REPUBLIC OF INDIA

DATA COLLECTION SURVEY ON DISASTER RISK REDUCTION SECTOR IN INDIA

FINAL REPORT

December 2024

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

YACHIYO ENGINEERING CO., LTD.

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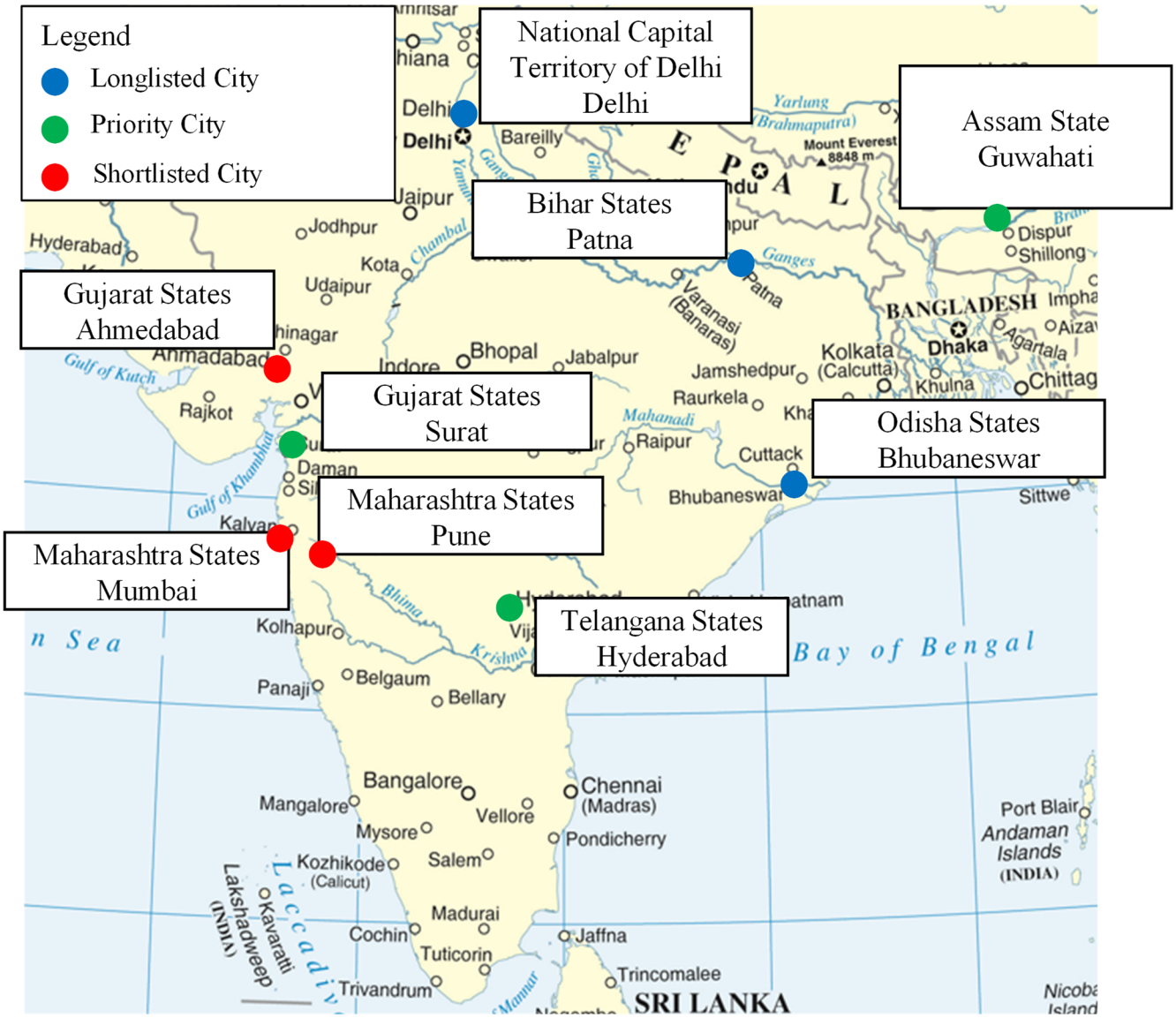

Source：JICA Survey Team modified based on a map prepared by the United Nations

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Location Map

DATA COLLECTION SURVEY ON DISASTER RISK REDUCTION SECTOR IN INDIA FINAL REPORT

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3-1 Meeting Material
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States	Cities	Organization	Date	Note	No.
NDMA			Sep.26, 2023	Online	3-2-1
Gujarat	Ahmedabad	AMC	Nov.9, 2023	Online	3-2-3
		AMC	Nov.28, 2023	Site	3-2-5 3-2-9
	Surat	SMC	Nov.30, 2023	Site	3-2-10
	-	GSDMA	Nov.29,2023	Site	3-2-13
Maharashtra	Mumbai	MCGM (SWD+MITRA)	Nov.20, 2023	Site	3-2-15
	Mumbai	MCGM (Disaster Management)	Nov.21, 2023	Site	3-2-17
	Pune	PMC	Nov.24, 2023	Site	3-2-18
Telangana	Hyderabad	GHMC	Nov.8, 2023	Online	3-2-20
		GHMC	Dec.7, 2023	Site	3-2-22
Assam	Guwahati	GMDW&SB	Nov.10, 2023	Online	3-2-26
		GMDA	Dec.4, 2023	Site	3-2-27
Odisha	Bhubaneswar	BMC	Jan.3, 2024	Online	3-2-32
Delhi	Delhi	-	-	-	-
Bihar	Patna	PMC	Jan.22, 2024	Online	3-2-34

3-3 Outline of Existing Status and Plan: M/P, DPR and Presentation

States	Cities	Document	No.
Gujarat	Ahmedabad	Comprehensive Drainage and Storm Water Master Plan for Drainage and Storm Water System of Ahmedabad City for Next 30 years (2051)	3-3-1
		Project Proposal for Urban Flood Risk Management Programme Under National Disaster Management Authority (NDMA)	3-3-8
	Surat	Development of Creeks including remodeling and restructuring at Surat (Feasibility Report and Detailed Project Report)	3-3-14

Maharashtra	Mumbai	Brimstowad-II Master Plan Vol-E: Master Plan Report for the "City" Vol-F: Master Plan Report for the "Eastern Suburbs" Vol-G: Master Plan Report for the "Western Suburbs"	3-3-18
	Pune	Urban Flood Risk Management Program for City of Pune 2023 Proposal for National Disaster Management Authority under UFRMP 2023-2025	3-3-30
Telangana	Hyderabad	Presentation of MP updated in 2020	3-3-38
Assam	Guwahati	Water Supply, Storm Water Drainage, Underground Sewerage and Road Restoration of Guwahati Metropolitan Area under "JNNURM" Scheme/ Detail Project Report, Storm Water Drainage (Volume-1 General Report)	3-3-40
Odisha	Bhubaneswar	-	-
Delhi	Delhi	-	-

4. Flood Affected Area and its Basic Information in Longlisted Cities

5. Information from Priority Cities

5-1 Meeting Material

5-2 Minutes of Meeting

States	Cities	Organization	Date	Note	No.
NDMA			Feb. 26, 2024	Online	5-2-1
MoHUA			Feb. 26, 2024		5-2-3
Gujarat	Ahmedabad	AMC	Feb.29-Mar.1, 2024 Mar.11-20,2024	Incl. site visit	5-2-5 5-2-6 5-2-8 5-2-10
Maharashtra	Mumbai	MCGM(SWD)	Mar. 6-7, 2024	Incl. site visit	5-2-13
	Mumbai	MCGM (Disaster Management)	Mar. 6, 2024		5-2-15
	Pune	PMC	Mar. 7, 2024		5-2-16
	-	SUDD- Maharashtra	Mar.4, 2024		5-2-17 5-2-19
Assam	Guwahati	PMU of JICA project	Feb. 27, 2024		5-2-20
		GMDA	Feb. 27, 2024		5-2-22
	-	SDMA- Assam	Feb. 27, 2024		5-2-24

Note: Meeting with SDMA-Gujarat is just courtesy call with Director of SDMA
Meeting with SUDUH-Gujarat is to get basic agreement by Director of SUDUH to proceed the project formulation.

5-3 Outline of Existing Status and Plan of Priority Cities:

- Situation of AMC
- Situation of MCGM

6. Information from Shortlisted Cities

6-1 Meeting Materials

- UDD Maharashtra
- MCGM (Draft PPR for discussion)

- PMC (Discussion documents for PMC)
- GHMC
- MCGM (Preparation of BRIMSTOWAD-III)
- JICA (Outline of request from Shortlisted Cities)

6-2 Minutes of Meeting

States	Cities	Organization	Date	Note	No.
Third Field Survey					
Gujarat	Ahmedabad	AMC	Jun. 13, 2024	Site -1	6-2-1
		AMC	Jun. 13, 2024	Site -2	6-2-2
		AMC	Jun. 14, 2024	Site	6-2-3
Maharashtra	Mumbai	MCGM	Jun. 18, 2024	Site	6-2-4
		MCGM	Jun. 19, 2024	Site	6-2-6
		MCGM	Jun. 20, 2024	Site -1	6-2-8
		MCGM	Jun. 20, 2024	Site -2	6-2-9
		IIT Bombay	Jun. 21, 2024	Site	6-2-10
	Pune	PMC	Jun. 10, 2024	Site	6-2-11
		PMC	Jun. 11, 2024	Site	6-2-13
		PMC	Jun. 12, 2024	Site	6-2-15
	-	State Government (UDD)	Jun. 20, 2024	Site	6-2-16
Fourth Field Survey					
Maharashtra	Mumbai	MCGM: SWD dep.	Sep. 05, 2024	Site	6-2-17
		MCGM: Haji Ali PS	Sep. 06, 2024	Site	6-2-20
		MCGM: Mini PS	Sep. 06, 2024	Site	6-2-22
		MCGM: Mithi River	Sep. 06, 2024	Site	6-2-23
Telangana	Hyderabad	GHMC: CE	Sep. 09, 2024	Site	6-2-25
		GHMC: Commissioner	Sep. 10, 2024	Site	6-2-26
	-	MRDCL	Sep. 11, 2024	Site	6-2-29

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Abbreviations

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
AMC	Ahmedabad Municipal Cooperation
ARG	Automatic Rainfall Gauge
AUDA	Ahmedabad Urban Development Authority
BMC	Bhubaneswar Municipal Cooperation
BMP	Best Management Practice
BMTPC	Building Materials and Technology Promotion Council
BUIDCO	Bihar Urban Infrastructure Development Corporation Limited
CAPF	Central Armed Police Forces
CCA	Climate Change Adaptation
CCS	Cabinet Committee on Security
CDRI	Coalition for Disaster Resilient Infrastructure
CEEW	Council on Energy, Environment and Water
CMIP	Coupled Model Intercomparison Project
CPHEEO	Central Public Health and Environmental Engineering Organization
Cr	Crore (10,000,000)
CWC	Central Water Commission
CWRPS	Central Water and Power Research Station
DDMA	District Disaster Management Authority
DDMF	District Disaster Mitigation Fund
DDRF	District Disaster Response Fund
DEA	Department of Economic Affairs
DM	Disaster Management
DOF	Department of Finance
DOR	Department of Revenue
DoWR, RD & GR	Department of Water Resources, River Development and Ganga Rejuvenation
DPR	Detailed Project Report
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EU-JRC	European Union-Joint Research Centre
FMP	Flood Management Programme
FS	Feasibility Study
FY	Fiscal Year
GCM	Global Climate Models
GDP	Gross Domestic Product
GHMC	Greater Hyderabad Municipal Corporation

GMDA	Guwahati Metropolitan Development Authority
GMDW-SB	Guwahati Metropolitan Drinking Water and Sewerage Board
GOA	Government of Assam
GOI	Government of India
GSDMA	Gujarat State Disaster Management Authority
HUA	Hyderabad Urban Agglomeration
ICT	Information and Communication Technology
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
IRR	Internal Rate of Return
ISOR	Indian Space Research Organization
IVM	Institute for Environmental Studies
JICA	Japan International Cooperation Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JPY	Japanese Yen
JST	JICA Survey Team
M/D	Minutes of Discussion
MC	Municipal Cooperation
MCGM	Municipal Cooperation of Greater Mumbai
MHA	Ministry of Home Affairs
MITRA	Maharashtra Institution for Transformation
MLIT	Ministry of Land, Infrastructure, Transport and Tourism, Japan
MoA	Ministry of Agriculture
MOES	Ministry of Earth Sciences
MOHUA	Ministry of Housing and Urban Affairs
MOJS	Ministry of Jal Shakti
MOM	Ministry of Mines
MP	Master Plan
N/A	Not Applicable, Not Available
NAPCC	National Action Plan in Climate Change
NASA	National Aeronautics and Space Administration
NCMC	National Crisis Management Committee
NDC	Nationally Determined Commitments
NDMA	National Disaster Management Authority
NDMF	National Disaster Mitigation Fund
NDMP	National Disaster Management Plan
NDRF	National Disaster Response Force
NDRF	National Disaster Response Fund

NDRMF	National Disaster Risk Management Fund
NEC	National Executive Committee
NERUDP	Northeastern Region Urban Development Programme
NIDM	National Institute of Disaster Management
ODA	Official Development Assistance
PIB	Press Information Bureau
PIU	Project Implementation Unit
PMC	Patna Municipal Cooperation
PMC	Pune Municipal Cooperation
PPR	Preliminary Project Report
RBM	River Basin Management
RCP	Representative Concentration Pathways
Rs	Indian Rupee
SDGs	Sustainable Development Goals
SDMA	State Disaster Management Authority
SDMF	State Disaster Mitigation Fund
SDRF	State Disaster Response Force
SDRF	State Disaster Response Fund
SDRF	State Disaster Response Force
SDRMF	State Disaster Risk Management Fund
SEC	State Executive Committee
SEOC	State Emergency Operation Centre
SMC	Surat Municipal Cooperation
SMDP	State Disaster Management Plan
SME	Small and Medium Enterprise
SPS	Sewage Pumping Station
SSP	Shared Socio-economic Pathways
STP	Sewerage Treatment Plant
SUDD	State Urband Development Department
SWD	Storm Water Drainage
SWDD	Storm Water Drainage Department
TC	Technical Corporation
TOR	Terms of Reference
UDD	Urband Development Department
UFRMP	Urban Flood Risk Management Program
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
ULB	Urban Local Bodies
UN	United Nations

UNDP	United Nations Development Programme
UNDRR	UN Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
USGS	United States Geological Survey
UT	Union Territories
WB	World Bank
WRI	World Resources Institute
WRIS	Water Resources Information System

CHAPTER 1 INTRODUCTION

1.1 Background of the Survey

India frequently experiences various natural disasters such as floods, cyclones, droughts, landslides, earthquakes, and tsunamis. In recent years disaster damage has tended to become more serious due to climate change and unplanned urbanization.

Since the enactment of the Disaster Management Act in 2005, the Indian government has required each state to formulate a disaster management plan and establish an organization to strengthen the preparatory measures for disaster prevention and mitigation. Based on the central government guidelines published in 2008, each state government promotes disaster countermeasures, disaster forecasting, and damage mitigation.

On the other hand, despite the high risk of disasters, the government's countermeasures tend to focus on post-disaster emergency responses, such as rescuing victims and supporting reconstruction in affected areas. However, the development of infrastructures to prevent disaster occurrence and damage mitigation is still insufficient.

Considering this situation, there might be a need for further cooperation and collaboration with India in the field of disaster risk reduction (DRR) in identifying, forming, and implementing valuable cooperation projects such as Japanese yen loan projects and technical cooperation projects.

1.2 Objectives of the Survey

The objectives of this survey are as follows:

- to collect and organize basic information on the DRR sector in India
- to propose potential yen loan[1] projects and technical cooperation by the Japan International Cooperation Agency (JICA) to reduce or mitigate disaster risk, especially for urban flood protection and flood management; and
- to prepare a Preliminary Project Report (PPR) to promote the candidate projects in shortlisted cities.

If the need for yen loan in the DRR sector is confirmed, the JICA Survey Team (hereinafter called as "JST") will support the approval procedure of the candidate projects of shortlisted cities.

1.3 Outline of the Survey

(1) Terms of Reference (TOR) of the Survey

The outline of the survey is as follows:

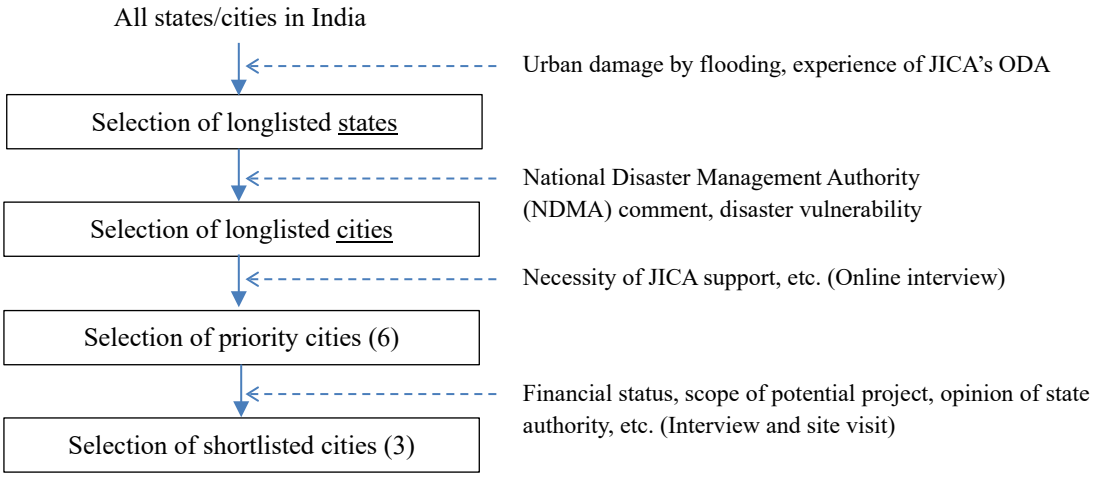
- Create an Inception Report
- Review existing plans and systems, and analyze issues

[1] Condition of yen loan in disaster risk reduction sector (Preferential terms as of August 2023):
- Interest rate for construction work: 1.90% per year (at fixed interest rate) / 0.75% per year (for high specification loan)
- Interest rate for consulting service: 0.10% per year (at fixed interest rate)
- Repayment period: 30 years
- Grace period: 10 years

- Create a longlist of candidate states/cities for yen loan
- Interview target states/cities
- Select the shortlisted cities for yen loan candidates
- Create an Interim Report
- Prepare a visit to Japan for shortlisted cities' administrators
- Examine draft support outline of shortlisted cities
- Propose Preliminary Project Report (PPR) of shortlisted cities
- Conduct a visit to Japan for shortlisted cities' administrators[2]
- Create a Draft Final Report
- Support discussions on the PPR
- Propose PPR for Sikkim's mountain road development [3]
- Create a Draft Final Report for Sikkim's mountain road development [3]
- Create a Final Report

(2) Selection Process of Shortlisted Cities

The target of this survey is to formulate a yen loan project or technical cooperation project focusing on urban drainage sector. The main target in developing the project is not the states but the city. From the data collection survey, three shortlisted cities will be selected to formulate either the yen loan projects or technical cooperation projects under the following selection process:



Source: JST

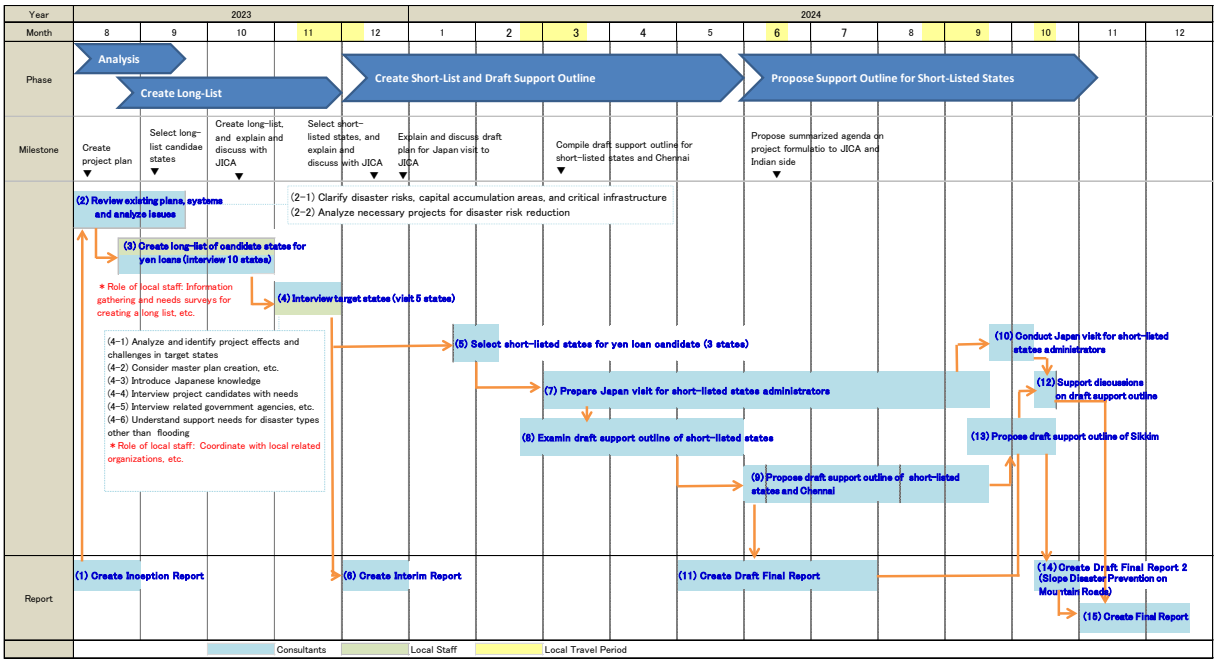
Figure 1.3.1 Selection Process of Shortlisted Cities

(3) Workflow of the Survey

The workflow of the survey is shown below.

[2] Japan visit was conducted from September 29 to October 5, 2024 under different contract.

[3] Site survey and preparation of PPR and final report on Sikkim's mountain road development was added in this study. Its final report was prepared in separate volume.



Source: JICA Survey Team

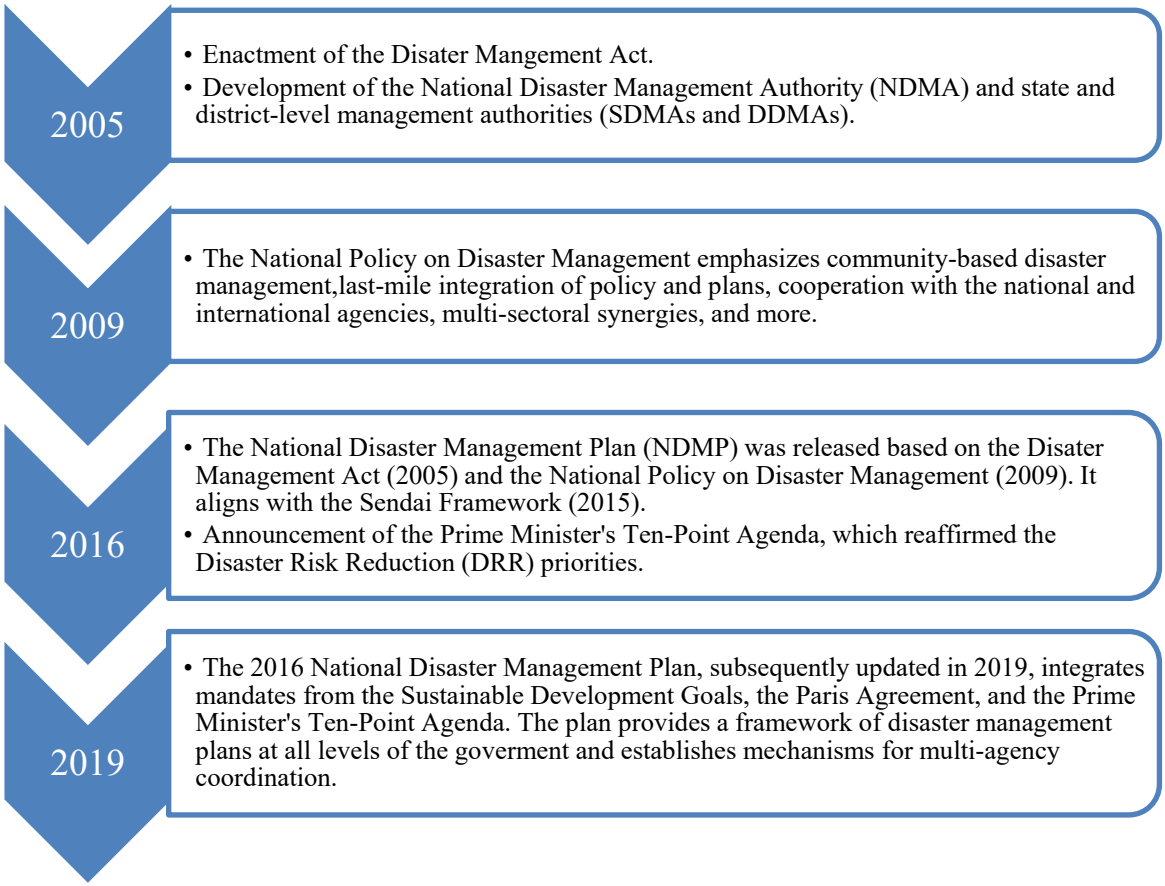
Figure 1.3.2 Workflow of the Survey

CHAPTER 2 LEGAL AND INSTITUTIONAL FRAMEWORKS IN DISASTER RISK REDUCTION SECTOR

2.1 Disaster Risk Reduction History in India

India has set a "Strong and Stable Macro-Economic Environment" as one its core policies in the Union Budget for FY 2023-24, announced in February 2023. One of the top priorities is the development of resilient infrastructure to address flood damages, which have the most significant impacts on people's lives and economic activities compared with other disaster types.

India's disaster management approach has evolved through institutional, legislative, and policy interventions. The chart below illustrates the historical development of the legal framework in the disaster management sector in India:



Source: Created by the JICA Survey Team (JST) based on India's Disaster Risk Reduction Journey, Disaster Risk Reduction in India, Status Report 2020 by the Asian Disaster Preparedness Center

Figure 2.1.1 Legal Framework of the Disaster Risk Reduction

2.2 India's Flood Management Related Legal and Policy Framework

2.2.1 Disaster Management (DM) Act, 2005

The Disaster Management Act, 2005 provides a legal foundation for all disaster-related activities, including disaster preparedness, mitigation, and risk reduction, to be implemented at the national, state, and district levels.

Key regulations related to DRR include:

- Establishment of disaster management organizations at the NDMA, SDMA and the DDMA levels.
- Requirement for every ministry and department of the Government of India, as well as state and district authorities, to prepare a disaster management plan.
- Integration of disaster prevention and mitigation measures into development policies, plans, projects, and budget allocation at all levels.
- Preparation of disaster-specific disaster management plans by nodal ministries and departments designated by the Government of India.
- Establishment of disaster response funds and disaster mitigation funds at the central, state, and district levels.

Table 2.2.1 Nodal Ministries of Hydrological and Meteorological Disaster

Disaster	Nodal Ministry/ Department
Urban Flood	Ministry of Housing and Urban Affairs (MOHUA)
Flood	Ministry of Jal Shakti (MOJS)
Cyclone/ Tornado	Ministry of Earth Sciences (MOES)
Earthquake	Ministry of Earth Sciences (MOES)
Landslides	Ministry of Mines (MOM)

Source: National Disaster Management Plan

2.2.2 National Policy on Disaster Management, 2009

This policy broadens the scope of disaster management activities by developing a holistic, proactive, and multi-disaster strategy at the community level, aiming to build a safe and disaster-resilient India. It was prepared by the NDMA and approved by the Union Cabinet in 2009.

The central theme focuses on creating disaster-awareness and resilient communities that are properly empowered and engaged in multi-sectoral collaboration. This reflects the national leadership's commitment to allocating the necessary financial resources for disaster prevention, preparedness, and mitigation, rather than incurring repetitive post-disaster expenditures year after year.

From the DRR perspective, the policy emphasizes that critical infrastructure should be consistently monitored to ensure compliance with global safety standards and strengthened where deficiencies are identified. The following are listed as critical infrastructure, namely: dams, roads, bridges, flyovers, railway lines, power stations, water storage towers, irrigation canals, delta water distribution networks, river and coastal embankments, ports, and other civic utilities.

The policy also highlights the increasing trend of disasters in urban areas, urging state governments and union territories (UTs) to prioritize improvements in urban drainage systems while avoiding obstructions to natural drainage systems.

2.2.3 National Disaster Management Plan (NDMP)

The 2016 NDMP was updated in November 2019 by the NDMA. This plan was established under the Disaster Management Act and the National Policy on Disaster Management. It integrates principles from three global frameworks, namely: Sendai Framework, Sustainable Development Goals, and the Paris Agreement.

The NDMP provides a framework and guidance for all government agencies including ministries, departments, and the state and district authorities to mainstream their responsibilities and intervention strategies. It addresses all phases of the disaster management cycle, including mitigation, preparedness, response, recovery, and capacity development. Additionally, the plans establish mechanisms of multi-agency coordination to ensure that local needs are identified and incorporated into plans and strategies.

The Disaster Management Act, 2005, mandates that the NDMP shall include the following components and specify its annual review and update:

- Measures to prevent disasters or mitigate their effects.
- Measures to integrate mitigation efforts into development plans.
- Measures for preparedness and capacity building to effectively respond to potential disaster situations.
- Roles and responsibilities of ministries and departments of the Indian Government, with specified measures to be undertaken.

2.2.4 National Disaster Management Guidelines - Management of Floods

The National Disaster Management Guidelines- Management of Floods is prepared by NDMA in 2008. These guidelines are intended for central ministries, state and district governments, and other agencies to develop holistic and integrated flood management plans. The primary aim of these guidelines is to create a safer country by effectively managing floods while promoting economic development in flood-prone areas through actionable strategies. The guidelines cover institutional frameworks, disaster risk reduction measures, flood forecasting and warning, regulations, capacity development, flood response, and the preparation of flood management plans.

(1) Structural Measures

Below are the listed structural measures to mitigate floods:

- Construction of embankments, banks, floodwalls, and levees.
- Development of dams, reservoirs, and other water storages facilities.
- Desilting and dredging of rivers.
- Improvement of drainage systems through the construction of new channels or enhancing the capacity of existing ones.

- Diversion of floodwaters to new or existing channels through by-pass.
- Watershed management, including soil conservation combined with structural works like check dams and detention basins.
- Anti-erosion measures such as revetments and slope pitching.
- Construction of seawalls and coastal protection works.
- Proper alignment, location, design, and provision of waterways, such as vents, culverts, bridges, and causeways, in roads.

(2) Non-structural Measures

The following non-structural measures are designed to mitigate the impacts of floods:

- Flood plain zoning to regulate land use in flood-prone areas.
- Flood proofing measures, such as constructing shelters with basic amenities and ensuring flood protection for all public utilities.
- Flood forecasting and warning systems.

2.2.5 National Disaster Management Guidelines - Management of Urban Flooding

The National Disaster Management Guidelines - Management of Urban Flooding, prepared by the NDMA in 2010, represent the first holistic guidelines that distinguish urban flooding from other types of floods. The primary objective of these guidelines is to accelerate urban flood management from a post-disaster response approach to preparedness and mitigation-centric strategy. The guideline outline roles and responsibilities for implementing early warning systems, enhancing urban drainage systems, managing risks, strengthening the techno-legal framework, improving response mechanisms, building capacity, and preparing disaster management plans.

Below are some of the key action points related to DRR.

- Establish an urban flooding organization within the Ministry of Housing and Urban Affairs (MoHUA), state nodal departments, and urban local bodies (ULB).
- Create a technical framework for urban flood forecasting and warning at the national and state/ UT levels.
- Establish a local network of Automatic Rainfall Gauges (ARGs) for real-time monitoring in Class I-III cities and towns.
- Develop an urban flood early warning system.
- Use catchment areas as the basis for planning and designing stormwater drainage system.
- Future stormwater drainage system will be designed with a runoff coefficient of up to 0.95 in using rational method considering the approved land use pattern.

2.2.6 National Water Policy 2012

The National Water Policy 2012, formulated by the Ministry of Water Resources outlines a framework for building a legal and institutional systems and an action plan for water resources management. It also mandates that State Water Policies be drafted and revised to align with this national policy. This policy was developed in response to concerns about waste rising demand along with population growth and impacts of climate change.

Regarding Climate Change Adaptation, the policy emphasizes the following:

- Importance of strengthening local community capacity through adoption of climate-resilient technologies.
- Incorporating planning and management of water resource infrastructure, such as embankments and dams should incorporate strategies to address possible climate change.

For Flood Management, the policy proposes the following measures for effective flood management:

- Adoption of both structural and non-structural measures to mitigate floods, with a strong emphasis on rehabilitating natural drainage systems.
- Modernizing flood forecasting systems by utilizing real-time data, linking with various basin sections, and integrating medium-range weather forecasts.
- Developing and implementing reservoir management strategies to provide flood cushions and reduce sediment entrapment during flood periods.
- Enhancing preparedness by conducting dam and embankment break studies and updating emergency action plans and disaster management plans, with active involvement from related communities.

2.2.7 National Action Plan in Climate Change (NAPCC) 2008

The National Action Plan on Climate Change (NAPCC), published by the Prime Minister's Council on Climate Change 2008, is a strategic framework for adapting to climate change while enhancing the ecological sustainability of India's development. The plan emphasizes that reducing vulnerability to climate change and improving people's living standards is critical.

The NAPCC comprises eight core national missions:

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission on Sustainable Habit
4. National Water Mission
5. National Mission for Sustaining the Himalayan Eco-System
6. National Mission for a Green India
7. National Mission for Sustainable Agriculture

8. National Mission on Strategic Knowledge for Climate Change

The mission, National Mission on Sustainable Habitat, highlights the need to improve the resilience of infrastructure, implement community-based disaster management practices, and establish effective warning systems for extreme climate events.

Regarding infrastructure, disaster risk reduction must be part of infrastructure design, particularly in disaster-prone areas. The following elements are key to reducing risks through improved design:

- Disaster specific vulnerability assessments and sectoral impacts assessments at the state and district levels for preparing contingency plans.
- Maintenance of critical facilities, such as healthcare services and water supply systems.
- Capability building among design engineers, project planners, and financial institutions to incorporate disaster management considerations into infrastructure projects.
- Develop prefabricated structures as an alternative to cast-in-place construction at vulnerable areas.
- Enforcement of building code and enhancing urban planning practices to include zoning regulations for vulnerable areas.

2.2.8 State Disaster Management Plan (SDMP)

The Disaster Management (DM) Act requires all states to formulate a SDMP. This plan is prepared by the State Executive Committee along with NDMA Guidelines. It involves consultations with local authorities, district authorities, and the people's representatives, as deemed appropriate by the State Executive Committee.

The DM Act (2005) specifies that the SDMP shall include the following:

- Vulnerability of the area by disaster type.
- Measures to be adopted for the prevention and mitigation of disasters.
- Ways to integrate mitigation measures with development planning and projects.
- Capacity-building and preparedness measures to be taken.
- Roles and responsibilities of each department with the state government for implementing the specified measures and responding to disasters.

Additionally, the SDMP must be subject to annual review and update.

2.2.9 District Disaster Management Plan (DDMP)

The DDMP is prepared by the District Disaster Management Authority in consultation with local authorities. It aligns with the NDMP and SDMP.

As stipulated by the DM Act (2005), the DDMP shall include the following:

- Assessment of vulnerability within the district to various types of disasters.
- Measures to be taken for prevention and mitigation of disasters.

- Capacity-building and preparedness measures to be taken.
- Detailed response plans and procedures in the events of disasters.

The DDMP must also specify its annual review and updates.

2.2.10 Prime Minister's Initiatives on Disaster Risk Reduction

Prime Minister Narendra Modi has introduced significant initiatives in the DRR, including the Ten-Point Agenda and leadership in the Disaster Risk Reduction Working Group within the G20.

(1) Ten-Point Agenda

The Ten-Point Agenda is a comprehensive approach to manage disaster risks, which was addressed by Prime Minister Narendra Modi at the 2016 Asian Ministerial Conference on Disaster Risk Reduction. It is regarded as a key governance framework in disaster management, alongside the DM Act (2005), the National Policy on Disaster Management, and the National Disaster Management Authority (NDMA) Guidelines.

The Ten-point areas are as follows:

1. All development sectors must imbibe the principles of disaster risk management.
2. Risk coverage must include all, starting from poor households to small and medium enterprises (SMEs) to multi-national corporations to nation states.
3. Women's leadership and greater involvement should be central to disaster risk management.
4. Invest in risk mapping globally to improve global understanding of nature and disaster risks.
5. Leverage technology to enhance the efficiency of disaster risk management efforts.
6. Develop a network of universities to work on disaster-related issues.
7. Utilize the opportunities provided by social media and mobile technologies for disaster risk reduction.
8. Build on local capacity and initiative to enhance disaster risk reduction.
9. Make use of every opportunity to learn from disasters and, to achieve that, there must be studies on the lessons after every disaster.
10. Bring about greater cohesion in international response to disasters.

(2) Disaster Risk Reduction Working Group in the G20

The G20 summit was held in Delhi in September 2023 with a new working group, i.e., Disaster Risk Reduction Working Group. This working group was established by the Indian President to integrate disaster risk reduction into global policy discussions by promoting technical knowledge and capacity building within the G20.

The following key priorities for action are identified by the working group:

1. Global coverage of early warning systems.

2. Disaster and climate resilient infrastructure.
3. Financing frameworks for disaster risk reduction.
4. Disaster recovery, rehabilitation, and reconstruction.
5. Nature-based and eco-system-based approaches for disaster risk reduction.

2.2.11 Disaster Related Funds

The DM Act (2005) mandates the establishment of two types of funds:

1. Disaster Response Fund (DRF): Allocated for emergency response, relief, and rehabilitation
2. Disaster Mitigation Fund (DMF): Reserved for disaster prevention and mitigation efforts.

The purpose of Disaster Risk Management Fund (DRMF) is to cover the entire cycle of disaster management, including prevention, preparedness, response, mitigation, recovery, and reconstruction. The DRMF has been proposed by the Finance Commission, while the central government may establish these funds at the national, state, and district levels, their management and implementation are the responsibility of the respective state governments. The Disaster Mitigation Fund, as stipulated in the DM Act of 2005, was officially established in 2022. This marks a significant step in aligning financial resources with disaster risk reduction objectives.

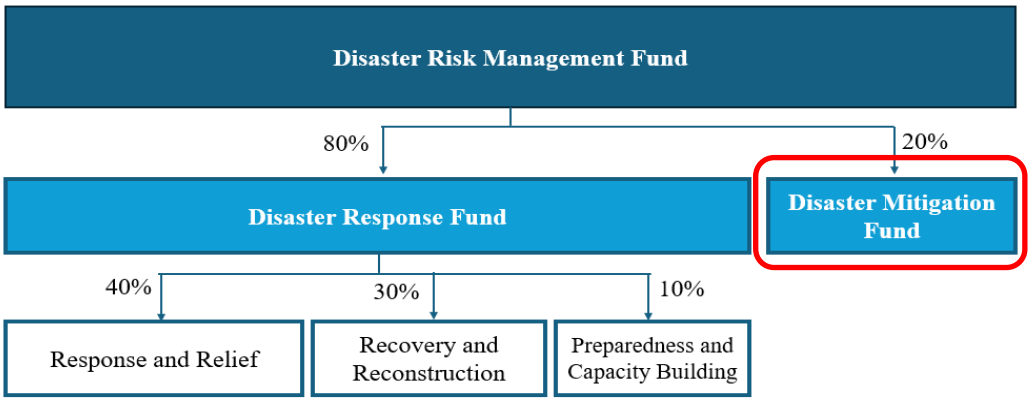
Table 2.2.2 Disaster Related Funds by Administrative Level

National	**National Disaster Risk Management Fund (NDRMF)**	**National Disaster Response Fund (NDRF)** Applied by the National Executive Committee	**National Disaster Mitigation Fund (NDMF)** Applied by NDMA Nodal Ministry: MHA
State	**State Disaster Risk Management Fund (SDRMF)**	**State Disaster Response Fund (SDRF)** Applied by the State Executive Committee	**State Disaster Mitigation Fund (SDMF)** Applied by SDMA Nodal Ministry: MHA
District		**District Disaster Response Fund (DDRF)** Applied by the District Authority	**District Disaster Mitigation Fund (DDMF)** Applied by the District Authority

Source: Created by the JST based on the Disaster Management Act 2005, National Disaster Management Policy 2009, the Fifteenth Finance Commission, Presentation on Mitigation Fund Guidelines

The proposals regarding the allocation of funds for the union and states for the 5-year period (2021-2026) are made by the Fifteenth Finance Commission in their 2020-2021 report, which was issued in 2019. Below are the recommendations mentioned in the report. Figure 2.2.1 illustrates the budget allocation relevant to both the national and state levels.

- Allocate 80% of Disaster Risk Management Fund for disaster response and 20% for mitigation funds for both the national and state levels.
- Disaster Response Fund is sub-divided into three windows. The 40% is for response and relief, 30% is for recovery and reconstruction, and 10% for preparedness and capacity building.
- The central government contributes 75% of SDRF and SDMF allocation except North-East and Himalayan states which is 90%.



Source: The Fifteenth Finance Commission

Figure 2.2.1 Budget Allocation of National Disaster Risk Management Fund

The fund related to this study, DRR, is the Disaster Mitigation Fund. Below are the usage recommendations for the Disaster Mitigation Fund by the Fifteenth Finance Commission.

- Small amounts should be granted for community-based local initiatives.
- The initiatives should focus on soft measures, rather than hard measures. Large-scale measures will be funded through development schemes.

Following the establishment of the fund, the nodal ministry, Ministry of Home Affairs, in consultation with NDMA, created the fund guidelines, indicating the scope of application for the fund.

Scope of NDMF:

- State projects where SDMF is insufficient, but are important from a disaster mitigation perspective.
- Local-level/community-based conservation activities for projects of national and strategic importance, including ecosystems and natural resources against disasters.
- Projects that are implemented regionally or involve two or more states.
- Projects requiring national-level technical assistance or collaboration with national agencies.
- Research and studies related to disaster mitigation through small grant window.

Scope of SDMF:

- Mitigation measures for notified disasters.
- Projects to protect assets, ecosystems, and settlements within the state.
- Projects that promote practices to reduce risks and impacts.
- Projects that build community resilience through information and knowledge.
- Projects focused on creating safe living environments for people from weaker sections.
- Regional projects funded from NDMF.
- Research and studies related to disaster mitigation.

The five-year (2021-2026) period allocation at the national level is as follows. As mentioned above, the NDMF budget is 20% of NDRMF, which is 13,693 crores. The earmarked allocation for the four priority

initiatives under NDMF budget is listed below. One of the priorities is for urban flooding mitigation, and the breakdown of the allocation to relevant cities is also provided below.

Table 2.2.3 Four Priority Initiatives Under NDMF 5-year (2021-2026) Budget

Initiative	Budget (cr)
Reducing risks of urban flooding (7 most populous cities)	2,500
Mitigation measures to prevent erosion	1,500
Catalytic assistance (12 most drought prone states)	1,200
Managing seismic and landslide risk (10 hill states)	750

Mumbai Chennai Kolkata	Rs 500 cr each
Bengaluru Hyderabad Ahmedabad Pune	Rs 250 cr each
Total	2,500 cr

Source: Presentation on Mitigation Fund Guidelines, Fifteenth Finance Commission Recommendations for Disaster Risk Management

2.3 International Disaster Risk Reduction Framework

2.3.1 Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework for Disaster Risk Reduction 2015-2030 (hereafter referred to as the Sendai Framework) is an international framework designed to reduce, prevent and respond to disaster risks globally. This framework was adopted by the United Nations (UN) Member States at the Third UN World Conference in Sendai, Japan, in 2015. Its goal is to "prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience". To achieve this goal, the framework outlines seven global targets, four priorities for action, as well as role of stakeholders, international cooperation, and global partnerships.

(1) Global Targets

The seven targets are as follows:

1. Reduce global disaster mortality by 2030.
2. Reduce the number of affected people globally by 2030.
3. Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.
4. Reduce disaster damage to critical infrastructure and disruption of basic services by 2030.
5. Increase the number of countries with national and local disaster risk reduction strategies by 2020.
6. Enhance international cooperation to developing countries by 2030.
7. Increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

(2) Priorities for Actions

The four priorities for actions are as follows:

1. Understanding disaster risk.
2. Strengthening disaster risk governance to manage disaster risk.
3. Investing in disaster risk reduction for resilience.
4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation, and reconstruction.

2.3.2 Utilization of Sendai Framework to Indian DRR

The Sendai Framework is utilized by many organizations and countries to create their own DRR plans and/or assess the progress of DRR countermeasure, among other purposes.

Regarding India, as shown in the table below, major policies and programs utilize the Sendai Framework. Recently, at the 2023 G20 Summit, during India's presidency, a new working group called "Disaster Risk Reduction Working Group" was established, aligning with the Sendai Framework.

Table 2.3.1 Nodal India's Policies/ Programs with Potential Link to Sendai Framework for Disaster Risk Reduction

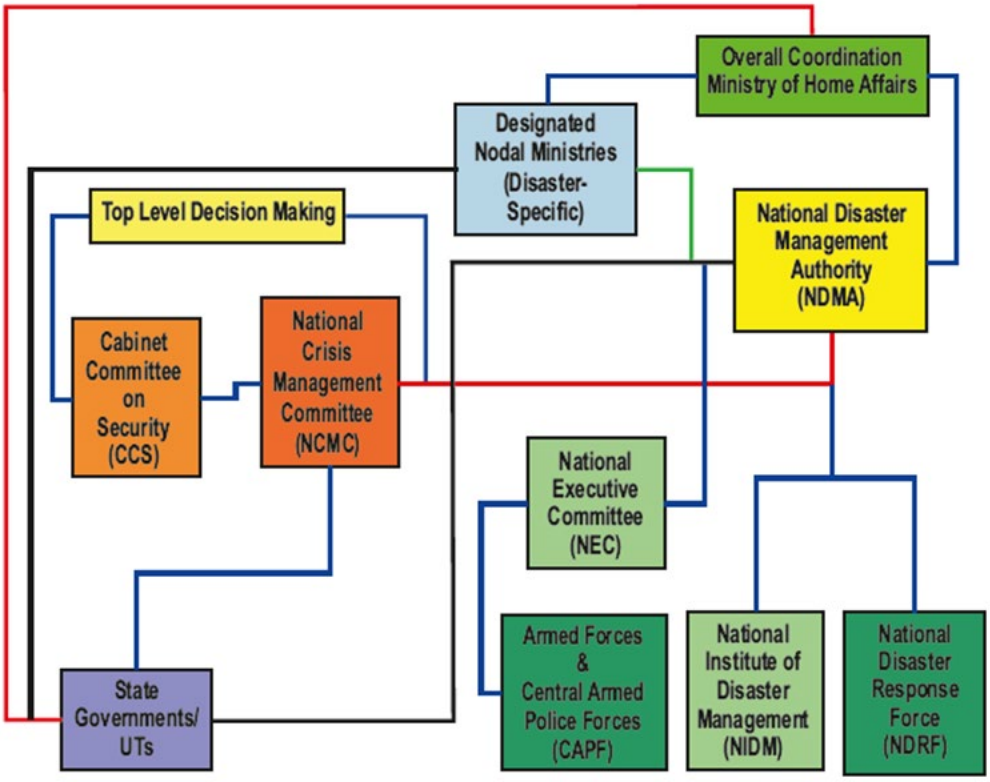
Sector	India's Policies/ Programs with Potential Link to Sendai Framework
National Development	National Policy on Disaster Management (2009) Prime Minister's Agenda 10 (2016)
Disaster and Climate Risk Reduction	National Disaster Management Plan (2019) Prime Minister's Agenda 10 (2016)
Vulnerability Reduction	National Disaster Management Plan (2019)
Urban Development	Urban Development Strategy (2016) National Disaster Management Plan (2019)
Agriculture and Resource Management	National Disaster Management Plan (2019)

Source: Created by the JST based on Disaster Risk Reduction in India, Status Report 2020 by ADPC

2.4 Institutional Framework for Disaster Management

2.4.1 Institutional Framework of National and State Levels

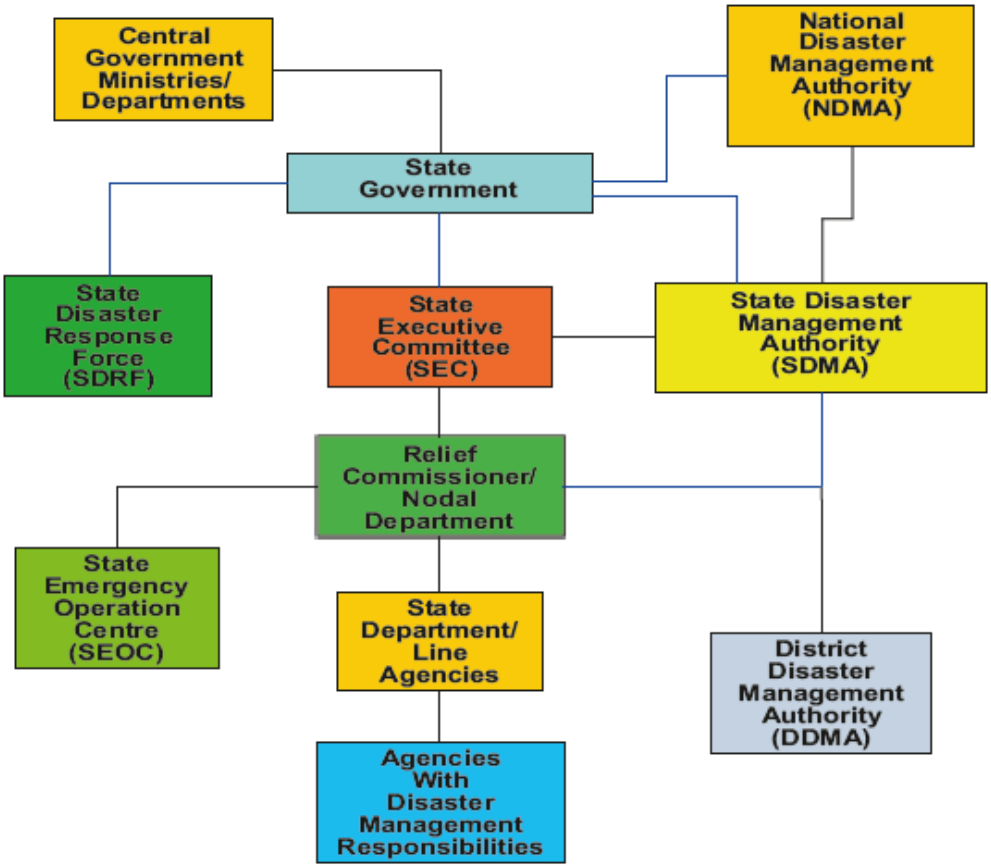
At the national level, the Ministry of Home Affairs (MHA) coordinates overall disaster management. The NDMA is responsible for approving the National Disaster Management Plan and facilitating its implementation.



Note: This represents merely the institutional pathways for coordination, decision-making, and communication for disaster management and does not imply any chain of command.
Source: National Disaster Management Plan, 2019

Figure 2.4.1 National Level Disaster Management Institutional Mechanism

At the state level, each state or union territory shall have its own institutional framework for disaster management, according to the Disaster Management Act, 2005. The chart below shows a typical state-level institutional framework.



Note: This represents merely the institutional pathways for coordination, decision-making, and communication for disaster management and does not imply any chain of command.
Source: National Disaster Management Plan, 2019

Figure 2.4.2 State Level Disaster Management Institutional Mechanism

2.4.2 Disaster Risk Reduction Related Administration

Related organizations and their role and responsibilities are summarized as shown below.

Table 2.4.1 Related Organizations of Disaster Risk Reduction Sector

Administration	Role and Responsibility
Ministry of Home Affairs (MHA)	Nodal ministry for overall coordination on disaster management. The MHA has been leading projects, such as GoI-UNDP Disaster Risk Management (DRM) Program, Information and Communication Technology (ICT) for disaster reduction, and regulations for land use zoning, among others.
Ministry of Housing and Urban Affairs (MoHUA)	Nodal ministry for the urban flood disaster management plan. MOHUA has initiated projects such as the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), Northeastern Region Urban Development Program (NERUDP), and the stormwater drainage manual preparation.
National Disaster Management Authority	Established in 2005 under the Disaster Management Act, as the highest authority for disaster management, headed by the Prime Minister.

Administration	Role and Responsibility
(NDMA)	The parent department is the Ministry of Home Affairs. Key functions include: ・ Lay down policies, plans and guidelines for disaster management. ・ Approve the National Disaster Management Plan and Disaster Management Plans prepared by the nodal ministries and departments of the government. ・ Coordinate the enforcement and implementation of the policy and plans. ・ Recommend provisions of funds for mitigation purposes. ・ Lead the National Disaster Response Force (NDRF) and the National Institute of Disaster Management (NIDM), both of which are under NDMA.
National Executive Committee (NEC)	Assists the NDMA in performing its function under the Disaster Management Act of 2015. The committee consists of the Union Home Secretary as chairperson, along with secretaries to the Government of India from related ministries and departments, among others. Key functions include: ・ Coordinate and monitor the implementation of NDMA and nodal ministries' policies and plans. ・ Ensure compliance with directions issued by the central government for disaster managements. ・ Prepare the National Disaster Management Plan. ・ Assist state governments and authorities in preparing their disaster management plans. ・ Evaluate the preparedness of all governmental levels to respond to disasters and enhancing it where necessary. ・ Provide technical assistance and/or advice to state and district authorities in carrying out their functions under the Disaster Management Act 2015.
Ministry of Jal Shakti (MOJS) Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD & GR)	Responsible for laying down policy guidelines and programs for development and regulation of country's water resources. The flood related functions are: ・ Provide technical guidance and monitoring of flood control. ・ Operate flood forecasting and warnings for inter-rivers. ・ Assist state schemes in special cases and prepare flood control master plans for the Ganga and Brahmaputra rivers. ・ Discuss and negotiate with neighboring countries regarding the management of international rivers such as Indus and Ganga. ・ Nodal ministry for flood disaster management planning. The flood management-related projects are formulated and implemented by state governments or union territories with their own resources. The central government provides financial assistance through the Flood Management Program (FMP) since the Eleventh Plan, to states or union territories for implementing critical projects. ・ The Central Water Commission (CWC) is the leading agency for water resources including flood management, except for the Ganga and Brahmaputra River basins. For these two basins, the Government of India has created separate organizations, namely: Ganga Flood Control Commission and Brahmaputra Board.
State Disaster	Led by the chief ministers.

Administration	Role and Responsibility
Management Authority (SDMA)	Key functions are: ・ Lay down state policies, plans, and guidelines for disaster management. ・ Approve State Disaster Management Plan in accordance with the National Disaster Management Authority (NDMA) Guidelines. ・ Coordinate the implementation of the state disaster management plans. ・ Recommend provisions of funds for the mitigation purposes. ・ Review the development plans of the state to ensure DRR measures are integrated. ・ Serve as the primary responsible agency when disasters occur within the state, while the central government plays a support role upon request from the state government. In the case of union territory, the equivalent administration is Disaster Management Authority for the union territory.
Urban Development Department in the State/ Union Territory	Nodal department for managing urban floods in the state or union territory, led by a joint secretary cadre officer. The key responsibility is establishing a state-level monitoring and approval mechanism for Urban Flood Disaster Management and guiding urban local bodies to align with the Urban Flood Disaster Management.
State Executive Committee (SEC)	Assists SDMA in the performing its function under the Disaster Management Act 2015. The chairperson of the committee is the Chief Secretary to the state government. Key functions include: ・ Prepare the State Disaster Management Plan. ・ Coordinate and monitoring the implementation of the National Policy, the National Disaster Management Plan, and the State Disaster Management Plan. ・ Specify measures to be taken for DRR based on vulnerability study. ・ Evaluate the preparedness at all governmental and non-governmental levels to respond disasters and enhance it where necessary. ・ Coordinate and direct to related departments regarding actions to be taken in the event of disasters. ・ Ensure district level disaster management plans are prepared, reviewed, and updated. ・ Assist district or local authorities in carrying out their functions. ・ Direct district or local authorities to secure construction standards for DRR when substandard constructions are found. ・ Provide information to the NDMA related to different aspects of disaster management.
District Disaster Management Authority (DDMA)	The state government is responsible for establishing a District Disaster Management Authority (DDMA) in every district, led by the District Collector or District Magistrate or Deputy Commissioner. It acts as the district planning, coordinating, and implementation body for disaster management. Key functions include: ・ Prepare the District Disaster Management Plan that aligns with the National

Administration	Role and Responsibility
	Disaster Management Authority (NDMA) and State Disaster Management Authority (SDMA) guidelines. ・ Coordinate and monitor the implementation of the National Policy, State Policy, National Disaster Management Plan, State Disaster Management Plan, and District Disaster Management Plan. ・ Ensure to identify disaster vulnerable district areas and undertake measures for prevention and mitigation. ・ Ensure all construction projects under its jurisdiction meet the standards of DRR. ・ Lay down guidelines for disaster management, monitor its implementation, and provide necessary technical assistance. ・ Review the state capabilities for responding disasters and give directions to relevant department at the district level. ・ Order any department/ officer at the district level to take disaster management measurements.

Source: Created by the JICA Survey Team based on National Disaster Management Plan, National Disaster Management Authority (NDMA) home page (Home | NDMA, GoI), MOJS home page (Department of Water Resources, River Development and Ganga Rejuvenation | India (jalshakti-dowr.gov.in), Disaster Management Act 2005, National Policy on Disaster Management, National Disaster Management Guideline: Management of Urban Flooding, National Disaster Management Guideline: Management of Floods

2.5 Capacity Assessment of Disaster Risk Reduction Sector in India (Disaster Risk Reduction in India, Status Report 2020 by Asian Disaster Preparedness Center)

The report, published by the Asian Disaster Preparedness Center (ADPC) on behalf of the United Nations Office for Disaster Risk Reduction (UNDRR) in 2020, provides an assessment of DRR. It covers disaster risk profile across the major disasters in India, and the Indian government's capacity in managing disaster risks.

(1) Capacity Assessments for the Indian Government

Below are the capacity assessment results along with the four priorities of Sendai Framework:

1) Priority 1. Understanding disaster risk

The Government of India has highlighted the importance of building a robust information database to inform land use and risk-informed infrastructure development. However, risk and disaster information in India has remained fractured across various agencies, ministries, and administrative levels, with little cross-compatibility and harmonization which limits comprehensive analysis of risks in the country.

2) Priority 2. Strengthening disaster risk governance to manage disaster risk

The root of disaster risk governance is the Disaster Management Act 2005, and the scope of legislative provisions was expanded by the implementation of the 2009 National Policy on Disaster Management. It emphasizes the importance of state and district-level authorities having primary responsibilities over disaster management. In 2016, the National Disaster Management Plan was released in coherence with the Sendai Framework, and it was further updated in 2019 to align with the Sustainable Development Goals (SDGs) and the Paris Agreement. Besides these

considerations, the National Disaster Management Plan has four other main pillars; i) national legal mandates (Disaster Management Act 2005 and 2009 National Policy on Disaster Management), ii) Indian Prime Minister's Ten-Point Agenda, iii) social inclusion as a cross-cutting principle for all activities, and iv) mainstreaming DRR as a base of all development.

Regarding climate change, the National Action Plan on Climate Change (NAPCC) was established in 2008. It was complemented by the Nationally Determined Commitments (NDC) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, and the Prime Minister's Council on Climate Change reimposes to rationally incorporate climate change action objectives into the existing legal framework.

3) Priority 3. Investing in disaster risk reduction for resilience

Along with the Disaster Management Act 2005, the Indian government established the National Disaster Response Fund and required states and union territory to formulate their State Disaster Response Fund. The National Disaster Response Fund supports states to recover from severe disaster. Another fund, National Disaster Mitigation Fund, which is for DRR and disaster risk mitigations has not established yet[1]. Disaster Mitigation Fund may be supported by the national and state disaster management funds based on the allocation ratio of 20% for disaster mitigation and 80% for response as outlined in the Fifteenth Commission's Framework for sector specific.

As of this report, the Indian government has not made specific investments in DRR and climate change adaptation, aside from a few projects funded by public foundation schemes.

4) Priority 4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation, and reconstruction

For disaster response, the DM Act of 2005 mandates the formation of National Disaster Response Force. Regarding early warning systems, disaster monitoring information is reported to the Ministry of Home Affairs, which issues alerts and warnings through its communication channels and mobile applications.

In terms of Build Back Better, the National Disaster Management Plan outlines structural transfer from response to sustained and sustainable recovery.

(2) Challenges for India to Implement DRR

Table 2.5.1 describes the challenges in disaster risk reduction sector in India.

Table 2.5.1 Challenges in Disaster Risk Reduction Sector in India

Administrative Level	Challenge	Impact of Challenge
National	No platform to integrate DRR data at the national level and remains a single effort by government agencies and research institutions. This makes prioritization difficult and limits the potential scope of policy development at the national level.	Lack of comprehensive understanding of disaster and climate risks hinders prioritization and limits the potential scope of policies.
States and Union	Disaster and climate change measures should	Major cities at risk of flooding and sea level

[1] After publishing this report in 2020, the National Disaster Mitigation Fund was established in 2022.

Administrative Level	Challenge	Impact of Challenge
Territories	be integrated into all urban planning, but this has not been achieved.	rise are vulnerable to adverse impacts on their social and economic activity.
Municipal Cooperation	Most of the budget is allocated to maintaining public utilities, and expenditures on DRR and climate change are limited.	Disaster frequency is increasing while DRR and climate change measures are not progressing.
Municipal Cooperation	Lack of human resources to implement appropriate measures to situation within a limited budget.	Limit the implementation of effective disaster prevention measures.
	Some municipalities lack the financial and human resources to implement Environmental Protection Acts.	DRR with sustainable planning and green growth is hindered.
	No evaluation system to check the progress of projects.	Misutilization of funds, corruption, and lack of motivation have led to delays in disaster prevention measures.
Relevant Ministries	Lack of coordination among implementing agencies, relevant ministries, and other authorities.	National goals and targets are not shared among stakeholders, and district levels are not prepared to work towards national goals.

Source: Created by the JST based on Disaster Risk Reduction in India, Status Report 2020 by ADPC

CHAPTER 3 SELECTION OF LONGLISTED CITIES

3.1 Issues in Disaster Risk Reduction Sector by Analyzing Existing Reports

3.1.1 Data Collection Survey for Disaster Risk Reduction in India, 2015 by JICA

The objective of this survey is to examine the direction of supports on India's disaster risk reduction sector focusing on policies, systems, and organizations related to risk controls and financing by considering current situations, issues, and support needs.

The survey area covers all of India with focus on Bihar, Uttarakhand, and Andhra Pradesh. Disasters to be surveyed in depth are flood, landslides and cyclones.

(1) Issues and Impact of Disasters in India

1) Issues by Disaster Type

Among the disaster types, flood damage is the most severe, followed by cyclones and sediment disasters. Issues of each disaster are listed below.

Table 3.1.1 Issues of Each Disaster

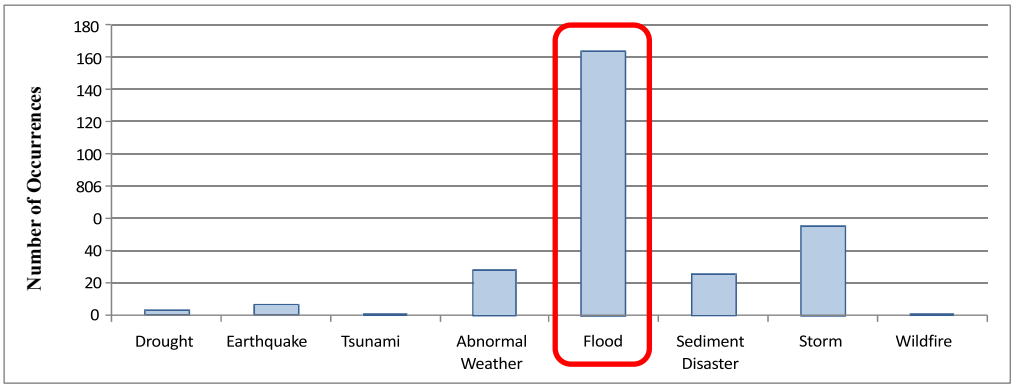
DRR Sector	Issues
Flood	
Disaster preparedness	Lack of strategies to introduce floodplain zoning through collaboration between central and state governments.
System	Rivers are managed by each state and based on the concept of river basin management (RBM), there is no comprehensive sediment management when rivers cross state boundaries.
Countermeasure work	Not taking appropriate measures from the long-term perspective; embankment works cause the riverbed to rise and there is a possibility to cause inland water flooding due to the blockage of waterways and channels because of the decrease in flow capacity (the amount of river water that can flow down) in the future.
Sediment disaster	
Risk assessment	No measures in determining sediment disasters for prevention works.
Disaster forecasting and warning systems	No forecast and warning systems for sediment disaster.
Emergency response	Poor dissemination of emergency information to the local level, considered as "last mile connectivity".
Organization and system	Lack of collaboration and coordination between implementing agencies and survey/research institutions.
Disaster preparedness	Lack of disaster risk awareness by residents living in landslide-prone areas.
Countermeasure work	Inappropriate countermeasure without considering disaster types.
Cyclone	
Risk assessment	No risk analysis for logistics/transportation sectors in wildlife conservation areas and zoo.
Disaster preparedness	Not enough stockpile of food, water, energy, and basic necessities. No prior arrangements for the prompt supply of first aid items in the event of an emergency. Inappropriate maintenance of cyclone shelters. There are no suitable environments for women, children, the elderly, and people with disabilities. Almost all public information and communication systems (mobile phones, landlines) are out of service in the event of disasters.
Organization and system	District disaster management plan focuses on rehabilitation after disasters, not disaster risk reduction.
Disaster forecasting and warning systems	No forecasting and warning system with adequate accuracy at the local level.

Source: Created by the JICA Survey Team (JST) based on Data Collection Survey for Disaster Risk Reduction in India, 2015

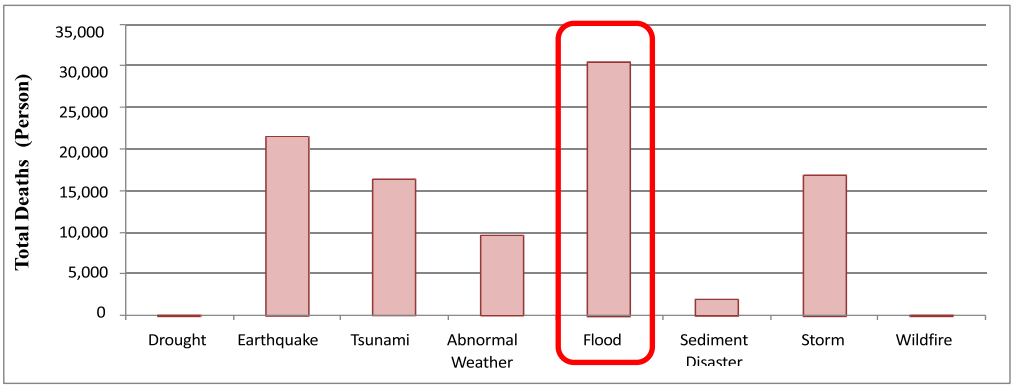
2) Quantitative Impact among Disasters

As shown in the figure below, it has been confirmed that the number of occurrences, deaths, and damage caused by floods are higher than those of other disasters in India from 1995 to 2014.

Occurrence



Fatalities



Economic Loss

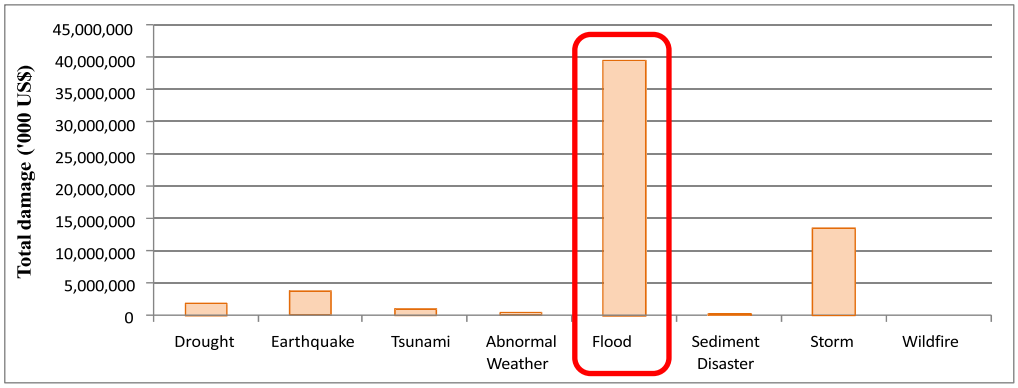


Table 3.1.2 Impact of Each Disaster in India

Type of Disaster	Frequency (Times/year)	Average Number of Deaths (Persons/year)	Average Economic Damage (Thousand US$/year)
Drought	0.2	1	102,056
Earthquake	0.4	1,079	189,100
Tsunami	0.1	819	51,140
Abnormal Weather	1.5	484	20,000
Flood	8.2	1,532	1,979,169
Sediment Disaster	1.3	101	2,725
Storm	2.8	852	681,656
Wildfire	0.1	0	0

Source: Data Collection Survey for Disaster Risk Reduction in India, 2015

(2) Disaster Issues by State

In terms of the number of deaths due to disasters at the selected three states in this survey, Bihar is in the second place and Uttarakhand is in the third place due to the flood, Andhra Pradesh is in the third place due to the cyclones, and Uttarakhand is in the first place and Bihar is in the fourth place due to the sediment disaster.

Table 3.1.3 Top Five States with Highest Number of Deaths by Major Disaster (1995-2014)

Rank	Flood	Cyclone	Sediment Disaster	Earthquake	Abnormal Weather
1	Himachal Pradesh	Odisha	Uttarakhand	Gujarat	Andhra Pradesh
2	Bihar	Gujarat	Jammu & Kashmir	Tamil Nadu	Odisha
3	Uttarakhand	Andhra Pradesh	Himachal Pradesh	Madhya Pradesh	Uttar Pradesh
4	West Bengal	Karnataka	Bihar	Punjab	Bihar
5	Gujarat	West Bengal	Maharashtra	Uttarakhand	Himachal Pradesh

Source: Data Collection Survey for Disaster Risk Reduction in India, 2015

1) Uttarakhand

Based on the survey, Uttarakhand's major natural disaster is sediment disaster and flood. The state had the highest number of deaths caused by sediment disasters between 1995 and 2014. The table below presents the issues pointed out by related agencies of Uttarakhand and the data collection survey team in 2015.

Table 3.1.4 Disaster Issues in Uttarakhand

DRR Sector	Issues
Risk assessment	Sediment disaster hazard map is neither regularly reviewed nor revised.
Disaster preparedness	No evacuation map. Only selected areas are strengthened by evacuation systems; hence, not all areas are considered as disaster-prone.
Organization and system	Lack of collaboration and coordination between implementing agencies and survey/ research institutions.
Emergency response	Poor dissemination of emergency information to the local level, considered as "last mile connectivity".
Disaster forecasting and warning systems	No warning system for sediment disaster.
Countermeasure work	Inappropriate countermeasure without considering the type of disaster.

Source: Created by the JST based on Data Collection Survey for Disaster Risk Reduction in India, 2015

2) Bihar

Bihar's major natural disaster is flood, earthquake, and drought. The state has the second highest number of deaths caused by flood between 1995 and 2014. Below are the issues found by related agencies of Bihar and the 2015 data collection survey team.

Table 3.1.5 Disaster Issues in Bihar

DRR Sector	Issues
Risk assessment	No risk assessment for the rise in riverbed and inland water in urban area is not drained.
Disaster preparedness	Lack of strategies to introduce floodplain zoning.
Organization and system	No comprehensive sediment management using the concept of river basin management (RBM).
Disaster forecasting and warning systems	No warning system for the Ganges River tributary.
Countermeasure work	Have not strengthened the embankments in areas where the riverbed is rising.

	Also, reservoir function is not ensured in the land use management.

Source: Created by the JST based on Data Collection Survey for Disaster Risk Reduction in India, 2015

3) Andra Pradesh

Andra Pradesh's major natural disaster is cyclone, flood, and drought. And the state has the third highest number of deaths caused by cyclone between 1995 and 2014. Below are the issues raised by related agencies of Andra Pradesh and the data collection survey team.

Table 3.1.6 Disaster Issues in Andra Pradesh

DRR Sector	Issues
Risk assessment	Inaccuracy of information.
Disaster preparedness	Houses and buildings are vulnerable to disasters. Many shelters need repairs.
Organization and system	No disaster management framework. Low awareness of disaster mitigation at the district level.
Disaster forecasting and warning systems	No reliable communication environment to monitor rivers in events. Not capable to issue warning during localized heavy rainfalls in urban area.
Countermeasure work	Coasts in urban areas are not protected from high waves and storm surge.

Source: Created by the JST based on Data Collection Survey for Disaster Risk Reduction in India, 2015

(3) Possibility to Utilize Japanese Technologies for Major Disaster Issues

Below is a list of Japan's proposed assistance based on issues and evaluations of countermeasure effects, relevant Indian agencies' capability, and Japan technologies adaptation.

Table 3.1.7 Proposed Japanese Technologies for Major Disaster Issues

Disaster	DRR Sector	Project	Scheme	Candidate State
Flood	Organization and system	Sediment management based on the concept of river basin management (RBM).	Technical cooperation	Bihar
Flood	Countermeasure work	Countermeasures against inland water flooding due to the blockage of waterways and streams. Phase 1: Planning Phase 2: Implementation	Phase 1: Technical cooperation Phase 2: Grant aid	Bihar
Landslide	Disaster forecasting and warning systems	Develop landslide monitoring and early warning system. Phase 1: Planning Phase 2: Implementation	Phase 1: Technical cooperation Phase 2: Grant aid	Uttarakhand
Landslide	Risk assessment	Risk assessment and countermeasures implementation based on the priority. Phase 1: Planning Phase 2: Implementation	Phase 1: Technical cooperation Phase 2: Loan financial cooperation	Uttarakhand
Cyclone	Disaster forecasting and warning systems	Phase 1: Improve river management Phase 2: Develop warning system for localized heavy rains at urban area.	Phase 1: Technical cooperation Phase 2: Grant aid	Andra Pradesh
Cyclone	Risk assessment	Improve risk analysis of cyclones and flood.	Technical cooperation	Andra Pradesh

Source: Created by the JST based on Data Collection Survey for Disaster Risk Reduction in India, 2015

3.1.2 Data Collection Survey on Disaster Risk Reduction for Flood Protection in 2022 by JICA

The objective of this survey is to review the administration, legal system, strategies, and plans related to flood management in 12 targeted countries. Moreover, it aims to identify project investments for flood management in basins, especially external water flooding at flood prone areas. The surveyed countries are India, Indonesia, Vietnam, Philippines, Pakistan, Bangladesh, Sri Lanka, Cambodia, Nepal, Laos, Bhutan, and Myanmar.

(1) Candidate States in India

The evaluation criteria are gross domestic product (GDP) caused by floods, necessity of project based on the progress of existing projects, necessity and urgency of formulating and revising the master plan (M/P), and necessity and effectiveness of Japan's support. The evaluation unit for India is by state, not by basin since there is a limitation to apply this survey method into international rivers, like Ganges River and Indus River.

1) Flood Risk Analysis Method

A flood risk analysis was conducted using the data shown below.

Table 3.1.8 Data Source for Flood Risk Analysis

Data Type	Local Agency	Global Data	Remarks
Basin area			Created from Digital Elevation Model (DEM) since there is no available data
Population		World PoP (2020)	UN is urban and others, World PoP is 1 km mesh
GDP	Gross State Domestic Product		Reserve Bank of India
Flood history	BTMC (Building Materials and Technology Promotion Council)		Vulnerability Atlas of India, Third Edition (2019)
M/P formulation and project implementation by donors, local governments, etc.		JICA World Bank (WB) ADB	
Area expected to be flooded		CIMA-UNEP (2015), GLOFRIS(Aqueduct) (2019), JRC by European Union (GFM) (2018)	Each resolution is 90 m mesh for CIA-UNEP, 1 km for GLOFRIS, 1 km for JRC *Use LFMs in addition

Source: Data Collection Survey on Disaster Risk Reduction for Flood Protection in 2022

2) Result of Flood Risk Analysis

First Phase: Evaluate the flood risk for each state by validating the state GDP with the 100-year return period flood area using UNEP and EU-JRC data. The calculation formula is as follows:

Flood damage = population in flooded area × GDP per capita of the state

The evaluation results are as follows. The amount of damage in urban areas may be underestimated since per capita GDP remains the same in urban and rural areas in this calculation.

Table 3.1.9 Flood Risk Analysis by State Level (First Phase)

River Basin	State area	Flood area (EL<5m)	Damage Potential							
			Pop in flood area (2020)		Pop growth in area (2010-2020)		GDP in flood area (2020)		GDP growth in flood area (2010-2020)	
	km2	km2	People	rank	%	rank	bil.USD	rank	%	rank
West Bengal	88,752	50,284	64,764,034	3	7.8%	17	95	1	158.3%	27
Uttar Pradesh	240,928	110,963	92,998,928	1	13.2%	10	79	2	178.5%	23
Punjab	50,362	48,841	25,527,739	4	7.5%	18	52	3	140.0%	29
Gujarat	196,024	37,444	15,777,687	6	19.1%	5	44	4	228.9%	6
Bihar	94,163	53,896	67,970,620	2	18.0%	8	40	5	178.9%	22
Delhi	1,483	730	7,061,334	10	18.8%	6	35	6	207.8%	12
Andhra Pradesh	160,205	23,082	13,366,226	7	0.6%	28	29	7	188.3%	19
Haryana	44,212	16,857	8,607,394	9	12.9%	11	28	8	197.8%	14
Assam	78,438	35,047	17,257,194	5	12.3%	13	19	9	194.5%	16
Kerala	38,863	7,237	6,106,414	11	-3.2%	30	18	10	207.2%	13
Orissa	155,707	22,678	11,695,621	8	6.2%	23	17	11	196.7%	15
Maharashtra	307,713	12,828	3,802,875	12	0.5%	29	10	12	139.5%	30
Tamil Nadu	130,058	5,144	3,469,211	13	6.7%	21	10	13	190.1%	17
Karnataka	191,791	5,300	1,493,172	17	2.3%	26	4	14	266.8%	4
Telangana	112,077	7,639	1,250,063	19	-5.8%	31	4	15	228.5%	7
Uttaranchal	53,483	2,461	1,314,268	18	18.7%	7	3	16	226.2%	8
Chandigarh	114	103	770,674	23	10.6%	15	3	17	188.2%	20
Rajasthan	342,239	9,735	2,055,119	14	5.7%	25	3	18	173.5%	25

Source: Data Collection Survey on Disaster Risk Reduction for Flood Protection in 2022

Second Phase: Evaluate (1) the necessity of the project based on the progress of existing projects, (2) the necessity and urgency of formulating and revising the M/P, and (3) the necessity and effectiveness of Japan's support. As a result, five states with high GDP within the flood area were selected as priority states for countermeasures.

