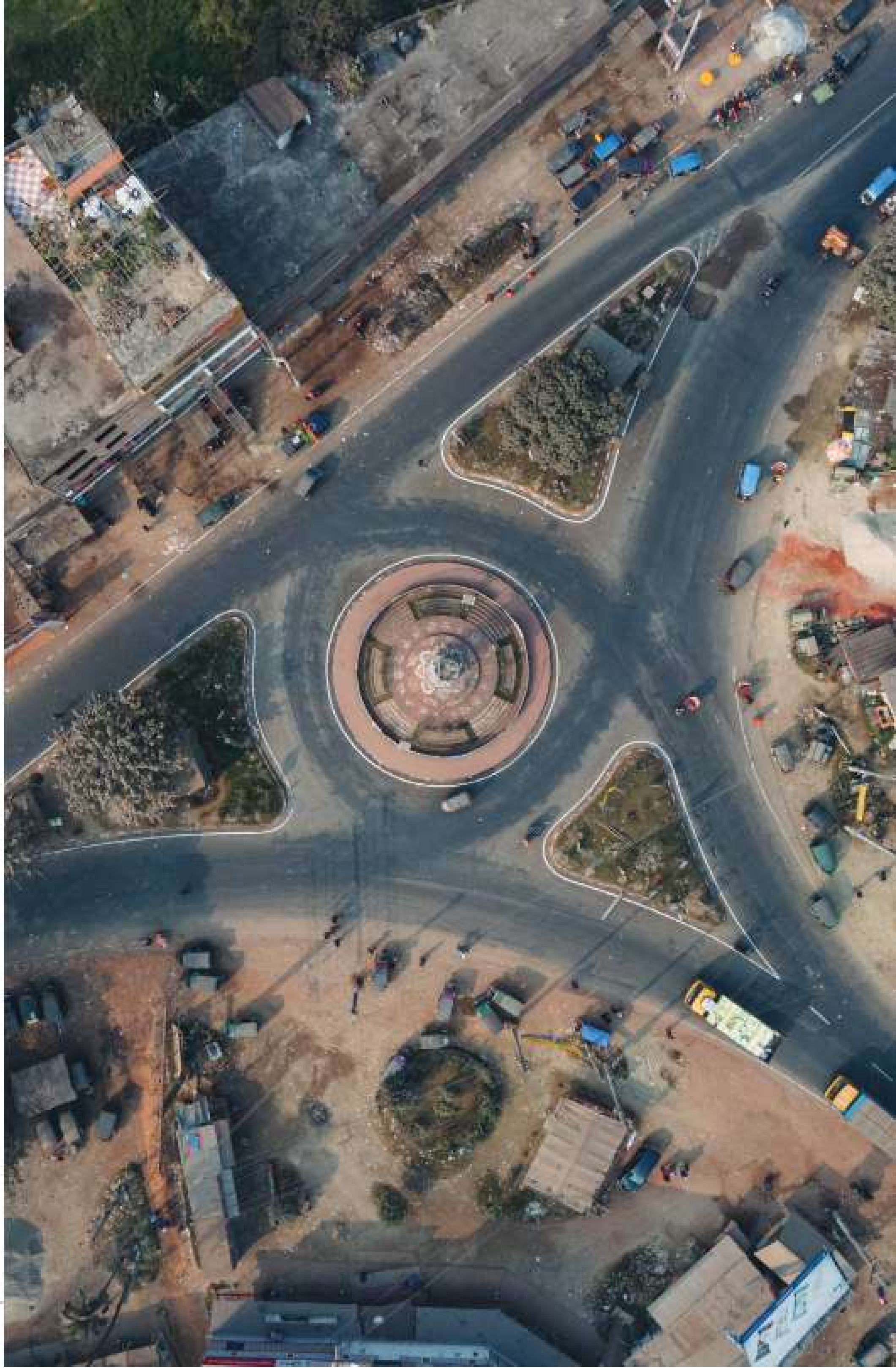

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
CAP	Climate Action Plan
CBO	Community-Based Organization
CDC	Community Development Committee
CEO	Chief Executive Officer
CHRS	Center for Hydrometeorology and Remote Sensing
CR	Climate Resilience
CRU	Climatic Research Unit
DMC	Disaster Management Committee
DPHE	Department of Public Health Engineering
DRBP	Dhaka River Basin Project
FSTP	Fecal Sludge Treatment Plant
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HBB	Herring Bone Bond
HIGS	Hazard, Infrastructure, Governance, Socio-Economic
KL	Kiloliter
KM	Kilometer
LGED	Local Government Engineering Department
LIC	Low-Income Community
LIUPCP	Livelihoods Improvement for Urban Poor Communities Project
LST	Land Surface Temperature
MDMC	Municipal Disaster Management Committee
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization
NUPRP	National Urban Poverty Reduction Program
PDB	Power Development Board
PNO	Paura Nirbahi Officer
RCC	Reinforced Cement Concrete
REB	Rural Electrification Board
SC	Standing Committee
SDG	Sustainable Development Goal
Sq. Km.	Square Kilometer
SWM	Solid Waste Management
TLCC	Town Level Coordination Committee
UDD	Urban Development Directorate
UNDP	United Nations Development Programme
UPSM	Urban Poor Settlement Mapping
USGS	United States Geological Survey
WASH	Water, Sanitation, and Hygiene
WC	Ward Committee
WL	Waterlogging
WVI	Ward Vulnerability Index
WW	Waste Water

GLOSSARY

Adaptation: The process of preparing for and adjusting to the impacts of climate change to withstand its effects. It is a key pillar of climate action, alongside mitigation.

Bottom-up Approach: An approach to planning that starts by engaging local residents to understand their needs, demands, and perceptions, ensuring that strategies are inclusive and reflect community priorities.

Canal: Khal or river channel

Carbon Credit: A financial instrument representing a reduction in greenhouse gas emissions. Projects that reduce emissions, like a Material Recovery Facility, can potentially earn carbon credits as part of global circular economy trends.

Climate Action Plan (CAP): A strategic document for municipalities that provides a structured, evidence-based framework for local climate action.

Climate Financing: The mobilization of funds for projects aimed at climate change mitigation and adaptation, such as the development of low-carbon city infrastructure.

Climate Resilience Plan: A strategic plan that outlines actions and interventions to help a community or system prepare for, withstand, and recover from climate-related shocks and stresses. The Climate Action Plan (CAP) serves this function at the municipal level.

Coldwaves: A climatic hazard characterized by unexpected drops in temperature, particularly during winter.

Detail Project Report (DPR): A comprehensive document outlining the plan for a specific project identified within the Climate Action Plan.

Flood Risk: The likelihood of an area being inundated by water, assessed using factors like topography, land elevation, rainfall intensity, and proximity to water bodies.

Floodplains: Low-lying areas of land adjacent to a river that are subject to flooding.

Heatwaves: A climate hazard defined by prolonged periods of extreme heat. In urban areas, their impact is often intensified by the "urban heat island effect,"

HIGS Framework: A methodology used for climate vulnerability assessments at the ward level, which analyzes four key dimensions: Hazards, Infrastructure, Governance, and Socio-economic indicators.

IPCC Guidelines 2006: A specific methodology provided by the Intergovernmental Panel on Climate Change (IPCC) for calculating and inventorying greenhouse gas (GHG) emissions.

Kancha/Jhupri: Terms for non-permanent housing structures common in low-income communities. Kancha houses are typically made of materials like mud, bamboo, or thatch, while jhupri refers to a slum shack or hut.

Land Cover Classification: A process that uses satellite imagery to map and analyze how different types of land surfaces (e.g., vegetation, water bodies, built-up areas) change over time.

Land Surface Temperature (LST): The temperature of the ground's surface, which can be measured using satellite data. LST maps are used to identify areas exposed to extreme heat and to understand the effects of urban heat islands.

Littering: The improper disposal of waste in open spaces, drains, or water bodies.

Material Recovery Facility (MRF): A specialized facility designed to receive, sort, and process inorganic and recyclable waste materials for recycling or resale, thereby improving overall waste management efficiency.

Mitigation: A primary component of climate action focused on reducing the impact of climate change to limit the severity of future climate change.

Non-WASH System: Urban infrastructure and services that are not part of the WASH (Water, Sanitation, and Hygiene) sector. This includes critical systems like housing, transportation, and electricity & communication.

Overlay Analysis: A geographic information system (GIS) technique where multiple data maps (e.g., land surface temperature, rainfall, and flood risk) are superimposed on one another to identify "hotspot" areas.

Pourasabha or Paurashava: Local governing body, municipality or municipal corporation of a city or town in Bangladesh

Pre-monsoon: The season immediately preceding the main monsoon rainy season, often referred to as spring.

Rainwater Harvesting: The practice of collecting and storing rainwater for future use, which serves as a key strategy for managing groundwater resources.

Recyclable: Able to be collected, separated, and processed to be used as raw material in the manufacture of a new product

Recycling: The process by which waste materials are transformed into new products in such a manner that the original products may lose their identity

Shared Toilet: A communal toilet facility used by multiple households, often implemented in densely populated low-income communities or slums to improve sanitation and hygiene.

Solid Waste Management: Systematic control of generation, storage, collection, transport, separation, processing, recycling, recovery, and final disposal of solid waste

Stormwater Drainage: The urban infrastructure system, including street gutters and storm drains, is designed to manage runoff from heavy rainfall, prevent water accumulation, and minimize flood risks.

Urbanization: The process of population growth and expansion of cities, often involving the conversion of agricultural land for urban use.

Vulnerability Assessment: A systematic process to identify which geographic areas, communities, or systems are most susceptible to the impacts of climate hazards.

Ward: An administrative and electoral division of a municipality. In the provided documents, vulnerability assessments and climate action planning are conducted at the ward level.

WASH System: An acronym for Water, Sanitation, and Hygiene. It refers to the essential urban services that ensure public and environmental health, including water supply, sanitation and wastewater management, stormwater drainage, and solid waste management.

EXECUTIVE SUMMARY

The world is facing an escalating climate emergency marked by rising global temperatures, erratic rainfall patterns, intensifying heatwaves, floods, and extreme weather events. Rapid urbanization has increased exposure to climate-induced risks, particularly in developing nations where inadequate infrastructure and institutional capacities exacerbate these risks. Cities, home to over half the global population, are becoming the epicenters of both vulnerability and opportunity for climate action. Against this backdrop, global initiatives such as the Paris Agreement and the Sustainable Development Goals (SDGs) have emphasized the need for local-level resilience and climate-adaptive urban governance. Yet, while frameworks and targets exist globally, localized action, particularly at municipal levels, often remains underdeveloped due to data limitations, resource constraints, and a lack of localized planning instruments.

Bangladesh, one of the most climate-vulnerable nations in the world, faces recurrent challenges from cyclones, floods, heatwaves, waterlogging, and river erosion. While national efforts, such as the National Adaptation Plan (NAP 2023–2050), Nationally Determined Contributions (NDC), Perspective Plan, and Delta Plan 2100, provide comprehensive frameworks, a critical gap persists in translating national commitments into local actions. Municipalities, being the first responders to urban climate impacts, often operate with limited capacity and lack ward-level data to design effective climate responses.

Located near the Padma River, the city is increasingly exposed to flooding, heat stress, waterlogging, and drainage congestion, with low-income communities (LICs) suffering the most. The Climate Action Plan (CAP) for Goalanda Municipality addresses these challenges through a scientific, data-driven, and participatory approach, integrating both satellite-based environmental assessment and community-based vulnerability analysis.

The CAP for Goalanda was developed through a collaborative process involving the Goalanda Municipal Authority and community stakeholders. The process began with orientation sessions, followed by the collection of secondary and primary data, and GIS-based analyses to identify ward-specific vulnerabilities.

- Secondary Data included land use, hydrological, and climatic datasets from sources such as USGS, CRU, and CHRS.
- Primary Data was gathered through household surveys and focus group discussions, capturing the perceptions and lived experiences of residents, especially from low-income settlements.

This structured process ensured inclusivity and accuracy, aligning local priorities with national climate strategies.

The CAP adopted an advanced GIS and remote-sensing methodology to quantify and map the municipality's climate vulnerability. The satellite analysis focused on four key dimensions:

- **Land Use and Land Cover (LULC) Change**, revealing increasing built-up areas and declining vegetation cover, which exacerbate surface runoff, flooding, and heat stress.
- **Land Surface Temperature (LST)**, highlighting localized heat hotspots in densely built wards with limited green cover.
- **Rainfall Intensity and Variability**, identifying areas prone to short-duration, high-intensity rainfall events that overwhelm drainage systems.
- **Flood and Waterlogging Risk**, using elevation, proximity to rivers, and hydrological characteristics to identify flood-prone zones.

The overlay analysis combined LST, rainfall, and flood data to generate multi-hazard hotspot maps, identifying wards with compounded climate exposure critical for prioritizing adaptation interventions.

HIGS Framework (Hazard, Infrastructure, Governance, Socio-Economic)

To complement the physical risk assessment, the HIGS framework was applied to evaluate ward-level vulnerability based on both quantitative and qualitative indicators:

- **Hazard**: Frequency and intensity of cyclones, floods, rainfall, heatwaves, and cold waves.
- **Infrastructure**: Resilience of WASH (Water Supply, Sanitation, and Waterlogging, Stormwater Drainage, and Solid Waste Management) systems and Non-WASH Systems (Housing, Transport, and Electricity).
- **Governance**: Institutional capacity, planning, accountability, and disaster management readiness.
- **Socio-Economic**: Poverty levels, literacy rates, housing types, and access to basic services.

The assessment reveals that Goalanda Municipality faces compound climate risks, with certain wards experiencing multiple hazards simultaneously. Key findings include:

- Flooding and Waterlogging remain dominant risks due to river proximity, low elevation, and inadequate drainage infrastructure.
- Heat stress is emerging as a significant but previously under-recognized hazard, particularly in densely built wards with limited vegetation.
- Low-income and informal settlements exhibit higher vulnerability due to poor housing quality, limited access to WASH services, and weak adaptive capacity.
- Infrastructure gaps and governance limitations amplify climate impacts, especially during extreme rainfall events.

The CAP proposes a phased and prioritized action framework informed directly by the vulnerability assessment:

Short-Term Actions (Primarily WASH-Focused)

- Improvement of drainage systems to reduce waterlogging and flood duration
- Expansion of access to safe drinking water and climate-resilient sanitation
- Promotion of waste segregation and decentralized waste management facilities

Medium-Term Actions (Non-WASH and Structural Measures)

- Climate-resilient housing improvements in vulnerable wards
- Urban greening and tree plantation to mitigate heat stress
- Upgrading of roads, electricity, and public facilities with climate-resilient design principles

Unlike conventional master plans which often exclude Climate Action Plans or treat them as standalone documents and unlike many existing CAPs that focus narrowly on cyclones and floods, the Goalanda CAP clearly identifies heatwaves and localized urban hazards as growing threats. This aligns with Bangladesh's evolving national regulatory and planning frameworks, which increasingly emphasize localized, ward-level climate planning as a prerequisite for effective adaptation.

The Climate Action Plan for Goalanda Municipality represents a significant step toward evidence-based, locally grounded climate resilience planning. By integrating satellite imagery with the HIGS framework, the CAP bridges the gap between scientific analysis and community realities. It provides a replicable model for other municipalities seeking to operationalize national climate commitments through ward-level, data-driven action, ensuring that climate resilience planning in Bangladesh moves from policy intent to practical implementation.

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1.1 Global Context: A Shared Climate Emergency

Climate change has emerged as one of the most pressing global challenges of the 21st century, posing profound threats to ecosystems, economies, and human well-being worldwide. Driven by extensive land-use changes and human-induced greenhouse gas emissions, the Earth's climate system is undergoing unprecedented transformations. These disruptions are manifesting through rising temperatures, shifting rainfall patterns, more frequent and intense extreme weather events, and accelerating sea-level rise, intensifying vulnerabilities and placing immense pressure on both natural and human systems. The Intergovernmental Panel on Climate Change (IPCC) has unequivocally stated that global warming has already reached 1.1 °C above pre-industrial levels and is likely to exceed 1.5 °C in the near term unless immediate and sustained emissions reductions are achieved (IPCC, 2023).

The effects of this warming are already widespread and intensifying, impacting all aspects of the Earth system. The last decade, 2015-2024, was the warmest on record, with 2024 being the hottest year since recordkeeping began in 1880. This rise in temperature is causing more frequent and severe extreme weather events, including intense heatwaves, heavy rainfall, thunderstorms and prolonged droughts. According to the IPCC, with just a 1.1°C of warming so far, approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to these impacts, particularly in regions across Africa, South Asia, and Central and South America. Similarly, the planet's oceans have absorbed over 90% of the extra heat, leading to rising sea levels from thermal expansion and melting ice sheets.

The rising intensity and frequency of climate extremes have resulted in severe human and economic losses. Between 2000 and 2019, over 475,000 people died worldwide as a direct consequence of more than 11,000 extreme weather events, with total economic losses exceeding US$ 2.5 trillion (Germanwatch, 2021). In 2022 alone, weather and climate-related disasters caused an estimated US$ 313 billion in global economic losses (Munich Re, 2023). These impacts are not evenly distributed: low- and middle-income countries, despite contributing the least to global greenhouse gas emissions, bear a disproportionate share of the damages and are the least equipped to respond.

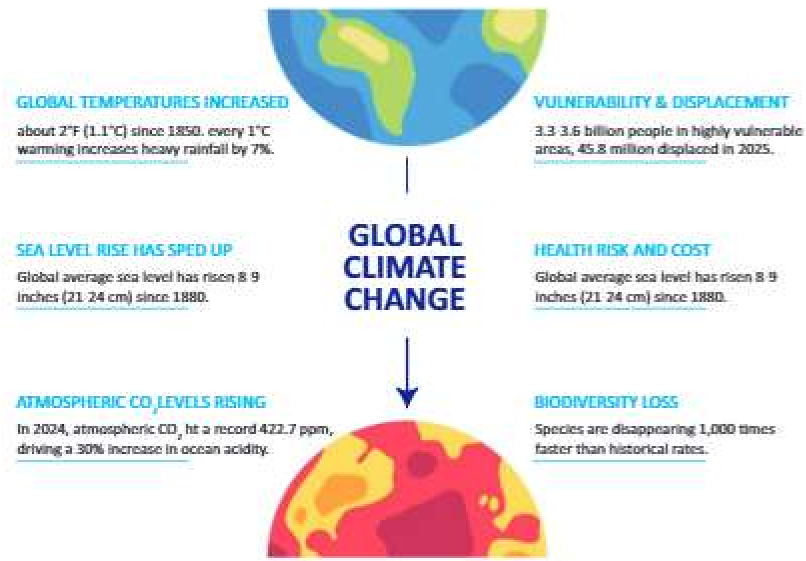


***Figure 1:** Impact of Global Climate Change*

Source: IPCC Report, 2023

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

Mitigation, reducing emissions and adaptation, preparing societies to withstand impacts, are both critical pillars of global climate action. Urban areas, home to over 56% of the world's population and responsible for more than 70% of global CO_2 emissions, are increasingly recognized as key actors in achieving global targets (UN DESA, 2022; UN-Habitat, 2020). Cities and municipalities have become frontlines for innovative climate solutions, from green infrastructure to renewable energy transitions and resilient urban development.

1.2 National Context: Bangladesh's Rising Climate Risks

Bangladesh, located on the world's largest delta formed by the Ganges-Brahmaputra-Meghna River system, is one of the most climate-vulnerable countries globally. Its low elevation, high population density, and reliance on climate-sensitive sectors such as agriculture and fisheries make it highly susceptible to both slow-onset climate impacts and extreme events. Bangladesh ranked 7th most affected country globally on the Global Climate Risk Index 2021 for the period 2000–2019 (Germanwatch, 2021).

1.2.1 Observed Impacts and Emerging Threats

Bangladesh is experiencing escalating extreme heat, with the maximum temperature in the country increasing by 1.1°C, and the heat index—or "feels like" temperature—rising even more dramatically by 4.5°C (World Bank, 2025). This warming trend has intensified urban heat stress, particularly in urban areas, aggravating health risks and energy demand (Rahman et al., 2022).

Flooding remains the most frequent and damaging hazard. The 2020 monsoon floods, the longest in recent decades, affected 5.4 million people and inundated 37% of the country's area, disrupting livelihoods and infrastructure (UN OCHA, 2020). Moreover, intense rainfall events have increased by 12% since the 1980s, leading to recurrent urban waterlogging in major cities (BMD, 2022). Similarly, Cyclone Amphan (2020) impacted 2.6 million people and caused losses exceeding US$130 million, highlighting the increasing severity of coastal disasters (World Bank, 2021).

Salinity intrusion poses another growing threat, as sea-level rise and reduced river flow have increased soil and water salinity in coastal districts, affecting agriculture and safe drinking water for nearly 20 million people (World Bank, 2018).

Climate change is also accelerating rural–urban migration. Every year, hundreds of thousands of people migrate to urban centers due to river erosion, crop failure, and cyclones. By 2050, up to 13.3 million Bangladeshis could become internal climate migrants (World Bank, 2018).