Table 3.1.10 Selection of Priority States (Second Phase)

Flood Area	GDP in 2020 (Bn US$)	% of total India GDP in 2020	(1) Necessity of the project based on the progress of existing projects	(2) Necessity and urgency of formulating and revising the M/P	(3) Necessity and effectiveness of Japan's support
West Bengal	95	18.8%	○: No information for projects (Execute WB small-scale irrigation development projects 2019-2021 as a related project)	○: No information for M/P formulation	○: Room for new support from Japan
Uttar Pradesh	79	15.6%	○: No information for projects (Execute WB water sector reconstruction project, as a related project)	○: No information for M/P formulation	○: Room for new support from Japan
Punjab	52	10.3%	○: No information for projects	○: No information for M/P formulation	○: Room for new support from Japan
Gujarat	44	8.7%	○: No information for projects	○: No information for M/P formulation	○: Room for new support from Japan
Bihar	40	7.9%	○: Partial supports by WB (Kosi River flood rehabilitation in Bihar)	○: No information for M/P formulation	○: Room for new support from Japan
Delhi	29	6.9%	○: No information for projects (Execute WB small-scale irrigation development projects 2019-2021, as a related project)	○: No information for M/P formulation	○: Room for new support from Japan
Andra Pradesh	29	5.7%	○: No information for projects (ADB's Water Sector Operations in India: Review and Way Forward 2011, as a related project)	○: No information for M/P formulation	○: Room for new support from Japan
Haryana	28	5.5%	○: No information for projects	○: No information for M/P formulation	○: Room for new support from Japan
Assam	19	3.8%	○: Execute embankment repair for 90 km section of Brahmaputra River by ADB (Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program-Project 2 (2019-2021))	○: No information for M/P formulation	○: Room for new support from Japan
Kerala	18	3.6%	○: MLIT proposes implementation of flood countermeasures (improving existing dam functions)	○: No information for M/P formulation	○: Room for new support from Japan

Source: Data Collection Survey on Disaster Risk Reduction for Flood Protection in 2022

(2) Countermeasure

Different countermeasures are proposed for large river basin and urban area.

1) Large river basin area

Since it is difficult to control floods flowing from upstream areas such as China and Nepal, land protection like ring embankment should be the main countermeasure. Large cities in the top five states with the highest GDP within the flood area (population of two million or more) are listed below. These cities are candidates of land protection countermeasures.

- Kolkata (West Bengal, population: 14.6 million)
- Ahmedabad (Gujarat, population: 6.35 million），
- Kanpur (Uttar Pradesh, population: 2.92 million)
- Lucknow (Uttar Pradesh, population: 2.9 million)
- Ghaziabad (Uttar Pradesh, population: 2.36 million)
- Indore (Uttar Pradesh, population: 2.17 million)
- Patna (Bihar, population: 2.05 million)

2) Urban area

In cities such as Mumbai and Chennai, major flood damages are occurring due to complex factors such as external water flooding of small rivers, inland water flooding within cities, and storm surges. A combination of flood countermeasures is therefore required.

(3) Challenges and proposal

There are two challenges mentioned in the report as well as proposals to solve them.

Challenge 1: Although some cities have experienced major flood damage, the inundation area is relatively small. Therefore, these cities would not be selected under this survey method.

➔ Solution plan:
- Set flood-prone areas for each city by utilizing high accuracy data/ information.
- Dividing the survey areas into smaller administrative units.

Challenge 2: Many donors such as JICA, WB, and ADB are implementing support projects. However, these projects are not always mutually coordinated, and/or collaborated.

➔ Solution plan:
- Further coordination and collaborations among donors are ideal to produce a collective impact.

3.1.3 Country Partnership Strategy India, 2023-2027 --- Catalyze Robust, Climate-Resilient, and Inclusive Growth by ADB

The Country Partnership Strategy India describes ADB's strategic approach to deliver development results. One of its three strategic pillars is "Climate-Resilient Green Growth" and one of the key expected outcomes is "climate adaptation, disaster resilience, and environmental sustainability intensified".

On disaster risk management, the following are the supports that ADB plans to execute with nature-based solution:

- Strengthening the disaster risk financing system with insurance solutions.
- Flood and coastal protection to protect the livelihood of the poor.
- Riverbank erosion management to stabilize river course, navigate channels, and reclaim lost floodplain land.

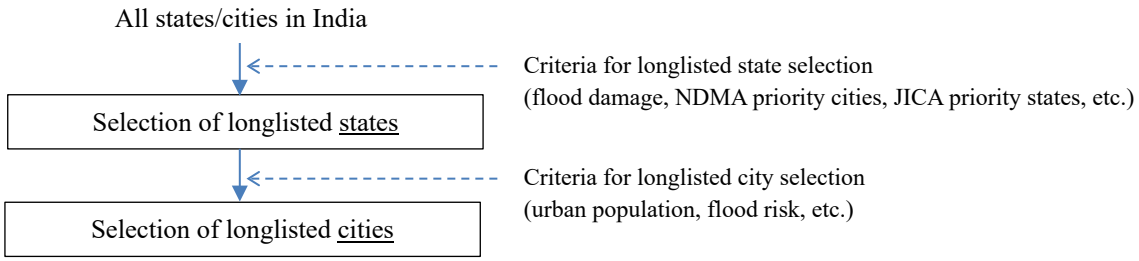
Climate change adaptation supports are as follows:

- Climate proofing of infrastructure.
- National architecture for climate adaptation financing.
- Preparation and implementation of state climate change action plans.
- Effective water usage by improving river basin management.
- Water harvesting and storage.
- Modernize irrigatimouon systems with digital technologies.
- Promote alternative livelihoods such as ecotourism to conserve biodiversity.

3.2 Outline to Select Longlisted Cities

3.2.1 Selection Process of Longlisted Cities

The target of this survey is to formulate a yen loan project or technical cooperation project mainly in the urban drainage sector. In this regard, the main target is not the states but the city. In this data collection survey, after selecting the longlisted states taking into consideration flood risk and other factors, cities with large populations and high risk of flooding within these states shall be selected as the longlisted cities.



Source: JICA Survey Team

Figure 3.2.1 Selection Process of Longlisted Cities

3.2.2 Summary of Differences in Evaluation Items from the Previous Survey

The existing reports' criteria to select longlisted states are: "Number of flood deaths by state" in the "Data Collection Survey for Disaster Risk Reduction in India" (hereafter referred to as "the 2015 Survey"), and "GDP of inundation area by state" in the "Data Collection Survey on Disaster Risk Reduction for Flood Protection" (hereafter referred to as "the 2022 Survey"). In this survey, longlisted states were selected by modifying these criteria to fit the survey's objectives.

The differences between the existing and this survey are described in the table below. As described earlier, the purpose of this survey is to formulate yen loan projects and technical cooperation projects in the field of urban flooding. Therefore, the project unit is the city. In addition, this survey also takes into account the effect of future climate change which is important to urban flooding.

Table 3.2.1 Difference of Each Survey

		2015 Survey	2022 Survey	THIS Survey
Objective	Disaster Type	Flood, etc.	Flood	Urban flood
	Target Area	State	State	State → City
Factor	Climate Change	N/A	N/A	Reflect to risk evaluation
	Urbanization	N/A	Partially reflected	Reflect to city selection

Source: Created by the JST based on the 2015 Survey and the 2022 Survey

3.2.3 Conditions to Select Longlisted States/Cities

As shown in the table below, target cities are selected by evaluating urban damage (amount of property damage based on land use) rather than GDP damage, NDMA's priority cities, and each state's financial situation (debt situation).

Table 3.2.2 Criteria to Select Longlisted States/Cities

	2015 Survey	2022 Survey	THIS Survey
Target Area	State	State (Some parts are big cities from selected states)	Over 1 million: urban mega-city
Criteria (State)	1. Number of deaths by flood (1995-2014)	1. Affected GDP (2019) 2. Rainfall return period of 100 years (2019) 3. Necessity of project 4. Necessity and urgency of formulating and revising MP 5. Necessity and effectiveness of Japan's support *No evaluation difference between states in criteria 2-4	1. Urban damage 2. Current risks with rainfall return period of 100 years (2010) 3. Projected risks with rainfall return period of 100 years under RCP4.5/SSP2 scenario (2030 forecast) 4. States including NDMA focused cities 5. JICA focused states 6. Northeastern states 7. States where JICA implements metro project
Criteria (City)			1. City population (2023) 2. Urban flood risk (2021) 3. NDMA information

Source: Created by the JST based on the 2015 Survey and the 2022 Survey

3.3 Criteria to Select Longlisted States

3.3.1 Evaluation-1: Urban Damage by Flood

(1) General Information of the Data Source

The assessment in this survey used Aqueduct (https://www.wri.org/aqueduct), which is one of the data published by the World Resources Institute (WRI), and a global standard assessment tool for water risks.

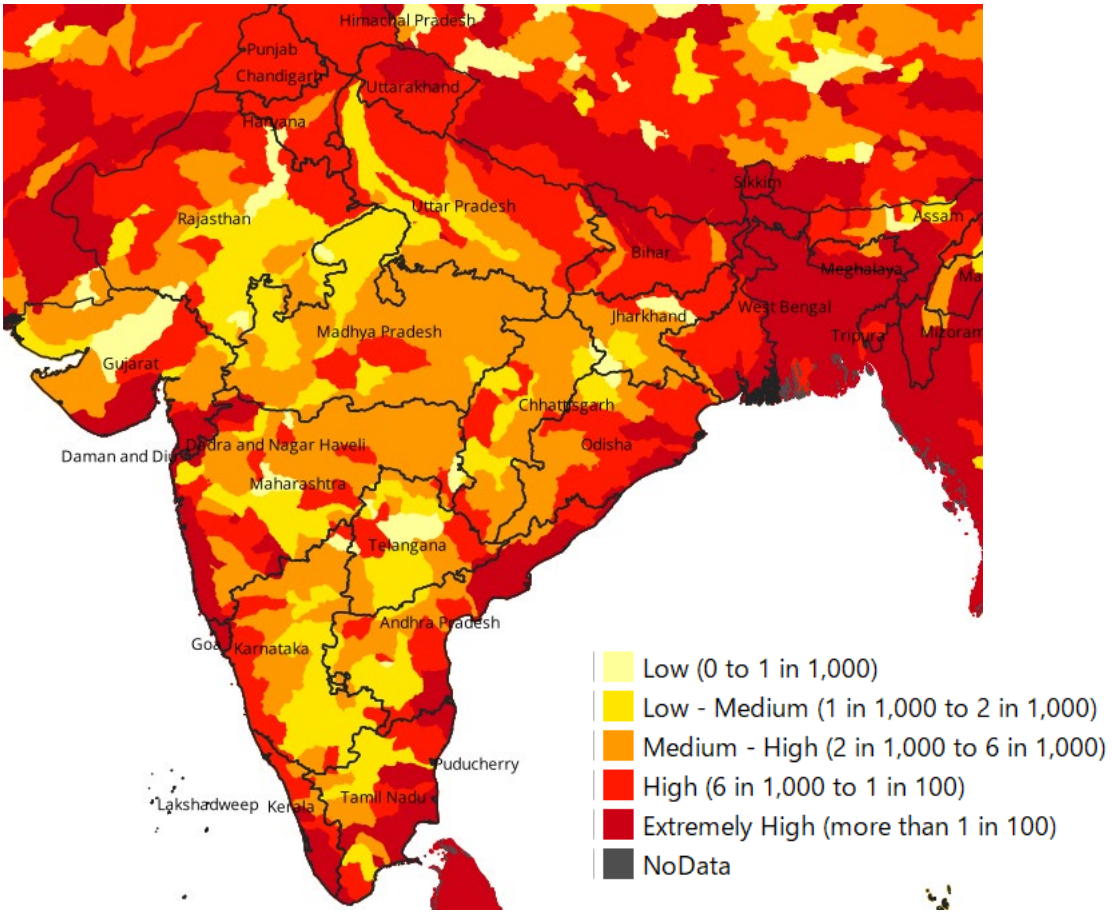
It is a reliable tool since the data is cited by multiple international authorities such as the United Nations, World Bank, governments, hundreds of companies, publications (Economist, Bloomberg, New York Times, etc.), and well-known authorities. Also, this is supported by the Aqueduct Alliance which is a coalition of leading companies in water management, governments, and foundations. On the other hand, the main sources of funding for WRI are the Dutch Ministry of Foreign Affairs, the Royal Danish Ministry of Foreign Affairs, and the Swedish International Development Cooperation Agency. The research partners are known to be reliable international authorities such as Delft University of Technology, Deltares, Utrecht University, Institute for Environmental Studies (IVM), International Food Policy Research Institute (IFPRI), PBL Netherlands Environmental Agency, and RepRisk.

(2) Aqueduct Global Flood Risk Map

The Aqueduct Global Flood Risk Map Data provides estimates of the current and future river flood risk in terms of urban damage, affected GDP, and affected population by country, river basin, and state. In the current scenario, hydrological data from 1960 to 1999 were used to simulate nine types of flood inundations from 2-year return to 1000-year return and GDP in 2010, population, and land use data to assess the flood impact.

For future projections, five Global Climate Models (GCMs) from Coupled Model Intercomparison Project Phase 5 (CMIP5) were used under two climate scenarios: RCP4.5 (medium-emission scenario) and RCP8.5 (high-emission scenario). Socioeconomic data were predicted using SSP2 (Socioeconomic Shared Pathways 2) and SSP3 from the Intergovernmental Panel on Climate Change Assessment Report 5.

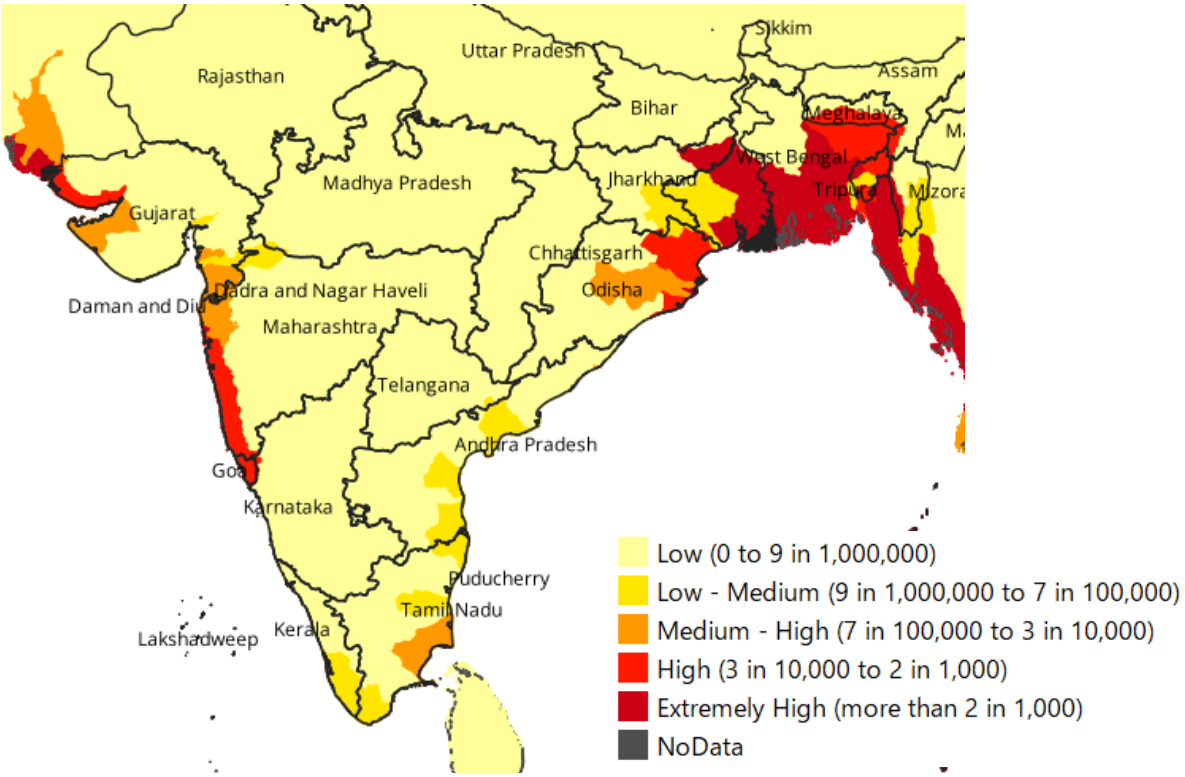
River flood damage in India (current situation) was estimated as shown in Figure 3.3.1 and the areas with high risk of flood damage have been identified.



Source: Created by the JST based on Aqueduct

Disclaimer: This map is only for illustrative purposes and does not imply any opinion of JICA on the legal status of any country or territory, the border line of any country or territory or its demarcation, or the geographic names.

Figure 3.3.1 River Flood Damage in India (Current Situation)



Source: Created by the JST based on Aqueduct
Disclaimer: This map is only for illustrative purposes and does not imply any opinion of JICA on the legal status of any country or territory, the border line of any country or territory or its demarcation, or the geographic names.

Figure 3.3.2 Damage by High Tide in India

(3) Flood Damage by Return Period

1) Urban damage amount

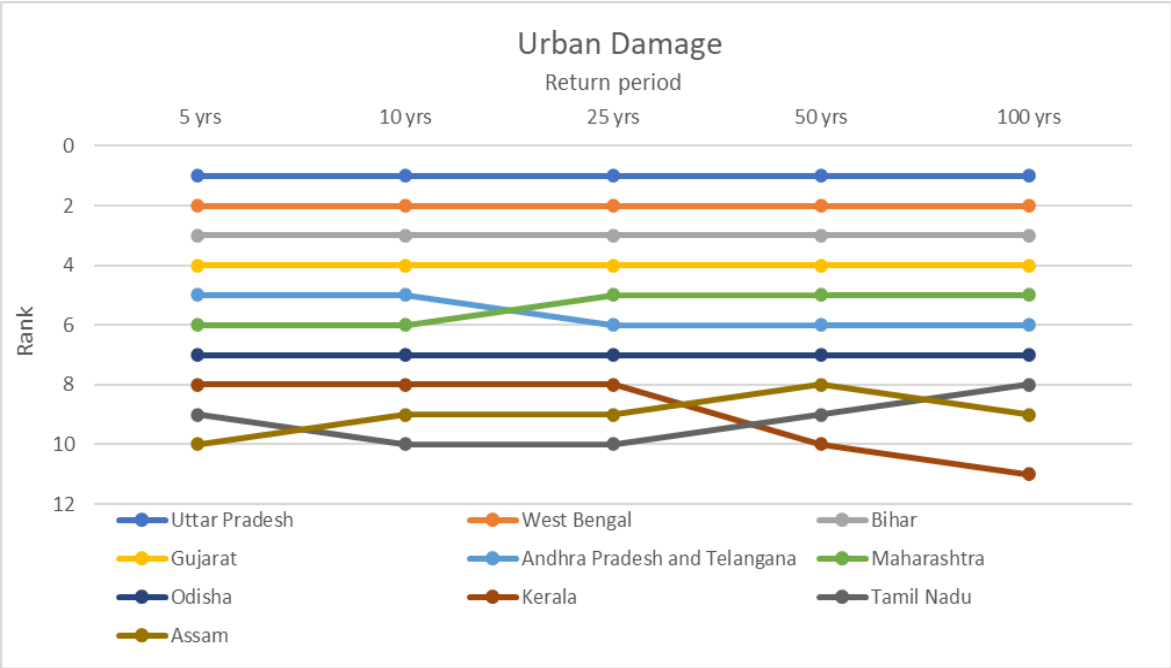
According to Aqueduct's calculation, it was confirmed that the ranking of urban flood damage amounts by state remains almost the same regardless of the rainfall return period. In other words, it is concluded that the ranking of state in terms of flood damage amount remains almost the same regardless of the scale of rainfall.

Table 3.3.1 Urban Damage Amount Ranking by State

State	Urban Damage Rank				
	Return period of 5 years	Return period of 10 years	Return period of 25 years	Return period of 50 years	Return period of 100 years
Uttar Pradesh	1	1	1	1	1
West Bengal	2	2	2	2	2
Bihar	3	3	3	3	3
Gujarat	4	4	4	4	4
Andhra Pradesh and Telangana	5	5	6	6	6
Maharashtra	6	6	5	5	5
Odisha	7	7	7	7	7
Kerala	8	8	8	10	11
Tamil Nadu	9	10	10	9	8
Assam	10	9	9	8	9
Madhya Pradesh	11	11	11	11	10
Delhi	12	13	14	14	14

State	Urban Damage Rank				
	Return period of 5 years	Return period of 10 years	Return period of 25 years	Return period of 50 years	Return period of 100 years
Rajasthan	13	12	12	12	12
Jharkhand	14	15	15	15	15
Chhattisgarh	15	14	13	13	13
Punjab	16	16	16	16	16
Karnataka	17	17	17	17	17
Jammu and Kashmir	18	18	18	18	18
Haryana	19	19	19	19	19
Himachal Pradesh	20	20	20	21	21
Uttarakhand	21	21	21	20	20
Puducherry	22	22	22	22	22
Arunachal Pradesh	23	23	23	23	23
Nagaland	24	25	25	25	25
Manipur	25	24	24	24	24
Dadra and Nagar Haveli	26	26	26	26	26
Sikkim	27	27	27	28	29
Tripura	28	28	28	27	28
Daman and Diu	29	29	29	30	30

Source: Created by the JST based on Aqueduct



Source: Created by the JST based on Aqueduct

Figure 3.3.3 Urban Damage Amount Ranking by Return Period

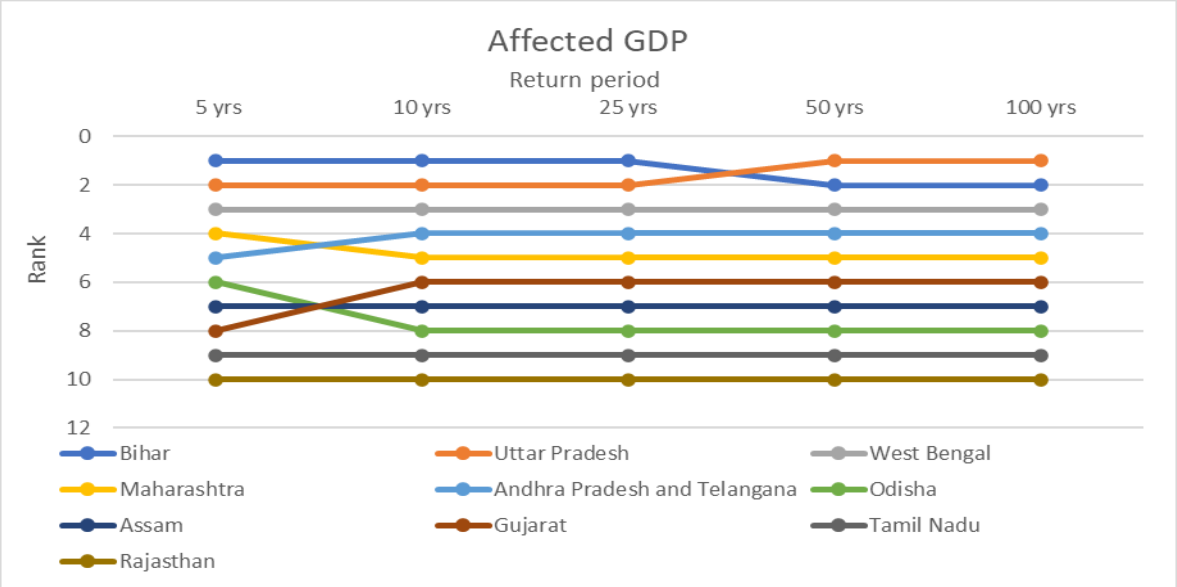
2) Affected GDP

According to Aqueduct's calculation, it was also confirmed that the ranking of the affected GDP amounts does not change much even if the rainfall return period differs as shown below. In other words, it is concluded that the ranking of state in terms of affected GDP remains almost the same regardless of the scale of rainfall.

Table 3.3.2 Affected GDP Ranking by State

State	Affected GDP Rank				
	Return period of 5 years	Return period of 10 years	Return period of 25 years	Return period of 50 years	Return period of 100 years
Bihar	1	1	1	2	2
Uttar Pradesh	2	2	2	1	1
West Bengal	3	3	3	3	3
Maharashtra	4	5	5	5	5
Andhra Pradesh and Telangana	5	4	4	4	4
Odisha	6	8	8	8	8
Assam	7	7	7	7	7
Gujarat	8	6	6	6	6
Tamil Nadu	9	9	9	9	9
Rajasthan	10	10	10	10	10
Delhi	11	11	11	11	11
Kerala	12	13	13	13	13
Madhya Pradesh	13	12	12	12	12
Karnataka	14	14	16	16	16
Haryana	15	16	15	15	15
Punjab	16	15	14	14	14
Jammu and Kashmir	17	17	17	18	18
Jharkhand	18	18	19	19	19
Chhattisgarh	19	19	18	17	17
Himachal Pradesh	20	20	20	20	20
Uttarakhand	21	21	21	21	21
Manipur	22	22	22	22	22
Arunachal Pradesh	23	23	23	23	23
Tripura	24	24	24	24	24
Sikkim	25	25	25	25	25
Nagaland	26	26	26	26	26
Mizoram	27	27	27	28	29
Meghalaya	28	28	29	29	28
Puducherry	29	29	30	27	27
Dadra and Nagar Haveli	30	30	28	30	30

Source: Created by the JST based on Aqueduct



Source: Created by the JST based on Aqueduct

Figure 3.3.4 Affected GDP Ranking by Return Period

3.3.2 Evaluation-2: States Including NDMA's Priority Cities

The National Disaster Management Authority (NDMA) is the key authority in the disaster management sector in India. Considering the purpose of this project to formulate a yen loan project or JICA's technical assistance in the sector, cities that are prioritized by NDMA for urban flood countermeasures shall also be prioritized in this survey. In this regard, the states including NDMA's priority cities were categorized as longlisted states.

RECOMMENDATION OF 15th FINANCE COMMISSION – URBAN FLOODS

- To address the issue of Urban Floods, it is required to develop an approach which brings together urban planning, ecological conservation and disaster management together.
- In view of the regular incidence of flooding and heavy losses, XVth finance commission recommend that a targeted allocation be made to address urban flooding in seven cities (excluding Delhi), which have a metropolitan area with a population exceeding five million.
- **DELHI** being UT will get separate allocation from MoF.

Table 8.9: Allocation to Cities for Reducing the Risk of Urban Flooding

(Rs. crore)

Cities	Annual Allocation	Total Allocation (2021-26)
Mumbai	100	500
Chennai	100	500
Kolkata	100	500
Bengaluru	50	250
Hyderabad	50	250
Ahmedabad	50	250
Pune	50	250
Total	**500**	**2500**

Mumbai → Chennai → Kolkata → Bengaluru → Hyderabad → Ahmedabad → Pune

Source: NDMA's Introductory Session in the National Seminar on Urban Flood Mitigation on September 13, 2022

Figure 3.3.5 NDMA's Priority Cities on Urban Flood Protection

3.3.3 Evaluation-3: JICA's Priority States

Through the Act East Policy, the Indian government aims to strengthen connectivity in a broad sense, including politics, economics, culture, and people-to-people relations, with neighbouring regions. The northeastern region is expected to be the gateway to these regions, and infrastructure development and social development are progressing. The Act East Forum was established in 2017 with the Japanese government, and the development of the region has become an important topic for both the Indian and Japanese governments. For this reason, JICA is also willing to consider Assam, a northeastern state, as a candidate for assistance.

Kerala State, which is rank 8th in the urban damage amount ranking, is excluded from the longlisted states, as it is predicted to be difficult to implement yen loan projects in this state based on past project results.

3.3.4 Selection of Longlisted States

The longlisted states are selected from the states with the highest flood damage amounts (Aqueduct data) after selecting the states that include NDMA priority cities and JICA priority states. The selection results are shown in Table 3.3.3.

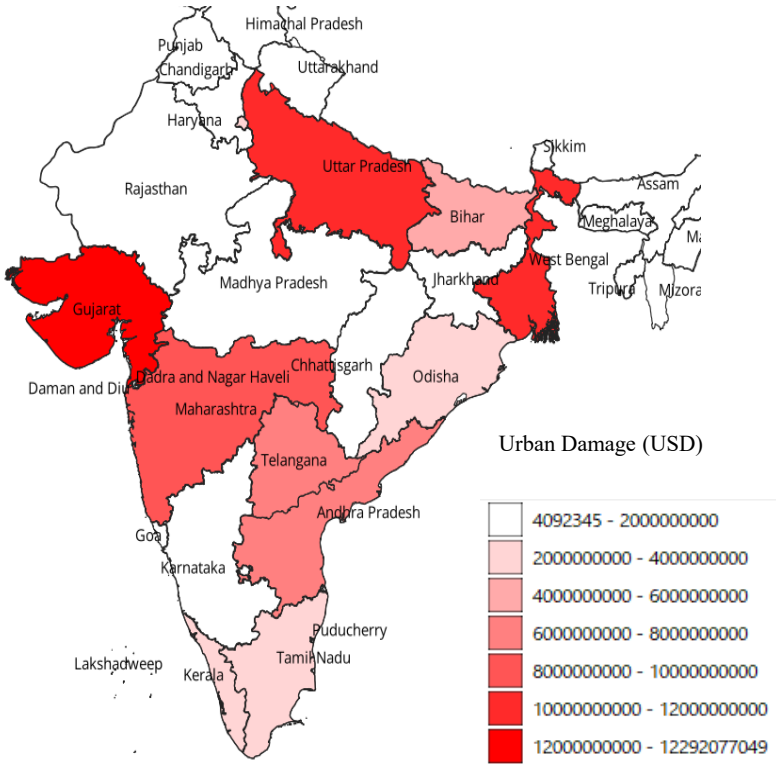
Table 3.3.3 Selection of Longlisted States

State	Urban Damage_Current		Number of NDMA Focus City	JICA's Priority State
	USD	Rank		
Gujarat	12,292,077,049	1	1	
West Bengal	11,779,272,720	2	1	
Uttar Pradesh	10,802,335,608	3		
Maharashtra	9,165,855,980	4	2	
Andhra Pradesh and Telangana	6,392,774,879	5	1	
Bihar	4,260,690,088	6		
Tamil Nadu	3,650,396,541	7	1	
Kerala	3,256,704,995	8		X
Delhi	2,977,373,011	9	1	
Odisha	2,869,118,575	10		
Assam	1,560,904,792	11		○
Madhya Pradesh	1,312,000,081	12		
Rajasthan	1,083,402,355	13		
Punjab	1,069,884,966	14		
Chhattisgarh	953,749,562	15		
Karnataka	638,892,633	16	1	
Jharkhand	635,726,905	17		
Haryana	519,157,188	18		
Jammu and Kashmir	396,578,125	19		
Uttarakhand	247,044,927	20		
Himachal Pradesh	207,367,728	21		
Puducherry	115,387,225	22		
Arunachal Pradesh	61,186,628	23		
Nagaland	31,979,736	24		
Manipur	31,054,498	25		

Source: JST

As Table 3.3.3 shows, the longlisted states are Gujarat, West Bengal, Uttar Pradesh, Maharashtra, Andhra Pradesh and Telangana, Bihar, Tamil Nadu, Delhi, Odisha, Assam, and Karnataka.

As a result, all seven priority states selected in the two previous surveys, except for the northwestern states of Punjab and Uttarakhand, were selected as longlisted states. The estimated urban flood damages in the selected states are shown in Figure 3.3.6.



Source: Created by the JST based on Aqueduct

Disclaimer: This map is only for illustrative purposes and does not imply any opinion of JICA on the legal status of any country or territory, the border line of any country or territory or its demarcation, or the geographic names.

Figure 3.3.6 Estimated Urban Damage Amount Due to Flooding (2010)

3.4 Selection of Longlisted Cities

3.4.1 Evaluation-1: Population and Flood Risk of the City

The following is the result of identifying cities with a population of 1 million or more in the longlisted states. The cities with more than 10 million and 5 million populations are distinguished in Table 3.4.1.

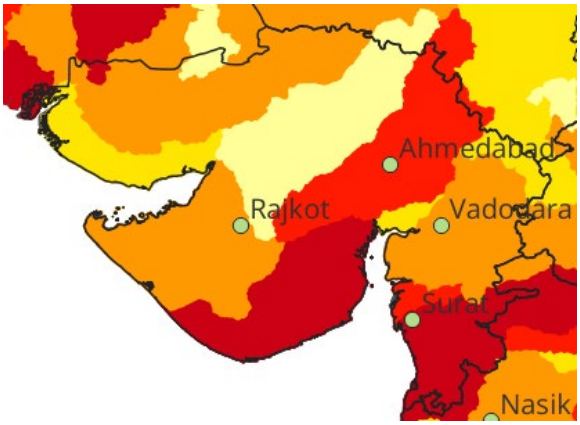
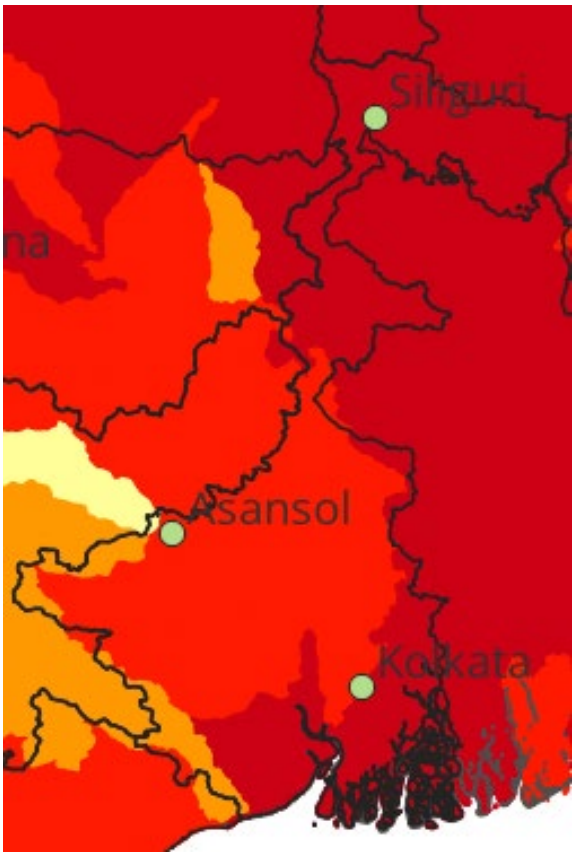
Table 3.4.1 Populated Cities in the Longlisted States

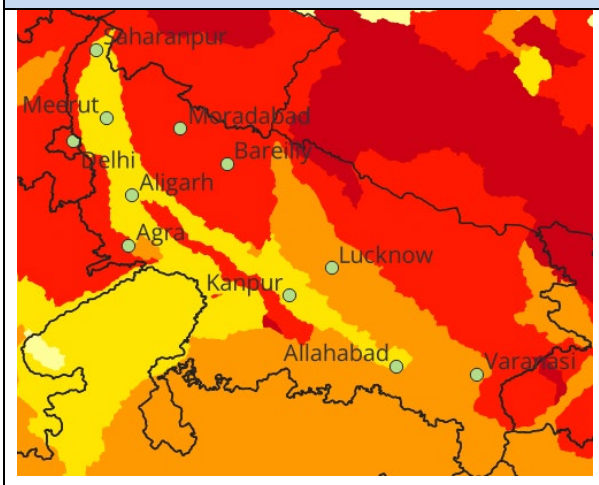
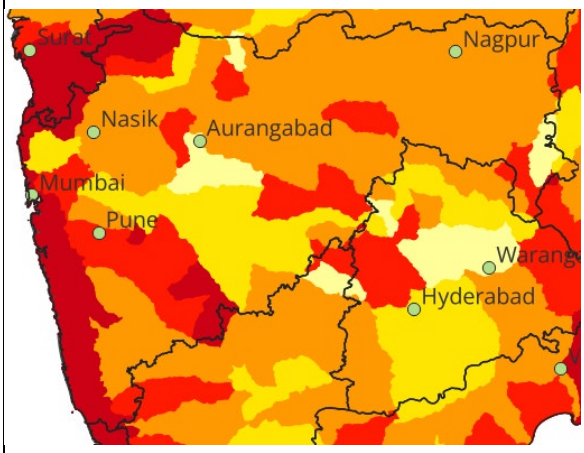
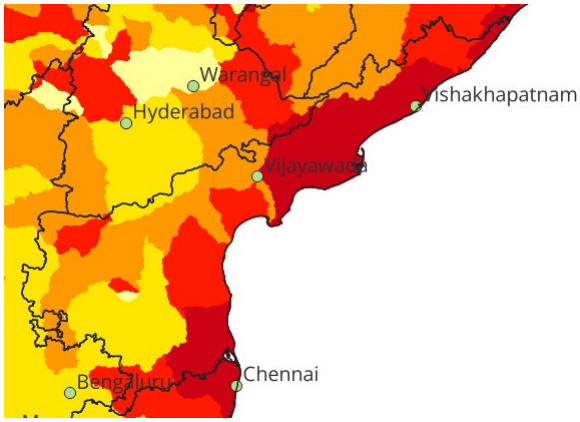
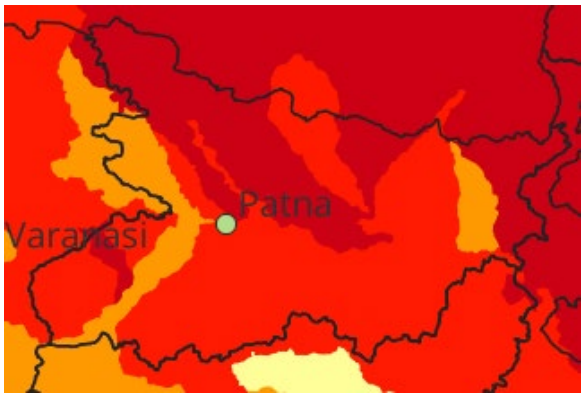
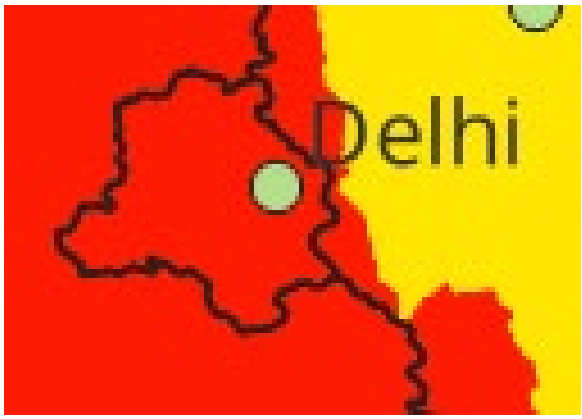
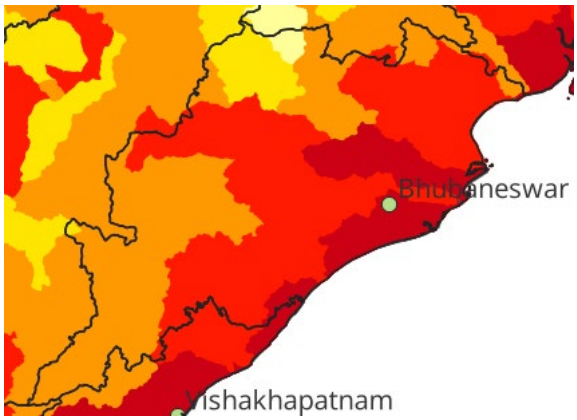
State	Major City
Gujarat	Ahmadabad*2, Surat*2, Rajikot, Vadodara
West Bengal	Kolkata*1, Asansol, Siliguri
Uttar Pradesh	Lucknow, Kanpur, Saharapur, Meerut, Moradabad, Bareilly, Aligarh, Agra, Allahabad, Varanasi
Maharashtra	Mumbai*1, Pune*2, Nagpur, Nasik, Aurangabad, Sholapur
Andhra Pradesh and Telangana	Hyderabad*1, Visakhapatnam, Vijayawada, Warangal
Bihar	Patna
Tamil Nadu	Chennai*1, Coimbatore, Salem, Trippur, Tiruchirappalli, Madurai
Delhi	Delhi*1
Odisha	Bhubaneswar
Assam	Gwahati
Karnataka	Bengaluru*1

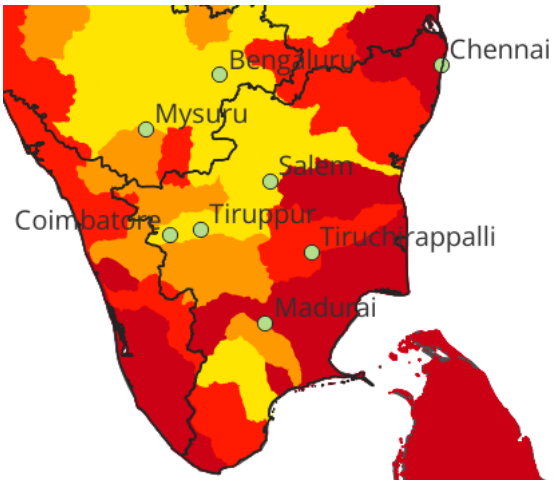
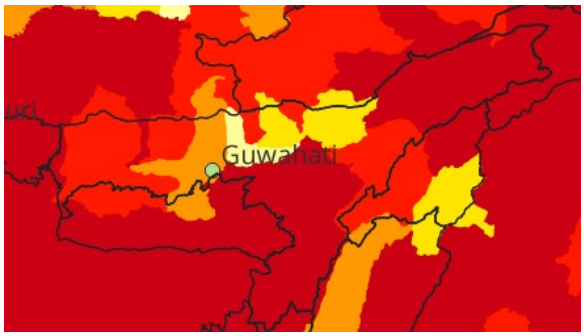
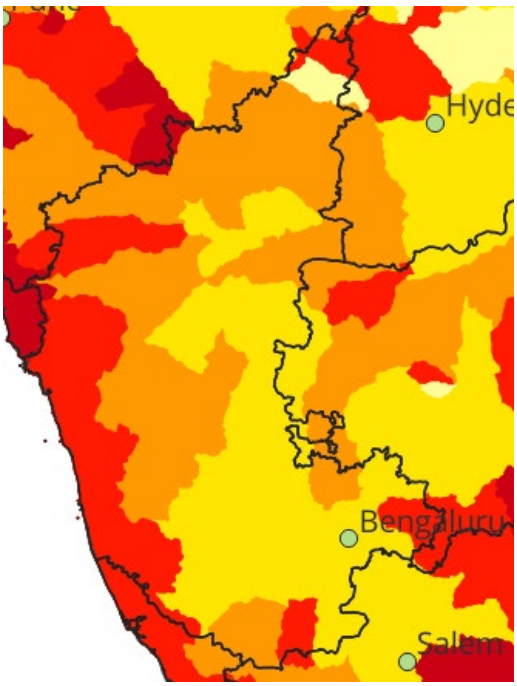
*1: Population over 10 million, *2: Population between 5 and 10 million (2023)

Source: JST

For the cities with a population of 1 million or more in the longlisted states as shown in Table 3.3.1, the risk of flooding was confirmed based on Aqueduct data.

Gujarat	West Bengal
	
Cities with a population of over 1 million with high risk of flooding: Ahmadabad, Surat, Rajikot, Vadodara	Cities with a population of over 1 million with high risk of flooding: Kolkata, Asansol, Siliguri

Uttar Pradesh	Maharashtra
	
Cities with a population of over 1 million with high risk of flooding: Lucknow, Moradabad, Bareilly, Agra, Varanasi	Cities with a population of over 1 million with high risk of flooding: Mumbai, Pune, Nagpur, Nasik
Andhra Pradesh and Telangana	**Bihar**
	
Cities with a population of over 1 million with high risk of flooding: Visakhapatnam, Vijayawada	Cities with a population of over 1 million with high risk of flooding: Patna
Delhi	**Odisha**
	
Cities with a population of over 1 million with high risk of flooding: Delhi	Cities with a population of over 1 million with high risk of flooding: Bhubaneswar

Tamil Nadu	Assam
	
Cities with a population of over 1 million with high risk of flooding: Chennai, Tiruchirappalli, Madurai	Cities with a population of over 1 million with high risk of flooding: Guwahati
Karnataka	
	Legend Low (0 to 1 in 1,000) Low - Medium (1 in 1,000 to 2 in 1,000) Medium - High (2 in 1,000 to 6 in 1,000) High (6 in 1,000 to 1 in 100) Extremely High (more than 1 in 100) NoData
Cities with a population of over 1 million with high risk of flooding: N/A	

Appendix-1 presents a list of past disasters that occurred in the major cities of the longlisted states. It shows that there have been multiple urban floodings in the major cities.

3.4.2 Evaluation-2: NDMA's Comments and Disaster Vulnerability Study

(1) NDMA's Comments

The following NDMA's comments are taken into consideration when finalizing the longlisted cities:

- NDMA had no issue with the proposed longlisted candidate cities.
- The seven cities to which the NDMA has allocated flood management budget (Mumbai, Chennai, Kolkata, Bengaluru, Hyderabad, Ahmedabad, Pune) will receive appropriate funding. It is necessary to confirm whether there is a need for further funding to mitigate urban flooding.
- NDMA recommends the following six second-tier cities: Surat, Kanpur, Nagpur, Coimbatore, Kochi[1], and Bhubaneshwar.

(2) Disaster Vulnerability to Climate Change

The Council on Energy, Environment and Water (CEEW) is conducting a district-level climate vulnerability assessment in India with support from NDMA. CEEW is one of Asia's leading not-for-profit policy research institutions. In India, they executed the National Water Resources Framework Study for India's 12th Five Year Plan.

Disaster vulnerability is an index that identifies areas with high vulnerability to disasters. For this reason, NDMA expects policymakers and administrative authorities in highly vulnerable areas to plan and implement disaster risk reduction measures based on the data.

1) Target Disaster Type

The target disasters are floods, cyclones, and droughts.

2) Vulnerability Calculation Method

The formula to calculate vulnerability is as follows:

$$\text{Vulnerability (f)} = \frac{\text{Exposure (E)} \times \text{Sensitivity (S)}}{\text{Adaptive Capacity (AC)}}$$

Where:

Exposure (E): People, livelihood, assets, etc. that could be adversely affected.

Sensitivity (S): The degree to which a system is affected.

Adaptive Capacity (AC): The ability of a system to adjust to climate change or to cope with the consequences.

The indicators and their sources for the calculation are as follows:

Indicators	Sources
Frequency and intensity of extreme events and their associated events	Extreme events catalogue developed by CEEW (Mohanty, 2020)
Land use and land cover*	Bhuvan-Indian Space Research Organization (ISOR)

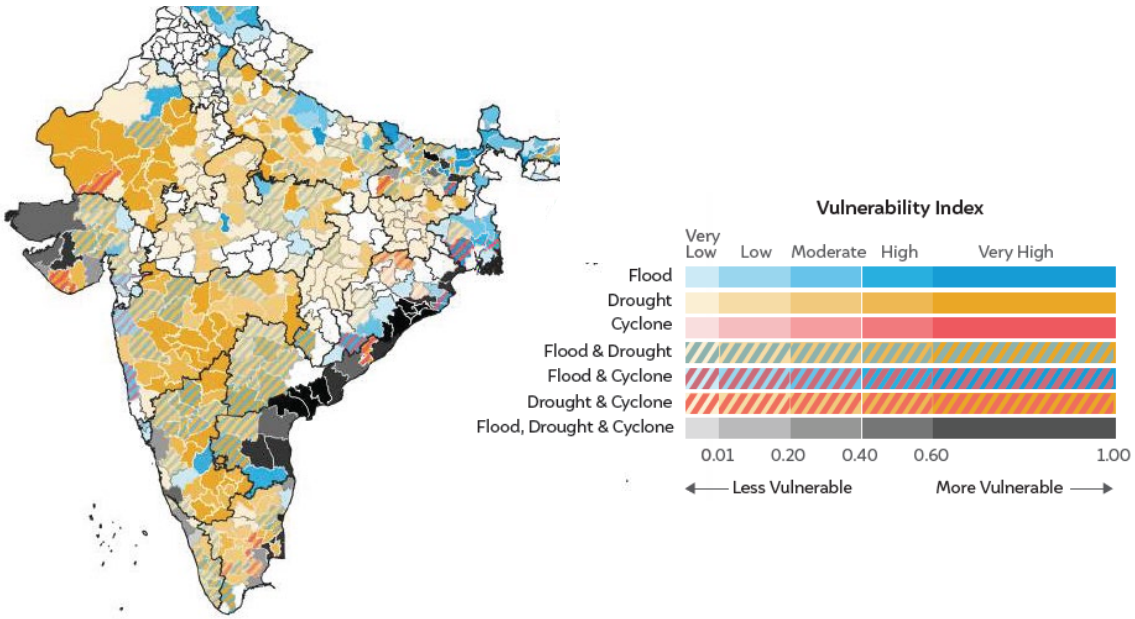
[1] The State of Kerala, where Kochi is located, is excluded at the stage of longlisted state selection due to the insufficient capacity of the state's implementing agencies to implement yen loan projects (see Table 3.3.3).

Elevation*	United States Geological Survey (USGS)
Slope*	USGS
Groundwater*	Water Resources Information System (WRIS)
Soil moisture*	National Aeronautics and Space Administration (NASA)
District Disaster Management Plan	Census 2011 Ministry of Statistics and Program Implementation Ministry of Agriculture (MoA) and Farmers Welfare Press Information Bureau (PIB)
Gross district domestic product	
Literacy rate	
Sex ratio	
Availability and accessibility to critical infrastructure	
Availability of disaster-ready shelters	
Population density	

*Resolution: 30 m x 30 m

3) Vulnerability to Hydro-met disaster

As a result of the estimation, vulnerability to hydro-met disaster (flood, drought, cyclone) in each district was evaluated as shown in Figure 3.4.1.



Source: Mapping India's Climate Vulnerability
Disclaimer: This map is only for illustrative purposes and does not imply any opinion of JICA on the legal status of any country or territory, the border line of any country or territory or its demarcation, or the geographic names.

Figure 3.4.1 Vulnerability to Flood, Drought, and Cyclone

3.4.3 Selection Result of Longlisted Cities

As shown in Evaluation 1, cities with a population of 1 million or more that are at high risk of flooding are selected from the longlisted states. The nine longlisted cities are selected based on: i) the results of district-basis natural disaster vulnerability assessments (cities vulnerable to flooding), calculated with the cooperation of NDMA, and ii) JICA's priority states. The selection results are shown in Table 3.2.2. Chennai was excluded from the longlisted cities in this study because it is being surveyed in a separate technical assistance project.

Table 3.4.2 Selection of Longlisted Cities

State	City	Vulnerability			NDMA Focus City Rank	JICA Input	Selection
		Rank	Level	Disaseter			
Delhi	Delhi	168	Moderate	Flood			Selected
Maharashtra	Mumbai (Bombay)	28	Very High	Flood & Cyclone	1		Selected
West Bengal	Kolkata (Calcutta)	258	Low	Flood & Cyclone	3		
Karnataka	Bangalore	132	Moderate	Drought	4		
Tamil Nadu	Chennai (Madras)	2	Very High	Flood & Cyclone	2		-
Telangana	Hyderabad	165	Moderate	Flood, Drought & Cyclone	5		Selected
Gujarat	Ahmadabad	66	High	Flood & Drought	6		Selected
Gujarat	Surat	254	Low	Flood & Cyclone	Additional	Although the vulunerability is low, the city shows high level of interest on JICA suppots as well as there are certain level of flood countermeasure needs.	Selected
Maharashtra	Pune (Poona)	117	Moderate	Flood & Drought	7		Selected
Uttar Pradesh	Lucknow	272	Very Low	Drought			
Uttar Pradesh	Kanpur	172	Moderate	Drought	Additional		
Maharashtra	Nagpur	61	High	Drought	Additional		
Tamil Nadu	Coimbatore	239	Low	Flood & Drought	Additional		
Bihar	Patna	64	High	Flood & Drought			Selected
Odisha	Bhubaneswar	20	Very High	Flood & Drought, Cyclone	Additional		Selected
Assam	Guwahati	101	High	Flood			Selected
	Low vulunerability in either floods or cyclone						

Source: JST based on the World Urbanization Prospect 2018, Mapping India's Climate Vulnerability

CHAPTER 4 SELECTION OF PRIORITY CITIES

4.1 Record of Meeting with Longlisted Cities

The JICA Survey Team (hereinafter called "JST") held physical and online meetings with longlisted cities and state disaster management authorities (SDMAs) from November 2023 to January 2024, as detailed in Table 4.1.1.

Table 4.1.1 Record of Meetings with Longlisted Cities

States	Cities	Authority	Date	Note
Gujarat	Ahmedabad	AMC	Nov. 9, 2023	Online
		AMC	Nov. 28, 2023	Site
	Surat	SMC	Nov. 30, 2023	Site
	-	GSDMA (State Government)	Nov. 29,2023	Site
Maharashtra	Mumbai	MCGM (SWD + MITRA)	Nov. 20, 2023	Site
	Mumbai	MCGM (Disaster Management)	Nov. 21, 2023	Site
	Pune	PMC	Nov. 24, 2023	Site
Telangana	Hyderabad	GHMC	Nov. 8, 2023	Online
		GHMC	Dec. 7, 2023	Site
Assam	Guwahati	GMDW&SB	Nov. 10, 2023	Online
		GMDA	Dec. 4, 2023	Site
Odisha	Bhubaneswar	BMC	Jan. 3, 2024	Online
Delhi	Delhi	-	No reply to request (unable to conduct)	
Bihar	Patna	PMC	Jan. 22, 2024	Online

Source: JST

As shown in the meeting material attached in Appendix 3-1, the main objectives of the meetings were i) to understand situation of disasters in the cities, ii) to request necessary information for this survey, and iii) to confirm the need for Japanese official development assistance (ODA) or technical assistance in disaster management and mitigation, especially in urban flooding sector. In the said meetings, the following points were confirmed:

(1) General Information Related to Disaster in the City

1) Information on disasters such as flood, cyclone, earthquake, landslide, tsunami, etc.
2) Disaster-related master plan, feasibility study (DPR).
3) Organizations/authorities in charge for each type of disaster.

(2) Information Related to Urban Flooding in the City

1) Drainage master plan, feasibility study (DPR) for the urban flooding project.
2) Other ongoing plans carried out by international organizations or donors.
3) Assumed financial sources to implement the project.
4) Future actions, studies, and project plans related to urban flooding in the city.

(3) Utilization of JICA's Assistance for Urban Flooding

1) Intention to utilize Japanese ODA loan to implement the project for urban flooding.
2) Intention to utilize JICA's technical assistance to formulate a comprehensive master plan.

The results of the meetings with longlisted cities are summarized in Table 4.1.2, and the minutes of each meeting are attached in Appendix 3-2.

Table 4.1.2 Summary of the Meetings with Longlisted Cities

State	Gujarat		Maharashtra		Telangana	Bihar	Odisha	Assam
City	**Ahmedabad**	**Surat**	**Mumbai**	**Pune**	**Hyderabad**	**Patna**	**Bhubaneswar**	**Guwahati**
Authority	**AMC**	**SMC**	**MITRA, MCGM**	**PMC**	**GHMC**	**PMC**	**BMC**	**GMDA**
(1) Basic Information of Urban Disaster								
1) Disaster information such as flood, cyclone, earthquake, landslide, tsunami, etc.	- Flooding is the most prioritized disaster. - The only other concern is earthquake.	- Flooding is the most prioritized disaster. - The only other concern is cyclone.	- Flooding is the most serious disaster. - Landslides and earthquakes are also major concerns.	- No other disasters in Pune besides flooding.	- No other disasters in Hyderabad beside flooding.	- Flooding is the most serious disaster. - It is also prone to earthquakes.	- Urban flooding is the most critical disaster. - Cyclone is also a major disaster.	- Landslides, earthquakes, and flooding are the major disasters.
2) Disaster-related master plan, feasibility study (DPR)	- Drafted the drainage and stormwater master plan (MP). Only the DPR for 250 Cr to NDMA is available. - No other MP or DPR.	- Disaster Management Plan (2023) - FS for river rejuvenation projects were completed with a total cost of Rs. 3,012 Cr.	- BRIMSTOWAD (1995, 2018). - DPRs of subprojects such as Mithi River.	- DPR was updated in 2023 to account for the recent increase in rainfall intensity.	- Drainage Master Plan (2020)	- Patna Master Plan 2031	- Flood-prone areas were detected, but a master plan has not yet been prepared.	- MP and DPR (2008) are available. - The MP is to be updated soon.
3) Organization / Authority in charge for each disaster								
Urban Drainage	- Water resources management of AMC - Ahmedabad Urban Development Authority (AUDA)	- Irrigation Dept. of SMC - Drainage Dept. of SMC	- MCGM (SWD)	- Sewerage, Maintenance and Repair Department of PMC	- Environment Vigilance & Disaster Management in GHMC	- Bihar Urban Infrastructure Development Corporation Ltd (BUIDCO)	- BMC	- GMDA
Flood, Cyclone Land slide, Earthquake	Gujarat-SDMA	- Gujarat-SDMA - Sulat District- DMA	- MCGM (Disaster management) - Maharashtra-SDMA	- Maharashtra-SDMA	- Hyderabad Disaster Response and Assets Monitoring Protection (HYDRA)	- Bihar-SDMA	- Odissa-SDMA	- Assam-SDMA
(2) Situation of Each City in the Stormwater Drainage Sector in Urban Areas								
1) Drainage master plan, feasibility study (DPR) for the urban flooding project	- Drainage and stormwater master plan (MP) is being updated.	- FS for river rejuvenation projects.	- BRIMSTOWAD (1995, 2018)	- DPR has approved for NDMA financial support.	- Strategic Nallah Development Program (SNDP)	- Master plan for stormwater outfall. - DPR of state funded project.	- None	- MP and DPR (2008)
2) Other ongoing plans carried out by international organizations or donors	- WB funded project for sewerage sector - ADB funded project for water supply and drainage (AUDA)	- WB funded project for Tapi riverfront improvement project	- None	- Plan to implement sewerage project under IFC.	- None	- None	- None	- ADB plans to provide financial support of Rs.150 Cr for Bahini and Hathinala basins.
3) Assumed financial sources to implement the project	- Government fund - NDMA - World Bank - ADB - JICA loan	- Government fund - Japanese ODA loan	- Government fund - NDMA - JICA's assistance for preparation of MP (BRIMSTOWAD-3) and Japanese ODA loan for priority project	- NDMA - Japanese ODA loan	- Government fund - NDMA - Japanese ODA loan for stormwater drainage improvement based on the Strategic Nala Development Programme (SNDP) and Musi Riverfront Project	- State budget of Bihar	- Government fund - JICA loan	- Government fund - JICA loan
4) Future actions, studies and project plans related to urban flooding in the city	1. Updating MP by Dec. 2024 2. Preparation of DPR based on the MP 3. FS for JICA loan	1. Implementation of Bhedwad Creek (Rs.678 Cr) 2. Preparation of DPR for Varachha (Rs.335 Cr) and Chhaprabatha creeks (Rs.258 Cr)	1. Updating MP 2. Formulation of FS for the prioritized project	1. Implement the NDMA funded project (Rs.286 Cr). 2. Other 60 spots improvement (DPR was approved: Rs.190 Cr).	1. Remaining works for Phase-1 of SNDP: Lake to lake connection works (90% completed). 2. Preparation of DPR for Phase-2 of SNDP.	1. Procurement of contractor is ongoing for the urban flood project with an estimated cost of Rs.980 Cr.	1. Formulation of MP 2. Formulation of DPR and FS for the priority project.	1. Updating MP 2. Updating DPR based on the MP 3. Implementation of the project for Bahini and Hathinala by ADB. 4. FS for JICA loan

		3. FS for JICA loan		3. Improvement for 11 villages (DPR not prepared yet: Rs.600 Cr). 4. Improvement for 23 new villages (required to prepare city plan: Rs.1,000 Cr).				
(3) Necessity of JICA Support in the Stormwater Drainage Sector in Urban Areas								
1) Japanese ODA loan for implementing the urban flooding project.	- Financial support to implement the project, with an estimated amount of Rs.8,271 Cr in the draft MP.	- Items 1 and 2 in the above column under JICA ODA loan.	- Based on the FS, drainage improvement projects will be implemented under JICA loan.	- Items 2, 3, and 4 in the above column under JICA ODA loan.	- Financial support to implement the project for Phase-2 (approx. Rs.5,000 Cr) of SNDP - Early flood warning system (Rs.57 Cr)	- Not necessary	- Based on the FS, drainage improvement projects will be implemented under JICA loan.	- Financial support to implement the project at Baharalu basin (Rs.450 Cr) and other basins (except for Bahini and Hathinala)
2) JICA's technical assistance	- Recycling of the sewage sludge	- Preparation of DPR for Varachha and Chhaprabatha creek	- Formulation of MP and FS	- Preparation of FS (DPR) for items 3 and 4 in the above column - Review of DPR for item 2	- Preparation of DPR for Phase-2	- Not necessary	- Formulation of MP and FS	- Updating the MP and DPR

Source: JST

4.2 Requests from Longlisted Cities

Based on the hearing surveys described in Section 4.1, requests from each longlisted city are summarized in Table 4.2.1. It should be noted that flooding issues are the most prioritized project for all the longlisted cities, as identified in the hearing survey.

Table 4.2.1 Summary of Requests from Longlisted Cities

City	Request in Urban Flooding Sector	Request in Other Disaster Sector
Ahmedabad	- Financial support to implement the project, with an estimated amount of Rs.8,271 Cr in the draft MP. Some part of the project, such as lake interlinking and flood early warning systems, will be implemented under NDMA project and state budget, with an estimated amount of Rs.275 Cr.	- Financial support and technical assistance related to the reuse and recycle of sewage sludge.
Surat	- Implementation of Bhedwad Creek (Rs.678 Cr) - Preparation of DPR for Varachha (Rs.335 Cr) and Chhaprabatha creek (Rs.258 Cr)	- Financial support for Phase 2 of the Tapi Riverfront Development Project, currently under implementation by the WB. The scope of Phase 2 includes: Eco Park, recreational park, informal market, pedestrian bridges, and other public utilities. - Infrastructure development in the expanded area will be needed in the future (not officially requested).
Mumbai	- Formulation of MP and FS, taking into consideration climate change (rainfall exceeding 55 mm/hr) - Based on the FS, drainage improvement projects will be implemented under JICA loan, including the construction of an underground stormwater discharge tunnel.	- Technical assistance for tackling landslides, seismic design, and the reuse of stormwater.
Pune	- Sixty spots improvement (DPR was approved: Rs.190 Cr).	- Sewerage and stormwater drainage (SWD) development for 11 villages (expanded area of PMC, DPR not prepared yet: Rs.390 Cr for Sewerage + Rs.600 Cr for SWD) - Improvement for 23 new villages (City plan required to be prepared: Rs.1,000 Cr)
Hyderabad	- Financial support to implement the Phase-2 project (approx. Rs.5,000 Cr) - Early flood warning system (Rs.57 Cr) - Preparation of DPR for Phase-2	- No request
Patna	- As of January 2024, a huge stormwater drainage project is being prepared using the state budget, so JICA's financial support is unnecessary at this moment.	- No request
Bhubaneswar	- Formulation of MP and FS for a flood-free	- No specific request but measures for

	city. - Based on the FS, drainage improvement projects will be implemented under JICA loan.	cyclone are needed.
Guwahati	- Financial support to implement the project at Baharalu basin (Rs.450 Cr) and other basins (except for Bahini and Hathinala) - Updating the MP and DPR	- No request

Source: JST

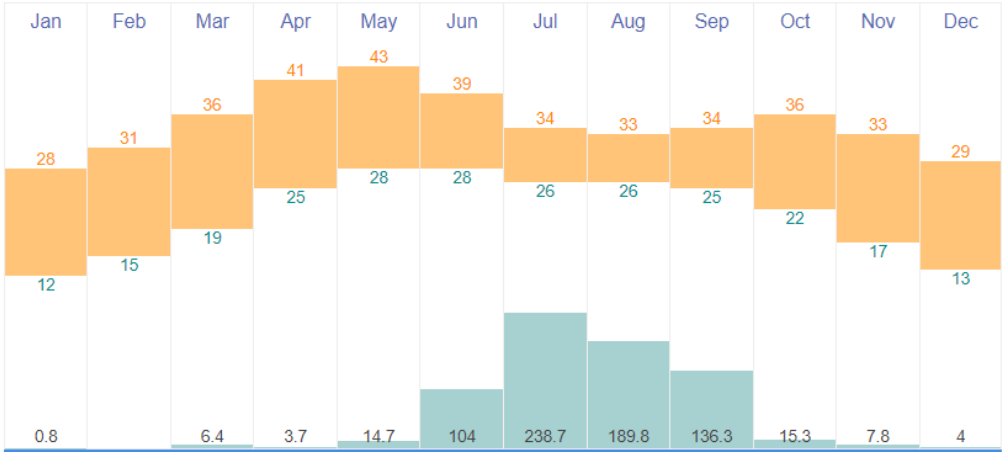
4.3 Assessment of Potential Projects

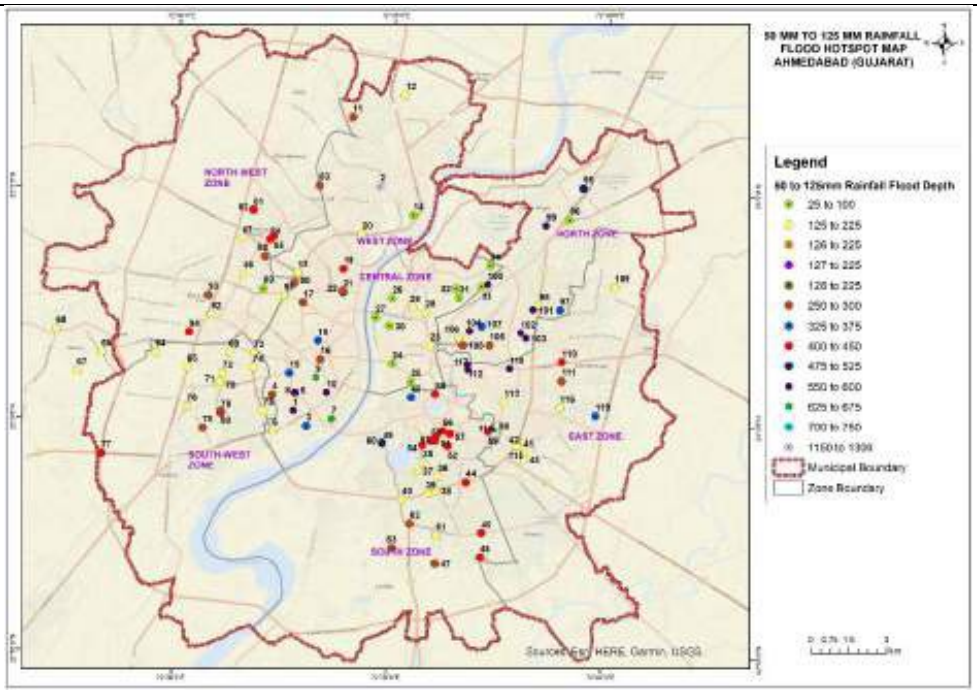
4.3.1 Analysis of Flooding in Longlisted Cities which Requested JICA's Support

As shown in Table 4.1.2, all longlisted cities have experienced flooding, with some cities facing severe floods. Floods include river flooding (overflow from rivers) and urban flooding (waterlogging when rainfall in urban areas exceeds the capacity of stormwater drainage facilities). River flooding is generally larger in scale, while urban flooding is relatively smaller in scale but more frequent. As cities develop, their impact (damage) on socio-economy tends to increase. Major phenomena include overflow from tributaries of the main river and flooding of low-lying areas. The causes of flooding include: i) insufficient drainage capacity due to rainfall exceeding the capacity of the facilities, ii) rising water levels of rivers to which the water is discharged, and iii) obstruction of flow due to sediment and solid waste accumulation (resulting from improper maintenance). In the longlisted cities, river levees have already been constructed.

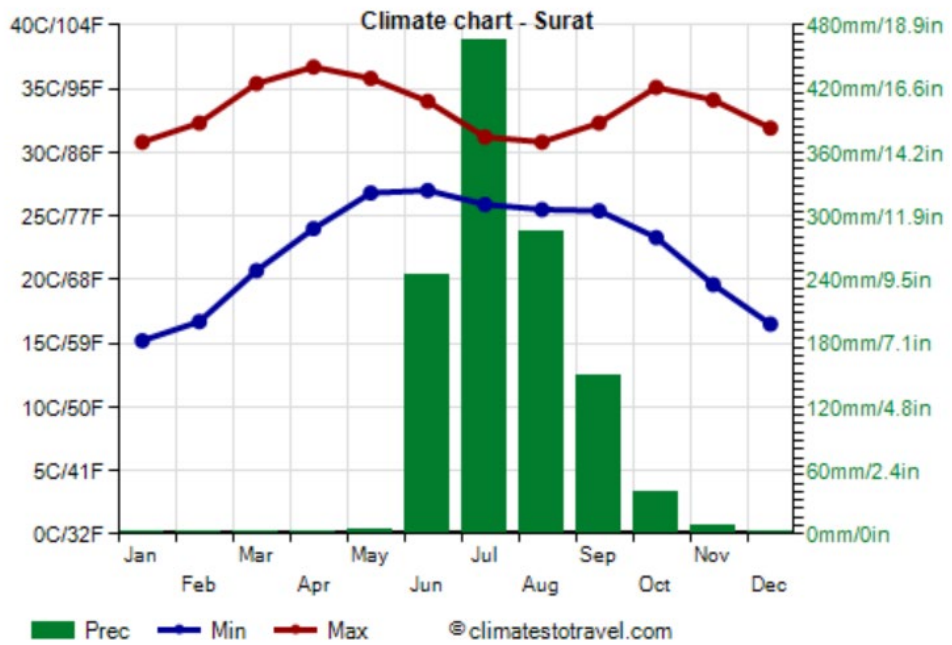
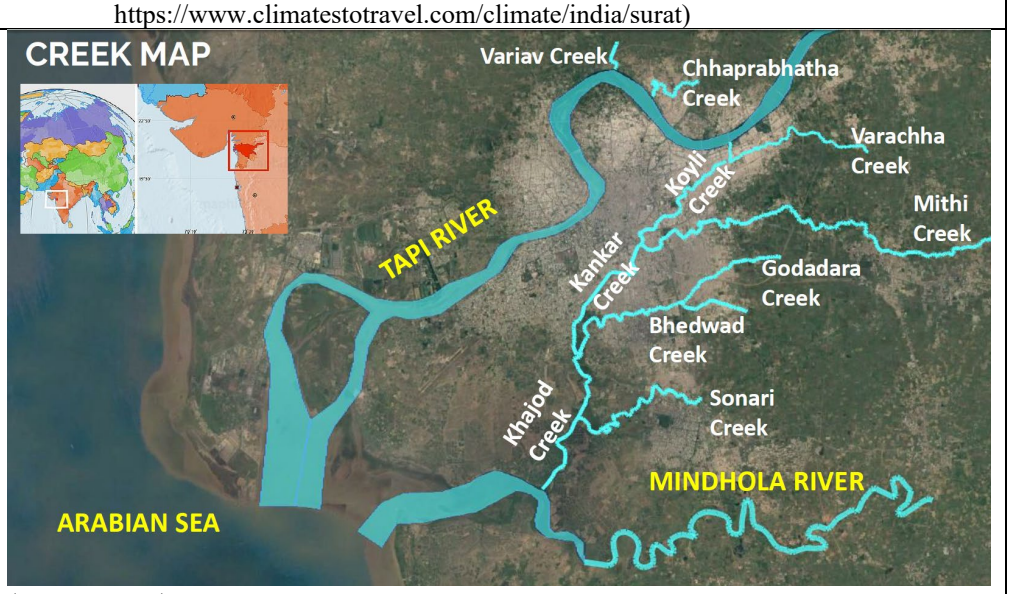
The flood extent, flood history, flood causes, and urban flood prevention measures for each city were analyzed based on available information, including data provided by each city, the EM-DAT (Disaster Database), and online sources. In addition, basic information on flood-affected areas, topographical details, precipitation data, and land use are summarized in Appendix 4.

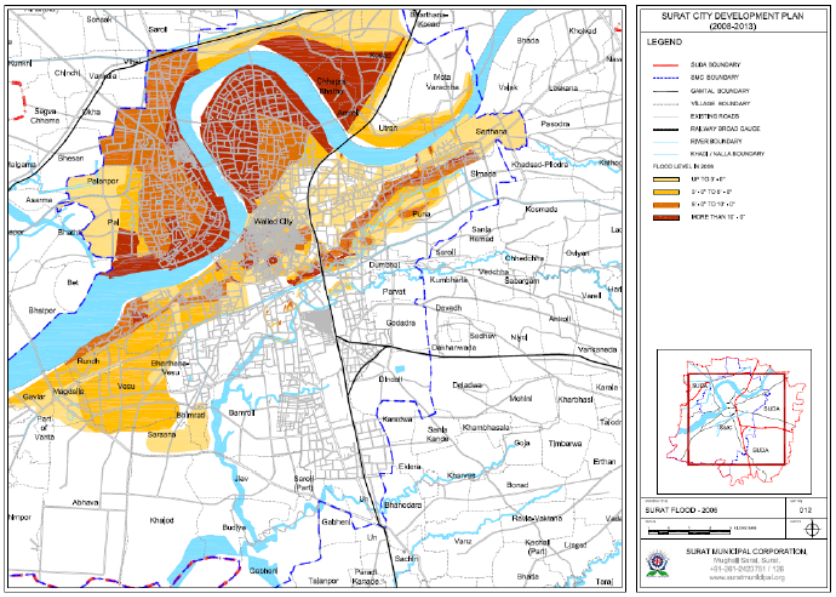
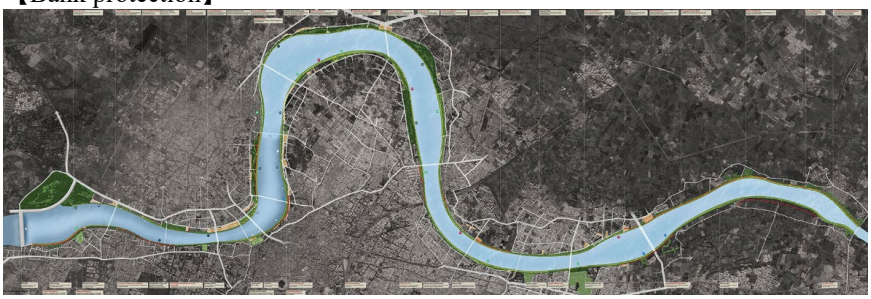
[Ahmedabad]

Item	Contents
Rainfall information	- Annual Precipitation: 721.7 mm - Annual Precipitation Graph: Based on weather reports collected during 2012–2021.  (Source: Time and Date https://www.timeanddate.com/weather/india/ahmadabad/climate)
River system map	 (Source: Project Proposal for Urban Flood Risk Management Programme under the National Disaster Management Authority (NDMA), 2023)
Flood area	- In July 2022, 159 locations across 47 wards were flooded after the rainfall, due to insufficient stormwater drainage facilities. - Flood spots were spread all over the cities and the flood spot under 50-125 mm rainfall was analyzed as follows:

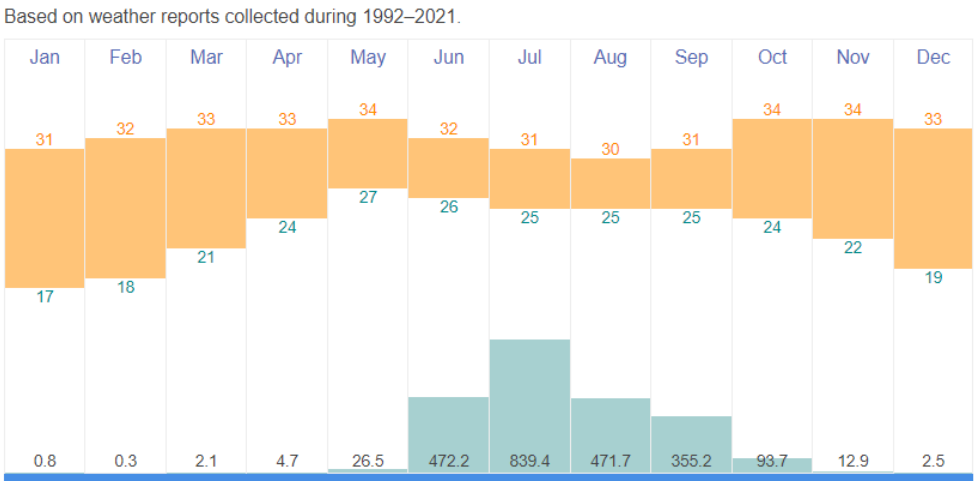
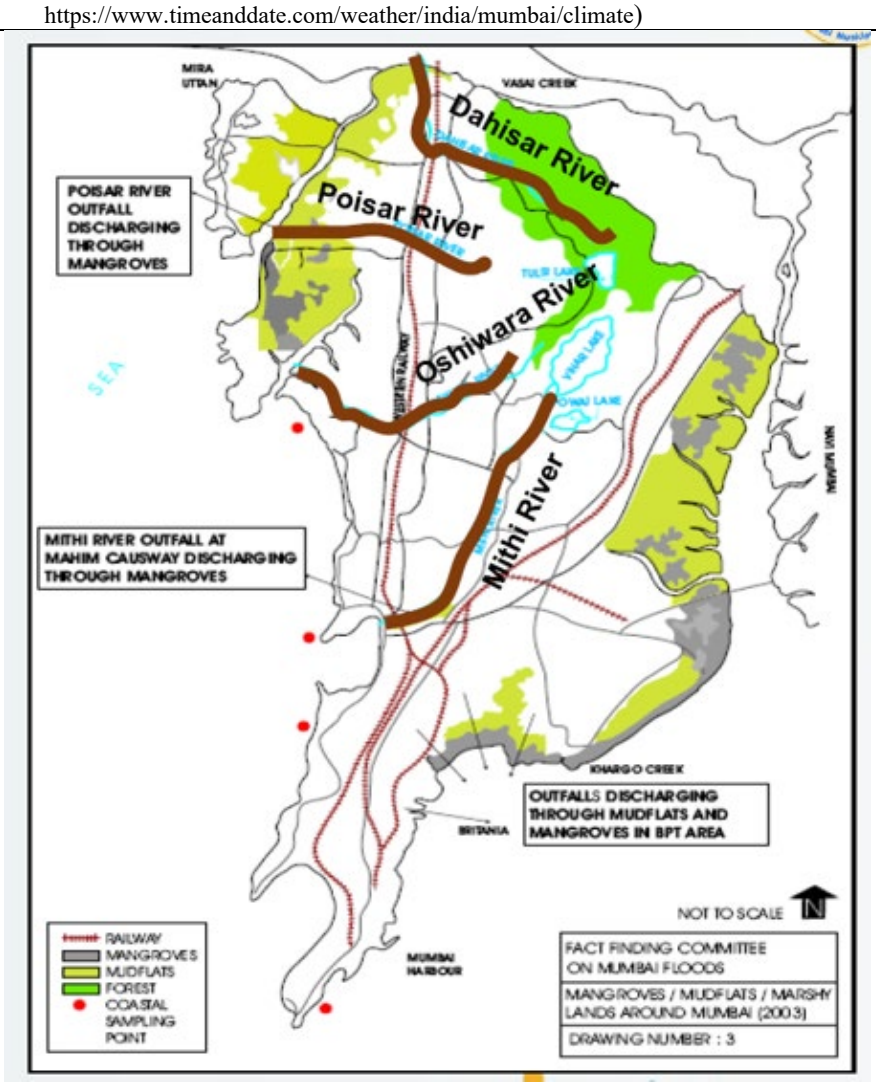
	 (Source: AMC) - Flood area in Flood Affected Area of India-Satellite based study: 233,388 ha
Number of flooding from 2000 to 2022 (Source: EM-DAT)	Four times (in 2005, 2006, 2017, 2022).
Cause of flooding	1) River Flooding: The Sabarmati River, which runs through the center of Ahmedabad, has undergone river improvement work as part of a waterfront development project, reducing the risk of river flooding. However, the flow capacity of its tributaries remains inadequate, and ongoing river improvement works are being made. 2) Urban Flooding: ・ The drainage channels in the central city does not have sufficient capacity, as the existing facilities are designed to only handle a 2-year rainfall return period. Additionally, flood control ponds are not functioning effectively due to their limited capacity. ・ Furthermore, drainage facilities have not been developed in the newly expanded urban areas. ・ Measures to address creeks are currently being implemented.
Economic loss of last flooding	- In 2005: US$3.447 billion (total for Gujarat, according to EM-DAT)
Measures for urban flooding	- The MP proposes both structural and non-structural measures with a total amount of Rs.8,271 Cr. - The DPR for the NDMA project proposes interlinking water bodies (lakes) to increase stormwater storage capacity, with total amount of Rs.275 Cr.