The economic and social consequences of climate change are becoming increasingly severe. According to the Country Climate and Development Report (World Bank, 2022), average tropical cyclones already cost Bangladesh approximately US$1 billion annually, while severe flood events could reduce national GDP by as much as 9%. By 2050, climate variability and extreme events could reduce agricultural GDP by nearly one-third, threatening a sector that provides employment for almost half of the country's workforce. The report further estimates that 13.3 million people may become internal climate migrants over the next three decades due to declining agricultural productivity, water scarcity, and sea-level rise, with women expected to experience disproportionate impacts. Consequently, Bangladesh is projected to require at least US$12.5 billion, equivalent to approximately 3% of GDP, in medium-term investments to strengthen climate resilience and adaptation (World Bank, 2022).

Beyond these direct impacts, climate change is expected to impose substantial losses on national productivity, employment, public health, and infrastructure. Heat stress alone could reduce GDP by approximately 4.9% by 2030, resulting in annual economic losses exceeding US$30 billion, a 4.84% reduction in working hours, and the loss of approximately 3.83 million full-time jobs. Air pollution associated with climate change is estimated to cost about US$2.3 billion annually, while climate-induced disasters such as floods, droughts, and storms may generate additional annual losses exceeding US$4 billion by 2030. Habitat degradation and declining labor productivity are projected to incur losses of more than US$50 billion per year by 2030.

Sea-level rise presents one of the most significant long-term threats. It could result in the loss of approximately 4% of Bangladesh's land area and reduce national food production by nearly 30% by 2050. Furthermore, approximately one-third of the country's population could face displacement due to sea-level rise, while annual GDP losses associated with coastal impacts are projected to range between 1.49% and 3.02% by 2031. During major monsoon events, as much as 67% of the country may become inundated, significantly disrupting livelihoods, infrastructure, and economic activities.

Climate change is also expected to intensify natural disasters and associated socioeconomic risks. Rising temperatures are projected to increase lightning strike frequency by approximately 12% for every 1°C increase, while climate-related damage to capital stock in the construction sector is expected to grow steadily over time. By 2030, climate change could contribute to an additional 150,000 deaths annually and affect nearly 55 million people, with overall climate and carbon-intensive losses reaching approximately 6.8% of GDP, including a direct carbon-intensive loss equivalent to 0.5% of GDP. Looking further ahead, an additional 14% of the country may become classified as "extremely vulnerable" to flooding, potentially displacing more than 35 million people by 2050. Collectively, these projections underscore the magnitude of Bangladesh's climate challenge and reinforce the urgency of strengthening climate-resilient development policies, particularly in rapidly urbanizing areas.

According to the Country Climate and Development Report for Bangladesh by World Bank

- Average tropical cyclones cost Bangladesh about $1 billion annually.
- By 2050, one-third of agricultural GDP may be lost due to climate variability and extreme events – a devastating figure as the agriculture sector represents around half of employment in the country.
- 13.3 million people may become internal migrants in next 30 years due to climate impacts on agriculture, water scarcity, and rising sea levels, with higher impacts on women.
- In case of a severe flooding, GDP could fall by as much as 9 percent.
- The costs of environmental degradation and natural disasters are predicted to rise over time, compounded by higher heat, humidity, and health impacts.

Bangladesh will need at least $12.5 billion, approximately 3 percent of GDP in the medium-term for climate action (World Bank, 2022).

1.2.2 Urban Vulnerabilities

In 2023, Bangladesh's urban population accounted for 40.47% of the total population, growing at an annual rate of 3.12%, and is projected to reach 50% by 2050, reflecting a rapid pace of urbanization (World Bank, 2024). While urban centers drive economic growth, they are increasingly becoming hotspots of climate risk. Rapid and often unplanned urbanization has heightened exposure to multiple hazards. Urban flooding is becoming more frequent and severe due to intense rainfall events, inadequate drainage systems, and encroachment on natural water bodies (World Bank, 2021). Densely built-up areas with limited vegetation amplify the urban heat island effect, increasing heat stress and energy demand (Dasgupta et al., 2019). Unplanned infrastructure expansion leaves critical services vulnerable to extreme weather, while poor sanitation and stagnant water contribute to growing health risks from vector- and water-borne diseases, such as dengue, cholera, and diarrhea, which are expected to worsen with changing climate patterns (WHO, 2020). These intersecting pressures make urban centers particularly susceptible to climate impacts, threatening lives, livelihoods, and essential urban systems.

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 1: 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

Despite notable advances in national climate policies and strategic frameworks, a critical gap persists in local implementation, particularly at the municipal level. As the core of urban settlements, municipalities are at the frontline of climate impacts—facing heightened risks from urban flooding, heat stress, infrastructure vulnerability, and public health threats. Yet, municipal institutions often have limited capacity, resources, and localized data to translate national priorities into actionable interventions on the ground.

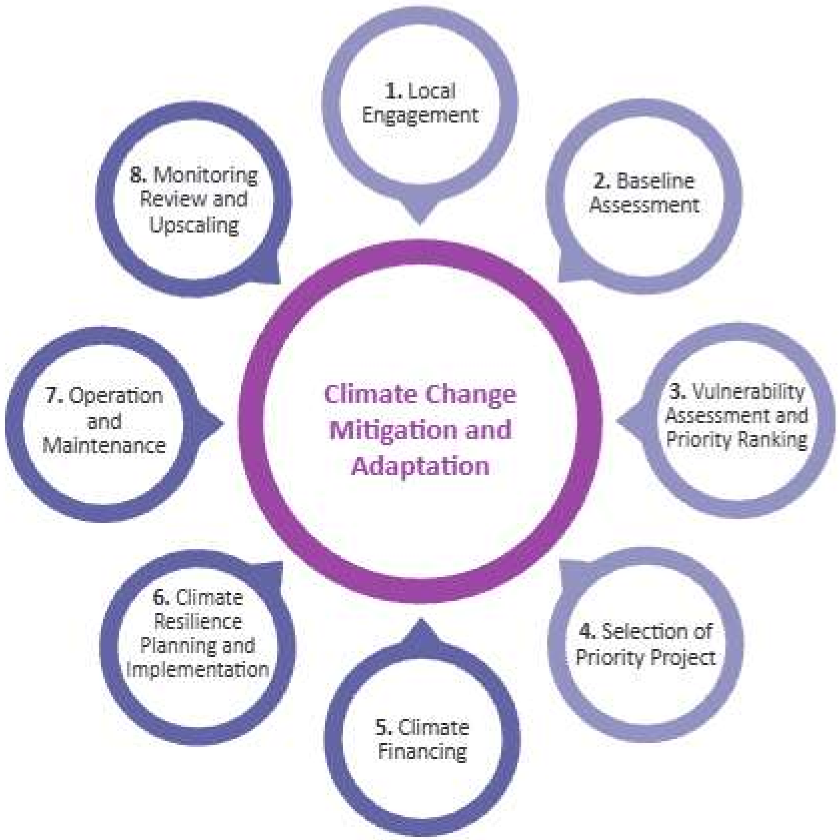


Figure 2: *Development of Local Level Climate Action Plan*

A Municipal Climate Action Plan (MCAP) provides a structured mechanism to address this gap by enabling evidence-based, localized climate action. Through ward-level vulnerability assessments, municipalities can identify climate risk hotspots, set clear priorities, and design targeted interventions that address the most pressing needs. The MCAP will serve as both a strategic planning tool and a critical data source, supporting the integration of climate actions into master plans, local development plans, and municipal budgets.

Importantly, the MCAP will promote community engagement and local empowerment, ensuring that climate strategies are context-specific, inclusive, and supported by local stakeholders. By aligning municipal initiatives with national climate strategies, the MCAP will strengthen institutional capacity, improve resource allocation, and foster resilient, low-carbon urban development at the local level.

1.5 Preparation of Municipal Climate Action Plan

The preparation of the Climate Action Plan (CAP) for Goalanda Municipality followed a structured, participatory, and data-driven approach to ensure local relevance, inclusivity, and comprehensiveness. Active participation of municipal officials and local residents, including marginalized groups, was ensured throughout the process to capture diverse perspectives and community priorities, as shown in Figure 2. The first four segments (1-4), from local engagement to priority projects, represent CAP preparation, while the subsequent segments (5-8) reflect its implementation.

The CAP preparation process is described in five key steps in the following subsection and is further summarized in Figure 3.

Step 1: Orientation Meeting with Municipal Authority

The process commenced with an orientation meeting between *Goalanda Municipal Officials* and *Waste Concern* to introduce the Climate Action Plan concept. The session highlighted climate impacts across national to local scales and stressed the importance of local action, community engagement, and inclusive planning. It also outlined the CAP's scope, objectives, and implementation approach, leading to strong municipal commitment and technical collaboration with Waste Concern.

Step 2: Data Collection

Data collection combined both secondary and primary sources to ensure comprehensive coverage of climatic, environmental, and socio-economic conditions.

- **Secondary Data:** Collected from institutional sources such as the Goalanda Paurashava Master Plan, UNDP, BBS, UDD, and Waste Concern. In addition, Landsat satellite imagery was collected to analyze the spatiotemporal dynamics of land use and climate-induced extreme weather events.
- **Primary Data:** A town-level stakeholder consultation was conducted to initially understand Goalanda-specific climate change impacts and ensure the active participation of diverse stakeholders in the CAP preparation process. This was followed by a structured questionnaire survey targeting local residents to assess household-level exposure and perceptions of climate risks.

Step 3: Data Analysis

The collected datasets were analyzed at both ward and municipal levels to (i) understand the existing condition of the municipality, (ii) estimate greenhouse gas (GHG) emissions from municipal operations, and (iii) assess ward-wise climate vulnerability.

- **Vulnerability Assessment using Secondary Data**: Satellite imagery and GIS-based analysis were conducted to identify spatial variations in extreme climate events and land use changes contributing to local vulnerability. This helped compare climate exposure across wards and determine the areas at greatest risk.
- **Vulnerability Assessment using Primary Data**: Community perceptions were captured to complement the spatial analysis. The HIGS framework, covering Hazard, Infrastructure, Governance, and Socio-economic dimensions, was adopted and contextualized for Goalanda Municipality. Originally developed by Integrated Research and Action for Development (IRADe), the framework was scaled down to capture ward-level vulnerabilities instead of a broader city-level approach.

Step 4: Prioritization of Vulnerable Wards and Urban Systems

Based on the vulnerability findings, wards and critical urban systems were prioritized according to their level of risk. This step guided the identification of where interventions are most needed and what actions should be prioritized, ensuring resources are directed toward the most vulnerable communities and sectors.

Step 5: Recommendations and CAP Implementation Pathway

Finally, recommendations have been developed incorporating community inputs and local insights. The CAP outlines actionable measures that translate national climate policies into local implementation strategies, focusing on both mitigation and adaptation. The plan provides a clear way forward for Goalanda Municipality to build climate resilience and integrate sustainable practices into municipal governance and service delivery.

1.6 Implication of Municipal Climate Action Plan

The Climate Action Plan (CAP) provides a clear, actionable roadmap for Goalanda Municipality to strengthen climate resilience and reduce vulnerability across all wards. By combining ward-level vulnerability assessments with community-driven insights, the CAP ensures that interventions are targeted, evidence-based, and locally relevant. It translates national climate policies into practical local actions, bridging policy with implementation.

The CAP also enhances municipal capacity for planning, governance, and monitoring, while fostering inclusive participation to ensure that the most vulnerable populations are protected. By guiding sustainable investments in infrastructure, disaster risk reduction, and urban services, the CAP positions Goalanda for climate-resilient growth and long-term urban sustainability. It establishes a framework for measurable outcomes, accountability, and adaptive management, setting a precedent for other municipalities to follow.

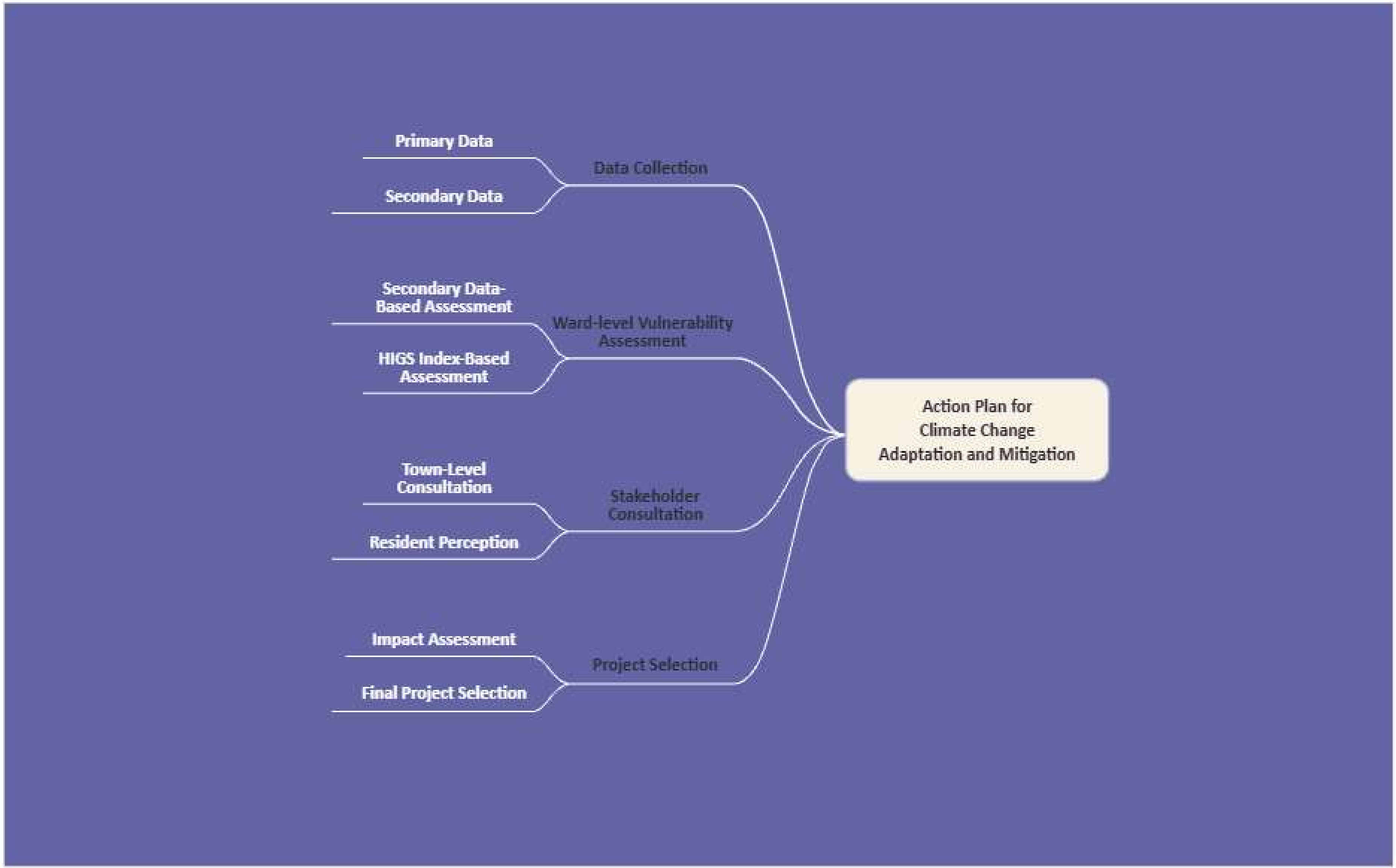


Figure 3: *Methodology of Climate Action Plan (CAP) Development*

02. PROFILE OF GOALANDA MUNICIPALITY

2.1 Establishment, Area and Location

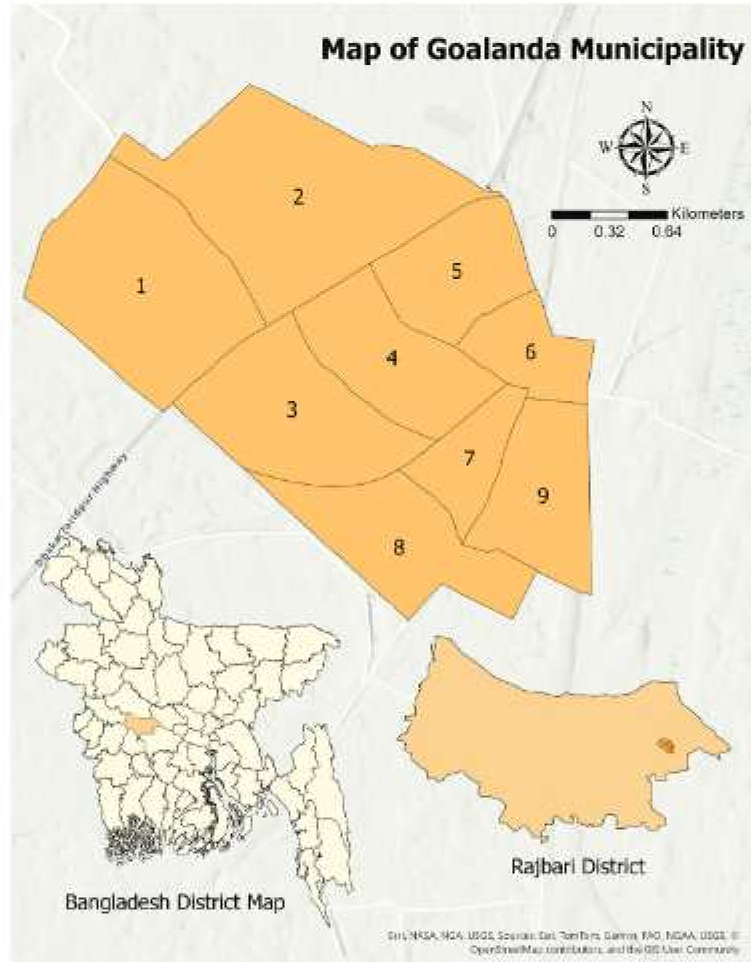
Goalanda municipality was established on 26 July 2000 under Goalanda Upazila of Rajbari District. It is classified as a 'Kha' (B) category municipality under the Local Government (Paurashava) Act, 2009, which determines administrative and funding arrangements. Goalanda municipality lies between 23°41′–23°50′ N and 89°41′–89°51′ E, about 95 km southwest of Dhaka. The municipality comprises 9 wards and 10 mouzas, covering approximately 4.86 sq. km (1,200 acres) according to the Gazette notification. Among the wards, Ward 2 has the largest area (about 285 acres), while Ward 7 is the smallest (about 58 acres). The Paurashava represents the smallest administrative unit within the Rajbari District in both area and population.

2.2 Boundary and Connectivity

The municipality is bounded by the Padma River to the north and east, Rajbari Sadar Upazila to the west, and Faridpur District to the south. The Padma River serves as a key natural boundary and transport corridor. Although the Daulatdia Ferry Ghat, a major national transport hub, lies about 10 km away, it significantly influences the town's connectivity and economic activities.

2.3 Urban Development and Growth Pattern

The urban development and growth patterns in Goalanda municipality have been significantly shaped by the dynamic and often erosive actions of the Padma River. The natural processes of riverbank erosion and sedimentation have led to significant changes in land use and land cover (LULC), with severe consequences for local communities. Frequent erosion along the riverbanks has destroyed homes, agricultural lands, and critical infrastructure—including roads, bridges, and embankments—forcing repeated relocation of settlements and disrupting socioeconomic stability.