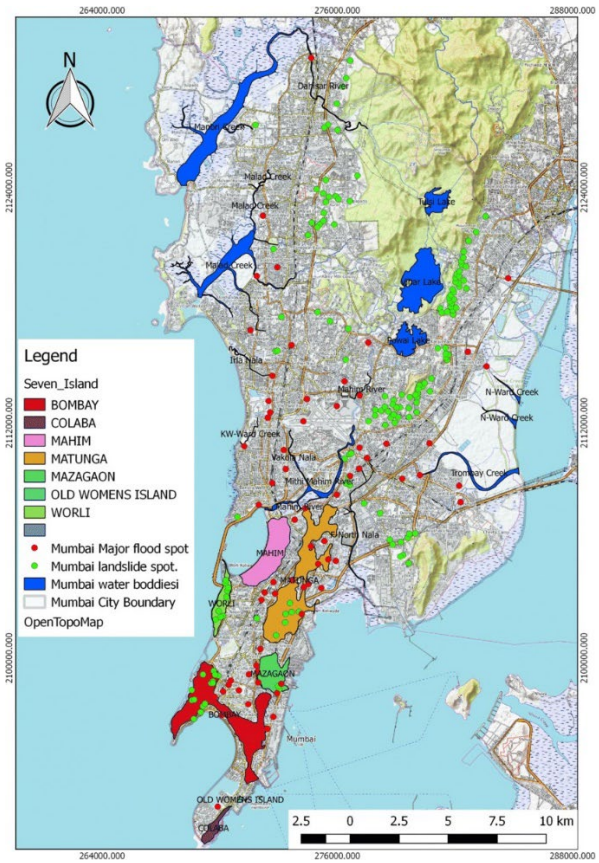
[Surat]

Item	Contents
Rainfall information	- Annual Precipitation: 1,205.0 mm - Annual Precipitation Graph:  (Source: Climate to Travel, World Climate Guide https://www.climatestotravel.com/climate/india/surat)
River system map	 (Source: SMC)
Flood area	In 2006, continuous rains caused severe flooding in Maharashtra (area shown in the figure below). The sluice gates of the Ukai Dam upstream were opened, resulting in a large amount of water continuously being discharged. This, combined with the high tide, caused flooding in the bend area of the Tapi River in Surat City and in certain parts of the creek.

	 FIGURE 13 SURAT FLOOD 2006 (Source: SMC) - Flood area in Flood Affected Area of India-Satellite based study: 212 ha
Number of flooding from 2000 to 2022 (Source: EM-DAT)	Four times (in 2005, 2006, 2015, 2016, 2017)
Cause of flooding	1) River Flooding: In 2006, the emergency release of water from the Ukai Dam upstream of the Tapi River during heavy rains coincided with a high tide, causing flooding in the city. However, the situation has improved since a World Bank-funded project was carried out to improve the bank protection and the establishment of a warning system. 【Bank protection】  2) Urban Flooding Flooding has occurred due to the insufficient drainage capacity of the creek. To address this, measures such as expanding the creek and installing pumping stations are being implemented.
Economic loss of last flooding	- In 2006: US$4.84 billion (Rs.21,000 Cr: preliminary estimation by Gujarat government). - In 2015: US$746 million (total in Gujarat and Maharashtra: EM-DAT).
Measures for urban flooding	- The main cause of the flood in 2006 was the release of water from the Ukai Dam upstream of the Tapi River during high tide. In response, the Tapi Riverfront Development Project (Phase I) is being implemented with support from the World Bank. • Phase I: Approximately Rs.2,982 Cr allocated for the construction of a 33 km-long riverbank, promenade, toilets, lighting, and other infrastructure. • Phase II: Includes development of an eco-park, recreational park, market, footbridges, and other public facilities. - Creek rejuvenation projects are currently being prepared.

[Mumbai]

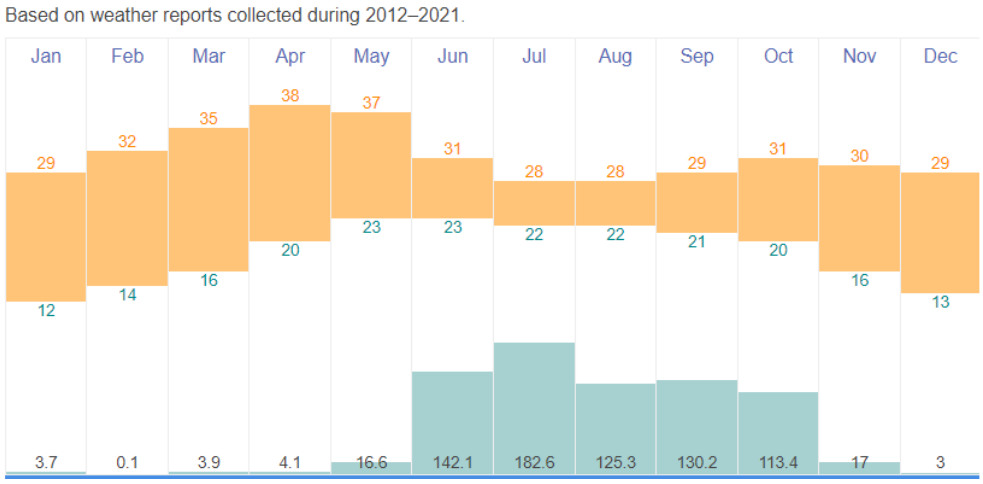
Item	Contents
Rainfall information	- Annual Precipitation: 2,282.0 mm - Annual Precipitation Graph:  (Source: Time and Date https://www.timeanddate.com/weather/india/mumbai/climate)
River system map	 (Source: Presentation on Measures Taken by BMC to Abate Flooding in Mumbai, for Meeting with the JICA Survey Team on 21/11/2023, BMC)

Flood area	- The 2005 floods impacted several parts of the Indian state of Maharashtra, including large areas of the metropolis Mumbai, where approximately 1,094 people died. The floods were caused by 944 mm of rainfall in 24 hours on July 26, 2005, marking it as the eighth heaviest rainfall ever recorded, continuing intermittently into the following day. The 12-hour rainfall between 8 AM and 8 PM was 644 mm (25.35 inches). - Although the worst serious flood took place in July 2005 on their record, floods occurred every year from 2004 to 2007, causing enormous loss and damage. According to the records from 2011-2020 show that Mumbai experiences 4-5 heavy rains per year. In particular, the frequency of heavy rains has increased since 2017. In low-lying areas, flooding occurs several times in a year and continues for several hours if it coincides with high tides, which tend to be occurred in western and central parts of the city, including Worli, Dadar, Kurla, and Andheri.  (Source: Major flood spots and landslide locations in Mumbai[1])
Number of flooding from 2000 to 2022 (Source: EM-DAT)	Seven times (in 2001, 2005, 2006, 2007 - twice, 2017, 2019)
Cause of flooding	1) River Flooding: The risk of flooding has not been eliminated due to the ongoing (not yet completed) Mithi River Improvement Project and restrictions on the drainage capacity of the culvert under the airport. 2) Urban Flooding Urban drainage facilities, including pumps, drainage channels, culverts, and pipes, were designed to handle a planned rainfall intensity of 55 mm/hr. While most measures have been implemented, flooding still occurs when rainfall exceeds this capacity. 3) Cyclones

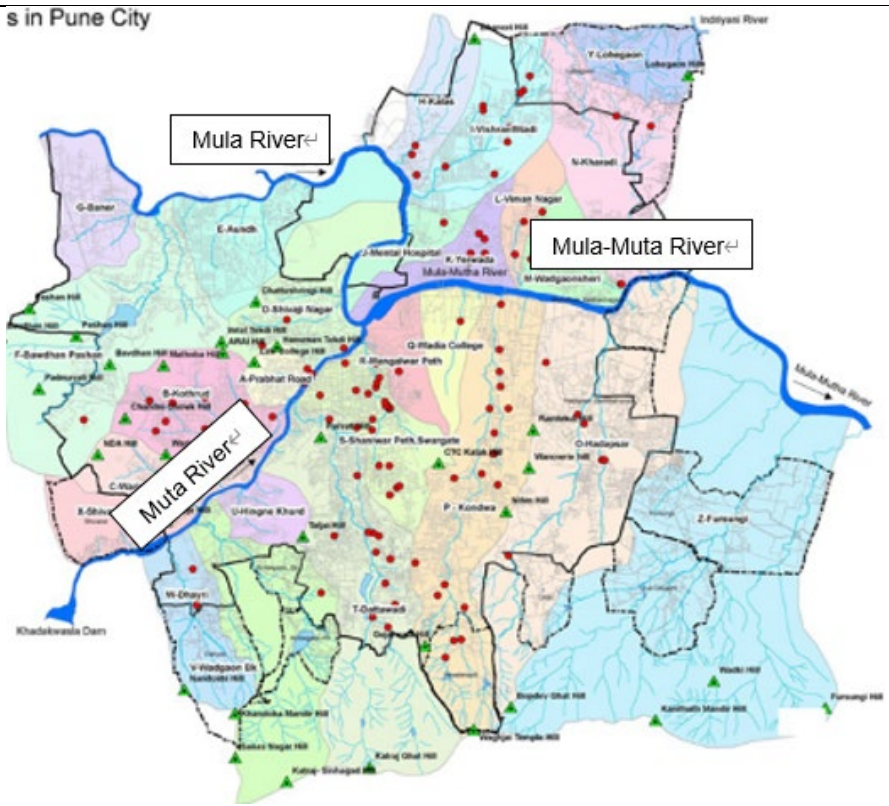
1 ResearchGate: https://www.researchgate.net/figure/Major-flood-spots-and-landslide-locations-in-Mumbai_fig14_338391464

	Being a coastal city, there is still a pertinent risk of flooding due to high tides caused by cyclones.
Economic loss of last flooding	- In 2005: US$690 million (Source: THE CONVERSATION[2]) and US$4.99 billion (total in Gujarat, Madhya Pradesh, Maharashtra, Goa, Orissa, Karnataka, Himachal Pradesh, Jammu, and Kashmir: EM-DAT) - In 2017: US$358 million (total in Maharashtra: EM-DAT)
Measures for urban flooding	- To address flooding in Mumbai, several projects have been implemented to improve and construct SWD facilities and networks, such as pumping stations and stormwater holding ponds. - The existing capacity of SWD network is 55 mm/hr. Further measures are needed to reduce the risk of flooding due to the impact of climate change.

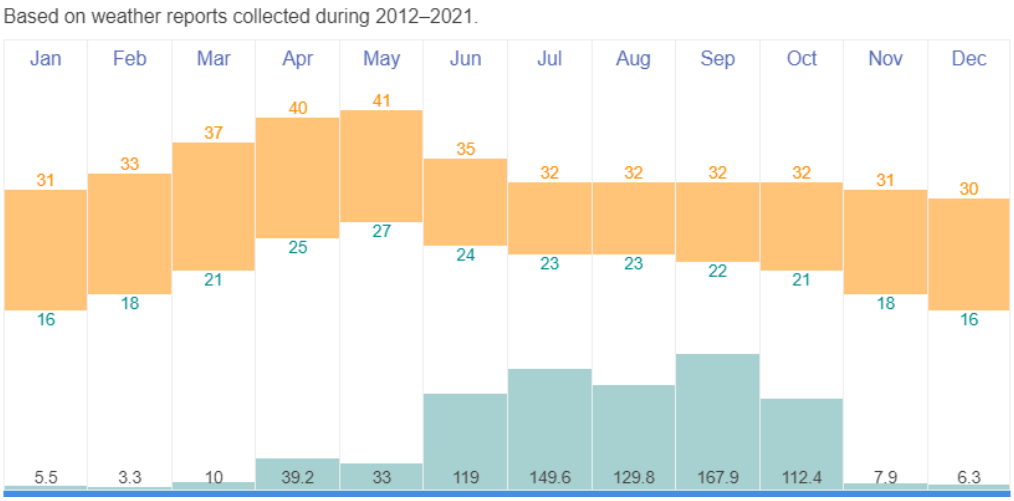
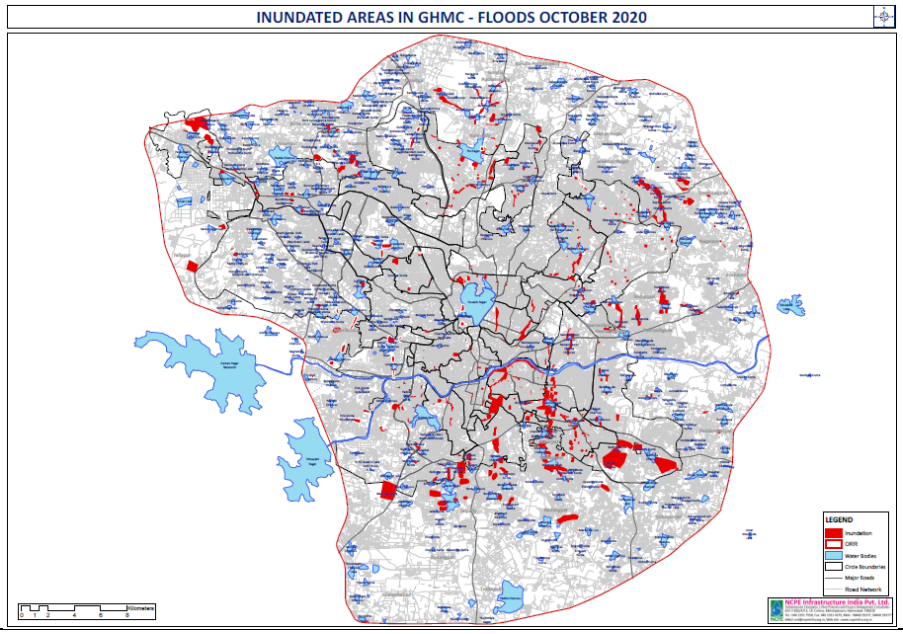
[Pune]

Item	Contents
Rainfall information	- Annual Precipitation: 742.0 mm - Annual Precipitation Graph:  (Source: Time and Date https://www.timeanddate.com/weather/india/pune/climate)
River system map and flood area	- In 2021-2022, Pune City experienced heavy rainfalls of more than 100 mm and 143 locations all over the city were flooded in 2022 as shown below. - Pune City has been subject to frequent flooding, with frequent rainfall from 2021 to 2022, and 143 locations across the city were flooded in 2022, as shown below. Flooding occurred within two hours of rainfall.

2 THE CONVERSATION: https://theconversation.com/mumbai-floods-what-happens-when-cities-sacrifice-ecology-for-development-83328

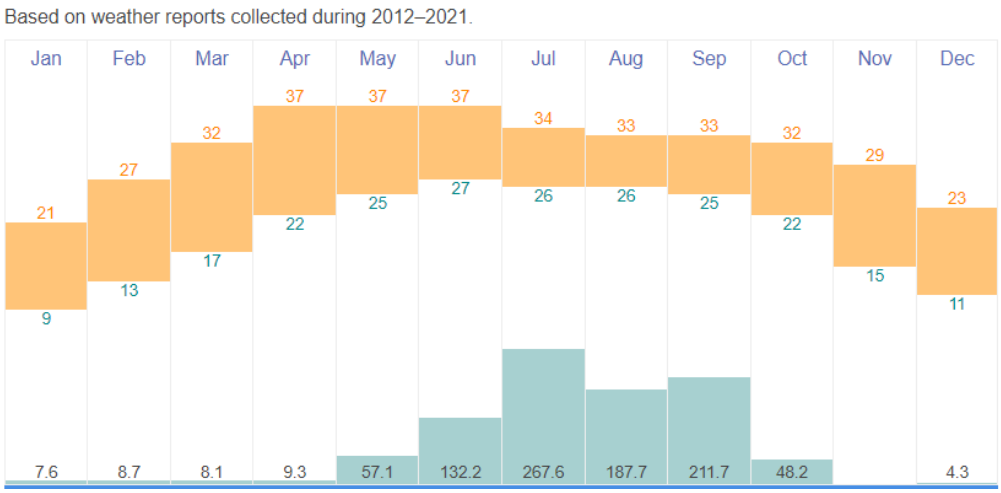
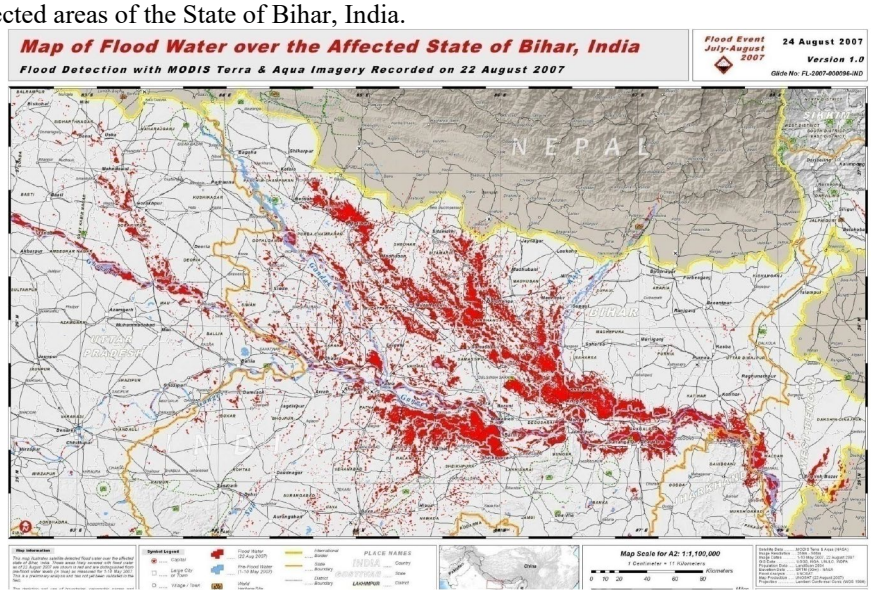
	 (Source: PMC)
Number of flooding from 2000 to 2022 (Source: EM-DAT)	7 times (in 2006, 2007, 2016, 2019 - twice, 2020, 2021)
Cause of flooding	1) River Flooding: The water level of the Mula River rises due to the release of water from the Hadakwasla Dam upstream. However, the risk of river flooding is low due to the relatively sloping terrain. 2) Urban Flooding: Inland flooding occurs during heavy rainfall due to insufficient flow capacity of the Mula Muta River tributaries. Additionally, the area suffers from inadequate road drainage, which exacerbates the situation. To address these issues, the construction of creeks, drainage culverts, and drainage pipes is planned as part of the flood mitigation efforts.
Economic loss of last flooding	- In 2020: more than US$24 million (Rs.200 Cr (Source: Hindustan times https://www.hindustantimes.com/) and US$927 million (total in Maharashtra, source: EM-DAT).
Measures for urban flooding	- The DPR for the NDMA project has been approved, and flood control work is scheduled to begin. - The NDMA budget cannot cover all the construction work, and an additional budget (Rs.191.5 Cr) is needed. - The existing urban drainage master plan does not meet the planning conditions of the latest CPEHEEO manual and will be updated in the future.

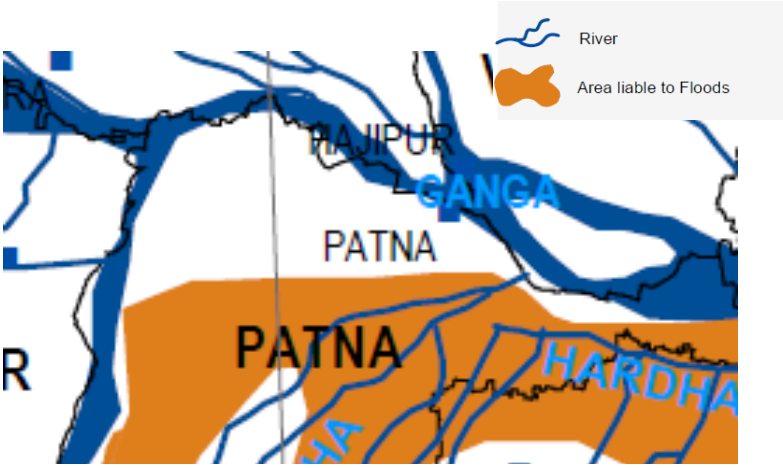
[Hyderabad]

Item	Contents
Rainfall information	- Annual Precipitation: 783.9 mm - Annual Precipitation Graph:  (Source: Time and Date https://www.timeanddate.com/weather/india/hyderabad/climate)
Flood area	- A series of floods resulted in extensive damage and loss of life due to flash flooding in Hyderabad in October 2020. Among the most affected areas were Balapur, L. B. Nagar, parts of the Old City such as Hafiz Baba Nagar, Al Jubail Colony, Omer Colony, Osman Nagar, Nabeel Colony, Falaknuma, and Chaderghat. The damage was estimated at Rs.900 Cr. - On October 18, 2020, a second cyclone killed two more people in Hyderabad. Over 37,000 families were affected by the second flood. Rainfall reached over 300 mm in six hours, out of the mean annual rainfall of 827.2 mm. This resulted in over 80 people losing their lives and about 40,000 families being displaced, and post rain gathering up to 20,000 tons of waste. - Flood area during the 2020 rainfall is shown in the figure below. 
Number of flooding from 2000 to 2022	Ten times (in 2000, 2005, 2006, 2008, 2014, 2016, 2019, 2020, 2021 - twice)

(Source: EM-DAT)	
Cause of flooding	1) River Flooding: The Musi River, which runs through the center of the city, has sufficient flow capacity, with two flood-regulating ponds upstream: Osman Sagar and Himayat Sagar. Therefore, the risk of river flooding is not so high. 2) Urban Flooding: Urban flooding (waterlogging) occurs as the flow capacities of the drainage channels and the connections of the regulating ponds are insufficient.
Economic loss of last flooding	- In 2020: US$135 million (Rs.900 Cr) and US$4.523 billion (total loss in Telangana, Andhra Pradesh, Karnataka, Odisha: EM-DAT)
Measures for urban flooding	- As per the master plan, the Phase 1 project, which is primarily for the interconnection of lakes, has been implemented, and almost 90% of the work has been completed, with a project cost of about Rs.1,000 Cr. - The Phase 2 project, estimated at more than Rs.2,000 Cr, also needs to be implemented. - The Strategic Nala Development Programme, a project mainly for interconnection of lakes, has been formulated in line with the MP.

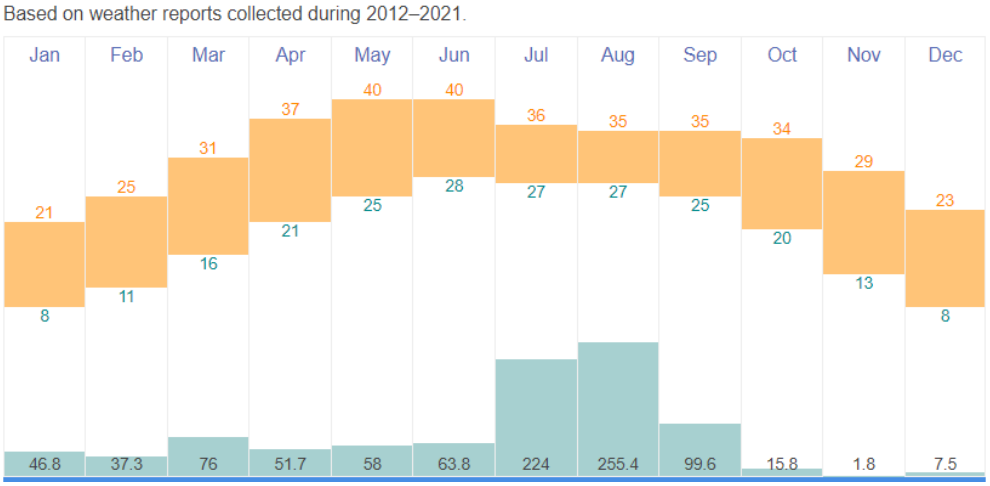
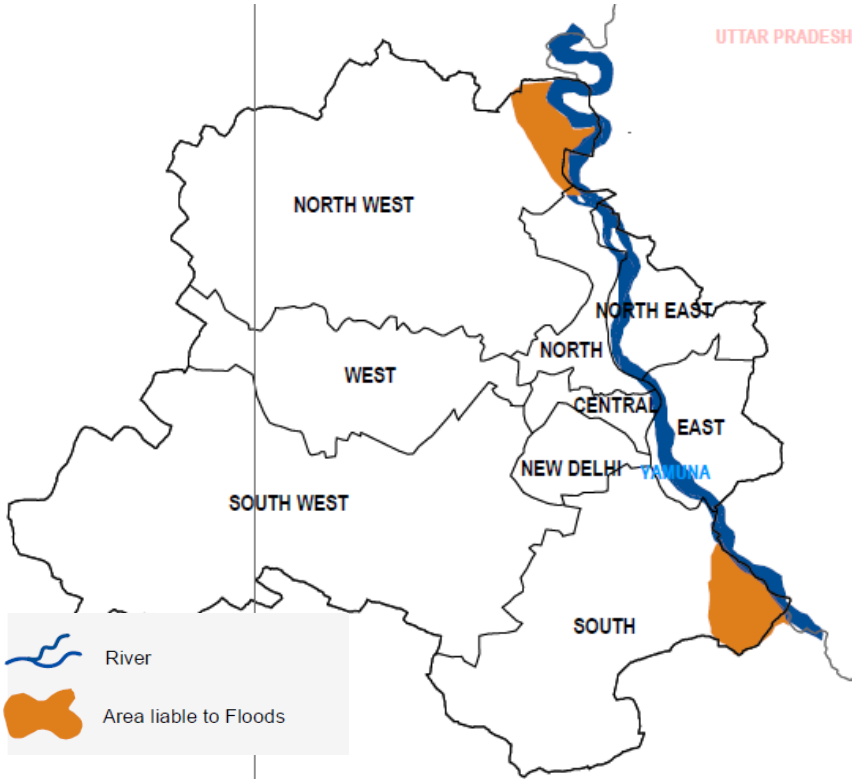
[Patna]

Item	Contents
Rainfall information	- Annual Precipitation: 942.5 mm - Annual Precipitation Graph:  (Source: Time and Date https://www.timeanddate.com/weather/india/patna/climate)
Flood area	- Patna falls within a flood-risk zone. The planning area is situated along the middle course of the Ganges River, where the vulnerability to flooding is very high. This vulnerable position has caused immense damage to the planning area. The Punpun River causes significant flood damages to the east of the Patna planning area. A series of bunds and embankments have been constructed along Punpun River to control the floodwaters. Map 2 shows the flood-affected areas of the State of Bihar, India.  (Source: PMC, Patna Master Plan 2031)

	 (Source: BMTPC Vulnerability Atlas of India[3]) - Flood area in Flood Affected Area of India-Satellite based study: 170,333 ha
Number of flooding from 2000 to 2022 (Source: EM-DAT)	11 times (in 2001, 2002, 2007, 2008, 2011, 2012, 2016 - twice, 2017, 2019, 2021)
Cause of flooding	1) River Flooding: The Ganges River used to flood, but since embankments were built, it appears that flooding has not occurred. 2) Inland Flooding: Inland flooding has occurred due to insufficient capacity of pumping stations, creeks, drainage culverts, and drainage pipes (a budget for countermeasures has been allocated).
Economic loss of last flooding	- In 2016: US$426 million (total in Bihar, Uttar Pradesh: EM-DAT).
Measures for urban flooding	- An urban drainage improvement project, with a budget of Rs.982 Cr, is to be implemented under the state budget of Bihar. It will be carried out by BUIDCO.

[3] BMTPC Vulnerability Atlas of India : https://www.bmtpc.org/DataFiles/CMS/file/VAI2019/flood.html

[Delhi]

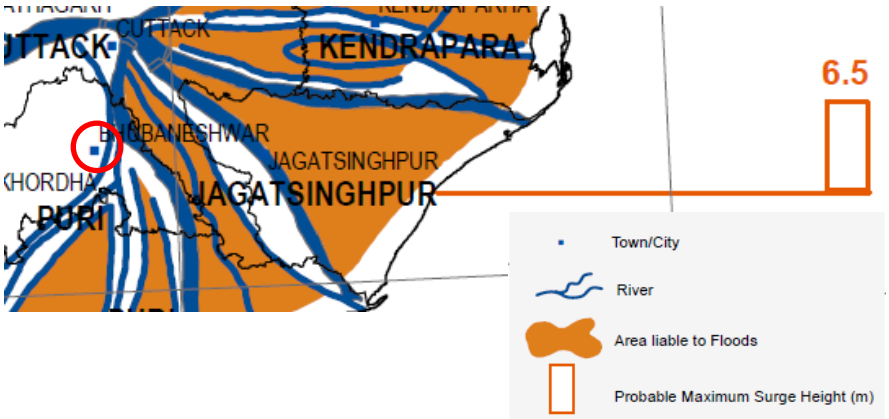
Item	Contents
Rainfall information	- Annual Precipitation: 937.7 mm - Annual Precipitation Graph:  (Source: Time and Date https://www.timeanddate.com/weather/india/new-delhi/climate)
Flood area	 (Source: BMTPC Vulnerability Atlas of India) - Flood area in Flood Affected Area of India-Satellite based study: 5,848 ha
Number of flooding from 2000 to 2022 (Source: EM-DAT)	Six times (in 2001, 2009, 2010, 2014, 2019, 2021)
Reason of	- River Flooding: Not expected, as the Yamuna River, which flows through the center of the

flooding	city has enough capacity and the flood-prone area is near its tributary. - Urban Flooding: This occurs due to insufficient capacity of pumps, creeks and drainage culvert/pipes. Measures are in progress.
Cause of flooding	1) River Flooding: In low-lying areas near the Yamuna River, which flows through the center of the city, river flooding frequently occurs due to monsoon rainfall. In July 2023, monsoon rainfall of 153 mm/day caused large-scale flooding in the Yamuna River basin. Delhi was also flooded, including low-lying and important areas, and at least 16,000 residents were forced to evacuate (Source: FloodList[4]). 2) Urban Flooding The city's urban drainage facilities were designed to withstand rainfall of 50 mm/hr, and are frequently flooded when rainfall exceeds this threshold. (Source: India Today[5])
Economic loss of last flooding	- In 2021: US$1.512 billion (total in Kerala, Karnataka, Goa, Maharashtra, Gujarat, Rajasthan, Delhi, Haryana, Uttar Pradesh, Uttarakhand: EM-DAT)
Measures for urban flooding	- The existing urban drainage master plan is designed to handle rainfall of 50 mm/hr; however, rainfall of greater magnitude occurs, causing flooding (Source: India Today[2]. - The Draft Drainage Master Plan for NCT of Delhi was formulated in 2018 and published on the website of the Irrigation and Flood Control Department, Government of NCT of Delhi. However, it is still in the "draft" stage, and the specific project name is unknown.

[4] FloodList: https://floodlist.com/asia/india-floods-delhi-july-2023

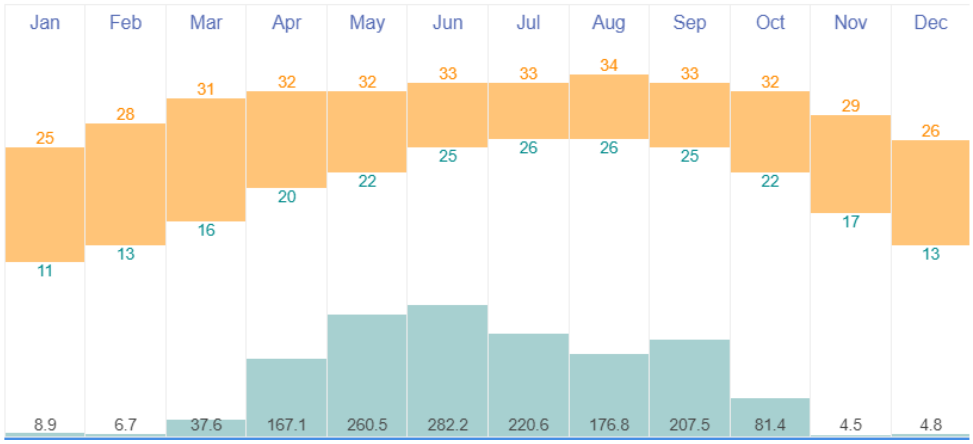
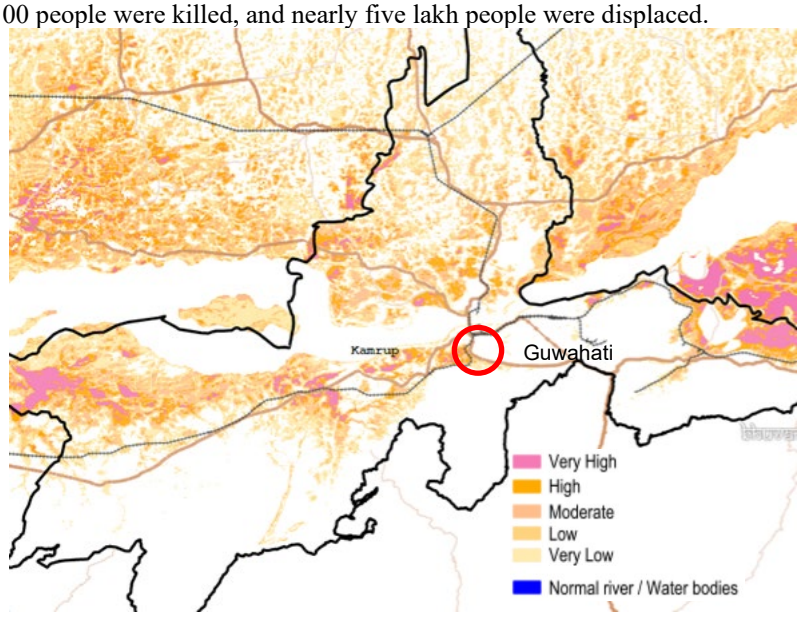
[5] India Today: https://www.indiatoday.in/cities/delhi/story/delhi-waterlogging-flooding-monsoon-rains-2560487-2024-07-01

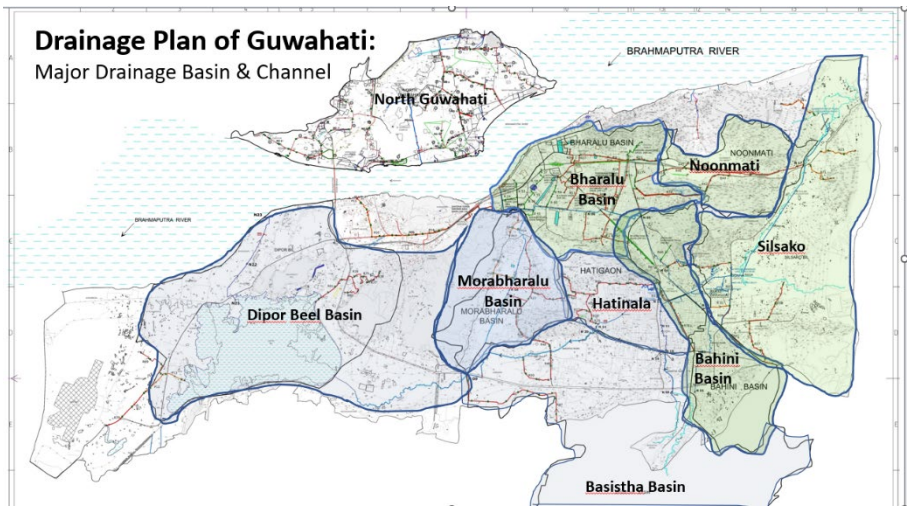
[Bhubaneswar]

Item	Contents
Rainfall information	- Annual Precipitation: 1,394.3 mm - Annual Precipitation Graph: (Source: Time and Date https://www.timeanddate.com/weather/india/bhubaneshwar/climate)
Flood area	- Waterlogging occurred in Ward No. 4, along NH16 (underpass, Jaydev Vihar, and ISKCON Temple), and in the suburban area.  (Source: BMTPC Vulnerability Atlas of India) - Flood area in Flood Affected Area of India-Satellite based study: 73,503 ha - In July 2024, monsoon rainfall of 195 mm/day occurred, and it caused flooding in several low-lying areas in Bhubaneswar City.
Number of flooding from 2000 to 2022 (Source: EM-DAT)	Five times (in 2001, 2007 - twice, 2011, 2014)
Cause of flooding	1) River Flooding: Flood-prone areas are located along national highways, so river flooding is not expected. 2) Urban Flooding: Inland flooding is occurring due to insufficient capacity and maintenance of urban drainage facilities, illegal occupation near drainage channels, inadequate urban drainage planning, and other factors. (Source: Indian Express[6])
Economic loss of last flooding	- In 2011: US$1.21 billion (total in Odisha: EM-DAT).
Measures for urban flooding	- BMC has identified over 70 locations vulnerable to flooding and will take mid- to long-term measures (MP and DPR for countermeasures have been prepared).

[6] Indian Express: https://www.newindianexpress.com/cities/bhubaneswar/2021/Jun/23/heavy-rain-triggers-urban-deluge-in-bhubaneswar-exposes-citys-shoddy-monsoon-preparedness-2320327.html

[Guwahati]

Item	Contents
Rainfall information	- Annual Precipitation: 1,458.4 mm - Annual Precipitation Graph: Based on weather reports collected during 2012–2021.  Source: Time and Date https://www.timeanddate.com/weather/india/guwahati/climate
Flood area	- Guwahati has a long history of flooding. The 1954 flood was the worst, with over 1,000 people killed. The 2012 flood, caused by heavy rains, resulted in significant destruction. Over 100 people were killed, and nearly five lakh people were displaced.  (Source: India Geo-Platform of ISRO, Flood Hazard https://bhuvan-app1.nrsc.gov.in/disaster/disaster.php?id=flood_hz) - Flood area in Flood Affected Area of India-Satellite based study: 22,564 ha - In March 2023, 167.8 mm of rainfall over two days caused flooding in various parts of the city.
Number of flooding from 2000 to 2022 (Source: EM-DAT)	Seven times (in 2002, 2004, 2012, 2013, 2014, 2015, 2019)
Cause of flooding	1) River Flooding: The Brahmaputra River, which runs through the center of the city, used to be a major flooding area, but the frequency of such floods has decreased due to the construction of

	embankments. 2) Urban Flooding: The Brahmaputra River tributaries (urban drainage channels) have insufficient flow capacity, and the drainage channels and pipes are also poorly maintained, which causes urban flooding (waterlogging). - Although there are no quantitative records in the EM-DAT, flooding occurs frequently in most parts of Assam.
Economic loss of last flooding	- There is no quantitative record in EM-DAT, but flooding occurs frequently in major parts of Assam.
Measures for urban flooding	- Drainage measures are planned for the entire city, covering a total of eight basins. - The ADB has announced that it will give priority to supporting the two basins shown in the figure below. However, at the time of the survey, the supporting agency for the remaining six basins had not yet been decided. (Note: During the second field survey, the state government confirmed that the ADB would support urban drainage measures for the entire city.) 

4.3.2 Assessment of Existing Master Plan Prepared by Longlisted Cities

(1) Requirements in the CPHEEO Design Guideline

The design guideline for the stormwater drainage system in India is the "Manual on Storm Water Drainage System, Central Public Health and Environmental Engineering Organization (CPHEEO)" which was published in August 2019. In the guideline, the following requirements are indicated:

2.12 City Drainage Master Plan

Drainage Master Plan is usually prepared for big cities as their coverage at one time may not be financially feasible due to huge cost investment. The master plan provides a broader framework of the system such as broad layout plan and other system components, outfall locations, rainfall characteristics enunciating the design criteria, outline and brief description of system components. The drainage master plan should be prepared in consonance with the City Master Plan, keeping in view the land use plan of the city. Broad cost estimates are also framed for clearance and approval of master plan by competent authorities. Its main objective is to direct and control DPR formulation consistent and conducive with the master plan framework and provision so that future sectorial development of storm drainage infrastructure should function as whole system of master plan rather than separate part.

2.13 Preparation of Reports

Identification and Pre-Feasibility Reports are prepared before framing of detailed project report which is oriented to get initial approvals to proceed on preparation of DPRs. The approach for preparation of Identification and Pre-Feasibility report are adequately explained in Chapter 3 of Manual on Sewerage and Sewage Treatment, 2013 of Part A: Engineering, and can be referred.

1.9.3 Pre-Feasibility Report

A pre-feasibility report can be taken to be a Preliminary Project Report, the structure and component of which are as follow:

i) Executive summary

ii) Introduction

iii) The project area and the need for a project

iv) Long term plan for sewage collection, treatment, and disposal (stormwater drainage)

v) Proposed sewage collection, treatment and disposal project (stormwater drainage project)

vi) Conclusions and recommendations

vii) Tables, figures/maps and annexes

Regarding the planning conditions, the design return period is proposed in Table 4.1 in the manual as follows:

Table 4.1: Recommended Design Return Period for various types of urban catchments

S. No.	Urban Catchment	Return Period	
		Class I Cities**	Other cities***
1.	Central Business and commercial	Once in 5 years	Once in 2 years
2.	Industrial	Once in 5 years	Once in 2 years
3.	Urban Residential	Once in 5 years	Once in 2 years
4.	Airports and other critical infrastructure*	Once in 100 years	Once in 50 years

*Critical infrastructure includes Railway Stations, Power stations, etc.
** Class I Cities are cities having population 1 Lakh and above
*** Other cities are cities having population less than 1 lakh
Note:

1. It may not be always feasible to design / retrofit the storm water drains for the recommended return period in all the cities. In cases where redesigning / retrofitting is not feasible as per recommended return period due to city profile / site constraints, efforts should be made to adopt recommended return period by adopting 'Best Management Practices, (BMP) like in-situ rainwater harvesting methods within premises / plots, along the storm water channels / conduits and storm retention/ detention structures to accommodate the excess runoff. However, the preferred return period shall be as per those recommended in the Table 4.1 above.
2. Under exceptional circumstances, a high-powered committee constituted by State / UT Government through a notification may justify the adoption of higher return period considering techno-economical and socio-environmental conditions than the one recommended in Table 4.1 after exploring various other available options to meet the design requirements.

(2) Status of Preparation of Drainage MP in Longlisted Cities

The status of master plan preparation as of January 2024 is as follows:

Table 4.3.1 Status of Urban Drainage Master Plan Preparation

MP Preparation Status	City
Urban drainage MP has been prepared in accordance with the latest CPHEEO manual	Hyderabad (GHMC), Patna (BUIDCO)
Urban drainage MP has been prepared, but does not comply with the latest CPHEEO manual	Mumbai (MCGM)
Urban drainage MP is currently being prepared	Ahmedabad (AMC)
Urban drainage MP will be prepared in the future	Guwahati (GMDA), Pune (PMC)*
No plans to prepare urban drainage MP	Bhubaneswar (BMC) and Surat (SMC)

Source: JST
Note: Pune will prepare MP under NDMA budget.

Among the cities, the formulation of MP was requested by Mumbai (MCGM) and Bhubaneswar (BMC) from JICA. Particularly in Mumbai, MCGM has been implementing development of drainage facilities based on the existing MP (BRIMSTOWAD-II), but in view of recent climate change, it is necessary to update the MP to a higher drainage facility level by utilizing Japanese technology. For the implementation of ODA project, an acceptable MP is indispensable to ensure the quality of the project. The existing MP is assessed as follows:

[Mumbai]

The urban drainage master plan, known as BRIMSTOWAD-I, was prepared in 1993 with a target capacity of 25 mm/hr, and BRIMSTOWAD-II was prepared in 2018 with a target capacity of 55 mm/hr. However, the urban drainage MP should be updated in accordance with the latest CPHEEO manual. Additionally, the master plan requested from MCGM, which considers climate change, will apply a higher rainfall probability than the recommended condition in Table 4.1. The application of higher planning condition will be justified by a high-powered committee constituted by Maharashtra State.

[Ahmedabad and Hyderabad]

For both municipal corporations, the drainage MP was prepared after the publication of the CPHEEO manual (2019). Therefore, the proposal for the MP is assumed to be sufficient to implement the subsequent projects based on the plan.

4.4 Selection of Priority Cities

4.4.1 Selection Criteria of Priority Cities

The longlisted cities were evaluated based on the criteria in Table 4.4.1. For each evaluation item, the situation of the city was assessed and scored as "High (score: 3)", "Middle (score: 2)", or "Low (score: 1)". Each score was multiplied by the "Rate", which was defined based on the importance of each evaluation item or criteria.

Table 4.4.1 Criteria and Score to Select Priority Cities

Category	Evaluation Item/Criteria	Rate
Economic and appealing impact	Economic impact (Project scale)	2
	Appealing impact-1: Number of Japanese companies in the city	1
	Appealing impact-2: Possibility to utilize Japanese technologies	1
Reduction of economic loss by the project	Effectiveness of disaster risk reduction (Loss and Damage)	3
Capacity of implementing agency	Organization for urban flooding	1
	Experience of organization	1
Project timeline	Availability of MP or FS	2
	Consensus with the JICA Project Scheme	2
Related future development plan	Availability of the related plan	1
Project implementation with another donor or financial scheme in India	Ongoing project with another donor Ongoing project under another financial scheme	2
Request from implementing agency	Request for JICA's assistance from the Indian agency	3
Social considerations	Necessity of land acquisition and resettlement	1

Source: JST

The details of each evaluation criterion are as follows:

(1) Economic and Appealing Impact

Considering the importance of the project scale and the impact of Japanese companies, the following evaluation criteria were selected: i) Economic impact (project scale), ii) Number of offices of Japanese companies in the city as Appealing impact-1, and iii) The possibility of utilizing Japanese technology as Appealing impact-2. The evaluation was conducted in three categories: "High", "Middle", and "Low", with scoring as follows:

Evaluation Item	Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Economic impact (project scale)	2	Project cost (C) is greater than or equal to US$200 million (US$200 million ≦ C)	Project cost (C) is greater than or equal to US$100 million and less than US$200 million (US$100 million ≦ C < US$200 million)	Project cost (C) is less than US$100 million (C < US$100 million)
Number of offices of Japanese companies in the city	1	The number of offices of Japanese company (N) is greater than or equal to 300. (300 ≦ N)	The number of offices of Japanese company (N) is greater than or equal to 100 and less than 300. (100 ≦ N < 300)	The number of offices of Japanese company (N) is less than 100. (N < 100)
Possibility to utilize Japanese technology	1	- Large-scale underground stormwater tunnel can be proposed. - Plastic media for stormwater storage and filtrate facility can be proposed.	- Plastic media for stormwater storage and filtrate facility is proposed.	- Left scope is not included

(2) Reduction of Economic Loss by the Project

The economic impact of the project was evaluated based on the economic loss or mortality from the past flooding, as detailed below.

Evaluation Item	Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Effectiveness of disaster risk reduction (Damage and Loss)	3	- There was mortality due to flood, or - The economic loss from flood (L) is greater than or equal to Rs.1,000 Cr. (Rs.1,000 Cr ≦ L)	- The economic loss from flood (L) is greater than or equal to Rs.500 Cr and less than Rs.1,000 Cr. (Rs.500 Cr ≦ L < Rs.1,000 Cr)	- Economic loss from flood (L) is less than Rs.500 Cr. (L < Rs.500 Cr)

(3) Capacity of Implementing Agency

The capacity of the implementing agency was evaluated based on two items: i) organization of urban flooding and ii) experience of the organization, as outlined below.

Evaluation Item	Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Organization of urban flooding	1	- There is an independent organization to manage urban flooding with sufficient human resources.	- There is an independent organization to manage urban flooding, but additional human resources will be	- There is no independent organization to manage urban flooding.

			needed to implement the ODA project.	
Experiences of the organization	1	- Experience of JICA ODA loan project	- Experience of another international donor project	- Experience of GOI funded project only

(4) Project Timeline

Each municipal corporation has to prepare a master plan (MP) or feasibility study (DPR) to implement the project for reducing the disasters. For the formulation of the project to be supported by JICA, it is evaluated by: i) availability of MP or DPR and ii) whether the schedule to formulate the JICA project will be in harmony with the schedule based on the MP or DPR.

Evaluation Item	Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Availability of master plan or feasibility study (DPR)	2	- The master plan is available, or - The DPR of the priority project is available where ODA is requested.	- A related plan is available.	- No plan is available.
Consensus with the JICA project scheme:	2	- The schedule of procedure in Japan to formulate the loan will match with the expected schedule of Indian authorities.	- The schedule of procedure in Japan to formulate the loan will cause a delay, but it is assumed to be acceptable.	- The schedule of procedure in Japan to formulate the loan will NOT match with the expected schedule of Indian authorities.

(5) Related Future Plan

The availability of the related MP or DPR will be evaluated. The cities with specific plans are highly valued.

Evaluation Item		Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Availability of related plan		1	- Execute a river improvement project that can positively impact the urban drainage project.	- There is potential for future projects, such as the expansion of the jurisdiction of the MC.	- No related projects.

(6) Project with Another Donor or Financial Scheme in India in Urban Drainage Sector

The existence of an urban drainage project under financial support from another donor or under another financial scheme in India was considered as follows:

Evaluation Item	Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Ongoing project with another donor or under another financial scheme	2	- No project and JICA's support is needed.	- A project under state budget of India is ongoing.	- International organizations' assistance projects are underway.

(7) Requests from the Implementation Agency

Regarding the position of the person requesting assistance from each city to JICA, the higher the position, the easier it is to reach an agreement. A higher position receives a higher rating.

Evaluation Item	Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Position of JICA assistance requester	3	- Executives of the state, such as the minister or deputy minister.	- Municipal commissioner or additional municipal commissioner.	- Officials of the municipal commissioner.

(8) Social Considerations

The need for land acquisition or resettlement in order to implement the project is evaluated as follows:

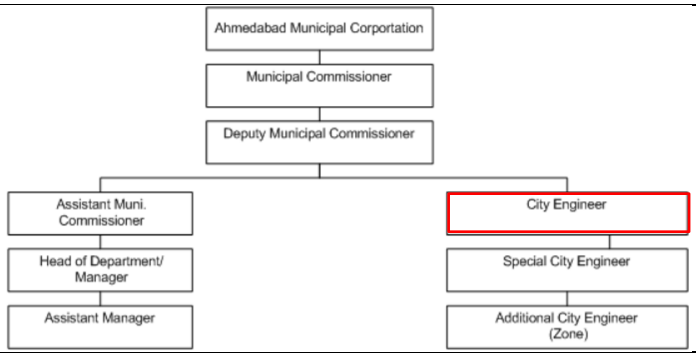
Evaluation Item	Rate	High (Score: 3)	Middle (Score: 2)	Low (Score: 1)
Necessity of land acquisition and resettlement	1	- Land acquisition or resettlement is NOT needed.	- Land acquisition or resettlement is needed for the construction of drainage pumping station or expansion of drains.	- Land acquisition or resettlement is needed for creek (or wide channel) expansion.

4.4.2 Evaluation of Longlisted Cities which Request JICA's Assistance

Each longlisted city was evaluated based on the selection criteria mentioned in Section 4.4.1, and the results are shown below.

[Ahmedabad]

Criteria	Evaluation Contents	Evaluation
1. Economic and Appealing Impact		
Economic impact	- An approximate ¥140 billion project was proposed.	Mid
Number of Japanese offices	- 152 offices of Japanese companies are located in the city.	Mid
Possibility to utilize Japanese technology	- Plastic media for stormwater storage and filtration facilities can be utilized for Sponge City.	Mid
2. Economic Impact to Reduce Loss by the Project		
Effectiveness of disaster risk reduction	- 2015: US$3.447 billion losses (total in Gujarat: EM-DAT).	High
3. Capacity of Implementing Agency		
Organization of urban flooding	- The city engineer in charge of water resources management is also responsible for urban drainage in AMC. AMC has sufficient human resources to implement an international project. The organization chart of AMC is as follows:	High

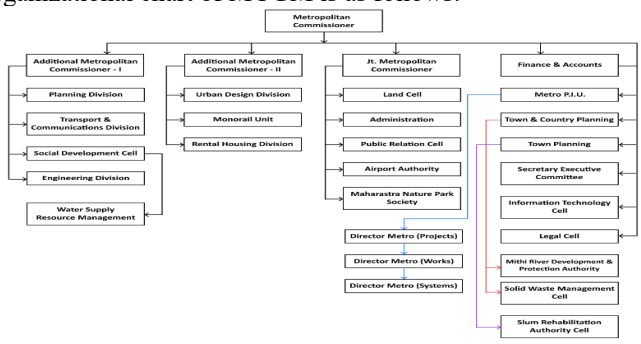
		
Experiences of the organization	- Railway projects were implemented under JICA loan. However, the implementation agency is not AMC. - WB (Sewerage), ADB (Water Supply/Drainage)	Mid
4. Project Timeline		
Availability of MP or DPR	- The draft MP will be formulated by the end of 2024. The DPR for the NDMA-financed project has been prepared. - No DPR has been prepared for the other project yet. Therefore, the project schedule will be able to match if JICA's support is provided.	High
Consensus with the JICA project scheme	- JICA has been requested to finance the next phase of the project.	High
5. Related Future Development Plan		
Availability of related plan	- Water supply, sewerage, and drainage projects funded by the WB and the ADB - High-speed railway	Mid
6. Project with Another Donor or Financial Scheme to Improve Urban Drainage		
Ongoing project with another donor or financial scheme in India	- World Bank and ADB funded sewerage and drainage projects are being executed. - A drainage project with financial support from NDMA will be implemented.	Mid
7. Requests from the Implementation Agency		
Requested by	- AMC Municipal Commissioner	Mid
8. Social Considerations		
Necessity of land acquisition and resettlement	- Land acquisition and resettlement are not expected so much. - If they will be required, AMC will be able to follow the necessary procedures in accordance with the JICA guidelines.	Mid

[Surat]

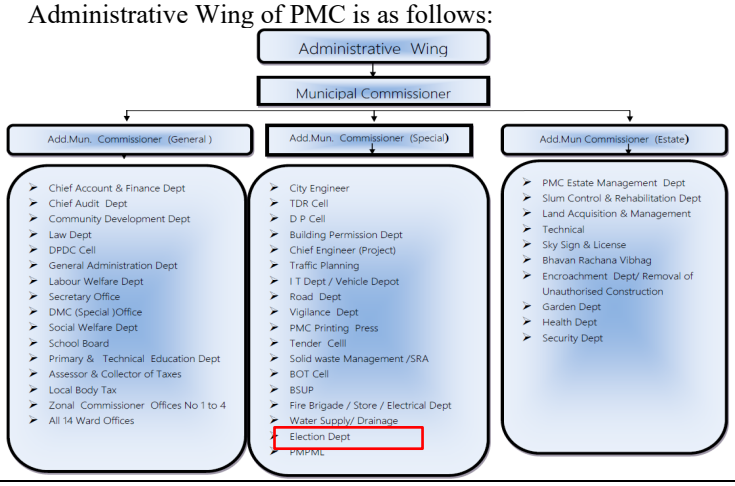
Criteria	Evaluation Contents	Evaluation
1. Economic and Appealing Impact		
Economic impact	- Approximately ¥21 billion: ➢ Implementation of Bhedwad Creek (Rs.678 Cr) ➢ Preparation of DPR and construction for Varachha Creek (Rs.335 Cr) ➢ Preparation of DPR and construction for Chhaprabatha Creek (Rs.258 Cr)	Mid
Number of Japanese offices	- 27 offices of Japanese companies are located in the city.	Low
Possibility to utilize Japanese technology	- Plastic media for stormwater storage and filtration facilities can be utilized for Sponge City.	Mid
2. Economic Impact to Reduce Loss by the Project		
Effectiveness of disaster risk reduction	- 2006: 150 people died, economic loss amounting to Rs.21,000 Cr	High
3. Capacity of Implementing Agency		

Organization of urban flooding	- SMC has a drainage department that is in charge of creek rejuvenation.	High
Experiences of the organization	- WB（Tapi Riverfront Improvement Project）	Mid
4. Project Timeline		
Availability of MP or DPR	- No master plan. ➢ FS has been formulated. ➢ DPR for the project, amounting to ¥11 billion out of ¥21 billion, has been prepared.	Mid
Consensus with JICA project scheme	- Slightly difficult since Bhedwad Creek will be implemented soon based on the prepared DPR. - While Varachha and Chhaprabatha creeks will be aligned with JICA's project schedule.	Mid
5. Related Future Development Plan		
Availability of related plan	- WB（Tapi Riverfront Improvement Project） - High-speed railway	High
6. Project with Another Donor or Financial Scheme to Improve Urban Drainage		
Ongoing project with another donor or financial scheme in India	- The WB is implementing the Tapi Riverfront Improvement Project. - River rejuvenation projects are under implementation (approximately 480 Cr).	Mid
7. Requests from the Implementation Agency		
Requested by	- Officials of MC	Low
8. Social Considerations		
Necessity of land acquisition and resettlement	- Creek expansion is proposed. - If required, SMC will be able to follow the necessary procedures in accordance with the JICA guidelines, with support from consultant.	Low

[Mumbai]

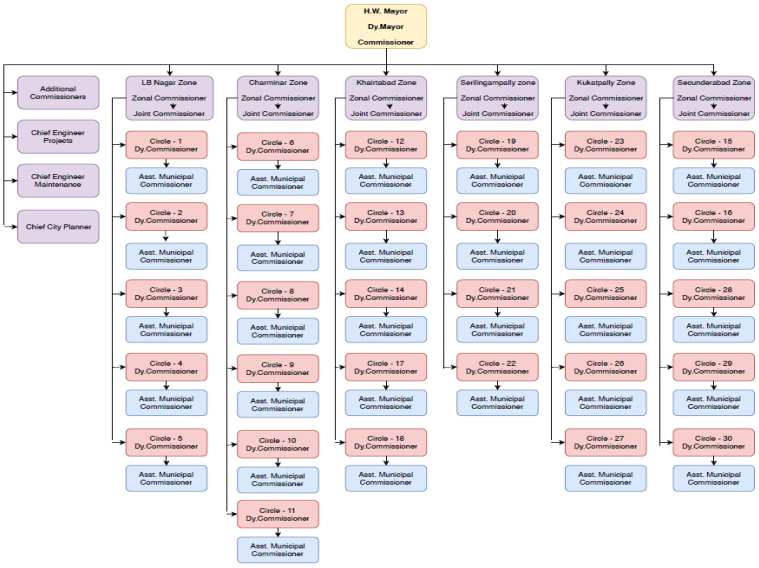
Criteria	Evaluation Contents	Evaluation
1. Economic and Appealing Impact		
Economic impact	- Assumed around ¥50 billion ➢ MCGM is planning to construct a large-scale stormwater drainage pipe after establishing the MP.	High
Number of Japanese offices	- 336 offices of Japanese companies are located in the city.	High
Possibility to utilize Japanese technology	- An underground stormwater drainage tunnel is requested. - Plastic media for stormwater storage and filtration facilities can be utilized for the Sponge City.	High
2. Economic Impact to Reduce Loss by the Project		
Effectiveness of disaster risk reduction	- 2005: 447 people died; US$1.7 billion loss - 2017: US$358 million loss (total in Maharashtra: EM-DAT)	High
3. Capacity of Implementing Agency		
Organization of urban flooding	- MCGM has a Stormwater Drainage Department (SWDD) in charge of urban drainage in Mumbai, which has enough human resources to implement an international project. The organizational chart of MCGM is as follows:  	High
Experiences of the organization	- Metro, high-speed railway, and road projects under JICA loan	High
4. Project Timeline		
Availability of MP or DPR	- MP is available, but is requested to be updated to consider climate change.	High
Consensus with the JICA project scheme	- DEA has made approval in principle in 2020 to request JICA to implement technical cooperation to formulate MP. - It will be possible to harmonize with JICA's project schedule although MCGM requested to implement as soon as possible.	High
5. Related Future Development Plan		
Availability of related plan	- Road projects, etc. - Metro, railway	High
6. Project with Another Donor or Financial Scheme to Improve Urban Drainage		
Ongoing project with another donor or financial scheme in India	- The NDMA-funded project will be implemented to address urban flooding (Rs.500 Cr). - MCGM is implementing the Mithi River Improvement Project with its own funds.	Mid
7. Requests from the Implementation Agency		
Requested by	- Deputy Chief Minister of Maharashtra and MCGM	High
8. Social Considerations		
Necessity of land acquisition and resettlement	- To be studied in the MP - If required, MCGM will be able to follow the necessary procedures in accordance with the JICA guidelines with support from the Consultant.	Mid

[Pune]

Criteria	Evaluation Contents	Evaluation
1. Economic and Appealing Impact		
Economic impact	- Approximately ¥3.3 billion (Also, drainage project with the amount of ¥16 billion will be required to be implemented in the future.)	Low
Number of Japanese offices	- 193 offices of Japanese companies are located in the city.	Mid
Possibility to utilize Japanese technology	- Not included.	Low
2. Economic Impact to Reduce Loss by the Project		
Effectiveness of disaster risk reduction	- 2019: 26 people died, with a loss of Rs.200 Cr. - 2020: Loss of more than US$24 million	High
3. Capacity of Implementing Agency		
Organization of urban flooding	- Existing but limited human resources: Managed by Superintending Engineer in charge of Water Supply/Drainage under Additional Municipal Commissioner. The organization chart of the Administrative Wing of PMC is as follows:  	Mid
Experiences of the organization	- Mura/Muta River Pollution Mitigation Project under JICA loan	High
4. Project Timeline		
Availability of MP or DPR	- The MP will be prepared under the NDMA project. - The DPR for the NDMA-funded project, and the drainage plan for approximately ¥3.3 billion are available. No further plan has been prepared.	Mid
Consensus with the JICA project scheme	- JICA is requested to finance the next phase of the project with an estimated amount of ¥3.3 billion.	High
5. Related Future Development Plan		
Availability of related plan	- Sewerage project funded by IFC and expansion of the administrative boundary of Pune.	Mid
6. Project with Another Donor or Financial Scheme to Improve Urban Drainage		
Ongoing project with another donor or financial scheme in India	- IFC (sewerage) - NDMA-funded project to be implemented against urban flooding (Rs.250 Cr)	Mid
7. Requests from the Implementation Agency		
Requested by	- Officials of MC	Low
8. Social Considerations		
Necessity of land acquisition and	- Nallah (waterway) expansion is proposed. - If required, PMC will be able to follow the necessary procedures	Mid

resettlement	in accordance with the JICA guidelines, with support from the Consultant.	

[Hyderabad]

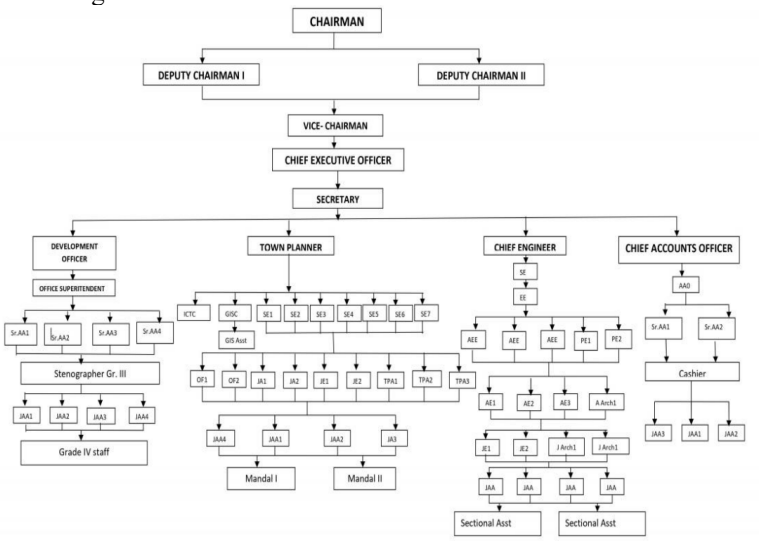
Criteria	Evaluation Contents	Evaluation
1. Economic and Appealing Impact		
Economic impact	- Approximately ¥87.5 billion	High
Number of Japanese offices	- 119 offices of Japanese companies are located in the city.	Mid
Possibility to utilize Japanese technology	- Plastic media for stormwater storage and filtration facilities can be utilized for Sponge City.	Mid
2. Economic Impact to Reduce Loss by the Project		
Effectiveness of disaster risk reduction	- 2020: Rs.900 Cr loss	Mid
3. Capacity of Implementing Agency		
Organization of urban flooding	- The Chief Engineer manages urban flooding in GHMC. GHMC is a large authority responsible for overseeing the management of the mega city, as shown in the figure below.  	High
Experiences of the organization	- Outer Ring Road and architectural projects under JICA loan	High
4. Project Timeline		
Availability of MP or DPR	- Master plan (2020) is available.	High
Consensus with the JICA project scheme	- It is slightly difficult since GHMC plans to commence the Phase-2 project in 2024. However, it is assumed that the schedule can be negotiated due to the delay of the Phase-1 project.	Mid
5. Related Future Development Plan		
Availability of related plan	- Government-owned funds (Phase-1 Project)	Mid
6. Project with Another Donor or Financial Scheme to Improve Urban Drainage		
Ongoing project with another donor or financial scheme in India	- No project. - The NDMA-funded project will be implemented to address urban flooding (Rs.250 Cr).	Mid
7. Requests from the Implementation Agency		
Requested by	- Officials of MC; however, the request was withdrawn after the state government elections, as the new government changed its strategy to reduce the financial debt of the state (February 2024). Note: The state government subsequently changed its policy in June	High

	2024, and again requested assistance from JICA.	
8. Social Considerations		
Necessity of land acquisition and resettlement	- Drain expansion is proposed. - If required, PMC will be able to follow the necessary procedures in accordance with the JICA guidelines, with support from consultant.	Mid

[Bhubaneswar]

Criteria	Evaluation Contents	Evaluation
1. Economic and Appealing Impact		
Economic impact	- Based on the FS, drainage improvement projects will be implemented using JICA loan.	Low
Number of Japanese offices	- 25 offices of Japanese companies are located in the city.	Low
Possibility to utilize Japanese technology	- Not included	Low
2. Economic Impact to Reduce Loss by the Project		
Effectiveness of disaster risk reduction	- 2011: 239 people died, and US$1.21 billion was lost (total in Odisha: EM-DAT)	High
3. Capacity of Implementing Agency		
Organization of urban flooding	- Not existing	Low
Experiences of the organization	- No experience	Low
4. Project Timeline		
Availability of MP or DPR	- No master plan	Low
Consensus with the JICA project scheme	- Required to formulate MP and FS	High
5. Related Future Development Plan		
Availability of related plan	-	Low
6. Project with Another Donor or Financial Scheme to Improve Urban Drainage		
Ongoing project with another donor or financial scheme in India	- No project	High
7. Requests from the Implementation Agency		
Requested by	- Municipal Commissioner	Mid
8. Social Considerations		
Necessity of land acquisition and resettlement	- To be studied in the MP	Mid

[Guwahati]

Criteria	Evaluation Contents	Evaluation
1. Economic and Appealing Impact		
Economic impact	- Approximately ¥7.8 billion	Low
Number of Japanese offices	- 28 offices of Japanese companies are located in the city.	Low
Possibility to utilize Japanese technology	- Not included	Low
2. Economic Impact to Reduce Loss by the Project		
Effectiveness of disaster risk reduction	- 2012: 100 people died - More than 100 people died in the flood in 2022, and its economic loss is nearly Rs.10,000 Cr in Assam. (Assam flood loss may be around ₹10,000 crore: officials | Latest News India - Hindustan Times)	High
3. Capacity of Implementing Agency		
Organization of urban flooding	- According to the letter from the Government of Assam (GOA) in November 2021, GOA reconstituted the GMDA with 31 members. The organizational chart is as follows:  	High
Experiences of the organization	- Water supply and sewerage project under yen loan	High
4. Project Timeline		
Availability of MP or DPR	- Existing, but required to update MP	High
Consensus with the JICA project scheme	- JICA was requested to update the drainage master plan if JICA can materialize the project soon. - For the implementation of the project, there is no problem since JICA is requested to implement the project at Baharalu and other basins (except for Bahini and Hathinala) for the second phase of the project.	High
5. Related Future Development Plan		
Availability of related plan	- Sewerage project	Mid
6. Project with Another Donor or Financial Scheme to Improve Urban Drainage		
Ongoing project with another donor or financial scheme in India	- ADB intends to support in the future.	High
7. Requests from the Implementation Agency		
Requested by	- Officials of MC	Low
8. Social Considerations		

Necessity of land acquisition and resettlement	- New pump stations are proposed. - Drain expansion is expected; therefore, land acquisition issues are anticipated for the implementation of the project at Baharalu basin.	Mid

4.4.3 Selection of Priority Cities

Based on the evaluation of each longlisted city in Section 4.4.2, priority cities were selected. The summary of the evaluation and result of scoring are shown in Table 4.4.2. As a result of the evaluation, Mumbai, Ahmedabad, Guwahati, Hyderabad, Pune, and Surat were selected as priority cities. The main reasons for the selection are summarized below.

City	Request in Urban Drainage Sector	Reason of Evaluation
1) Mumbai	- Formulation of the MP and FS, taking into consideration the impact of climate change (with rainfall exceeding 55 mm/hr). - Based on the FS, drainage improvement projects will be implemented under JICA loan, including the construction of an underground stormwater discharge tunnel.	**Selected (Total Score: 57)** - Mumbai is the economic center of India. - Drainage MP needs to be updated. JICA technical cooperation (TC) request was conditionally approved in 2020; however, since time has passed, it is necessary to resubmit the request. - Economic losses due to flooding have been significant in Mumbai, and the risks of climate change must be considered. - Urban drainage facility, like Japanese large-scale underground stormwater drainage pipes, was requested by MCGM. - Deputy Chief Minister of Maharashtra State has requested JICA to implement this project.
2) Ahmedabad	- The project is proposed in the draft MP with an estimated amount of Rs.8,271 Cr, excluding the Phase-I project implemented under NDMA project and the state budget (Rs.275 Cr). -	**Selected (Total Score: 46)** - Drainage MP will be formulated within this year based on the latest CPHEEO guidelines. - Flood spots are spread throughout the entire city. - The project scale is expected to be huge, with a positive impact anticipated. - Ahmedabad is an important city in India. - The Municipal Commissioner has requested Japanese ODA.
3) Guwahati	- Financial support to implement the project at the Baharalu basin (Rs.450 Cr) and other basins (except for Bahini and Hathinala). - Updating of the MP and DPR.	**Selected (Total Score: 44)** - Assam is an important state to support as it has established the intergovernmental Act East Forum, and infrastructure and social development is underway as the gateway to neighboring countries. - Drainage MP will be formulated based on the latest CPHEEO guidelines. - Urban drainage is a critical issue in Guwahati. ADB is planning to implement drainage project in priority catchments, and JICA is requested to support the remaining catchments.
4) Hyderabad	- Financial support to implement the Phase-2 project	**Selected (Total Score: 43)** - Hyderabad is a mega city in southern India.

	(approximately Rs.5,000 Cr) - Early flood warning system (Rs.57 Cr) - Preparation of the DPR for Phase-2	- Drainage MP was formulated based on the latest CPHEEO guidelines. - The proposed project is large-scale and is planned to be initiated soon. - More phased development of the drainage facility shall be discussed.
5) Pune	- 60 spots improvement (DPR was approved amounting to Rs.190 Cr).	**Selected (Total Score: 43)** - Drainage MP is not available and will be prepared in the upcoming NDMA project. - The requested project scale is not very large, and the most urgent work will be implemented under the NDMA project.
6) Surat	- Implementation of Bhedwad Creek (Rs.678 Cr) - Preparation of DPR for Varachha (Rs.335 Cr) and Chhaprabatha creeks (Rs.258 Cr).	**Selected (Total Score: 40)** - Drainage MP is not prepared. - Proposed project is creek rejuvenation project with latter phase projects implemented under the state budget.
6) Bhubaneswar	- Formulation of the MP and FS for a flood-free city - Based on the FS, drainage improvement projects will be implemented under JICA loan.	Not selected (Total Score: 38) - Drainage MP does not exist, and BMC requested JICA to formulate a TC. - The Municipal Commissioner requested JICA TC, but the expected project after the MP is assumed to be not huge.
7) Delhi	- As of July 2024, requests have not been responded to, and meetings have not been held.	Not selected (Total Score: -) - It is assumed to be of low priority since the online meeting was not accepted by Delhi.

Table 4.4.2 Summary of Evaluation to Select the Priority Cities

		State	Gujarat				Maharashtra				Telangana		Odisha		Assam	
		City	Ahmedabad		Surat		Mumbai		Pune		Hyderabad		Bhubaneswar		Guwahati	
Evaluation																
Rate	2-1.	**Economic and appealing impact**														
2		1) Economic impact (Project scale) - C>USD200M - USD100M< C< USD200M - C< USD100M	Approx. JPY 140 billion	Mid	Approx. JPY 21 billion	Mid	Assumed around JPY 50 billion	High	Approx. JPY 3.3 billion. (Plus drainage project with the amount of JPY 16 billion will be required to implement in the future.)	Low	Approx. JPY 87.5 billion	High	Based on the FS drainage improvement projects will be implemented by JICA's loan.	Low	Approx. JPY 7.8 billion	Low
1		2) Appealing impact-1: Number of Japanese companies in the city (Source: JETRO)	152	Mid	27	Low	336	High	193	Mid	119	Mid	25	Low	28	Low
1		2) Appealing impact-2: Possibility to utilize Japanese technologies	Plastic media for stormwater storage and filtrate facility can be utilized for Sponge City.		Plastic media for stormwater storage and filtrate facility can be utilized for Sponge City.	Mid	- Underground stormwater drainage tunnel is requested. - Plastic media for stormwater storage and filtrate facility can be utilized for Sponge City.	High	Not included	Low	Plastic media for stormwater storage and filtrate facility can be utilized for Sponge City.	Mid	Not included	Low	Not included	Low
	2-2.	**Economic impact to reduce loss by the project**		Mid												
3		Effectiveness of disaster risk reduction (Damage and Loss by Urban Flood)	2015: USD3,447 million loss (total in Gujarat: EM-DAT) 2017:214 people died in Gujarat state.	High	2006: 150 people died, Rs.21,000 Cr loss	High	2005: 1,094 people died. USD 690 million lost 2017: USD 358million loss (total in Maharashtra: EM-DAT)	High	2019: 26 people died. Rs200Cr. Loss 2020: more than USD 24million loss	High	2020: Rs.900Cr loss	Mid	2011: 239 people was died and USD1,210million was lost (total in Odisha: EM-DAT)	High	2012 100 people died.	High
	2-3.	**Capacity of Implementing Agency**														
1		Organization for urban flooding	Existing	High	Existing	High	Existing	High	Existing with limited human resources	Mid	Existing	High	Not existing	Low	Existing	High
1		Experience of Organization: 1) JICA's ODA loan: 2) ODA from another donors: 3) GoI project:	1) Railway Projects such as Ahmedabad Metro, Mumbai-Ahmedabad high-speed railway etc. (not by AMC) 2)WB(Sewerage)、ADB(Water supply/Drainage)	Mid	1) Not Available 2) WB（Tapi River Front Improvement Project）	Mid	1) Metro, High-speed railway and road projects etc.	High	1) Mura/Muta river pollution mitigation project	High	1) Outer Ring Road and architectural projects	High	Not experienced	Low	1) Water supply and sewerage project	High
	2-4.	**Project timeline**														
2		1) Availability of MP or FS	Draft MP(to be completed by the end of 2024), and DPR for NDMA	High	No master plan, FS has been formulated. DPR for the project with the amount of JPY 11 billion out of JPY 21 billion has been prepared.	Mid	Available, but requested to update a Master Plan	High	MP will be prepared in NDMA project. DPR for NDMA funded project, and drainage plan for approx. JPY 3.3 billion. No further plan has been prepared.	Mid	Master Plan (ver2020)	High	No master plan	Low	Existing, but required to update a Master Plan	High
2		2) Consensus with JICA Project Scheme:	JICA is requested to finance next phase project.	High	Slightly difficult since Bhedwad creek shall be implemented soon based on the prepared DPR. While, Varachha, Chhaprabatha creek will be made a consensus with JICA's project schedule.	Mid	Required to formulate a MP and FS and it was already approved by Government	High	JICA is requested to finance next phase project with the approx. amount of JPY 3.3 billion.	High	Slightly difficult since GHMC plans to commence the Phase-2 project from 2024	Mid	Required to formulate a MP and FS	High	JICA is requested to finance next phase project with the approx. amount of JPY 3.3 billion.	High
	2-5.	**Related Future Development Plan**														
1		Availability of the related plan	-Waster supply, sewerage and drainage projects funded by WB and ADB -Railway	Mid	-WB（Tapi River Front Improvement Project） -Railway	High	Gov. own Fund（Mithi River Improvement Project） -Metro, Railway	High	Sewerage project funded by IFC and expansion of the administrative boundary of Pune.	Mid	-Gov. own fund (Phase-1 Project)	Mid	No project	Low	Sewerage Project	Mid
	2-6.	**Project implementation with another donor or financial scheme in India**														
2		Ongoing project with another donor	WB(Sewerage)、ADB(Water supply/Drainage)	Mid	WB is implementing Tapi river front improvement project.	Mid	Road projects etc.	Mid	IFC(sewerage)	Mid	No project	Mid	No project	High	ADB intends to support in the future	High
		Ongoing project under another financial scheme	NDMA funded project will be implemented against urban flooding.		River rejuvenation projects are under implementation. (Approx. 480Cr)		NDMA funded project will be implemented against urban flooding.(500Cr)		NDMA funded project will be implemented against urban flooding (250Cr)		NDMA funded project will be implemented against urban flooding.(250Cr)		No project		No project	
	2-7.	**Request from Indian authorities**														
3		Requested by: - Government or state - Municipal commissioner - Other officials of MC	Requested by Municipal Comissioner	Mid	Requested by officials of MC	Low	Requested by Deputy Chief Minister of Maharashtra, MITRA and AMC of MCGM	High	Requested by Municipal Comissioner	Mid	Requested by officials of MC	Low	Requested by Municipal Commissioner	Mid	Requested by officials of MC	Low
	2-8.	**Social considerations**														
1		Necessity of Land acquisition and resettlement	New pump stations are proposed	Mid	Creek expansion is proposed	Low	To be studied in the MP	Mid	Nallah expansion is proposed	Mid	Drain expansion is proposed	Mid	To be studied in the MP	Mid	- New pump stations are proposed - Drain expansion is expected	Mid
		Score		46		40		57		43		43		38		44

Source: JST

Note: A request for a meeting with Delhi was not accepted, and Delhi has been removed from this table.

CHAPTER 5 PREPARATION OF PRELIMINARY PROJECT REPORT

5.1 Selection of Shortlisted Cities for Preparation of Preliminary Project Report

5.1.1 Record of Meeting and Site Survey for Priority Cities and Relevant Authorities

The JICA Survey Team (hereinafter called as "JST") conducted a second field survey to have physical meetings with related ministries (NDMA and MoHUA), state governments, and priority cities (municipal corporations) from February 2024 to March 2024.

Following the first field survey, the JST confirmed that the request from Hyderabad had been withdrawn due to the change of policy to decrease debt of the Telangana State following a change in administration. In addition, Surat was excluded from the list of priority cities since the JICA' s technical cooperation for drainage master planning was under formulation process and priority project would be proposed in the technical cooperation. Consequently, the JST visited Guwahati Metropolitan Development Authority (GMDA), Ahmedabad Municipal Corporation (AMC), Municipal Corporation of Greater Mumbai (MCGM), and Pune Municipal Corporation (PMC) to finalize selection of shortlisted cities, define the potential project scope, and gather relevant data for the preparation of the Preliminary Project Report (PPR).

The schedule of the meetings with states and priority cities are as shown in Table 5.1.1. Moreover, the meeting materials and results of the meetings are shown in the Appendix 5-1 and Appendix 5-2, respectively.

Table 5.1.1 Record of Meetings with Priority Cities and Relevant States

States	Cities	Authority	Date	Note
Gujarat	Ahmedabad	AMC	Feb.29-Mar.1, 2024 Mar.11-20,2024	Incl. site visit
	-	SDMA- Gujarat	Mar.1, 2024	
	-	SUDUH- Gujarat	Mar.1, 2024	
Maharashtra	Mumbai	MCGM(SWDD)	Mar. 6-7, 2024	Incl. site visit
	Mumbai	MCGM (Disaster Management)	Mar. 6, 2024	
	Pune	PMC	Mar. 7, 2024	
	-	SUDD- Maharashtra	Mar.4, 2024	
Assam	Guwahati	PMU of JICA project	Feb. 27, 2024	
		GMDA	Feb. 27, 2024	
	-	SDMA- Assam	Feb. 27, 2024	

Source: JST

5.1.2 Selection of Shortlisted Cities to Prepare Preliminary Project Report

The shortlisted cities were selected considering the result of second field survey. Mumbai, Ahmedabad, and Pune were selected as the shortlisted city as shown in Table 5.1.2.