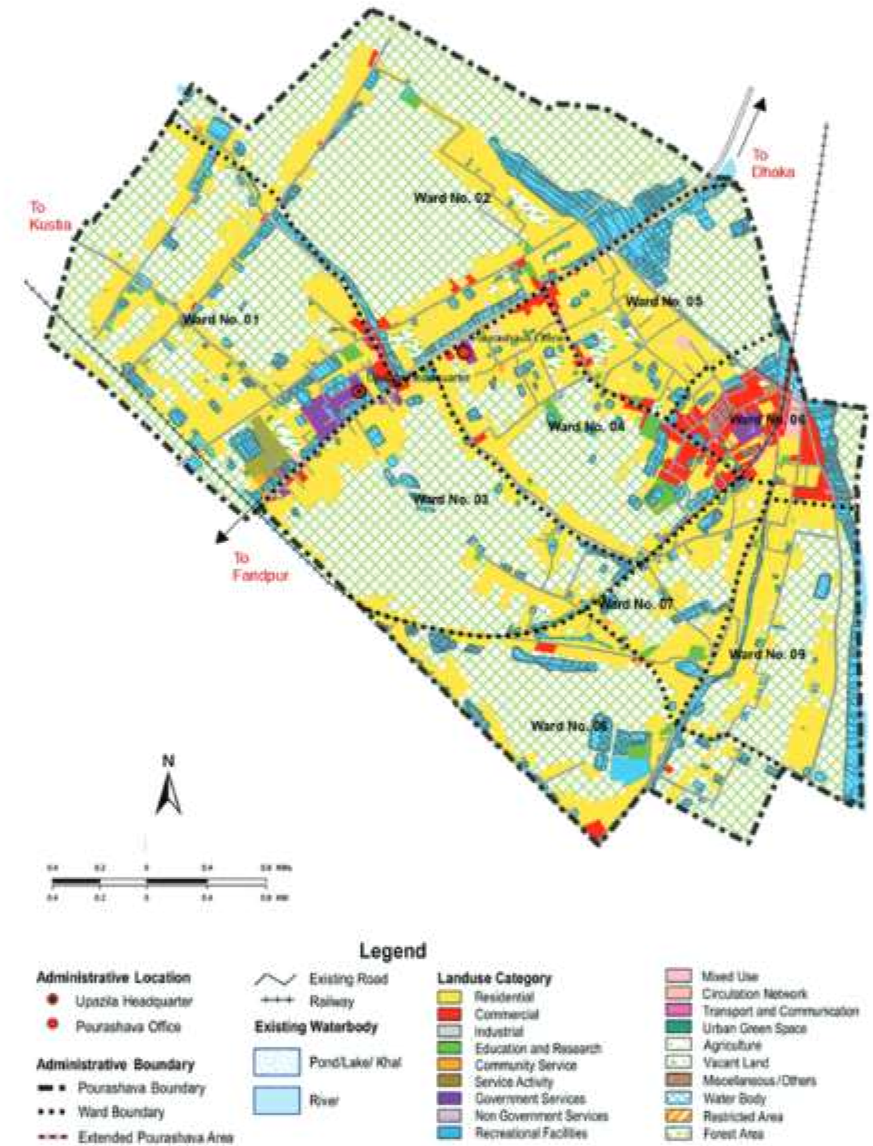


Map 1: *Location and Map of Goalanda Municipality*

Areas along the river in Kushtia, Rajbari, and Shariatpur regions have been particularly vulnerable to soil degradation, loss of fertile land, and damage to their ecosystems. Despite these challenges, urban and village areas along the Padma River continue to expand due to population pressure and shifting land patterns.

2.4 Land Use Pattern

The land use pattern of Goalanda Paurashava highlights its strong agricultural base. Agriculture is the dominant land use, covering 660.52 acres or 51.83% of the total area. Residential areas come next, occupying 357.78 acres, followed by water bodies spanning 131.63 acres. The circulation network, including roads and pathways, accounts for 42.12 acres. Other uses, such as commercial, institutional, and industrial activities, together occupy less than 1% of the total land, showing that Goalanda retains a primarily agrarian setting with limited urban development.

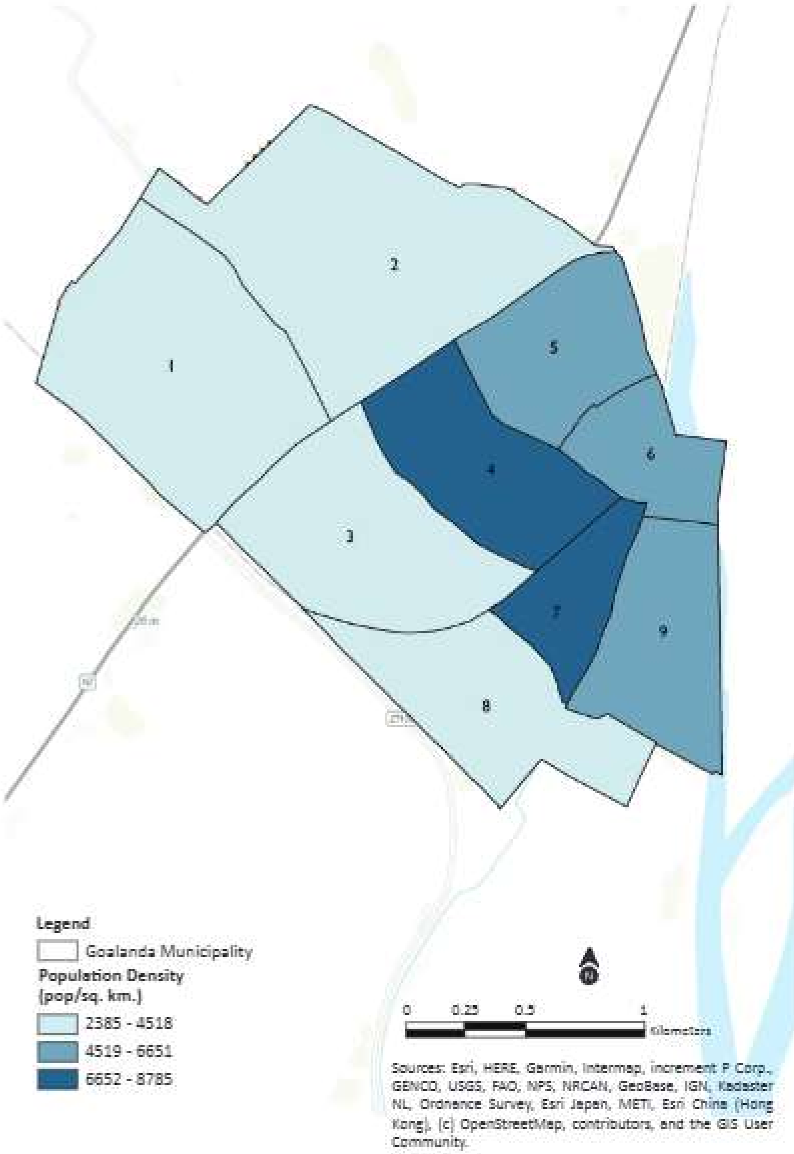


***Map 2:** Existing land use of Goalanda Municipality*

2.5 Demographic Features

Town Population: According to BBS 2022, Goalanda Paurashava (Goalanda Ghat Municipality) has a population of 22,370, with a population density of 3,463 persons per km². The municipality's annual population growth rate between 2011 and 2022 is 1.6%, and the average household size is 4.06 (BBS, 2022). For ward-wise population density in 2024, refer to Map 3.

Educational Status: The literacy rate in Goalanda municipality stands at 67.52%, which is lower than the national average of 74.8%, the Dhaka Division average of 78.24%, and the Rajbari District average of 69.49%, indicating relatively low educational attainment. Male literacy is 69.47%, while female literacy is 65.73%, reflecting a gender gap of 3.74 percentage points. Educational participation declines sharply beyond the lower secondary level, with 31,922 students enrolled in primary and 26,408 in secondary classes, but only 6,883 completing SSC, 5,010 HSC, and 3,258 attaining graduate or higher degrees. This decline is more severe in rural areas with limited access to quality education, while urban areas, though smaller in population, account for nearly half of all graduates.



***Map 3:** Population density across the wards of Goalanda*

2.6 Employment Status

Approximately 31% of Goalanda's working-age population is employed, while 32% are engaged in household work and 36% are not working, indicating a sizable inactive group. Among the employed, males constitute 91% and females 9%. Most employed individuals work in the service sector (84.7%), followed by agriculture (7.7%) and industry (7.6%) (BBS, 2022).

2.7 Local Government Bodies

Functions and Responsibilities: According to The Local Government (Paurashava) Act (2009), Goalanda Municipal Government is responsible for service delivery, including provisioning road network, solid waste management, water supply, public safety, registration, etc. DPHE provides policy and technical assistance for water supply and sanitation, and LGED provides technical support for road and drainage services. The municipality relies on own sources or donor/NGO programs for high-level technical support for these services. **Elected Personnel, Structure and Staff:** Goalanda Municipal Council consists of 10 elected members, including a Mayor and nine ward councilors. The Mayor chairs the council, while the Chief Executive Officer (CEO) serves as the administrative head. In practice, the Mayor's post is vacant, and the CEO performs both roles. The municipality has 127 employees across 10 sections under three wings.

Division:	(A) General Administration Division	(B) Engineering Division	(C) Health Division
Section:	1. General Section 2. Accounts Section 3. Tax Assessment Section 4. Tax Collection/License Section 5. Municipal Bazar Section 6. Education, Culture & Library Section	1. Water Supply and Sewage Section 2. Civil, Electrical, Mechanical Section	1. Sanitation Section 2. Health and Family Planning Section

As per the organogram, Goalanda Municipality has a total sanctioned staff strength of 126, whereas the current staff strength is 87, which is 39 staff less than the sanctioned positions. It is to be noted that the number of sanctioned staff does not include the Education, Culture and Library Section as mentioned in the organogram. Therefore, the following table has been created, keeping the aforementioned section excluded, for a detailed presentation of the figures.

SL#	Name of Division	Number of Sections	Staff Required as per Organogram	Present Staff	Vacant Positions
1	General Administration Division	6	42	24	18
2	Engineering Division	2	56	41	15
3	Health Division	2	28	22	6
	Total	**10**	**126**	**87**	**39**

Source: Goalanda Municipality, August 2024.

Committees: Goalanda Municipality has established several coordination committees to align development activities and prevent overlaps. In line with the Local Government (Paurashava) Act 2009, it has formed one Town Level Coordination Committee (TLCC) and 9 Ward Committees (WCs), along with 11 Standing Committees (SCs), including one on disaster management (when necessary). However, these committees remain largely non-functional due to limited awareness of roles, lack of political will, and inadequate financial resources (UNDP, 2022).

Town Level Coordination Committee (TLCC): The Town Level Coordination Committee (TLCC) is chaired by the Mayor, with the Paura Nirbahi Officer (PNO) serving as Member Secretary. It consists of 50 members, including representatives from government offices, NGOs, civil society, and academia. Among them, 40% are women and 10% are low-income representation. The committee meets quarterly (UNDP, 2022).

Ward Committees (WCs): There are 9 Ward Committees, each chaired by the Ward Councilor and vice-chaired by the Female Ward Councilor. Each committee has 9 members. The committee meets quarterly to identify and prioritize local issues for the Municipal Council, though its overall performance remains weak.

Standing Committees (SCs): The municipality has 11 Standing Committees on 11 subjects, each with 5 members, except the one on Information & Culture, which has 5 members. These committees review project proposals and provide recommendations to the council.

Training for Staff: Over the past five years, municipal staff have attended about 12–13 government and donor-funded trainings, including sessions on tax collection and trade license management by MoLGRD, and on waste management and health by DPHE.

2.8 Baseline Condition

2.8.1 Poverty Scenario

The Low-Income Community (LIC) data shows that Wards 5, 6, and 7 of Goalanda Municipality together have 3,095 LIC residents. Ward 7 has the highest concentration, with 1,410 residents (69% of its population), followed by Ward 6 with 960 residents (61%) and Ward 5 with 725 residents (31%), indicating higher poverty concentration in Wards 6 and 7.

2.8.2 Water Supply

The majority of residents across all nine wards in Goalanda rely on tubewells for drinking water, with usage exceeding 90%. Limited piped water is available only in Wards 2, 4, and 6, while bottled or surface water use remains below 1%. The municipality is expanding piped water systems, with Wards 1–6 already connected through 32.5 km of pipelines of varying diameters (4"–12"), serving about 2,400 households. The goal is to supply piped water three times daily, reducing dependence on groundwater.

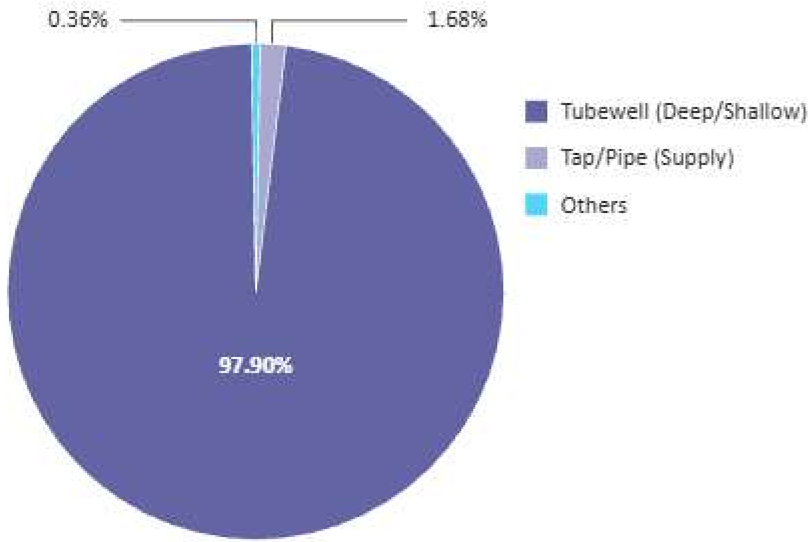


Figure 4: *HHs By Main Source of Drinking Water*

2.8.3 Solid Waste Management

Open dumping remains widespread in Goalanda, despite the Paurashava Master Plan (2011–2031) assigning waste management responsibilities to the municipality. The plan envisions residents depositing waste at collection points for municipal disposal; however, in practice, drains remain clogged, and the dumping site along the Marapadma River poses serious water pollution risks. Dustbins are installed in both commercial and residential areas, yet collection is inconsistent—waste from the Bazar is collected daily, while residential waste is collected irregularly, despite generating around 7.59 tonnes per day (0.33 kg per capita). Limited operational capacity further constrains efficiency, as only two three-wheelers collect about 1 tonne daily, garbage trucks are nonfunctional, and the single vacuum truck operates only two to three times a month. Annually, Goalanda produces approximately 2,296 tonnes of municipal solid waste, of which 2,004 tonnes remain unmanaged. About 97% of households dispose of waste directly into the environment, and only 3% use dustbins. The municipality maintains three formal dumpsites, all of which are open to the environment (WaterAid, 2024)

Street Sweeping and Drain Cleaning: The municipal conservancy section hires street sweepers for street sweeping and drain cleaning. Drain cleaning consists of removing dirt from drains and letting the dug-up materials dry on the roadsides before collecting them for disposal.

2.8.4 Sanitation and Wastewater

Sanitation: Sanitation facilities in Goalanda municipality shows uneven access across wards, with significant disparities in hygiene and safety. Wards 2, 5, and 6 perform comparatively well, as over 59% of households use safe flush or pour-flush toilets connected to proper disposal systems. In contrast, Wards 3, 4, 7, and 8 face major sanitation challenges, with Ward 8 having 71.61% unsafe flush systems and only 0.85% improved latrines.

Wastewater: The Department of Public Health Engineering (DPHE) is constructing a Faecal Sludge Treatment Plant, expected to be completed by December 2025 and

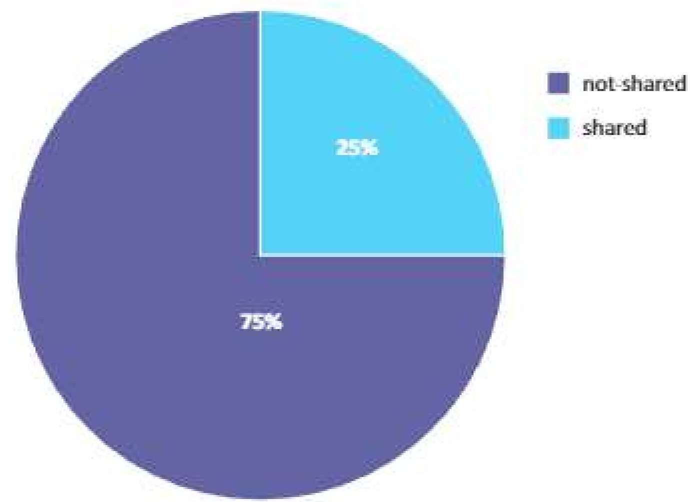


Figure 5: *Distribution of General Households by Toilet Facility*

later handed over to Goalanda Municipality for operation and maintenance. However, DPHE will not provide operational training, raising concerns about the municipality's capacity to manage the facility effectively and sustainably.

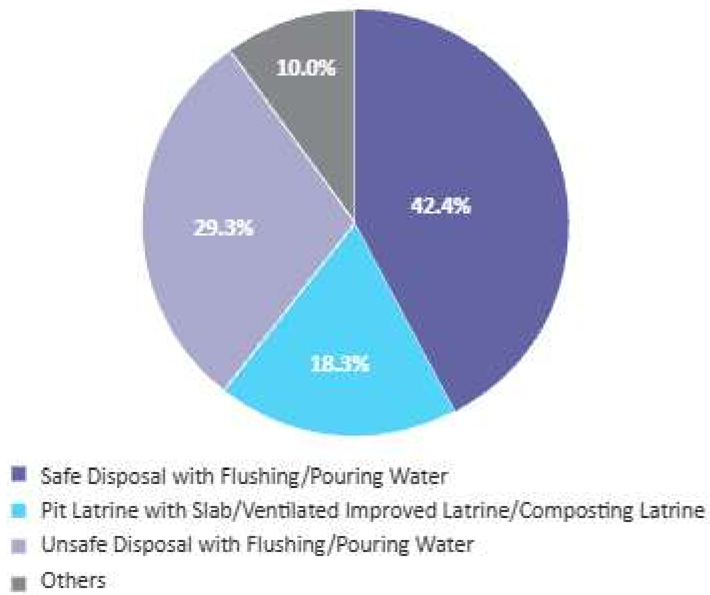


Figure 6: Distribution of General Households by Type of Toilet Use

2.8.5 Drainage

The drainage system of Goalanda Municipality is poorly developed, with most drains being shallow, Kancha, and discontinuous. The Goalanda Paurashava Master Plan (2011–2031) highlights the absence of a planned drainage network, poor gradients, and inadequate maintenance, leading to frequent waterlogging and debris accumulation (LGED, 2015). Drainage infrastructure has largely evolved through community initiatives rather than municipal planning. Although the Bangladesh Municipal Water Supply and Sanitation Project (BMWSSP) includes provisions for drainage improvement, progress remains limited, and most drains are still unlined and nonfunctional (AIIB, 2022).

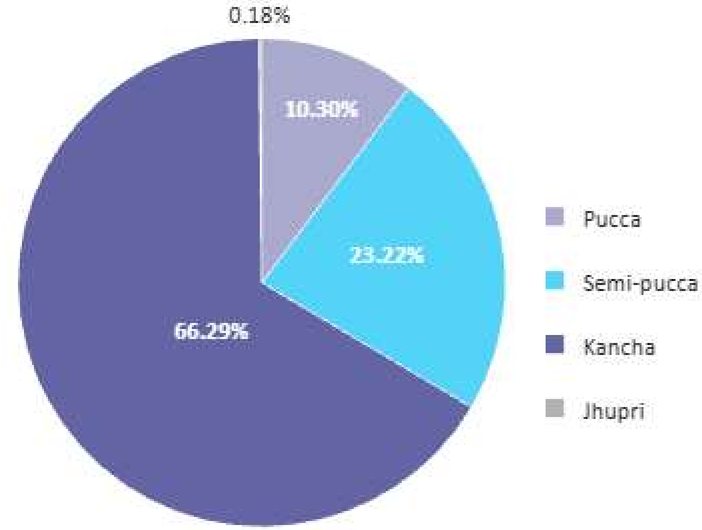


Figure 7: Distribution of Dwelling Units by Structure Type

2.8.6 Housing Condition

According to the BBS Community Report (2022), most wards in Goalanda Upazila have over 60% kancha houses, indicating poor housing conditions and economic vulnerability, refer to figure 9. Wards 7, 8, and 9 show the highest proportion of kancha housing (over 69%), while Ward 4 has the best quality, with 20.6% pucca and 31.56% semi-pucca houses. Although jhupri housing is nearly absent, the overall dominance of kancha structures highlights the need for sustainable housing, disaster resilience, and economic development initiatives (66.29% kancha structures).

The ownership data for Goalanda Upazila highlights strong housing security and economic stability across its nine wards. Overall, 86% of households live in owned dwellings, while 14% reside in rented units (figure 10). Ward 9 reports the highest ownership rate (96.02%), followed by Wards 8, 3, and 1, indicating widespread long-term housing stability. In contrast, Ward 4 has the lowest ownership rate at 71.98%, reflecting relatively higher housing mobility and rental dependency in that area.