Table 5.1.2 Preliminary Selection of Shortlisted Cities

	Nomination for Shortlisted City	Reason for Nomination of Shortlisted City
1) Mumbai	Selected	During the first field survey in November 2023, the Maharashtra State government requested JICA to formulate stormwater drainage master plan, including a large-scale underground drainage pipe system. However, during the second field survey, the JST confirmed that MCGM planned to formulate its master plan under the state budget, which was

		still in the preparatory stage. In light of this situation, JICA and the JST decided to keep investing the possibility to materialize TC or yen loan project for urban drainage.
2) Ahmedabad	Selected	During the second field survey, the JST observed that the AMC was updating its stormwater drainage master plan and identified several candidate projects for improving the stormwater drainage system in the AMC. Considering this, JICA and the JST decided to further explore the possibility of materializing TC or yen loan projects.
3) Guwahati	Not Selected	During the second site visit, the JST confirmed that the GMDA had already initiated the procurement process for a consultant to prepare a stormwater drainage master plan and its Detailed Project Report (DPR) for a potential project under the ADB support. In addition, the JST could not ascertain the future possibility of requesting JICA assistance from DoHUA. Consequently, JICA and the JST decided to omit Guwahati from shortlisted cities in this study, but continue to investing the possibility of second phase of project by monitoring under another technical corporation for northeastern states.
4) Hyderabad	Not Selected	Hyderabad withdrew its request following a change in the Telangana state government, which shifted its development policy to reduce state debt. Consequently, the city was omitted from the shortlist.
5) Surat	Not Selected	JICA is formulating a technical cooperation project to formulate a urban flood master plan, and once the technical cooperation is executed, it is expected that a priority project will be proposed and implemented with a yen loan. Considering that a project is already being formulated by JICA and that there are three other cities that could be shortlisted, it was decided not to include this city on the shortlist in this study.
6) Pune	Selected	In the second field survey, the JST confirmed that PMC was planning to implement the projects to develop urban drainage facilities and sewerage systems in the newly expanded municipal districts (Note: Although they are described as “village” in English, translate as “municipal districts because these districts have already urbanized, and the impression given by the Japanese word “village” is different). Considering the said situation, JICA and JST decided to keep investing the possibility to materialize sewerage and urban drainage projects.

Source: JST

5.1.3 Discussions with Shortlisted Cities Regarding the Contents of the Requests and Review of Shortlisted Cities

The JST conducted the third field survey in June 2024 and held meetings with the Maharashtra State Government and the shortlisted cities (Ahmedabad, Mumbai, and Pune) to interview and exchange opinions regarding the contents of the support from JICA based on the Preliminary Project Report (draft). During the third field survey period, Hyderabad again informed necessity of JICA’s assistance for an urban drainage project and the Musi Riverfront project. This change followed Telangana State’s shift in policy from debt reduction to the active utilization of yen loans to support infrastructure development. In response to this request, reconfirmed the criteria for selecting shortlisted cities, and

given the request from Telangana State, confirmed that Hyderabad's evaluation score is sufficient to be shortlisted, and decided to add Hyderabad as a shortlisted city.

Furthermore, the JST conducted the fourth field survey to Mumbai and Hyderabad in September 2024. The JST collected relevant information for formulation of the master plan in Mumbai. In Hyderabad, the JST confirmed the current situation of the stormwater drainage works in GHMC, discussed their priority project, and confirmed the necessity of JICA's support.

The schedule of meetings with shortlisted cities in third and fourth field surveys is as shown in Table 5.1.3, and the meeting materials and meeting results are shown in Appendix 6-1 and Appendix 6-2, respectively.

Table 5.1.3 Record of Meetings with Shortlisted Cities and Relevant States

States	Cities	Authority	Date	Note
Gujarat	Ahmedabad	AMC	Jun. 13-14, 2024	
Maharashtra	Mumbai	MCGM(SWD)	Jun. 18-20, 2024	Incl. site visit
			Sep. 5-6, 2024	
	Pune	PMC	Jun. 10-12, 2024	Incl. site visit
	-	SUDD- Maharashtra	Jun. 20, 2024	
Telangana	Hyderabad	GHMC	Sep. 9-10, 2024	Incl. site visit
	-	MRDCL	Sep.11, 2024	

Source: JST

5.1.4 Selection of Shortlisted Cities for Preparation of Proposal for Promotion (PPR)

Based on the items in Section 5.1.3, Hyderabad was selected as a shortlisted city in addition to Mumbai, Ahmedabad, and Pune. MCGM is focussing to formulate stormwater drainage master plan at the first step, so PPR is not required to formulate its study. Among these four municipal corporations, the PPR for remaining three municipal corporations were prepared as shown in Table 5.1.4.

Table 5.1.4 Selection of Shortlisted Cities and Necessity of PPR

	Recommendation for shortlisted cities	Reasons for recommendation	Preparation of PPR
1) Mumbai	Recommended	During the third field survey, discussions were conducted with MCGM and the Maharashtra Urban Development Department (UDD). It was confirmed that there is interest in updating the urban drainage master plan to address climate change impacts (development of BRIMSTOWAD-3), preparing detailed project report (DPR) for priority projects, and implementing them through yen loans. Based on the interest of MCGMabove, JICA and the JST decided to continue evaluating the feasibility of technical cooperation and yen loan projects.	Not necessary since master planning study is the scope of first phase
2) Ahmedabad	Recommended	The third field survey also confirmed that the AMC has another alternative to apply for state government grant projects (grant aid projects) for the candidate projects for yen loans (the two projects to be implemented and the project to be proposed in the urban drainage master plan is currently being formulated). It was further	Necessary since ODA loan is required to implement the candidate project

		confirmed that, depending on the results of the selection, the municipal commissioner and deputy municipal commissioner will hold discussion and reconsider whether to request JICA's assistance. Based on the above situation, the JST decided to continue investigating the feasibility of yen loan projects.	
3) Pune	Recommended	During the third field survey, it was confirmed that the PMC is formulating an urban drainage master plan for the 23 newly expanded municipal districts and intends to develop a new urban drainage master plan for the remaining areas with NDMA funds. Additionally, PMC has shown the need of support from JICA and yen loans for urban drainage improvement projects in these areas, as well as for sewerage system development in the expanded 16 municipal districts. Based on this situation, JICA and the JST decided to continue to investigate the feasibility of yen loan projects for urban drainage and sewerage.	Necessary since ODA loan is required to implement the candidate project
4) Hyderabad	Recommended	The state government's fiscal cutback policy has changed, and a policy of actively utilizing yen loans has been announced. In response to this change, the need of support from JICA was confirmed for i) an implementation of second phase of Strategic Nallah Development Program (SNDP-2) which is urban drain improvement program for expanded area of Hyderabad and ii) the Musi River Riverfront Development Project (including river bank protection, sewerage development, etc.). JICA and JST decided to investigate the feasibility of yen loan projects since the potential project from GHMC was related to urban drainage sector.	Necessary since ODA loan is required to implement the candidate project
5) Guwahati	Not recommended	As shown in Table 5.1.2 (excluded since it is planned to be implemented under ADB. However, this will continue to collect information through ongoing technical cooperation projects in DRR sector and will investigate the possibility of cooperation in future yen loan projects.)	-
6) Surat	Not recommended	See in Table 5.1.2 (excluded since JICA's technical cooperation is currently being formulated by JICA).	-

Source: JST

5.2 Process of Project Approval in India

This study intends to formulate i) A yen loan project in the urban drainage sector, or ii) Technical cooperation to develop a drainage master plan.

As urban drainage projects fall under urban infrastructure development, the Ministry of Housing and Urban Affairs (MoHUA) and its corresponding state government authority (e.g., UDD or Department of Housing and Urban Affairs [DoHUA]) serve as the responsible authorities of the yen loan projects. For projects in other disaster sectors, such as cyclones or landslides, the National Disaster Management Authority (NDMA) and the respective State Disaster Management Authorities (SDMA) are responsible authorities. In contrast, for technical cooperation projects within the disaster management sector including urban drainage and other disaster, NDMA and its respective state government line authorities (SDMAs) oversee the formulation and execution processes.

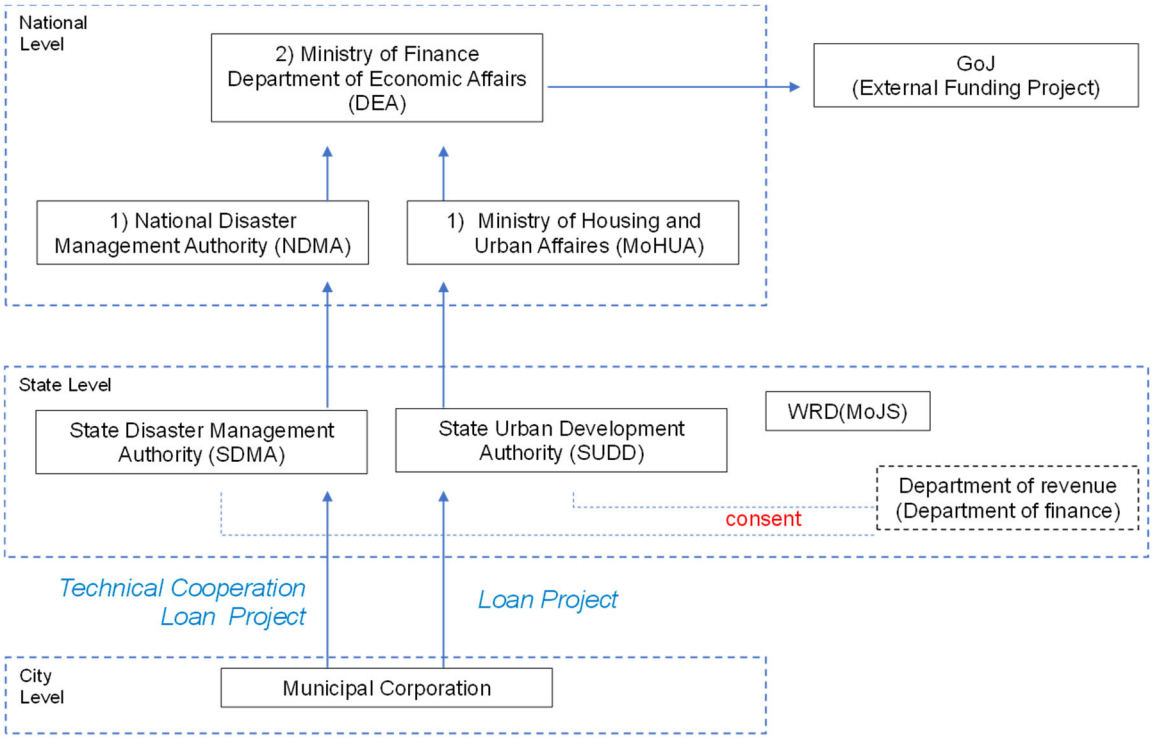
In addition, the state authority is the implementing agency and municipal corporation is the executing agency respectively in the yen loan project in the urban drainage sector. Regarding the budgetary arrangement for yen loan projects, once the implementing agency such as UDD approve the project proposal, consults with relevant states' DOR or DOF to confirm the budgetary arrangement, and request the necessary yen loan approval to the DEA through national relevant ministries such as MoHUA.

The documents required for submission to the relevant higher authority are as below:

- Yen Loan Project: Preliminary project report (PPR) of the candidate projects.
- Technical Corporation: Application form for Japan's Technical Cooperation.

Once the above project application is approved by the DEA, that proposed project will be listed on the rolling plan (yen loan list), and the DEA will officially request it to JICA.

The process flow for the approval of the candidate projects in India is illustrated in Figure 5.2.1.



Source: JST

Figure 5.2.1 Process of Project Approval in Urban Drainage Sector

5.3 Necessary Information for the Project Approval

5.3.1 Preliminary Project Approval for Yen Loan Project

The items to be detailed in the PPR for a loan project have already been defined by the relevant Indian authorities. As a reference, the required information for each item in PPR is specified in the "CPHEEO Storm Water Drainage System Manual," published in August 2019, which also mandates referencing the "Sewerage and Sewage Treatment Manual (Second Edition, 1993)". The items and contents of the PPR are outlined below.

Table 5.3.1 Items and Contents of PPR

<table>
<tr><th>No.</th><th>Item</th><th colspan="6">Contents
(Italic type: required in the CPHEEO Manual)</th></tr>
<tr><td>1</td><td>Name of the Project</td><td colspan="6"></td></tr>
<tr><td>2</td><td>Sectoral Area</td><td colspan="6"></td></tr>
<tr><td>3</td><td>Total Financial Outlay</td><td colspan="6"></td></tr>
<tr><td>4</td><td>Details of the External Development Cooperation Agencies (and the requested amount)</td><td colspan="6"></td></tr>
<tr><td rowspan="5">5</td><td>Funding Breakdown</td><td colspan="6">Cost estimates of each component of the project should be prepared and annual requirement of funds for each year should be worked out, taking into consideration the likely annual progress of each component. Physical contingency and price fluctuation contingency are included.</td></tr>
<tr><td>Total External Assistance</td><td colspan="4">Counterpart funds being made available by</td><td rowspan="3">Total</td></tr>
<tr><td>International Agency</td><td>Implementing Agency</td><td>State Government</td><td>Central Government</td><td>Others</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>Project Duration (dates/months/years)</td><td colspan="6"></td></tr>
<tr><td>7</td><td>Location of Project</td><td colspan="6">i) Give geographical description of the project area with reference to maps
ii) Describe special features such as topography, climate, culture, religion, migration, etc., which may affect project design, implementation, and operation
iii) Map showing administrative and political jurisdiction
iv) Describe any ethnic, cultural, or religious aspects of the communities which may have a bearing on the project proposal.</td></tr>
<tr><td>8</td><td>Previous Phases, if any</td><td colspan="6">i) Describe the benefits of system improvements (which may include rehabilitation or developing a new system)
ii) Evaluate the need to improve existing systems, expand systems, or develop new systems; and prioritize project preparation and implementation.</td></tr>
<tr><td>9</td><td>Statutory Clearances Required</td><td colspan="6"></td></tr>
<tr><td>10</td><td>Statutory Clearance Obtained</td><td colspan="6"></td></tr>
<tr><td>11</td><td>Details of Feasibility Studies Done, if any</td><td colspan="6"></td></tr>
</table>

12	Implementing Agency		*i) The institutions (government, semi-government, and non-government) which are related to each project's phase (planning, preparing projects, financing, implementation, O&M and evaluation)* *ii) Comment on roles, responsibilities, and limitation (territorial or others) of all the identified institutions (This may be indicated on a diagram).*
	・Central Line Ministry		
	・Administrative State Government Agency		
13	Basic Design of the Project		
	-	Goals and Objectives	
	-	Activities Involved	
	-	Outputs of the Project (Project Scope)	*Project Components* *All project components should be thoroughly described, duly supported by documents such as:* *i) Location maps* *ii) Technical information for each physical component and economic analysis where necessary* *iii) Preliminary engineering designs and drawings in respect of each physical component, such as collection network, SPS, STP and disposal system.* *Phased development plan (Long-term/Short-term plan)* *- Short-term project (priority project) : yen loan project.*
	-	Outcome of the Project	
	-	Contents of Oversea Supports and Technical Cooperatives	
14	Target Population and Groups		
15	Detailed Action Plan (Year wise) Implementation Schedule		*A realistic implementation schedule should be presented, taking into consideration the time required for all steps to be taken, such as conducting feasibility study, appraisal of the project, sanction to the project, fund mobilization, implementation, trial and commissioning. In preparing this schedule due consideration should be given to all authorities/groups whose inputs and decisions can affect the project and its timing.*

Year	Physical progress (%)	Financial Progress (Rs. in Crores)
2024-25		
2025-26		
2026-27		

16	Quantitative and Qualitative (verifiable) Target Indicators	
17	Environmental Sustainability of the Project	
18	Land Acquisition and Resettlement and Rehabilitation Involved	
19	Linkages with Similar Projects	

(i)	Information Regarding Previous Projects Similarly Undertaken (add evaluation reports, if any)	
(ii)	Does the project form part of the sectoral loan project? If yes, who are the other partners with details of the specific activities being undertaken by them?	
20	Approval Procedure	
21	Benefit of the Project	

Source: JICA and CPHEEO Manual (sewerage)
Note: Items with underline are additional information, which are not included in PPR.

Under normal circumstances, the detailed descriptions required by the CPHEEO guidelines can be included in the PPR since it is typically prepared after the preparation of Detailed Project Report (DPR). However, for this study, the JST must draft the PPR even if the DPR for the candidate project has not yet been completed. In this regard, certain items will be prepared with general description and the requirement needs to be met after the preparation of DPR.

5.3.2 Application Form for Japan's Technical Cooperation

In the application of Technical Cooperation, the following information shall be described.

1. Date of Application
2. Applicant
3. Technical Cooperation Title
4. Type of Technical Cooperation
5. Contact Point (Implementing Agency)
6. Background of the Technical Cooperation
7. Outline of the Technical Cooperation
   (1) Overall Goal
   (2) Technical Cooperation Purpose
   (3) Outputs
   (4) Technical Cooperation Site
   (5) Technical Cooperation Activities
   (6) Implementation structure and facilities provided by the recipient government
   (7) Implementation structure, activities, and equipment provided by the Japanese government
8. Implementation Schedule
9. Description of Implementing Agency
10. Related Information
    (1) Prospects of further plans and actions/ Expected funding resources for the Project

(2) Activities in the same sector of other donor agencies, the recipient government and NGOs and others

11. Global Issues (gender, poverty, climate change, etc.)
12. Environmental and Social Considerations (In case of Technical Cooperation Project (including SATREPS)/ Technical Cooperation for Development Planning, fill in the attached screening format)
13. Others

5.4 Overview of Candidate Projects of JICA's Support in Shortlisted Cities

During the field surveys, the JST confirmed the intentions of the shortlisted cities and discussed the details of the candidate projects. Based on the information collected, PPRs were drafted, and their contents were discussed during the third and fourth field surveys. The table below shows the outline of candidate projects of JICA's support in shortlisted cities.

Table 5.4.1 Outline of Candidate Projects of JICA's Support in Shortlisted Cities

	Project (Yen Loan)	T/C
1) Mumbai	• Update the urban drainage master plan considering climate change (formulation of BRIMSTOWAD-III) • Preparation of DPR for priority projects • Implementation of priority projects (yen loan) • Technical cooperation project accompanying yen loan (MCGM capacity development)	Flooding occurred in July 2024, and urban drainage measures are urgently needed
2) Ahmedabad	• Kharicut Canal Project (Phase II) - DPR prepared • Chandrabhaga Canal (Phase II and III) - DPR in preparation • Other development projects based on the urban drainage master plan which is being formulated - Project details undetermined	• An urban drainage master plan based on the new CPHEEO manual is under formulation • Considering application for a state government grant for the left-mentioned-projects. Will consider whether to request a yen loan for projects that are not selected.
3) Pune	• Urban drainage project for urban areas and extended municipal districts. The details of the project will be determined by the urban drainage master plan, which will be revised. The estimated project scale is based on the past urban drainage master plan as follows: ➢ Urban area: Rp.2800 Cr ➢ 11 municipal districts: Rp.1200 Cr ➢ 23 municipal districts: Rp.1500 Cr -The details of all projects are yet to be determined. Sewerage development for seven municipal districts out of the 23 extended municipal districts. The cost is estimated to be Rp.900 Cr. -DPR prepared	• Urban drainage master plan based on the new CPHEEO Manual will be developed by PMC ➢ 23 municipal districts: Under preparation ➢ Other urban areas + 11 municipal districts: Planned to prepare using NDMA funds (Target date: March 2026). • Flooding occurred in June and July 2024, and urban drainage measures are highly urgent

4) Hyderabad	• Development of urban drainage in the Hyderabad Metropolitan Area based on the Strategic River Development Project (SNDP). The estimated cost in the DPR is Rp. 5,135 Cr. ➢ Hyderabad Municipal Corporation (HMC): Necessity to be considered ➢ Greater Hyderabad Municipal Corporation (GHMC): Rp. 2,141 Cr. ➢ Hyderabad Urban Agglomeration (HUA): Rp. 2,994 Cr. • The Musi Riverfront Development Project (SNDP-2 has higher priority for GHMC)	• Currently, the Musi Riverfront Development Project is only a concept. It includes urban drainage measures, sewerage development for water quality improvement, and riverfront development for riverbank landscaping.

Source: JST

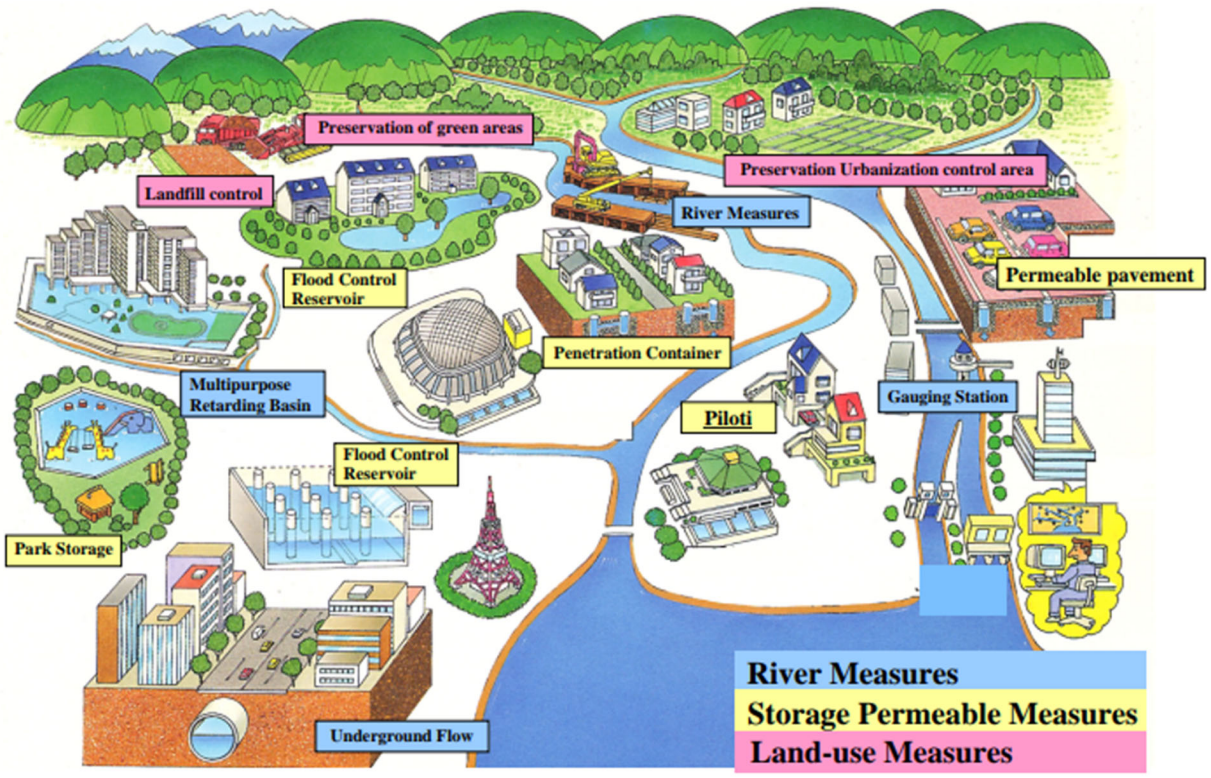
5.5 Examples of Japanese Technologies Applicable to Urban Drainage Projects in India

The project outline is required to include a description of the application of overseas technologies. And examples of Japanese technologies applicable to each candidate project are shown below.

(1) Comprehensive Flood Management

Comprehensive flood management is applied at the river basin with high flood risk due to urbanization. Aiming at preventing water-related disasters across entire river basins, not only measures by river management authorities such as river improvement and dam construction, but also measures by urban planning, housing, and land development authorities in local governments such as the development of storage facilities, land use regulations which impose the runoff control facilities for developers, and other measures to reduce the loss by flooding. These measures are taken to comprehensively reduce flood risks.

- River Measures: i) River development such as embankment and dredging, and ii) the development of dams and retarding basins.
- Basin Measures: i) Preservation of water retention functions (such as the installation of rainwater storage and infiltration facilities such as permeable pavement and infiltration pits, etc.
- Damage Mitigation Measures: Land use regulations and guidance, and the establishment of early warning and evacuation systems.

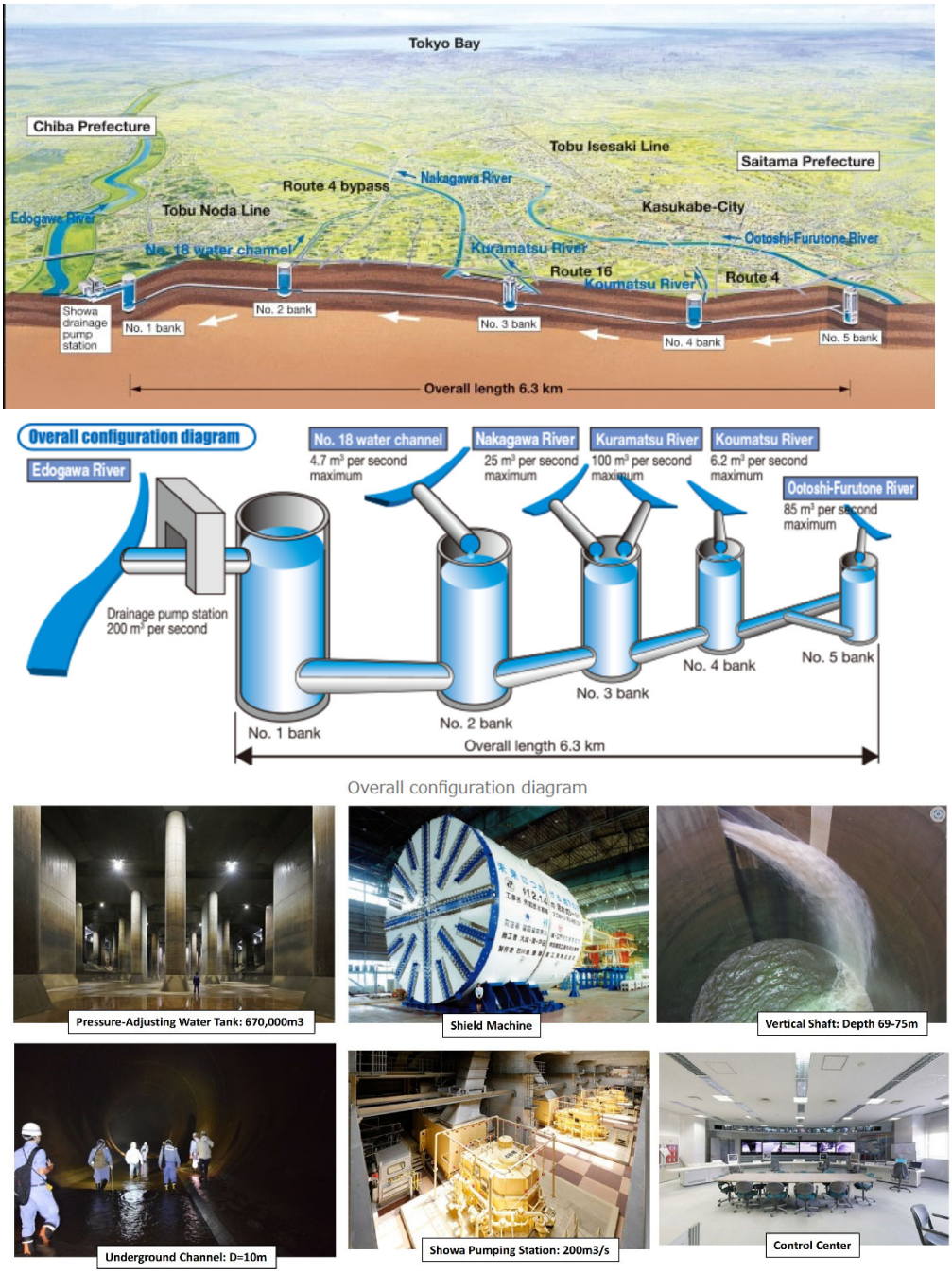


Source: Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

Figure 5.5.1 Image of Comprehensive Flood Control

(2) Large-scale Underground Discharge Channel and Drainage Pipes

This technology applied to divert excess river flow or stormwater to the water bodies with sufficient flow capacity if the capacity of existing river or drain is not sufficient. In Japan, this technology is normally applied in urban area since the land to develop open channel is limited due to urbanization.,Many projects in Japan use underground drainage channels and drainage pipes. One such project for urban drainage facilities is the "underground tunnel" (large-scale underground drainage tunnel) technology, as shown in Figure 5.5.2, typified by the Tokyo Outer Underground Discharge Channel.



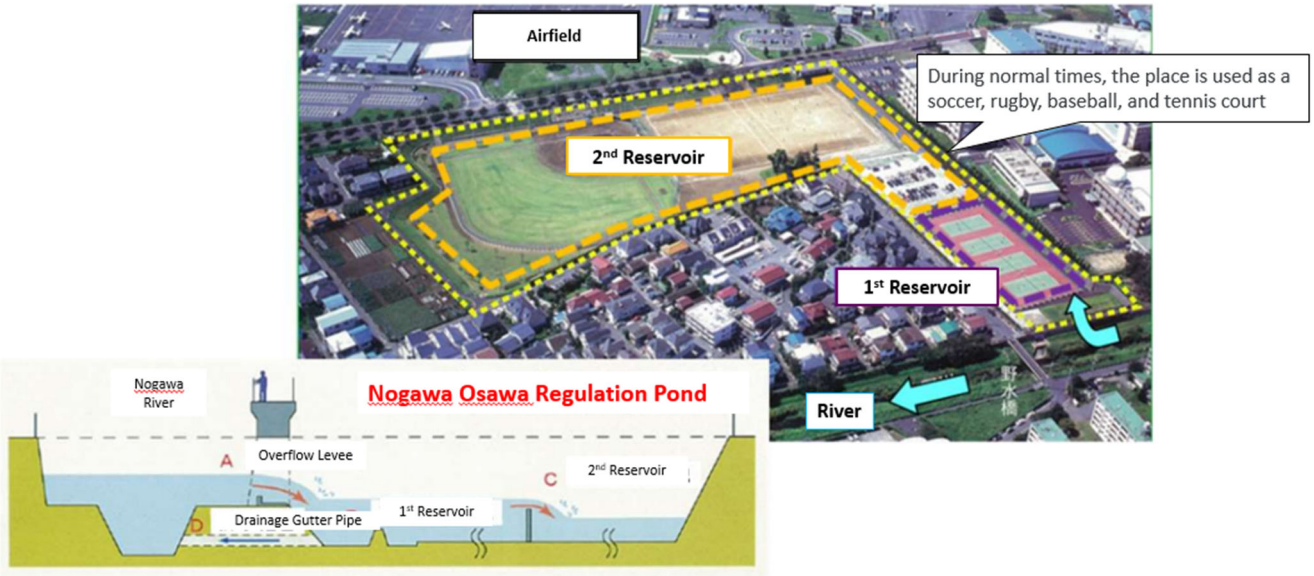
Source: Home page of the Ministry of Land, Infrastructure, Transport and Tourism Kanto Regional Development Bureau

Figure 5.5.2 Large-scale Underground Discharge Channel
(Tokyo Outer Underground Discharge Channel)

(3) Regulation Pond

When there is a limit to the flow capacity of the downstream river channel, regulation pond is applied to temporarily store excess flow to accommodate the downstream capacity, and preventing flooding downstream. The stored water is discharged by pump after the downstream water level drops.

Figure 5.5.3 is an example of regulation pond, i.e., the Nogawa Osawa Regulation Pond. The regulation pond has two reservoirs, and floodwater first flow into the first reservoir near the intake. If the capacity of the first reservoir exceeded, it flows into the second reservoir. This structure takes into consideration maintenance aspects such as reducing the effort required for cleaning.



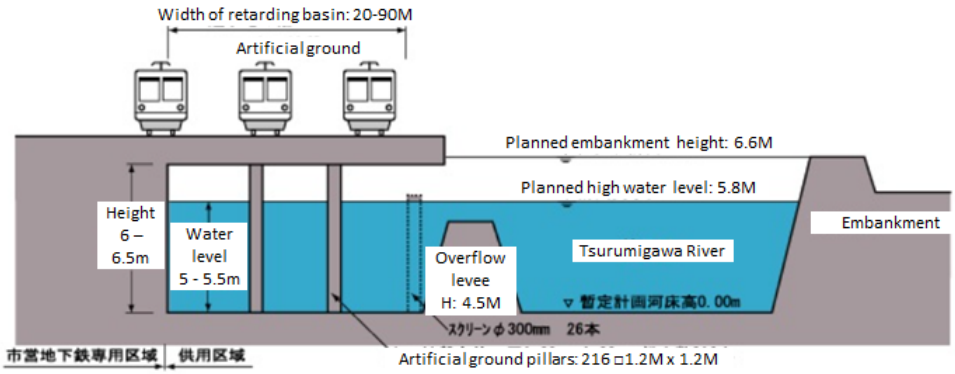
Source: Home page of the Tokyo Metropolitan Government Bureau of Construction, River Department

Figure 5.5.3 Regulation Pond (Nogawa Osawa Regulation Pond)

(4) River Retarding Basin

Same as regulation pond, river retarding basin is applied where the capacity of downstream river channel is not enough. The retarding basin has same function with regulation pond and underground space in an urban area is utilized as an underground storage tank to prevent flooding. An example of this approach is found in Yokohama City, Kanagawa Prefecture, where the underground space of the Kawawa Rail Yard of the Yokohama Municipal Subway Green Line serves as an underground reservoir. This system is designed to mitigate flood risks in areas that are highly vulnerable due to proximity of the Tsurumi River and Kawawa River. The operation of underground storage during heavy rainfall is as follows:

- As the water level of the Tsurumi River rises due to intense rainfall, water flows into the underground reservoir through the "overflow dike," positioned one level lower than the upstream dike.
- By storing water in underground reservoirs, the flow volume of the Tsurumi River is reduced, and the surrounding and downstream areas are protected from flood risk.
- After rainfall, when the water level of the Tsurumi River drops, and there is no danger of it rising again, the gates of the drainage culverts downstream of the underground storage are opened and the water gradually flows into the river.



Source: Home page of the Kanagawa Prefecture Government

Figure 5.5.4 River Retarding Basin (Kawawa River Retarding Basin)

(5) Canal Tide Embankment / Flood Gate

The canal seawall serves as a protective structure against tsunamis and storm surges, safeguarding urban areas.

An example from Tokyo illustrates a seawall design that integrates environmental considerations, including stairs and plantings for accessibility and aesthetic value. Also, sluice gates are installed where the seawall crosses canals and other waterways. The sluice gates are normally open to allow ships to navigate and water to pass, but close at high tide to fulfil the same function as a seawall.

Earthquake-proofing and waterproofing measures are also in place to ensure that the seawall will function reliably even in the event of a major earthquake.

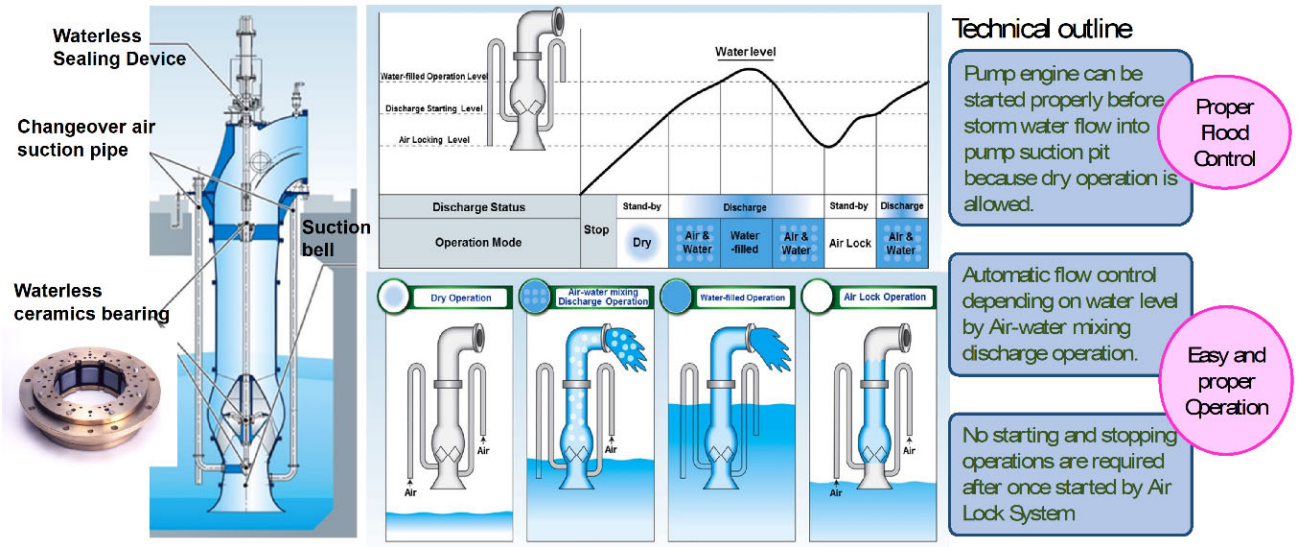
Source: Tokyo Metropolitan Government, Bureau of Port and Harbor

Figure 5.5.5 Canal Tide Embankment (Tatsumi Canal Tide Embankment)

(6) Drainage Pump (Stand-by Operation)

This pumping system is applied in the area where heavy and rapid rainfall is expected, and it is effective to manage the rapid stormwater inflow in urban areas and features the following:

- Full speed operation is possible even no rainwater in a pump suction pit. → Suitable for discharging peak flow coming into downstream in a short time.
- Simple steps to start and less time to re-start. → Easy to re-start and reduce the number of backup pump.
- Reduction of electric consumption (Air operation is 5～20% and air-water mixed operation is 20～100% compared with full operation (100%)). → Operation and maintenance cost is lower than normal type pump.

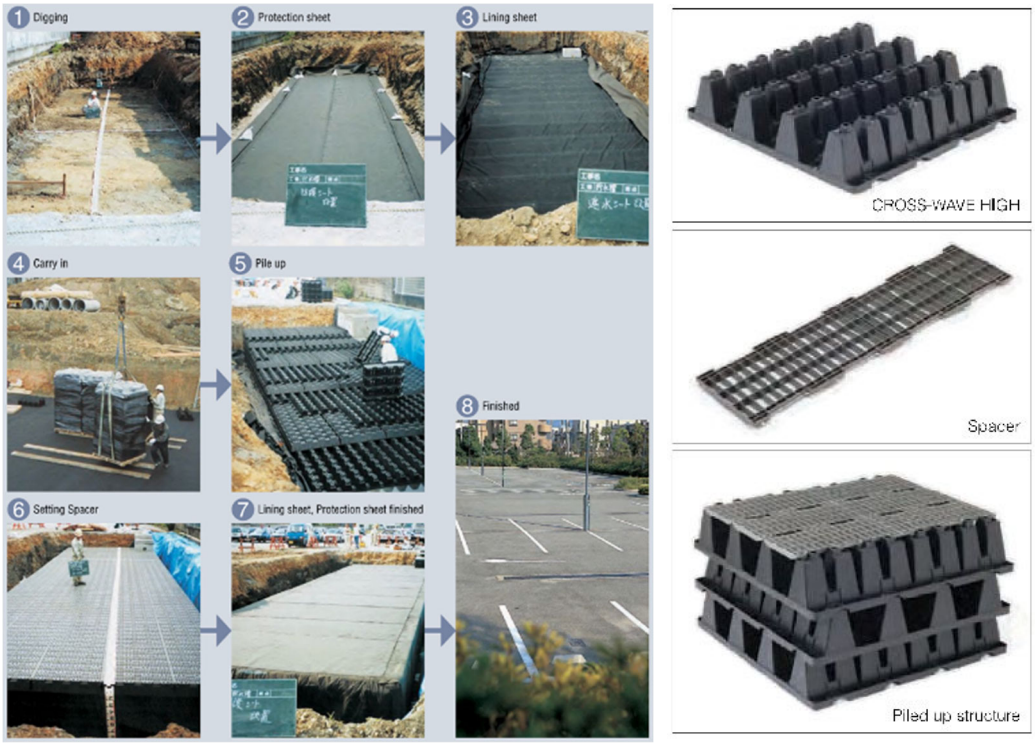


Source: Kubota Corporation

Figure 5.5.6 Drainage Pump (Stand-by Operation)

(7) Plastic Media for Storage and Filtration Facility

Storage and filtration facility is commonly applied to reduce flood damage by reducing runoff. Plastic media for storage and filtration facility has been developed and there are examples of them being used as part of sponge cities in India and they have also been used in Japan. Compared with conventional RC storage sheds, they have the advantages of reducing construction costs to about 60% while having enough strength and shortening the construction period of about one-third compared with concrete structures.

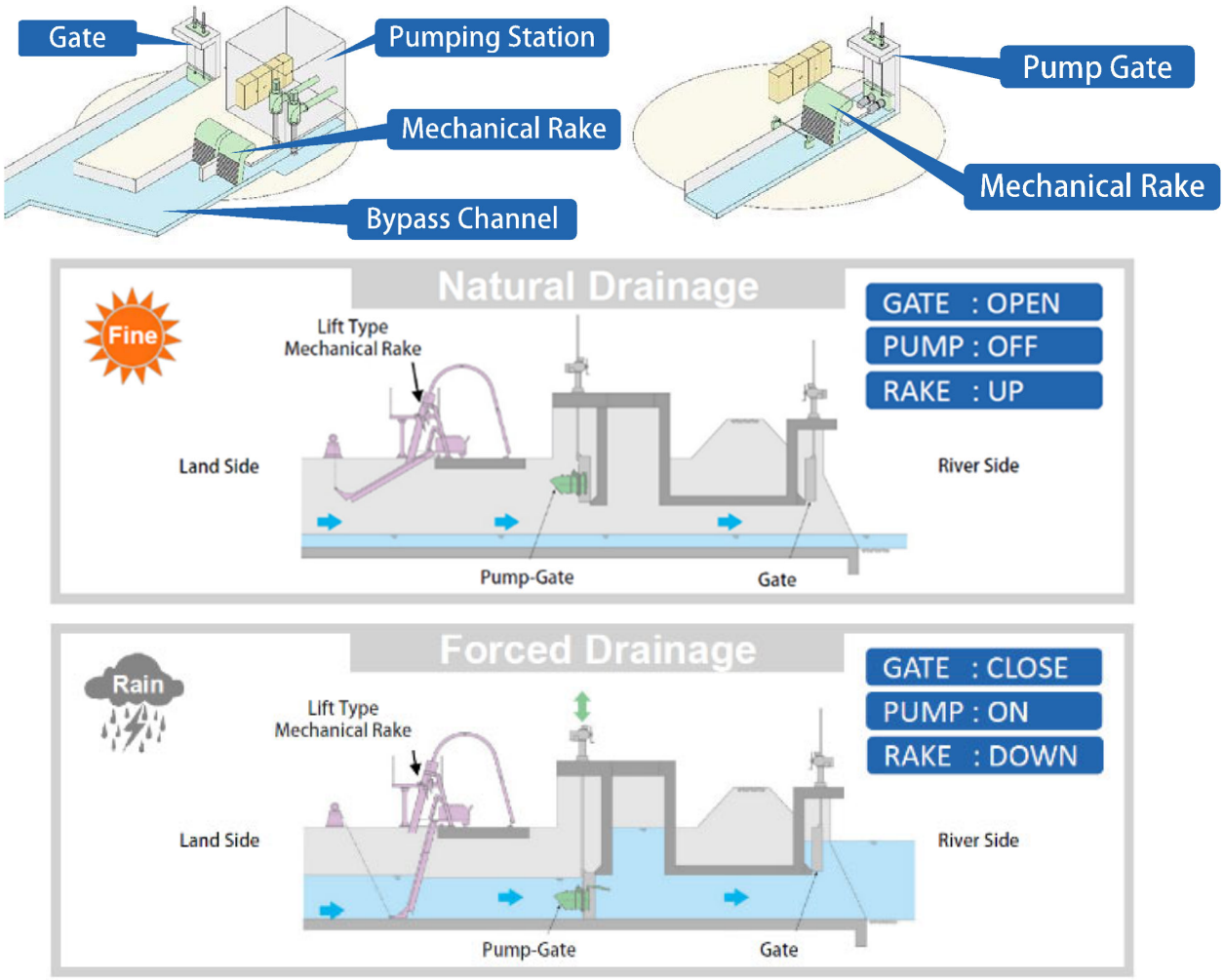


Source: Sekisui Chemical Co., Ltd.

Figure 5.5.7 Plastic Media for Storage Facility

(8) Pump Gate

As a solution for urban drainage where river water level is high, compact and highly economical equipment that integrates pumps and gates has been developed by simplifying the equipment and eliminating the bypass channels to draw in storm water.

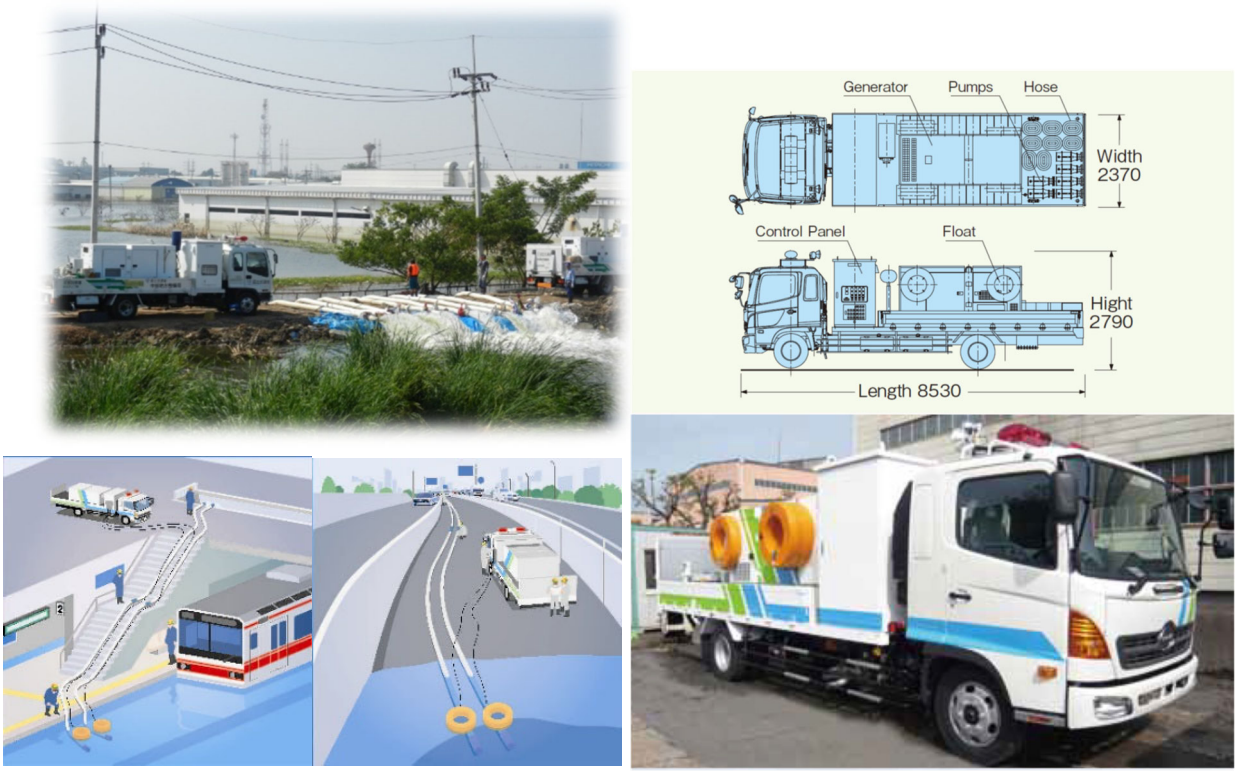


Source: Ishigaki Company Ltd.

Figure 5.5.8 Submergible Pumping System Installed at Pump Gate

(9) Drainage Pump Vehicle

In contrast to fixed pumping stations, drainage pump vehicles, equipped with pumps and motors, are deployed to mitigate localized flooding in areas such as subway stations and beneath elevated roads. Although their drainage capacity is smaller than that of fixed pumping stations, these vehicles offer the advantage of flexibility, as they can rapidly deployed to locations where flooding occurs. Even in India, movable pumps are applied to resolve flooding, but this drainage pump vehicle can be applied more flexible according to status of flooding.



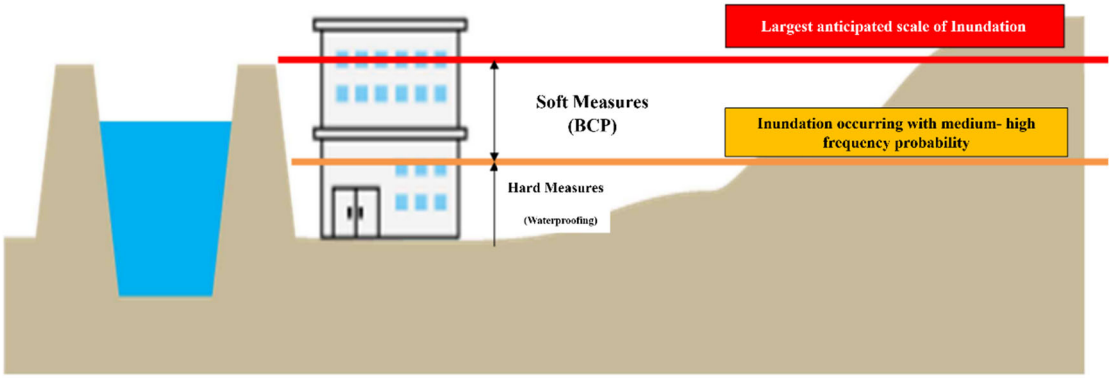
Source: Kubota Corporation

Figure 5.5.9 Drainage Pump Vehicle

(10) Water Resistance

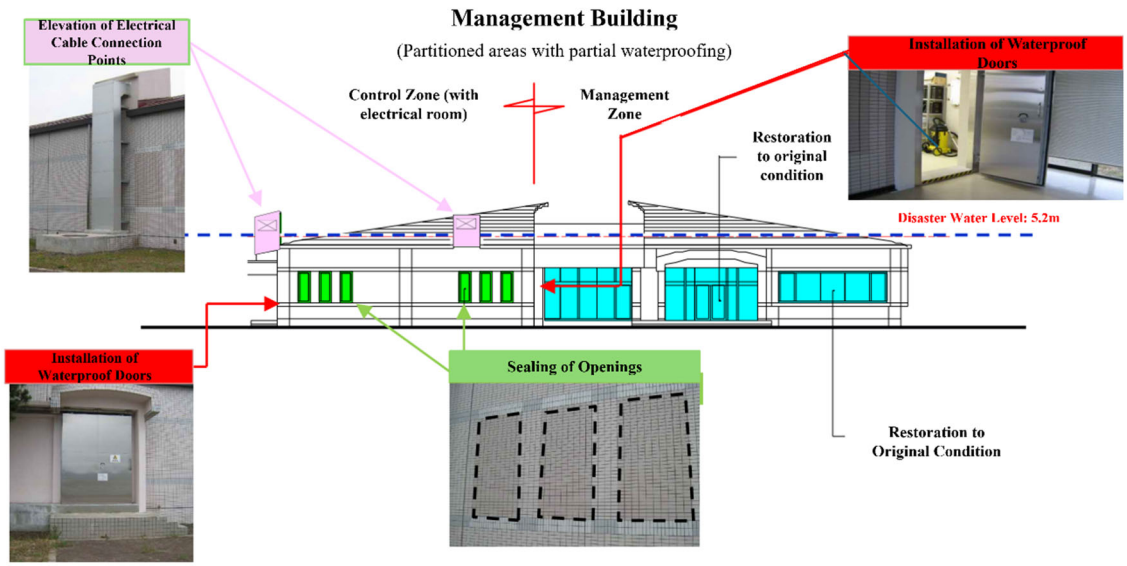
In Japan, sewage treatment plants and pumping stations are critical infrastructure and must remain operational even during disasters such as river flooding. Therefore, hardware measures known as "waterproofing" are being implemented in anticipation of river flooding, which has a medium-to-high frequency probability (approximately 1/30 to 1/80). Specific hard measures are as follows:

- Protecting the entire facility from flooding using waterproof barriers, such as walls.
- Installing key equipment in designated flood-resistant areas.
- Relocating critical infrastructure, including electrical and monitoring rooms, to higher floors.
- Installing watertight doors and seals.
- Sealing apertures to prevent water ingress.



Source: "Concept of Water Resistance of Sewerage Facilities" Ministry of Land, Infrastructure, Transport and Tourism

Figure 5.5.10 Demarcation of the Measures of Water Resistance



Source: "Concept of Water Resistance of Sewerage Facilities" Ministry of Land, Infrastructure, Transport and Tourism

Figure 5.5.11 Example of Water Resistance

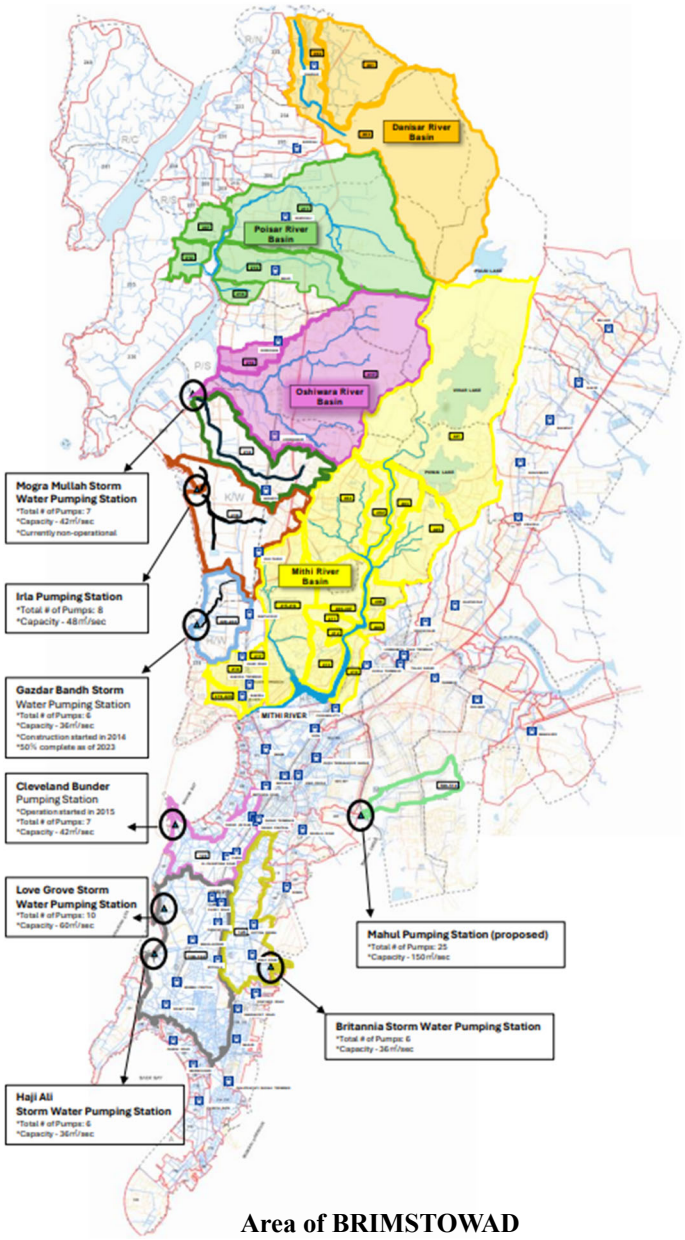
(Miyagi Prefecture Yamamoto Sewage Treatment Center)

5.6 Related Information of Candidate Projects

5.6.1 MCGM

Information of existing Stormwater Drainage Master Plan (BRIMSTOWAD-II) and necessary information to fix scope of coming master plan which was obtained from MCGM and analyzed by JST are summarized in Table 5.6.1.

Table 5.6.1 Basic Information of Stormwater Drainage Master Plan

Item	Contents
Structure of MP	• BRIMSTOWAD -II was prepared in 2018 with the target catchments of City, Western suburb, and Eastern suburb • BRIMSTOWAD-II includes: topographic features, issues of each catchments, proposal to develop SWD facilities in each catchment considering topographic features, and cost to develop SWD facilities.  **Area of BRIMSTOWAD**

<table>
<tr><td>Assessment of safety level against flooding</td><td>• Design rainfall intensity applied in BRIMSTOWAD-II is 55mm/hr and its return period is unclear since the its design report has not provided
• According to the rainfall analysis in BRIMSTOWAD, the rainfall intensity with 55mm/hr is less than 1/1 year return period.
Average intensity in mm/hr
<table>
<tr><td>Return period</td><td colspan="5">Duration hours</td></tr>
<tr><td></td><td>1</td><td>2</td><td>4</td><td>8</td><td>12</td></tr>
<tr><td>1 in 10 Yrs.</td><td>109.0</td><td>89.0</td><td>61.5</td><td>35.5</td><td>28.0</td></tr>
<tr><td>1 in 5 Yrs.</td><td>91.4</td><td>70.3</td><td>51.0</td><td>27.6</td><td>24.0</td></tr>
<tr><td>1 in 2 Yrs.</td><td>74.0</td><td>53.3</td><td>38.0</td><td>22.5</td><td>19.4</td></tr>
<tr><td>1 in 1 Yrs.</td><td>58.0</td><td>40.6</td><td>30.4</td><td>18.1</td><td>16.5</td></tr>
<tr><td>2 in 1 Yrs</td><td>48.0</td><td>33.0</td><td>23.2</td><td>14.6</td><td>12.0</td></tr>
<tr><td>10 in 1 Yrs</td><td>25.0</td><td>17.0</td><td>12.0</td><td>7.6</td><td>5.9</td></tr>
</table></td></tr>
<tr><td>Contents of MP</td><td>• Detail information for each sub-catchment such as area is not indicated in the MP although outline and features are indicated.
• Rainfall analysis such rainfall duration, rainfall volume, as is not provided and Climate change is not considered.
• The result of hydraulic calculation (maximum flow or hydrograph of each sub-catchment) is not indicated.</td></tr>
<tr><td>Assessment of the reason of flooding</td><td>Following issue is pointed out in the MP
• Ground level is lower than the high spring tide, which prevents smooth drain of stormwater and causes flooding where pumping station is not installed.
• Due to limitation of available land, pumping station cannot be installed even in low lying area
• Due to sedimentation of silt and gavages, capacity of pipe and culvert got decreased, which cause flooding.
• Utility lines and pipes crossing drainage culvert becomes obstacle of the flow.
• Since the city development plan does not include storm water drainage plan such as filtration and storage, the flooding risk become increase due to city development.</td></tr>
</table>

Source: Information provided by MCGM such as BRIMSTOWAD-II

Table 5.6.2 Basic Information of Stormwater Drainage Master Plan

Item	Contents
1. Information to determine target catchment for master planning	
Map of rivers and its catchments	• Hydraulic calculation was made in the BRIMSTOWAD-II. Information of all rivers, drainage pipes & culverts, and information of sub-catchment areas are included in its hydraulic model. • However, the data of hydraulic model is in PDF format and it was divided in huge number of files with multiple layers. When they are converted to CAD or GIS format and each files are integrated, there is huge risks for some attribute data to be disappeared and coordinates to be inaccurate. So it is not recommended to utilize these PDF files as the basis of hydraulic model of BRIMSTOWAD-III..

<table>
<tr><td>Asset and population by catchments</td><td>

- MCGM has population and asset data. MCGM will provide them when the MP study is started.
- IIT-Bombay and Tohoku Univ. are planning to apply SATREPS scheme. If they are awarded, they will prepare mapping of mesh-wised asset in MCGM to assess the priority of the investment.

</td></tr>
<tr><td>Mechanism of flooding in 2005</td><td>

The reasons of serious flood in 2005 are as below. Detail is shown in Appendix-8.

- Heavy rainfall of 944 mm happened within a period of less than one day. The rainfall was evaluated as more than 200 years on the rainfall probability scale.
- Very high-density rainfall of 136 mm/hour occurred in the vicinity of Bihar.
- The topography of the area, which is mostly low-lying due to land reclamation in the past, makes many areas lower than the tide level and prone to inundation. In addition, regulating reservoirs, drainage channels, and pumping stations were not constructed sufficiently.
- Width of the Mithi River was too small and had insufficient flow capacity, and Mithi River was also affected by the tidal level, causing it to overflow from the river.
- The Mithi River has a bottleneck near the drainage outlet of the airport and MMRDA controlled area, causing flooding.

</td></tr>
<tr><td>Existing plan, Ongoing and completed sub-project</td><td>

- Sub-projects proposed in BRIMSTOWAD-II have implemented as below:

<table>
<tr><th colspan="5">Priority Works under BRIMSTOWAD Project</th></tr>
<tr><th></th><th>City</th><th>W.S.</th><th>E.S.</th><th>Total</th></tr>
<tr><td>No. of the works</td><td>20</td><td>17</td><td>20</td><td>57</td></tr>
<tr><td>No. of Completed works</td><td>19</td><td>10</td><td>14</td><td>43</td></tr>
<tr><td>No. of the works in progress</td><td>1</td><td>6</td><td>5</td><td>12</td></tr>
<tr><td>Tenders allotted, preliminary work is in progress</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Tenders invited</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
</table>

- Stormwater Pumping Station

<table>
<tr><th>Name of SWPS</th><th>Year of Commissioning</th><th>Capacity (CuM/Sec)</th><th>Total No. of Pumps</th></tr>
<tr><td>Haji Ali</td><td>2011</td><td>36</td><td>6</td></tr>
<tr><td>Irla</td><td>2011</td><td>48</td><td>8</td></tr>
<tr><td>Lovegrove</td><td>2015</td><td>60</td><td>10</td></tr>
<tr><td>Cleveland</td><td>2015</td><td>42</td><td>7</td></tr>
<tr><td>Britannia</td><td>2016</td><td>36</td><td>6</td></tr>
<tr><td>Gazdar Bandh</td><td>2019</td><td>36</td><td>6</td></tr>
<tr><td>Mogra</td><td>In Progress</td><td>42</td><td>7</td></tr>
<tr><td>Mahul</td><td>Tendering in Progress</td><td>Phase I – 60
Phase II – 60</td><td>10
10</td></tr>
</table>

</td></tr>
</table>

- Mini Pumping Station

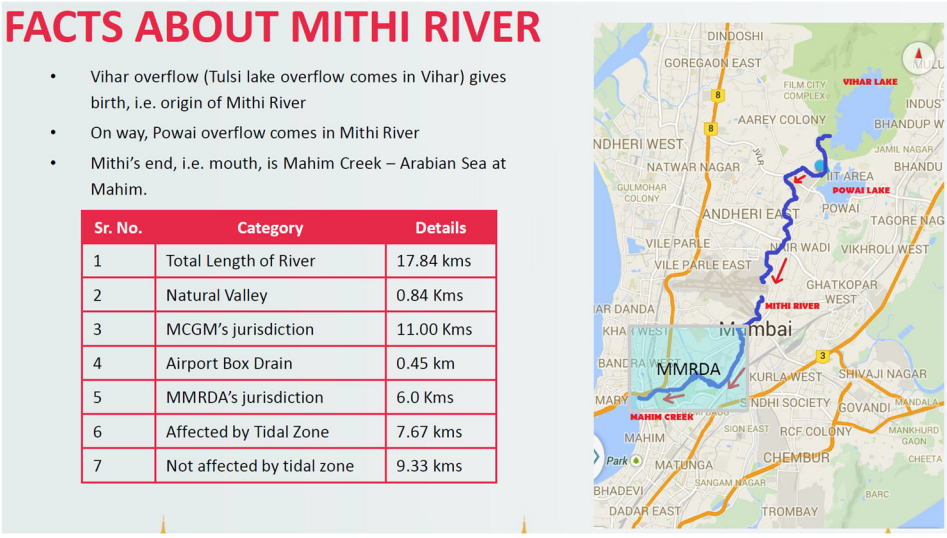
Sr. No.	Location	Total No of Pumps	Remarks
1	Gandhi Market	14	Work Completed
2	Hindmata	15	Work Completed
3	Chunabhatti	6	Work Completed
4	Mahalaxmi	8	Work Completed
5	Yellow Gate P D Mello	3	Work in Progress
6	Bharni Naka Wadala Fire Brigade	4	Work completed
7	90 Feet Jn Sant Rohidas	3	Work will be started before Monsoon 2024
8	T junction Dharavi (with Gate Pump Techanology)	2	Work will be completed before Monsoon 2024
9	Vidhyalankar college road	3	Work completed
	Total	**58**	

- Holding Ponds: Hindamata: 36,000m^3, Milan: 30,000m^3
- Hindmata Flood Relief work: 28,700 m^3
- Mithi River Pollution Control Project

Priority	Work Type	Key Elements	Contract Period	Status
Package 1 (Filterpada to WS P Compound, Powai)	Sewage treatment	8MLD STP at WSP Compound	24 M (I.M.)	Work Completed.
	Sewer line	Construction of interceptors & Laying of 1.65 kms sewer line		
	Service Road	Construction of 1.50 kms service road		
Package 2 (WSP Compound to CST Bridge, Kurla)	Sewer line	Construction of 102 nos. of minor interceptors	24 M (E.M.)	Work is in progress 30% Completed.
	Service Road	Construction of 3.325kms Retaining Wall, 9.375 kms service road		
		Laying of sewer 8.07 kms line		
Package 3 (CST Bridge to Mahim Causeway)	Sewer line, interceptors, Pumping stations	Laying of 8.4 kms of sewer line, Construction 1 no. of major interceptors at Vakola River, Construction of 1 no of sewer pumping stations	36 M (I.M.)	Tendering process is in progress.
	Retaining Wall & Service Road	construction of 7.490 kms of Retaining Wall and 6.421 kms of service road.		
	Gate Pumps	Construction of Gate Pumps at 26 outfalls (including interception work)		
Package 4 (Bapat Nalla – Saphed Pul Nalla – Dharavi WWTF)	Sewer Tunnel	Construction of Major Interceptors at Bapat Nalla & Saphed Pool Nalla	48 M (I.M.)	Work is in progress 30% Completed
		Construction of 2.6m dia Sewer Tunnel from Bapat Nalla & Saphed Pool Nalla to Dharavi WwTF, total length – 6.5 kms		

2. Information to utilize in master planning

Topographic Map	• Topographic data is included in the PDF map of BRIMSTOWAD-II, but the latest DTM is requested to MCGM since the PDF map divided in huge number of files and there is risk of inaccurate when they are converted to CAD or GIS format and integrated into one map
River data (longitudinal and section)	• Topographic map of Mithi River (longitudinal and sectional data) has been provided in PDF format. The original data in CAD format shall be provided when BRIMSTOWAD-III is prepared. • Topographic map of another rivers are under confirmation by MCGM.
Precipitation, Tidal level, Flow	• Disaster management department of MCGM has these data: precipitation and tidal data and the JICA and JST have requested to provide them.
Stormwater drainage network	• All networks are included in the hydraulic model of BRIMSTOWAD-II. • In addition, as-built drawings are available.

Including new areas from BRIMSTOWAD-II	• In the preparation of BRIMSTOWAD-III, there is not so huge expansion of the target area. Expanded area is just the change of the jurisdiction such as port area development.
2-6. Identification of Priority works	• The SWD of MCGM commented the priority of SWD works are: i) City catchment (southern area), ii) northwest catchment, iii) northeast catchment. • This proposal is same as JST's idea since the asset and economic and administrative are concentrate in south area, and main flooded area is concentrated in south and northwest catchments in MCGM.
3. Related information	
Jurisdiction of drainage management	• Jurisdiction of Mithi River was defined in July 2015 as below: ➢ MCGM：Filterpada, Powai and CST Bridge, Kurla, ➢ MMRDA：CST Bridge, Kurla to Mahim Causeway  • All remaining river and drainage in MCGM area are managed by SWD department of MCGM including planning, construction and management.
Possibility to utilize dam for flood control	• There is a natural dam upstream of Mithi-river, and there is no gate to control water level of the upstream dam. • The catchment area of the dam and storage capacity of dam is limited, so SWD of MCGM commented its impact to prevent flooding is limited. • The outfall (spillway) is located in a preservation area, and the possibility to develop it is not yet confirmed.
Issues to construct underground tunnel	• Most critical issue to construct SWD facility in MCGM is land acquisition. For the construction of underground tunnel, land for PS and shaft will be the problem. Only MCGM area such as park shall be utilized. • In addition, there is plan of metro in Mumbai, so the underground tunnel will become deeper to avoid overlap of vertical and horizontal alignment.

FACTS ABOUT MITHI RIVER

- Vihar overflow (Tulsi lake overflow comes in Vihar) gives birth, i.e. origin of Mithi River
- On way, Powai overflow comes in Mithi River
- Mithi's end, i.e. mouth, is Mahim Creek – Arabian Sea at Mahim.

Sr. No.	Category	Details
1	Total Length of River	17.84 kms
2	Natural Valley	0.84 Kms
3	MCGM's jurisdiction	11.00 Kms
4	Airport Box Drain	0.45 km
5	MMRDA's jurisdiction	6.0 Kms
6	Affected by Tidal Zone	7.67 kms
7	Not affected by tidal zone	9.33 kms

<table>
<tr><td>Flow of Mithi River</td><td>In the reports and documents provided by MCGM, no discharge distribution diagram in Mithi River was shown. In the technical report 2013 prepared by Central Water and Power Research Station (CWPRS), 100-year return period hydrographs were created for each sub-catchment (A1-A6) as boundary conditions for discharge in hydraulic simulations for examining the river water levels of Mithi River. Based on these discharges, discharge for each reference river section was calculated by accumulating the peak discharge as shown in these hydrographs according to the drainage area. The 100-year return period hydrograph corresponds to a daily rainfall of 570 mm and was calculated using the rational method.
<table>
<tr><th>Sub. Catchments</th><th>Dranage Area</th><th>Cummulated Area (Km2)</th><th>Peak Discharge (m3/s)</th></tr>
<tr><td>A1</td><td>Vihar Lake to Jogeshawari-Link Road</td><td>18.69</td><td>719</td></tr>
<tr><td>A1+A2</td><td>Jogeshawari-Link Road to Santacruz Airport</td><td>37.91</td><td>1,458</td></tr>
<tr><td>A1～A3</td><td>Santacruz Airport to Kurlakalina Road</td><td>43.61</td><td>1,677</td></tr>
<tr><td>A1～A4</td><td>Kurlakalina Road to Mini Confluence</td><td>49.68</td><td>1,880</td></tr>
<tr><td>A1～ A5</td><td>Mini Confluence to mahim Causeway</td><td>63.88</td><td>2,426</td></tr>
<tr><td>A1～A6</td><td>Vakola Nalla (Right Tributary)</td><td>72.95</td><td>2,775</td></tr>
</table></td></tr>
<tr><td>Possibility to Widening Mithi River</td><td>• Mithi River has already widened as much as possible, and no more widening can be expected.</td></tr>
<tr><td>Budget of SWD department of MCGM</td><td>• SWD of MCGM has enough own budget to implement SWD works and has implemented the subprojects based on BRIMSTOWAD-II.
• The detailed annual expenditure for SWD works will be provided after the meeting with AMC of MCGM.</td></tr>
<tr><td>Environmental Protection</td><td>In the Coastal Zone Development Plan, environmental protection area is defined as below:
• Ecologically Sensitive Areas (CRZ-IA): In this area, environmental protection and preservation of nature are the most prioritized. And most of development works are restricted in this area. The mangrove area nearby rivers is categorized CRZ- IA in Mumbai.</td></tr>
</table>

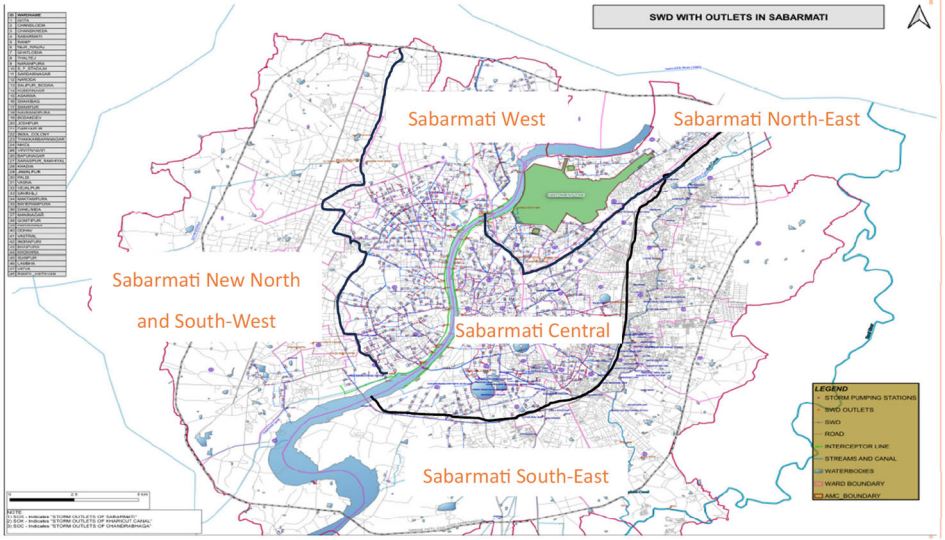
Source: Information provided by MCGM

5.6.2 Ahmedabad

The information on the urban drainage master plan currently being formulated in Ahmedabad is summarized below. Note that the scope of priority project based on the updated urban drainage master plan has not yet been determined as of December 2024.

Table 5.6.3 Basic Information of Urban Drainage Master Plan

Item	Contents
Structure of MP	• A total of four urban drainage master plans have been formulated, three for each river basin and one for pumping stations. • With 2021 as the base year, runoff control measures including future plans, and the

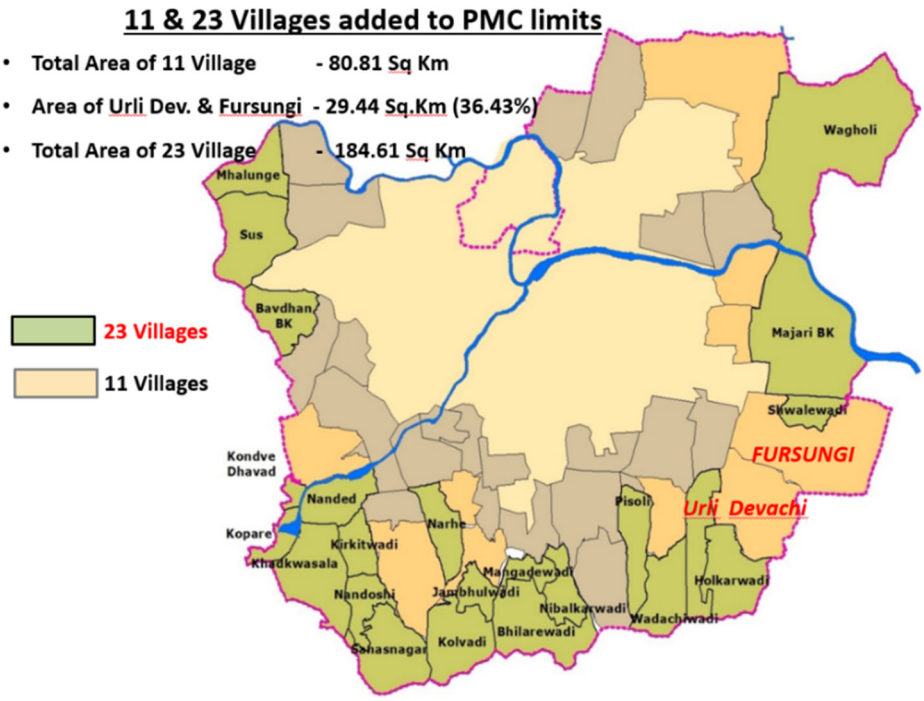
	necessary costs are being considered for the target years of 2036 (15 years later) and 2051 (30 years later). • The target area is the entire AMC. 
Assessment of safety level against flooding	• Plan the facilities with the design rainfall of a 5-year of 2-hours duration. • The "Interlinking of Lakes in South-west Zone" project, which is described in the Project Proposal for Urban Flood Risk Management Programme Under National Disaster Management Authority (NDMA), is planned for a 10-year rainfall (80mm/h).
Contents of MP	• Although the characteristics of the drainage basin are described, the basin area, etc. are not described. • The results of rainfall and rainfall analysis (duration, rainfall volume, rainfall intensity by probability) are not shown. Climate change is not taken into consideration. • The results of runoff analysis of the drainage area (flow volume) are not indicated.
Assessment of the reason of flooding	Although there is no specific description of the causes of flooding (inundation), it is analyzed as follows: • Narrowing of waterway cross section due to illegal occupation. • Increase in stormwater runoff due to development. • Insufficient drainage capacity in the central city area (old city area) • Lack of urban drainage facilities in the expansion area
Progress of MP and bottleneck of the project	• As of December 2024, the packages of priority projects according to SWD MP is still under formulation and the project has not yet initiated. • The Sabarmati River, discharge water body of stormwater from AMC jurisdiction, has well developed by the riverfront project and there is no critical bottleneck of the implementation of the project. At this moment, the sewerage project is ongoing under WB support, so sewerage development is assumed to be more prioritized in the budget allocation.

Source: Information provided by AMC

5.6.3 Pune

(1) Urban Drainage Master Plan

Pune is divided into three areas: the old city area, the expanded 11 administrative districts, and 23 administrative districts. Although an urban drainage master plan has been formulated for the old city area and the 11 administrative districts, it was formulated based on a two-year return period rainfall in accordance with the previous CPHEEO manual, and an urban drainage master plan is planned to be created for a five-year return period rainfall in line with the latest CPHEEO manual. Meanwhile, an urban drainage master plan is being formulated for the expanded 23 administrative districts based on a five-year return period rainfall in accordance with the latest CPHEEO manual and is expected to be completed within FY2024.



Source: PMC

Figure 5.6.1 Expanded Areas of Pune City

Although the scope has not yet been determined, the estimated cost has been calculated based on a review of probable rainfall and price fluctuations and is expected to be approximately Rp.5,500 Cr., as shown below.

Table 5.6.4 Estimated Project Cost Based on the Urban Drainage Master Plan

The status of development of stormwater drainage (SWD) and sewerage are as below:

		City Center		11 Villages (merged in 2018)	23 villages (merged in 2021)	
SWD						
	Plan	MP in 2007	DPR of NDMA project for priority area	DPR in 2020	DPR under preparation (by Oct.2024)	
		RP: 2years (based on previous Guideline)	*RP: 5years (based on latest Guideline)*	*RP: 2years (based on previous Guideline)*	*RP: 5years (based on latest Guideline)*	
		MP will be update in NDMA project with budget Rp 4.6Cr. (by Mar.2026)			-	
	Project	- 4 basins under JNNURM scheme	NDMA project for priority area (to be executed)	-	-	
	Estimated Cost	2800 Cr.		1200 Cr	1500Cr	
		Total 5500 Cr. (4600(85%)+800(15%))				
Sewerage						
	Plan	DPR for JICA project		DPR for Sewerage development	MP for 23 villages	
	Project	JICA ODA project is ongoing		Project under state budget is ongoing	Phase I: 16 villages	Phase II: 7 villages
					under AMRUT 2.0	-
	Cost	-		-	533.85Cr.	900Cr.

Source: PMC and JST

Assessment of Safety Level against Flooding

The SWD MP for 23 expanded local districts is now under preparation and its facilities are planned with design rainfall of 5 year return period according to the latest CPHEEO guideline which mentioned in Chapter 4. On the contrary, design condition of existing SWD MP is less than this condition, and coming MP for city center and 11 expanded local districts will be prepared based on rainfall with 5 year return period. Both MPs does not consider climate change.

Assessment of the Reason of Flooding and Bottleneck of the Project

It is impossible to assess the contents of the SWD MP or compare it with Japanese SWD MP since it is not yet completed as of December 2024. However, the reason of flooding is well investigated and the solution to improve flooding is also expected to be reasonably proposed since flood spot is well detected.

The terrain condition in PMC jurisdiction has enough slope to discharge stormwater, and the main rivers (Mura and Mutha Rivers) have sufficient flow capacity except for the timing of emergency discharge from Khadakwasla dam which is upstream of Mutha River. In this regard, the reason of flooding is just the lack of sufficient drainage facility in the city area. Especially, the SWD is not well developed in newly merged area (11+23 local districts).

The bottleneck of the project implementation might be encroachment as same as another cities. In addition, the gate and pump facility to Muha River might be needed considering the emergency discharge of Khadakwasla dam.