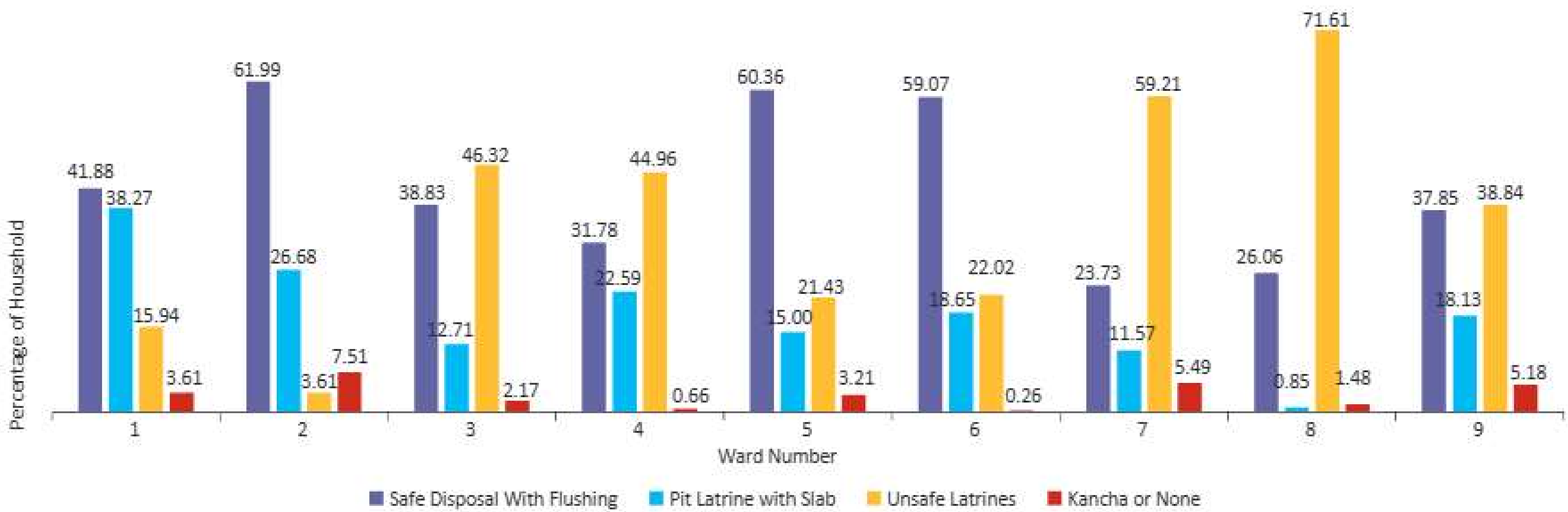


Figure 8: *Distribution of General Households Across the Wards by Type of Toilet*

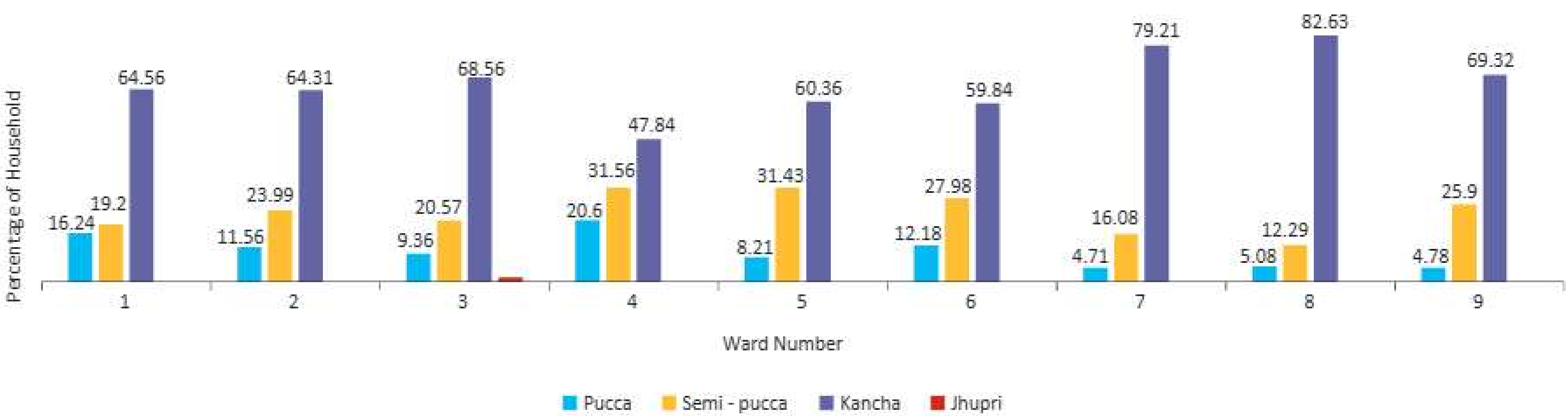


Figure 9: *Distribution of Dwelling Units Across the Wards by Types of Structure*

2.8.7 Transportation System

Road Network: Goalanda Paurashava has a total of 193 roads covering about 36.5 km across 41.5 acres of land. Around 42% of the roads are pucca, 23% semi-pucca, and 34% are Kancha (earthen) roads. The largest share of road area is found in Ward 2, while Ward 8 has the least coverage. There is no dedicated transport terminal, and vehicles usually park along roadside areas. The municipality has two main bus stands - Aratpatti Bus Stand and Goalanda Bus Stand, serving daily commuters.

Waterway: No official waterway operates under the municipality or BIWTA. However, the area includes four RCC bridges and 15 culverts over canals and drains. Being flood-prone, the municipality faces frequent waterlogging, worsened by the absence of embankments.

Railway: The Goalanda Bazar Railway Station, located on the western side of the town, connects residents to other regions through two intercity and one mail train service each day, providing an important link for travel and trade.

2.8.8 Cooking Fuel

Cooking fuel use in Goalanda's nine wards is heavily dominated by wood-based sources, ranging from 54% in Ward 8 to 87% in Ward 9. While Straw, Leaf, Bran, or Husk are also used—highest in Ward 8 (32.2%)—and Wood- coal, Charcoal, and Dried Dung contribute notably in Ward 7 (23.33%).

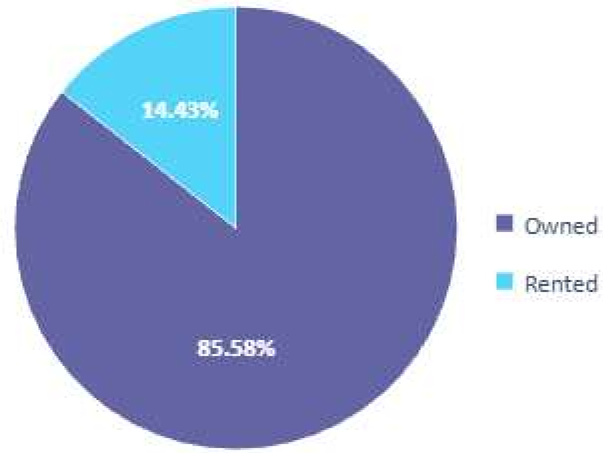


Figure 10: *Distribution of HHs by Ownership of Dwelling Units*

Source: BBS District Report for Rajbari, 2022

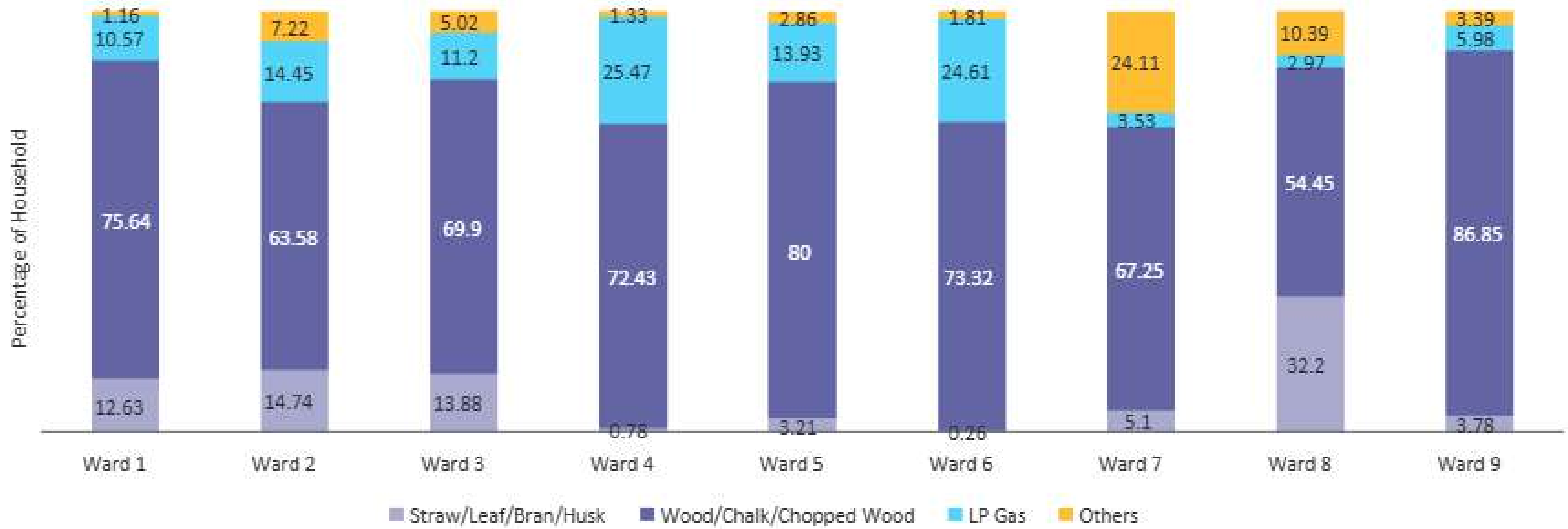


Figure 11: *Types of Cooking Fuels Used Across the Wards*


GOALANDA

03. CLIMATE RISK AT NATIONAL AND REGIONAL LEVELS

This chapter is based on the "Climate Risk Country Profile: Bangladesh" published by the World Bank in 2024. The report explains the current and projected adverse impacts of climate change on Bangladesh and the Dhaka Division, including Goalanda.

1. **Climate Type:** Bangladesh has a moist, humid, tropical monsoon climate (average mean temperature of 25.71°C) with one rainy and dry season (2,174.10 mm annually), influenced interannually by the El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD).

2. **Temperature:**

	National Level		Dhaka	
	Max	**Min**	**Max**	**Min**
Warmest	32.01°C	25.49°C	31.88°C	26.18°C
Coolest	25.26°C	12.31°C	25.58°C	12.26°C

Between 1991 and 2020, Bangladesh recorded a mean annual temperature of 25.71°C, with an increase of 0.16°C per decade from 1971 to 2020. The warmest months are May through August, during the monsoon season, while January is the coolest month of the year.

Projected Temperature:

- **2020-2039:** Will increase by 0.41°C (–0.19°C, 0.76°C) from the historical reference period to 26.03°C (25.26°C, 26.65°C)
- **2040-2059:** Will increase by 0.89°C (0.45°C, 1.70°C) from the historical reference period to 26.59°C (25.78°C, 27.56°C).

Extreme Heat Risk:

By midcentury, Bangladesh is expected to face higher day and night temperatures, along with more intense heat due to greater moisture in the air.

2020–2039: The number of very hot days (Heat Index above 35°C) will rise to about 100 days per year (range: 56–129).

2040–2059: The number will further increase to around 133 days per year (range: 86–172).

Southern coastal areas: Will see the biggest rise in hot days, especially during the pre-monsoon (spring) season.

Northern and eastern floodplains: Will face the largest increase in hot days during the summer months.

3. **Precipitation:**

   (A) National Level (1971–2020):

   - **Mean annual precipitation:** 2,174.10 mm.
   - **Regional trends:**
     - **Eastern divisions:** Drier annually, especially during spring pre-monsoon months.
     - **Western divisions:** Wetter annually, particularly in post-monsoon fall months.

Projections (SSP3-7.0):

- Overall **annual precipitation expected to increase by midcentury**, with regional and seasonal variability.
- **Southern divisions:** Decrease in 2020–2039, mainly in **pre-monsoon** months.
- **Northern divisions:** Highest increase by 2040–2059, during **monsoon** months.

(B) Dhaka Region (1971–2020): The region recorded the largest annual rainfall increase, rising by +13.3 mm per decade.

Projected annual rainfall:

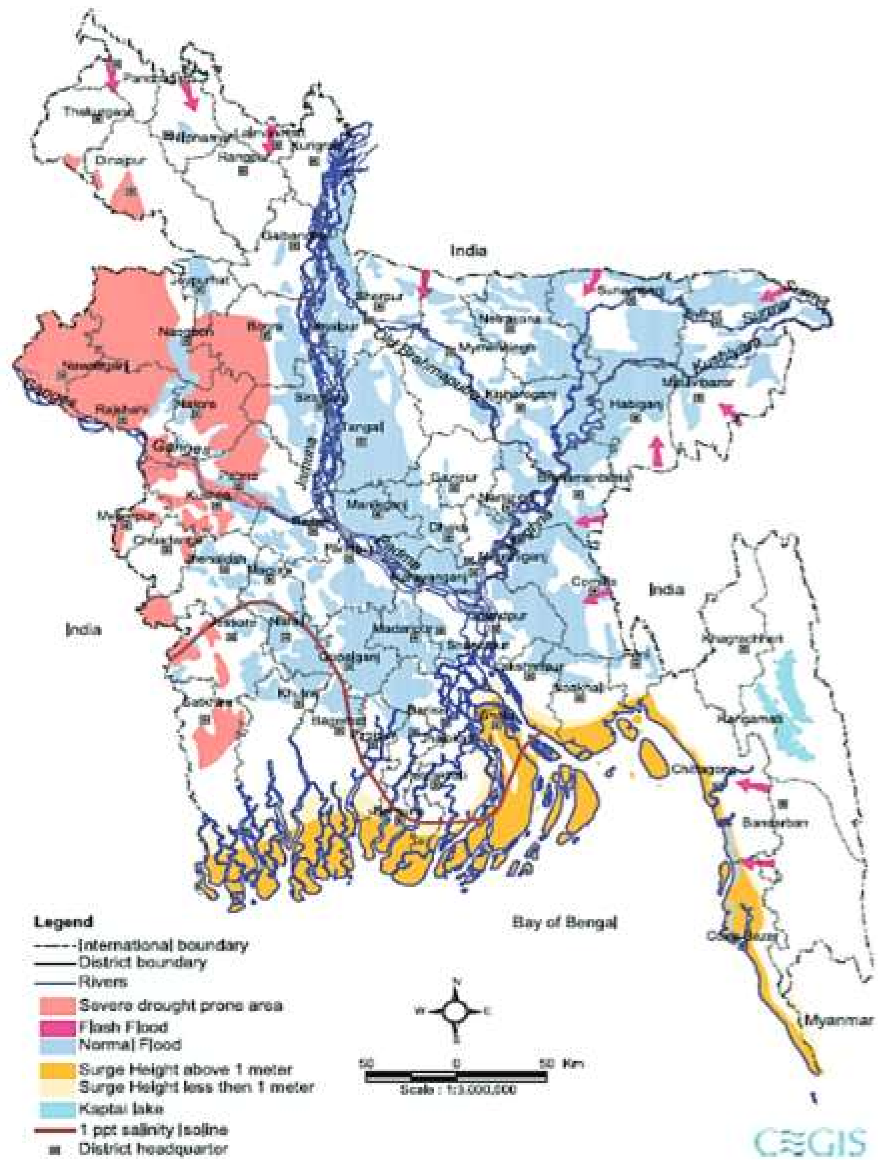
- **2020-2039:** 2053.69 mm (1684.22 mm, 2466.07 mm)
- **2040-2059:** 2058.90 mm (1677.97 mm, 2591.62 mm)

Precipitation Intensity & Risk (2040–2059):

- The average highest 5-day rainfall is expected to increase by about 25 mm (range: −97 to 143 mm).
- This will lead to a higher risk of flooding due to more intense rain events.
- The northern regions are likely to see the biggest increase in extreme rainfall, with heavy rain events that once happened every 100 years possibly occurring every 58 years, increasing the risk of flooding and damage to infrastructure.

4. Climate- Related Hazards:

- Sea level rise and inundation will increasingly threaten Bangladesh's deltaic coastal zones, causing a significant retreat of the coastline by the end of the century without mitigation measures.
- The frequency and intensity of flooding along major river systems and droughts in the northwest divisions have increased and will likely continue to persist.



***Map 4:** Climate-Related Hazards in Bangladesh*

- Climate variability can exacerbate Bangladesh's moderately high seismic risk conditions. Earthquake and landslide hazards pose the greatest risk along the northern and eastern borderlands.

04. METHODOLOGY OF CLIMATE VULNERABILITY ASSESSMENT OF GOALANDA MUNICIPALITY

The methodology for assessing municipal vulnerability under this Climate Action Plan follows two primary approaches. One approach focuses on the adaptation of the hazard, and the other focuses on mitigation.

4.1 Vulnerability Assessment Using Secondary Sources:

A comprehensive vulnerability assessment of Goalanda Municipality was conducted using satellite imagery to analyze key climatic parameters, including rainfall and temperature, and to identify wards most exposed to extreme weather events. For this assessment, satellite images have been collected from reliable sources such as USGS (United States Geological Survey), CRU (Climatic Research Unit), and the Center for Hydrometeorology and Remote Sensing (CHRS). Satellite observations overcome gaps in station-based weather data, providing insights into local variations and supporting detailed comparisons at the ward level.

4.1.1 Development of Overlay Analysis of Vulnerability Assessment

A comprehensive climate action plan requires a detailed analysis of land use, temperature fluctuations, rainfall patterns, and flood vulnerability to pinpoint urban areas most susceptible to climate extremes. These four factors provide a holistic view of a region's exposure to climate-related risks.

4.1.1.1 Land Cover Classification and Land Use Change

Land use and land cover (LULC) classification is crucial for assessing climate vulnerability in urban areas, as it reveals how natural and human-modified landscapes evolve. Conversion of green spaces to built-up areas intensifies waterlogging and the urban heat island effect. Using GIS-based satellite imagery analysis, we prepared LULC maps for Goalanda Municipality, identifying wards affected by deforestation, urban expansion, or other land cover changes, and highlighting areas most at risk from climate hazards.

4.1.1.2 Land Surface Temperature Map:

Rising temperatures are a direct impact of climate change, causing frequent heatwaves that threaten public health, strain energy systems, and worsen environmental degradation. Using satellite-derived data, Land Surface Temperature (LST) maps for Goalanda Municipality have been prepared to assess spatio-temporal temperature dynamics and identify wards most exposed to extreme heat. This Ward-wise LST mapping guides municipal climate planning by identifying priority areas and supporting targeted heat mitigation strategies.

4.1.1.3 Rainfall Map

Climate change is altering rainfall patterns, leading to more sudden and intense rainfall events over short periods. Such heavy rains increasingly overwhelm drainage, causing frequent flash floods and waterlogging that threaten urban infrastructure and public health. Hence, local rainfall data is essential for identifying vulnerable areas. Using satellite imagery, a rainfall map was created to capture spatial variations in rainfall intensity across wards, informing climate adaptation strategies to better manage the impacts of rapid-onset rainfall events.

4.1.1.4 Flood Risk Map

Floods are becoming more frequent and severe, driven by climate change. Sudden upstream rainfall often triggers rapid river and canal overflows, causing damage not only to infrastructure but also to human lives and livestock. A flood risk map was developed using GIS-based analysis of topography, land elevation, rainfall intensity, and proximity to water bodies. This assessment highlights spatial variations in flood vulnerability, identifies high-risk areas, and supports targeted interventions and effective flood protection measures to minimize damage from flood events.

4.1.1.5 Overlaying Secondary Data

To identify areas most affected by extreme climate events in Goalanda Municipality, an overlay analysis was conducted by superimposing land surface temperature (LST), rainfall, and flood risk information. This assessment identified "hotspot" wards with consistently high temperatures, frequent heavy rainfall, and elevated flood risk, highlighting areas of compounded vulnerability. This method also uncovers spatial patterns that might not be apparent when examining each hazard individually. The findings provide crucial guidance for prioritizing adaptation and mitigation, ensuring targeted interventions in vulnerable areas. This approach strengthens climate resilience by addressing local needs and reducing exposure to multiple hazards.

4.2 Vulnerability Assessment Using Primary Sources (HIGS)

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

The HIGS framework supports climate-resilient city planning by identifying where and how cities are most vulnerable. However, urban services and infrastructure are neither uniformly distributed nor equally impacted across the city, so some wards require specific attention. For example, certain areas may have predominantly Kancha and semi-pucca housing, while other wards may need strengthened transportation infrastructure. Similarly, the coverage and quality of critical services, such as water supply, sanitation, and solid waste management, vary across wards, underscoring the need for ward-specific strategies in the municipal climate action plan.