(2) Scope of Sewerage Development

For 7 of the 23 expanded administrative districts, JICA assistance has been requested for sewerage development. The target 7 districts are highlighted in Table below and the scope of works are: 574.4km of sewer network, 3 **STPs** with total capacity of 115MLD, and 2 fecal sludge treatment plants with total capacity of 65KLD, and procurement of 2 suction vehicle. And the cost is expected to be Rp.776Cr. and approximately Rp.900 Cr. Including contingencies.

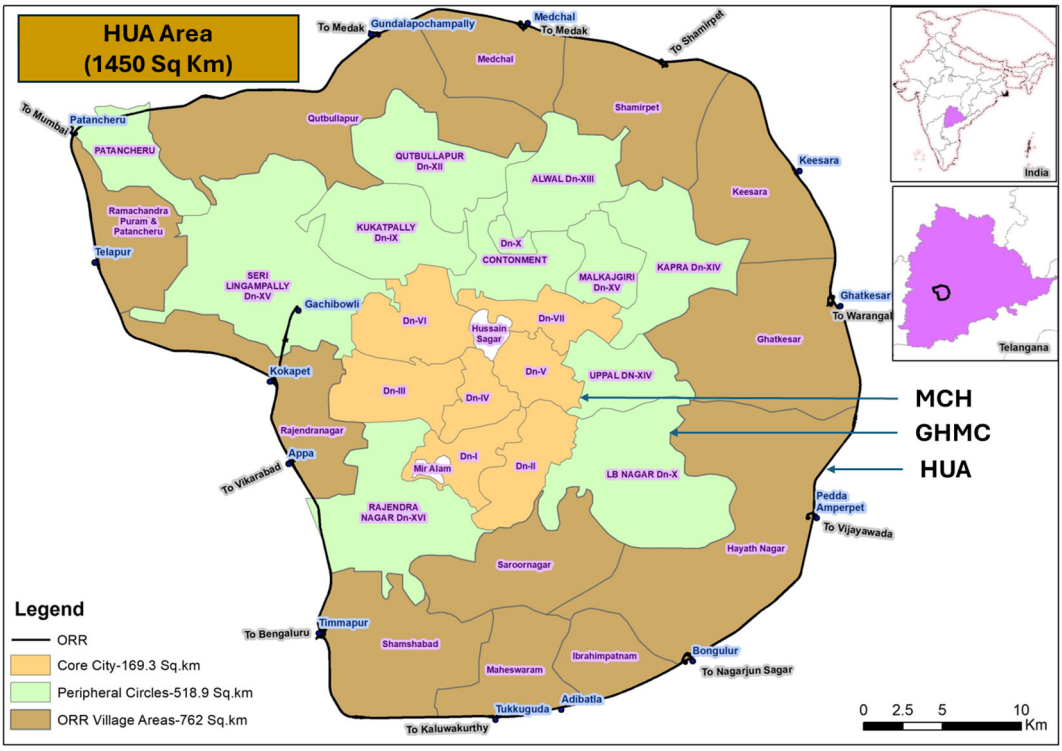
Table 5.6.1 Proposed Project Scope of Sewerage Components

		AMOUNT FOR NETWORK			STP		FSTP		SUCTION VEHICAL 4000 lit.		AMOUNT (STP+FSTP+ SV+IPS	FINAL AMOUNT IN CRS.
SR.	VILLAGE	COLLECTION	TRUNK	1.TOTAL AMOUNT	CAPACITY (MLD)	AMOUNT w/o O&M	CAPACITY (KLD)	AMOUNT	NOS	AMOUNT	2.TOTAL AMOUNT	1+2
1	Sus	43.87	11.56	55.43							-	55.43
2	Mhalunge	39.83	21.05	60.88	38	77.71	10	1.07	2	0.61	79.39	140.27
3	Narhe	39.79	5.83	45.62		-		-		-	-	45.62
4	Pisoli	36.24	11.37	47.61	14	28.59	0	-	1	0.30	28.89	76.50
5	Sanas Nagar	9.26	8.55	17.81		-		-		-	-	17.81
6	Khondwa Dhavad	5.34	3.17	8.50		-		-		-	-	8.50
7	Kirkitwadi	13.72	5.94	19.65		-		-		-	-	19.65
8	Nandoshi	5.06	3.28	8.34		-		-		-	-	8.34
9	Khadakwasla	16.30	8.00	24.29		-		-		-	-	24.29
10	New Kopare	2.16	0.00	2.16		-		-		-	-	2.16
11	Nanded	3.18	5.28	8.46	20	36.35	60	3.34	2	0.61	40.30	48.76
12	Bavdhan	6.46	8.05	14.51		-		-		-	-	14.51
13	Autade Handewac	33.97	7.05	41.02		-		-		-	-	41.02
14	Bhilarewadi	8.38	1.74	10.12		-		-		-	-	10.12
15	Gujar Nimbalkarw	27.80	0.97	28.77	10	25.88		-		-	25.88	54.65
16	Holkarwadi	31.17	21.00	52.17	18.50	34.59	40	2.50	1	0.30	37.39	89.56
17	Jambhulwadi	15.40	8.95	24.35		-		-		-	-	24.35
18	Kolewadi	5.74	2.28	8.02		-		-		-	-	8.02
19	Mangadewadi	31.01	0.00	31.01		-		-		-	-	31.01
20	Wadachiwadi	27.65	4.83	32.48		-		-		-	-	32.48
21	Wagholi	202.69	71.02	273.72	51.50	73.38	25	1.84	1	0.30	75.52	349.24
		0.00		-	4.50	16.20		-		-	16.20	16.20
22	Shewalwadi	17.22	0	17.22		-		-		-	-	17.22
23	Manjari	132.31	10.97	143.28	45	88.95		-			88.95	232.23
				-				-			-	0.00
	Total	**754.56**	**220.89**	**975.45**		**381.65**		**8.75**		**2.12**	392.52	**1,367.94**

Source：Information provided by PMC, and JST adjusted

5.6.4 Hyderabad

As shown in the figure below, Hyderabad's city area is expanding. And it became the Greater Hyderabad Municipal Corporation (GHMC) in 2007 and the Hyderabad Urban Agglomeration (HUA) in 2020 successively.



Source: HUA

Figure 5.6.2 Hyderabad Metropolitan Expansion Area

Regarding the urban drainage master plan, the urban drainage master plan was formulated for the GHMC area in 2012, and the DPR for the Strategic Nala Development Programme (SNDP) was prepared in 2022, and Phase 1 of the plan is currently executing.

Table 5.6.5 Urban Drainage Master Plan for Hyderabad Urban Agglomeration

Year	1933-2007	2007-2020	2020 to Present
Name	Hyderabad Municipal Corporation (MCH)	Greater Hyderabad Municipal Corporation (GHMC)	Hyderabad Urban Agglomeration (HUA)
Area (Km^2)	169.3	518.9 (=688.2-169.3)	762.8 (=1450-688.2)
Drainage Studies	Kirlosker Committee Study (Unit hydrograph)	Storm Water Drainage Master Plan (Voyants Solutions Pvt Ltd: 1/5Y)	DPR Under SNDP (Phase-I and Phase -II) (1/5Y based on CPHEEO)
Report	2002	2012	2022
Proposal Executed	Channelization of Major Nalas Taken up	Not fully implemented (5-10% only) No DPR, lack of fund, land issue	64 No. of works with INR 1095 Crores (Phase I loan) . Phase II Proposal are Yet to be taken up

Source: HUA

Currently, urban drainage projects based on the SNDP are being executed, and it is necessary to proceed the Phase-II of the project. The estimated cost is Rp. 5,135 Cr.

Table 5.6.6 Project Cost Based on the Strategic Nala Development Programme of Phase II

S. No	Project Area (GHMC / ULB)	No. of Works	Length in 'Km'	Cost in Rs. Crores
A	GREATER HYDERABAD MUNICIPAL CORPORATION			
1	L B Nagar	23	38.021	460.53
2	Charminar	33	26.350	305.70
3	Khairatabad	11	14.651	148.37
4	Serilingampally	30	38.760	434.43
5	Kukatpally	31	47.269	663.51
6	Secunderabad	20	10.780	128.68
	Total (A)	**148**	**175.831**	**2141.22**
B	ULBs (Excluding GHMC within ORR)			
	(Details annexed)			
	Total (B)	**267**	**275.401**	**2993.93**
	Grand Total (A + B)	**415**	**451.232**	**5135.15**

Source: HUA

Assessment of Safety Level against Flooding

As mentioned before, the SNDP proposed facilities based on design rainfall of 5 year return period according to the latest CPHEEO guideline. The climate change is not considered in the SNDP.

Assessment of the Reason of Flooding and Bottleneck of the Project

The HUA has enough slope to discharge stormwater and the Musi River has enough capacity since there are dams in upstream of the river to regulate its flow. Therefore, the main reason of flooding is seemed to be insufficient drainage facilities in HUA and serious rainfall in resent years.

The bottleneck of the project implementation is mainly encroachment, so SNDP was prepared to minimize land acquisition and resettlement by diverting the alignment of drainage facilities.

5.7 Preparation of Documents for Project Approval in India

The draft PPR proposals for the candidate projects listed in Table 5.4.1 are attached in Appendix 7. For Ahmedabad, Pune and Hyderabad, the contents were validated by the AMC, PMC, and GHMC during the third and fourth field surveys.

Regarding Mumbai, the JST prepared the PPR and the draft of the potential activities for updating the masterplan and PPR for the discussion purpose. JICA will discuss the further steps internally.

Table 5.7.1 Requested Support for Projects and Next Steps Required

	Mumbai (MCGM)	Ahmedabad (AMC)	Pune (PMC)	Hyderabad (GHMC)
Scope of Proposed Project	Preparation of SWD MP (BRIMSTOWAD-III) and Pre-FS for priority project	Implementation of priority projects under Japanese ODA - Kharicut Canal project - Chandrabhaga Canal project - Priority project proposed in the MP (under preparation)	Implementation of priority projects under Japanese ODA 1) Stormwater drainage: - 1st phase: 23 expanded municipal districts - 2nd phase: City center and 11 expanded municipal districts 2) Sewerage - 23 expanded municipal districts (phase 2)	Implementation of priority projects SNDP-Phase2 under Japanese ODA Musi Riverfront Development Project (Telangana State project)
PPR Submission	-	Not yet submitted	Submitted to UDD Maharashtra	Not yet submitted
Necessary action for JICA after the study	To support preparation of the BRIMSTOWAD-III and pre-FS for its priority project	1) To confirm AMC's decision whether to utilize Japanese ODA for the priority projects 2) To request AMC to submit PPR to Gujarat UDUH if AMC require ODA 3) To facilitate approval of PPR (state authority and ministry)	1) To confirm progress of master planning • SWD MP for the 23 municipal districts (initially to be completed by Oct.2024) • SWD MP for city center and the 11 municipal districts (procurement of consultant is under preparation) 2) To facilitate approval of PPR (state authority and ministry)	To facilitate approval of PPR (state authority and ministry) after GHMC submit PPR to Telangana- MAUD

Source: JST

APPENDIX

Appendix-1

URBAN FLOOD RECORD IN THE MAJOR CITIES OF LONG-LISTED STATES

APPENDIX-1. Urban flood record in the top cities in each state with over 1 million population

The table below summarizes the disaster situation caused by floods in each city. The data included are as follows:

- Date of disaster occurrence
- Event name
- Number of deaths
- Number of victims
- Number of evacuees
- Number of house damages
- Damage amount
- Critical infrastructure damage
- Damaged basin
- Rainfall
- Flood depth
- Associated disaster

And the data sources of these data are EM-DAT and web search.

Gujarat State

	1	2	3	4	5	6	7	8
City	Ahmadabad	Ahmadabad Surat	Ahmadabad	Surat	Surat	Surat	Surat	Surat
Date of disaster occurrence (start-end date)	2000/8/2-2000/8/30	2005/6/28-2005/7/15	2022/7/16-2022/7/16	1998/6/9-1998/6/11	2005/9/22-2005/10/11	2015/6/19-2015/6/20	2016/8/1-2016/8/3	Jun of 2017-Aug of 2017
Event name	Monsoonal rain	Heavy rains	Heavy Monsoon Rain		Heavy rains	Monsoon rains	Monsoonal rains	Monsoon
Deaths	867	239	63	2871	15		37	284
Victims	22,000,000	405,000	11,194,069 (300 villages)	4,600,893		9,000	3,000	520,000
Evacuees			40,000					
House damage			25 houses destroyed & 1,509 houses damaged					
Damage amount	73,079 ('000 US$)	3,446,671('000 US$)		842,013('000 US$)		745,784 ('000 US$)		298,482 ('000 US$)
Critical infrastructure damage			50 roads shut Crops: 50,000 ha damaged					370 roads damaged, 753 villages electricity cut off, Train operation cancelled
Damaged states	Bihar, Himachal Pradesh, Uttarakhand, Gujarat, Andhra Pradesh, Assam, Arunachal Pradesh, Madhya Pradesh, Punjab, Uttar Pradesh, Maharashtra, Rajasthan, Chandigarh, Kerala	Gujarat		Gujarat, Rajasthan, Maharasthra		Gujarat, Maharasthra		Gujarat, Rajasthan, West Bengal
Damaged basins	Brahmaputra and its tributaries, Bagmati, Kosi, Gandak, Murigandak, Kamlabalan, Mahananada, Adhwara, Ganges, Bhagra, Ganga, Burhi Gandak, Bagmati and Punpun	Vishwamitry, Purnea, Auranga, Wanki, Ambika, Kaveri, Kharera	Southern Gujarat		Vishwamitri, Tapi			Banas river
Rainfall			Chhota Udaipur and Panchmahal districts: 400 to 550 mm/24hrs (11 July).					Gujarat: 1-28 July, 559.4mm
Flood depth								
Associated disaster					Broken Dam/Burst bank			
Source	EM-DAT	EM-DAT	https://floodlist.com/asia/india-floods-gujarat-july- https://www.bbc.com/news/world-asia-india-62131723 https://www.thehindu.com/news/national/other-states/in-gujarat-over-40000-people-shifted-from-flood-affected-areas/article65645350.ece	EM-DAT	EM-DAT	EM-DAT	EM-DAT	EM-DAT https://en.wikipedia.org/wiki/2017_Gujarat_flood

West Bengal State

	1	2	3	4	5	6	7	8
City	Kolkata	Kolkata	Kolkata	Kolkata	Kolkata	Kolkata	Kolkata	Kolkata
Date of disaster occurrence (start-end date)	2002/4/27-2002/4/27	2005/5/4-2005/5/4	2007/9/22-2007/10/3	2009/5/25-2009/5/25	Jun of 2017-Aug of 2017	2018/4/17-2018/4/17	2020/5/20-2020/5/20	2021/10/2-2021/10/3
Event name			Tropical depression in Bay of Bengal	Tropical cyclone Cyclone "Aila"	Monsoon		Tropical cyclone Cyclone 'Amphan'	
Deaths	11	11	80	96	284	50	90	11
Victims		20	7,200,000	5,100,000	520,000	22,050	18,000,000	
Evacuees					47,000 people(311 relief camps)			500,000 (1,100 Relief camps)
House damage					7,870 Damaged, 44,362 partially damaged			
Damage amount			388151 ('000 US$)		298482 ('000 US$)	116546 ('000 US$)	15265339 ('000 US$)	
Critical infrastructure damage								
Damaged basin			Brahmani, Baitarani, Burhabalang, Budhabalanga, Suvarnarekha, Kalo, Sunei, Jalaka, Kansabansha (Orissa), Hugli, Kangsabati, Keleghai, Silabati, Subarnarekha, Dulung, Bhagirathihad, Bhagirathiis, Bhagirati (West Be,gal		Banas river			Ajoy, Dwarakeswar & Damodar Rivers
Rainfall					400mm/3days (South Bengal) 142mm/48hrs (Kolkata)			Asansol:(340mm/24hrs), Raniganji (400mm/24hrs)
Flood depth								
Associated disaster				Slide (land, mud, snow, rock)				
Source	EM-DAT	EM-DAT	EM-DAT https://www.reuters.com/article/idINIndia-29023620070817	EM-DAT	EM-DAT https://en.wikipedia.org/wiki/2017_West_Bengal_floods	EM-DAT	EM-DAT	https://floodlist.com/asia/india-floods-west-bengal-october-2021

Uttar Pradesh State

	1	2	3	4	5	6
City	Kanpur	Kanpur	Kanpur	Lucknow	Lucknow	Lucknow
Date of disaster occurrence (start-end date)	2005/7/7-2005/7/28	2011/8/15-2011/10/2	2019/9/26-2019/9/30	2013/7/20-2013/7/21	2014/10/13-2014/10/15	2021/9/15-2021/9/17
Event name	Monsoon rain	Monsoonal rain			Cyclone Hudhud	
Deaths	70	204	93	152 (?)	18	58
Victims	1,908,000	5549080	580,000			90,000 people (470 villages in 13 districts)
Evacuees			48,000			1,200 people (186 relief camps)
House damage						15 homes destroyed, 100+ severely damaged
Damage amount						
Critical infrastructure damage			Power supply, Roads and Railways. Schools & healthcare facilities			
Damaged basin	Brahmaputra and tributaries. Lohit, Dikhow, Jai Bharati, Puthimari, Subansairi, Dhansiri, Durra, Burhi-Dehing, Kundli, Jiyadhol, Lali and Siang, Barak. Ganges and tributaries. Baghmati, Ganga, Sharda, Gandak, Yamuna, Varuna, Nagwa nullah, Kane, Kosi, Bagmati, Kamla, Budi Gandak, Rapti, Ghaghra, Gomti, Ken, Budhi Rapti.	Bagmati, Burgi, Dhansiri, Gandak, Ganges, Ghanghra, Kosi, Pupun rivers	Ganga & Ghagra rivers	Gomti river Sharda, Ghaghra, Ramganga, Ganga, Yamuna, Betwa, Kain, Gomti, Sai and Saryu.		the Kwano, Sarda, Ganges and Ghagra rivers
Rainfall			Prayagraj:102.2mm/day Varanasi:84.2mm/day		Lucknow:61.1 mm/24hrs Gorakpur: 126mm/24hrs	Fursatganj:186 mm/24 hrs, Sultanpur: 118 mm/24hrs, Lucknow: 107 mm/24hrs . Barabanki: 176 mm/24hrs, Lucknow: 128 mm/24hrs, Kanpur 102 mm/24hrs, Hardoi 112 mm/24hrs.
Flood depth						
Associated disaster	Slide (land, mud, snow, rock)					
Source	EM-DAT	EM-DAT	https://floodlist.com/asia/india-floods-uttar-pradesh-bihar-september-2019	https://floodlist.com/asia/uttar-pradesh-india	https://floodlist.com/asia/aftermath-cyclone-hudhud-18-killed-uttar-pradesh-floods	https://floodlist.com/asia/india-floods-uttar-pradesh-september-2021

Bihar State (1/2)

	1	2	3	4	5	6
City	Patna	Patna	Patna	Patna	Patna	Patna
Date of disaster occurrence (start-end date)	Aug of 2001 - Aug of 2001	2002/6/21-2002/8/28	2007/7/3-2007/9/22	2008/8/30-2008/9/8	2011/8/15-2011/10/2	2012/9/19-2012/9/23
Event name		Monssonal rain	Monsoonal rain	River Kosi in Nepal discharged huge levels of water, monsoonal rains	Monssonal rain	Monsoonal rains
Deaths		549	1,103	47	204	21
Victims	400,000	42,000,000	18,700,000	2600000	5549080	2000000
Evacuees						
House damage			29,000 houses destroyed & 44,000 houses damaged			
Damage amount		50,066 ('000 US$)		27,185 ('000 US$)		124,917 ('000 US$)
Critical infrastructure damage						
Damaged states		Assam, Bihar, Himachal Pradesh, Madhya Pradesh, Uttarakhand, Andhra Pradesh, West Bengal, Meghalaya, Tripura, Arunachal Pradesh, Gujarat, Kerala, Manipur, Maharashrta		Bihar, Assam		Assam, Bihar, Jharkhand, Sikkim, Uttar Pradesh, West Bengal, Arunachal Pradesh
Damaged basins		Ganga-Padma, Brammaputra-Jumuna and the Meghna river , Torsa, Tista, Bagmati, Kosi, Gandak, Kareh, Adhwara, Ganga, Burhi Gandak, Punpun. Jiadhal, Subansiri, Bramaputra, Barak and Kathakal,	Ganga, Brahmaputra, Meghana rivers	Brahmaputra river	Bagmati, Burgi, Dhansiri, Gandak, Ganges, Ghanghra, Kosi, Pupun rivers	
Rainfall						
Flood depth						
Associated disaster				Broken Dam/Burst bank		Slide (land, mud, snow, rock)
Source	EM-DAT	EM-DAT	EM-DAT https://en.wikipedia.org/wiki/2007_Bihar_flood	EM-DAT	EM-DAT	EM-DAT

Bihar State (2/2)

	7	8	9	10	11
City	Patna	Patna	Patna	Patna	Patna
Date of disaster occurrence (start-end date)	2016/6/12-2016/6/12	2016/7/15-2017/9/12	2017/7/8-2017/7/11	2019/9/26-2019/9/30	2021/8/16-2021/8/17
Event name		Monsoonal rains	Monsoon		
Deaths	11	254	23	93	12
Victims		1600000	12	580,000	2.7 Million pepple (2,176 Villages in 15 Districts)
Evacuees				48,000	85,000 people
House damage					
Damage amount		426,776 ('000 US$)			
Critical infrastructure damage				Power supply, Roads and Railways. Schools & healthcare facilities	
Damaged states		Biha, Uttar Pradesh,			
Damaged basin				Ganga & Ghagra rivers	Ganges River
Rainfall				Prayagraj:102.2mm/day Varanasi:84.2mm/day	
Flood depth					
Associated disaster					
Source	EM-DAT	EM-DAT	EM-DAT	https://floodlist.com/asia/india-floods-uttar-pradesh-bihar-september-2019	https://floodlist.com/asia/india-floods-bihar-august-2021-update

Maharashtra State(1/2)

	1	2	3	4	5	6	7
City	Mumbai Pune	Mumbai (Suburban)	Mumbai	Mumbai Pune	Mumbai City Pune	Mumbai (Suburban)	Mumbai
Date of disaster occurrence (start-end date)	1989/7/23-1989/7/25	Jun-01	2005/7/24-2005/8/5	2006/7/1-2007/7/7	2007/6/22-2007/7/4	2007/7/1-2007/7/6	2017/8/29-2017/8/29
Event name		Flood	Monsoonal rain		Monsoonal rain and tropical cyclone	Monsoonal rain	Torrential rains
Deaths	917	28	1200	131	127	62	14
Victims			20,000,000		200,000	10,000	
Evacuees	200k households		5000				
House damage	1.1 million		2,000				
Damage amount			4,990,180 (000USD)				358178 ('000 US$)
Critical infrastructure damage	・Damage to building, road and power stations would be rs. 91 crores ・Train services were cancelled		・Total collape of transport and communication system. ・Airport was closed down for 2 days. ・The major roads were submerged. ・Suburban trains stopped the operation for 36 hours. ・Intercity train stopped the operation for over 1 week.	Road/rail /air traffic disrupted.			
Damaged states			Gujarat, Madhya Pradesh, Maharashtra, Goa, Orissa, Karnataka, Himachal Pradesh, Jammu and Kashmir				Maharashtra
Damaged basins					Krishna, Godavari and tributaries		
Rainfall	72cm in 24 hours		・944mm during 24 hours ・Almost 35% of annual rainfall occurred on a single day, Jul 26				330 mm within 12 hours
Flood depth							
Associated disaster	Landslide in Pune		Land slide		Slide (land, mud, snow, rock)		
Source	IFI https://github.com/hydrosenselab/India-Flood-Inventory	EM-DAT	EM-DAT International Journal of Scientific & Engineering Research https://www.ijser.org/researchpaper/Urban-Floods-in-India.pdf Municipal Corporation of Greater Mumbai https://www.preventionweb.net/files/section/230_mumbaiflood Shanghai.pdf IFI https://github.com/hydrosenselab/India-Flood-Inventory	IFI https://github.com/hydrosenselab/India-Flood-Inventory	EM-DAT	EM-DAT	EM-DAT Hindustan Times https://www.hindustantimes.com/cities/mumbai-news/mumbai-coastline-crisis-urban-flooding-is-a-public-health-issue-101636482795368.html

Maharashtra State(2/2)

	8	9	10	11	12	13
City	Mumbai Pune	Pune	Pune	Pune	Pune	Nagpur
Date of disaster occurrence (start-end date)	2019/6/28-2019/7/4	2016/8/1-2016/8/3	2019/7/14-2019/9/30	2020/6/3-2020/6/3	2021/6/1-2021/9/30	2005/9/14-2005/9/20
Event name	Monsoon	Monsoonal rains	Monsoon rains	Tropical cyclone Cyclone 'Nisarga'	Monsoon rains	
Deaths	52	37	1,900	6	1282	89
Victims		3,000	3,000,000	7,500	375,000	550,000
Evacuees					434,150	
House damage						
Damage amount			11,447,148 ('000 US$)	927,228 ('000 US$)	3,348,087 ('000 US$)	629,392 ('000 US$)
Critical infrastructure damage						
Damaged states			Bihar, Assam, Maharashtra, Kerala, Rajasthan, West Bengal, Karnataka, Uttarakand, Himachal Pradesh, Punjab, Uttar Pradesh, Odisha	Maharashtra	Maharasthra, Goa, Karnataka, Jharkhand, Bengale, Himachal Pradesh, Uttarakand	
Damaged basin		Savitri				Budhabalanga, Subarnarekha, Baitarani, Mahanadi, Kathajod, Shivnath, Banganga
Rainfall			87.3mm			
Flood depth						
Associated disaster	Broken Dam/Burst bank		Slide (land, mud, snow, rock)		Slide (land, mud, snow, rock)	Broken Dam/Burst bank
Source	EM-DAT	EM-DAT	EM-DAT DownToEarth https://www.downtoearth.org.in/news/natural-disasters/what-fuelled-this-year-s-flood-fury-in-pune--67154	EM-DAT	EM-DAT Asia Disster Reduction Center (ADRC) https://www.adrc.asia/publications/annual/21/21eng/pdf/3-0E.pdf	EM-DAT

Telangana State (1/2)

	1	2	3	4	5	6
City	Hyderabad	Hyderabad	Hyderabad	Hyderabad	Hyderabad	Hyderabad
Date of disaster occurrence (start-end date)	1998/9/20-1998/9/20	2000/8/23-2000/8/31	2005/7/10-2005/7/10	2006/2/15-2006/4/18	2008/8/8-2008/8/10	2014/3/6-2014/3/7
Event name		Brief torrential rain	Heavy rains	Heavy rain		Convective storm
Deaths	230	179	12	20	14	7
Victims	375,000	252,016	10,000			1,928
Evacuees						
House damage					hundreds	
Damage amount	949015 ('000 US$)	294014 ('000 US$)			68 ('000 US$)	
Critical infrastructure damage						
Damaged states	Andhra Pradesh, Telangana	Andhra Pradesh, Telangana			Telangana*	
Damaged basins		Godavari				
Rainfall		240 mm			15cm in less than 14 hours 237mm	
Flood depth						
Associated disaster						
Source	EM-DAT	EM-DAT MDPI https://www.mdpi.com/2071-1050/13/11/6346	EM-DAT	EM-DAT	International Journal of Scientific & Engineering Research https://www.ijser.org/researchpaper/Urban-Floods-in-India.pdf MDPI https://www.mdpi.com/2071-1050/13/11/6346	EM-DAT

* No data available about damaged states since the data source is focusing on urban damage only

Telangana State (2/2)

	7	8	9	10	11
City	Hyderabad	Hyderabad	Hyderabad	Hyderabad	Hyderabad
Date of disaster occurrence (start-end date)	2016/9/23	2019/6/1-2019/6/3	2020/10/1-2020/10/26	2021/9/26-2021/9/26	2021/10/3-2021/10/3
Event name		Convective storm	Heavy rains	Tropical cyclone Cyclone 'Gulab'	Tropical cyclone Cyclone 'Shaheen'
Deaths		10	152	20	7
Victims			150,000		179,000
Evacuees					
House damage					
Damage amount	138 ('000 US$)		4523063 ('000 US$)		
Critical infrastructure damage					
Damaged states	Telangana*		Telangana, Andhra Pradesh, Karnataka, Odisha		
Damaged basin					
Rainfall	165 mm				
Flood depth					
Associated disaster					
Source	MDPI https://www.mdpi.com/2071-1050/13/11/6346	EM-DAT	EM-DAT	EM-DAT	EM-DAT

Tamil Nadu State

	1	2	3
City	Coimbatore	Coimbatore	Coimbatore
Date of disaster occurrence (start-end date)	1978/11/1-1978/11/7	2002/10/1-2002/10/1	2019/11/29-2019/12/4
Event name			Heavy rains
Deaths	200	20	27
Victims		200	25,000
Evacuees			
House damage			
Damage amount			
Critical infrastructure damage			
Damaged basin			
Rainfall			
Flood depth			
Associated disaster	Landslide		
Source	IFI https://github.com/hydrosenselab/India-Flood-Inventory	EM-DAT	EM-DAT

Kerala State

	1	2	3	4	5
City	Kozhikode	Kozhikode	Kozhikode Kochi	Kochi	Kochi
Date of disaster occurrence (start-end date)	2002/10/10-2002/10/16	2004/6/9-2004/6/11	2017/12/2-2017/12/2	2018/8/7-2018/8/20	2019/10/21
Event name	Monsoonal rain	Early monsoonal rain	Tropical cyclone Cyclone 'Ockhi'	Monsoonal rains	
Deaths	11	45	884	504	
Victims		1,000	60,000	23,220,000	
Evacuees					
House damage				Thousands	
Damage amount				3324452 ('000 US$)	
Critical infrastructure damage					Main power sub-station and arterial rods were flooded.
Damaged basin			Amaravathi, Bhavani, Suwarnamukhi and Kalingi Rivers		
Rainfall				400 mm	
Flood depth					
Associated disaster		Slide (land, mud, snow, rock)		Slide (land, mud, snow, rock)	
Source	EM-DAT	EM-DAT	EM-DAT	EM-DAT MDPI https://www.mdpi.com/2071-1050/13/11/6346	Kerala SDMA https://sdma.kerala.gov.in/kochi-2019/

Delhi (1/2)

	1	2	3	4	5	6
City	Delhi	Delhi	Delhi	Delhi	Delhi	Delhi
Date of disaster occurrence (start-end date)	1962/9/16-1962/9/16	1978/3/17-1978/3/17	1988/9/22-1988/10/9	1994/8/17-1994/8/17	Sep-99	Aug-01
Event name	Storm	Convective storm/ Tornado	Riverine flood	Riverine flood	Flood	Flood
Deaths		26	1000	14	229	10
Victims	40,000	700	221,000	2,550	22,120,000	36
Evacuees						
House damage						
Damage amount			44545 ('000 US$)		4217 ('000 US$)	
Critical infrastructure damage						
Damaged states			Punjab, Himachal Pradesh, Haryana, Jamuu and Kashmir, Delhi		Uttar Pradesh, Bihar, West Bengal, Madhya Prasdeh, Delhi	
Damaged basins						
Rainfall						
Flood depth						
Associated disaster						
Source	EM-DAT	EM-DAT	EM-DAT	EM-DAT	EM-DAT	EM-DAT

Delhi (2/2)

	7	8	9	10	11
City	Delhi	Delhi	Delhi	Delhi	Delhi
Date of disaster occurrence (start-end date)	2009/7/29-2009/7/29	2010/7/13-2010/7/13	2014/5/30-2014/5/31	2019/8/19-2019/8/23	2021/5/14-2021/5/19
Event name	Flash Flood	Heavy rains	Storm		Tropical cyclone Tropical cyclone 'Tauktae'
Deaths	11	11	15		198
Victims			26		700,153
Evacuees					
House damage					
Damage amount					1512039 ('000 US$)
Critical infrastructure damage					
Damaged states					Kerala, Karnataka, Goa, Maharashtra, Gujarat, Rajasthan, Delhi, Haryana, Uttar Pradesh, Uttarakhand
Damaged basin					
Rainfall					
Flood depth					
Associated disaster					
Source	EM-DAT	EM-DAT	EM-DAT	Central Water Commission https://cwc.gov.in/sites/default/files/water-and-related-statistics-2021compressed-2.pdf	EM-DAT

Odisha State

	1	2	3	4	5
City	Bhubaneswar	Bhubaneswar	Bhubaneswar	Bhubaneswar	Bhubaneswar
Date of disaster occurrence (start-end date)	2001/7/8-2001/7/10	2007/8/3-2007/8/27	2007/9/22-2007/10/3	2011/9/23-2011/10/23	2014/10/12-2014/10/12
Event name	Monsoonal rain	Monsoonal rain	Tropical depression in Bay of Bengal	Monsoonal rain	Tropical cyclone Cyclone Hudhud
Deaths	100	15	80	239	53
Victims	9,670,000	500,000	7,200,000	3,443,989	920,000
Evacuees					
House damage					
Damage amount	148752 ('000 US$)		388151 ('000 US$)	1209967 ('000 US$)	8653447 ('000 US$)
Critical infrastructure damage					
Damaged states					
Damaged basins		Bansadhara, Subamarekha, Jalaka, Kharasrota, Brahmani	Brahmani, Baitarani, Burhabalang, Budhabalanga, Subarnarekha, Kalo, Sunei, Jalaka, Kansabansha	Odisha	Andhra Pradesh, Odisha, Chhattisgarh
Rainfall					
Flood depth					
Associated disaster					
Source	EM-DAT	EM-DAT	EM-DAT	EM-DAT	EM-DAT

Karnataka State

	1
City	Bengaluru (Bangalore) Rural
Date of disaster occurrence (start-end date)	2005/10/23-2005/11/13
Event name	Monsoonal rain
Deaths	162
Victims	2,000,000
Evacuees	
House damage	
Damage amount	
Critical infrastructure damage	
Damaged basin	
Rainfall	
Flood depth	
Associated disaster	
Source	Em-DAT

Appendix-2

PROPOSAL OF MAJOR CITIES IN CDRI SEMINAR

APPENDIX-2: Proposal of Major Cities in CDRI Seminar

CDRI organized the urban flood seminar which was held on September 13th, 2022 with the participation of eight major Indian cities, NDMA, Indian Institute of Technology, JICA, and others. The major cities made presentation about the current situations and countermeasures on urban floods. And experts propose the risk mitigation measures. The main point proposed by eight major Indian cities are listed as shown in next table.

Challenges, Future Measures, and Requests in Flood Countermeasures by City

City	Challenges			Upcoming Project		Support Needed
	Geographical	Weather/ Climate Change	Drainage System/ DRR measures	Non-structural measurement	Structural measurement	
Mumbai	・Surrounded by the sea on three sides ・Many area are below sea level ・A significant population residents in flood prone areas	・Extreme rainfall events (35-40% of the annual rainfall) occurs in 2-3 events ・Increasing sea level ・Heavy rainfall coincides with high tides	・Drainage system designed based on gravity principal and affected by tides ・Existing network was designed for rainfall intensity of 35mm/hour and coefficient of run off as 0.5 → In 1989, a consultant company suggested to improve sewerage and drainage system with rainfall intensity of 50mm/hr with runoff coefficient of 1.00	・Execute multi hazard vulnerability risk and capacity analysis ・Update LiDAR mapping and other necessary layers ・Update open/ underground drainage network and other utilities like power supply, gas lines, etc on GIS platform	・Install 97 ARGs(Automatic Rain Gauges) ・Rejuvenate all four major rivers in Mumbai	・Funding engineering solutions by adoption of innovative financial models ・Housing and protecting vulnerable communities living disaster prone areas ・Enhancing the scope of disaster management protocol by increasing preparedness and flood resilience tools
Chennai	・Rapid urbanization leads reduction in storage capacity, flood buffering space of irrigation tanks and coastal wet lands ・Existence of naturally formed ecologically sensitive shoals within the creeks and river mouths ・Narrowed width of the creek and river mouth slowing down the discharge into the sea ・Sedimentation in the river mouths due to littoral movements	・Climate Change brings short duration high intensity rainfall and thunderstorms ・Increased tide level during extreme weather	・Insufficient capacity of urban drainages to cope up heavy rainfall ・Inadequate linear waterway for the releases from the surplus arrangements of irrigation tanks ・Radical change in land use and land cover ignoring drainage aspects ・Surplus courses of the Irrigation tank system which existed in the private agricultural lands, have been converted into other land uses ・Absence of flood protection walls	N/A	・Developing sponge city	・Tamil Nadu State is prone to various disasters and the funding allocation available under SDMF is not adequate to implement the structural and non-structural measures to reduce multi-hazard risks
Kolkata	・The land is tilted toward from the west to the east ・The shape of the central part of the city is like a bowl shape and storm water need to be pumped out ・Reduction of water bodies, removing vegetation and greeneries	・Climate change and extreme rainfalls ・Heavy rainfall coincides with high tides	・Unpanned land and town planning ・Reduced hydraulic capacity of the outfall canal system	・GIS map of underground sewerage and drainage network ・Assess vulnerable brick sewer, and it's preventive measures ・Desilting of trunk sewers and appurtenances	・ADB will develop infrastructure to the newly added two Gram Panchayats ・Refurbishment of the damaged trunk sewers ・Re-sectioning of drainage channels ・Dredging of outfalls ・Forced discharge from chronic water logging pockets	N/A
Bengaluru	・Increased in run-off due to construction activities and coverage of open lands ・Encroachments of lakes ・Rainwater flow from outside of Bengaluru increases the volume in sewerage and drainage and lakes	N/A	・Narrowing of pipe culverts and insufficient public land to widen SWD(storm water drain) ・Non-existence of retaining walls in outer zones ・Obstructions in SWD(storm water drain) ・Collapse of stone masonry wall at critical Locations ・Chocking at bridges, narrow sewerages and drainages due to throwing of solid waste into SWD(storm water drain) ・Unpanned land and town planning	・Flood risk and vulnerability assessment ・Developing early warning dissemination system and monitoring mechanism ・Implementation of laws to improve resilience of the built environment for floods ・Capacity development for engineers and field officers	・Budget Rs 1500.0 cr for 173 km of SWD (storm water drain) remodelling ・Improve 96 vulnerable points of SWD ・Develop 65 lakes with 250 crores	・Technical guidelines ・Decentralisation of approval mechanism to SEC under NDMF framework ・Reimbursement of funds spent in last 6 months

City	Challenges			Upcoming Project		Support Needed
	Geographical	Weather/ Climate Change	Drainage System/ DRR measures	Non-structural measurement	Structural measurement	
Hyderabad	N/A	N/A	N/A	Short term(1 year) ・Pre-monsoon and post monsoon cleaning of sewers/ drains manholes and culverts ・Desilting of drains ・Maintenance of sluice valves and spillway gates ・Removal of obstructions in the drains ・Implementation of lake management Mid term (5 years) ・Removal of encroachments from the natural and built-up drains Long term(15 years) ・Develop flood inundation modelling using 1D-1D and 1D-2D modeller or any other suitable software ・Using technologies like GIS, RS, Flood forecasting and Early Warning Systems and deployment of urban flood Nowcasting System	Short term(1 year) ・Installation of pumps with actuators linked with water level of rain gauges Mid term (5 years) ・Construction of reservoirs as per land availability ・Capacity augmentation of the drainage system by constructing new drains, remodelling of existing drains by widening / deepening and construction of parallel drains Long term(15 years) ・Developing sponge city ・Construction of permeable pavements footpaths and gardens ・Creation of flood plains ・Roof top gardens and wall gardens	N/A
Ahmedabad	・Lakes are filled with rain water of its surrounding catchment areas	N/A	N/A	N/A	Short term • Clearing of catch pit and line • Installation of dewatering pumps • Construction of percolation wells Long term • Laying of new storm water lines • Construction of new storm water pumping station • Desilting of existing storm water lines • Development of lake with its surrounding network in catchment areas	N/A

Source: Created by JICA Survey Team based on National Seminar on Urban Flood Mitigation

Appendix-3

INFORMATION FROM LONGLISTED CITIES

Appendix-3-1

MEETING MATERIAL FOR LONGLISTED CITIES

DATA COLLECTION SURVEY ON DISASTER RISK REDUCTION SECTOR IN INDIA

October 2023

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd (NK)

Yachiyo Engineering Co., Ltd

Agenda of Meeting

1. Introduction of JICA Survey Team
2. Objectives of the Survey
3. Outline of the Survey
4. Implementation Schedule
5. Provisional Idea of Long List (to be discussed with JICA)
6. Questionnaire

1. Introduction of JICA Survey Team

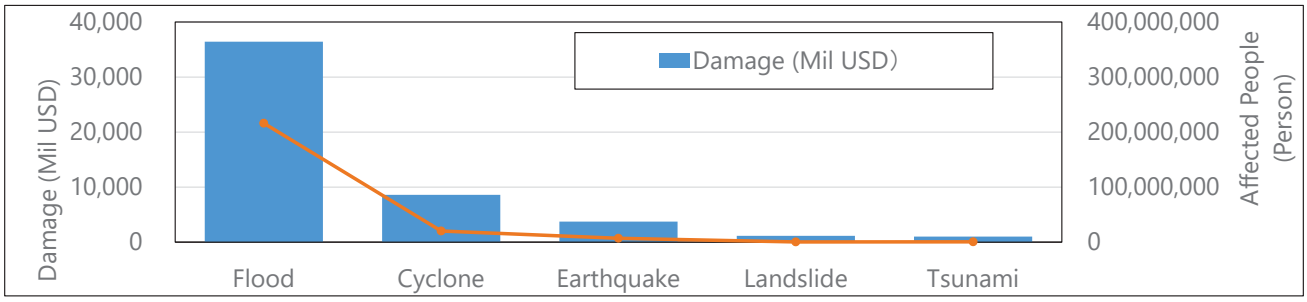
Position	Name	Company
Team Leader/Formulation of disaster risk reduction	Takamasa NISHIKAWA	Nippon Koei (NK)
Deputy Team Leader/ Disaster risk assessment	Shoichiro MISAKI	Nippon Koei (NK)
Measures against flooding	Toru TAKAHASHI	Yachiyo Engineering (YEC)
Organization and legal structure/ formulation of flood management project	Yuichi YAMAGUCHI	Nippon Koei (NK)
Economic/ investment impact analysis	Uyu TANAKA	Yachiyo Engineering (YEC)
Supporting Staff	Mahmood Ahmad Mayank Agrawal Rishabh Chaudhary	Nippon Koei India (NKI)
	Kaori TANIMOTO	Nippon Koei (NK)

2. Objectives of the Survey

The objectives of this survey are:

- to collect and organize basic information on disaster risk reduction sector in India,
- to propose potential yen loan projects and technical cooperation by Japan International Cooperation Agency (JICA) to reduce or mitigate disaster risk especially for urban flood protection or management, and
- to prepare Preliminary Project Report (PPR) to promote the potential project.

If the needs of ODA and cooperation are confirmed in the sector, the JICA Survey Team will support approval procedure of the potential projects.



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3. Outline of the Survey

Long-List of Candidate Cities for Yen Loans (10 cities)

▼

Online Interview with Longlisted Cities (10 cities)

▼

Selection of Targeted Cities (5 cities)

▼

Site Survey for Targeted Cities (5 cities)

▼

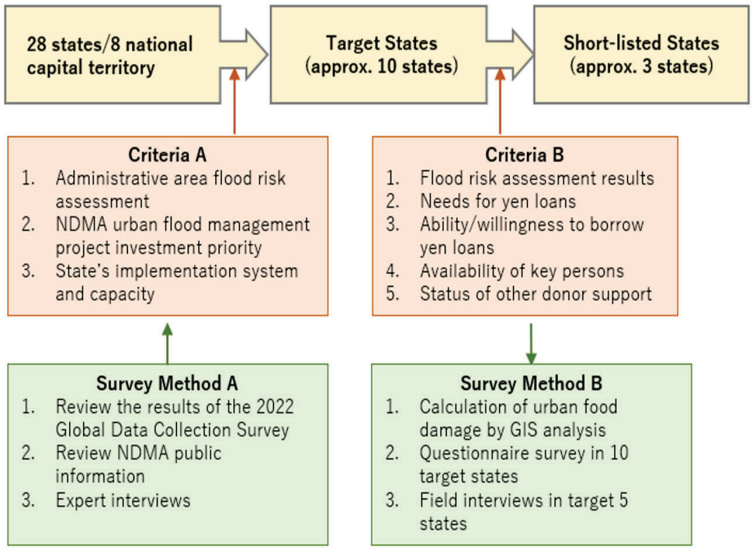
Selection of Shortlisted Cities (3 cities)

▼

Site Survey to formulate of potential project for Shortlisted Cities (3 cities)

▼

Preparation of Preliminary Project Report of Shortlisted Cities and Chennai

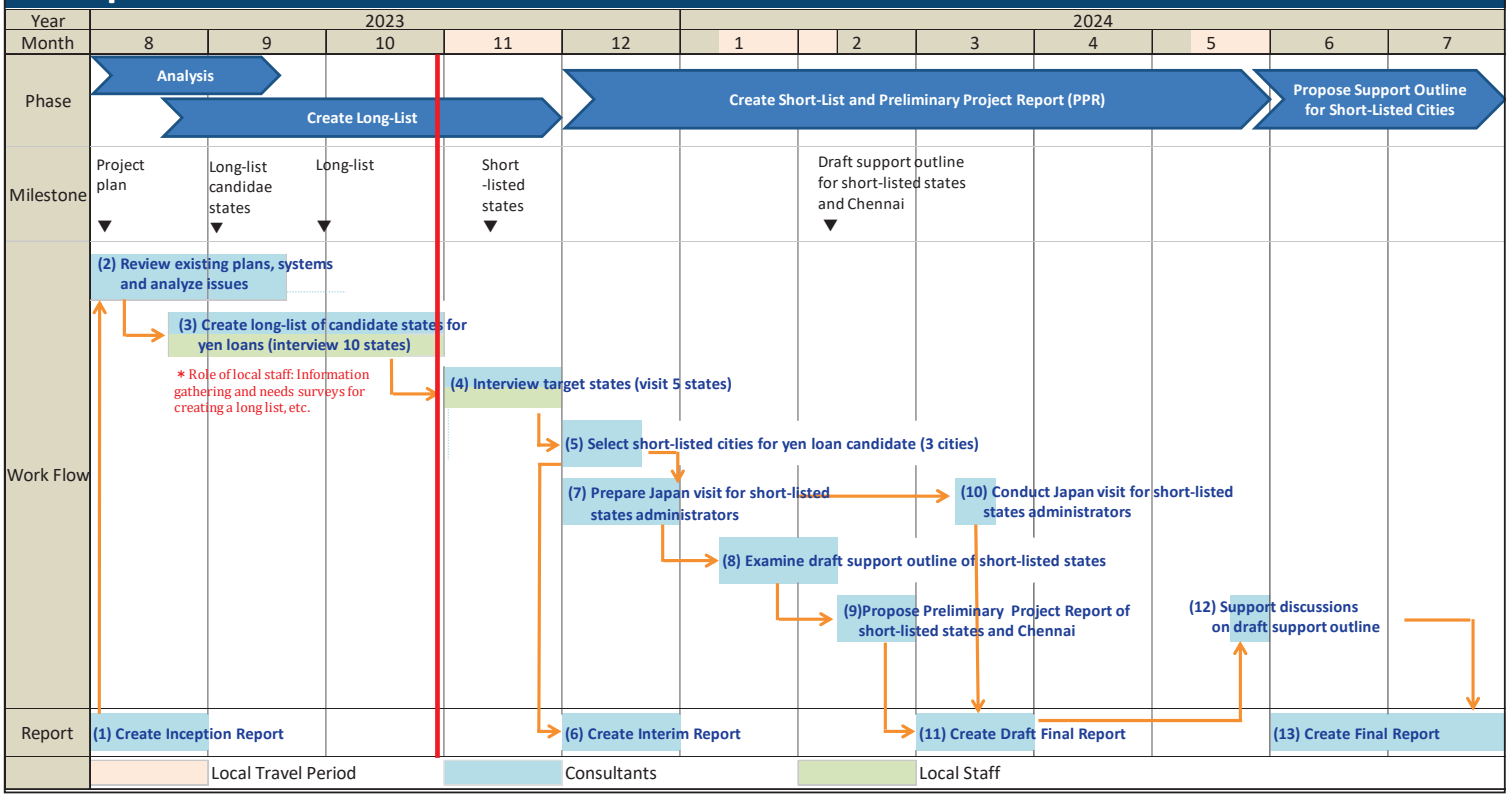


* **Target Disaster:** Urban Flood Mitigation/Management, Cyclone , Tsunami, Earthquake, Landslide, etc.

* **Type of Project:** ODA Loan Project, Sector Loan Project, Technical Assistance (Capacity Development)

5

4. Implementation Schedule



5. Long Listed Cities

Following states and 10 cities were proposed considering i) priority cities of NDMA's flood management activities, ii) asset in flooded area, iii) population of the city, and iv) vulnerability of the city.

States	Potential Cities of Long List
Gujarat	Ahmedabad, Surat
Maharashtra	Mumbai (Bombay), Pune (Poona)
Andhra Pradesh and Telangana	Hyderabad
Bihar	Patna
Delhi	Delhi
Odisha	Bhubaneswar
Assam	Guwahati

* Cities in Red: Population in 2023 is more than 10million
Cities in Green: Population in 2023 is more than 5million

6. Required Information (at this moment)

(1)General Information related to disaster in the City

1) Disaster information such as flood, cyclone, earthquake, landslide, tsunami etc.
2) Disaster related master plan, feasibility study (DPR)
3) Organization / Authority in charge for each disaster

(2)Information related to urban flooding in the City

1) Drainage master plan, feasibility study (DPR) for the urban flooding project
2) Other on-going plan carrying out by international organizations or donors
3) Assumed financial source to implement the Project
4) Future actions, studies and projects plan related to urban flooding in the City

(3)Utilization JICA's assistance for urban flooding

1) Intention to utilize Japanese ODA loan to implement the project for urban flooding
2) Intention to utilize JICA's technical assistance (grant) to formulate comprehensive master plan, etc.

6. Required Information (in future)

Following information will be needed to prepare Preliminary Project Report (PPR) for the formulation of the project after nominated to the shortlisted cities.

Main Items	Details
Existing drainage facilities and inundation data in the City	1) Available existing major drainage facilities such as primary drain, pump, gate, storage facilities etc. in the City. 2) Operation of those drainage facilities (regular maintenance, operation rules, condition of the facilities etc.) 3) Location map and information of inundation (frequency, area, period, flood scale, etc.) 4) Damage situation due to the inundation (damage types, population affected, total financial damage etc.) 5) Current general forecast and monitoring system (method) of rainfall and flood
Hydraulic related information	1) Precipitation record in the last 10 years (total mm, mm/hour) 2) Flood records in the last 10 years 3) Function and information (Storage volume, operation situation, regular maintenance etc.) of dam site upstream of the City, if any. 4) Water level of river, canal and sea, and tide level related with inundation area 5) Tendency and effect of recent climate change (reports, literatures etc.)
Other information	1) Current and future plan of annual budget allocation to drainage sector in the Municipal Corporation 2) Land use plan or city development master plan

Appendix-3-2

MINUTES OF MEETINGS WITH LONGLISTED CITIES

September 26 , 2023

India office

Agenda Note

Date : Monday , September 25 , 2023 15:00 – 16:00			
Subject: Report on basic research)			
	Affiliation	Position	Name
other party	NDMA	Member & HoD Advisor (Mitigation)	Mr. Kamal Kishore Mr. Safi Ahsan Rizvi
our side	India office Survey Team	Deputy director Planning investigator Senior Development Specialist Nippon Koei	Jun Watanabe Noriko Sakurai (record) Vipul Mishra Takamasa Nishikawa et al.
Location: Visit / Teams / Visit /Meeting (Location: N /A)			

[About disaster risk reduction basic survey]

(our side)

- After the Survey Team gave a presentation to explain the survey outline, the team members, process, etc., the long-listed states/cities and priority cities for NDMA were confirmed.

(other party)

- There is some overlap in the long-listed states/cities with the seven cities to which the NDMA has allocated urban flood countermeasures budget, but overall there is no sense of incongruity. If you narrow down your target to five cities, I would like you to consider one or two for earthquake countermeasures and two for urban floods. Plus one city is that Chennai is an appropriate as it has the results of technical cooperation.
- In addition, regarding the target cities for urban flooding, there are cities at the next tier that have greater financial and technical needs than the seven cities covered by the NDMA countermeasure budget, such as Surat, Kanpur, Nagpur, Coimbatore, and Kochi, Bhubaneshwar, etc. is more desirable to target.
- Regarding the budget distribution to the seven cities, the project is currently undergoing the final approval process by the Ministry of Interior. The plan was for five years starting in 2021, but due to delays, it is expected to be implemented in about two and a half years (the end date remains 2026).

(our side)

- You would like to target cities other than the seven, but assuming that it would be difficult to meet all the needs of each city with the distribution budget (250 Crore to 500 Crore). Needs will change and expand in the future.

(other party)

- Although this is true, the seven cities have financial strength and seem to have little needs for loan projects. Furthermore, supporting cities with higher financial and technological needs is a more effective and efficient use of the budget, rather than meeting 100% of the needs of cities with financial and technological capabilities.

(our side)

- Would like to have a more detailed interview and discussion with NDMA some other day.

(other party)

- If you have any additional questions, please send them via email first. After preparing your answers at NDMA, having meetings if necessary.

(our side)

- Understood.

(other party)

- Please tell us about the involvement of the DEA and MHA in this survey, and the survey target. Also, is it possible for JICA and NDMA to hold a joint workshop targeting urban flooding ? (note: linked to the Cabinet Office-Ministry of Home Affairs' intention to restart the initiative).

(our side)

- This survey is being conducted under the initiative of JICA, and no reports have been made to DEA or MHA at this time. There is also a background in which DEA is sensitive to project formation led by JICA , so the timing of input needs to be carefully considered. Current plan is that we will provide explanations to DEA once the survey has progressed and narrowed down the cities/states that have a high probability of forming projects .
- Targets of this survey include the NDMA and other relevant central government ministries and agencies, as well as state disaster management departments, water resources departments, and Municipal Corporations in target cities .
- Regarding Joint WS , definitely would like to implement it. Regarding the ongoing Urban Flood Technical Project, we are also considering inviting other cities/states to seminars to share the best practices. If NDMA joins as a co-sponsor, inviting other cities will go smoothly.

(other party)

- WS could be held in December, taking into consideration the preparation period .

End

(These minutes have not been confirmed by the other party .)

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Ahmedabad Officials

Subject : **MOM of the Meeting Held with Ahmedabad Officials**

Day, Date and Time : **Thursday, 9th Nov 2023 11:30 AM – 12:30PM IST**

Place : **Virtual**

Attendance :

No.	Name	Position
Hyderabad Officials		
1.	Mr. Chirag	ACE (WRM), AMC
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misak	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Yuichi Yamaguchi	Organization and legal structure, JICA Survey Team (NK)
4.	Mr. Uyu Tanaka	Economic/ investment impact analysis (YEC)
5.	Mr. Mahmood Ahmad	Support Staff, JICA Survey Team (NKI)
6.	Mr. Mayank Agarwal	Assistant Engineer- 1, JICA Survey Team (NKI)
7.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)
8.	Mr. Aman Gupta	Supporting Staff, JICA Survey Team (NKI)
9.	Ms. Kaori Tanimoto	Supporting Staff, JICA Survey Team (NK)

The discussion points recorded during the meeting are as below:

1. During the meeting the points of discussion held are noted as mentioned below:

    a. ACE (WRM) informed that the city has a gradient from Northeast to Southeast. There are mainly three catchments in AMC: catchment of Sabarmati River, Kharicut Canal, and Gota-Godhavi Canal. All the drains are tapped and are diverted to discharge at the southern part of the Sabarmati River, eastern part of Korikat Canal and Gota-Godavari canal.

    b. One River Front of 11.25 km already exists along the river stretch in the city. The width of the river in the city area is 230m.

    c. There are 15 STPs operational in the city having a total treated installed capacity of 1335MLD.

    d. Vasna Barrage is constructed on the southern part of the Sabarmati River.

    e. AMC master plan is under preparation and is expected to get approved by Dec'25.

    f. Urban Flood Risk Mitigation Plan (UFRMP) is prepared based on the under-preparation master plan. The total estimated cost of the UFRMP is Rs 8,271.09 Cr (USD1,000million).

    g. The priority disasters for which mitigation plan/ infrastructure is required is in

the sequence- Flood →Cyclone→Seismic (zone-4).

h. Pumping stations are installed for draining excess water in the event of flood. These are controlled through the Central Controlling System using SCADA. However, full automation is not done, SCADA is installed for information dissemination while operation is done manually.

i. DPR for urban flood mitigation amounting to Rs 250 Cr (USD30million) has already been prepared and is submitted to NDMA.

j. The river has sufficient capacity to cater the flow even during monsoon period. The last river flooding event recorded in Ahmedabad was in the year 1971.

k. Due to rapid development, partial inundation in 2-3 hours and inundation at underpass are frequently occurred in monsoon season in Ahmedabad city.

l. World bank is implementing sewerage development project and ADB is implementing project to develop water supply, sewerage and drainage systems for 8 municipalities.

2. During the meeting, Ahmedabad officials expressed willingness for adopting JICA funding for taking up Disaster Risk Mitigation projects.

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Ahmedabad Municipal Corporation (AMC) Officials

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Subject : **MOM of the Meeting Held with AMC Officials**

Day, Date and Time : **Wednesday, 28th Nov 2023 11:00 AM – 13:00PM IST**

Place : **AMC Office**

Attendance :

No.	Name	Position
Ahmedabad Municipal Corporation (AMC) Officials		
1.	Mr. Harpalsinh Zala	City Engineer (WRM)
2.	Mr. Rakesh Bodhiwala	Addl. City Engineer Drainage Projects
3.	Mr. Niraj Purohit	Assistant City Engineer Drainage Projects
4.	Mr. Kalpesh Patel	Assistant City Engineer Drainage Projects
5.	Mr. Bhavesh	Assistant City Engineer Drainage Projects
6.	Ms. Neha Upadhyay	Environmental Engineer WRM
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misaki	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Mahmood Ahmad	Support Staff, JICA Survey Team (NKI)
4.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)

1. During the meeting the points of discussion held are noted as mentioned below:

   a. CE(WRM) informed the current status of storm water facility in AMC as below:

      - AMC currently has only 33% dedicated storm drain coverage,
      - Approximately 175km of storm water drains were laid in the western part of the city through JNNURM funding,
      - Pumping stations have also been installed at low lying areas for discharging storm water directly into the river in the event of heavy rainfall. Water level of Kharicut Canal flowing eastern part of the city is higher than ground level and enhancement of their capacity is needed, and
      - Interlinking of some lakes has already been done in the eastern part of the city.

   b. Situation of rainfall in AMC as below:

      - Currently 10-12 inches of rainfall occurs only in 4-5 hours which generates huge amount of runoff.
      - Due to change in rainfall pattern, the existing drainage system is insufficient to cater the storm water flood. (Design rainfall intensity: I= 25mm/hr to 74mm/hr)

c. The new master plan is being prepared as per the new draft CPHEEO guideline which will also be rolled out soon. The Master Plan till 2050 of the city is under preparation and is 70-80% finalized. It is informed that the master plan is expected to be finalized by Dec'24.

- Due to poor performance of the agency preparing the Master Plan, AMC is in the process of procurement of new agency for completion of the master plan.
- The hydraulic design done in the master plan will remain the same, however, new agency will formulate short-term, medium-term and long-term projects that needs to be taken up based on the final master plan.

d. Based on the draft Master Plan AMC has identified projects worth Rs 8600 Cr, and 80-90% components will remain same even after finalization of master plan.

e. The major works identified based on the master plan are:
   i. Improvement of ground infiltration
   ii. Flood management by detention ponds/ tanks
   iii. Interlinking of existing 125 lakes
   iv. Low impact development like the development of 250 gardens etc.

f. AMC has already submitted one DPR amounting to Rs 250 Cr to NDMA consisting with early warning system (40 Cr) and Structural measure (210 Cr). This DPR is prepared based on the new master plan.

g. Situation of the disaster in Ahmedabad is as below:

- The city is more than 500km away from the sea, therefore the city does not experience cyclone problems.
- Ahmedabad is under earthquake category 5 and the last massive earthquake was experienced in Jan 2001, which led to the collapse of more than 100 buildings and major fatalities. He further informed that since than the building codes have already been upgraded.

h. Situation of sewerage development is as below:

- Total water supply in the city is approximately 1600MLD and sewage treatment capacity is 1300MLD. Thus, sufficient treatment capacity is available for the treatment of sewage generation of the city.
- One World Bank funded project for the upgradation of 1100MLD capacity of STPs is under progress.
- Since sewage sludge recycle/reuse is not included in the scope of WB

project, AMC has willingness to get support for sewage sludge management including power generation by bio-gas, incineration, or its reuse as other objective such as fertilizer. When AMC visited Japan (Fukuoka), they visited the STP which reused sewage sludge.

2. AMC expressed willingness to take JICA loan for taking up infrastructure works for storm water drainage.

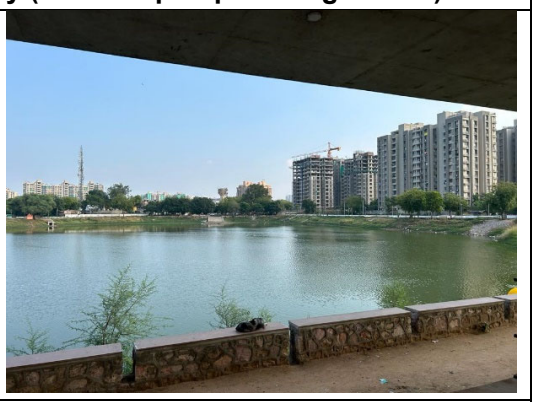
3. The meeting concluded with a site visit like- pumping station, lake for interlinking work.

Data received:

i. Final volume of comprehensive drainage and storm water master plan for next 30 years
ii. Copy of DPR submitted to NDMA.

Site Visit Photos

Vezalpur Storm Water PS of 5MLD Capacity (2W + 2S pumps configuration)



Chharodi lake Part of Interlinking of Lake Project

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Municipal Commissioner Ahmedabad Municipal Corporation (AMC)

Subject : **MOM of the Meeting Held with Municipal Commissioner**

Day, Date and Time : **Wednesday, 28th Nov 2023 17:00 PM – 18:00PM IST**

Place : **Municipal Commissioner Office**

Attendance :

No.	Name	Position
Ahmedabad Municipal Corporation (AMC) Officials		
1.	Mr. M. Thennarasan	Municipal Commissioner
2.	Mr. Mihir P Patel	Deputy Municipal Commissioner, Water and Drainage Projects
3.	Mr. Harpalsinh Zala	City Engineer (WRM)
4.	Mr. Bhavesh	Assistant City Engineer Drainage Projects
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misaki	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Mahmood Ahmad	Support Staff, JICA Survey Team (NKI)
4.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)

1. During the meeting the points of discussion held are noted as mentioned below:

   a. The Municipal Commissioner (MC) officially expressed AMC's willingness to utilize JICA loan for the improvement of drainage facilities based on new Master Plan.

   b. The MC informed current status of drainage works as below:

      - The city has no/ limited flood vulnerability due to river, however, during the event of excess rainfall city experiences flood like situation.
      - Underground drainage has limited carrying capacity and needs upgradation.
      - A major issue is the frequent breakdown of existing sewer and drainage lines during monsoon season. Rehabilitation work and strengthening of existing sewer and drainage lines needed for the city.
      - Another issue is the settlement of sewer and drainage lines during monsoon.
      - There are 35 storm water pumping stations to pump storm water to Kharicut canal during monsoon.

   c. MC suggested that the projects can be taken up in piece meal based on the priority.

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Surat Municipal Corporation (SMC) Officials

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Subject : MOM of the Meeting Held with SMC Officials

Day, Date and Time : Wednesday, 30th Nov 2023 11:00– 13:00 and 15:00-1600 IST

Place : SMC Office

Attendance :

No.	Name	Position
Tapi River Front (TPR) Officials		
1.	Mr. Jayesh Chauhan	DGM (Tapi River Front)
2.	Mr. Rakesh Barfiwala	Assistant Engineer Tapi River Front
3.	Ms. Sakshi	Company Secretary, Tapi River Front
4.	Ms. Nital Doshi	DPO, Surat District Disaster Management Authority
5.	Mr. Vinod Luhar	Assistant Engineer, Drainage Department
6.	Mr. Mitesh Patel	Assistant Engineer, Drainage Department
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misaki	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)

1. During the meeting the points of discussion held are noted as mentioned below:

   a. There is flood risk but river is not the source of flooding in Surat. River flooding occurs only when heavy rain and discharge of storage water from upstream dam occurs simultaneously. In this regard, SMC requests JICA ODA fund for rejuvenation project of the creeks. The outline is as below:

	FS	DPR	Project Cost (Cr)		
			Land	Construction	Total
1) Bhedwad Creek	Completed	Completed	864	678	1542
2) Varachha creek	Completed	-	585	335	920
3) Chhaprabatha creek	Completed	-	288	258	550
Total			1,737	1,271	3,012

   b. Situation of disaster in Surat is as follows:

   - Among the various disasters, urban flooding is the major issue faced by the city. Although many district/ city level initiatives have already been taken up for the mitigation, work still needs to be done.
   - The last major flood event occurred in the year 2006 due to overflow in the Tapi river. Ukai dam is the last dam on Tapi river and water takes 8-9 hrs to reach Surat city from Ukai dam.
   - Besides flood due to Tapi river, creeks are another major source of flooding.

c. Disaster management plan for Surat district was prepared in 2023 and is available online.

d. Necessary measures for urban food protection are as below:

- Rehabilitation and restructuring of the existing drains and creeks are the major requirement for mitigation of urban flooding for Surat.
- It was informed that the rainfall pattern has changed drastically. Presently, 6 inches of rainfall occurs in just 4 hrs, thus restructuring and upgradation of the stormwater drains needs to be done.
- Surat is divided into 9 zones based on the catchment of minor and major creeks flowing through the city. In order to mitigate the flooding due to Creeks, remodelling and restructuring of creeks is necessary.

e. SMC has taken up remodelling and restructuring of creeks. This has been done under three phases:

- Phase-I: Remodelling and restructuring of 6.6km of Mithi and 6.6km of Kankar creeks were done through Govt. of India and Govt. of Gujarat funding.
- Phase-II: Work on Koyli creek has been taken up. Development of initial 1.35km stretch completed, work on middle stretch of 1.5km is under progress while work on 3.85km is yet to start, however tender already awarded.
- Bhedwar creek DPR at an estimated cost of Rs 678.10 Cr is prepared and submitted to Irrigation Department for approval. However, approval and fund sanction is yet not given.
- The Meethi Creek remodelling work included chanelising it through 15m RCC box type drain. There are no pumps installed in creeks, however, within the creek basin pumps are installed at few strategic locations within the creek basin, which are used at the time when water level in the creek at HFL.

2. The meeting concluded with site visit.

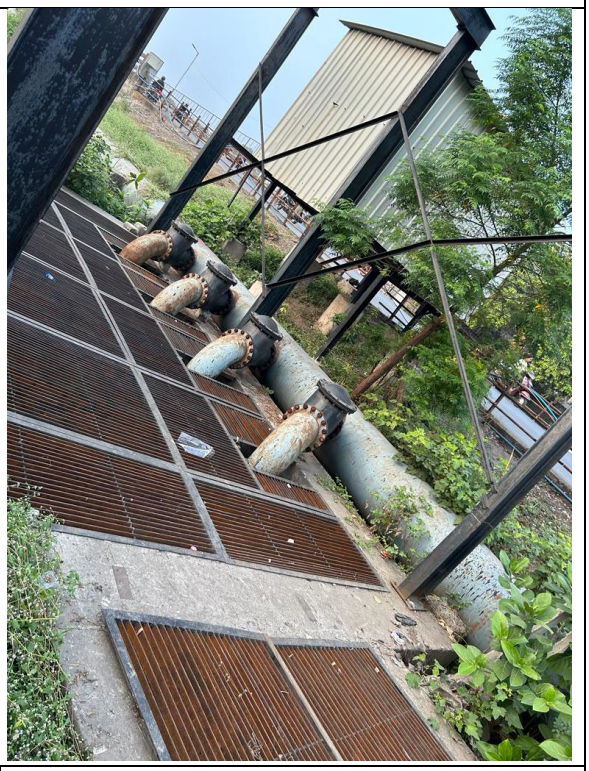
Data received:

i. Surat disaster management plan

ii. DPR of Bhedwar and Godadara Creek remodelling

iii. Feasibility report of Chaprabhatha, Varacha and Koyli Creek

Site Visit Photos

Koyli Creek Development Work	**Koyli Creek Last Stretch Where Work Yet to Start**
	
Completed Work on Kankar Creek	**Pumps Installed in Meethi Creek Basin**

Study on Data Collection Survey on Disaster Risk Reduction Sector in India
MOM of the Meeting Held with Gujarat State Disaster Management Authority (GSDMA)

Subject : **MOM of the Meeting Held with CEO**

Day, Date and Time : **Wednesday, 29th Nov 2023 15:30 PM – 16:30PM IST**

Place : **GSDMA Office**

Attendance :

No.	Name	Position
Gujarat State Disaster Management Authority (GSDMA) Official		
1.	Mr. Anupam Anand	Chief Executive Officer (CEO)
2.	Mr. Prashant Makhwana	
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misaki	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)

During the meeting the points of discussion held are noted as mentioned below:

a. During the start of the meeting CEO, GSDMA informed that no communication either from NDMA or State Government regarding the study project by JICA. He suggested that he can only share data if communication/ instruction either from State government or NDMA has been given.

b. The CEO informed that the state has sufficient fund available for disaster risk mitigation and JICA's support is not required. When AMC (Ahmedabad) or SMC (Surat) will implement JICA ODA project, GSDMA will not be the authority to approve their DPR. In this regard, the ODA projects can be proposed from each municipal corporation.

c. CEO informed that most part of the State is under category-5 of seismic zone and having been the longest coastline (approximately 1600km from Kutch to Surat), it suffers from cyclone and urban flooding.

d. CEO further informed that a project for early warning dissemination project for coastal areas from Bharuch to Surat is currently under implementation.

e. It was also informed that 76 cyclone shelters have been constructed in the coastal areas through World Bank funding. Apart from these shelters, village schools and anganbadi buildings are also used as shelters during the event of cyclone.

f. It was also informed that during the cyclone Biparjoy, struck Gujarat during June 2023, IMD intimidated one week earlier which enabled GSDMA to deploy NDRF & SDRF teams and evacuation of the people to safe locations.

g. Hazira and Dahej are the two major industrial areas for which project related to industrial disaster can be explored.

DATA COLLECTION SURVEY
ON
DISASTER RISK REDUCTION SECTOR IN INDIA

Minutes of Meeting

1. **Date:** November 20, 2023
2. **Time:** 18:15 - 20:00 (India Standard Time)
3. **Venue:** Maharashtra Institute of Transformation (MITRA) Office
4. **Attendance:**

No.	Name	Agency/Company
Maharashtra Institute of Transformation (MITRA)		
1	Praveen Singh Pardeshi	CEO of MITRA
Municipal Corporation of Greater Mumbai (MCGM)		
2	P. Velrasu	Additional Municipal Commissioner
3	Vibhas Acharekar	Chief Engineer of Storm Water Drainage Department
4	P.D. Ramngade	Department Officer of Storm Water Drainage Department (Mithi River Project)
JICA Survey Team (JST)		
5	Takamasa Nishikawa	JST- Team Leader / Formulation of Disaster Risk Reduction
6	Shoichiro Misaki	JST- Deputy Team Leader / Disaster Risk Assessment
7	Kumar Sampath	Nippon Koei India

5. Highlights of discussion

1. JST explained the outline of the survey. MCGM explained the current flood situation and completed/on-going drainage projects in Mumbai. MITRA suggested to apply large scale drainage tunnel to mitigate the further flood situation against the recent climate change.
2. MCGM has 15 departments such as drainage, sewerage, solid waste, disaster management and air pollution etc. Storm water drainage department is in charge for all the flood reduction projects including measures for rivers/nallahs in the city.
3. MCGM informed that MCGM has implemented several drainage projects by their own budget in accordance with the BRIMSTOWAD was formulated in 1995 and updated in 2018. The drainage facilities such as pumping station, expansion of the rivers and desilting of the rivers etc. are being carried out in order to reduce the flood against 55mm/hour rainfall intensity which is not taken into consideration the climate change.
4. MCGM is implementing the flood control and sanitation improvement project in Mithi River. The project has 4 packages, of which package-1 has already been completed in the upstream of the river. Package-2 is still on-going, around 80% of the work is completed. However, it will take time to relocate the residents along the river and the required process is proceeding gradually from the areas where land acquisition and relocation have progressed. Package-3 is to be announced the procurement of the contractor. Package-4 is implementing a construction of sewer including sewer installation by shield construction method with a diameter of 2.6m.
5. National Center of Coastal Research (NCCR) estimating the sea water level will be raised to 1.2m to 3.0m in future. It is required to study the conditions of climate change and update the drainage facilities.
6. MCGM emphasized that MCGM has enough budget to implement the flood mitigation projects which is listed in the BRIMSTOWAD (2018) with their own budget. However, to further improvement of drainage facility against the recent climate change, drainage master plan is required.
7. MITRA suggested that large scale underground drainage tunnel like Tokyo and Yokohama could be one of the option to address higher rainfall intensity due to climate change. It is also required to consider that Mumbai city is receiving the water 200km far from the center of the city. Therefore, utilization of stored rainwater shall also be considered in the formulation of the master plan. Furthermore, the measures of protection and preservation of mangrove at the downstream of Mithi river is also important to rejuvenation of the river,
8. MCGM would like to formulate a long term and a short term project in the master plan. MCGM insisted that the master plan will be able to formulate within 7-8 months by utilizing the required data and information studied in the updated BRIMSTOWAD (2018).
9. Other than physical solution to flood mitigation, MCGM would like to install a flood monitoring system, flood modeling, and synchronized system with metrological data (climate forecast) in Mumbai city.
10. JST was requested to issue a request letter for the detailed required information.

End

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Disaster Management – Brihanmumbai Municipal Corporation (BMC) Officials

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Subject	:	**MOM of the Meeting Held with Disaster Management – Brihanmumbai Municipal Corporation (BMC) Officials**
Day, Date and Time	:	**Wednesday, 21st Nov 2023 11:00 AM – 12:00 Noon IST**
Place	:	**Disaster management Control Room, 2nd Floor, Main BMC Office**

Attendance :

No.	Name	Position
Hyderabad Officials		
1.	Smt Ashwini Bhide - IAS	Additional Municipal Commissioner (E.S), BMC
2.	Sh. Mahesh Narvekar	Director - Disaster Management, BMC
3.	Smt. Rashmi Lokhande	Chief Officer - Disaster Management, BMC
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misak	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Mahmood Ahmad	Support Staff, JICA Survey Team (NKI)
4.	Mr. Mayank Agarwal	Assistant Engineer- 1, JICA Survey Team (NKI)

The discussion points recorded during the meeting are as below:

1. Director Disaster Management BMC showed the small video, which presents the efforts of BMC to tackle disasters.
2. Director Disaster Management BMC gave a tour to the entire Disaster control room and explains the various features equipped to tackle the disaster and mitigate it.
3. AMC (E.S) told that the Landslide is one of the major disaster in the city since some households are located at the hilly area. And JST are requested to suggest the measures to minimize the risk of landslides, if Japan is having some measures applicable.
4. The communication failure is the biggest fear of BMC during any disaster. Director Disaster Management BMC asked JST to suggest available Japanese technology to stabilize the communication during disaster.
5. Communal ditch for multiple utility line was also discussed due to limited space under or along road in Mumbai for installation of utility lines.
6. As per the Disaster Management officials, Mumbai is also prone to Earthquakes. The officials asked JST to look into Indian Standard Codes IS 1983 and NBC 2016 for updation to have earthquake resistant buildings.

DATA COLLECTION SURVEY
ON
DISASTER RISK REDUCTION SECTOR IN INDIA

Minutes of Meeting

1. **Date:** November 24, 2023
2. **Time:** 15:30 - 17:00 (India Standard Time)
3. **Venue:** Pune Municipal Corporation (PMC) Office
4. **Attendance:**

No.	Name	Agency/Company
Pune Municipal Corporation (PMC)		
1	Santosh Shrikrishana Tandle	Supretending Engineer
Primove Consultant		
2	Vishal Ujagare	Consultant
3	Manish Ahire	Sr- Engineer
JICA Survey Team (JST)		
4	Takamasa Nishikawa	JST- Team Leader / Formulation of Disaster Risk Reduction
5	Shoichiro Misaki	JST- Deputy Team Leader / Disaster Risk Assessment
6	Mayank Agarwal	Assistant Engineer-1, JICA Survey Team (NKI)

5. Highlights of discussion

1. JST explained the outline of the survey. PMC explained the current flood situation and on-going drainage projects in Pune.
2. PMC asked whether JST has explained about the Survey to state government. JST answered that we will visit the state government after the selection of priority project at the next trip.
3. PMC explained that Pune is surrounded by hilly area for 20 km around the city. Therefore, all the rainfall tends to go from hilly side into the center of the city. The main river of Mulla River has an enough capacity to flow those storm water. However, the tributaries connecting into the Mulla River has not been constructed sufficiently.
4. There are 23 basins with total area of around 480 km^2 in Pune city.
5. Population of Pune is getting increased since Pune is recently developing by IT sector as Bangalore city.
6. In 2019, heavy rainfall with the 180mm/hour was recorded and 20 people died. In 2019, 2021 and 2022, rainfall more than 100mm/hour was happened.
7. DPR was prepared in 2007, and that was approved by NDMA after updating the original DPR in 2023 taking into consideration the recent increasing of the rainfall intensity.
   Approved amount in DPR is INR 478 Cr in total of which NDMA will finance only INR 286 Cr.
   In NDMA financed project, spot drainage improvement and preparation of master plan are included.
8. Pune has the following priority projects:

Priority	Features	Project Cost	Status
1st	NDMA financed project which implement the spot improvement project about 78 locations	INR 286 Cr	NDMA will finance and commence the project soon.
2nd	Remaining 60 spots improvement project which does not found the finance yet	INR 190 Cr	DPR was approved. Still finding the financial source
3rd	Drainage facility improvement in 11 villages	INR 600 Cr	DPR has been prepared but not approved yet.
4th	Drainage facility improvement at 23 new villages	INR 1,000 Cr	City plan has to be prepared at first, accordingly drainage plan can also be prepared.

9. Pune also plans to implement the sewerage project under the IFC loan project with the approximate amount of INR 1,400 Cr. The feasibility study of the project has already been implemented.

End

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Hyderabad Officials

Subject : **MOM of the Meeting Held with Hyderabad Officials**

Day, Date and Time : **Wednesday, 8th Nov 2023 12:00 AM – 13:00PM IST**

Place : **Virtual**

Attendance :

No.	Name	Position
Hyderabad Officials		
1.	Mr. Prakash Reddy	Director, Enforcement Vigilance & Disaster Management (EVDM)
2.	Mr. Kishan	Chief Engineer, Greater Hyderabad Municipal Corporation (GHMC)
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misak	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Yuichi Yamaguchi	Organization and legal structure, JICA Survey Team (NK)
4.	Mr. Mahmood Ahmad	Support Staff, JICA Survey Team (NKI)
5.	Mr. Mayank Agarwal	Assistant Engineer- 1, JICA Survey Team (NKI)
6.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)
7.	Mr. Aman Gupta	Supporting Staff, JICA Survey Team (NKI)
8.	Ms. Kaori Tanimoto	Supporting Staff, JICA Survey Team (NK)

The discussion points recorded during the meeting are as below:

1. During the meeting the points of discussion held are noted as mentioned below:

    a. Chief Engineer informed that there are 2 wings in GHMC:

        i. Disaster Risk Management for non-structural works responsible for preparedness and response in the event of disaster

        ii. Engineering wing for structural works responsible for the construction of disaster mitigation related works

    b. The Chief Engineer informed that phase-1 of the Hyderabad Urban Flood Mitigation Project has already been completed at an estimated cost of Rs 1000 crore (USD120million). In the first phase strategic nallah impact program has been implemented under which lake to lake and major nala connectivity works have already been taken implemented. The project is implemented through Indian Nationalized Bank Loan named as State Bank of India

    c. The Chief Engineer (CE) further informed that DPR for second phase of works is also prepared. The total estimated cost of the project in phase-2 is approximately Rs 2,000 Cr (USD240million) for which agency is looking up for funding institutions for the implementation of second phase of works. The scope

covered under phase-2 DPR includes capacity enhancement of the existing storm water drains (desilting).

d. The CE informed that the Musi River which flows through the center of the city has enough capacity and does not cause flooding due to overflow. Also, he informed that there are two reservoirs/ dams already constructed on the upstream of the river as a precautionary measure for prevention of flooding.

e. The CE also informed that except for the urban flooding issue there is no other serious disaster risk in Hyderabad.

f. Due to urban flooding, there is no loss of life but business loss in Hyderabad.

g. The master plan of Hyderabad city was prepared 3 years back which also covers area beyond administrative boundaries and has catchment specific details.

h. Director, EVDM briefed about the available facilities and infrastructure for disaster risk preparedness and response. He informed that they have 30 Disaster Response Force (DRF) teams.

i. Director, EVDM also informed that the last major flood event occurred in the year 2020.