Therefore, the HIGS framework has been adopted and contextualized to assess climate vulnerability at the ward level rather than the broader city level to achieve a more precise, localized understanding of climate risks within the city. Climate

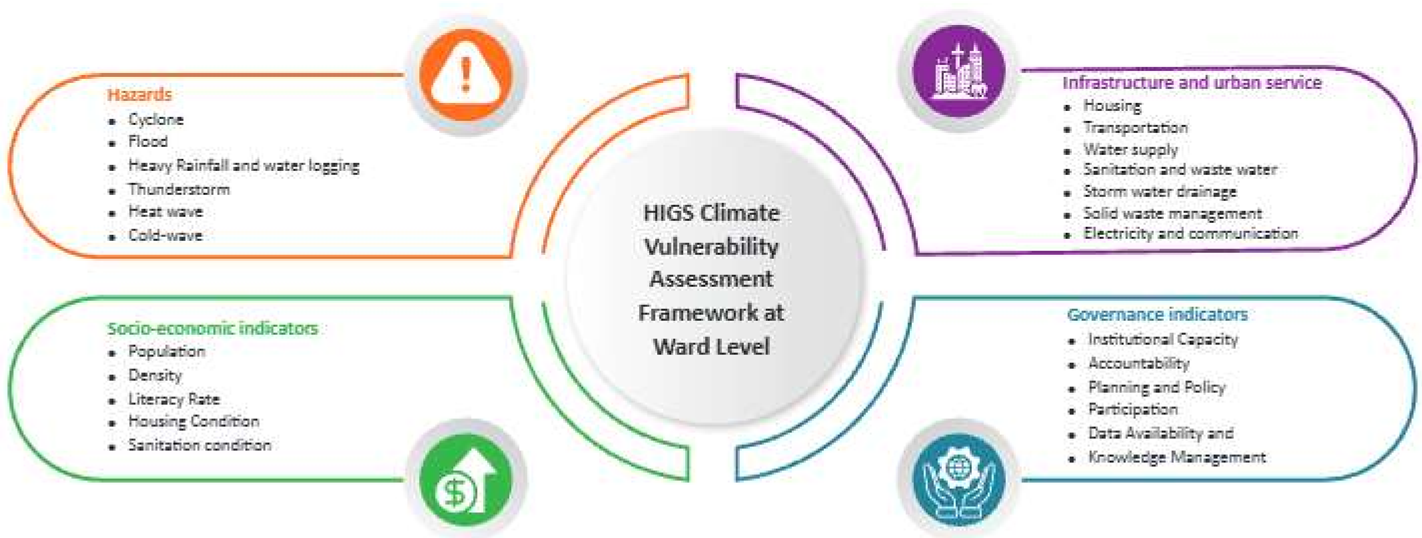


Figure 12: *Components of HIGS Framework*

vulnerabilities vary significantly from one ward to another due to differences in factors such as land use, socio-economic conditions, and infrastructure quality. While a city-wide approach provides a broad overview, it can obscure critical variations at the neighborhood level, where climate impacts may be far more severe or specific. We can identify precise vulnerabilities and tailor interventions by narrowing the focus to the ward level. For instance, some wards may require enhanced flood protection infrastructure, while others may benefit from expanded green spaces to mitigate urban heat. This ward-level assessment enables targeted interventions tailored to each ward's specific challenges, enhancing the effectiveness of adaptation efforts.

Using the HIGS framework at the ward level also ensures optimized resource allocation and promotes social equity in climate adaptation efforts. By pinpointing the wards most at risk, municipalities can prioritize investments and interventions where they will have the greatest impact, ensuring that funds are used with maximum efficiency and efficacy. Additionally, this localized approach fosters equity by addressing the unique needs of vulnerable communities that are disproportionately affected by climate risks, such as low-income populations or areas with aging, fragile infrastructure. By adapting the HIGS framework to this level of detail, we create a model for climate resilience planning that is more effective and inclusive, leading to a more resilient and equitable urban landscape.

4.2.1.1 Hazards

The "Hazards" dimension reveals the diverse risks associated with climate change, including cyclones, floods, extreme temperatures, and other climate-induced events. By assessing these hazards at the ward level, we can identify areas that are particularly vulnerable to specific climate threats. As previously mentioned, some wards may be more prone to flooding and waterlogging due to their proximity to rivers or low-lying topography, while others may experience more intense heat waves due to increased built-up areas or a lack of green spaces. Understanding these spatial patterns of hazard exposure is essential for designing targeted adaptation strategies and prioritizing resources in the municipal climate action plan.

The hazards selected for the HIGS framework are cyclones, floods, heavy rainfall and waterlogging, thunderstorms, heatwaves, and coldwaves, represent the most significant climate-related threats Bangladesh is experiencing nowadays. These hazards are selected following an in-depth review of extreme climatic events over the past 50 years in Bangladesh, focusing on those events that have shown a notable increase in frequency, intensity, or impact due to changing climate patterns. The hazards included were chosen for their prominence in the broader national context and their particular relevance to Goalanda. Data sources such as the Bangladesh Environment Statistics 2020, Bangladesh Disaster-related Statistics 2021, and Weather Atlas guided the selection process. These sources provide reliable data on historical and current climate trends, offering a basis for identifying which climatic events are most pressing for Goalanda Municipality.

Cyclones are powerful tropical storms that bring destructive winds, heavy rain, and storm surges, often causing severe damage along Bangladesh's coastal and inland regions. While Goalanda is further inland than coastal areas, cyclones can still affect the area by triggering intense rainfall, power disruptions, and structural damage as they move across the country. The growing frequency and intensity of cyclones in recent decades highlight the importance of preparedness for such events.

Floods are a recurrent hazard in Bangladesh, especially during the monsoon season when rivers overflow and low-lying areas become inundated. Goalanda Municipality, situated near major river systems, is vulnerable to flooding, which can disrupt transportation, damage housing, and affect livelihoods. Increasing rainfall variability and changing river dynamics due to climate change are heightening the flood risks.

Heavy rainfall and waterlogging are common challenges in urban areas, where drainage infrastructure is often inadequate to handle intense rainfall. In Goalanda Municipality, intense rainfall frequently exceeds the capacity of drainage systems, resulting in prolonged waterlogging that hampers daily activities. With climate change intensifying rainfall events, these disruptions are becoming more frequent, highlighting the need for effective and resilient drainage solutions.

Thunderstorms bring sudden bursts of rainfall, lightning, and strong winds, which can cause infrastructural damage and service disruptions. In recent times, thunderstorms have become more frequent and intense, occurring not only during the monsoon season but also in the post-monsoon period, disrupting electricity supply, threatening outdoor activities, and in some cases, causing casualties. Because of their unpredictable nature, thunderstorms pose a constant threat, especially in densely populated or inadequately sheltered areas.

Heatwaves have become more severe and frequent across Bangladesh as global temperatures rise, impacting both urban and rural communities. Goalanda Municipality experiences intense heatwaves that disrupt daily life, increase energy demand, and threaten public health, particularly affecting vulnerable populations and those without access to cooling. As urban areas grow, the urban heat island effect exacerbates these heatwaves, underscoring the need for cooling infrastructure and green spaces.

Coldwaves: Although less frequent, coldwaves can have severe impacts, particularly during winter and in recent decades when temperatures drop unexpectedly. In Goalanda, coldwaves pose health risks to low-income residents and those without adequate shelter, affecting both daily life and economic productivity. With climate shifts, coldwave patterns are becoming less predictable, creating additional challenges for local preparedness.

4.2.1.2 Infrastructure and Urban Services

This dimension focuses on key urban systems that are essential for residents' quality of life and resilience, for instance, housing, transportation, water supply, etc. By examining these infrastructures at the ward level, specific vulnerabilities can be identified in each ward's infrastructure. For instance, a ward with inadequate drainage may be more susceptible to waterlogging and flooding during heavy rains, while one with limited water supply services may struggle with drought periods. This analysis helps urban planners prioritize infrastructure upgrades in the most vulnerable wards, ensuring that investments are directed toward areas with the highest need.

The Infrastructure and Urban Service component of the HIGS framework includes critical urban systems—housing, transportation, water supply, sanitation and wastewater, stormwater drainage, solid waste management, electricity and communication. These urban systems were selected for their integral role in maintaining urban resilience and are prioritized in climate action planning to address each ward's unique vulnerabilities and service needs. Together, they provide a comprehensive foundation for ward-level resilience, focusing on targeted infrastructure improvements, emergency response capacity, and continuity of services under changing climate conditions.

Housing provides shelter and stability, forming the core of urban living spaces where people reside and seek safety. Natural hazards have a profound impact on housing, affecting not only the physical structure but also extending to the broader homestead and its functions. Damage to homes incurs substantial rebuilding costs and often leads to increased utility expenses, such as reliance on backup power sources or alternative lighting like candles. Beyond the residence itself, residents may suffer loss of property and livestock, furthering their economic burden, while interruptions to utilities disrupt daily life. Hazard-induced displacement, whether temporary or permanent, adds to the risks, with specific safety concerns, including the potential rise in gender-based violence.

Transportation Urban transportation is a crucial component of a city, The impact of hazards on the transportation system extends beyond just vehicle movement, affecting various critical aspects. Infrastructure damage often leads to high rebuilding costs and operational challenges, disrupting regular maintenance and adding to the burden on transportation networks. Hazards also increase health risks, including physical injuries and mental stress for individuals using or relying on the transportation system.

Water supply vulnerability in Goalanda Municipality extends beyond merely ensuring water reaches residents, encompassing several critical impacts due to natural hazards. Disruptions to maintenance and operational routines can create significant service interruptions, especially when supply routes are affected. Infrastructure damage from hazards such as floods increases repair costs and creates ongoing challenges in maintaining supply.

Sanitation and Wastewater The urban sanitation system reveals several common vulnerabilities that become prominent during hazards. These include damage to sanitation and wastewater infrastructure, often resulting in high repair costs and operational disruptions. Flooding of facilities can lead to environmental contamination and expose communities to untreated sewage and waste, significantly increasing health risks.

Stormwater Drainage is key to preventing water accumulation and minimizing flood risks in urban areas. Proper drainage management helps protect infrastructure, reduce waterlogging, and maintain safety and accessibility. Climate-resilient drainage planning aims to enhance drainage capacity, manage rainfall patterns, and avoid disruptions.

Solid waste management (SWM) is a critical component of the urban system and is severely affected during hazards, leading to issues such as the discontinuation of waste collection, waste pile-ups, and increased environmental pollution. In this context, the SWM sector faces several challenges, including blockages and overflows at waste disposal sites. Additionally, the increased decomposition of waste, coupled with damage to waste management infrastructure, leads to higher repair costs. Disruptions in waste collection and transportation further complicate the situation.

Electricity and Communication systems support daily operations, enable emergency response, and keep residents connected. Reliable energy and communication are critical in emergencies, as they support evacuation, information sharing, and recovery. Climate resilience in this sector includes strengthening power grids and ensuring uninterrupted communication channels during extreme events.

4.2.1.3 Governance

Governance plays a central role in building resilience, as effective policies, planning, and community engagement are necessary to mitigate climate change-related risks. This dimension includes indicators such as institutional capacity, accountability, planning and policy, participation, and data availability and knowledge management. This local-level governance assessment helps identify gaps in the planning and implementation of interventions, including delays in resource allocation and shortcomings in disaster preparedness. These gaps often result in inefficient responses during climate events, leaving vulnerable communities without adequate support or resources. Additionally, the absence of a clear institutional framework and responsibility at the ward level may hinder proactive climate adaptation measures. Strengthening governance at the ward level ensures that climate adaptation efforts are not only well-planned but also effectively implemented, ensuring the effectiveness and sustainability of resilience-building initiatives.

4.2.1.4 Socio-economic characteristics

The socio-economic dimension of climate vulnerability assessment focuses on how social and economic factors influence a community's ability to anticipate, respond to, and recover from climate impacts. The socio-economic indicators selected for the HIGS framework include population size, population density, housing conditions, education level, and sanitation conditions, all of which shape a community's resilience. These factors determine the degree of exposure to climate risks and influence the capacity to implement adaptive strategies and access recovery support. For example, infrastructure and services may be overstretched in densely populated areas, reducing the capacity to manage disaster risks effectively.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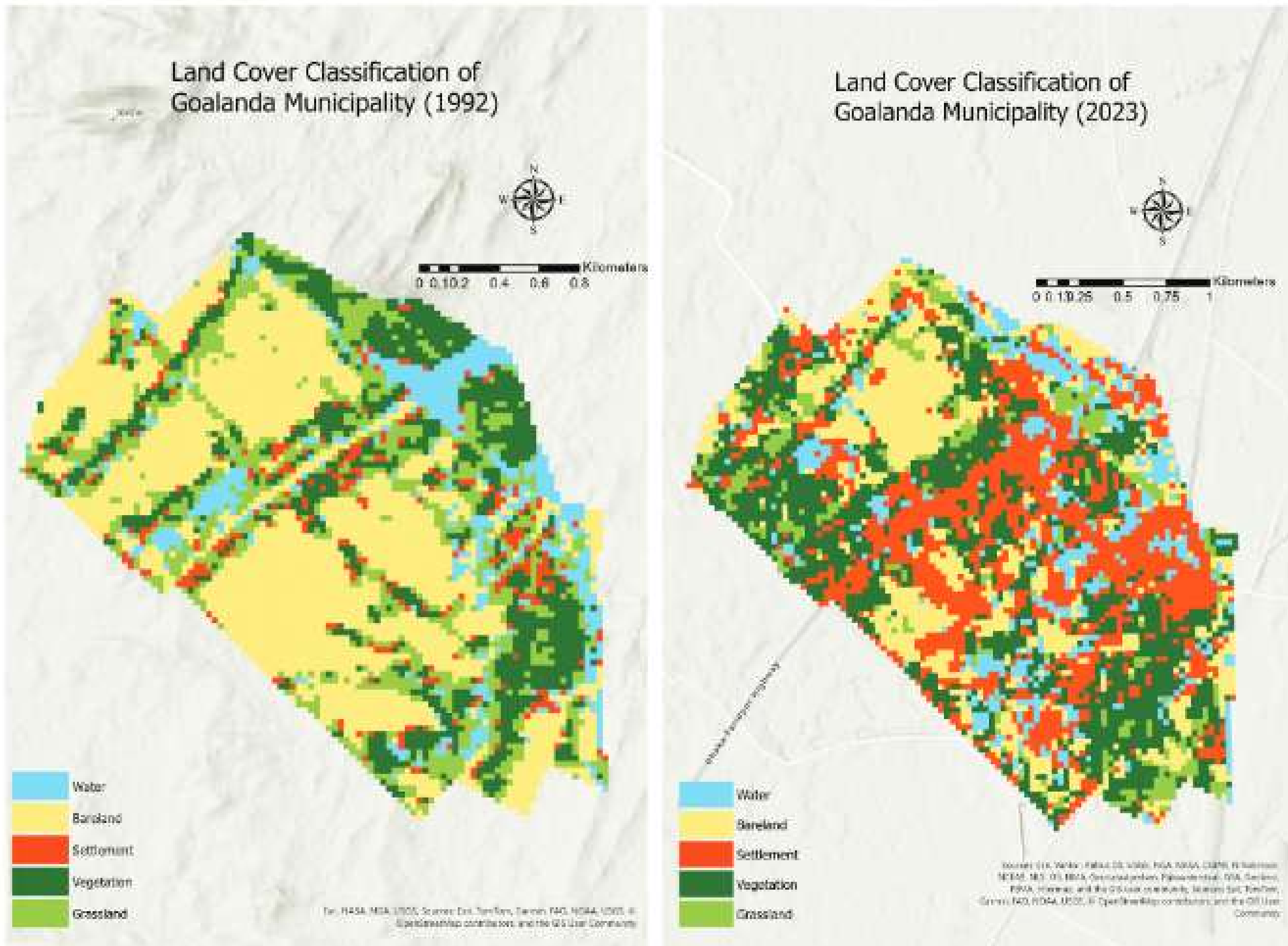
05. VULNERABILITY PROFILE ANALYSIS

This chapter presents the vulnerability profile of Goalanda Municipality, integrating findings from both secondary and primary data sources.

5.1 Ward Climate Vulnerability Profile of Goalanda Municipality Using Secondary Sources

5.1.1 Land Cover Classification and Land Use Change

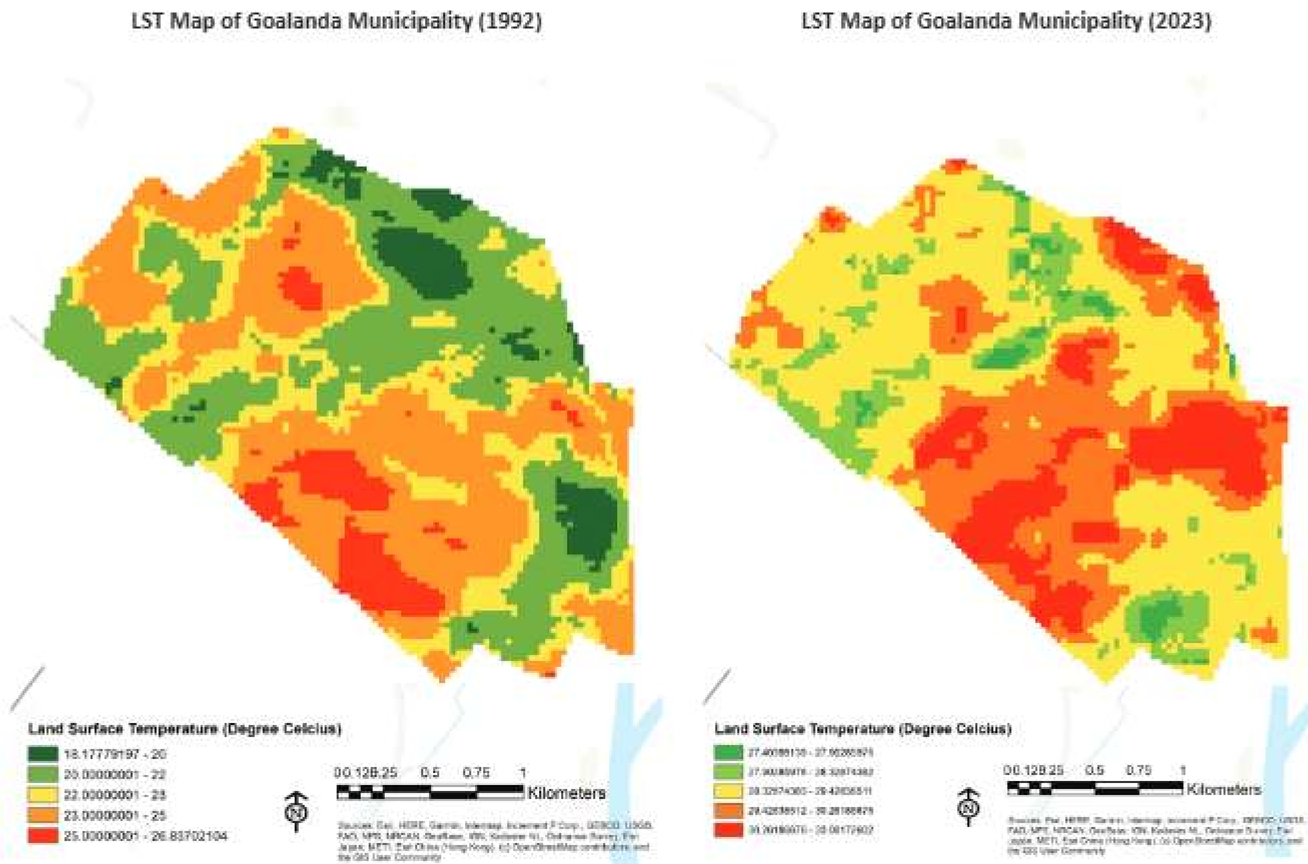
Map 5 illustrates the major land cover changes in Goalanda Municipality between 1992 and 2023. In 1992, settlement areas occupied a relatively small proportion of the municipality, while the majority of the land was characterized by vegetation and barren land. By 2023, the extent of settlements had increased significantly, particularly across wards 3, 4, 5, and 6, indicating rapid urban expansion. In contrast, vegetation cover also showed a notable increase during this period, especially in the peripheral areas of wards 1 and 2, reflecting natural regeneration and stabilization of floodplain landscapes over time.



Map 5: *Land Cover Classification and Land Use Change from 1992 to 2023*

5.1.2 Land Surface Temperature (LST)

Map 6 illustrates the Land Surface Temperature (LST) distribution across Goalanda Municipality in 2023, revealing spatial variations linked to land use changes from 1992 to 2023. The 2023 Land Use and Land Cover map shows a significant increase in built-up areas in Wards 3, 4, 5, and 6 compared with 1992, corresponding with the higher temperature zones observed in these wards. This demonstrates the influence of expanded settlements and reduced natural surfaces on localized heat intensification. Similarly, Ward 2 exhibits elevated temperatures, which align with the decline in vegetation cover since 1992, contributing to increased surface heating. In contrast, wards with lower to moderate temperatures contain less dense settlement areas and a higher proportion of vegetation, which helps regulate surface temperatures. Incorporating these findings into a climate action plan will support targeted strategies, such as enhancing green cover, improving urban planning, and developing heat-resilient infrastructure to mitigate climate risks.