2. During the meeting, Hyderabad officials expressed willingness for adopting JICA funding for taking up Disaster Risk Mitigation projects.

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Greater Hyderabad Municipal Corporation (GHMC) Officials

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Subject : **MOM of the Meeting Held with GHMC Officials and Site visit**

Day, Date and Time : **Thursday, 07th Dec 2023 10:30 AM – 17:00PM IST**

Place : **GHMC Office and Sites**

Attendance :

No.	Name	Position
Greater Hyderabad Municipal Corporation (GHMC) Officials		
1.	Sh. Prakash Reddy, IPS	Director Environment Vigilance & Disaster Management (EVDM)
2.	Sh. Kishan	Chief Engineer (CE), Strategic Nala Development Program (SNDP)
3.	Sh. A Krishnaiah	Executive Engineer, SNDP Projects
4.	Sh. Ajesh Reddy	Assistant Engineer
JICA Survey Team (JST)		
1.	Mr. Shoichiro Misak	Deputy Team Leader, JICA Survey Team (NK)
2.	Mr. Mayank Agrawal	Assistant Engineer- 1, JICA Survey Team (NKI)
1.	Mr. M. Anil Kumar	Senior Manager, Nippon Koei India Pvt Ltd
2.	Dr. S. M. Subhani	Managing Director, NCPE Infrastructure India (P) Ltd, Consultant to GHMC SNDP
3.	Mr. Ram Mohan Jafargad	General Manager, NCPE Infrastructure India (P) Ltd, Consultant to GHMC SNDP

1. During the meeting the points of discussion held are noted as mentioned below:

   a. CE informed that the Master Plan is already updated in 2020 with the guidelines as mentioned in Central Public Health and Environmental Engineering Organization (CPHEEO) manual for drainage works. The first Master Plan was prepared in 2003-04 for Municipal Corporation of Hyderabad (MCH) covering 175 km^2 area. The second Master Plan was prepared in 2008-09 for Greater Hyderabad Municipal Corporation (GHMC) covering 625 km^2 area.

   b. GHMC recently updated the Master Plan in the year 2020 as per the latest Drainage manual published by CPHEEO with consideration of 50 mm/hr rainfall and return period of once in a five year.

   c. As per the Master plan, the Phase 1 is majorly project for lake to lake connections by drains. Almost 90% of the phase 1 work has been completed which is having project cost of about Rs. 1,000 Cr.

   d. Phase 2 of the project consists of construction and redesigning of Tertiary & secondary drains. The estimated project cost for the Phase 2 is Rs. 5,000 Cr.

e. As informed by the CE, out of the total estimated amount in Phase 2, Rs. 2,500 Cr is required for GHMC area and Rs. 2,500 Cr is required for fringe area, which contributes as a catchment to GHMC.

f. For the removal of encroachment along the Musi river in Phase 2, GHMC will utilize in-house funds.

g. The major outfall in Hyderabad is Musi River. The development and maintenance of Musi River is done by the State Govt. Authority known as Musi Riverfront Development Cooperation Limited (MRDCL).

h. There is no plan to construct the pumping station since flows from tributaries to the Musi river could be by the gravity.

i. The preparation of detail design and DPRs for Phase 2 is underway.

j. As informed by CE the execution for Phase 2 works is scheduled to be start by July 2024.

k. Phase 2 is planned to be executed by several numbers of construction packages. The construction will proceed in stages, commencing with the highest priority area. Each package cost should not be more Rs. 500 Cr.

2. Director EV&DM informed that they need funding for the early flood alarming system. For the same he handed over the proposal in hard copy as well as in soft copy to JST.

3. It was advised by CE to write a letter to Commissioner GHMC requesting the data regarding Master Plan, ongoing Phase 1 works and proposed Phase 2 works.

4. Hyderabad is not an earthquake prone and there are no other serious disasters. Therefore, flood control is the highest priority issue in Hyderabad.

5. JST also had a site visit along with GHMC officials to look into the ongoing Phase 1 works.

Meeting Photos

Site Visit

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Guwahati Metropolitan Drinking Water and Sewerage Board (GMDW&SB) Officials

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Subject : **MOM of the Meeting Held with Guwahati Metropolitan Drinking Water and Sewerage Board (GMDW&SB) Officials**

Day, Date and Time : **Friday, 10th Nov 2023 11:00 AM – 12:00 Noon IST**

Place : **Virtual**

Attendance :

No.	Name	Position
Hyderabad Officials		
1.	Mr. Rupjyoti Talukdar	Executive Engineer – GMDW&SB
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misak	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Yuichi Yamaguchi	Organization and legal structure, JICA Survey Team (NK)
4.	Mr. Mahmood Ahmad	Support Staff, JICA Survey Team (NKI)
5.	Mr. Mayank Agarwal	Assistant Engineer- 1, JICA Survey Team (NKI)
6.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)
7.	Mr. Aman Gupta	Supporting Staff, JICA Survey Team (NKI)
8.	Ms. Kaori Tanimoto	Supporting Staff, JICA Survey Team (NK)

The discussion points recorded during the meeting are as below:

1. During the meeting the points of discussion held are noted as mentioned below:

    a. The Executive Engineer updated on the ongoing sewerage and water supply projects.

    b. It was communicated that Guwahati is Earthquake Prone.

    c. The Disaster Management plan is available on the website.

    d. The Executive Engineer also informed the JST that the Disaster Management and Urban Drainage part is taken care by Guwahati Metropolitan Development Authority (GMDA). The information and details for the Disaster Management shall be provided by GMDA only

2. It was suggested by GMDW&SB to arrange the meeting with GMDA.

Study on Data Collection Survey on Disaster Risk Reduction Sector in India
MOM of the Meeting Held with Guwahati Metropolitan Development Authority (GMDA) Officials

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Subject : **MOM of the Meeting Held with GMDA Officials**

Day, Date and Time : **Monday, 4th Dec 2023 11:15 AM – 12:30PM IST**

Place : **GMDA Office**

Attendance :

No.	Name	Position
Guwahati Metropolitan Development Authority (GMDA) Officials		
1.	Ms. Manali Jain	Secretary GMDA
2.	Mr. Mantu Bora	Superintending Engineer (SE), GMDA
3.	Ms. Seema	Assistant Engineer, GMDA
JICA Survey Team (JST)		
1.	Mr. Shoichiro Misak	Deputy Team Leader, JICA Survey Team (NK)
2.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)

1. During the meeting the points of discussion held are noted as mentioned below:

   a. SE informed that major disasters experienced in Guwahati are landslide, earthquake and flooding.

   b. It was informed that for landslide, projects have already been implemented as and when needed.

   c. Regarding earthquake, the last massive/major earthquake event occurred in 1952 which led to major fatalities. Since than building codes were revised and earthquake resistant infrastructure has been built. The last major earthquake of 7.2 Richter-scale occurred in 2021, however, no major fatalities happened.

   d. Brahmputra river divides the city into two parts. The average width of the river is 7-8 km, however the width around the city area is only 1.5km and water level of the river during rainy season becomes high. Therefore, it causes flooding in the city.

   e. It was informed that there are 4 creeks/ small rivers that drains stormwater flood from city to Brahmputra.

   f. There are 3 major lakes in the city- (a) Deepor beel (lake) which is a Ramsar site, (b) Silsako lake and (c) Borsola beel (lake). The southern side of the city has hills.

   g. The current master plan of the city was prepared in 2008 targeted for the year 2025. The city is divided into 8 basins for catering the urban flood issue. The master plan said that the capacity of pumping station and river improvement

are required in order to enhance the flow capacity.

h. Based on the master plan, basin wise DPRs at an estimated cost of Rs 754 Cr were prepared in 2008, however, due to scarcity of fund, not all the projects were implemented.

i. It was informed that ADB has in principally agreed to fund Rs 150 Crs for the two basins- Bahini & Hathinala. However, the DPRs in 2008 are very old, so ADB has instructed GMDA to update the DPRs to present situation and current price value. GMDA is in the process of issuing EOI for the updation of all the DPRs.

j. One project for construction of underground box drain for connecting the Bahini Basin with Silsako lake is under progress.

k. It was also informed that submergence is experienced in the city for at least 7 days every year. The total requirement of pumping is 90 m3/s against which only 10% capacity is available in the city.

l. There are 3 flood control gates available in the city, but these are inadequate. These are:
    - Bondajan Sluice Gate
    - Bharalu Sluice gate
    - Khanjan Sluice gate

m. It was informed that new Master plan is under preparation. Hydraulic modelling is also proposed to be done in the new master plan.

n. It was informed that the storage capacity of the lakes and creeks needs to be improved. Minimum 1-2m dredging needs to be done. Also, the widening of the creeks needs to be done. For widening of creeks sufficient govt land is available along the creeks.

o. It was informed that Water Sensitive Urban Design (WSUD) and aquifer management plan for the city has been prepared.

p. It was also informed that one DPR amounting to Rs 250 Cr for the development of Silsako lake was submitted to NRCD for funding, however, the project was not approved by the ministry due to shortage of funds.

q. Similarly, one DPR for the development of Borsola beel (lake) is prepared but the project could not be taken up due to unavailability of funds.

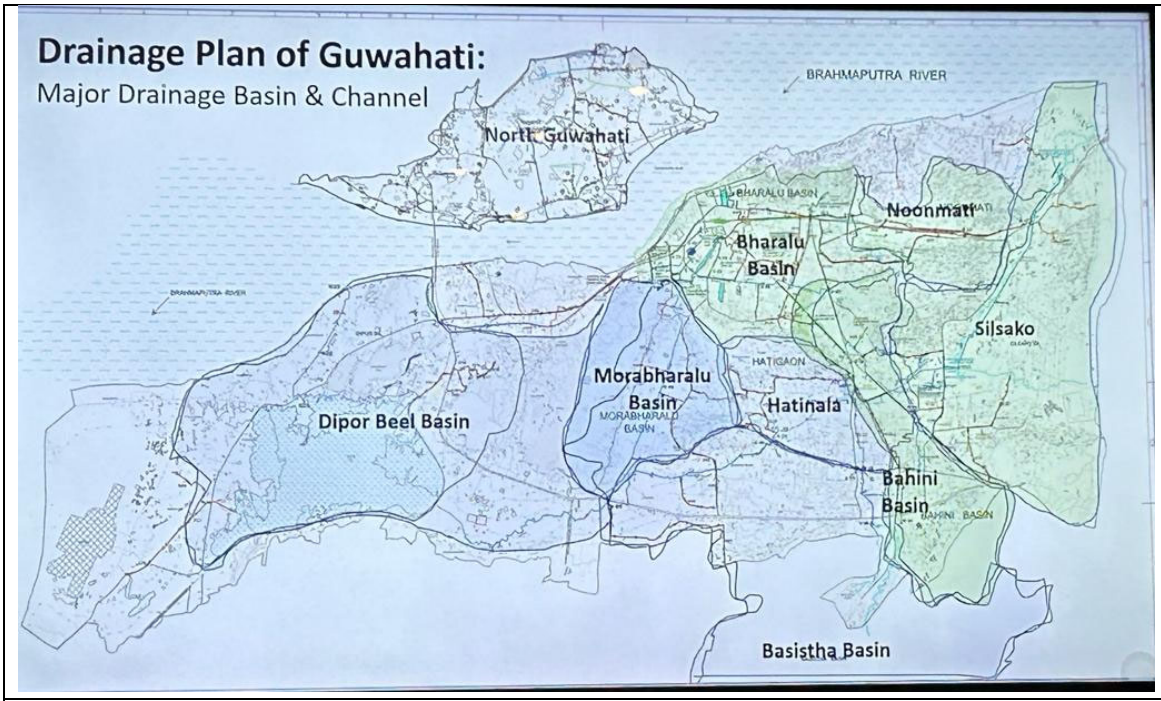
r. The two DPR of Silsako and Borsola proposes to increase the storage capacity of the lakes so that the flooding situation of the city can be improved.

2. GMDA expressed willingness to take JICA loan for taking up infrastructure works for storm water drainage. Beside the two basins of Bahini and Hathinala which might be implemented by ADB, GMDA would ask JICA's support for updating the DPR and implementation of the project. It is preliminary estimated that the construction cost for Baharalu is Rs 450 Cr (2008 MP price base).
3. The meeting concluded with a site visit like- pumping station, lake for interlinking work.

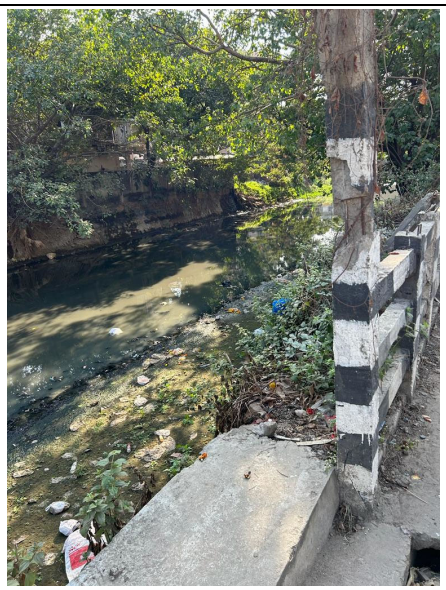
Data received:

i. Copy of DPRs available.

Site Visit Photos

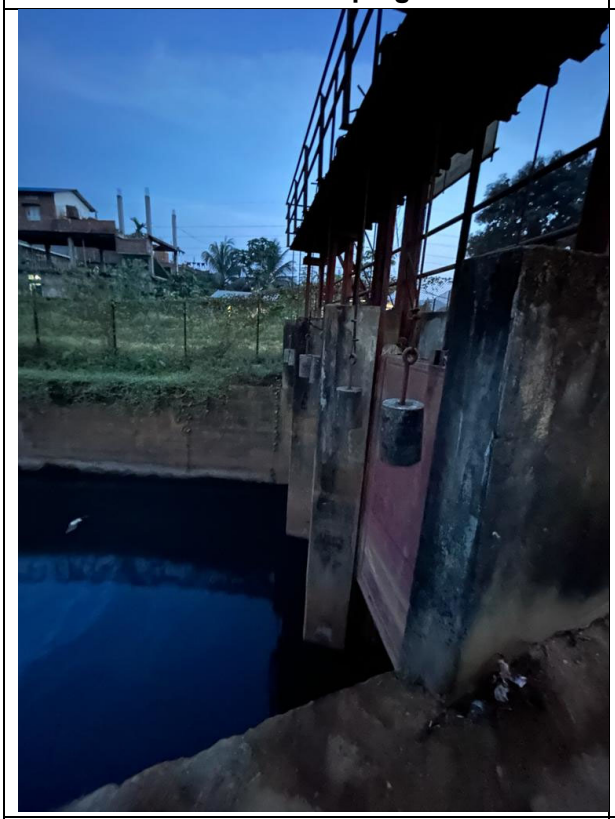


Guwahati Basin Map



Bharalu Drain

Borsola Beel (lake)

Bharalu Drain Pumping Station	**Bondajan Sluice Gate PS**
	
Bondojan Sluice Gate	**Under Construction Silsako Lake PS**

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Bhubaneswar Municipal Corporation (BMC) Officials

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Subject : **MOM of the Meeting Held with BMC Officials**

Day, Date and Time : **Wednesday, 03rd Jan 2024 11:00 AM – 12:00AM PM IST**

Place : **Online**

Attendance :

No.	Name	Position
Bhubaneswar Municipal Corporation (BMC)		
1.	Mr. Shri Vijay Amruta Kulange	Commissioner of Bhubaneswar Municipal Corporation (BMC)
2.	Dr. Manoranjan Sahu	Deputy Commissioner of Bhubaneswar Municipal Corporation (BMC)
3.	To be confirmed	Engineer, BMC
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Yuichi Yamaguchi	Organization and legal structure, JICA Survey Team (NK)
3.	Mr. Mayank Agrawal	Assistant Engineer- 1, JICA Survey Team (NKI)
4.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)
5.	Mr. Aman Gupta	Supporting Staff, JICA Survey Team (NKI)

1. After the explanation of the outline of the survey by JST, the Municipal Commissioner of BMC explained as below:

   - The disasters in Bhubaneswar are urban flooding and cyclone. No other disasters have occurred in Bhubaneswar.
   - The major locations of flooding have already been identified. The water logging is occurred ward No.4, along NH16 (underpass, jaideep vihar and ISKCON temple), and suburban area. Water logging will disappear 1-2 hours after heavy rainfall. The rainfall is 230-250 mm/day.
   - BMC is improving flooding situation to be logging free city, but no MP and DPR have been prepared regarding urban flooding. In this regard, BMC requires MP for urban flooding and would like to request JICA to formulate MP in technical assistance.
   - Rainwater harvesting (filtration to ground) is also required to reduce runoff and to recharge groundwater.
   - The Badagada canal requires redesigning as it causes flooding in Lakshmi sagar area.
   - In addition, the risk of cyclones and subsequent water logging is also an important

issue to be solved for BMC. Heavy rainfall occurs during cyclone which causes heavy destruction and flood like situation. At this moment, there is no pumping station for urban flooding and such PS will be required to reduce water logging.

2. BMC informed that it requires permission from UDD before sharing the information of urban floodings such as major locations of floodings and rainfall data. NKI engineers will contract BMC to collect information.

Study on Data Collection Survey on Disaster Risk Reduction Sector in India

MOM of the Meeting Held with Patna Municipal Corporation (PMC) Officials

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Subject : **MOM of the Meeting Held with PMC Officials**

Day, Date and Time : **Monday, 22nd Jan 2024 14:00– 15:00 IST**

Place : **Online**

Attendance :

No.	Name	Position
Patna Municipal Corporation (PMC) Officials		
1.	Mr. Surendra Kumar Sinha	Chief Municipal Engineer
JICA India		
1.	Mr. Vipul Mishra	Representative
JICA Survey Team (JST)		
1.	Mr. Takamasa Nishikawa	Team Leader, JICA Survey Team (NK)
2.	Mr. Shoichiro Misaki	Deputy Team Leader, JICA Survey Team (NK)
3.	Mr. Yuichi Yamaguchi	Organization and Legal Structure, JICA Survey Team (NK)
4.	Mr. Mayank Agrawal	Assistant Engineer- 1, JICA Survey Team (NKI)
5.	Mr. Rishabh Chaudhary	Assistant Engineer- 2, JICA Survey Team (NKI)
6.	Mr. Aman Gupta	Support Engineer (NKI)

1. During the meeting the points of discussion held with Patna Municipal Corporation (PMC) are noted as mentioned below:
   a) Patna is located on the southern bank of River Ganga and River Punpun flows south of Patna city which further joins Ganga. Patna has a saucer shaped topography having mild slope from North to South.
   b) It was informed that Bihar Urban Infrastructure Development Corporation Ltd (BUIDCo) is the responsible agency for the infrastructure works including urban drainage in the state.
   c) Drainage facility has been installed in Patna CIty.
      - There are 55 permanent pumping stations, and 25 temporary pumping stations are installed in the city for draining flood water from the city. Excess water from the city is removed using the pumping stations. The pumps drains excess water to Badshahi nala which discharges into Punpun and ultimately to Ganga.
      - Sufficient pumping capacity is installed in the city for draining out excess flood water during monsoon season. Only during very heavy rainfall invents or flash rains, flood like situations occurs in the city.
   d) Flood protection embankments have been already constructed on both rivers Ganga and Punpun. Three to four years ago was the last time the city experienced flooding due to river.

e) Storm Water Drainage scheme under the budget of Bihar State will be implemented.
   - Storm Water Drainage scheme has already been approved by Urban and Housing Ministry, Govt of Bihar. Accordingly, 13 cities of Bihar have been identified for storm water drainage works at an estimated cost of Rs 2031.32 Cr.
   - BUIDCO has already floated tender for construction Storm Water Drainage works in Patna at an estimated cost of Rs 982 Cr. Master plan and DPR are already approved. The funding source for the project is to be confirmed through BUIDCO.
   - Patna city is divided into 9 catchment zones for which the tender has been floated. This also include sub-urban areas of Patna.

f) Patna lies under zone-4 of seismic zone, thus earthquake is another disaster which is experienced by the city.

g) PMC official informed that the requirement for funding is unnecessary at this moment since new scheme is just to be commenced. Further information shall be confirmed by BUIDCo.

2. In addition to discussion with PMC, following were also discussed with JICA representative and JST:

   a. The methodology of the line ministry involved in the project approval was discussed and explained by NKI engineer and JICA representative which duly satisfied the project requirement.

   b. JICA India representative was requested to help in arranging the online meeting with Delhi. JICA representative conveyed his best possible effort to arrange the same.

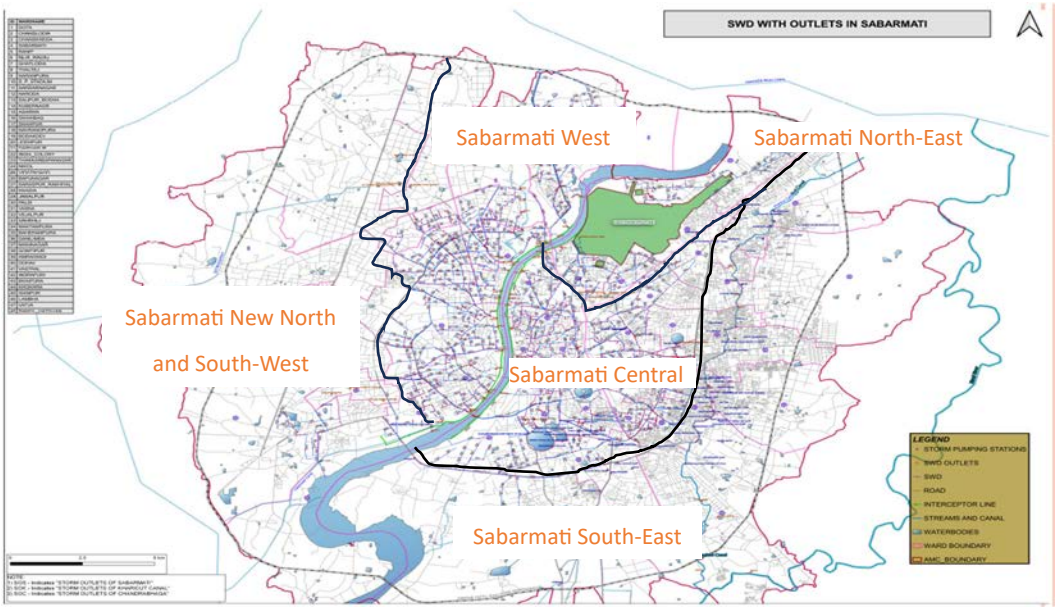
   c. JICA India representative was also requested to help in collection of data from Hyderabad and Bhubneshwar. JICA representative conveyed his best possible effort to arrange the same.

Appendix-3-3

OUTLINE OF EXISTING STATUS AND PLAN OF LONG-LISTED CITIES: M/P, DPR AND PRESENTATION

1. Ahmedabad M/P

(1) Basic Information

Municipal Corporation	Ahmedabad Municipal Corporation
Document	Comprehensive Drainage and Storm Water Master Plan for Drainage and Storm Water System of Ahmedabad City for Next 30 years (2051) Vol-IV-I&II: Sabarmati North East Catchment, Central East Catchment Vol-IV-III: Kharicut/ Sabarmati Southeast Catchment Vol-IV-IV: Sabarmati West Catchment Vol-IV-V: New North & South West Catchment Vol-V: Storm Water Drainage Network Pumping Station
Department in Charge	Water Resource Management
Prepared by	Multi Mantech International, Meinhardt Singapore Pte
Target Area	Entire AMC 
Existing Drainage Facilities	➢ **Area :- 505** Sq.Km. ➢ **Poppulation:-** 71,88,342 ➢ **Length of Drinage Network:-** 3400 Km ➢ **Length of Strom Water Drinage Network:-** 945 Km ➢ **Drainage Pumping Station:-** 73 No. ➢ **Sewage Treatment Plant:-** 15 ➢ **Total Sewage Generation:-** 1300 MLD ➢ **Treatment Capacity:-** 1335 MLD ➢ **River Bridges :-** 8 No. ➢ **Sabarmati River Length:-** 15.70 km (Indira brigde to Vasna barrage) ➢ **Sabarmati River Frount Development length:-** 11.25 km ➢ **Sabarmati River Width :-** 263 m ➢ **Barrage:-** 1- Vasna Barrage

Inundation record	During July 2022, several parts of Ahmedabad was severe waterlogging and flooded due to continuous heavy rainfall. Name of flooded 159 locations/wards are listed in the M/P. The list of inundation spots are listed below: *Table 1* ***List of Inundation Spots in Ahmedabad City (Ward wise)***

(2) Proposed Project

Target Year	Phase I: 2036/ Phase II: 2051
Target Catchments	1. Sabarmati North East 2. Central-East Catchment 3. Kharicut/Sabarmati East 4. Sabarmati West 5. New North & South West
Design condition	1/5years rainfall
Project Scope	1. Resection 2. Inter connections 3. Relief drain 4. New network

5. Unserved area
6. Low Impact Development (LID) Works
7. New SWPs
8. Desilt & rehabilitation
9. Elec & Mech rehabilitation

Proposed Project (Phase I)

Summary of project component

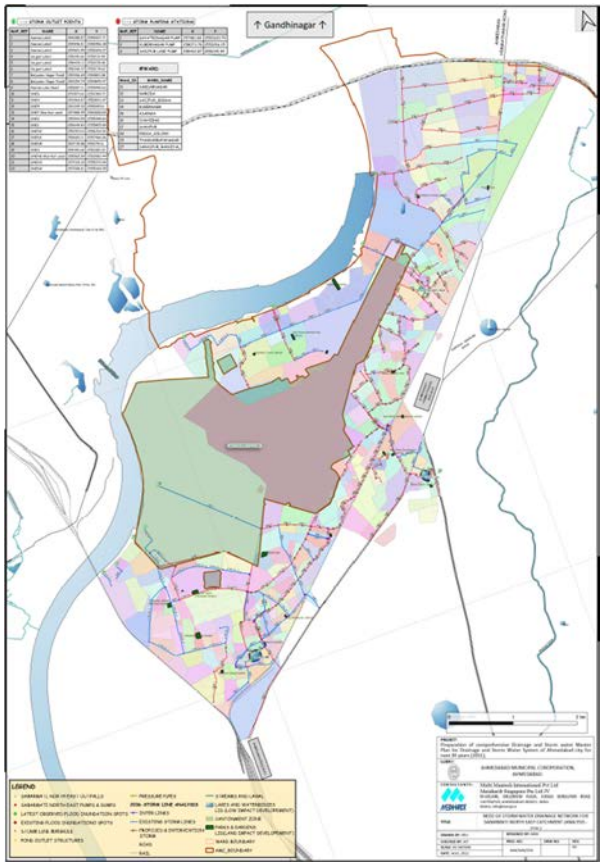
Catchment	Unit	1	2	3	4	5	Total
a) LID works	m2	98,684.2	336,933.9	284,082.4	581,983	319,574.4	1,621,257.9
b) New network	m	37,658.2	-	173,049.9	44,014.4	269,580.4	524,302.9
c) Relief drain	m	801.8	4,855.4	16,649.1	8,804.4	21,170.8	52,281.5
d) Resection	m	13,308.6	31,785.7	48,844.0	18,973.7	8,124.0	121,036.0
e) Interconnection	m	224.432	4,983.6	8,105.7	4,558.3	212.2	18,084.3
f) pumping	Nos.	1	-	18	-	2	21
Unserved area	m						

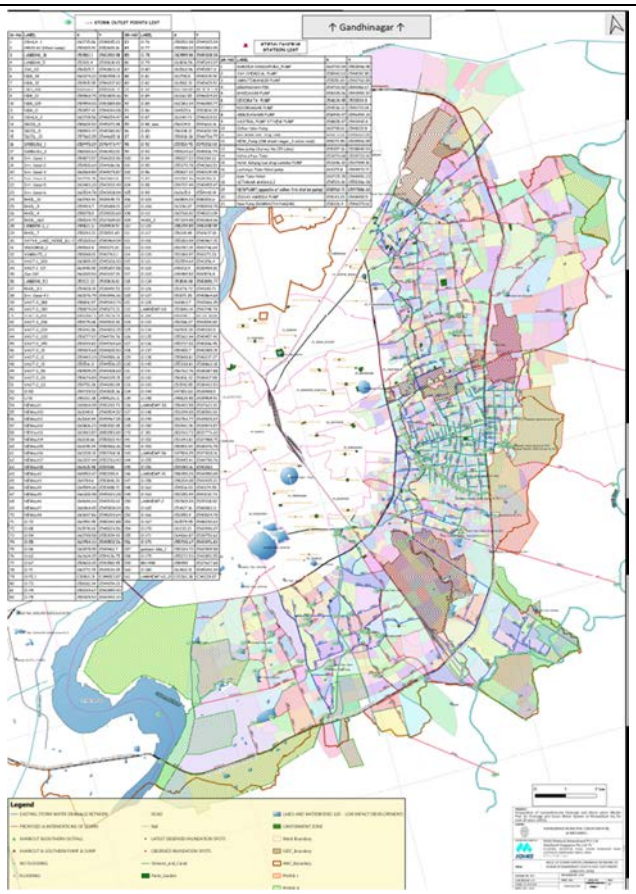
Note:

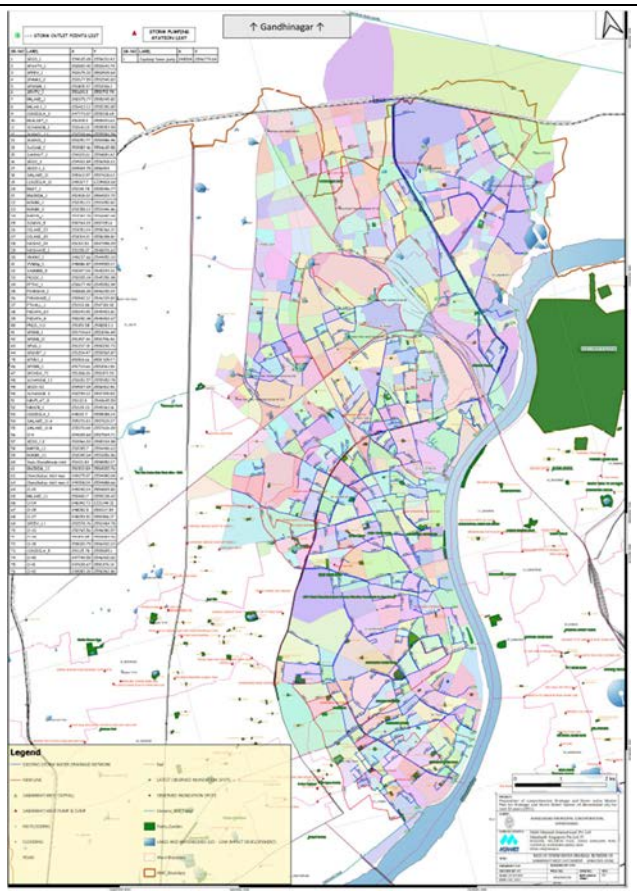
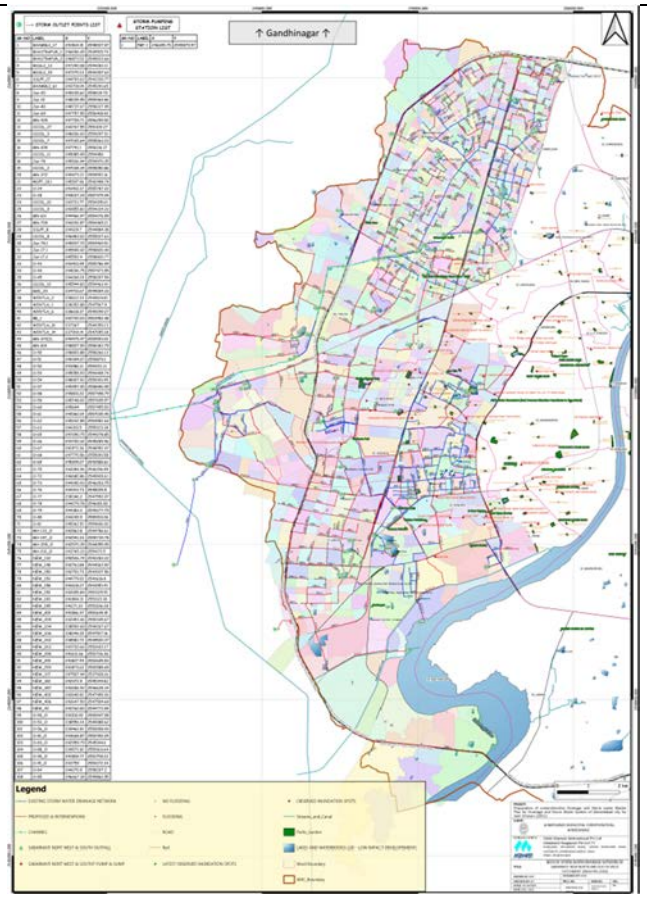
1. Sabarmati North East
2. Central-East Catchment
3. Kharicut/Sabarmati East
4. Sabarmati West
5. New North & South West

Need of stormwater drainage network (analysis-2036)

Sabarmati North-East Catchment



Sabarmati Central Catchment	
Sabarmati South-East Catchment	

Sabarmati West Catchment		
Sabarmati New North and South-West Catchment		
Pumping	1) Phase I	

Station

S/N	Name of pumping station	Type of Pump Sub. /SCF/VT	Existing Pumping M/C			Proposed Pumping M/C For Phase I				
			NO. of Pumps	Pump Discharge Capacity M3/Hour	TOTAL Pump Discharge Capacity M3/Hr	Flow Per Pump in M3/Hr	Quantity of pump	Total pumping capacity In M3/Hr	Total KW	Total Estimated coat Rs in lakhs with Electro-mechanical Items
27	AVKAR HALL	SUB	3	600	1800	4200	4	16800	960	335.1
28	NIRMANALA	SUB	2	1800	3600	1800	2	3600	220	77.4
29	DEVIMATA	SUB	3	2400	7200	2400	3	7200	405	154.6
30	NOORNAGAR	SUB	2	1800	3600	1800	2	3600	200	71.4
31	GEBANSHAH PIR	SUB	1	1800	2150	3600	4	14400	800	283.1
		SUB	1	350						
32	GAYATRI PS	SUB	3	2400	7200	2400	3	7200	405	154.6
33	GURUJIBRIDGE	SUB	2	1000	2000	4500	4	18000	1000	348.1
	TOTAL ESTIMATED COST Rs in Lakhs									6514.11

2) Phase II

S/N	Name of pumping station	Type of Pump Sub. /SCF/VT	Existing Pumping M/C			Proposed Pumping M/C For Phase II				
			NO. of Pumps	Pump Discharge Capacity M3/Hour	TOTAL Pump Discharge Capacity M3/Hr	Flow Per Pump in M3/Hr	Quantity of pump	Total pumping capacity In M3/Hr	Total KW	Total Estimated coat Rs in lakhs with Electro-mechanical Items
29	DEVIMATA	SUB	3	2400	7200	2400	3	7200	405	154.6
30	NOORNAGAR	SUB	2	1800	3600	1800	2	3600	200	71.4
31	GEBANSHAH PIR	SUB	1	1800	2150	3600	4	14400	800	283.1
		SUB	1	350						
32	GAYATRI PS	SUB	3	2400	7200	2400	3	7200	405	154.6
33	GURUJIBRIDGE	SUB	2	1000	2000	4500	4	18000	1000	348.1
	TOTAL ESTIMATED COST Rs in Lakhs									6588.91

3) New

S/N	Name of pumping station	Flow Per Pump in M3/Hr	Quantity of pump	Total pumping capacity In M3/Hr	Total KW	Estimated cost in Rs in lakhs
1	Odhav talav Pump/NEW Odhav lake	6000	6	36000	1750	592.1
2	Kathwada near Ring road/0.25 pump new	5800	5	29000	1575	535.2
3	NEW_Pump (OM shanti nagar_3 vatva	2700	3	8100	540	187.1
4	New pump (Survey No.135 Lake)	1800	3	5400	375	133.4
5	Vatva,Utiyu Talav	1800	2	3600	250	86.4
6	Hotel Sahyog bus stop Lambha PUMP	3800	4	15200	1000	348.1
7	Lachrayu Talav Nikol pump/NEW 1.4	2400	2	4800	310	104.3
8	Gam Talav Nikol/ new 1	6000	7	42000	2450	819.8
9	New Pump (RAMRAJYA NAGAR)/new 1	1800	1	1800	125	48.9
	TOTAL ESTIMATED COST Rs in Lakhs					2855.24

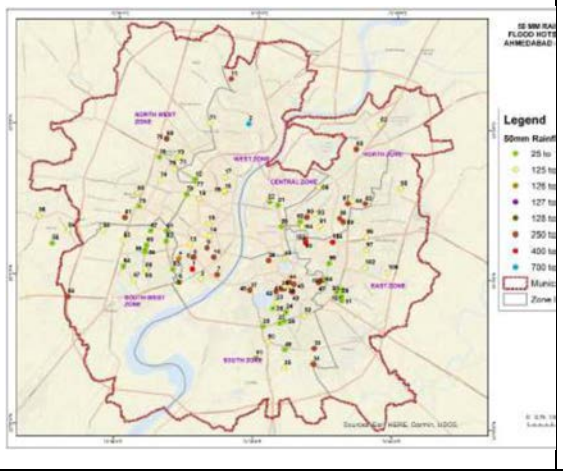
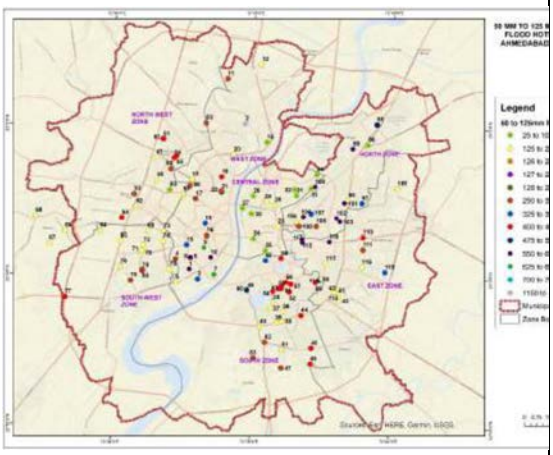
Project Cost

Strom Water Drain TENTATIVE COST OF NEEDS (Rs in Crores) AMC Master Plan 2021-2051						
CATCHMENT	Sabarati North East	Sabarati Central East	Sabarati South East / Kharicut	Sabarati West	New North & South West	TOTAL
RESECTION	55.79	159.92	1462.07	62.74	57.36	1797.88
INTER CONNECTIONS	0.48	15.83	18.75	23.64	0.92	59.62
RELIEF DRAIN	1.32	12.96	34.6	45.91	117.79	212.58
NEW NET WORK	159.43	163.72	1189.77	227.81	1213.73	2954.46
UNSERVED AREA PHASE 1	0.00	0.00	179.32	0.00	82.17	261.49
LID WORKS	23.42	79.81	297.56	102.27	338.23	841.30
NEW SWPS						28.55
DESILT & REHAB PHASE 1	102.18	404.67	69.89	245.85	186.8	1009.39
ELEC & MECH REHAB PHSE 1						65.14
DESILT & REHAB PHASE 2	87.18	391.35	71.66	257.87	166.73	974.79
ELEC & MECH REHAB PHSE 2						65.89
TOTAL	**429.80**	**1228.26**	**3323.62**	**966.09**	**2163.73**	**8271.09**

2. Ahmedabad DPR

(1) Basic Information

Municipal Corporation	Ahmedabad Municipal Corporation
Document	Project Proposal for Urban Flood Risk Management Programme Under National Disaster Management Authority (NDMA)
Department in Charge	Water Resource Management
Prepared by	Royal Haskoning DHV, TTI
Date	12 September 2023
Objective of the Project	■ Reduce the risk of flooding in the city. ■ Improve the city's storm water management system. ■ Make the city more sustainable and resilient to climate change.
Project Components	■ **Lake interlinking**: This project will connect the city's lakes and reservoirs, creating a more integrated water system. This will help to reduce flooding by storing excess water and releasing it slowly during periods of heavy rain. Lakes within two zones of AMC southwest and East Zone are proposed to be interlinked. These are upcoming zone where development is happening rapidly. ■ **Flood early warning system:** This system will use sensors and other technology to monitor water levels and rainfall. This information will be used to issue early warnings of flooding, giving people time to evacuate to safety. The project will be implemented in two phases – Now casting and forecasting using hydrological and hydraulic models. ■ **Eco blocks:** These are low-cost, flood-resistant housing units that will be built in vulnerable areas. The eco blocks will be made from sustainable materials and will be designed to withstand flooding. Around 2400 number of ecoblocks are proposed to be implemented phase wise in priority areas. ■ **Infiltration tanks:** These tanks will be used to collect rainwater and store it for later use. This will help to reduce the amount of water that flows into the city's drainage system, reducing the risk of flooding. Tentatively 25 numbers of infiltration tanks are proposed, and these tanks shall be located in the green areas. ■ **Sponge Park:** This sponge park will be a public space where people can learn about water conservation and the city's flood resilience efforts. The sponge park will also feature a water feature that will help to collect rainwater and store it for later use or discharge after peak rainfall is over thus. ■ Capacity development, trainings for AMC officials are also proposed. This shall help them in their skill enhancement and enable them to deliver better service. ■ Preparation of Detailed Drainage master plan – development of storm water master plan is essential to arrive at comprehensive solution for urban flood management. Master plan shall be developed to use holistic approach to use synergy of structural and interventions for urban flood management.
Project Budget:	275 Cr (250Cr from NDMA+ 25Cr from State Government)

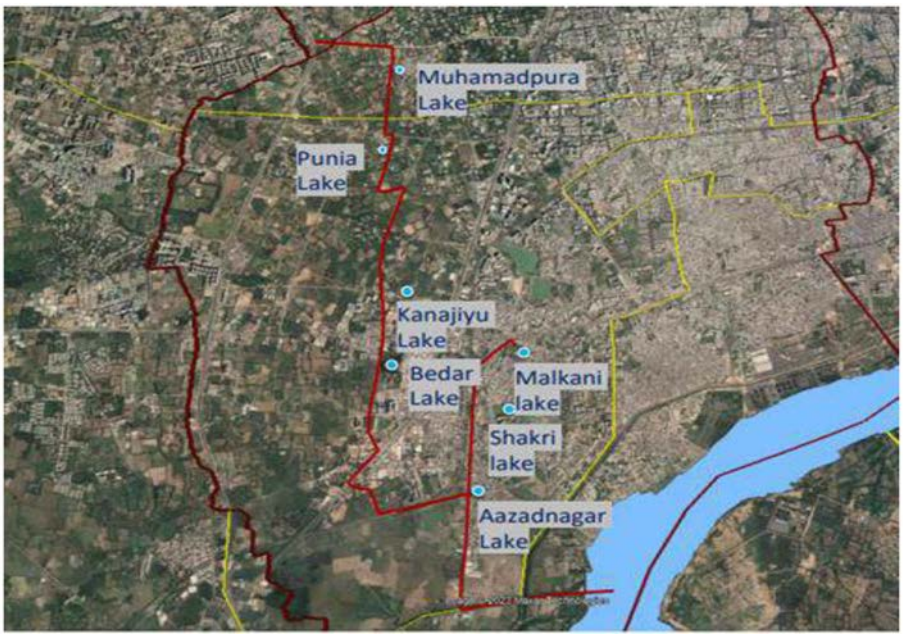
Existing Drainage Facilities	The city has network of existing storm water drainage network having a length of 945 km. The city also has network of 25 automatic rain gauge stations. The data of from these 25 Rain gauge stations is collected at central command and centre.	
Inundation record	Ahmedabad city recorded the worst flooding in 100 years in the year 2006. The city witnessed extreme water logging incidents in 2006, 2011, 2015, and 2017. In 2015, the release of 1.8 lakh cusecs2 of water from the Dharoi Dam led to the flooding of the riverfront shown in Figure 1-1. In July 2017, excess rainfall caused severe floods in Ahmedabad.	
Flood Hotspot	50 mm Rainfall	50-125 mm Rainfall
		
Project under implementation		

Sr. No.	Project	Project Cost in Cr	Outcome
1	Strengthening and Re- modelling Gota-Godhavi Drain under state government funding	223	Safeguard against any inundation or flooding in Northwest area having outfall in the canal
2	Strengthening and Re- modelling of Kharicut Canal	1068	Safeguard against any inundation or flooding in Eastern area having outfall in the canal
3	Desilting of Storm water drains of diameter 450-2000 MM in western side	18.3	Reduction is flooding in western zone
	Total	**1309**	

Projects proposed under AMRUT are given in Table below.

Sr. No.	Description of project	Project Cost in Crores INR
1	Rehabilitation of 1400 mm dia. line from Jashodanagar CR to Cosy Hotel.	33.75
2	Rehabilitation of old sewer line of 1200 mm dia. Sewer stretch from Pallav Junction to Amin CR via Ankur circle, Naranpura cross road.	22.39
3	Rehabilitation of 900 mm dia sewer line stretch from Shahpur road chowkdi to Jamalpur SPS via Mirzapur Traingle, Bhadra & Gayakvad Haveli	28.97
4	Rehabilitation of 1050 mm dia & 1200 mm dia. sewer line stretch from Idgah Circle to Sarangpur Circle via Prem Darvaja, Kalupur cross road & Kalupur Railway Station Compound wall.	28.90
5	Rehabilitation Of Drainage Trunk Main Line from Express Highway Junction Via. Lalgebi Circle to AUDA Underpass	33.75
6	Rehabilitation of 1400 mm dia. line from Jashodanagar CR to Cosy Hotel.	58.19
7	Rehabilitation Of Drainage Trunk Main Line from Shyam Shikharcross Road To Bapunagar Cross Road Via. Ajit Mill Via. Nagarvel Hanuman To Metro Bridge.	40.44
8	Rehabilitation Of Drainage Trunk Main Line from APMC Market To Fatehwadi Canal.	16.08
9	Rehabilitation Of Drainage Trunk Main Line from Nikol Cross Road Via. Pam Hotel to Odhav 310 Drainage Pumping Station.	18.16
10	Rehabilitation Of Old Sewer Lines In AMC Area From 1. Prabhat Chowk To Umiya Hall Parellel Rcc Road Line In Ghatlodiya Ward. 2. Kadiya Naka Ghatlodiya Gam to Nutan School To Prabhat Chowk In Ghatlodiya Ward of North-West Zone AMC. 3. Karamchari Cross Road to Bhuyangdev Cross Road."	13.49
11	Rehabilitation Of Drainage Trunk Main Line from Nirant Cross Road To Express Highway Junction (Alfa Hotel).	55.04
12	Rehabilitation of old sewer lines in central zone of amc areas from 1. Rani na Hajira to Sankadi sheri to Madan Gopal haveli to Astodiya rangati bazar road to astodiya darwaja rath yatra route. 2. Gollimda junction to Navio masjid to Jamalpur SPS 3.300 MM & 450 MM in Madhupura location in cz amc area. 4.600mm in Dariyapur location in CZ AMC area.	18.3
13	Rehabilitation work for existing drainage line from 1. avkar hall to Hirabai Tower In Maninagar ward. 2.Khodiyar Nagar CR to Sabarmati River.	23.11
14	Rehabilitation Of Drainage Trunk Main Line from Ladla Bridge To Namaste Circle.	9.24
15	Rehabilitation Of Drainage Trunk Main Line from Express Highway Junction Via. Lalgebi Circle to AUDA Underpass	14.66
	Total	**414.47**

(2) Proposed Project

Target Year	Project Timeline: March 2026
Target Catchments	hydraulic simulation: 1/10 (80mm/hr)
Interlinking lakes in South-west Zone	
Interlinking lakes in West Zone	

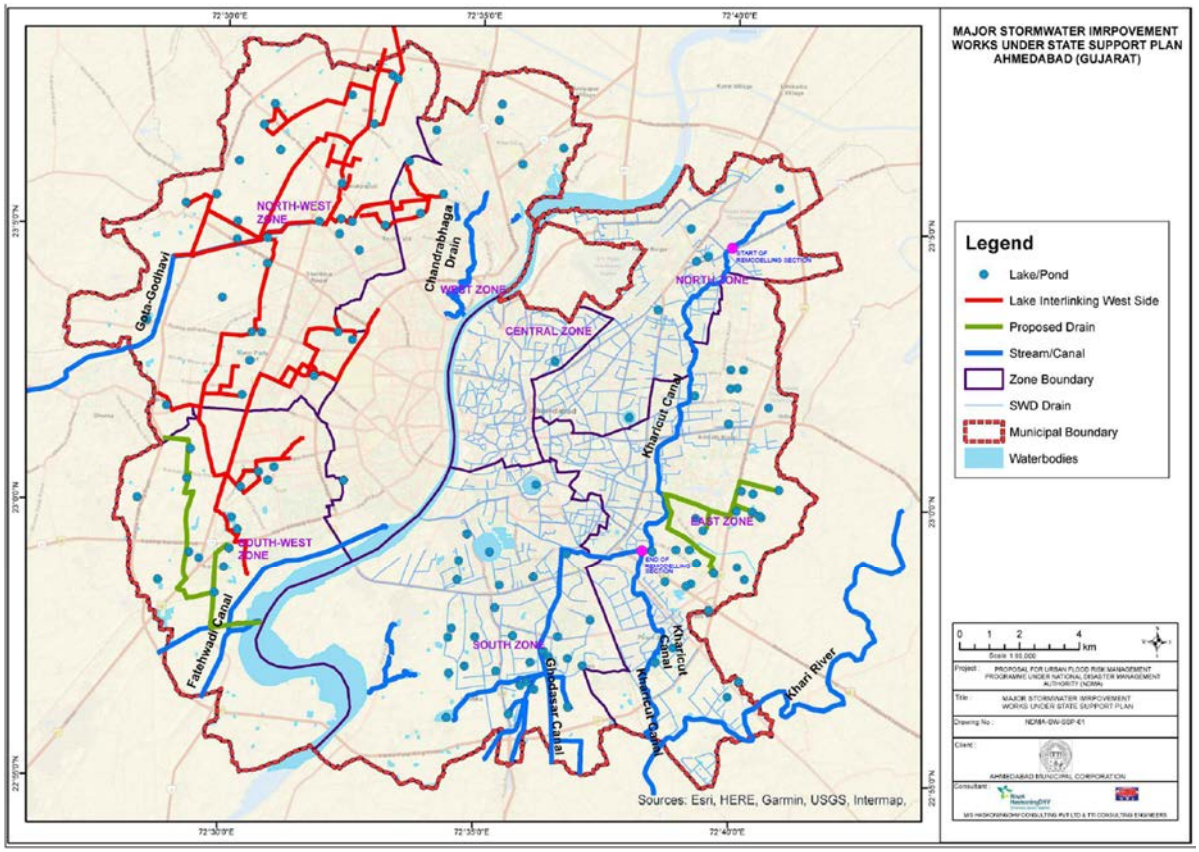
Name of lake	Catchment area (Sq Km)
Muhamadpura lake	1.94
Malkani lake	0.56
Bedar lake	2.85
Shakri lake	0.36
Aazadnagar lake	0.62
Kanajiyu lake	2.76
Punia lake	6.68
Near Khodiyar Mataji temple	0.51
Other contributary catchment	3.17
Total	**19.71**

Name of lake	Catchment area (Sq Km)
Mahadevia lake	0.44
Talavadi Vastral	2.26
Talavadi Vastral	1.35
Talavadi Vastral	0.48
Talavadi Vastral	1.35
Vadu Lake Ramol	1.98
Village Lake Vastral	1.6
Total	**9.48**

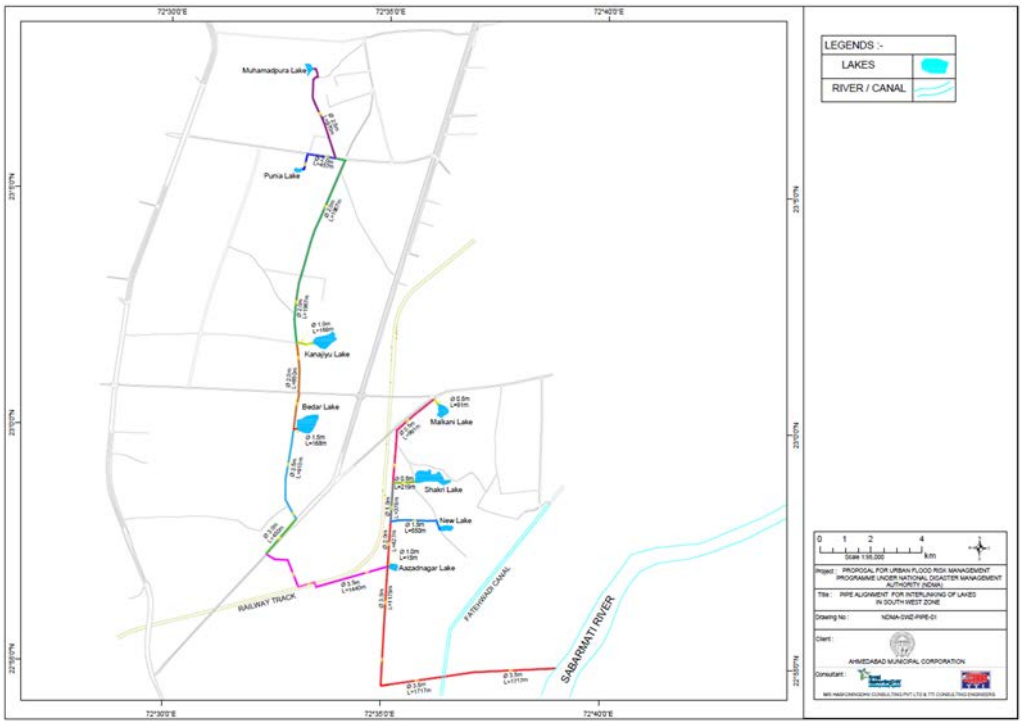
Project Cost

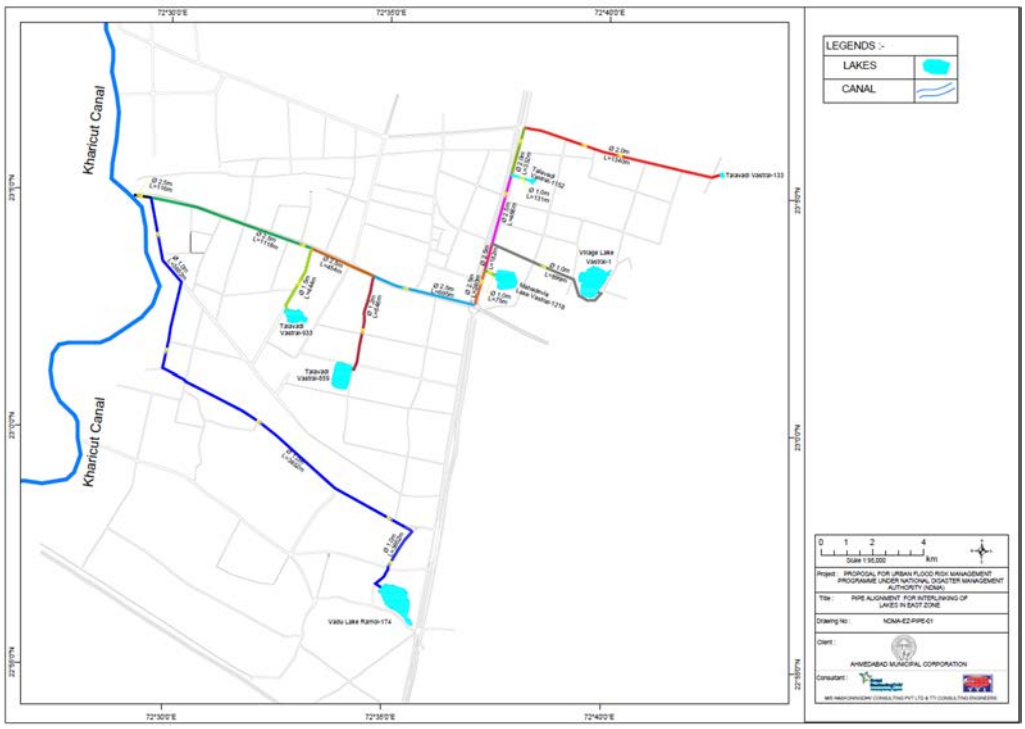
Sr. No.	Component	Tentative cost in Cr (INR)
1	Improved ground infiltration mechanism using Eco Block	25.0
2	Flood water management by Detention Cum Infiltration Tank	25.0
3	Interlinking of water bodies - South West Zone	76.0
4	Interlinking of water bodies - East Zone	78.0
5	Sponge Park and Underground Water Storage Facility	15.0
6	Ahmedabad Flood Early Warning System including all sensors, software, hardware, establishment of control room etc	40
7	5% Fund for Studies Research, Innovation and Training	
7.1	Preparation of Detailed Drainage master plan including detailed design	12.0
7.2	Capacity Building including trainings, workshops etc	4.0
	Total	**275.0**

General Map



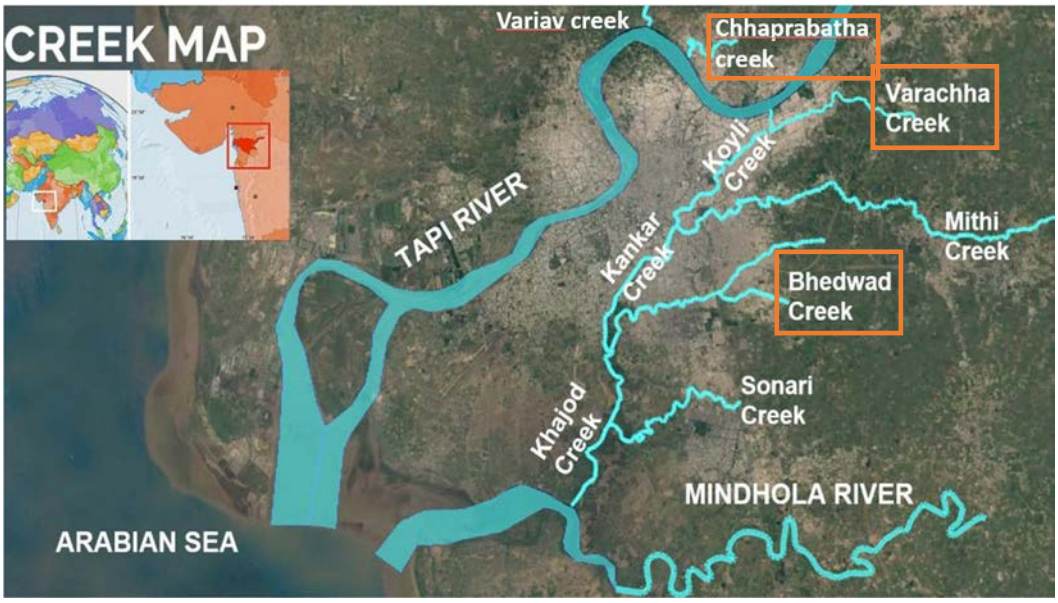
Interlinking of lakes





1. Surat

(1) Basic Information

Municipal Corporation	Surat Municipal Corporation (SMC) Drainage Department
Document	1) Creek Remodeling & Restructuring Work (PPT) 2) Development of Creeks including remodeling and restructuring at Surat/ Interim & Final Feasibility Report 3) Development of Creeks including remodeling and restructuring at Surat/ Detailed Project Report
Prepared by	1) SMC 2) WAPCOS Limited 3) WAPCOS Limited
Date	2) February 2017 3) May 2023
Objective of the Project	Creek Rejuvenation of Bhedwad Creek, Varachha Creek, and Chhaprabatha Creek
Project Components	
Project Budget:	

	FS	DPR	Project Cost (Cr)		
			Land	Construction	Total
1) Bhedwad Creek	Completed	Completed	864	678	1542
2) Varachha creek	Completed	-	585	335	920
3) Chhaprabatha creek	Completed	-	288	258	550
Total			1,737	1,271	3,012

Inundation record	In 2006, this was first time in the last 200 years that the city of Surat has seen floods of such a large magnitude. Due to incessant rains in Maharashtra, the flood gates of the Ukai reservoir were opened releasing the excess waters into Gujarat. A major portion of Surat urban area under the municipal corporation got flooded on both sides of the river banks.

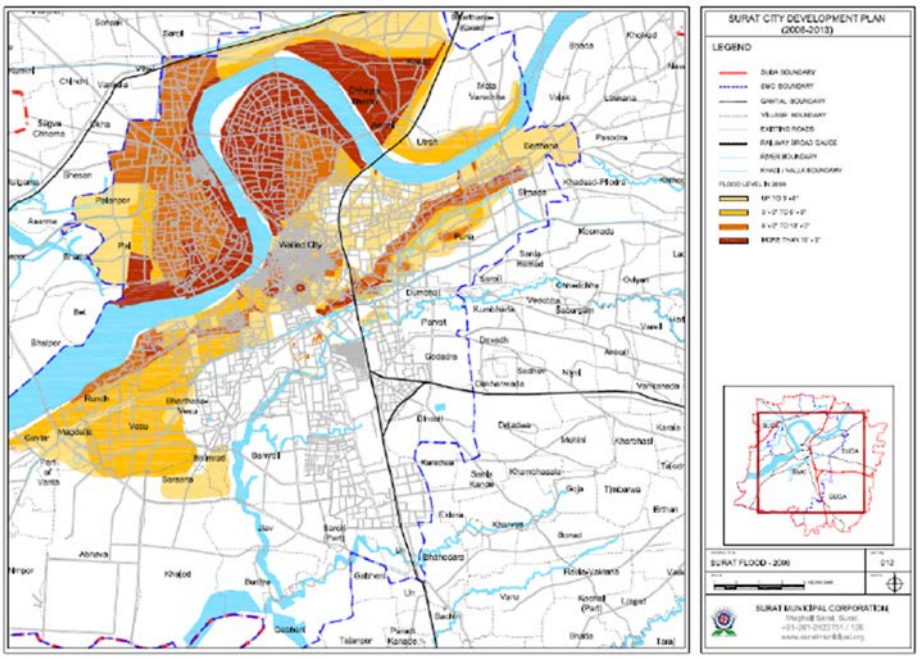


FIGURE 13 SURAT FLOOD 2006

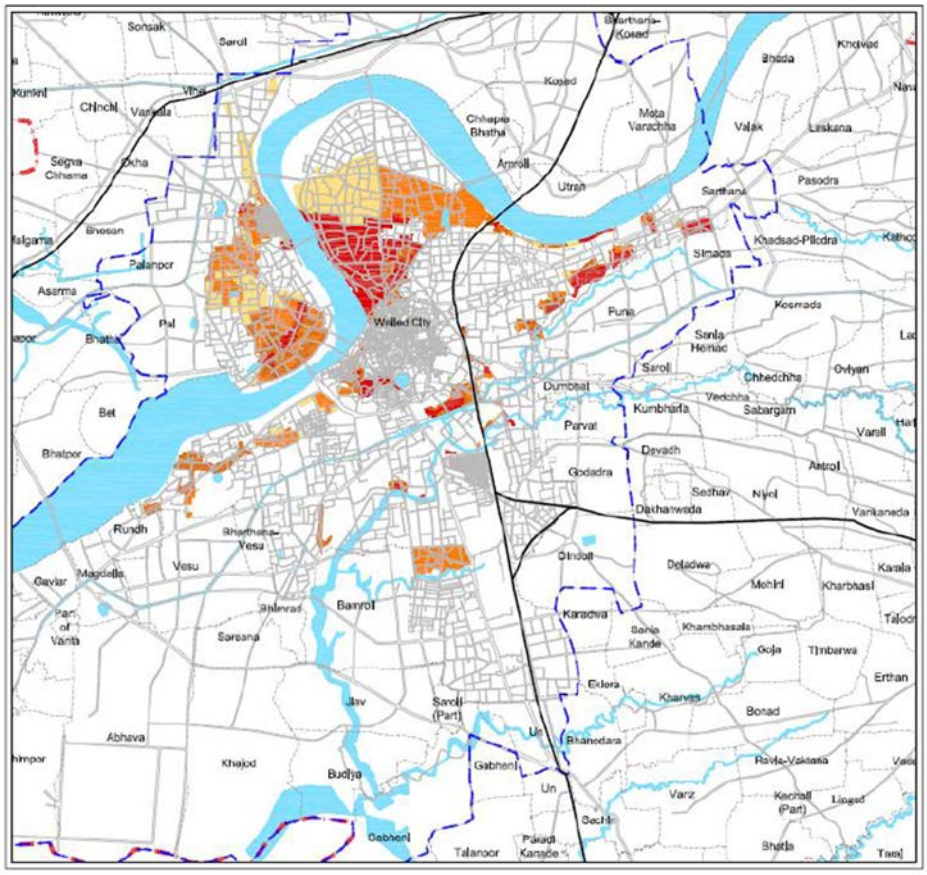
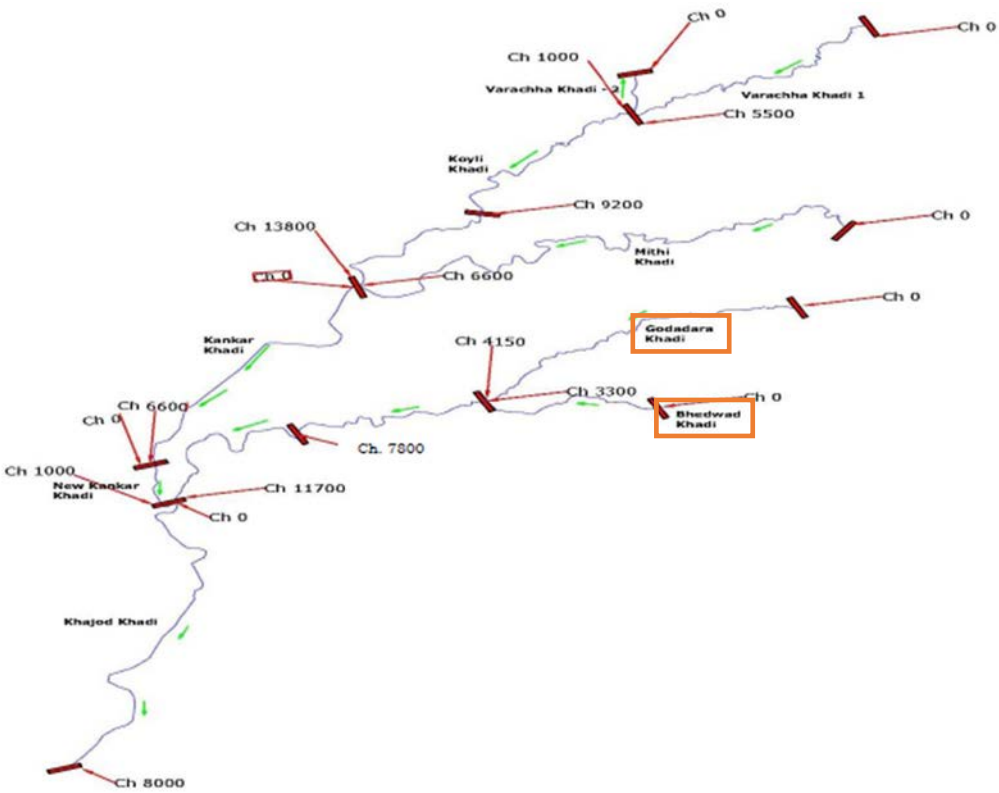


FIGURE 12 SURAT FLOOD 1998[1]

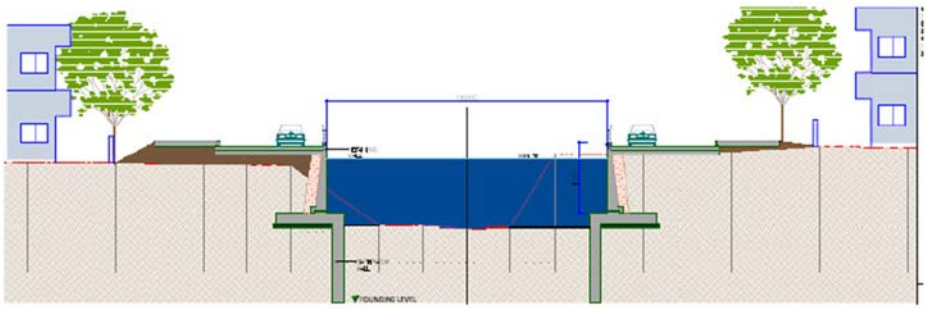
Completed works	SR. No.	Name of Work	Total Project Cost (Rs. In Cr.)
	1	**Kankar creek:** Location: Jivanjyot bridge to Ashirwad Enclave Soc., Bhimrad (Length- 6.6 Km) Bank protection work (Length – 6.6 Km) Underpass & Approaches - (Nos - 07) Sluice Regulator (Nos – 03)	139.56
	2	**Mithi creek:** Location: Jivanjyot soc. small creek bridge to Ashirwad Market, Magob (Length- 6.6 Km) Bank protection work (Length – 6.6 Km) Approaches - (Nos - 06) Creek Culvert (No – 01) Creek bridge (No- 01)	168.25
	3	**Koyli creek:** Location: Pkg -1 Karanj STP to Sarita Vihar Soc. (Length- 1.5 Km) Pkg- 2 Sarita vihar soc. to APMC Market (Length- 1.35 Km) RCC Box type structure with diaphragm & retaining wall with RCC slab- girder over creek	180.29
		Total Project Cost (Rs. In Cr.)	**488.10**

(2) Proposed Project (Bhedwad Creek)

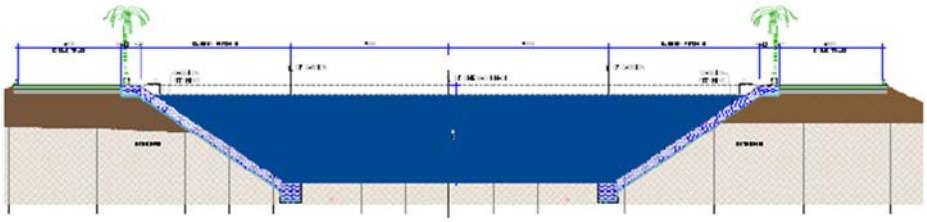
Target Year	Not specified
Target Catchments	Bhedwad Creek and Godadara Creek 

<table>
<tr>
<td>Proposed structures for Bhedwad Khadi</td>
<td>

- Retaining wall with Diaphragm wall having width is 15meter at chainage 0 to 3300m (without Road) & 18meter at chainage 3300 to 7800m



- Gabion Pitching with bed width of 18m and height of 5.5m (1.5H:1V) for Chainage 7800m to 11700m.



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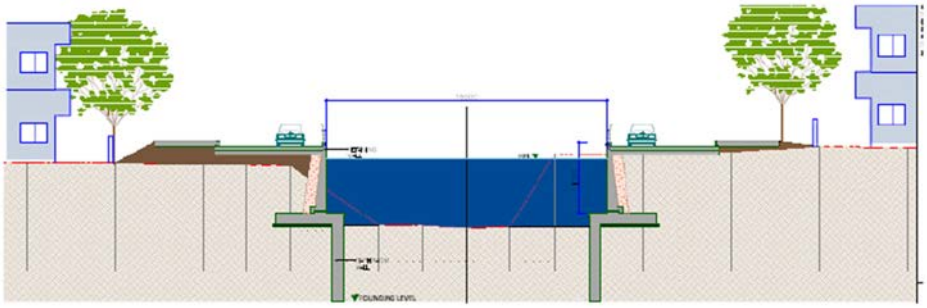
<tr>
<td>Proposed structures for Godadara Khadi</td>
<td>

- Retaining wall with Diaphragm wall having width is 18meter at chainage 0 to 4150m.



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<tr>
<td>Project Cost</td>
<td>

<table>
<tr><th>Name of Khadi</th><th>Type of Structure proposed</th><th>Length of khadi</th><th>Per meter cost in Rs. (as per 2021-22 price level)</th><th>Total cost in Rs.</th></tr>
<tr><td rowspan="3">Bhedwad khadi</td><td>Retaining wall with Diaphragm wall</td><td>3.30 km Length</td><td>4,07,800.00</td><td>1,34,57,85,828.00</td></tr>
<tr><td>Retaining wall with Diaphragm wall</td><td>4.50 km Length</td><td>5,16,300.00</td><td>2,32,32,12,877.00</td></tr>
<tr><td>Gabion Pitching</td><td>3.90 km Length</td><td>2,48,300.00</td><td>96,82,69,321.00</td></tr>
<tr><td>Godadara Khadi</td><td>Retaining wall with Diaphragm wall</td><td>4.15 km Length</td><td>5,16,600.00</td><td>2,14,37,08,196.00</td></tr>
<tr><td></td><td></td><td colspan="2">Total cost for development of Bhedwad & Godadara creek</td><td>6,78,09,76,222.00</td></tr>
</table>

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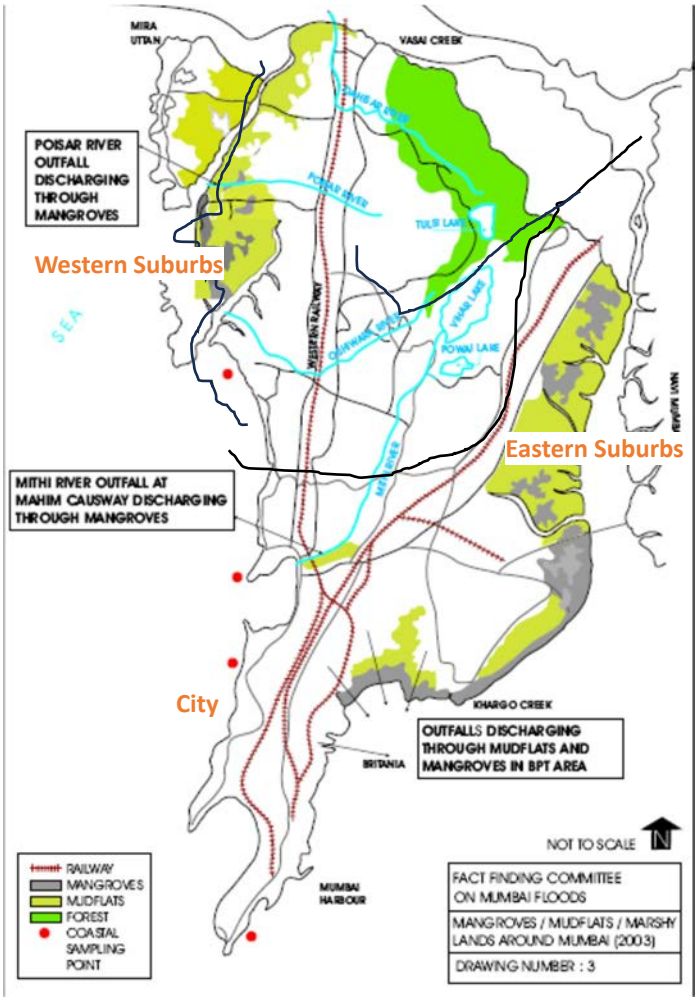
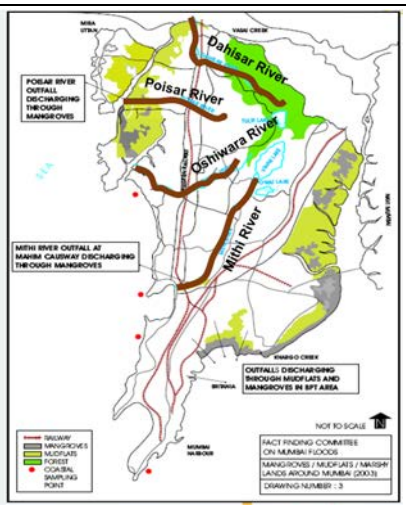
1. Mumbai M/P

(1) Basic Information

Municipal Corporation	Municipal Corporation of Greater Mumbai (MCGM)
Document	Brimstowad-II Master Plan Vol-E: Master Plan Report for the "City" Vol-F: Master Plan Report for the "Eastern Suburbs" Vol-G: Master Plan Report for the "Western Suburbs"
Department in Charge	Storm Water Drainage Department
Prepared by	MWH India Private Limited
Target Area	Entire Greater Mumbai 

Existing Drainage Facilities

- SWD system in Mumbai is designed for the maximum rainfall intensity of 55 mm/hr SWD network.
- When rainfall increases beyond 55mm/hr., it results in water logging at various low-lying areas
- When high tide coincides with heavy rainfall.
- Higher intensity of rainfall in short spell of time.