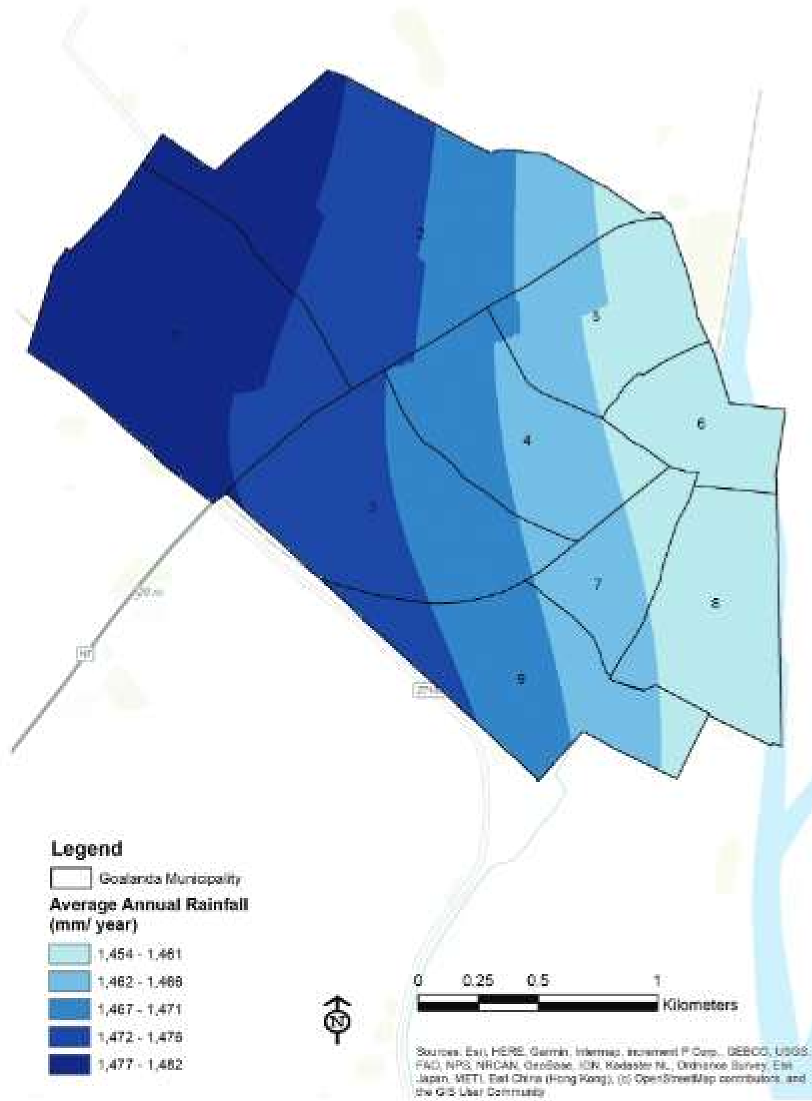


Map 6: Land Surface Temperature (LST) Comparison between 1992 and 2023

5.1.3 Rainfall

The Annual Rainfall Map of Goalanda Municipality between 2015- 2024 illustrates spatial variations in average annual rainfall across different wards. The map shows a gradual decrease in rainfall intensity from the western to the eastern part of the municipality. Wards 1 and 2, located in the northwest, receive the highest average annual rainfall, ranging between approximately 1,477 and 1,482 mm per year. In contrast, the eastern wards, particularly wards 5, 6, and 8, experience comparatively lower rainfall, between 1,454 and 1,466 mm per year. This west-to-east gradient suggests localized microclimatic differences influenced by topography, proximity to river channels, and prevailing wind patterns in the region.

Annual Rainfall Map of Goalanda Municipality



Map 7: Rainfall Volume Change from 2015-2024

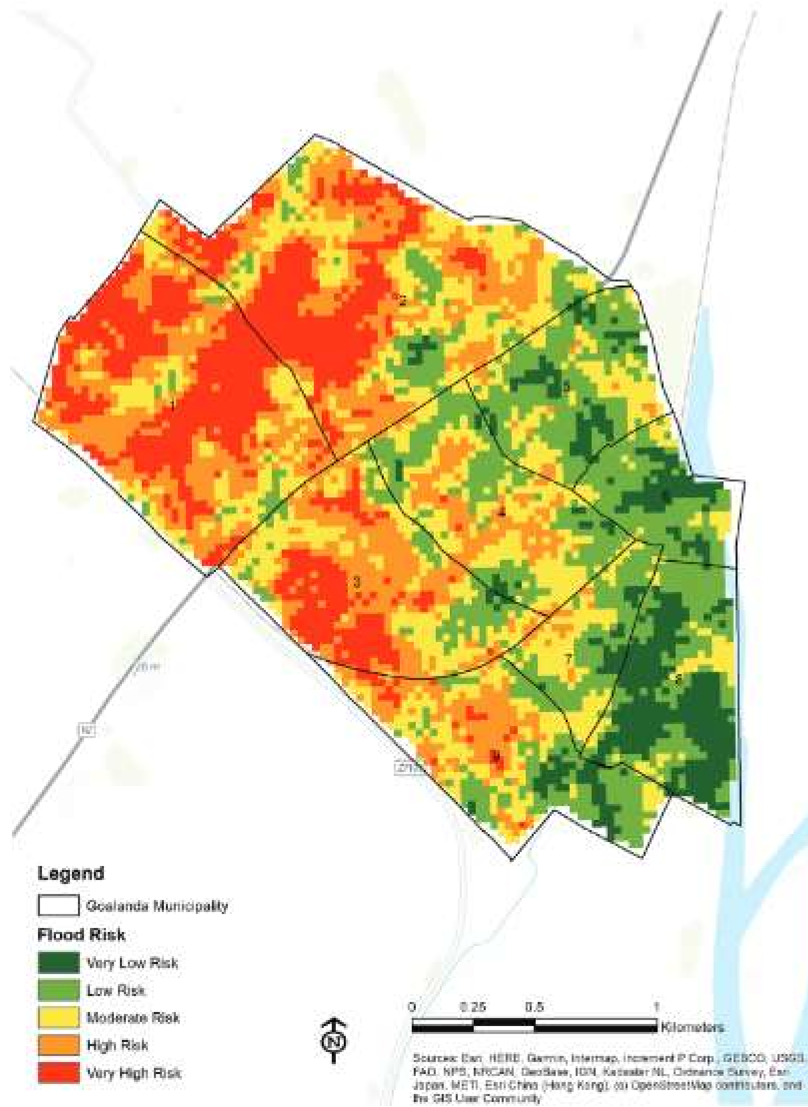
5.1.4 Flood Risk

The Flood Risk Map of Goalanda Municipality highlights spatial variations in flood vulnerability across its wards. The western and central parts, particularly wards 1, 2, and 3, are classified as high to very high flood risk zones. This elevated risk is primarily attributed to their low-lying topography, which makes them highly susceptible to flooding and prolonged waterlogging during heavy rainfall events. The lower elevation of wards 1 and 2 exacerbates this condition, as rainwater tends to accumulate due to poor drainage and limited runoff pathways. In addition, their proximity to the Padma–Jamuna river junction makes them prone to river overflows and backflow flooding during the monsoon season.

In contrast, the eastern wards, including wards 6, 7, and 8, are categorized as low to very low flood risk areas, benefitting from relatively higher elevation and are better protected from direct river inundation. The moderate-risk zones, mostly covering parts of wards 4, 5, and 9, face localized flooding due to uneven land gradients and inadequate stormwater infrastructure.

Overall, these spatial differences underscore the need for integrated flood management strategies, including enhanced drainage networks, embankment strengthening, and climate-resilient urban planning, to reduce long-term flood vulnerability and protect low-lying communities in Goalanda.

Flood Risk Map of Goalanda Municipality



Map 8: *Flood Vulnerability Assessment*

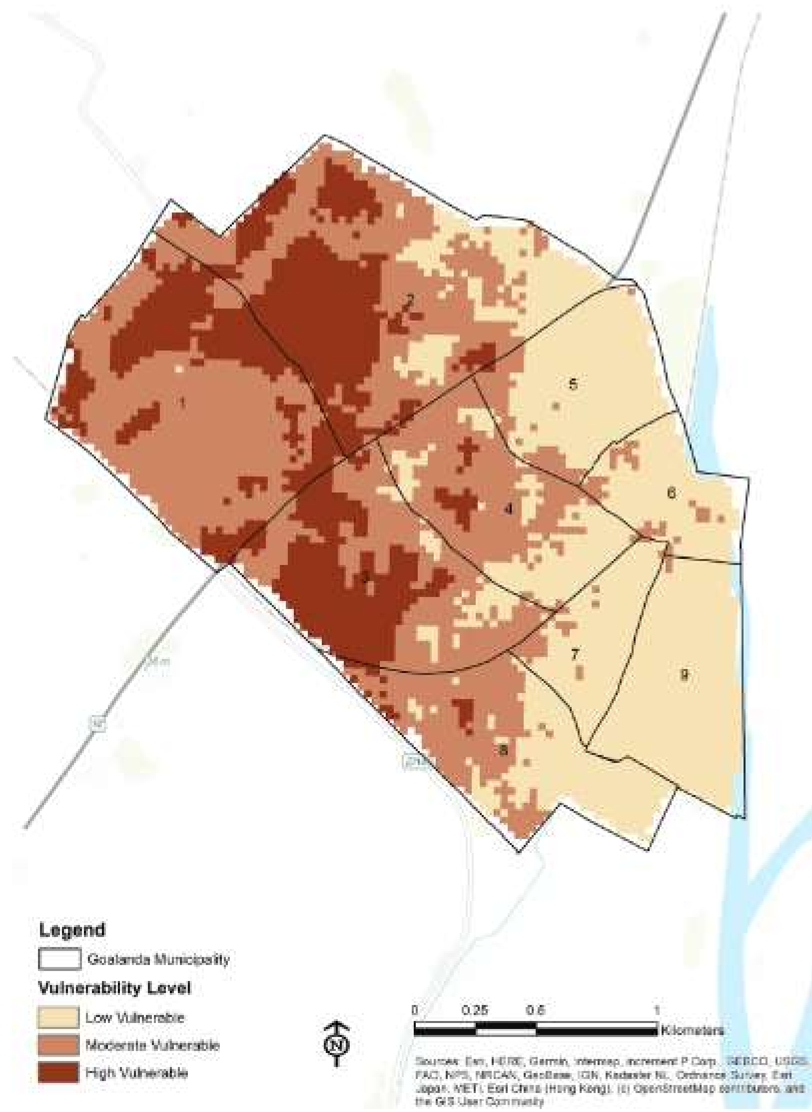
5.1.5 Overlay

Map 9 presents the Ward Climate Vulnerability Map of Goalanda Municipality, developed through an overlay analysis of satellite-derived data on temperature, rainfall, and flood risk. The analysis highlights clear spatial variations in climate vulnerability across the municipality, classifying wards into low, moderate, and high-vulnerability zones, with darker shades indicating higher risk.

The Climate Vulnerability Map of Goalanda Municipality shows distinct variations in climate risk across the wards. The western and central areas, particularly Wards 1, 2, and 3 appear as the most vulnerable, indicated by darker shades. These zones face higher exposure to climate hazards such as heavy rainfall, flooding, and extreme temperature events. In contrast, the eastern wards, especially Wards 6, 7, and 9, display lighter shades, reflecting comparatively lower vulnerability, likely due to better elevation, reduced flood exposure, and improved access to basic services. The remaining wards fall within the moderate vulnerability category, suggesting they experience several climate-related stressors but at less severe levels than the most affected areas.

This spatial distribution reveals uneven exposure to climate-induced hazards, emphasizing the urgency of targeted climate adaptation measures in high-risk areas. The map serves as an essential tool for climate action planning and disaster risk reduction, helping the municipality prioritize resources and interventions to strengthen overall urban resilience and sustainability.

Climate Vulnerability Map of Goalanda Municipality



Map 9: *Ward Vulnerability Map Based on Secondary Information*

5.2. Ward Climate Vulnerability Profile of Goalanda Municipality Using Primary Sources

A Climate Vulnerability Index for each ward of Goalanda Municipality was developed by integrating indicators of hazards, infrastructure, governance, and socio-economics. This index considers both the intensity and frequency of hazards, with higher values indicating greater vulnerability. A weighting system was applied to quantify the impact intensity and frequency of hazards for the index calculation. Impact intensity and frequency responses were assigned numerical values, as presented in the following table. This approach allows the Climate Vulnerability Index to capture both the severity and likelihood of hazards, ensuring that more frequent and severe hazards contribute proportionally more to the overall vulnerability score.

Table 2: Weightage Information for Intensity and Frequency of Hazard

Dimension	Category	Description	Weight
Frequency	< 3 times/year	Low frequency	0.25
	3–5 times/year	Low to moderate frequency	0.50
	5–7 times/year	Moderate to high frequency	0.75
	> 7 times/year	High frequency	1.00
Intensity	Low impact	Minor service disruption	0.33
	Medium impact	Moderate service disruption	0.66
	High impact	Severe service disruption	1.00

Hazard Vulnerability

The Hazard Vulnerability Index (H) quantifies the extent to which a ward is vulnerable to a specific hazard, considering both its frequency of occurrence and the cumulative intensity of its impact on all infrastructure and urban systems. While satellite imagery analysis only revealed spatial variation of hazards, this quantitative assessment establishes a robust basis for comparing hazard vulnerability across wards. A higher value indicates that the ward experiences frequent hazard events with widespread and severe impacts on multiple infrastructure and urban systems.

Infrastructure Vulnerability

Similarly, the vulnerability of a specific infrastructure type within a ward is determined as Infrastructure Vulnerability Index (I) by aggregating the effects of all hazards based on their frequency and intensity of impact on that infrastructure. The resulting infrastructure vulnerability index provides a combined score for each infrastructure type, reflecting the cumulative influence of multiple hazards on its overall risk level within the ward.

Governance Vulnerability

In the absence of quantifiable, ward-level governance indicators for climate adaptation, a uniform governance score was assigned to all wards. The governance index (G) was set at 1, reflecting the lack of measurable adaptation actions at the ward level and representing consistently high governance-related vulnerability across the municipality.

Socio-economic Vulnerability

The indicators selected for the socio-economic vulnerability assessment have different units and ranges. Therefore, min–max normalization was applied to convert them into a unitless scale from 0 to 1, allowing direct comparison across wards. After normalization, the resulting socio-economic vulnerability index (S) values range from 0 (least socio-economically vulnerable) to 1 (most socio-economically vulnerable).

HIGS Climate Vulnerability Index

The final HIGS Climate Vulnerability Index integrates four dimensions of vulnerability: Hazards (H), Infrastructure (I), Governance (G) and Socio-economic (S). The hazards vulnerability index and the infrastructure vulnerability index were subsequently rescaled to a common range [0,1] using Min–Max normalization. The final HIGS Climate Vulnerability Index for ward w was calculated as the summation of the four dimension scores.

$$HIGS_w = H_w + I_w + G_w + S_w$$

Since each dimension is normalized to the range [0,1], the composite HIGS index ranges from 0 (lowest possible vulnerability) to 4 (highest possible vulnerability). The higher the HIGS index, the greater the ward's overall climate vulnerability.

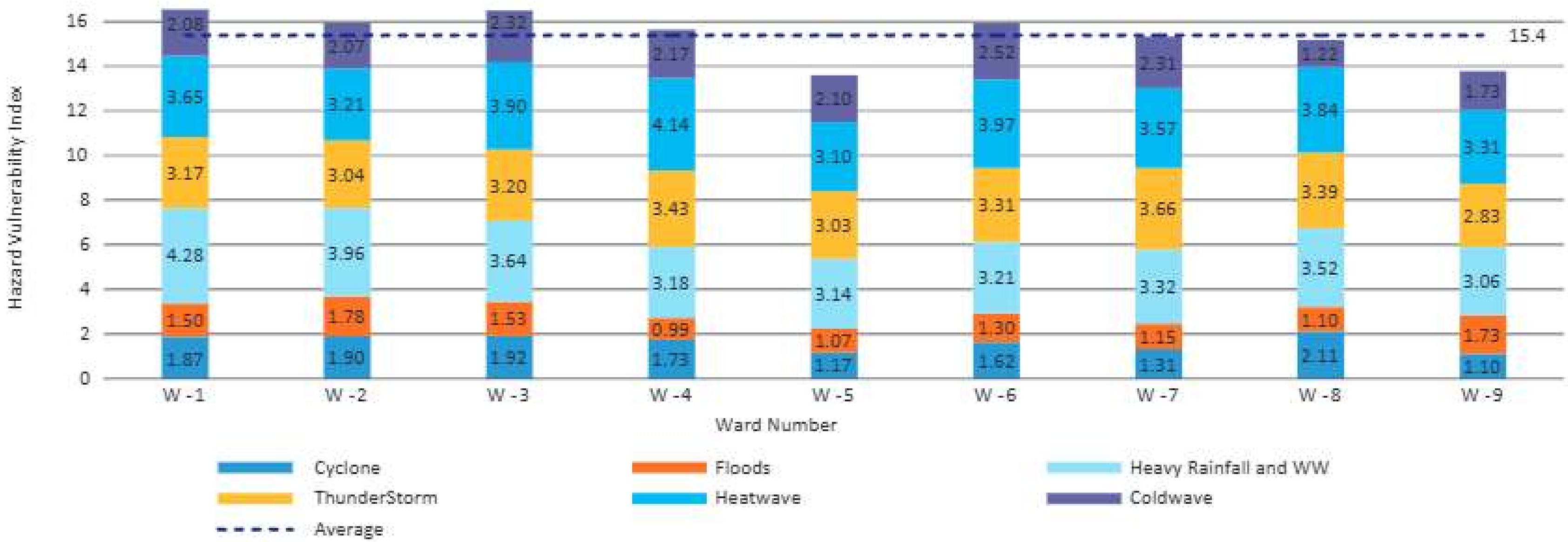


Figure 13: Wards Exposure to Hazards on Selected Infrastructures and Urban Systems

5.2.1 Hazard Vulnerability Profile of Goalanda Municipality

Based on the vulnerability index calculation, the ward-level hazard vulnerability index is presented in Table 3, using a color gradient where "Red" indicates the highest vulnerability levels and "Green" represents the lowest. The gradient visually highlights varying levels of susceptibility across wards. The variation in the index across the wards within the municipality signifies the importance of this study. Policymakers have to understand that some wards need special attention. The specific areas where such interventions can be made are discussed later.

Table 3: Hazard Vulnerability Index

Hazards	Ward Hazard Vulnerability Index of Goalanda Municipality								
	1	2	3	4	5	6	7	8	9
Cyclone	1.87	1.90	1.92	1.73	1.17	1.62	1.31	2.11	1.10
Floods	1.50	1.78	1.53	0.99	1.07	1.30	1.15	1.10	1.73
Heavy Rainfall and WL*	4.28	3.96	3.64	3.18	3.14	3.21	3.32	3.52	3.06
Thunder-storm	3.17	3.04	3.20	3.43	3.03	3.31	3.66	3.39	2.83
Heatwave	3.65	3.21	3.90	4.14	3.10	3.97	3.57	3.84	3.31
Coldwave	2.08	2.07	2.32	2.17	2.10	2.52	2.31	1.22	1.73

The "Ward Exposure to Hazards" chart, developed using multi-hazard indices from cyclones, floods, rainfall, thunderstorms, heatwaves, and coldwaves, illustrates the variation in hazard exposure across the wards of Goalanda Municipality. Each bar represents the cumulative exposure index, where higher values indicate greater overall vulnerability. The exposure scores range from 13.06 to 16.43, showing moderate to high vulnerability across all wards. Heavy rainfall and heatwaves emerge as the most dominant contributors, while floods and cyclones have relatively lower impacts throughout the municipality.

Among all wards, Ward 1 (16.6) and Ward 3 (16.5) show the highest exposure, exceeding the municipal average of 15.4 by nearly one standard deviation, indicating higher susceptibility to climate hazards. Conversely, Ward 5 (13.6) and Ward 9 (13.8) record the lowest exposure, falling below the mean and representing relatively safer areas.

The remaining wards, including 2 (15.9), 4 (15.6), 6 (15.9), 7 (15.3), 8 (15.1) show exposure levels clustered around the mean, reflecting moderate vulnerability that could intensify under extreme climatic events.

The radar chart in Figure 14 illustrates the hazard vulnerability of Goalanda Municipality across six types of natural hazards. Among these, the municipality demonstrates the highest vulnerability to heatwaves, with a score of 32.68, followed by heavy rainfall and waterlogging, with a vulnerability score of 31.31. Thunderstorms pose a

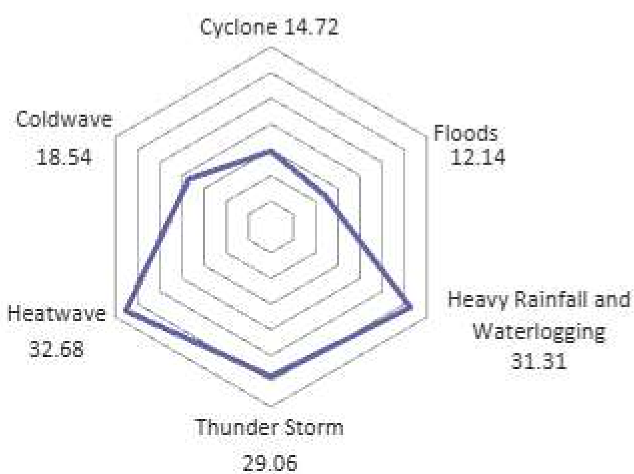


Figure 14: *Hazard Vulnerability in Goalanda Municipality*

moderate vulnerability level at 29.06, while cyclones and cold waves show relatively lower vulnerability scores of 14.72 and 18.54, respectively. The municipality is least vulnerable to floods, scoring only 12.14. The high vulnerability to heavy rainfall and heatwaves can be attributed to rapid urbanization, poor drainage infrastructure, and increasing impervious surfaces, which exacerbate waterlogging and intensify urban heat island effects. Recent climate extremes, such as record-breaking rainfall events and prolonged heatwaves in Bangladesh, underline the severity of these hazards for Goalanda, leading to health risks, economic disruptions, and damage to infrastructure.

This analysis informs climate action planning by identifying the need for targeted measures like improved drainage, green infrastructure, and heat-resilient design. Prioritizing these actions will strengthen the municipality's resilience and support sustainable urban development

5.2.1.a Cyclone

- Cyclones have a limited impact on Goalanda Municipality due to its inland location, away from the coastal areas where cyclones typically make landfall.
- However, Goalanda experiences strong winds and heavy rainfall from cyclonic systems, which can cause localized flooding, damage to infrastructure, and disruptions to daily life.
- Significant disruptions occurred in electricity and communication networks, especially in Wards 2, 3 and 8.

5.2.1.b. Floods

- Goalanda is located in the floodplains of the Padma river which makes it more vulnerable to river flooding, increasing the risk of seasonal flood inundation common in lower-lying areas of Bangladesh.
- Hence, flooding remains a risk due to its lower elevation in some wards, causing threats to infrastructure damage, water and sanitation, solid waste management and service interruptions etc. in wards 1, 2 and 3 which are most exposed to seasonal floods due to their lower elevation.

5.2.1.c. Heavy Rainfall and Waterlogging

- Goalanda is highly vulnerable to heavy rainfall and waterlogging due to its localized topographic variation, inadequate drainage system, and poor settlements.
- Wards 7 and 9 are the most affected across all infrastructure due to the poor drainage system and settlements. In contrast, wards in low-lying areas as well as with insufficient drainage are prone to prolonged waterlogging after heavy rainfall such as ward 1, 2 and 3.
- This phenomenon causes damage to infrastructure, including eroded roads and submerged buildings, disrupts transportation, contaminates water supplies, increases public health risks through waterborne diseases, and leads to economic losses.
- The severity of these impacts fluctuates across wards, influenced by factors such as local topography, infrastructure quality, and drainage capacity.

5.2.1.d. Thunderstorms and Lightning

- Goalanda is moderately vulnerable to thunderstorms and lightning due to its geographical location in Bangladesh, which experiences frequent monsoon-related storms and intense weather systems.
- The impact of thunderstorms varies across the municipality, with some wards experiencing more severe damage due to factors like urban density, infrastructure quality, and tree cover. Also, areas with less developed infrastructure or more open spaces may face greater risks, particularly from fallen trees and power outages.
- Thunderstorms are a common cause for the disruption of electricity supply, affecting daily activities and services.
- Electricity and communication networks are affected the most across all the wards.

5.2.1.e. Heatwaves

- Recent climatic trends indicate that Goalanda Municipality is facing a rising exposure to heatwaves, marked by multiple long-lasting and extreme heat events in the past few years.
- Nearly all wards in Goalanda are experiencing extended heat spells, with the impacts being especially severe in the less developed wards—such as Wards 7, 8, and 9—due to a higher concentration of low-income communities and inadequate housing structures

5.2.1.f. Coldwaves

- In recent years, Goalanda Municipality has been affected by several cold wave events, and the growing frequency and unpredictability of extreme weather suggest that the area may face heightened susceptibility to cold spells in the future.
- These cold waves have created significant hardships for residents, particularly among vulnerable groups such as the elderly, young children, and low-income households living in kancha and semi-pucca dwellings.

5.2.2 Infrastructure and Urban Systems Vulnerability Profile of Goalanda Municipality

The urban system components are categorized into two parts: Non-WASH Urban Systems and WASH Systems. Non-WASH Urban Systems include critical sectors such as housing, transportation, and electricity & communication, which form the backbone of urban infrastructure and daily life. WASH Systems, on the other hand, encompass water supply, sanitation & wastewater, stormwater drainage, and solid waste management, focusing on essential services that ensure public health and environmental sustainability. Each ward's index in Goalanda Municipality was measured based on hazard intensity and frequency, with data collected from residents' perceptions. These hazard indexes for Infrastructure and Urban Systems are represented in the table below (Table 4).

Table 4: Infrastructure and Urban System Vulnerability Index

Hazards	Ward of Goalanda Municipality								
	1	2	3	4	5	6	7	8	9
Housing	2.23	2.21	2.21	2.13	2.39	2.21	2.71	2.82	2.11
Transportation	2.2	2.28	2.16	2.03	2.06	2.38	2.02	2.02	1.97
Electricity and Communication	2.27	2.18	2.39	2.79	2.39	2.61	2.07	2.35	2.04
Water Supply	1.98	1.95	2.02	1.73	1.97	1.78	2.15	2.09	1.83
Sanitation and Wastewater	2.3	2.09	2.51	2.55	2.13	2.24	2.51	2.82	2.13
Storm Water Drainage	2.84	2.73	2.63	2.33	2.21	2.19	2.38	2.42	2.28
Solid Waste Management	2.56	2.46	2.21	2.58	2.22	2.34	2.61	2.52	2.2

5.2.2.1 Infrastructure and Urban Systems Vulnerability of Non-WASH Urban Systems

The vulnerability of non-WASH infrastructure and urban systems has been assessed, identifying the most vulnerable wards for each system and also which wards have comparatively better urban systems. Overall, Wards 7 and 8 show the highest vulnerability in housing, with scores above 2.7, indicating poor resilience. Wards 4 and 6 show notable weakness in electricity and communication. And most wards face challenges in transportation. But, Ward 9 shows the lowest vulnerability across most sectors, suggesting relatively stronger infrastructure conditions. These findings are visually represented in the figures above. (See figure 15).

Figure 15: Non-WASH Urban Systems Vulnerability of Wards

5.2.2.2 Infrastructure and Urban Systems Vulnerability of WASH Urban Systems

The vulnerability of WASH infrastructure and urban systems has been also assessed, identifying the most vulnerable wards for each system and also which wards that have more comparatively better urban systems. These findings are visually represented in the figures below. Overall, ward 1 and 8 are the most vulnerable particularly in storm water drainage and sanitation and wastewater.

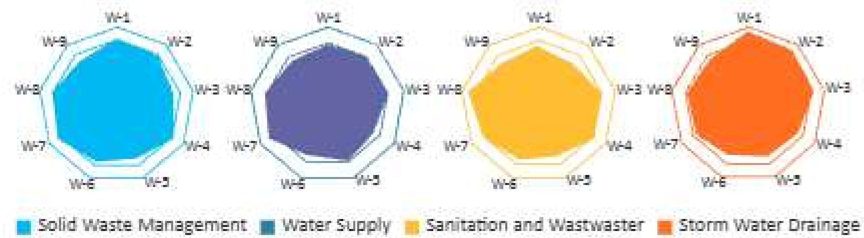


Figure 16: WASH Urban Systems Vulnerability of Wards

The figure 17 provides an overview of the infrastructure and urban system vulnerabilities in Goalanda Municipality. The index evaluation reveals that all seven systems have comparable vulnerability scores, indicating that each system faces similar risks from hazards.

Among WASH system, Stormwater drainage is the most vulnerable with a score of 22 followed by solid waste management (21.70) and sanitation and wastewater (21.28). The high vulnerability in both storm water drainage and sanitation and wastewater reflects the municipality's struggle with inadequate drainage system, along with poor waste management which causes drainage blockage during storms, leading to waterlogging.

Figure 17: Infrastructure Vulnerability in Goalanda Municipality

Besides WASH system, both electricity and communication (21.09) and housing (21.03) infrastructure are in a vulnerable position. The high vulnerability in electricity and communication reflects the municipality's struggle with reliable power and communication infrastructure, which can severely impact daily life, emergency responses, and economic activities. Housing issues highlight the challenges of urban expansion and inadequate planning.

Table 5: WASH Vulnerability Index

Infrastructure	Ward of Goalanda Municipality								
	1	2	3	4	5	6	7	8	9
Water Supply	1.98	1.95	2.02	1.73	1.97	1.8	2.15	2.09	1.83
Sanitation and Wastewater	2.3	2.09	2.51	2.55	2.13	2.2	2.51	2.82	2.13
Storm Water Drainage	2.84	2.73	2.63	2.33	2.21	2.2	2.38	2.42	2.28
Solid Waste Management	2.56	2.46	2.21	2.58	2.22	2.3	2.61	2.52	2.2

5.2.2.3. Ward-wise WASH System Assessment

Analyzing the WASH systems in Goalanda Municipality at the ward level has yielded two key outcomes. First, it identifies the most vulnerable WASH system in each ward based on the hazard index. Second, it highlights which wards require immediate intervention to reduce vulnerability effectively.

The table 5 presents the ward-wise vulnerability of WASH systems. Red indicates the most vulnerable WASH sector for a specific ward. Consequently, the green indicates less vulnerable wards. Wards 1, 2, and 3 exhibit the highest vulnerability in the stormwater drainage system, indicating inadequate drainage capacity and maintenance. The solid waste management system is also in a vulnerable condition, with scores exceeding 2.5 in Wards 1, 4, 7, and 8. Furthermore, Ward 8 demonstrates the greatest vulnerability in sanitation and wastewater management. In contrast, the water supply system remains relatively stable across all wards, reflecting the lowest overall vulnerability among the assessed sectors.

Assessing the overall index for WASH systems reveals the most vulnerable wards in Goalanda Municipality, identifying those requiring immediate intervention in WASH sectors. As shown in figure 19, Ward 8 has the highest index value, closely followed by Ward 1, indicating the greatest vulnerability. This conclusion was also

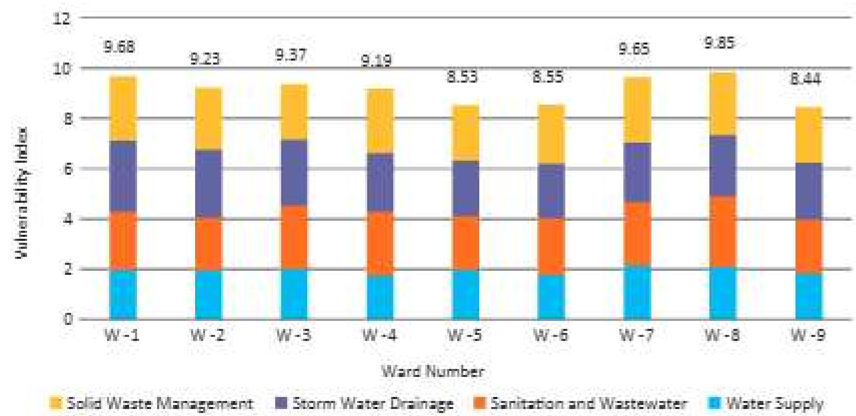


Figure 18: Ward-wise WASH Vulnerability

drawn earlier when WASH and Non-WASH systems were analysed. Ward 9 holds a relatively better position compared to the other wards from the perspective of local residents. Prioritizing improvements in stormwater drainage and solid waste management is crucial to enhancing resilience against climate impacts such as heavy rainfall and flooding.

5.2.2.4 Impacts on the Infrastructure and Urban Systems during Hazards

The questionnaire survey captured the various impacts on each infrastructure and urban system experienced by residents during hazards. The magnitude of these impacts was measured based on their intensity and frequency. This analysis was essential for determining the priority needs assessments for Goalanda Municipality.

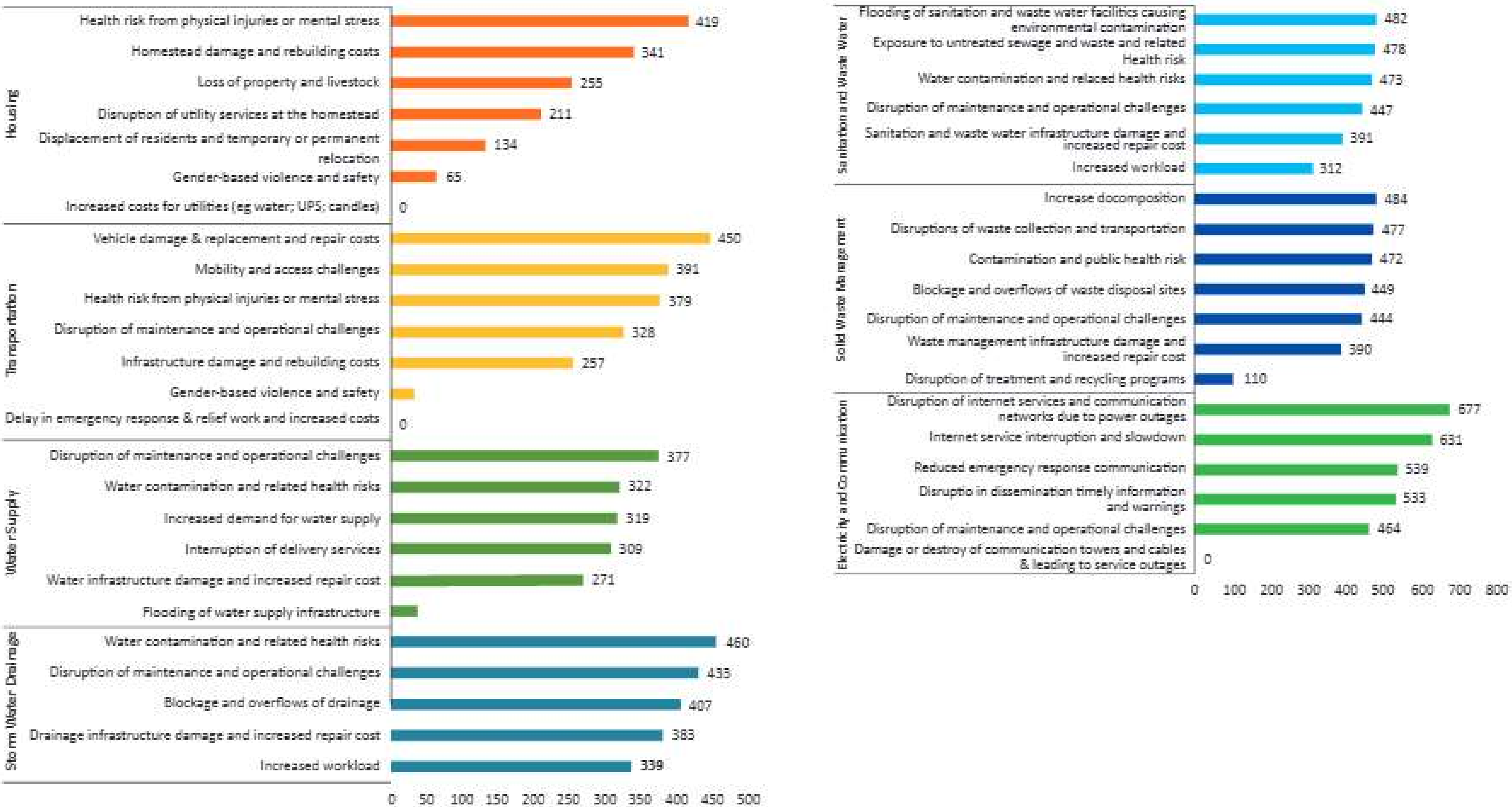


Figure 19: *Impacts Magnitude of Infrastructure and Urban Systems*

For example, a key priority for intervention in the SWM sector of Goalanda Municipality is ensuring uninterrupted waste collection during hazards, as "Increase decomposition" is the most significant challenge faced by residents. In the Non-WASH sector, particularly Electricity and Communication, the primary concern is "disruption of internet services and communication networks due to power outages."

5.2.3 Governance Vulnerability Profile of Goalanda Municipality

The table below summarizes the key governance vulnerabilities of Goalanda Municipality. As previously mentioned, since there are no ward-level activities for climate action, the available qualitative information could not be quantified or scored for comparative analysis. Hence, the table provides an overall summary for the municipality as a whole. These findings reveal critical areas requiring attention to enhance effective climate action planning.

Institutional Capacity	No dedicated framework for climate action or disaster preparedness at the ward level.
	Lack of trained personnel and specialized units for climate resilience activities.
	No mechanism to support awareness-raising initiatives and capacity-building efforts for climate change adaptation.
Accountability	No ward-level disaster management committees.
	No clear responsibility for implementing ward-level climate resilience measures.
	Weak enforcement of development regulations causing unplanned growth.
Planning and Policy	No dedicated climate action plan for Goalanda.
	Climate adaptation considerations remain overlooked in municipal master plans and local budgetary frameworks.
Participation	Limited stakeholder involvement in climate resilience planning.
	Low public awareness of climate risks and adaptation measures.
	Lack of formal structures for community participation in climate resilience planning.
Data and Knowledge Management	Lack of ward-level climate data and associated risk or exposure information.
	No data-sharing platforms for disseminating climate data and vulnerability assessments to stakeholders, including the public, local authorities, and the private sector.

5.2.4 Socio-economic Vulnerability Profile of Goalanda Municipality

The analysis indicates that wards 7, 8, and 3 show the highest socio-economic vulnerability, driven by poor housing, lower literacy, and high open defecation rates. High-density wards, particularly 7 and 3, experience greater pressure on housing, sanitation, and basic services, increasing overall vulnerability. In contrast, Ward 2 remains the least vulnerable due to low density and better socio-economic conditions. These densely populated areas face higher exposure to climate hazards and greater strain on resources during such events.

Poor housing conditions, characterized by a high prevalence of kancha structures, are concentrated in Wards 7, 8 and 9. Areas with such housing types are highly vulnerable to severe damage during extreme weather events. Low literacy rates are particularly notable in Wards 3, 7 and 8. Limited literacy can significantly hinder the effective communication and use of climate-related information, as communities may face difficulties in understanding and responding to guidance during extreme events. Sanitation vulnerability is highest in Wards 7, 8, 3, and 4, where open defecation increase public health risks—especially during floods or heavy rainfall. In contrast, Wards 1 and 2 show very low sanitation vulnerability, reflecting better access to sanitation facilities. Overall, Wards 2, 5 and 6 also exhibit relatively low socio-economic vulnerability across multiple indicators due to stronger housing conditions, lower population density, and higher literacy rates.

These findings underscore the importance of integrating socio-economic vulnerability into the Climate Action Plan, with targeted interventions in high-risk wards to strengthen community resilience and reduce exposure to climate-related hazards.

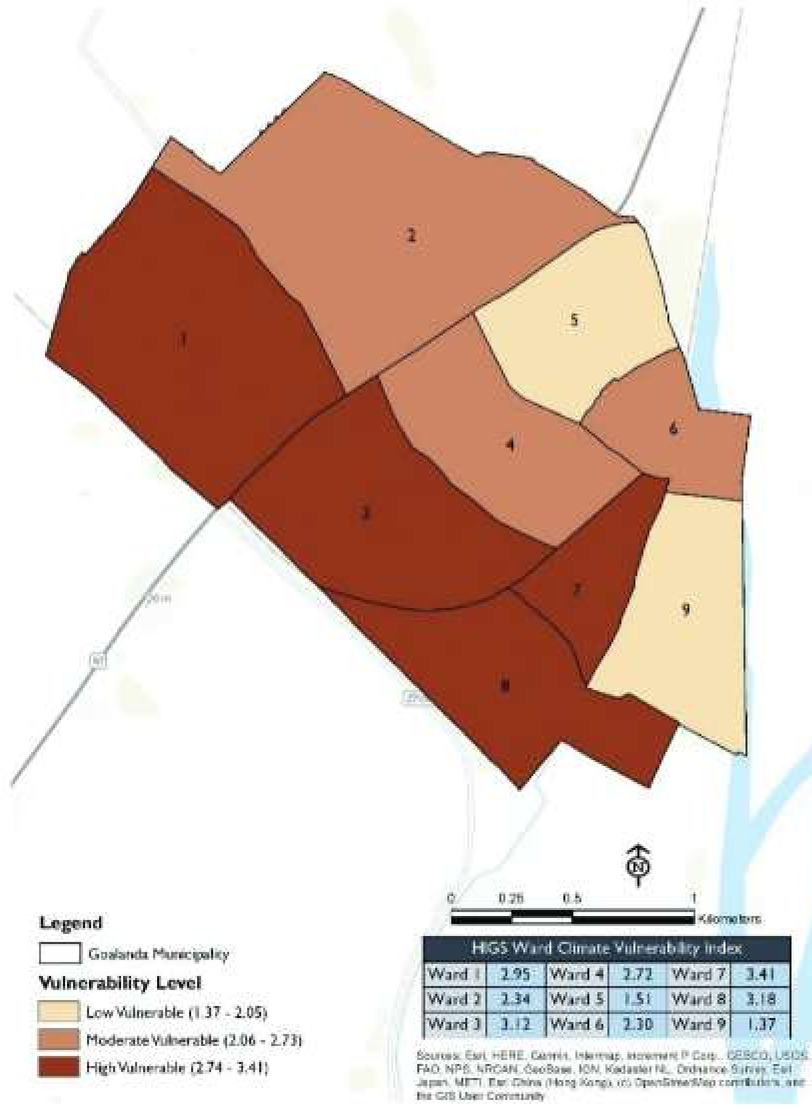
5.2.5 HIGS Climate Vulnerability INDEX

The Ward Climate Vulnerability Index, displayed in the table at the bottom of Map 10, presents the varying degrees of vulnerability across wards in Goalanda Municipality. The vulnerability index integrates the four dimensions of the HIGS framework: Hazards, Infrastructure, Governance, and Socio-economic indicators. Each dimension is normalized to a range of 0 to 1, resulting in a composite HIGS index ranging from 0 (lowest vulnerability) to 4 (highest vulnerability), providing a comprehensive understanding of ward-level vulnerability. These scores are crucial for the climate action planning process, as they identify the wards most at risk and highlight areas requiring targeted interventions. Higher index values indicate greater vulnerability, reflecting intensified climate hazards, limited infrastructure resilience, or significant socio-economic challenges.