CONSTRUCTION OF STORM WATER PUMPING STATIONS

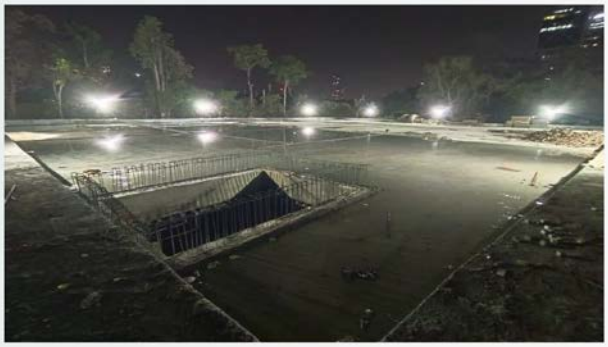
Name of SWPS	Year of Commissioning	Capacity (CuM/Sec)	Total No. of Pumps
Haji Ali	2011	36	6
Irla	2011	48	8
Lovegrove	2015	60	10
Cleveland	2015	42	7
Britannia	2016	36	6
Gazdar Bandh	2019	36	6
Mogra	In Progress	42	7
Mahul	Tendering in Progress	Phase I – 60 Phase II – 60	10 10

CONSTRUCTION OF MINI PUMPING STATIONS

Sr. No.	Location	Total No of Pumps	Remarks
1	Gandhi Market	14	Work Completed
2	Hindmata	15	Work Completed
3	Chunabhatti	6	Work Completed
4	Mahalaxmi	8	Work Completed
5	Yellow Gate P D Mello	3	Work in Progress
6	Bharni Naka Wadala Fire Brigade	4	Work completed
7	90 Feet Jn Sant Rohidas	3	Work will be started before Monsoon 2024
8	T junction Dharavi (with Gate Pump Techanology)	2	Work will be completed before Monsoon 2024
9	Vidhyalankar college road	3	Work completed
	Total	**58**	

HINDMATA FLOOD RELIEF WORK –
Storm Water holding pond at Pramod Mahajan Garden

Capacity Phase-I	16200 cu.m (Completed)
Capacity Phase-II	19926 Cum (In Progress)
Total Capacity	3.6 Crore Liters
Water Holding Duration	Final Capacity 150 minutes for rainfall of 55 mm/hr



Work Completed - 100%

MILAN SUBWAY FLOOD RELIEF WORK

Capacity	30000 cu.m (3 Crore Liters)
Status	Work in Progress & same will be completed before monsoon 2023
Water Holding Duration	Final Capacity 150 minutes for rainfall of 55 mm/hr

Work Completed - 100%

Ongoing project

MITHI RIVER POLLUTION CONTROL PROJECT

Priority	Work Type	Key Elements	Contract Period	Status
Package 1 (Filterpada to WSP Compound, Powai)	Sewage treatment	8MLD STP at WSP Compound	24 M (I.M.)	Work Completed.
	Sewer line	Construction of interceptors & Laying of 1.65 kms sewer line		
	Service Road	Construction of 1.50 kms service road		
Package 2 (WSP Compound to CST Bridge, Kurla)	Sewer line	Construction of 102 nos. of minor interceptors	24 M (E.M.)	Work is in progress 30% Completed.
	Service Road	Construction of 3.325kms Retaining Wall, 9.375 kms service road		
		Laying of sewer 8.07 kms line		
Package 3 (CST Bridge to Mahim Causeway)	Sewer line, interceptors, Pumping stations	Laying of 8.4 kms of sewer line, Construction 1 no. of major interceptors at Vakola River, Construction of 1 no of sewer pumping stations	36 M (I.M.)	Tendering process is in progress.
	Retaining Wall & Service Road	construction of 7.490 kms of Retaining Wall and 6.421 kms of service road.		
	Gate Pumps	Construction of Gate Pumps at 26 outfalls (including interception work)		
Package 4 (Bapat Nalla – Saphed Pul Nalla – Dharavi WWTF)	Sewer Tunnel	Construction of Major Interceptors at Bapat Nalla & Saphed Pool Nalla	48 M (I.M.)	Work is in progress 30% Completed
		Construction of 2.6m dia Sewer Tunnel from Bapat Nalla & Saphed Pool Nalla to Dharavi WwTF, total length – 6.5 kms		

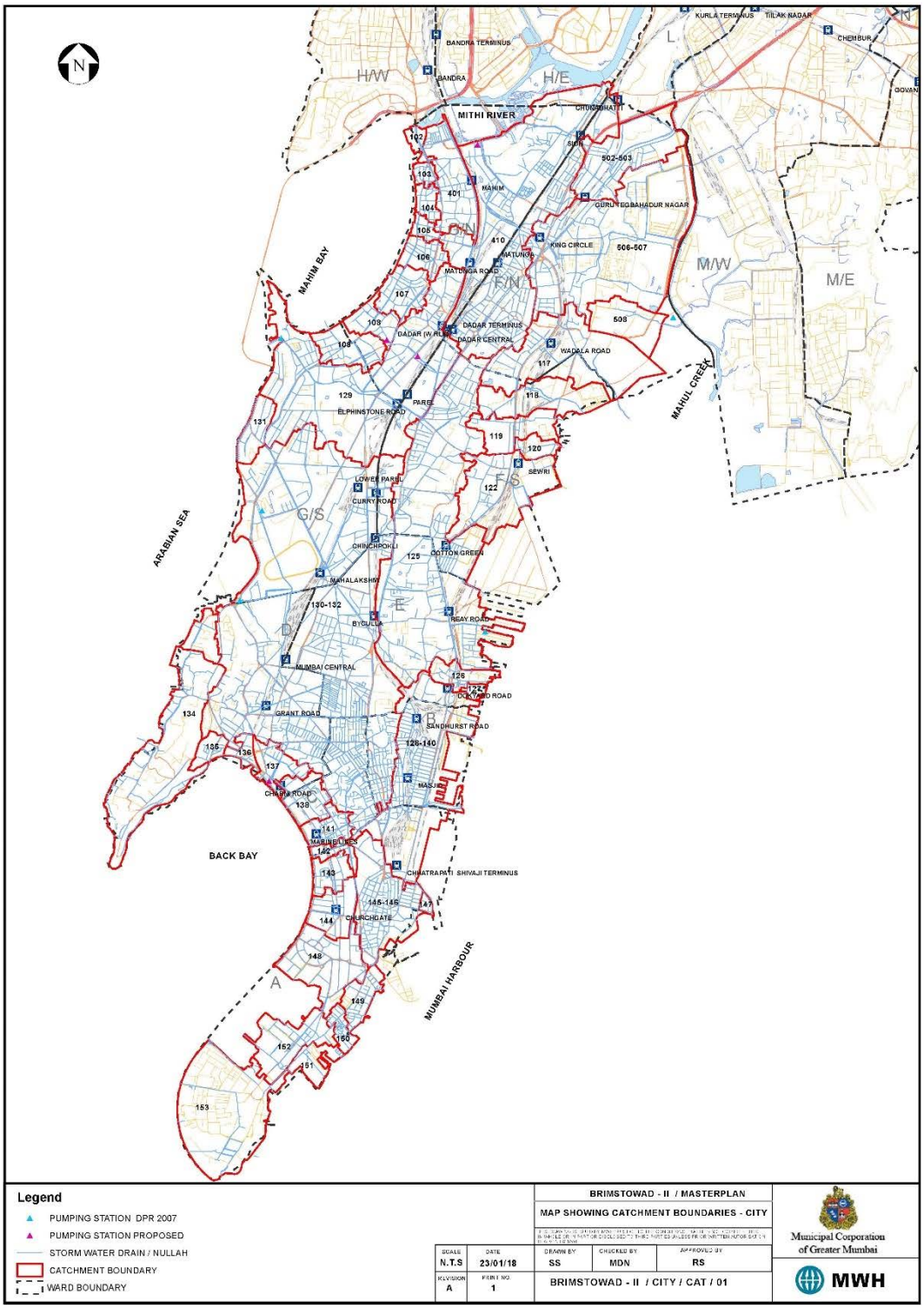
Inundation record

The 2005 Maharashtra floods impacted many parts of the Indian state of Maharashtra including large areas of the metropolis Mumbai, in which approximately 1,094 people died. Many people were stranded on the roads, lost their homes while many walked long distances back home from work that evening. The floods were caused by the eighth heaviest-ever recorded 24-hour rainfall figure of 944 mm (37.17 inches) which lashed the metropolis on 26 July 2005, and intermittently continued for the next day. 644mm (25.35 inches) was received within the 12-hour period

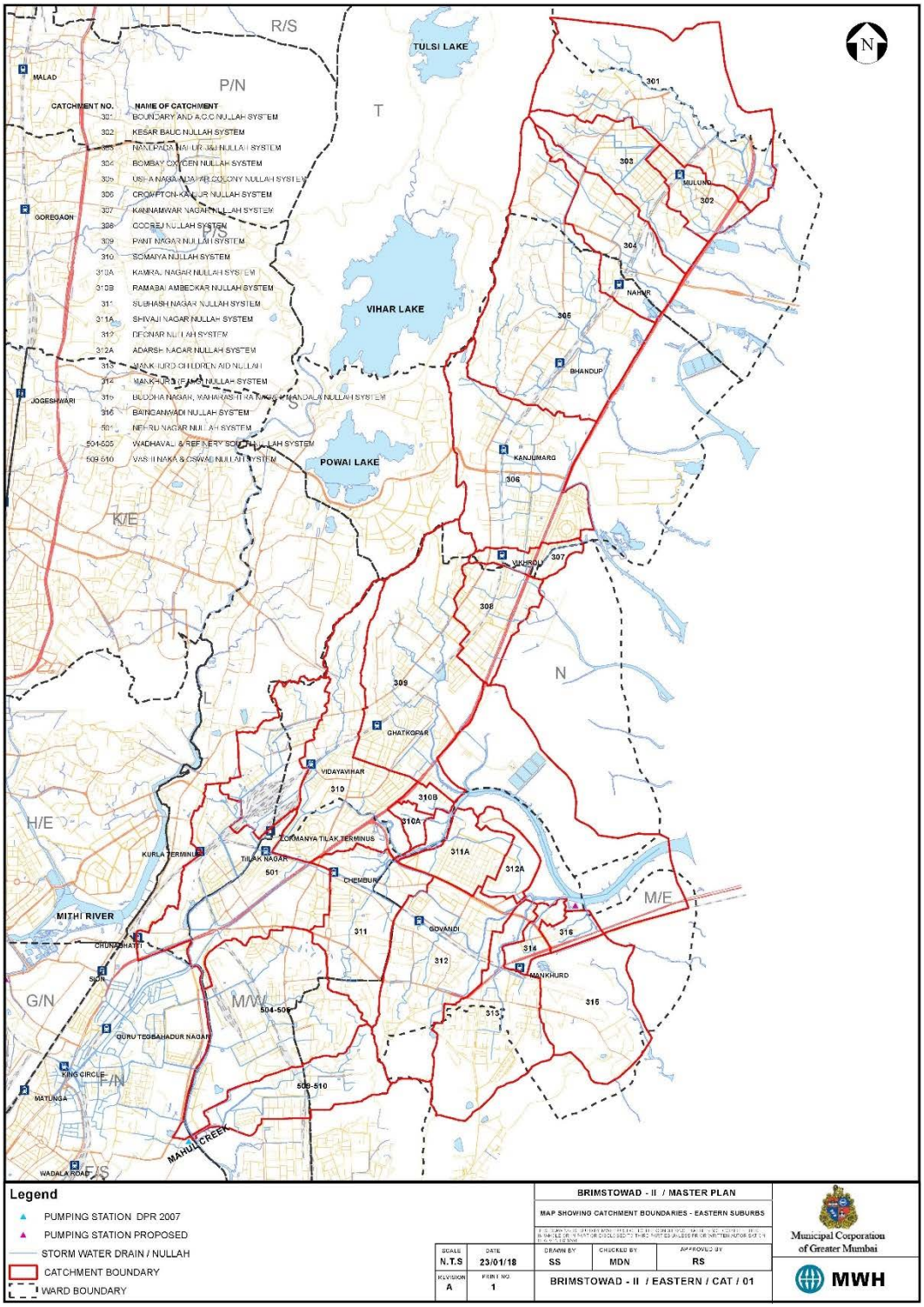
	between 8 am and 8 pm. The previous record high rainfall in a 24-hour period for Mumbai was 575 mm (22.6 inches) in 1974. The financial cost of floods was unprecedented, and these floods caused a stoppage of entire commercial, trading, and industrial activity for days. Preliminary indications indicate that the floods caused a direct loss of about ₹5.50 billion (€80 million or US$100 million).

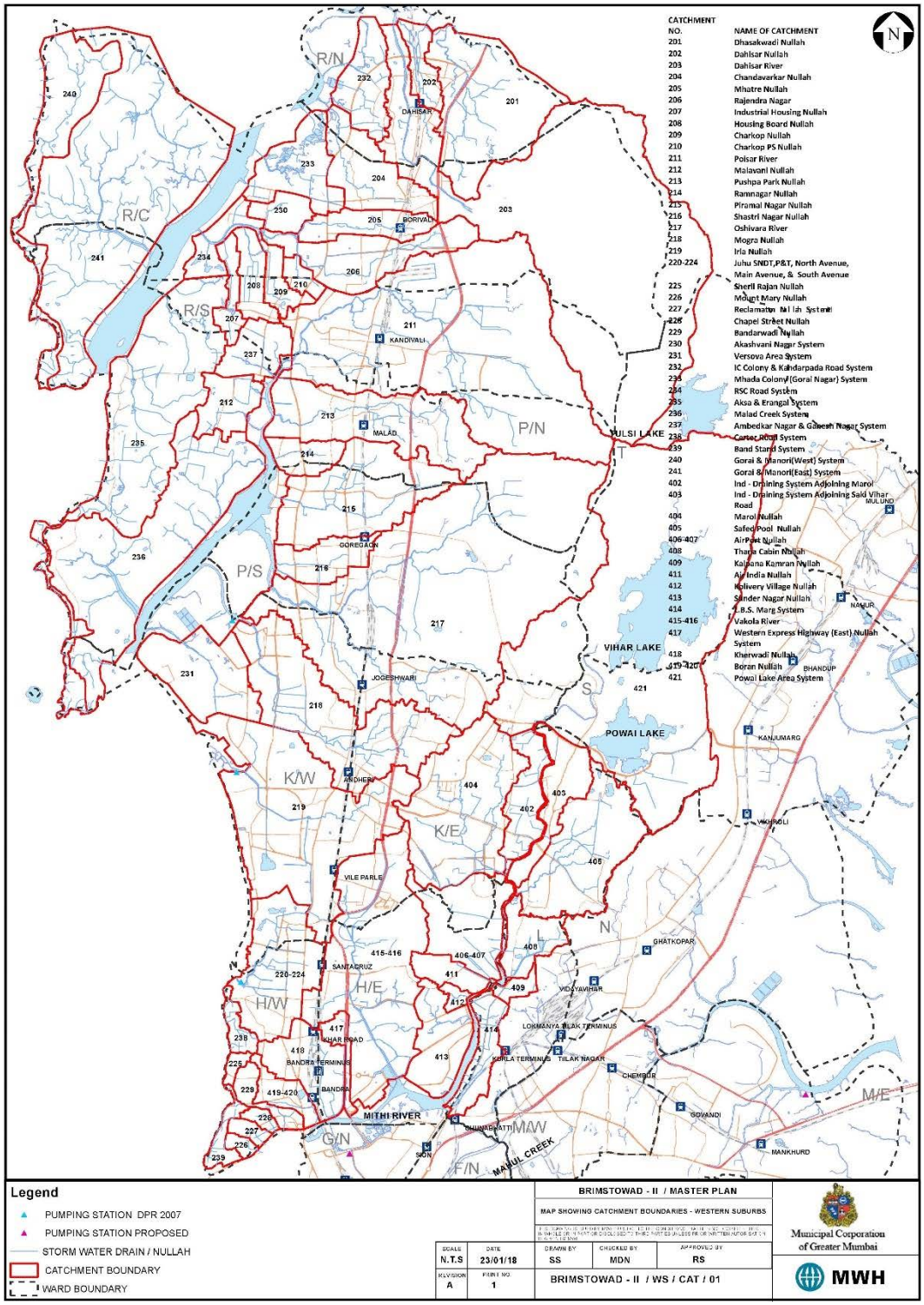
(2) Proposed Project

Target Year	N/A
Target Catchments	1. City 2. Eastern Suburbs 3. Western Suburbs
Design condition	Maximum rainfall intensity: 55mm/hr
Project Scope	1. New diversions (drainage network) 2. New pumping stations 3. Drain / Nullah improvement 4. Early food warning system

Proposed Development Plan	
City	

Eastern Suburbs



Western Suburbs	
Project Cost	City

Sr. No.	Catchment No.	Drain Improvements (Cr)	Diversion Inter catchment (Cr)	Local Area Network Improvement (Cr)	I&D Works (Cr)	Storage (Cr)	Early Flood Warnings System – Instrumentations (Cr)	Pumping Station (Cr)	Micro Tunnelling (Cr)	Total (Cr)	Other Municipal Charges 28% (Cr)	Total Project cost (Cr)	Compensation (Cr)	Grand Total (Cr)
1	102	1.06	-	0.31	5.75	-	0.14	-	-	7.26	2.03	9.29	-	9.29
2	103	3.11	0.25	0.32	1.44	-	0.09	-	-	5.21	1.46	6.67	-	6.67
3	104	6.81	1.75	0.48	1.44	-	0.14	-	-	10.62	2.97	13.59	-	13.59
4	105	7.50	0.35	0.34	1.44	-	0.09	-	-	9.72	2.72	12.44	-	12.44
5	106	11.36	-	0.88	1.44	-	0.18	-	-	13.86	3.88	17.74	-	17.74
6	107	15.85	-	1.34	1.44	-	0.32	-	-	18.95	5.31	24.26	-	24.26
7	108	23.87	0.21	0.93	4.02	-	0.28	-	-	29.31	8.21	37.52	-	37.52
8	109	17.89	-	1.47	2.01	-	0.37	-	-	21.74	6.09	27.83	-	27.83
9	117	53.24	-	5.70	3.32	-	1.10	-	-	63.36	17.74	81.10	126.00	207.10
10	118	24.38	-	2.43	4.04	-	0.46	-	-	31.31	8.77	40.08	52.20	92.28
11	119	14.44	-	1.56	1.44	-	0.27	-	-	17.71	4.96	22.67	14.50	37.17
12	120	-	-	0.51	1.44	-	0.09	-	-	2.04	0.57	2.61	-	2.61
13	122	28.11	-	3.87	5.75	-	0.78	-	-	38.51	10.78	49.29	-	49.29
14	125	194.43	0.88	15.85	12.99	-	2.94	65.24	75.00	367.33	102.85	470.18	5.20	475.38
15	126	4.01	-	0.80	1.44	-	0.23	-	-	6.48	1.81	8.29	-	8.29
16	127	3.18	0.09	0.19	1.44	-	0.09	-	-	4.99	1.40	6.39	-	6.39
17	128 & 140	90.80	-	7.41	10.65	-	1.63	-	-	110.49	30.94	141.43	-	141.43
18	129	126.16	-	12.78	9.81	-	2.64	-	-	151.39	42.39	193.78	76.00	269.78
19	130 & 132	253.00	-	34.11	20.77	3.72	7.00	81.55	138.75	538.90	150.89	689.79	51.40	741.19
20	131	6.07	-	0.96	2.87	-	0.23	-	-	10.13	2.84	12.97	-	12.97
21	133	3.36	-	0.77	2.87	-	0.28	-	-	7.28	2.04	9.32	-	9.32
22	134	26.15	-	6.06	18.68	-	1.10	-	-	51.99	14.56	66.55	7.10	73.65
23	135	2.55	-	0.51	1.44	-	0.14	-	-	4.64	1.30	5.94	-	5.94
24	136	3.92	-	0.43	1.44	-	0.09	-	-	5.88	1.65	7.53	-	7.53
25	137	11.47	-	1.06	4.31	-	0.23	-	-	17.07	4.78	21.85	-	21.85
26	138	5.86	-	1.25	4.31	-	0.32	-	-	11.74	3.29	15.03	-	15.03
27	141	4.42	-	0.88	1.44	-	0.38	-	-	7.12	1.99	9.11	-	9.11
28	142	2.95	-	0.45	1.44	-	0.14	-	-	4.98	1.39	6.37	-	6.37
29	143	8.79	-	0.82	1.44	-	0.18	-	-	11.23	3.14	14.37	-	14.37
30	144	19.71	-	1.32	4.31	-	0.42	-	-	25.76	7.21	32.97	-	32.97

31	145 & 146	57.30	-	3.63	4.33	-	0.74	-	-	66.00	18.48	84.48	-	84.48
32	147	6.90	2.70	0.13	2.01	-	0.14	-	-	11.88	3.33	15.21	-	15.21
33	148	29.96	-	2.90	7.19	-	0.65	-	-	40.70	11.40	52.10	10.40	62.50
34	149	4.79	-	0.94	4.31	-	0.28	-	-	10.32	2.89	13.21	-	13.21
35	150	2.91	-	0.49	7.19	-	0.19	-	-	10.78	3.02	13.80	1.80	15.60
36	151	5.26	-	0.79	2.87	-	0.18	-	-	9.10	2.55	11.65	-	11.65
37	152	10.87	-	2.06	8.33	-	0.61	-	-	21.87	6.12	27.99	7.80	35.79
38	153	35.55	-	5.99	18.68	-	1.10	-	-	61.32	17.17	78.49	27.40	105.89
39	401	37.96	0.46	2.49	4.31	-	0.55	-	-	45.77	12.82	58.59	9.10	67.69
40	410	115.00	0.03	14.93	11.37	-	2.71	87.54	28.57	260.15	72.84	332.99	116.20	449.19
41	502 & 503	57.23	-	3.52	4.61	-	0.64	175.09	-	241.09	67.51	308.60	265.60	574.20
42	506 & 507	84.71	-	11.69	10.39	-	1.96		-	108.75	30.45	139.20	188.20	327.40
43	508	9.21	-	1.73	2.58	-	0.27		-	13.79	3.86	17.65	57.20	74.85
44	Common for City Area	-	-	-		-	0.90	-	-	0.90	0.25	1.15	-	1.15
Sub total		**1,432.10**	**6.72**	**157.08**	**224.79**	**3.72**	**33.27**	**409.42**	**242.32**	**2,509.42**	**702.65**	**3,212.07**	**1,016.10**	**4,228.17**

Eastern Suburbs

Sr. No.	Catchment (No.)	Nullah Improvement (Cr)	Diversion Inter catchment (Cr)	Local Area Network Improvement (Cr)	I&D Works (Cr)	Gravity sewer for I& d works	Storage (Cr)	Early Flood Warnings System – Instrumentations (Cr)	Pumping Stations(Cr)	Micro Tunneling (Cr)	Total (Cr)	Other Municipal Charges 28% (Cr)	Total Project cost (Cr)	Compensation for PAP(Cr)	Grand Total (Cr)
1	301	40.81	1.96	16.01	5.13	-	-	2.95	-	-	66.86	18.72	85.58	-	85.58
2	302	25.45	1.25	3.11	4.89	-	-	0.84	-	2.18	37.72	10.56	48.28	-	48.28
3	303	36.62	-	6.01	4.46	-	-	1.34	-	-	48.43	13.56	61.99	23.80	85.79
4	304	20.46	-	5.87	6.47	-	-	1.33	-	2.86	36.99	10.36	47.35	53.30	100.65
5	305	31.33	-	17.91	8.28	-	-	3.76	-	-	61.28	17.16	78.44	118.80	197.24
6	306	16.34	-	11.48	7.47	-	-	2.32	-	-	37.61	10.53	48.14	28.40	76.54
7	307	2.62	-	1.64	3.73	-	-	0.37	-	-	8.36	2.34	10.70	-	10.70
8	308	0.00	-	2.85	6.03	-	-	0.72	-	-	9.60	2.69	12.29	-	12.29

9	309	80.84	-	15.22	7.14	-	-	2.88	-	-	106.08	29.70	135.78	38.40	174.18
10	310	88.00	6.09	11.45	7.99	-	-	2.65	-	-	116.18	32.53	148.71	41.20	189.91
11	310A	3.60	-	0.76	3.73	-	-	0.18	-	-	8.27	2.32	10.59	39.70	50.29
12	310B	4.96	-	0.76	4.87	-	-	0.18	-	-	10.77	3.02	13.79	60.10	73.89
13	311	19.94	-	8.21	6.18	-	-	1.81	-	-	36.14	10.12	46.26	12.50	58.76
14	311A	17.16	-	3.50	5.76	-	-	0.54	-	-	26.96	7.55	34.51	57.00	91.51
15	312	23.92	-	10.00	6.85	-	-	2.10	-	-	42.87	12.00	54.87	-	54.87
16	312A	15.03	-	2.07	2.60	-	-	0.36	-	-	20.06	5.62	25.68	-	25.68
17	313	22.47	-	7.30	7.42	-	-	1.73	-	-	38.92	10.90	49.82	-	49.82
18	314	0.00	-	1.43	3.15	-	-	0.32	-	-	4.90	1.37	6.27	-	6.27
19	315	151.32	-	6.44	10.95	-	-	1.26	-	-	169.97	47.59	217.56	-	217.56
20	316	22.53	-	1.15	4.30	-	-	0.18	-	-	28.16	7.88	36.04	-	36.04
21	501	55.82	-	17.44	7.16	-	-	3.58	-	-	84.00	23.52	107.52	55.60	163.12
22	504 and 505	11.65	-	8.92	11.79	-	-	2.51	-	-	34.87	9.76	44.63	-	44.63
23	509 and 510	18.16	-	3.96	5.90	-	-	1.09	-	-	29.11	8.15	37.26	48.40	85.66
24	301 -308	-				91.99					91.99	25.76	117.75		117.75
25	309 -316	-		-	-	119.84	-	-	-	-	119.84	33.56	153.40	-	153.40
26	501 - 510					50.93					50.93	14.26	65.19		65.19
27	501, 309 - 316	228.84							227.61		456.45	127.81	584.26		584.26
28	Common for Eastern Suburbs							0.90			0.90	0.25	1.15		1.15
Sub Total		**937.87**	**9.30**	**163.49**	**142.25**	**262.76**	**0.00**	**35.90**	**227.61**	**5.04**	**1784.22**	**499.58**	**2283.81**	**577.20**	**2861.01**

Western Suburbs

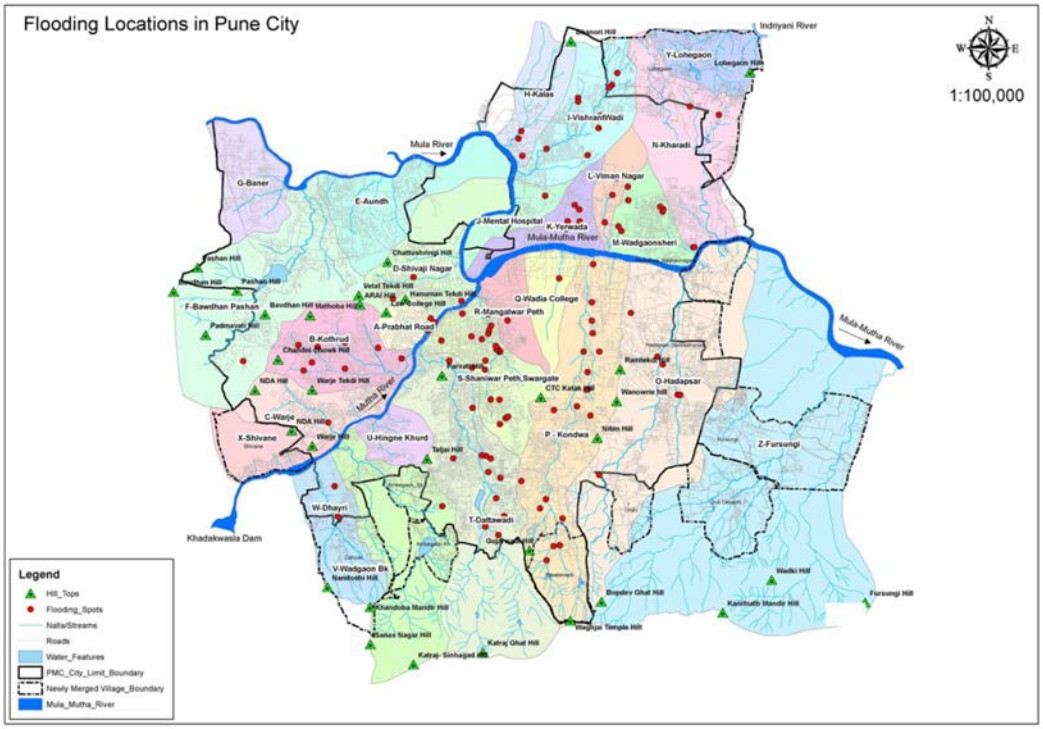
Sr. No.	Catchment (No.)	Nullah Improvement Cr)	Diversion Inter catchment (Cr)	Local Area Network Improvement (Cr)	I&D Works (Cr)	Storage (Cr)	Early Flood Warnings System – Instrumentations (Cr)	Pumping Stations (Cr)	Micro Tunnelling (Cr)	Total (Cr)	Other Municipal Charges 28% (Cr)	Total Project cost (Cr)	Compensation for PAP(Cr)	Grand Total (Cr)
1	201	56.90	-	10.04	7.47	-	2.84	-	-	77.25	21.63	98.88	57.50	156.38
2	202	14.96	-	2.10	6.75	-	0.55	-	-	24.36	6.82	31.18	7.70	38.88
3	203	0.00	-	12.04	13.77	-	9.36	-	-	35.17	9.85	45.02	-	45.02
4	204	10.87	-	6.24	5.22	-	1.48	-	-	23.81	6.67	30.48	-	30.48
5	205	0.00	-	3.85	6.23	-	0.88	-	-	10.96	3.07	14.03	-	14.03
6	206	43.06	-	8.01	10.37	-	1.56	-	-	63.00	17.64	80.64	121.60	202.24
7	207	8.23	-	1.68	3.94	-	0.36	-	-	14.21	3.98	18.19	-	18.19
8	208	17.45	-	2.12	4.51	-	0.45	-	-	24.53	6.87	31.40	-	31.40
9	209	7.16	-	2.02	3.67	-	0.36	-	-	13.21	3.70	16.91	-	16.91
10	210	0.00	-	1.11	3.67	-	0.18	-	-	4.96	1.39	6.35	-	6.35
11	211	29.41	-	26.59	12.05	-	7.92	-	-	75.97	21.27	97.24	52.60	149.84
12	212	7.72	-	3.35	9.61	-	0.59	-	-	21.27	5.96	27.23	-	27.23
13	213	36.12	-	13.20	13.12	-	2.47	-	-	64.91	18.17	83.08	122.90	205.98
14	214	4.17	-	2.64	3.37	-	0.55	-	-	10.73	3.00	13.73	-	13.73
15	215	35.60	-	13.62	7.47	-	2.82	-	-	59.51	16.66	76.17	4.20	80.37
16	216	5.86	-	3.98	9.61	-	1.08	-	-	20.53	5.75	26.28	71.20	97.48
17	217	161.72	-	28.53	17.20	-	9.85	-	-	217.30	60.84	278.14	135.90	414.04
18	218	81.76	-	18.46	11.48	-	3.30	122.57	13.42	250.99	70.28	321.27	156.30	477.57
19	219	34.28	-	24.11	4.04	-	4.37	-	-	66.80	18.70	85.50	29.70	115.20
20	220 to 224	42.68	-	9.59	3.51	-	2.12	-	-	57.90	16.21	74.11	3.10	77.21
21	225	0.00	-	0.59	3.67	-	0.09	-	-	4.35	1.22	5.57	-	5.57
22	226	2.26	-	0.52	2.52	-	0.09	-	-	5.39	1.51	6.90	-	6.90
23	227	3.45	-	0.63	3.09	-	0.18	-	-	7.35	2.06	9.41	5.50	14.91
24	228	3.08	-	0.51	3.09	-	0.18	-	-	6.86	1.92	8.78	-	8.78
25	229	2.99	-	1.69	3.09	-	0.37	-	-	8.14	2.28	10.42	4.10	14.52
26	230	0.00	-	2.17	3.94	-	0.36	-	-	6.47	1.81	8.28	-	8.28
27	231	41.30	-	7.01	6.37	-	1.26	-	-	55.94	15.66	71.60	34.80	106.40
28	232	52.59	-	4.13	15.22	-	0.81	-	-	72.75	20.37	93.12	30.20	123.32
29	233	63.44	-	3.34	11.26	-	0.99	-	-	79.03	22.13	101.16	-	101.16
30	234	57.21	-	1.23	8.82	-	0.45	-	-	67.71	18.96	86.67	-	86.67

31	235	298.77	-	10.91	25.46	-	3.60	-	-	338.74	94.85	433.59	54.30	487.89
32	236	219.45	-	10.40	31.83	-	3.69	-	-	265.37	74.30	339.67	-	339.67
33	237	24.32	-	3.24	8.47	-	0.54	-	-	36.57	10.24	46.81	36.30	83.11
34	238	21.06	-	1.32	2.52	-	0.27	-	-	25.17	7.05	32.22	-	32.22
35	239	13.60	-	1.30	2.52	-	0.27	-	-	17.69	4.95	22.64	-	22.64
36	240	103.70	-	1.59	5.22	-	1.53	-	-	112.04	31.37	143.41	32.00	175.41
37	241	445.74	-	4.08	31.32	-	5.85	-	-	486.99	136.36	623.35	-	623.35
38	402	32.48	-	4.37	8.13	-	0.63	-	-	45.61	12.77	58.38	-	58.38
39	403	22.44	0.99	4.96	12.36	-	0.72	-	-	41.47	11.61	53.08	47.50	100.58
40	404	14.68	-	15.11	7.47	-	2.63	-	-	39.89	11.17	51.06	-	51.06
41	405	32.94	-	11.69	6.33	-	2.00	-	-	52.96	14.83	67.79	-	67.79
42	406 and 407	45.08	-	0.28	6.73	-	1.17	-	-	53.26	14.91	68.17	9.10	77.27
43	408	7.27	-	3.45	10.41	-	0.54	-	-	21.67	6.07	27.74	17.20	44.94
44	409	0.00	-	0.94	3.09	-	0.28	-	-	4.31	1.21	5.52	-	5.52
45	411	0.00	-	2.11	3.94	-	0.41	-	-	6.46	1.81	8.27	-	8.27
46	412	0.00	-	0.60	3.09	-	0.14	-	-	3.83	1.07	4.90	-	4.90
47	413	10.08	-	4.55	14.65	-	0.95	-	-	30.23	8.46	38.69	-	38.69
48	414	94.04	-	3.38	12.36	-	0.54	-	-	110.32	30.89	141.21	54.40	195.61
49	415 and 416	65.30	-	19.13	13.20	-	4.17	-	-	101.80	28.50	130.30	210.00	340.30
50	417	8.34	-	1.38	3.67	-	0.37	-	-	13.76	3.85	17.61	48.80	66.41
51	418	7.45	0.42	5.29	4.51	-	1.30	-	-	18.97	5.31	24.28	-	24.28
52	419 and 420	47.59	16.26	2.07	3.94	-	0.56	-	-	70.42	19.72	90.14	22.80	112.94
53	421	29.25	-	14.83	9.81	-	1.08	-	-	54.97	15.39	70.36	-	70.36
54	Common for Western Suburbs	-	-	-	-	-	0.90	-	-	0.90	0.25	1.15	-	1.15
Sub Total		**2367.85**	**17.67**	**342.08**	**449.16**	**0.00**	**92.01**	**122.57**	**13.42**	**3404.76**	**953.33**	**4358.09**	**1369.70**	**5727.79**

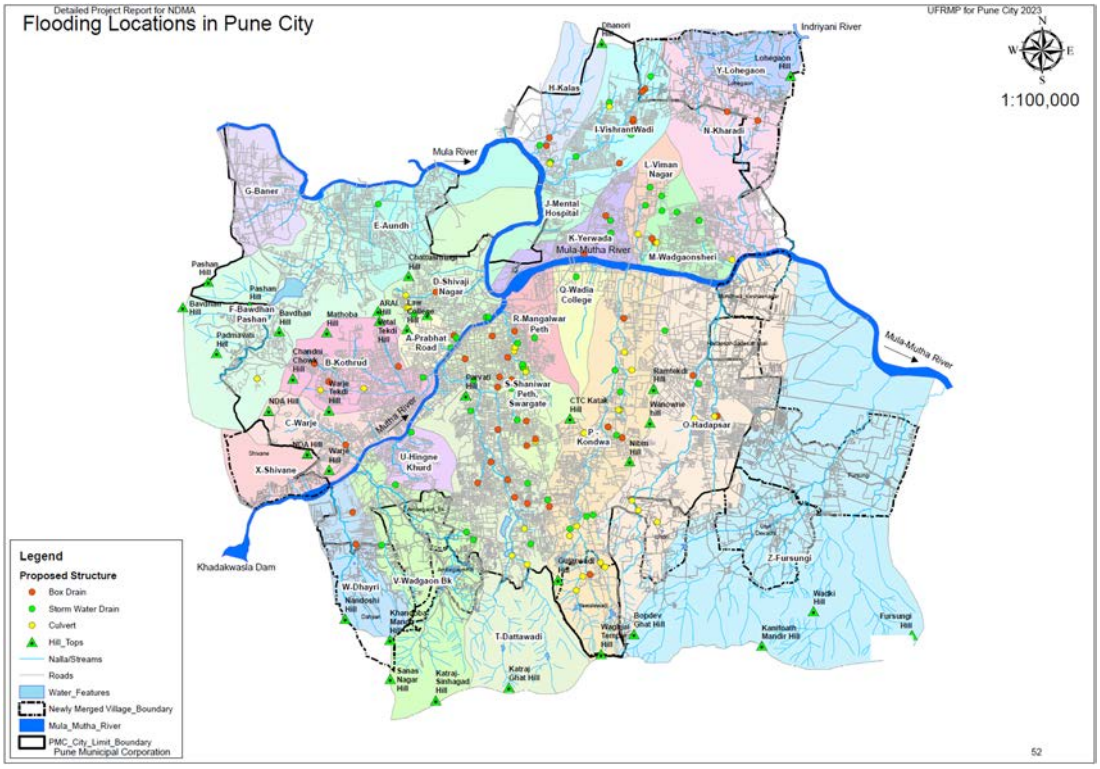
1. Pune DPR

(1) Basic Information

Municipal Corporation	Pune Municipal Corporation (PMC)
Document	Urban Flood Risk Management Program for City of Pune 2023 Proposal for National Disaster Management Authority under UFRMP 2023-2025 Detailed Project Report for NDMA project
Department in Charge	Sewerage, Maintenance And Repair Department of BMC
Prepared by	Primove Consultant
Date	September 2023
Target Area	Flooded area in 2021
Rainfall	In year 2005 and 2006, Pune city experienced one of the heaviest rainfalls of 1227.30 mm. and 1132.30 mm. maximum hourly rainfall is 66 mm/hr in year 1969. Recently maximum hourly rainfall occurred in 2004 and 2009 is 63.50mm and 64.50 respectively.
Inundation record	In November 2015 storm (more than 90mm in day) at Kalas, Dhanori, Vimannagar, Vishrantwadi and Yerwada area caused heavy flooding in the area. The Ambilodha (stream) overflowing hazard event, in 2019 has amounted to losses of 200 Crore Rupees (CDAC Report 2022) claiming lives of 26 persons. Fig 3. Images of floods on 25 September 2019 *(Source: Compiled from Newspaper and internet)*

	In year 2021-22 Pune City has experienced heaviest rainfalls of more than 100 mm and 143 locations all over the Pune City were flooded in 2022. 
Completed project	Phase I: a total of 162 flooding spots were identified and Tackled in the year 2016-17 Phase II: a total of 110 flooding spots were identified and Tackled in the year 2018-19 Phase III: total 80 Nos frequently flooding Location is tackled in the year 2019-21 and presently Phase 3 Remaining works are in progress.

(2) Proposed Project

Target Year	N/A
Objectives	To summarize the project focuses on 3 main objectives: ➢ To address priority 137 locations of flooding hotspots with structural measures ➢ To study the flooding challenges of the complete city for all the watersheds and basins and preparing integrated strategy for flood mitigation for various scenariosfor retaining, detaining and dispersing flood waters for future implementations ➢ To enhance the capacities of administration and stakeholders for flood response in predisaster, disaster and post disaster phase to make informed decisions.
Target Catchments	In entire Pune city, 137 locations identified by the Disaster Management Cell. Fig 1 shows the Map of Pune with 137 priority locations with proposed structure. 

Entire Project Scope (Structural Interventions)

Zone Nos	Component	Amount (Rs)	No of locations	Length (m)
STRUCTURAL INTERVENTIONS				
Zone 1	Storm Water Drain	17,60,92,612.70	19	5316.9
	Box Drain	49,62,22,805.58	15	8042.6
	Culvert	15,58,93,883.35	6	
		82,82,09,301.63	**40**	
Zone 2	Storm Water Drain	7,84,71,424.84	10	2486.2
	Box Drain	6,28,86,811.69	4	1151.4
	Culvert	11,81,84,395.43	6	
		25,95,42,631.96	**20**	
Zone 3	Storm Water Drain	11,70,21,407.33	9	3920.6
	Box Drain	16,34,33,636.05	6	2624.1
	Culvert	-	0	
		28,04,55,043.37	**15**	
Zone 4	Storm Water Drain	10,90,80,570.40	9	3022.2
	Box Drain	25,57,66,747.91	7	4875.5
	Culvert	83,48,95,197.63	20	
		119,97,42,515.94	**36**	
Zone 5	Storm Water Drain	8,70,61,659.22	9	2633
	Box Drain	40,86,05,201.36	11	7012.2
	Culvert	29,06,44,915.36	6	
		78,63,11,775.94	**26**	
	Total Amount	**357,71,43,869.84**	**137 Nos.**	

Entire Project Scope (Non-structural Interventions)

Sr. No.	Non Structural Interventions	Amount	Amount in Cr.
B	**Flood control measures**		
1	Nala deepening and widening	22,28,82,601	22.29
2	Lake Rejuvenation and desilting		
a	Pashan lake	5,17,97,827	5.18
b	Katraj lake	8,65,35,750	8.65
c	Jambhulwadi lake	8,68,09,500	8.68
	Flood control measures Component (B)	**44,80,25,678**	**44.80**
C	**Nature based solutions**		
1	Interventions for high risk Economical Weaker Sections – Gabbion Wall	2,31,76,800	2.32
2	Rainwater harvesting/Infilteration pits	11,98,31,250	11.98
3	Water Shed Management - Afforestation - Gully plug, Water absorption trench, continuous contour trench	10,92,97,500	10.93
4	Tree plantation	1,95,50,000	1.96
	Nature based solutions Component (C)	**27,18,55,550**	**27.19**
D	**Non-Structural Interventions**		
1	Project NS1 -Integrated Command And Control Center		
a	Integrated Command And Control Center	53,26,88,000	53.27
b	Equipment's for the flood response cell at the ward office	6,68,91,525	6.69
2	Project NS2 - Capacity Building Of Administration	3,79,87,500	3.80
3	Project NS3- Advocacy On Policy - Building Codes, Building Byelaws	1,40,00,000	1.40
4	Project NS4 - Review And Reworking Of Storm Water Masterplan	4,60,00,000	4.60
5	Project NS 5 - Capacity Building Of Stake Holders	1,04,82,000	1.05
	Non-Structural Interventions Component (D)	**70,80,49,025**	**70.81**
	Non-Structural Interventions Component (B + C + D)	**1,42,79,30,253**	**142.79**

Proposed Project To JICA	Phase I: under UFRMP (NDMA) Phase II: under another funding source (requested to JICA) Cr.191.5 (=478.20-286.70) was the proposed project under Yen Loan Project.

OVERALL COST SUMMARY OF THE PROJECT

Sr No.	Component	Total project Cost Proposal (Cr.)	Cost Approved under UFRMP (NDMA) Funding (Cr.)
A	Structural Interventions Flooding Hot Spots a. Storm Water Drains b. Box Drains c. Culverts	335.42	143.92
B	Structural Interventions Flood Control Measures a. Gabbion wall b. Nala desiliting c. Lake desilting and rejuvenation d. Rain Water Harvesting e. Water Shed Management	71.98	71.98
C	Non- structural Interventions Soft Component	70.80	70.80
	TOTAL AMOUNT	478.20	286.70

Location of proposed project

SR NO	SWD
1	Nandan Euphoria Society, Tingare nagar.
2	Laxmi nagar, Dhanori.
3	Patrakar nagar to sheti mahamandal chauk.
4	Kaikadi aali Bhawni Peth

SR NO	CULVERT
1	(Ctrl) - one-5-Runval Park Market
2	Zone-4-Khopade Nagar Gujarwadi
3	Zone-4-Kamthe Nagar Yewalewadi
4	Zone-4-Kondhwa Smashanbhumi
5	Zone-4-Sasane Nagar Rd, Ramtekdi Industrial
6	Zone-4-Universal Public School - Hadapsar
7	Zone-2-Mantri Park
8	Zone-1-(Behind Vitthal Mandir Dhanori
9	Zone-4-Jadhav Nagar Mangadewadi
10	Zone-1-Pansare Nagar Behind The Leaf Society
11	Zone-4-Hills Dales
12	Zone-4-Dobarwadi Wanvadi
13	Zone-4-Kalubai Mandir Wanowri
14	Zone-4-AIPT Depot Solapur Road Wanowri
15	Zone-4-Sinhagad College Campus
16	Zone-4-Govt Leprosy Hospital D/S
17	Zone-2-Jijai Chouk Kothrud
18	Zone-1-Banana Leaf Hotel Alandi Road
19	Zone-4-Lulla Nagar Kondwa Culvert
20	Zone-4-Takale Wasti
21	Zone-2-Shakuntala Udhyan
22	Zone-2-Gokhale Nagar
23	Zone-2-PVPIT College
24	Zone-1-Oasis Society Tithe Wasti Kharadi
25	Zone-4-Aabhuday Society Wanowri
26	Zone-4-Green Metro, Tilekar nagar Culvert

SR NO	BOX DRAIN
1	Adarsh Nagar Nalla to Saint Arnold School.
2	Maharashtra Housing board, yerwada.
3	DSK CHOWK BIKANER SWEETS DHAYARI
4	Dhor Galli Bhawani Peth
5	D- Mart To Kalepadal road
6	Ganraj Chowk Kalwad Wasti
7	Nivdungi vithoba Mandir Nana Peth
8	The Pentecostal church Ghorpadi (B.T. kawa
9	Airport road to 509 Chauk, Tingare nagar.
10	Dhankude plot culvert to Depot
11	Pasalkar Chowk +
12	Upper Indira nagar to VIT chowk
13	Commerce Zone – Mental Hospital, phule naga
14	Mogare vasti wanowri
15	Dagadushet mandir Shivaji Road
16	Hazrat Pathan Shah Dargah Aalandi Road.
17	Runval Park Market Yard
18	Wakhar mahamandal Neharu Road
19	Kalyan Bhel
20	Jay Bawani Hotel Satara Road
21	Bhandarkar Research Institute road
22	Hotel Blue Diamond to River Band Garden.
23	RAUT BAUG,3 HATTI CHOWK,DHANKWADI
24	Padmavati Satara Road
25	Training Batalian Aalandi Road.
26	Upper Indira nagar Upperotta
27	SP College to Alka Chowk Tilak Road
28	Shree hospital nala to Don Boscov school
29	D mart Punyadham aashram

Referential Information

MINISTRY OF HOME AFFAIRS (DISASTER MANAGEMENT DIVISION)

GUIDELINES ON CONSTITUTION AND ADMINISTRATATION OF THE NATIONAL DISASTER MITIGATION FUND (NDMF)

The Disaster Management Act, 2005 (hereinafter called as DM Act, 2005) defines mitigation as 'measures aimed at reducing the risl impact or effects of a disaster or threatening disaster situation.

2. National Disaster Mitigation Fund (NDMF) is constituted under section 47(1) of the DM Act, 2005. This fund is exclusively for the purpos of mitigation projects in. respect of disasters covered in National Disaster Response Fund (NDRF) Guidelines only. The Mitigation Fun shall be used for those local level and community-based interventions, which reduce the risks and promote environment-friendl settlements and livelihood practices. Large-scale mitigation interventions such as construction of coastal walls, flood embankments, suppo for drought resilience etc. shall be pursued through regular development schemes and not from the mitigation fund.

3. Mitigation measures can be both structural and non-structural

Structural measures: Structural mitigation measures include any physical construction to reduce or avoid possible impacts of hazards, c the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems. Thes measures attempt to strengthen buildings to better endure future disasters like cyclones and earthquakes.

Non- Structural measures: It does not involve physical construction but use of knowledge, practices, policies, laws/ regulations etc. e.g building codes and laws, location specific planning/strategies, forest management/restoration of mangroves, awareness campaigns etc.

These guidelines are issued under sections 47 and 62 of the DM Act, 2005 and shall be called 'National Disaster Mitigation Fund (NDMF guidelines and will be operative from the financial year 2021-22 to 2025-26, and will continue till further orders.

Project Cost

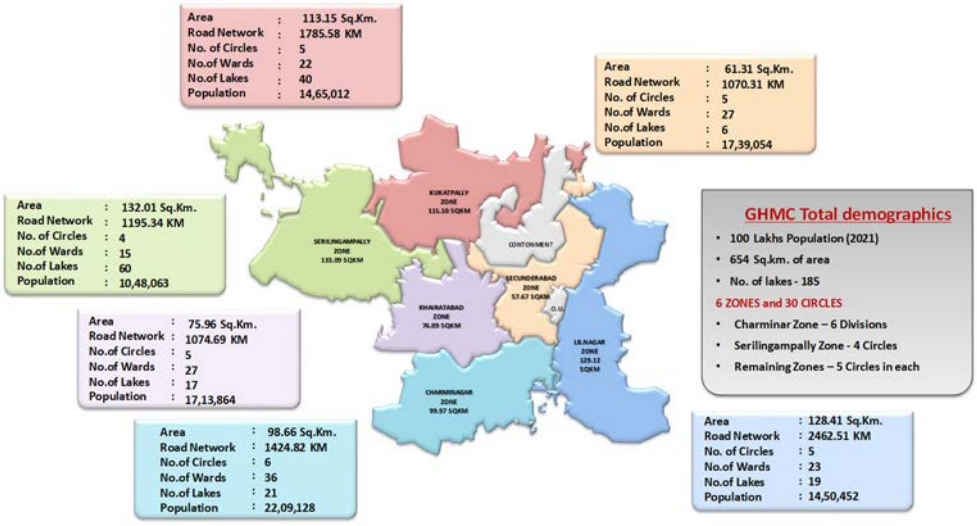
Sr No.	Component	Amount (Rs.)	Amount (Cr.)
A	**Structural Interventions**		
1	Storm Water Drain	56,77,27,674.48	56.77
2	Box Drain	1,38,69,15,202.59	138.69
3	Culvert	1,39,96,18,391.77	139.96
	Structural Interventions Component (A)	**3,35,42,61,268.84**	**335.43**
B	**Non- Structural Interventions (Flood control measures)**		
1	Nala deepening and widening	22,28,82,601.00	22.29
2	Lake Rejuvination and desilting		
a	Pashan lake	5,17,97,827.00	5.18
b	Katraj lake	8,65,35,750.00	8.65
c	Jambhulwadi lake	8,68,09,500.00	8.68
	Flood control measures Component (B)	**44,80,25,678.00**	**44.80**
C	**Non- Structural Interventions (Nature based solutions)**		
1	Interventions for high risk Economical Weaker Sections – Gabbion Wall	2,31,76,800.00	2.32
2	Rainwater harvesting/Infilteration pits	11,98,31,250.00	11.98
3	Water Shed Management - Afforestation - Gully plug, Water absorption trench, continuous contour trench	10,92,97,500.00	10.93
4	Tree plantation	1,95,50,000.00	1.96
	Nature based solutions Component (C)	**27,18,55,550.00**	**27.19**
D	**Non-Structural Interventions**		
1	PROJECT NS1 -		
a	Integrated Command And Control Center	53,26,88,000.00	53.26
b	Equipment's for the flood response cell at the ward office	6,68,91,525.00	6.69
2	Project NS2 - Capacity Building Of Administration	3,79,87,500.00	3.80
3	Project NS3- Advocacy On Policy - Building Codes, Building Byelaws	1,40,00,000.00	1.40
4	Project NS4 - Review And Reworking Of Storm Water Masterplan	4,60,00,000.00	4.60
5	Project NS 5 - Capacity Building Of Stake Holders	1,04,82,000.00	1.05
	Non-Structural Interventions Component (D)	**70,80,49,025.00**	**70.80**
	Non-Structural Interventions Component (B + C + D)	**1,42,79,30,253.00**	**142.79**
	TOTAL AMOUNT	**4,78,21,91,522.00**	**478.22**

OVERALL COST SUMMARY OF THE PROJECT

Sr No.	Component	Total project Cost Proposal (Cr.)	Cost Approved under UFRMP (NDMA) Funding (Cr.)
A	Structural Interventions Flooding Hot Spots a. Storm Water Drains b. Box Drains c. Culverts	335.42	143.92
B	Structural Interventions Flood Control Measures a. Gabbion wall b. Nala desiliting c. Lake desilting and rejuvenation d. Rain Water Harvesting e. Water Shed Management	71.98	71.98
C	Non- structural Interventions Soft Component	70.80	70.80
	TOTAL AMOUNT	478.20	286.70

1. Hyderabad M/P

(1) Basic Information

Municipal Corporation	Greater Hyderabad Municipal Corporation (GHMC)
Document	MP updated in 2020.
Department in Charge	Environment Vigilance & Disaster Management
Prepared by	N/A
Target Area	Entire GHMC (Inside the outer Ring Road): Area 625 km^2 
Existing Drainage Facilities (Phase-1)	• In GHMC area, out of 47.41 km, 40.32 Km were completed and balance will be completed in a couple of months. • Out of 18.03 km, 10.2 Km were completed and balance will be completed in a couple of months.
Inundation record	A series of floods resulted in extensive damage and loss of life as a result of flash flooding in Hyderabad in October 2020. Among the most affected areas were Balapur, L. B. Nagar, parts of Old City such as Hafiz Baba Nagar, Al Jubail Colony, Omer colony, Osman Nagar, Nabeel Colony, Falaknuma, Chaderghat etc. The damage was estimated at 900 crore. On 18 October 2020, a second cyclone killed two more people in Hyderabad. Over 37,000 families were affected by the second flood. Rainfall reached over 300mm in 6 hours in Hyderabad (Out of the mean annual rainfall of 827.2mm). With over 80 people having lost their lives and about 40,000 families being displaced, post rain gathering up-to 20,000 tons of waste.

(2) Proposed Project

Target Year	To be confirmed
Target Catchments	1. Kukatpally Zone 2. Serilingampally Zone 3. Khairatabad Zone 4. Secunderabad Zone 5. Charminagar Zone

	6. LB.Nagar Zone
Design condition	1/5years rainfall (50mm/hour)
Project Scope	1. Canal connection between Lake and Lake 2. Disilting of nalas and drains 3. Clearance of bottlenecks in drains and culverts 4. Creation of holding ponds 5. Construction of new drains, remodeling of existing drains (Widening, Deepening etc.)
Status of Phase-1 Project	1. As per the Master plan, the Phase 1 is majorly project for lake to lake connections by drains. Almost 90% of the phase 1 work has been completed which is having project cost of about Rs. 1,000 Cr.
Project Cost	1) Phase I (Under Implementation)

S. No.	Zone / ULB	No. of works	Estimated Cost (Rs. Crore)
A	GREATER HYDERABAD MUNICIPAL CORPORATION		
1	L B Nagar	10	122.33
2	Charminar	7	93.24
3	Khairatabad	7	137.12
4	Kukatpally	3	112.80
5	Secunderabad	8	261.08
6	Serilingampally	2	20.88
	Sub Total - A	**37**	**747.45**
B	SURROUNDING ULBs (Within ORR)		
1	Meerpet Municipality	3	18.19
2	Badangpet Municipal Corporation	7	64.05
3	Jalpally Municipality	2	24.85
4	Peddamberpet Municipality	1	32.42
5	Nizampet Municipal Corporation	7	84.63
6	Kompally Municipality	1	13.86
	Sub Total - B	**21**	**238.00**
	Grand Total	**58**	**985.45**

2) Phase II (Planed to commence from July 2024)

Sl. No.	Name of the Zone	Length in Km	Amount (Rs. in Cr)	Priority-I	
				No. of Projects	Amount (Rs. in Cr)
1	L B Nagar	38.021	460.53	12	200.60
2	Charminar	26.35	305.70	20	240.56
3	Khairatabad	14.651	148.37	8	104.67
4	Serilingampally	38.76	434.43	18	130.59
5	Kukatpally	47.269	663.51	20	222.48
6	Secunderabad	10.78	128.68	25	232.42
	Total (GHMC-Phase-II)	**175.831**	**2141.22**	**103**	**1131.32**

Guwahati DPR

(1) Basic Information

Municipal Corporation	Guwahati Municipal Corporation
Document	1) Presentation on Guwahati Existing Drainage Scenario 2) Water Supply, Storm Water Drainage, Underground Sewerage and Road Restoration of Guwahati Metropolitan Area under "JNNURM" Scheme/ Detail Project Report, Storm Water Drainage (Volume-1 General Report)
Department in Charge	Guwahati Metropolitan Development Authority (GMDA), Government of Assam
Prepared by	1) GMDA 2) Tahal Consulting Engineers
Date	1) October, 2023 2) October, 2008
Target Area	• The Detailed Project Report on Storm Water Drainage of Guwahati was prepared in 2008 by M/s Tahal Consulting Engineers Ltd. • Bharula, Bahini, Basistha and Bondajan are the main natural drainage channels for the city. Bharalu & Bahini channel flowing through the heart of the city which finally drains out in Brahmaputra river. Basistha channel outfalls to the Dipor Beel through Mora Bharalu channel. Dipor Beel connects with the Brahmaputra through Konnajan stream. Bondajan carries storm water from the south eastern part of the city. • Total Discharge through 3 channels namely Dipor Beel, Bharalu and Bondajan about 534 cumecs

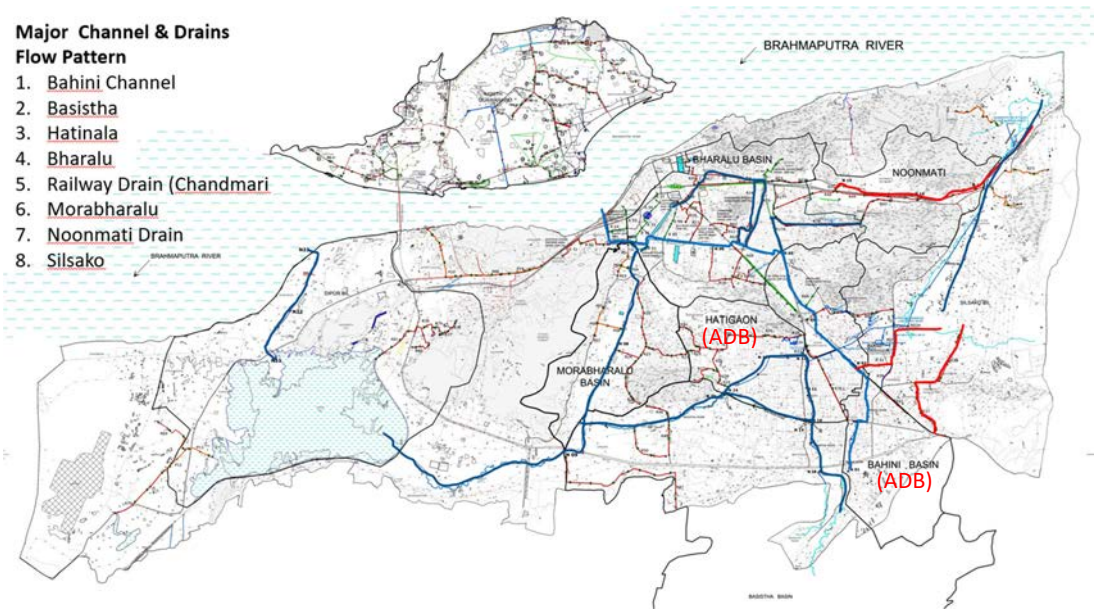
Major drainage basin and channel

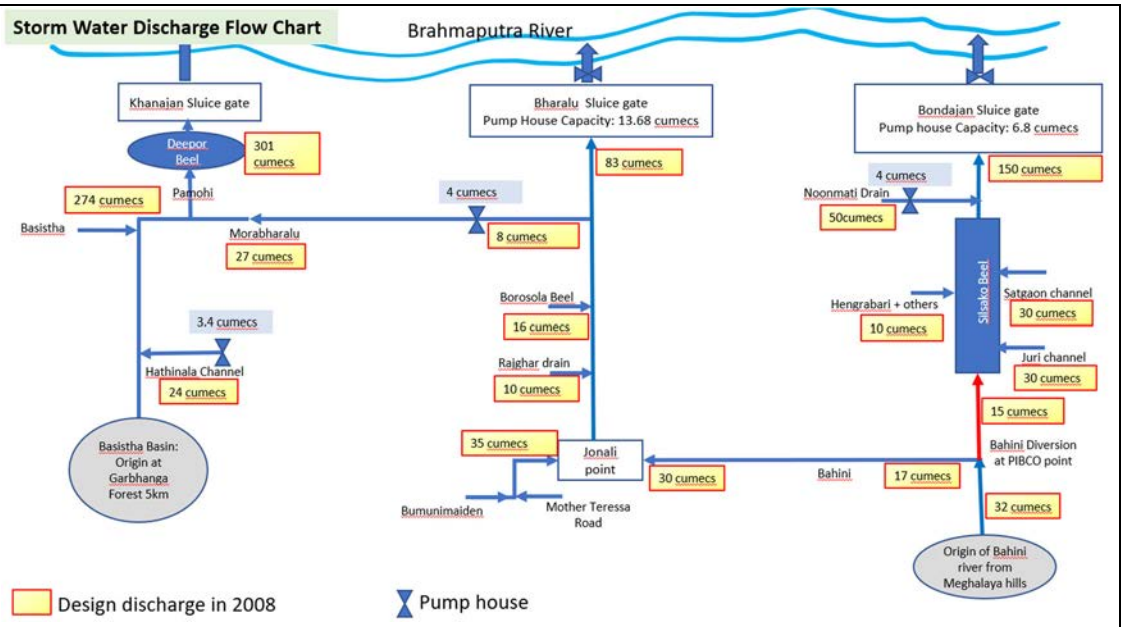
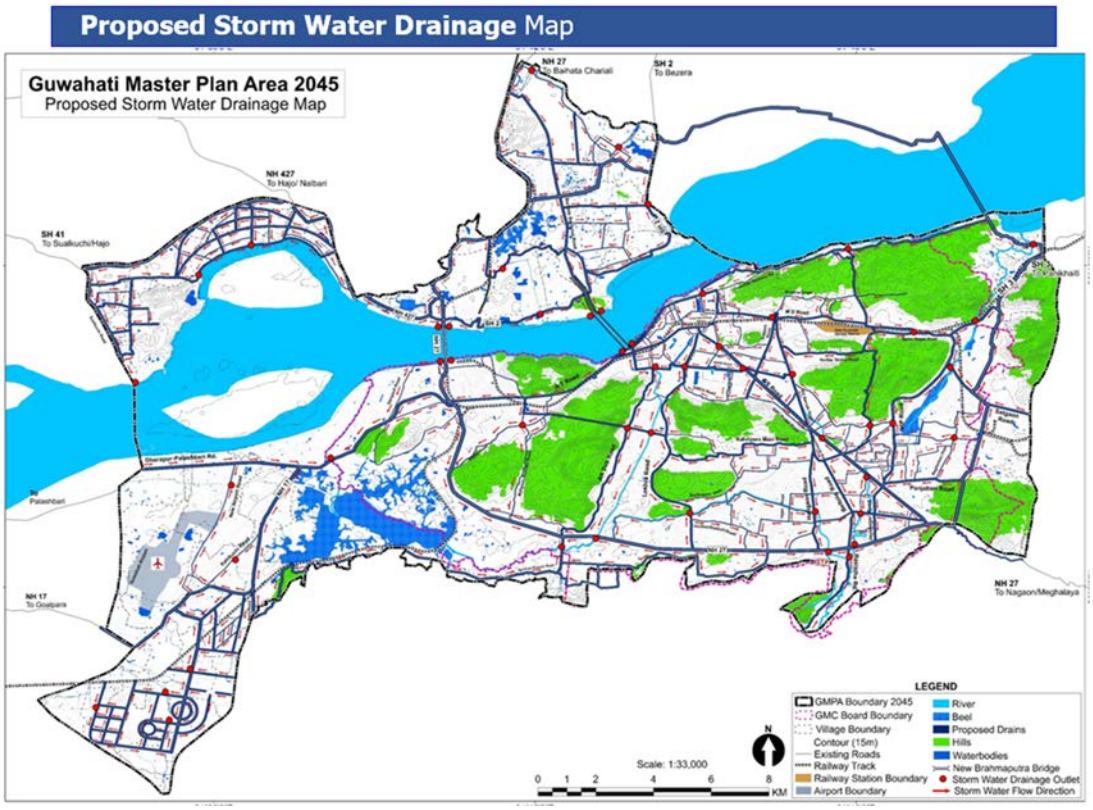
SN	Basin	Major Channel	Catchment Area SqKm	Length in Km	Design Discharge
1	Bahini basin	Bahini channel	16.83	8.5	48 cumecs
2	Bharalu basin	Bharalu river	19.36	4.8	83 cumecs
3	Morabharlu basin	Morabharlu channel	12.91	6.5	27 cumecs
4	Hatinala basin	Hatinala channel	11.9	5.1	24 cumecs
5	Basistha basin	Basistha channel	83.74	8.7	274 cumecs
6	Silsako Beel		50	5	75 cumecs
7	Noonmati basin	Noonmati drain	12.5	5.2	50 cumecs
8	Dipor beel basin	Dipor beel and Pamohi channel	46.24	Pamohi channel 7 km	66.3 cumecs
			253.49		

ADB

ADB

Existing Drainage Facilities



	
Proposed Project	
Inundation record	Guwahati has a long history of flooding. In 1954 flood was the worst over 1000 people were killed. The 2012 flood, which was caused by heavy rains resulted in heavy destruction. Over 100 people were killed and nearly 5 lakh people were displaced.

(2) Proposed Project

Target Year	2013
Design condition	I= 20mm/hr of stormwater
Project Scope	

S. No	Tender packages	Package Description
1	Survey & soil testing	Selection of agencies for Carrying out detail surveying & soil tests for execution sites.
2	Pre qualification bid	For all packages
3	For primary natural drains of each zone – Resection, construction of side walls, culverts and bridges.	Design, supply & execute all resectioning, construction of walls, culverts and bridges including all auxiliaries. electro-mechanical works including instrumentation for intermediate pumps & rising main Civil works for sewage sump and pump house building
4	For all secondary RCC drains of each zone Construction of RCC Drains, grit traps, skimming platforms, storm inlet mesh, storm inlet cover and frames etc.	Design, supply & execute civil works required for RCC Drains, grit traps, skimming platforms, storm inlet mesh, storm inlet cover and frames etc. electro-mechanical works including instrumentation for intermediate Lift pumps & rising main Civil works for sewage sump and pump house building
5	Storm water pumping station on Khanajan river and two smaller pumping stations.	Design and execution of storm water pumping station including all civil, electrical mechanical & instrumentation testing and commissioning. Electro-mechanical works including instrumentation for pumps & rising main Civil works for storm inlet forebay and pump house building All building and site development works within the campus of the pumphouse.
6	Supply of Electric Power	Substation and transformers.
7	Tertiary road side surface open trapezoidal drains along roads conveying more than 0.05 cumecs flow.	Planning and construction of all civil works required for tertiary drains.
8	O & M Agencies	(i) For infrastructure (ii) Security System

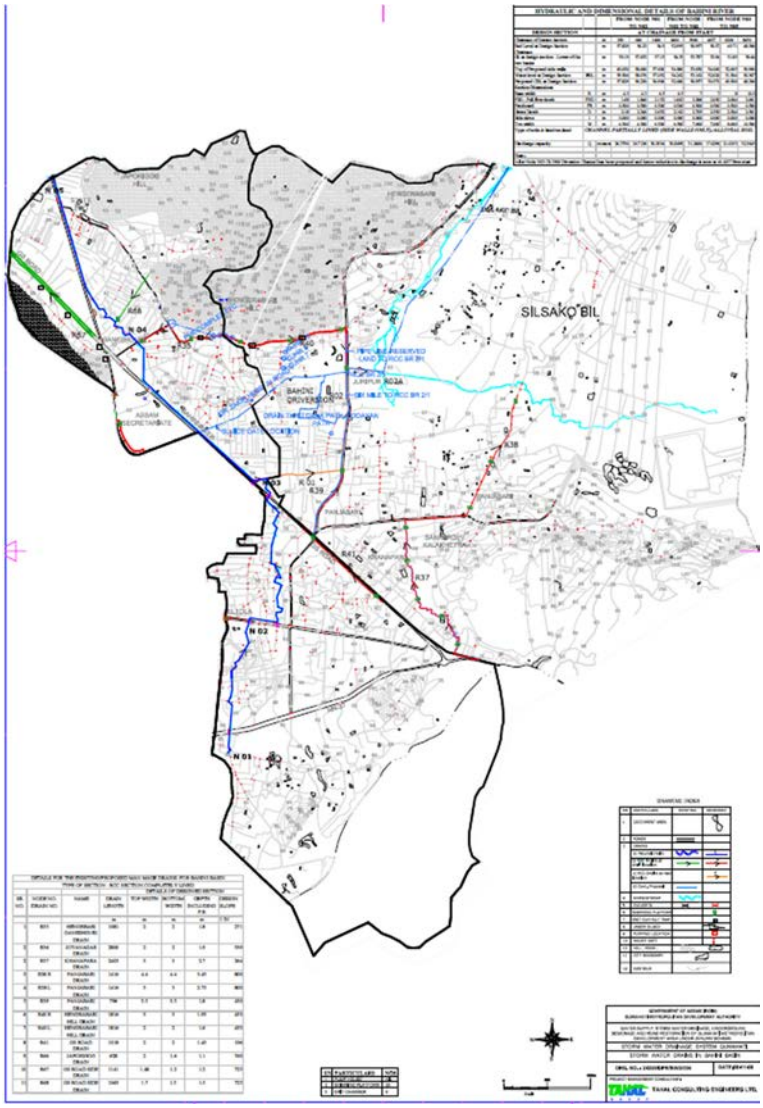
Project Cost (estimated in 2008)

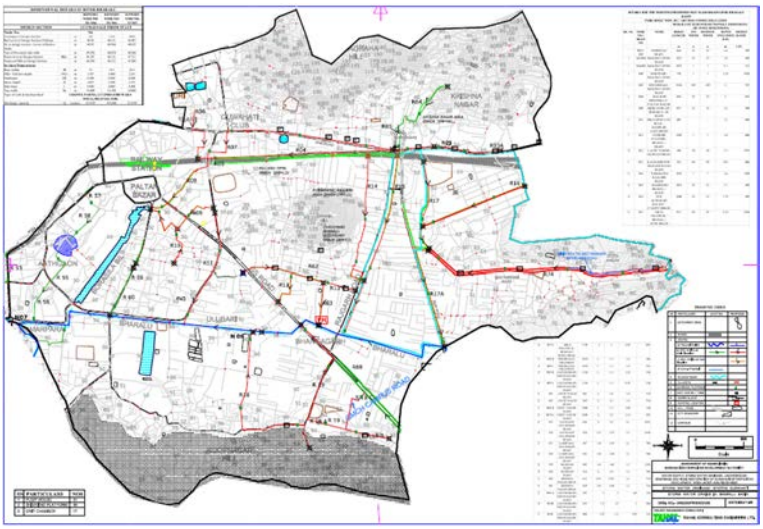
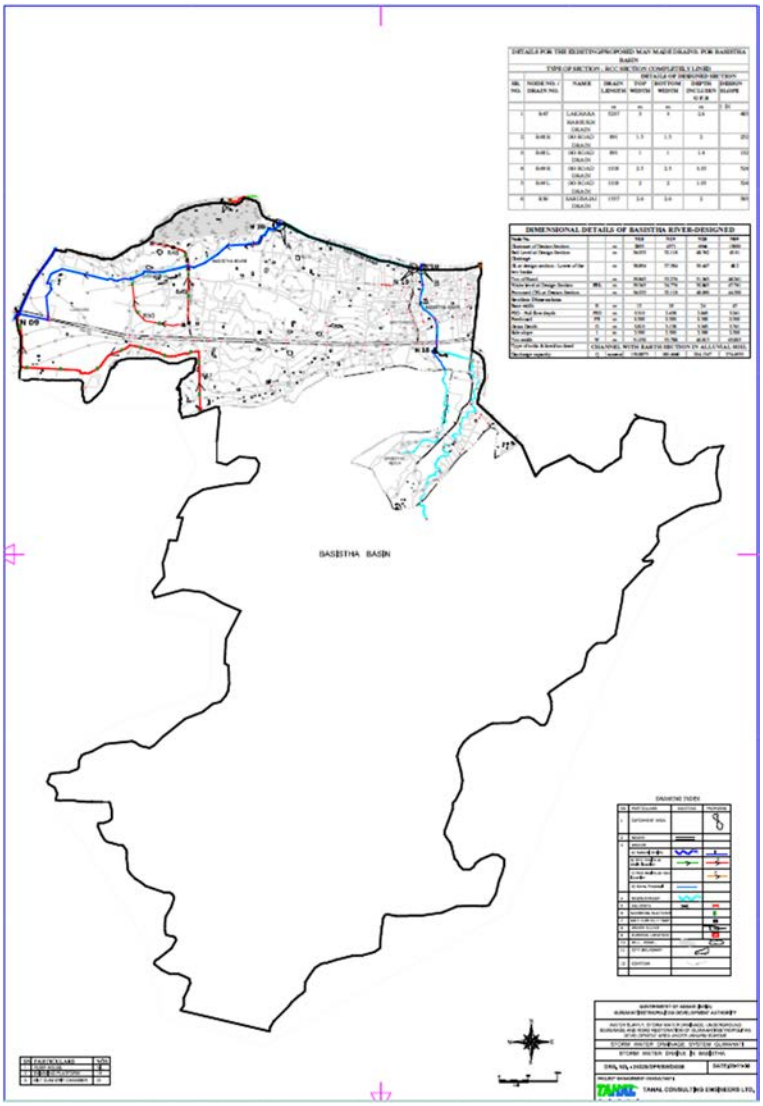
Abstract of Cost Estimates

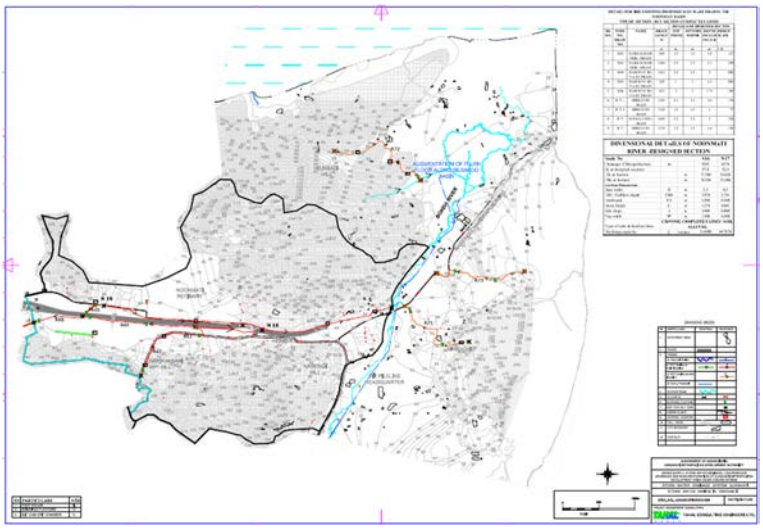
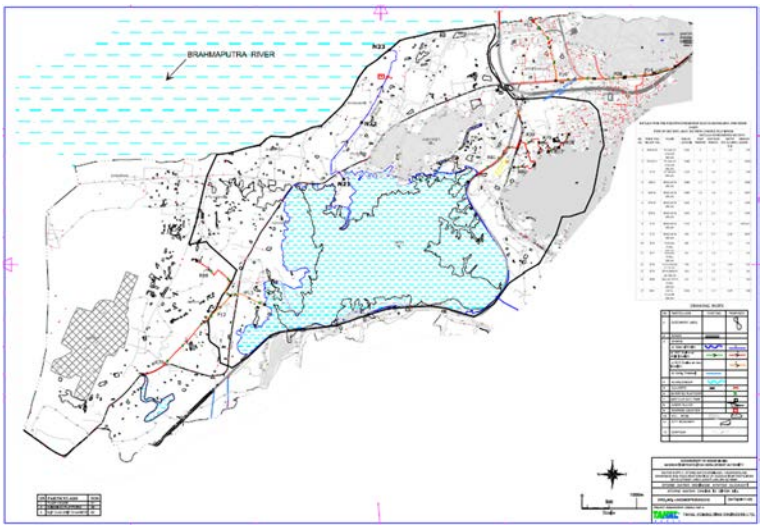
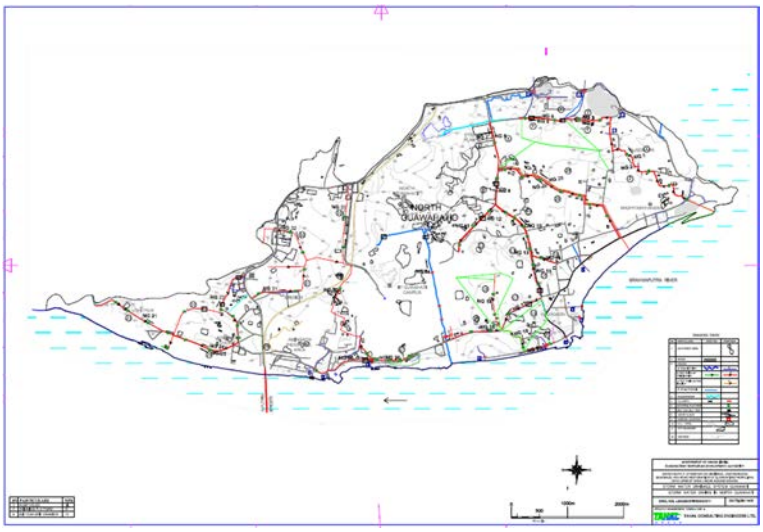
Sn	Component	Qty	Unit	Rate	Amount in Rs.
1	Cost of development works and improvements to natural drains, Proposed RCC Drains	Job			
	Bahini Basin including Diversion Channel		As per detail estimate		1,020,939,362
	Bharalu		As per detail estimate		973,298,215
	~~Morabharlu~~		~~As per detail estimate~~		~~450,545,427~~
	~~Hathinala~~		~~As per detail estimate~~		~~399,388,355~~
	Basistha		As per detail estimate		428,105,230
	Nonmati		As per detail estimate		539,785,561
	Diporbill		As per detail estimate		453,377,741
2	Cost of development works and Proposed RCC Drains in North Guwahati	Job	As per detail estimate		952,857,807
3	Cost of site development including removal of water hyacinth and other works such as construction of promenade, installation of benches, paving with CC blocks, Hedge and gardening along river front of Bahini on the East flank of GS Road and RG Baruah Road	Job	Block estimate		3,360,000
4	Cost of tertiary drains	200000	m	1800	360,000,000
5	Skimming Platforms	253	No	112450	28,449,850
6	Silt Cum Grit traps	60	No	880800	52,848,000
7	Sluice gates with cross regulator structure	5	Block estimate		131,625,000
8	Sump and Pump house at Khanajan sluice and at Daking Gaon and near Rajgarh Road	3	Block estimate		27,090,790
9	Cost of electro-mechanical works	Job	As per detail estimate		90,263,233
10	Control and Instrumentation Works	Job	As per detail estimate		8,240,000

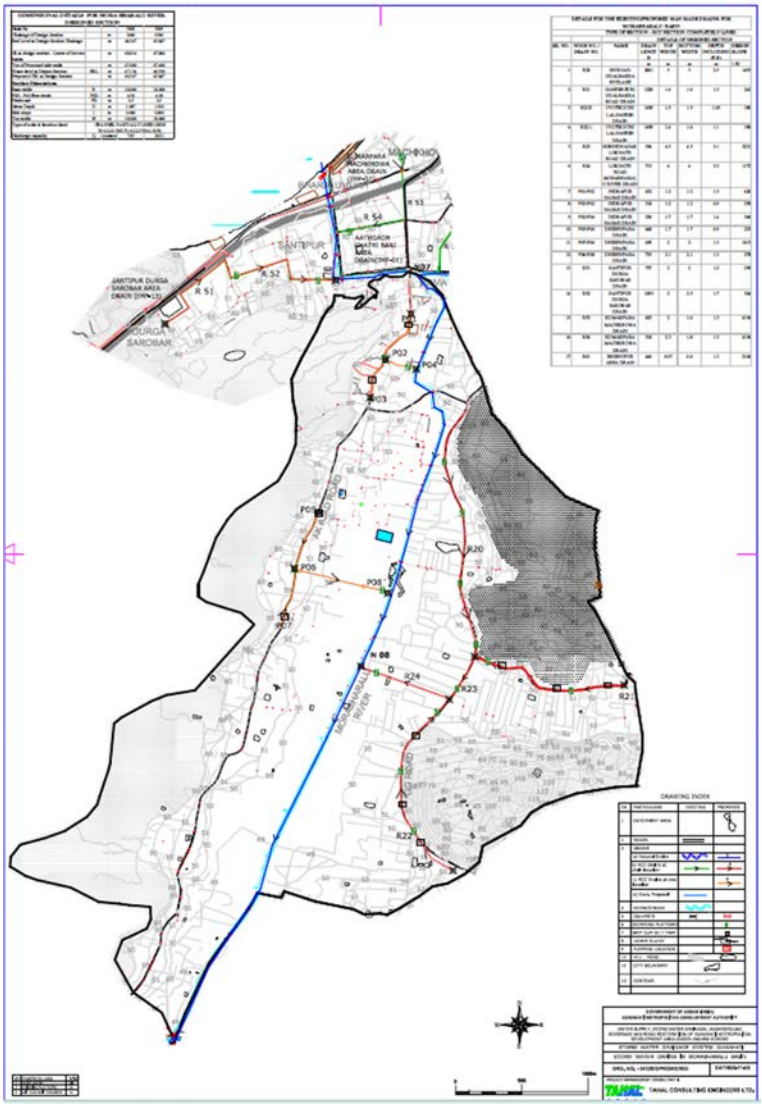
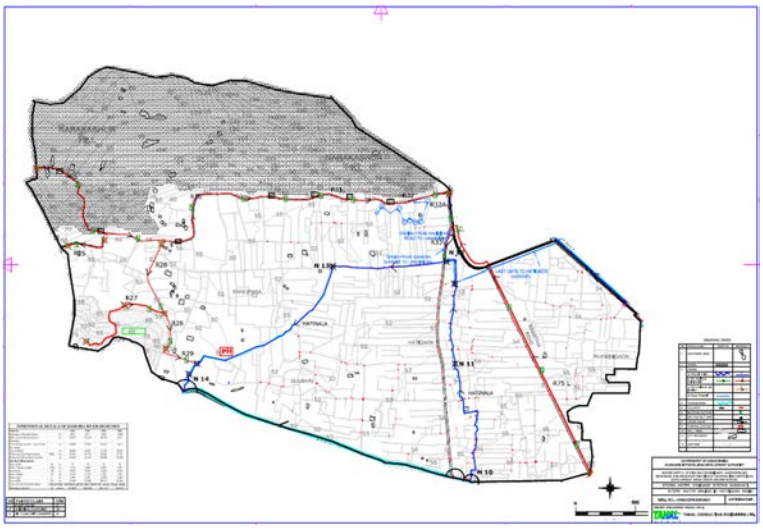
Sn	Component	Qty	Unit	Rate	Amount in Rs.
	Total				5,920,174,570
	Add for				
	Contingencies @	5%			296,008,729
	Work charged establishment @	3%			177,605,237
	Add cost of supervision @	8%			473,613,966
	Net total cost				6,867,402,502
	Period of execution	4 Years			
	Cost of execution per year at today rates	% in Year	Cost	Escalation @ 7% per annum	Escalated cost over duration of project execution
	1	30%	2,065,151,222	0	2,060,220,750
	2	25%	1,720,959,352	120,467,155	1,837,030,169
	3	25%	1,720,959,352	249,367,010	1,965,622,281
	4	20%	1,376,767,481	309,831,884	1,682,572,673
	Gross cost of project, including escalation				**7,545,445,873**