The index further categorizes wards into three vulnerability levels: Low, Moderate, and High. Wards with the highest vulnerability scores, such as wards 1, 3, 7 and 8 (shaded in dark brown), are exposed to significant climate risks and require immediate attention. In contrast, wards 2, 4, and 6 (shaded in lighter tones) exhibit low vulnerability, while the remaining wards fall under moderate vulnerability. This classification indicates that most of Goalanda Municipality lies within moderate to high vulnerability zones.

By identifying high-risk areas, the Ward Climate Vulnerability Index provides a data-driven basis for prioritizing interventions in the Climate Action Plan. Aligning resources and strategies with these vulnerability hotspots ensures that adaptation measures are both equitable and effective. Ultimately, this approach fosters long-term urban resilience and sustainability, enabling Goalanda Municipality to better prepare for and respond to the impacts of climate change.

Climate Vulnerability Map of Goalanda Municipality



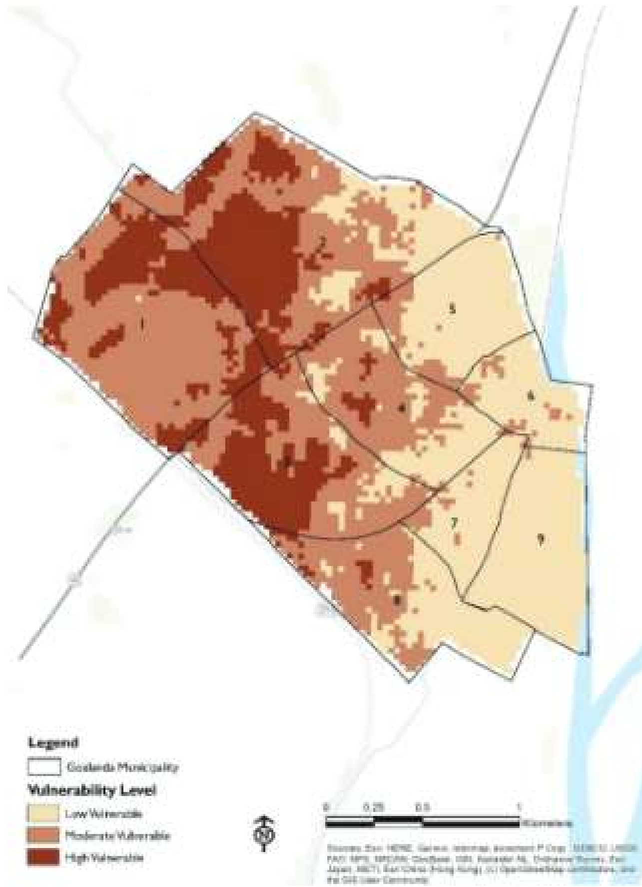
HIGS Ward Climate Vulnerability Index					
Ward 1	2.95	Ward 4	2.72	Ward 7	3.41
Ward 2	2.34	Ward 5	1.51	Ward 8	3.18
Ward 3	3.12	Ward 6	2.30	Ward 9	1.37

Map 10: Climate Vulnerability Map Based on HIGS Framework

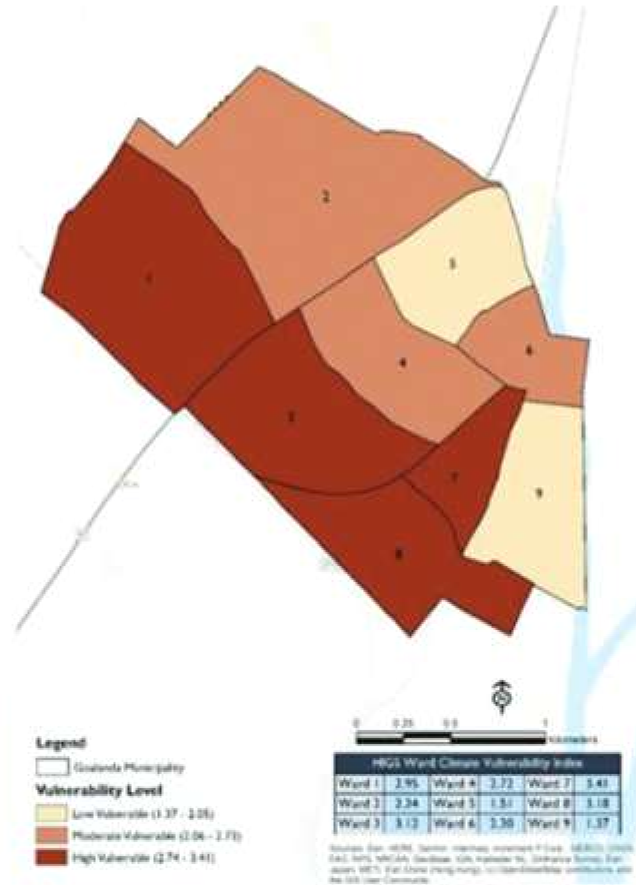
5.2.6 Correlation findings between the Satellite Vulnerability Map and HIGS Vulnerability Map

The climate vulnerability assessment for Goalanda Municipality combined satellite-based analysis of secondary data to present localized spatial variation of hazards across the municipality, with a community perception survey based on the HIGS framework to capture how different socio-economic groups perceive the impact of extreme events on urban infrastructure and services. Both approaches demonstrated strong alignment, consistently highlighting highly vulnerable wards 1, 2, and 3, while the perception-based findings highlight wards 1, 3, 7 and 8, where living conditions and service gaps increase susceptibility. This combined approach strengthens the reliability of the results. Overall, the assessment provides a strong basis for identifying vulnerable areas, planning targeted interventions, and supporting climate-resilient urban development (Map 11).

Climate Vulnerability Map of Goalanda Municipality



Climate Vulnerability Map of Goalanda Municipality



Map 11: Ward Climate Vulnerability Map of Goalanda Municipality using Primary and Secondary Data

06. WAY FORWARD AND RECOMMENDATIONS

To address urban system vulnerabilities to climate hazards, residents and stakeholders of Goalanda Municipality have highlighted several priority areas for intervention. The vulnerability assessment shows that Goalanda faces significant risks from heatwaves, heavy rainfall, waterlogging, flooding, thunderstorms, poor drainage, inadequate waste management, weak sanitation systems, and fragile housing conditions. Wards 1, 3, 7 and 8 require particular attention due to higher climate and socio-economic vulnerability, while Wards 1, 2 and 3 are especially exposed to flood-related risks.

This section presents the recommended way forward for Goalanda Municipality. In line with the Climate Action Plan approach, short-term interventions should focus on WASH urban systems, while medium-term interventions should address non-WASH urban systems. These measures should be implemented through coordinated municipal planning, community participation, donor support, and technical assistance from relevant agencies such as DPHE, LGED and other development partners.

6.1 Way Forward and Intervention for WASH Urban Systems (Short Term)

6.1.1 Water Supply System

Safe and reliable water supply should be treated as a core resilience priority for Goalanda Municipality, particularly because most residents still depend on tubewells and piped water coverage remains limited.

Recommended interventions:

- Expand piped water supply coverage across all nine wards, prioritizing vulnerable and low-income areas where dependency on tubewells is high.
- Ensure safe drinking water availability before, during and after flood, waterlogging and heatwave events.
- Extend the existing pipeline network beyond currently served areas and gradually reduce excessive dependence on groundwater.
- Install community-level water points in LIC areas, especially in wards where household-level connection is not yet affordable or available.
- Introduce rainwater harvesting systems at household, institutional and community levels to reduce pressure on groundwater.
- Protect existing water sources from contamination during floods and heavy rainfall.
- Raise or flood-proof water pumps, tube wells and related supply infrastructure in flood-prone wards, especially Wards 1, 2 and 3.
- Conduct regular water quality testing, particularly after flooding and waterlogging events.
- Promote household awareness on safe water storage, boiling, filtration and contamination prevention during climate hazards.

Figure 20: *Suggested Way Forward for Water Supply*

6.1.2 Sanitation and Wastewater System

Goalanda's sanitation system requires urgent improvement, especially in wards where unsafe toilet systems and poor wastewater disposal increase public health risks during floods and waterlogging.

Recommended interventions:

- Improve access to hygienic toilet facilities in vulnerable wards, especially Wards 3, 4, 7 and 8.
- Support low-income households with financial and technical assistance to construct safe, climate-resilient toilets.
- Increase the number of shared/public toilets in suitable locations, particularly near low-income settlements, bazar areas, transport points and densely populated neighborhoods.
- Ensure proper operation and maintenance of the Faecal Sludge Treatment Plant after completion, including municipal staff training before handover.
- Develop a regular faecal sludge collection and transportation system with scheduled service coverage.
- Prevent direct discharge of wastewater into drains, open land and nearby water bodies.
- Introduce awareness campaigns on safe sanitation, hygiene practices, menstrual hygiene, and sanitation management during floods.
- Prepare emergency sanitation plans for flood-affected wards to reduce contamination, open defecation and disease outbreak risks.

Figure 21: *Suggested Way Forward for Sanitation and Wastewater*

6.1.3 Storm Water Drainage System

Drainage is one of the most critical weaknesses in Goalanda Municipality. The existing drains are shallow, mostly Kancha, discontinuous and poorly maintained, causing frequent waterlogging and debris accumulation.

Recommended interventions:

- Prepare and implement a planned stormwater drainage network for the whole municipality.
- Prioritize drainage improvement in Wards 1, 2 and 3 because of their low elevation and higher flood exposure.
- Improve drainage in Wards 7, 8 and 9 where poor settlements and weak infrastructure increase waterlogging vulnerability.
- Convert Kancha and discontinuous drains into lined, connected and functional drains.
- Increase drain depth, width and carrying capacity in waterlogging-prone areas.

Figure 22: *Suggested Way Forward for Stormwater Drainage*

- Ensure proper gradients so that stormwater can flow naturally toward suitable outfalls.
- Install street gutters, culverts and cross-drainage structures in areas where roads block natural water flow.
- Conduct regular drain cleaning before and during the monsoon season.
- Prevent solid waste dumping into drains through enforcement and awareness campaigns.
- Introduce nature-based drainage solutions such as rain gardens, retention ponds, permeable surfaces and green buffers where possible.
- Protect natural canals, lowlands and water retention areas from encroachment and filling.

6.1.4 Solid Waste Management System

Solid waste management in Goalanda is highly vulnerable due to open dumping, irregular collection, limited vehicles, clogged drains and unmanaged waste disposal near water bodies.

Recommended interventions:

- Establish safe and designated waste disposal points in all wards.
- Increase municipal waste collection coverage, especially in residential and low-income areas.
- Procure additional waste collection vehicles and repair nonfunctional garbage trucks.
- Introduce regular door-to-door waste collection, beginning with high-density and vulnerable wards.
- Stop open dumping near the Marapadma River and other sensitive water bodies.
- Improve management of existing dumpsites and gradually shift toward controlled disposal.

Figure 23: Suggested Way Forward for SWM

- Establish a small-scale Material Recovery Facility or sorting center for recyclable waste.
- Promote household-level waste segregation into organic, recyclable and hazardous waste.
- Introduce composting of organic waste, especially from bazar and household sources.
- Conduct community awareness campaigns to reduce dumping in drains, roadsides, vacant lands and water bodies.
- Prepare emergency waste management plans for post-flood and post-storm debris removal.

6.2 Way Forward and Interventions for Non-WASH Urban Systems (Medium Term)

6.2.1 Housing System

Housing vulnerability is high in Goalanda because Kancha housing dominates many wards, particularly Wards 7, 8 and 9. These structures are highly exposed to damage from storms, heavy rainfall, flooding and heat stress.

Recommended interventions:

- Improve housing conditions in LIC areas and vulnerable wards, especially Wards 7, 8 and 9.
- Provide financial and technical support for upgrading Kancha houses into semi-pucca or pucca structures.
- Promote climate-resilient housing designs suitable for flood-prone and heat-prone areas.
- Encourage raised plinth construction in low-lying wards, especially Wards 1, 2 and 3.
- Use locally available, affordable and durable materials for resilient housing improvement.
- Develop community-level shelter facilities in suitable locations for emergency use during floods, storms and extreme weather events.
- Improve ventilation, roofing materials and shading in low-income housing to reduce indoor heat stress.
- Integrate housing improvement with sanitation, drainage, electricity and access road development.
- Prevent new settlements in highly flood-prone or erosion-prone areas through planned land-use control.

Figure 24: *Suggested Way Forward for Housing*

6.2.2 Transportation System

Goalanda's transportation system is vulnerable due to a significant share of Kancha and semi-pucca roads, roadside parking, lack of transport terminal facilities, poor drainage along roads and frequent waterlogging.

Recommended interventions:

- Upgrade damaged and Kancha roads into climate-resilient pucca roads.
- Prioritize road improvement in flood-prone and waterlogging-prone wards to ensure access during emergencies.
- Raise road levels in low-lying areas where repeated inundation disrupts mobility.
- Integrate roadside drains with road improvement works.
- Repair damaged culverts and construct additional cross-drainage structures where needed.
- Ensure all-weather access roads to schools, health facilities, markets, water points and emergency shelters.
- Develop designated parking and transport terminal spaces to reduce roadside congestion.
- Improve pedestrian access, especially in dense and vulnerable settlements.
- Install adequate streetlights along major roads, lanes and vulnerable public spaces.
- Ensure road maintenance before the monsoon season to reduce disruption during heavy rainfall.

Figure 25: *Suggested Way Forward for Transportation*

6.2.3 Electricity and Communication System

Electricity and communication systems are essential during climate hazards. In Goalanda, these services are particularly vulnerable during thunderstorms, cyclonic winds, floods and heavy rainfall.

Recommended interventions:

- Ensure uninterrupted electricity supply during normal and hazard periods.
- Strengthen electricity poles, wires and distribution lines in storm-prone and flood-prone areas.
- Raise or protect electrical infrastructure in low-lying wards to reduce flood-related damage.
- Install lightning protection systems in public buildings, schools, markets, municipal offices and community shelters.
- Improve emergency communication systems for early warning and disaster response.
- Establish ward-level communication channels for flood, storm, heatwave and coldwave alerts.
- Promote solar-powered streetlights and emergency lighting in vulnerable areas.
- Ensure backup power facilities for water supply pumps, health facilities, municipal offices and emergency shelters.
- Conduct regular inspection and maintenance of electricity and communication infrastructure before the monsoon season.

Figure 26: *Suggested Way Forward for Electricity and Communication*

6.3 Climate Action Implementation and Prioritization Framework

The implementation and prioritization framework translates the recommended climate actions into a practical and time-bound implementation pathway for Goalanda Municipality. The proposed interventions have been prioritized based on ward-level vulnerability, identified infrastructure and service gaps, dominant climate-related hazards, urgency of action, and the feasibility of implementation. The actions are organized into short-term (0–12 months), medium-term (1–3 years), and long-term (3–5+ years) periods to support phased implementation according to municipal capacity and available resources.

The matrix identifies the priority intervention, target location, associated hazard, indicative cost level, lead implementing entity, and a measurable Key Performance Indicator (KPI) for each action. This approach is intended to help the municipality direct resources toward the most vulnerable wards and urban systems while providing a simple mechanism for tracking implementation progress and outcomes. The actions cover both WASH and Non-WASH systems, including drainage, water supply, sanitation, solid waste management, housing, transportation, urban greening, and electricity and communication resilience, consistent with the recommendations presented in the preceding sections of this chapter.

Table 6: Climate Action Implementation and Prioritization Matrix for Goalanda Municipality

Timeline	Intervention Component	Target Location (Priority Wards)	Primary Hazard	Cost Level	Lead Entity	Key Performance Indicator (KPI)
0–12 Mo.	Drainage Desilting & Clearing	Wards 1, 2, & 3 (highest Storm Water Drainage Vulnerability: 2.84, 2.73, 2.63; low elevation, near Padma–Jamuna junction)	Waterlogging	Low	Pourashava Engineering Division	Linear kilometers of drains cleared per quarter
0–12 Mo.	Flood-Resilient Water Points & Tubewell Protection	Wards 1, 2, & 3 (Very High/High flood risk zones)	Water Contamination	Low	Pourashava / DPHE	Number of tubewells/water points raised or flood-proofed
0–12 Mo.	FSTP Operational Handover & Staff Training	Ward 8 (site of upcoming plant; 71.61% unsafe flush systems, highest sanitation vulnerability 2.82)	Sanitation	Low	Pourashava / DPHE	Number of municipal staff certified for FSTP operation
0–12 Mo.	Closure of Open Dumping sites near Marapadma River	Wards adjacent to river dumpsite (municipality-wide sites)	Water Pollution	Low	SWM Wing	Number of riverside dumpsites closed
1–3 Yrs.	Continuous Drainage Lining (Kancha to RCC)	Wards 7, 8, & 9 (poor settlements, weak drainage infrastructure)	Waterlogging	Medium	Pourashava / LGED	Kilometers of kancha drains upgraded to lined/concrete drains
1–3 Yrs.	Waste Segregation & Small-Scale MRF Pilot	Wards 1, 4, & 7 (highest SWM Vulnerability Index: 2.56, 2.58, 2.61)	Environmental / Health	Medium	SWM Wing	Percentage of collected waste segregated and recovered through the MRF pilot

Timeline	Intervention Component	Target Location (Priority Wards)	Primary Hazard	Cost Level	Lead Entity	Key Performance Indicator (KPI)
1–3 Yrs.	Safe Toilet Construction & Shared Sanitation Points	Wards 3, 4, 7, & 8 (major sanitation challenges; Ward 8 at 71.61% unsafe flush)	Sanitation / Waterborne Disease	Medium	DPHE / Pourashava	Number of households with safe/ climate-resilient toilets
1–3 Yrs.	Piped Water Network Extension	Wards 5, 6, & 7 (LIC concentration; >90% tubewell dependency)	Contamination / Drought Stress	Medium	DPHE / Water Supply Section	Number of new households piped-water connections
3–5+ Yrs.	Resilient Housing Retrofits	Wards 7, 8, & 9 (Kancha housing >69%; highest Housing Vulnerability >2.7)	Structural Risk / Heat Stress / Flood	High	Ministry / NGOs / Pourashava	Number of kancha houses upgraded to semi-pucca/pucca
3–5+ Yrs.	Urban Green Infrastructure & Tree Plantation	Wards 3, 4, 5, & 6 (LST hotspots; rapid built-up expansion 1992–2023)	Heat Stress	Low	Pourashava / Forest Dept.	Total canopy coverage (acreage) added in heat hotspots
3–5+ Yrs.	Climate-Resilient Road Upgrading	Wards 1, 2, & 3 (flood-prone access roads) and Wards 7 & 8 (lowest road coverage)	Flooding / Structural Damage	High	Pourashava / LGED	Kilometers of kancha/semi-pucca roads upgraded to pucca
3–5+ Yrs.	Electricity & Communication Resilience	Wards 4 & 6 (weakest infrastructure index: 2.79, 2.61) and Wards 2, 3, & 8 (highest cyclone-related disruption)	Cyclone / Thunderstorm	Medium	REB / Pourashava	Number of electric poles reinforced & backup power units installed

07. CONCLUSION

The Goalanda Climate Action Plan provides a practical and evidence-based roadmap for reducing climate vulnerability and strengthening urban resilience. By combining satellite-based spatial analysis, community perception, and HIGS-based vulnerability assessment, the CAP identifies the most climate-sensitive wards, hazards, and urban systems that require priority intervention.

The findings show that Goalanda's vulnerability is strongly influenced by its location near the Padma River, low-lying floodplain conditions, weak drainage, inadequate solid waste management, limited piped water supply, unsafe sanitation, and a high proportion of Kancha housing. Heatwaves, heavy rainfall, waterlogging, thunderstorms, and localized flooding are among the most critical hazards affecting municipal life, infrastructure, and public health.

The CAP emphasizes urgent short-term action in WASH-related sectors, including stormwater drainage, sanitation, wastewater management, solid waste management, and safe water supply. Medium-term attention is also needed for housing, roads, electricity, transportation, and communication to reduce long-term exposure and improve emergency response.

Successful implementation will require coordination among Goalanda Municipality, DPHE, LGED, development partners, community groups, and local residents. By integrating CAP priorities into municipal budgeting, focusing on vulnerable wards, and ensuring regular monitoring, Goalanda can move toward a safer, healthier, inclusive, and climate-resilient urban future.

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