Bahini Basin



Bharalu Basin	
Basistha Basin	

Noonmati Basin	
Dipor Beel Basin	
North Guwahati Basin	

Morabharalu Basin (ADB)	
Hathigaon Basin (ADB)	

Appendix-4

FLOOD AFFECTED AREA AND ITS BASIC INFORMATION IN LONGLISTED CITIES

APPENDIX-4. Flood affected area and its basic information in long-listed cities

The table below shows flood affected area and its basic information in long-listed cities. The data included are as follows:

- Name of basin which a long-listed city belongs to

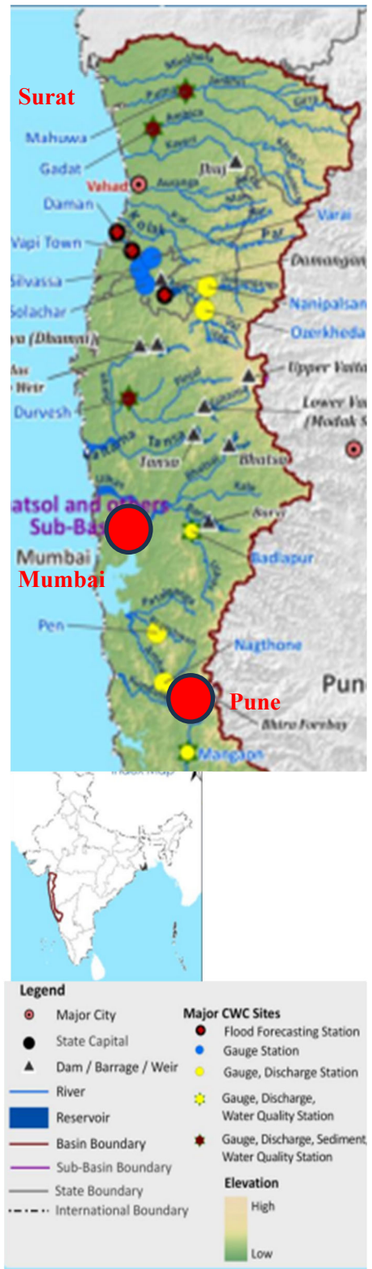
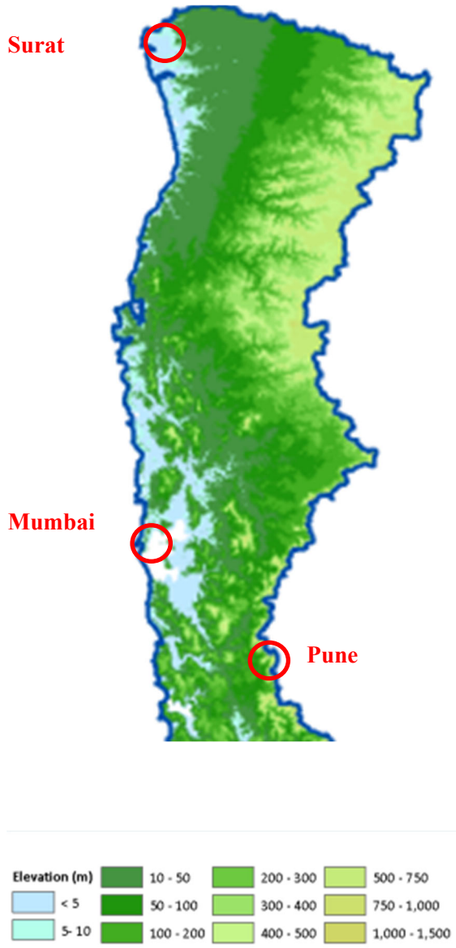
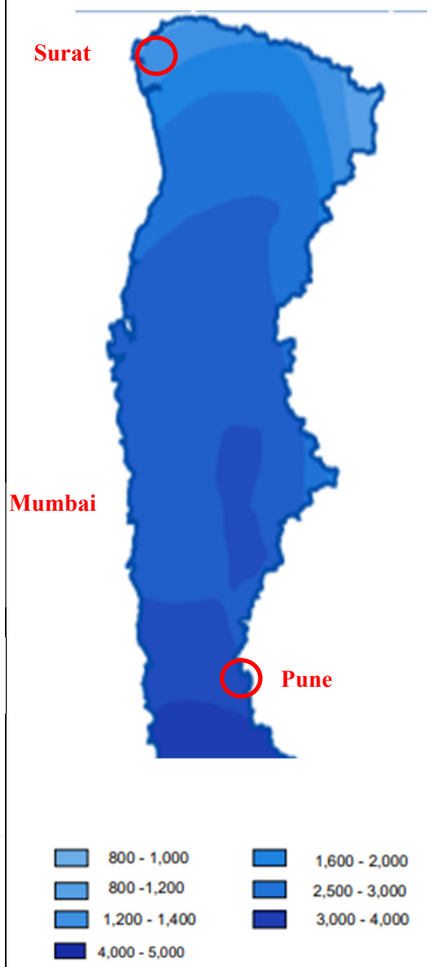
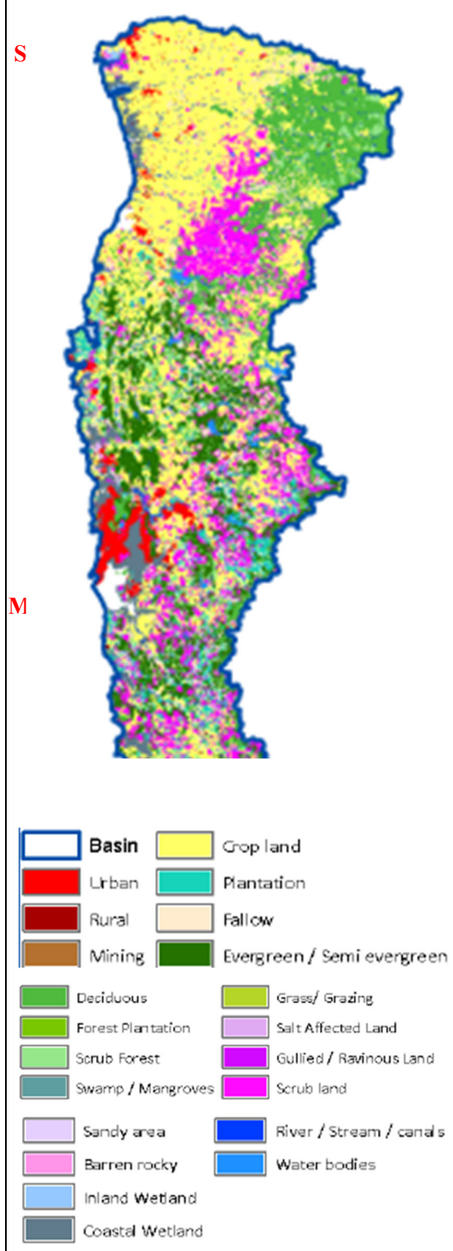
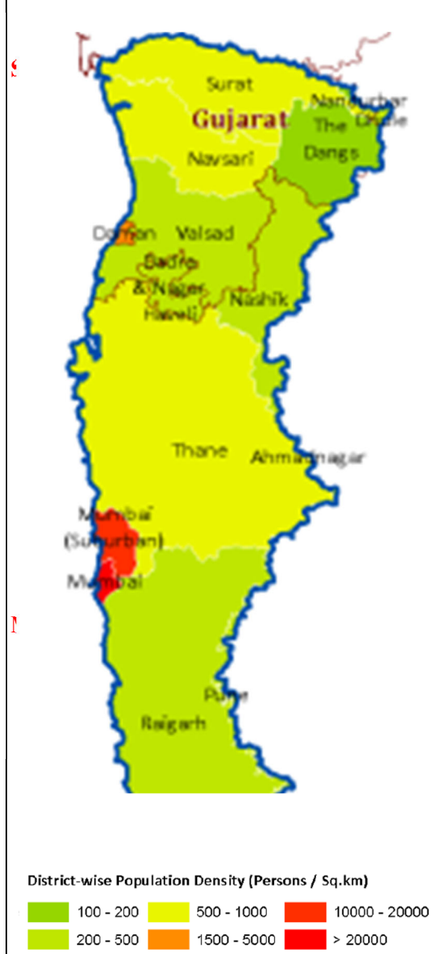
  *The divides of basins are according to Central Water Commission, Ministry of Water Resources

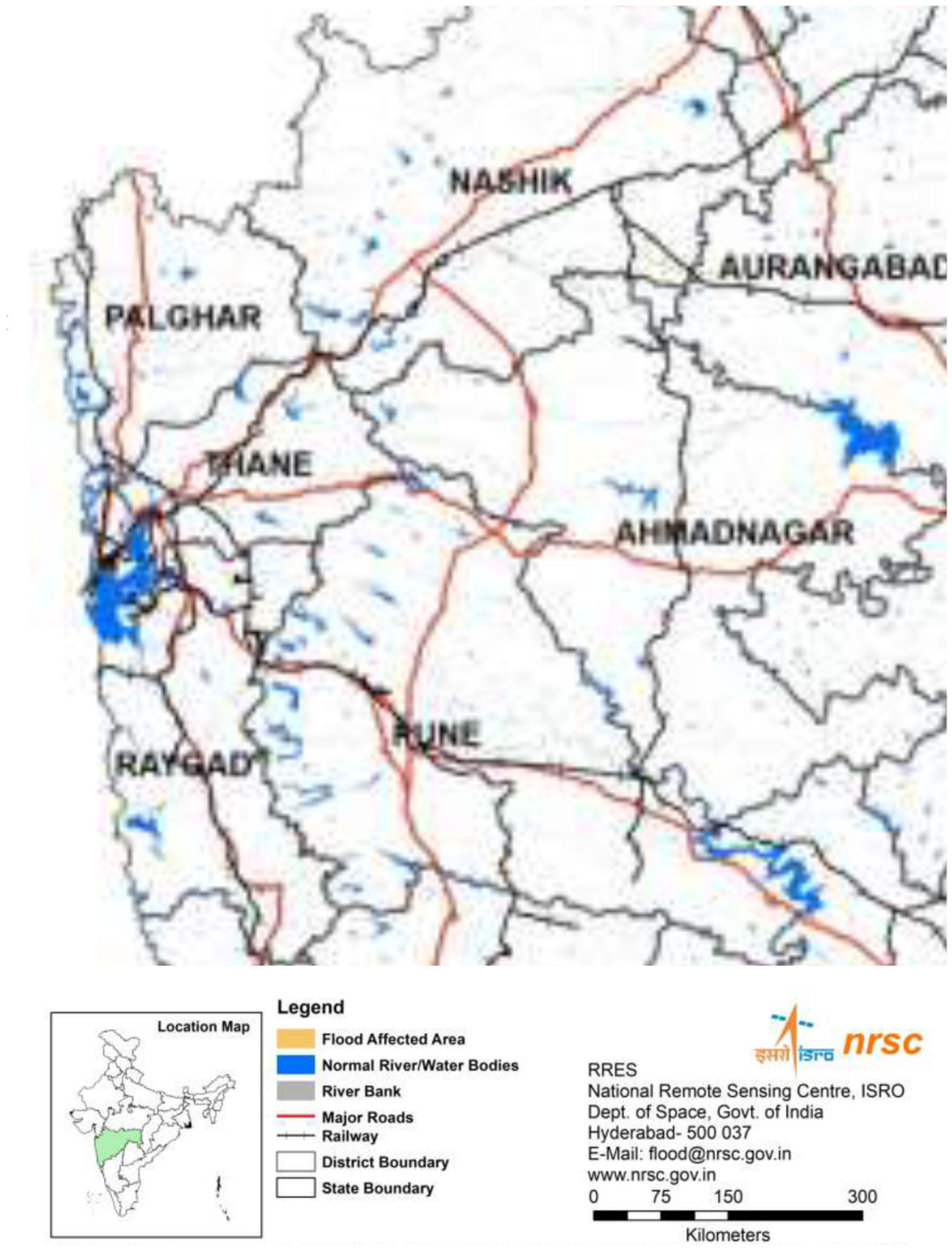
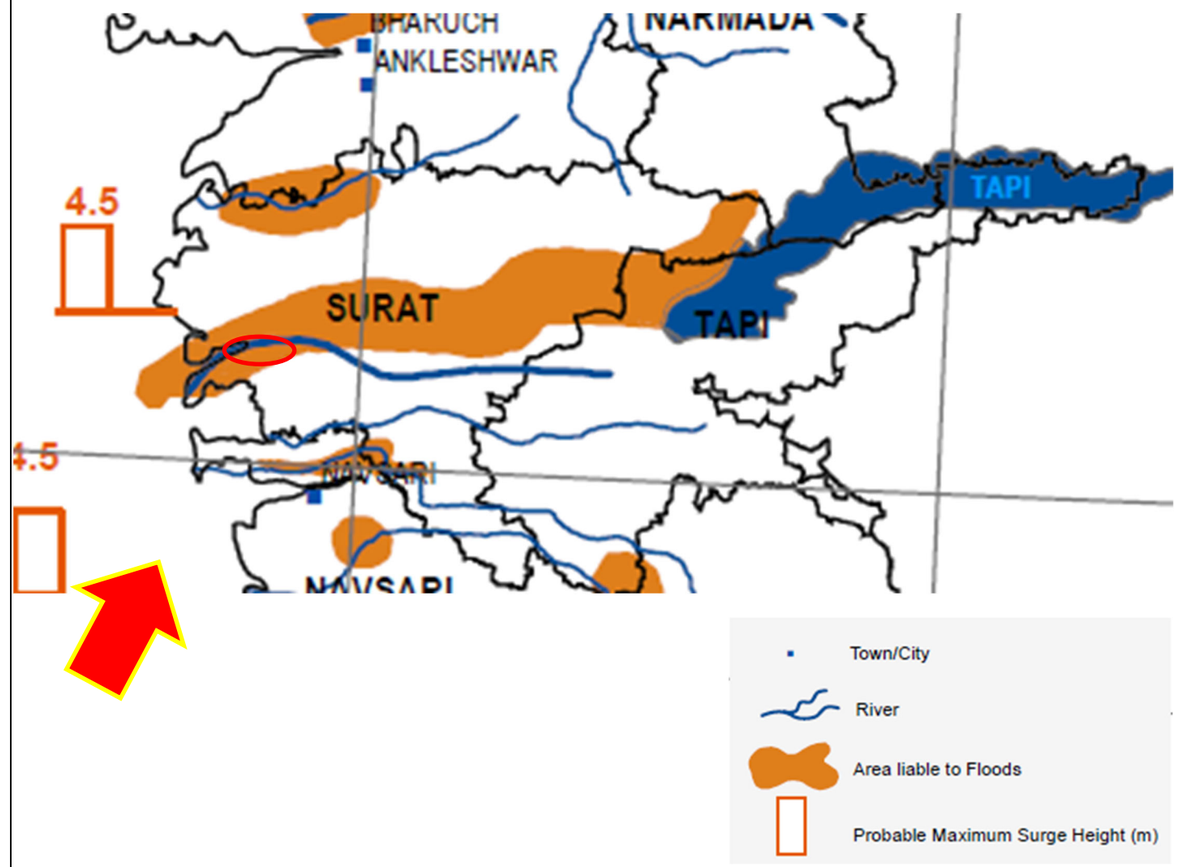
- Elevation
- Annual Average Rainfall
- Land Use/ Land Cover
- District-wise Population Density
- Flood Affected Area

  *The flood affected area map is created by using a combination of different types of satellite data. With this technology, identify flood inundation rea, land cover, etc.

And the data sources of these data are Flood Affected Area of India-Satellite based study, India Geo-Platform of ISRO; Flood Hazard, Vulnerability Atlas of India, and River Basin Atlas (Brahmaputra Basin, Ganga, Sabarmati Basin, Tapi to Tadri Basin, Mahanadi Basin, Krishna Basin).

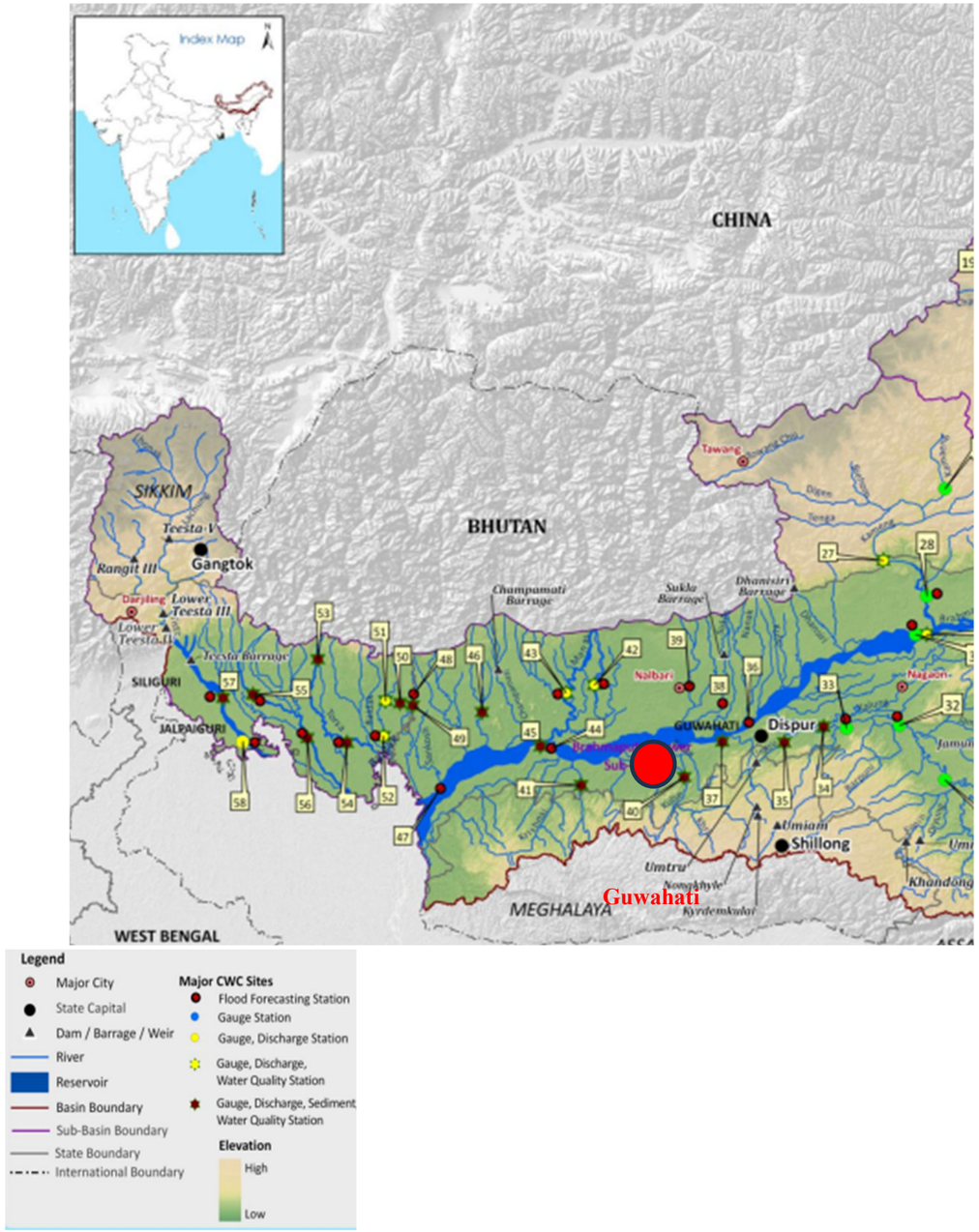
Candidate City: Surat (Gujarat), Mumbai (Maharashtra State) , Pune (Maharashtra State)

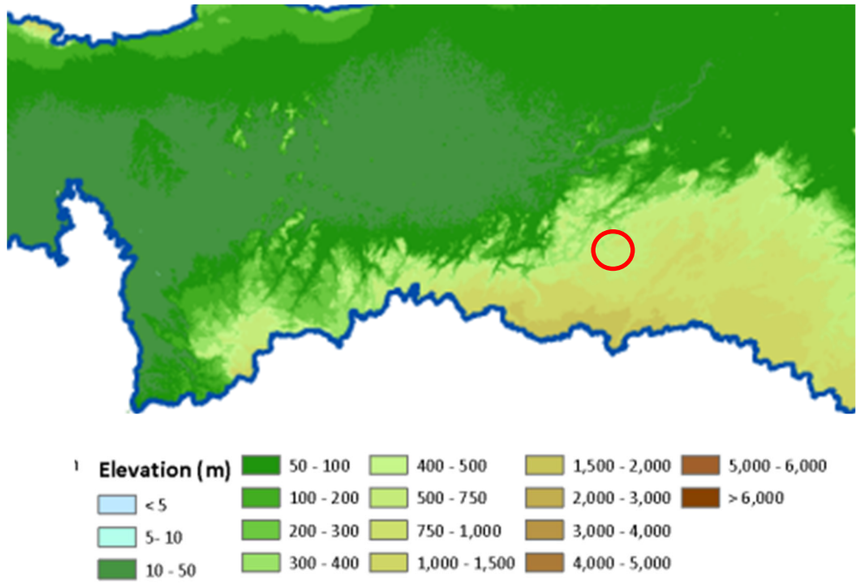
Basin	Elevation	Annual Average Rainfall	Land Use/ Land Cover	District-wise Population Density
Tapi to Tadri  	 	 	 	

Flood Affected Area: Mumbai/ Pune	Flood Affected Area: Surat
	

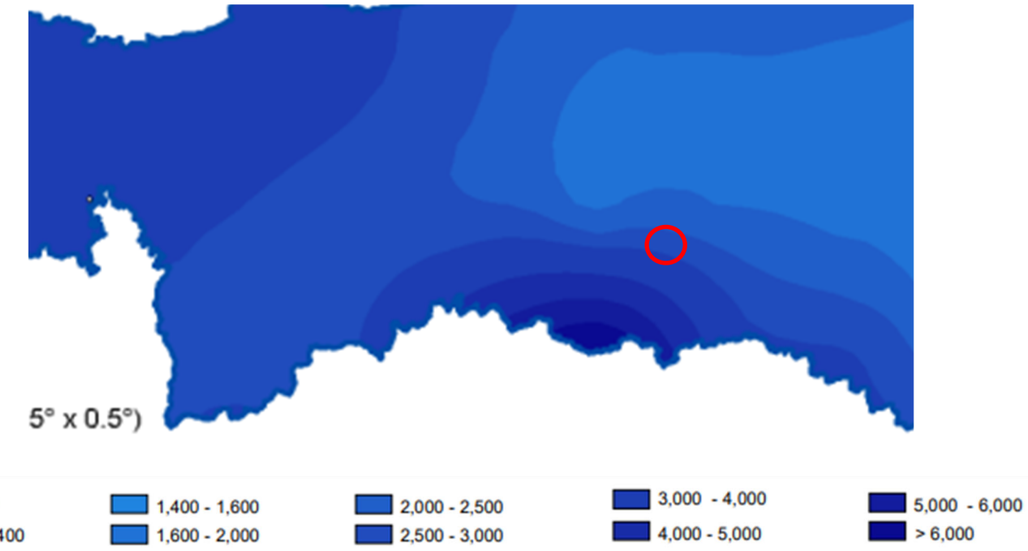
Candidate City: Guwahati (Assam)

Basin	Elevation
Brahmaputra	

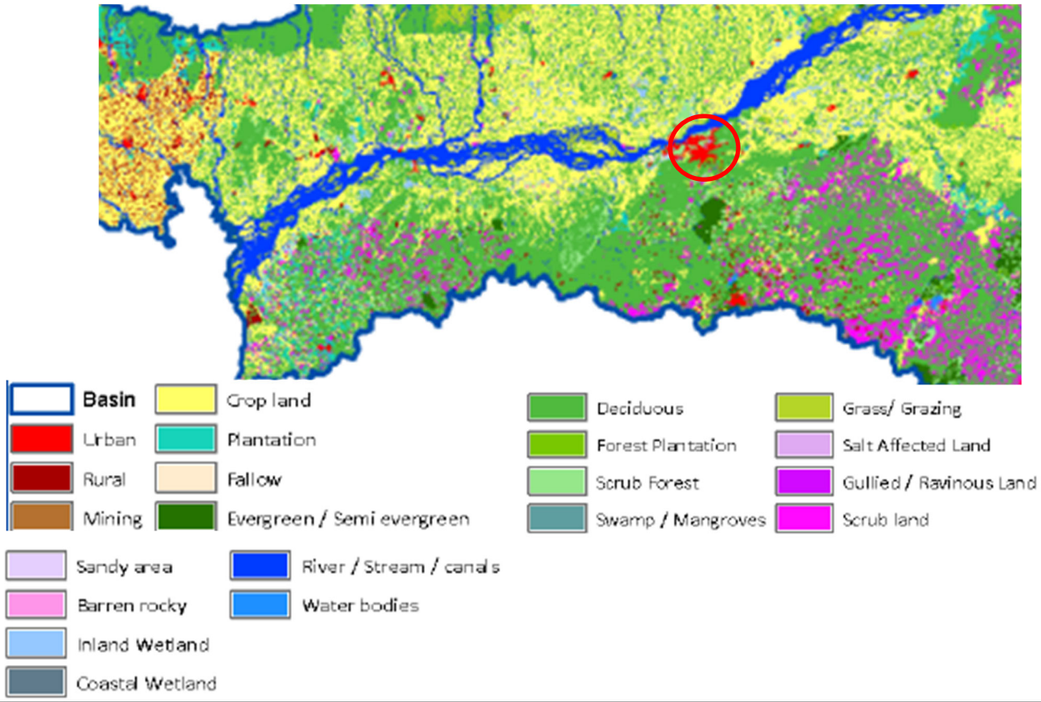




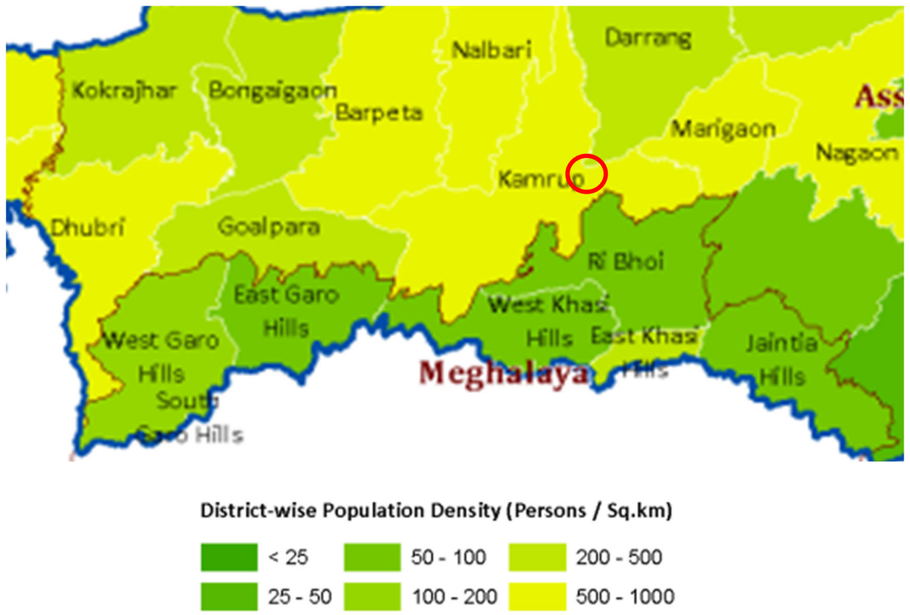
Annual Average Rainfall



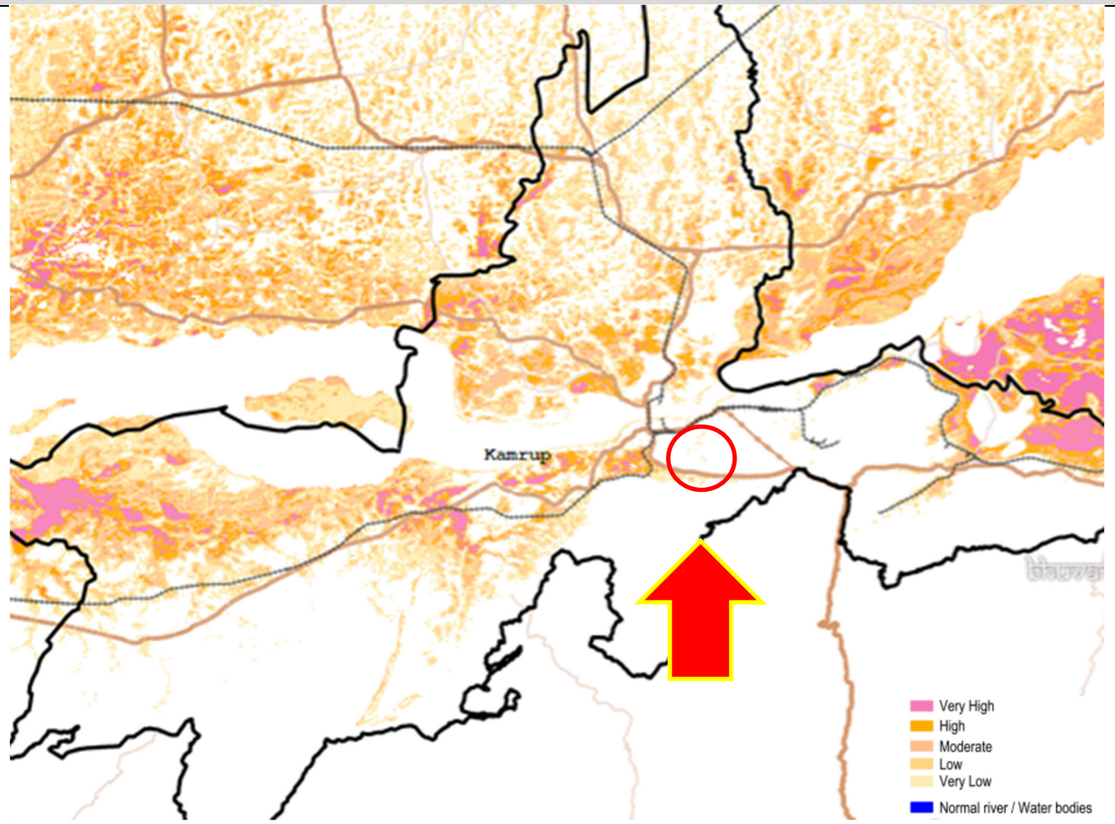
Land Use/ Land Cover



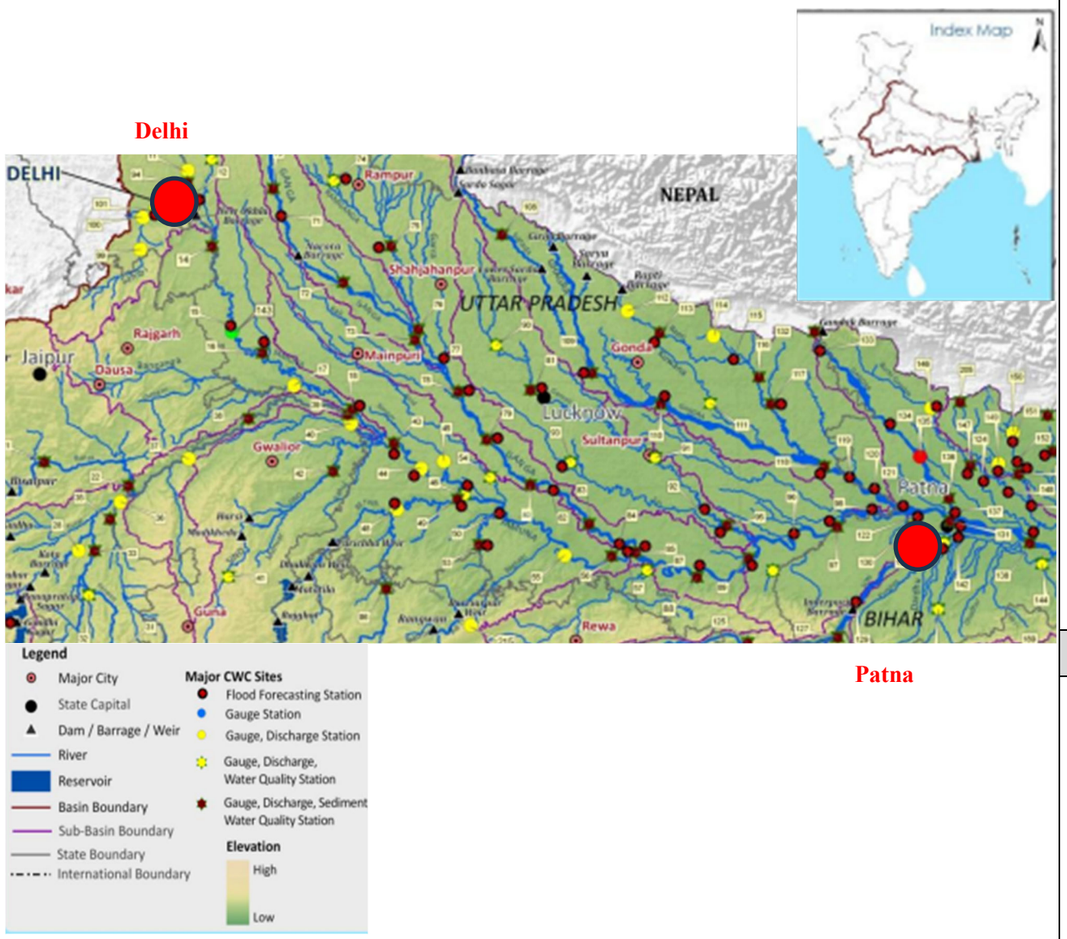
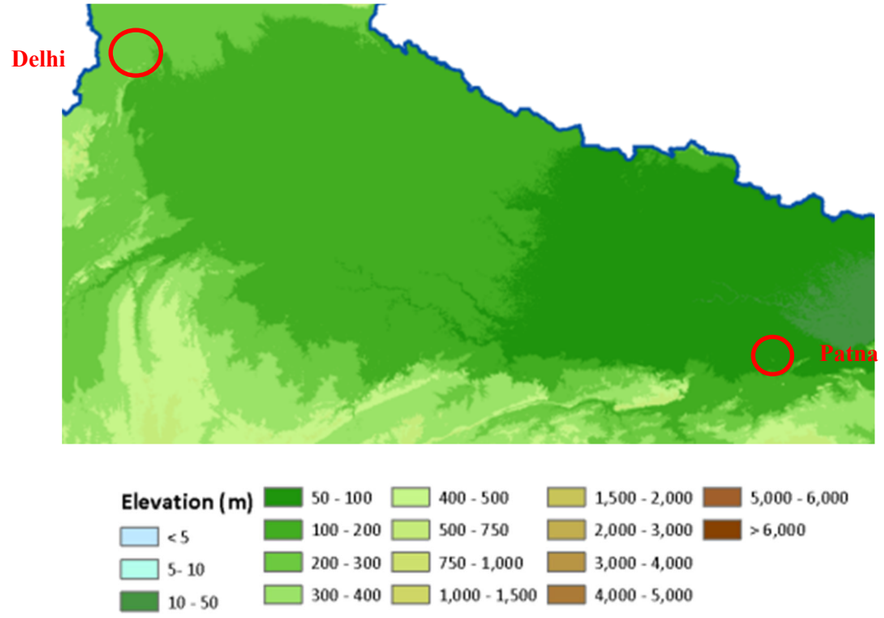
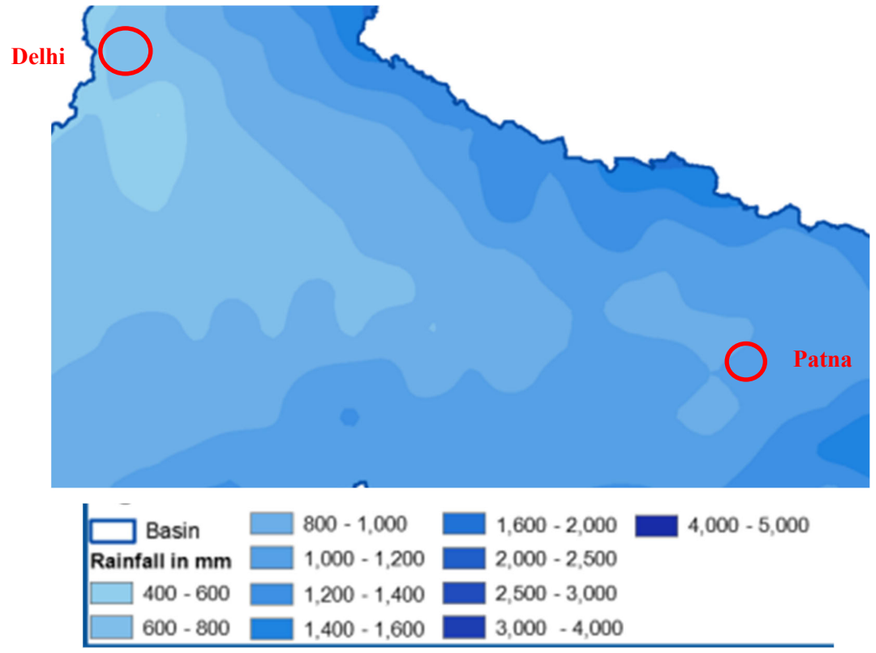
District-wise Population Density



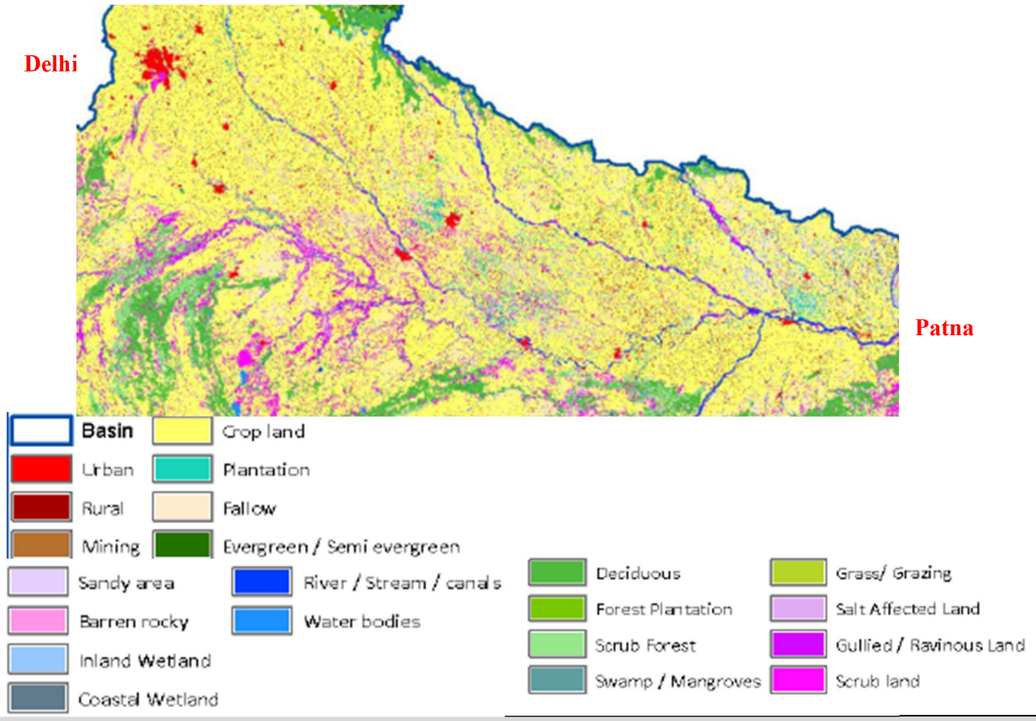
Flood Affected Area: Guwahati



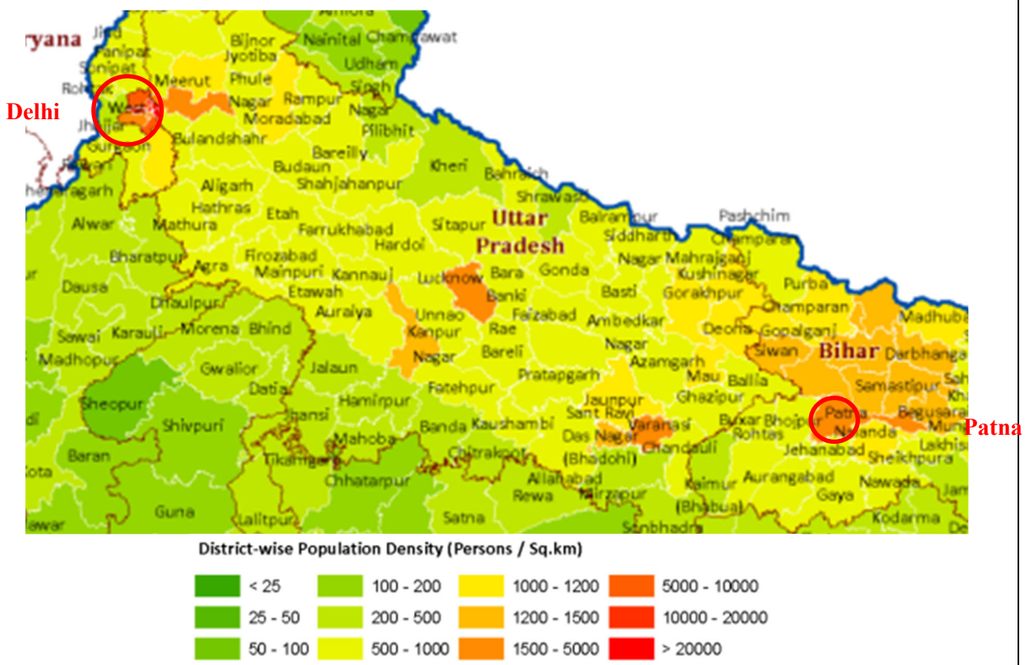
Candidate City: Patna (Bihar), Delhi

Basin	Elevation
Ganga 	
	Annual Average Rainfall
	

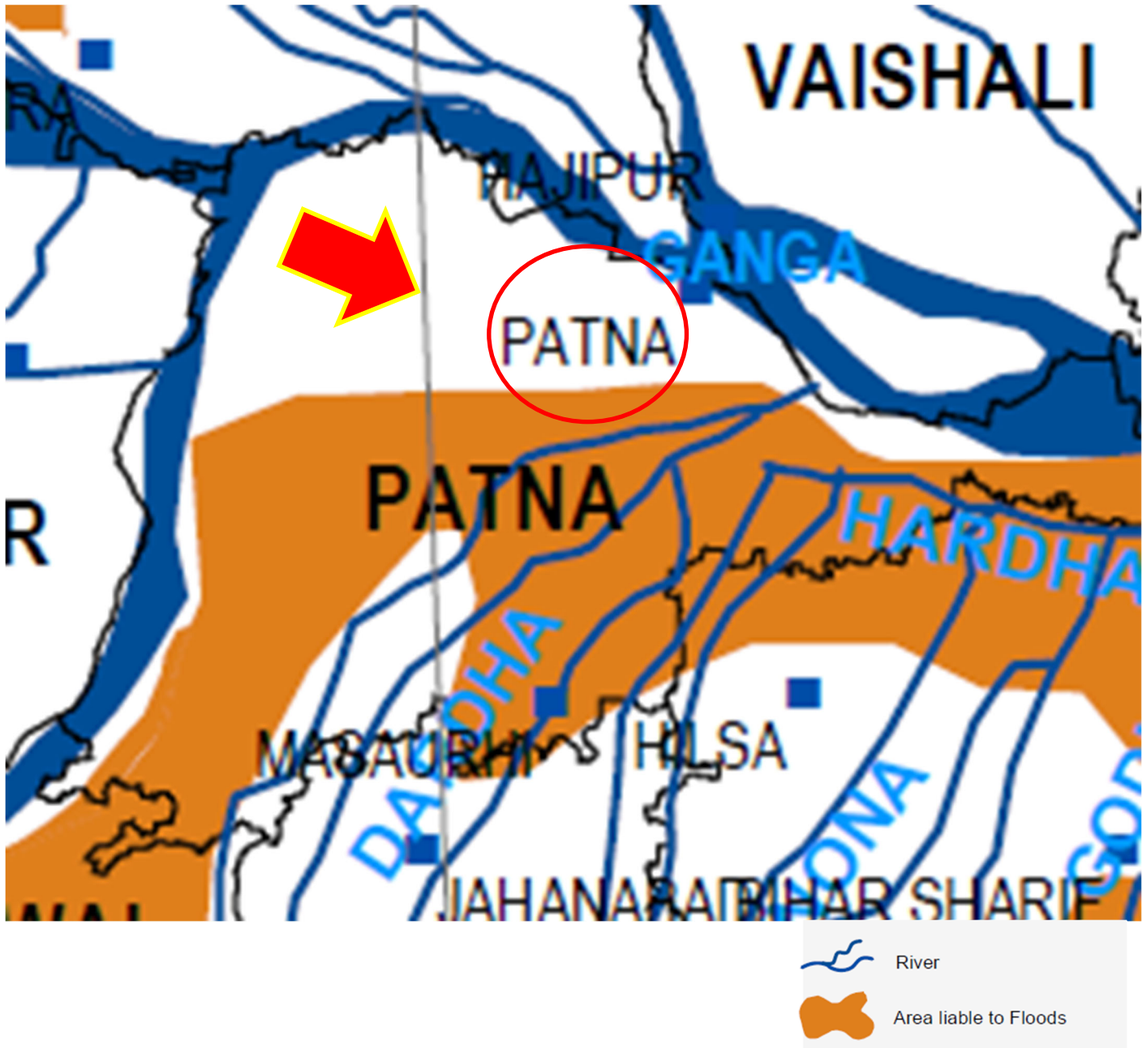
Land Use/ Land Cover



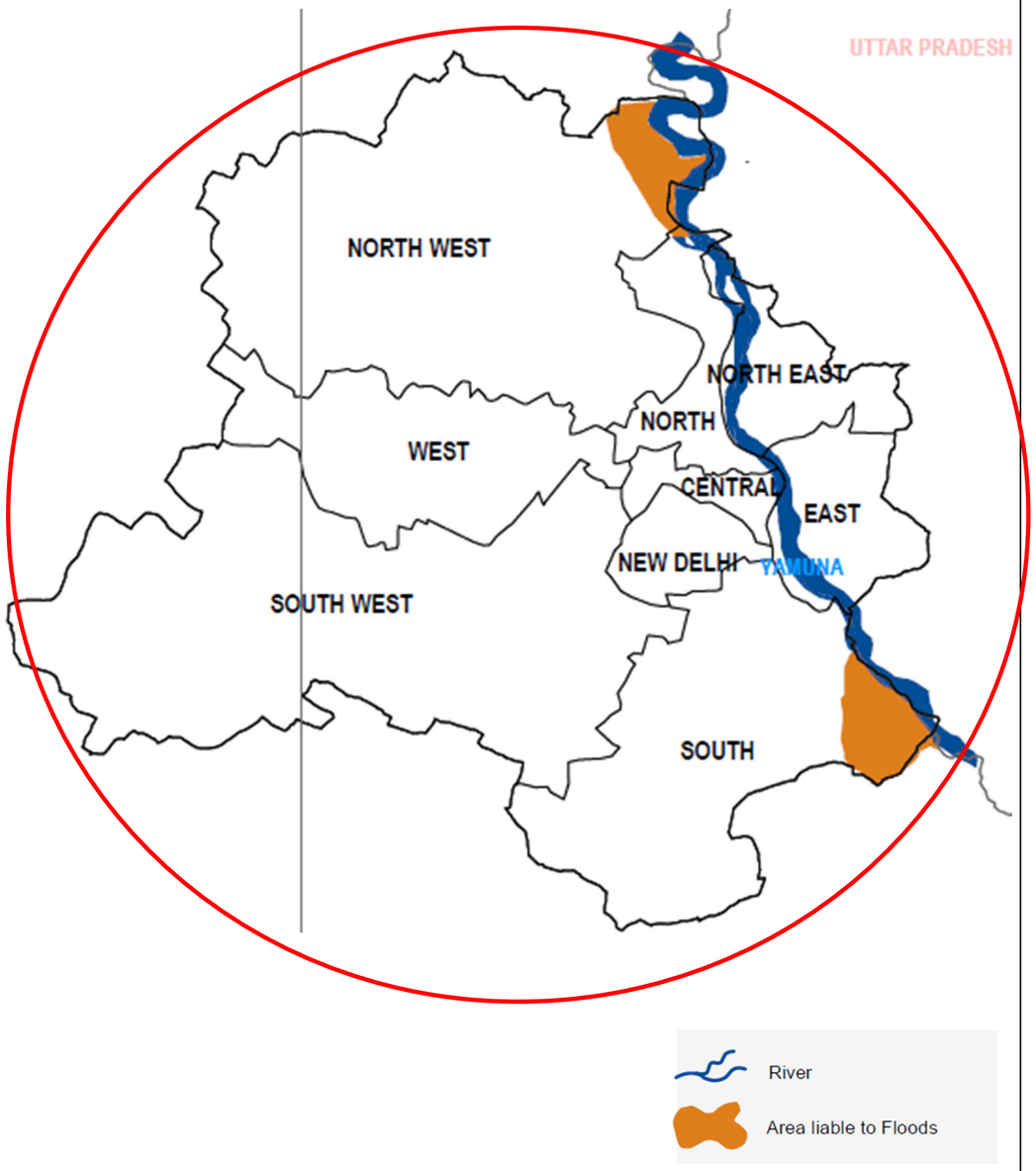
District-wise Population Density



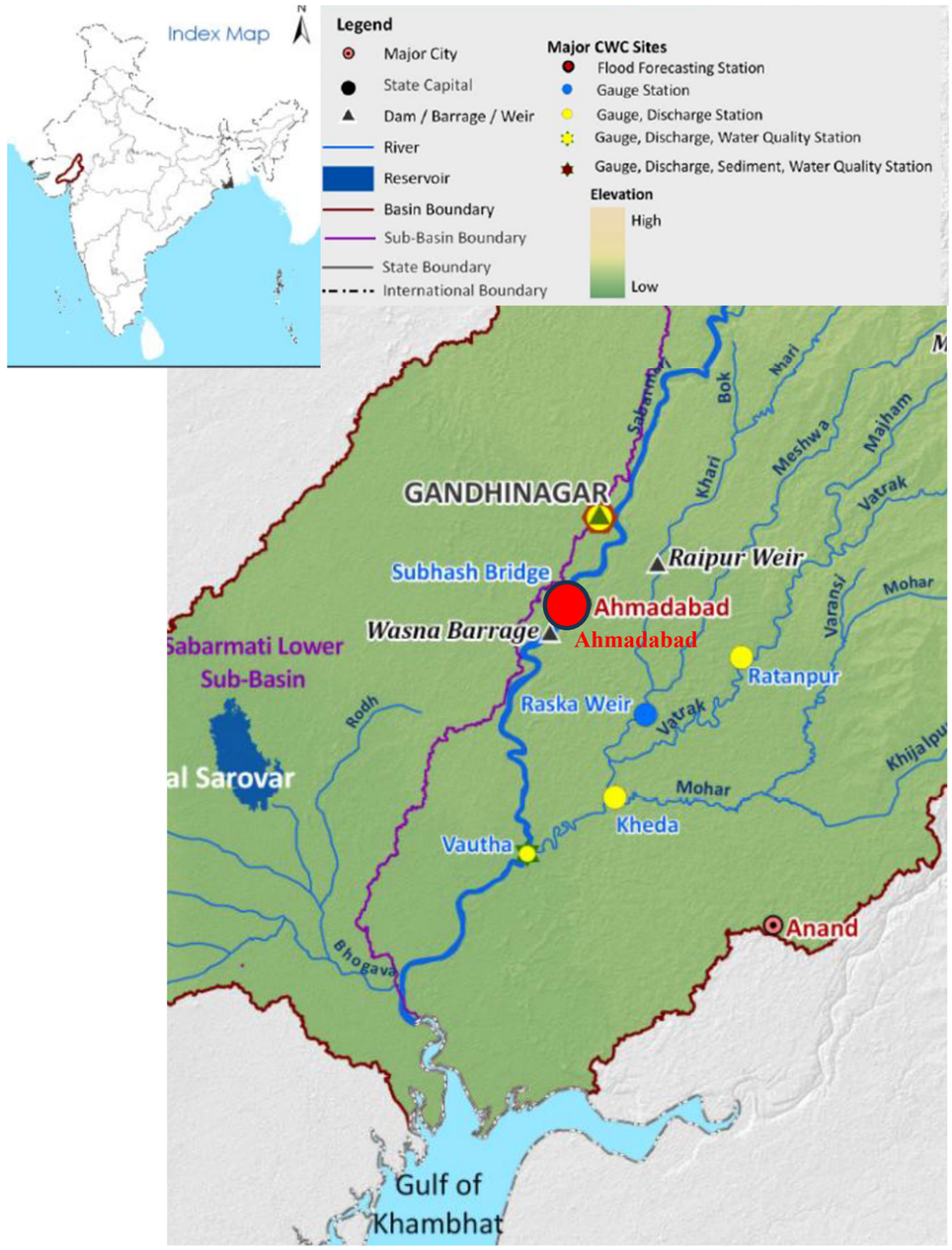
Flood Affected Area: Patna

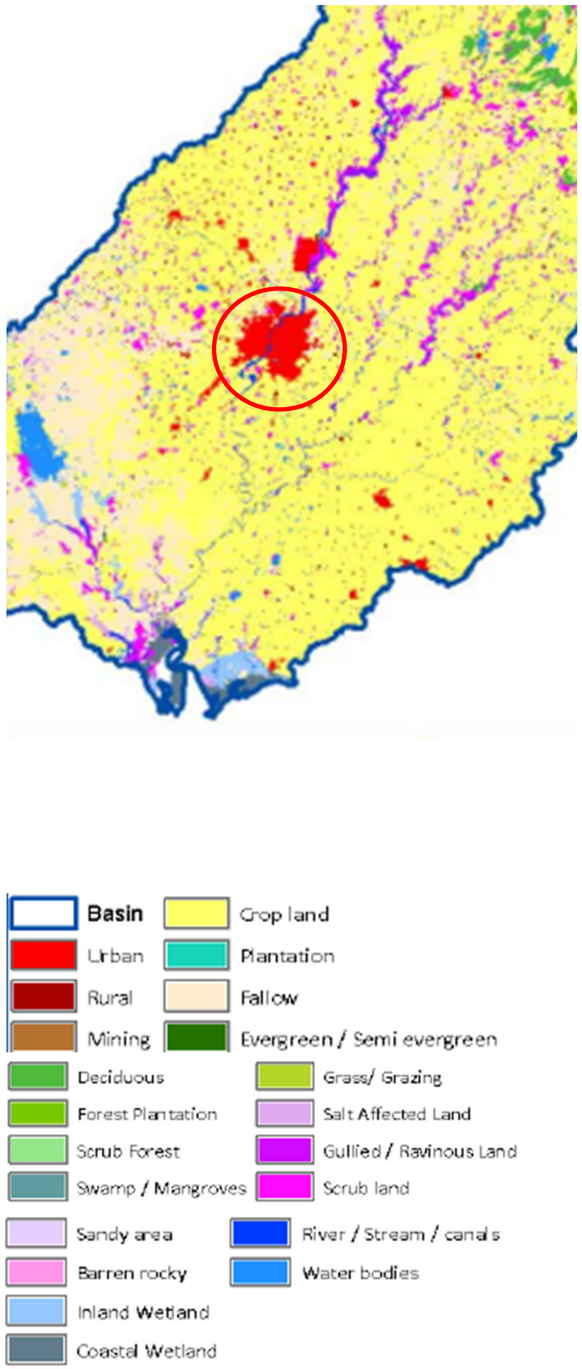
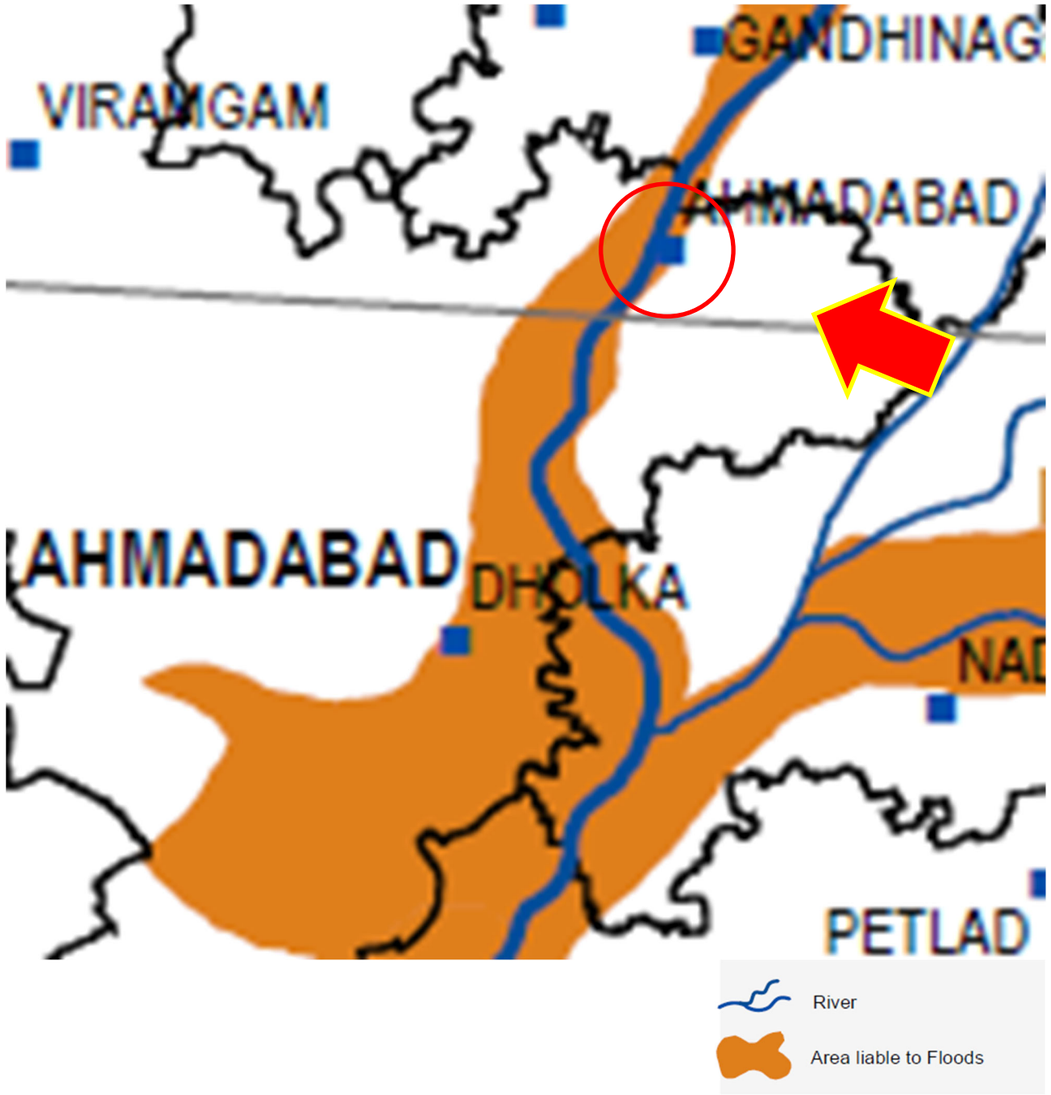


Flood Affected Area: Delhi

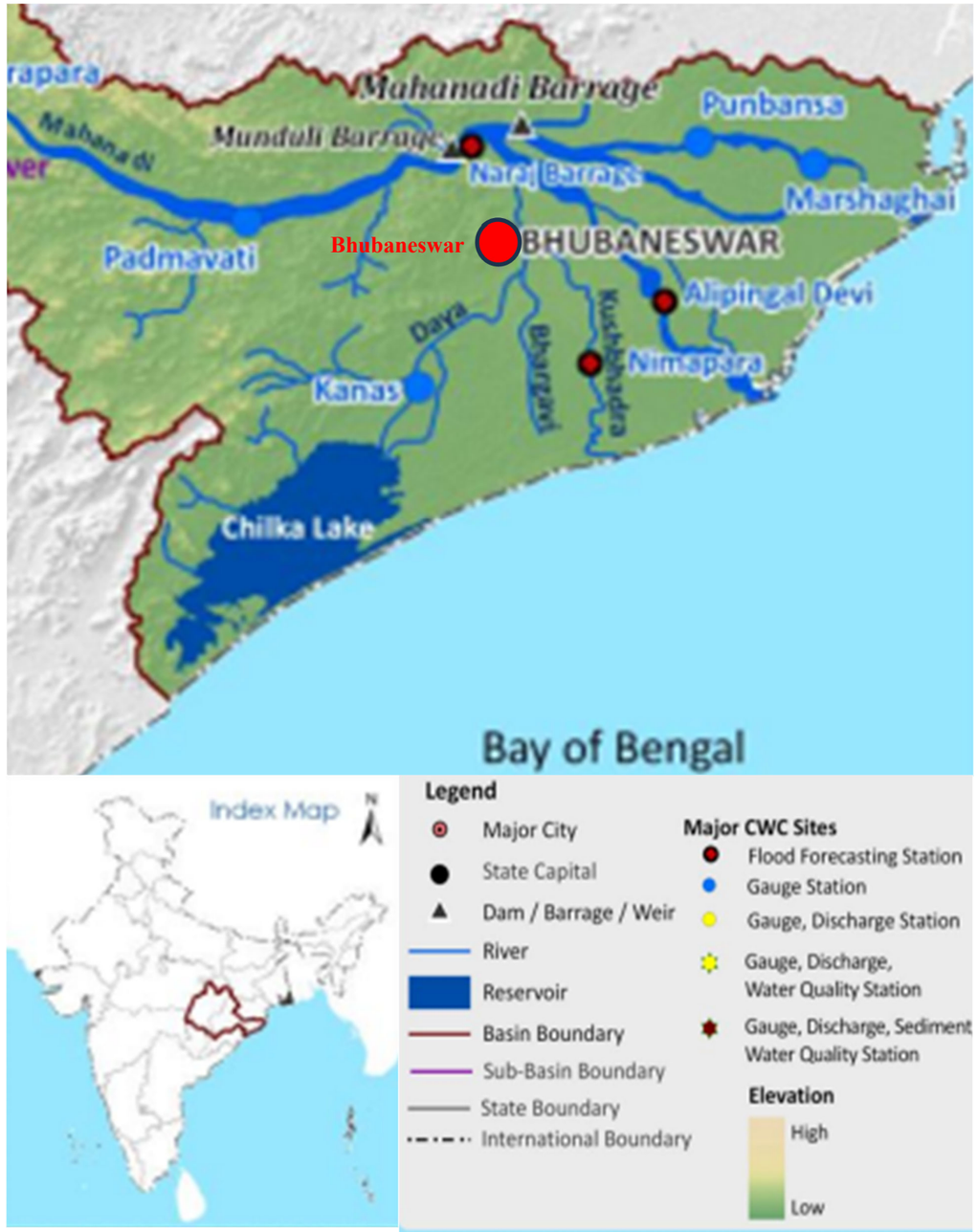
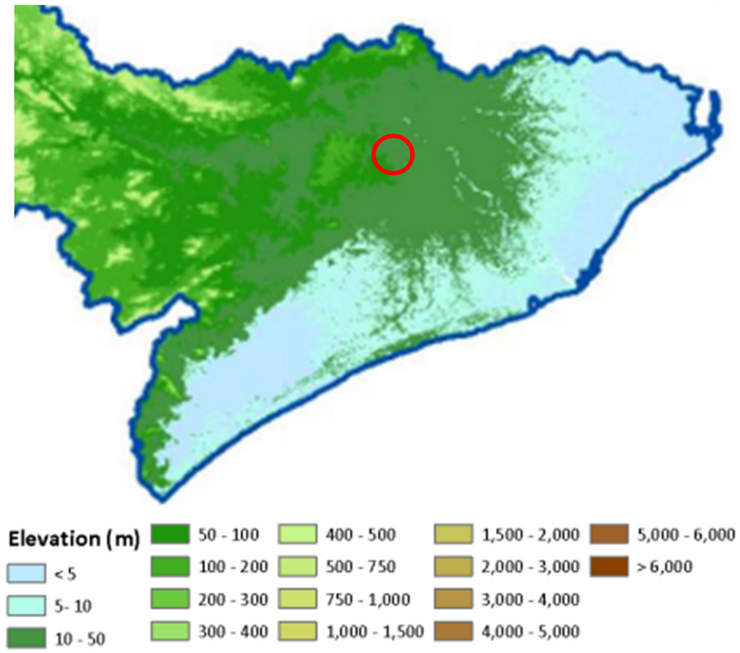
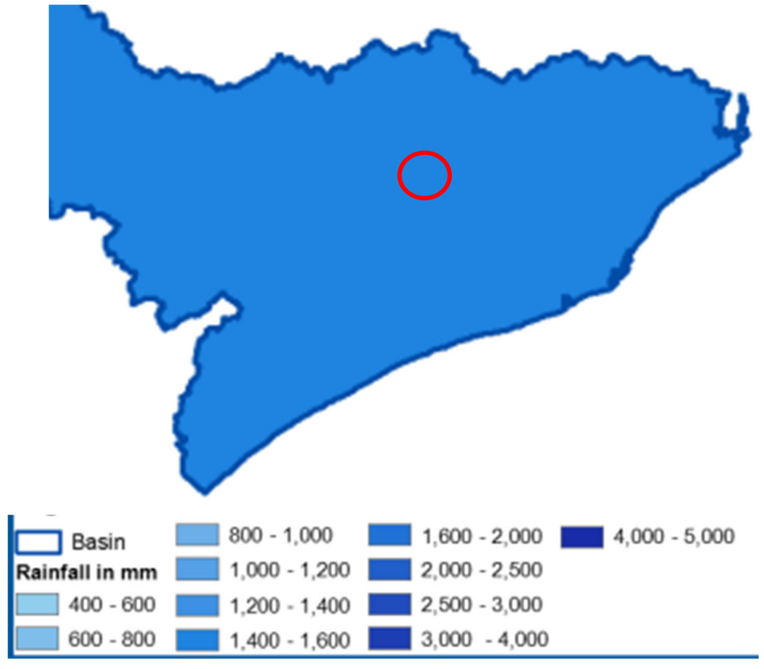


Candidate City: Ahmadabad (Gujarat)

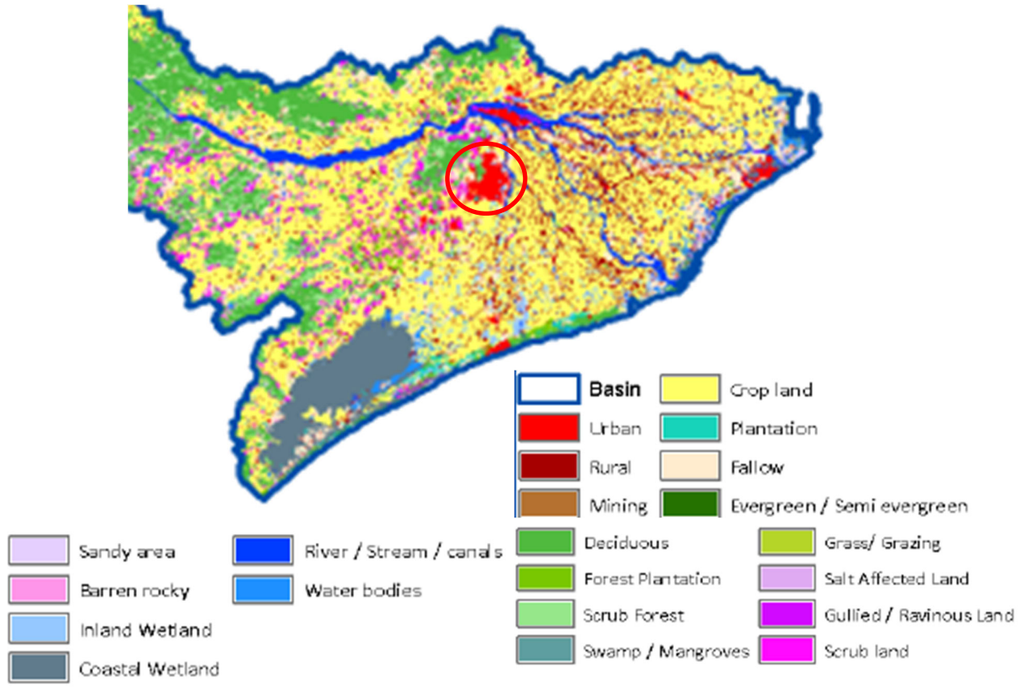
Basin	Elevation	Annual Average Rainfall
Sabarmati 		

Land Use/ Land Cover	District-wise Population Density	Flood Affected Area: Ahmadabad
		

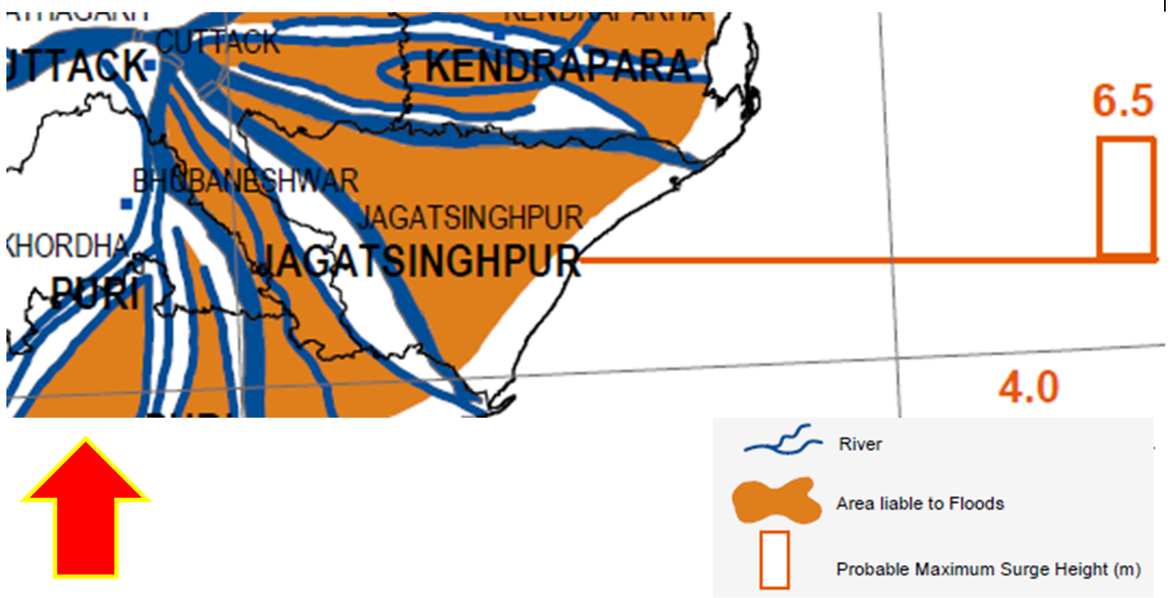
Candidate City: Bhubaneswar (Odisha)

Basin	Elevation
Mahanadi 	
	Annual Average Rainfall
	

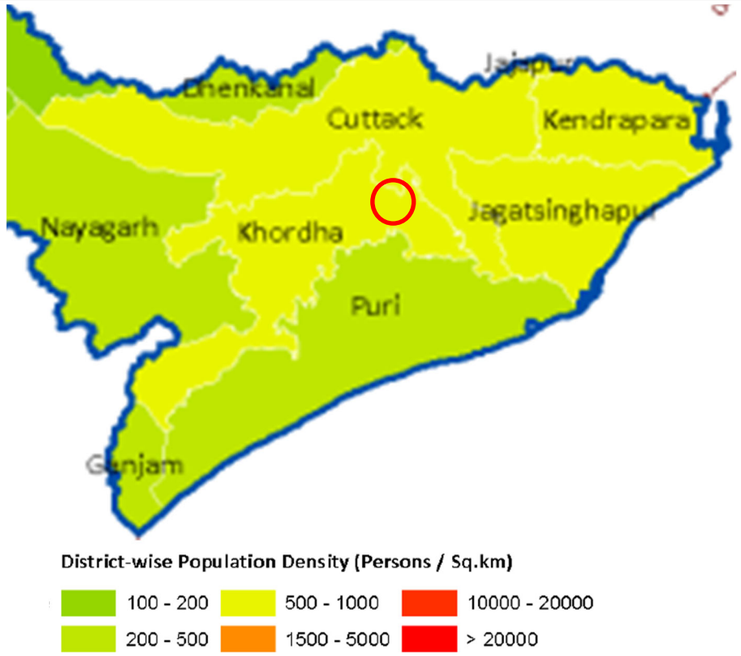
Land Use/ Land Cover



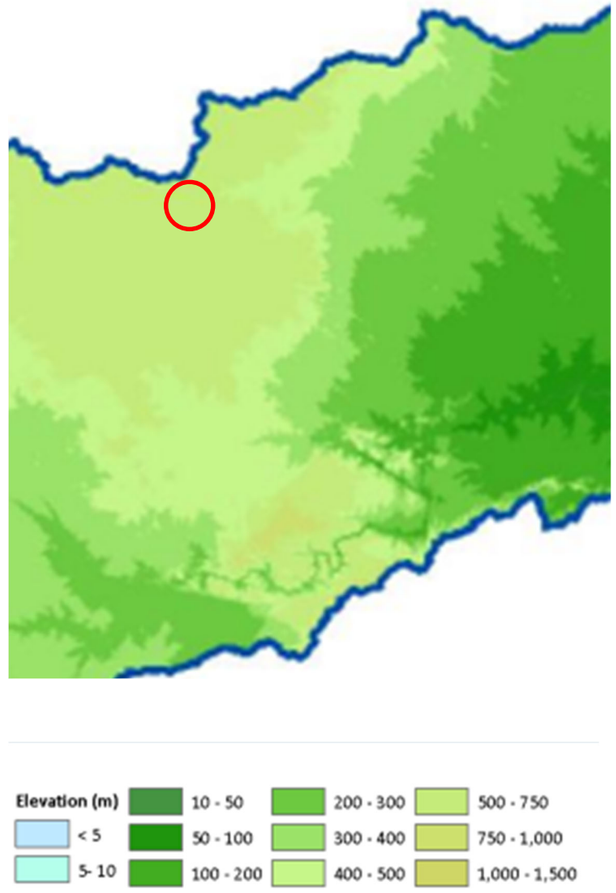
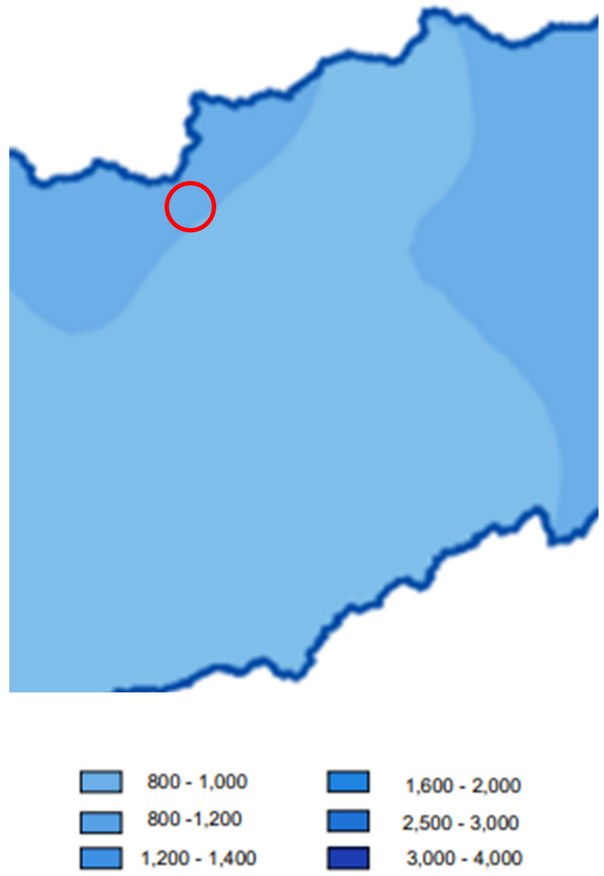
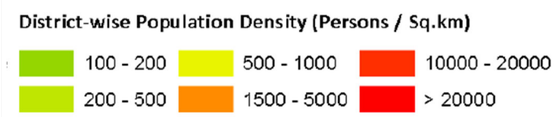
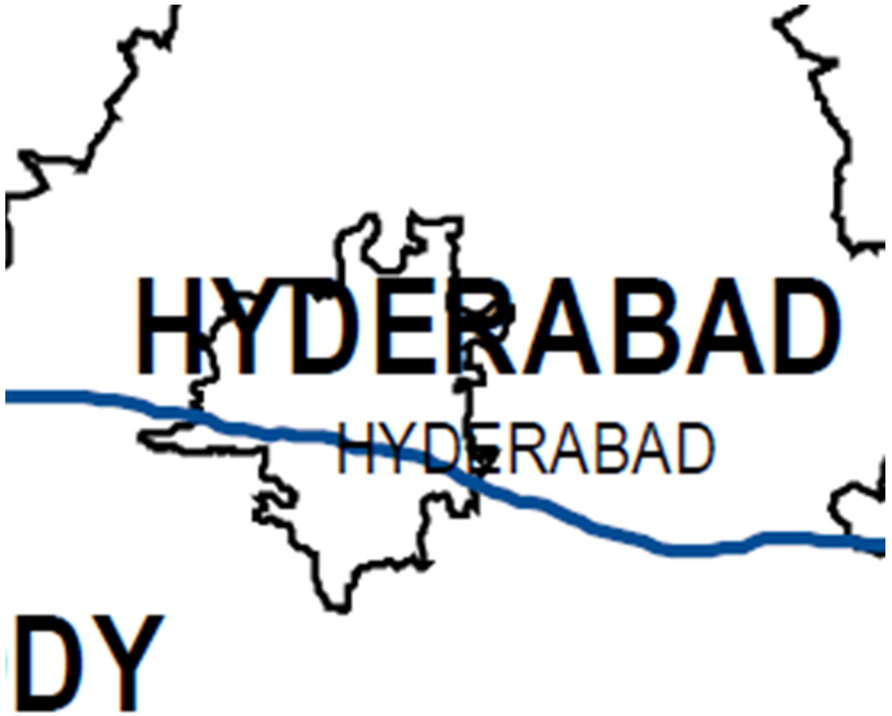
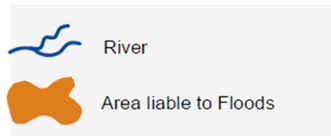
Flood Affected Area: Bhubaneswar



District-wise Population Density



Candidate City: Hyderabad (Telangana)

Basin	Elevation	Annual Average Rainfall
Krishna		

Land Use/ Land Cover	District-wise Population Density	Flood Affected Area: Hyderabad