

SECTOR ASSESSMENT (SUMMARY): WATER AND OTHER URBAN INFRASTRUCTURE AND SERVICES (URBAN FLOOD PROTECTION)

A. Sector Road Map

1. Sector Performance, Problems, and Opportunities

1. **Urban sector performance in India.** The urban population in India will reach 575 million by 2030. Census 2011 data show that 53 cities in India had populations exceeding 1 million.¹ At the current rate of urbanization, half of the country's population will live in urban areas by 2050. Rapid urbanization confronts India with many challenges, notably inequitable delivery of urban services, worsening urban poverty, unplanned land development, and expanding slum areas. While the country has improved its provision of basic urban services, it has not kept pace with rapid urbanization. Further, supplies of land and housing are not commensurate with the increase in urban population. India has established a strong institutional and legal framework for disaster management, and has steadily progressed in developing the required physical infrastructure and in implementing various nonphysical interventions needed to control risks related to urban flooding. However, many large Indian cities still face frequent flash floods, drainage infrastructure is inadequate, and appropriate operation and maintenance (O&M) practices are lacking.

2. **Challenges to urban flood management in Chennai.** Metropolitan Chennai, the capital of Tamil Nadu, is the fourth most populous agglomeration in India and its urban area ranks 31 in the world. Chennai has a diversified economy anchored by automobile and hardware manufacturing and software, health care, and financial services. The Confederation of Indian Industry has projected that the annual value of the Chennai economy will grow by 2025 to \$100 billion, or 2.5 times its size in 2017.² While rapid urbanization has fueled the local economy, the city is challenged to keep pace with demand for urban services while protecting its fragile environment. With urbanization, Chennai's jurisdiction expanded in 2011 from 174 to 426 square kilometers. A lack of appropriate planning has allowed urban expansion to alter the natural landscape and traditional land-use, shrinking water bodies and expanding impermeable areas. The capacity of the city's water bodies to retain water has been reduced by encroachment and nearby development, with little concern for hydrology. Unplanned urban sprawl has reduced infiltration capacity, with hardened and impermeable surfaces.

3. Chennai is located on the highly exposed southeast coast of India and is relatively low and flat, with average elevation 6.7 meters above sea level. Three major rivers—the Adyar, Cooum, and Kosasthalaiyar—traverse a coastal bowl, which they frequently inundate following even short periods of rain. The northeast monsoon brings heavy rain to Chennai, and the city has experienced nine severe floods since 1976. In 2015, Chennai recorded rainfall depth of 348 millimeters over a 24-hour period, exceeding the 1:100-year annual recurrence interval rainfall depth estimate, which occurred following multiple torrential rainstorms in the course of a month. The resulting floods destroyed properties and livelihoods, worsening the vulnerability of poor and other marginalized groups who reside in areas encroaching on water bodies. Impacts on the environment, public health, and the public purse are high as sanitation worsens and vector-borne diseases spread. Many slum residents live in substandard housing in flood-prone zones. Women suffer disproportionately from floods, reflecting their limited awareness of evacuation plans and involvement in decision-making within their communities, as well as potential

¹ Government of India, Office of the Registrar General and Census Commissioner. 2011. *Census of India*. Delhi.

² Government of Tamil Nadu, Department of Economics and Statistics. 2017. *District Statistical Handbook Chennai District 2016–2017*. Chennai.

discrimination against them in emergency assistance and at shelters. The risk of flooding in Chennai is expected to worsen with climate change. Climate models project heavier rainfall by midcentury. Sea level rise, projected at 4–6 millimeters per year up to 2050, will worsen coastal flooding and the tide-locking of drainage outlets. Higher storm surges from tropical cyclones can prevent the free drainage of stormwater and increase reliance on pumping.

4. The city has a drainage network alongside only 65% of its road length, and most of these drains are in the city core, leaving expanded areas such as the Chennai–Kosasthalaiyar basin poorly covered. In these areas, the capacity to retain floodwater is constrained by (i) reduced groundwater infiltration, resulting from the spread of impermeable surfaces, reduced green cover, and degraded ecosystem services; (ii) inadequate and deteriorating flood protection infrastructure such as stormwater drains, water storage bodies, large channels linking water bodies, and pump stations;³ and (iii) inadequate O&M under poor asset management, a lack of performance monitoring, and insufficient budget allocation. Further, flood risk is inadequately managed as (i) urban land-use planning and control regulations such as flood zoning regulations do not sufficiently recognize current and future hazards, (ii) flood forecasting and early warning systems are inadequate, and (iii) capacity and awareness shortfalls render the Greater Chennai Corporation (GCC) and city residents unable to respond quickly to floods. Further, flood-prone low-income urban communities are increasingly vulnerable to multiple crises from the coronavirus disease (COVID-19) pandemic and climate-related disasters, requiring integrated approaches that prepare for and respond to pandemic and disaster risks.

5. **Opportunities.** Urban floods stem from complex causes that include unplanned urbanization and meteorological and hydrological extremes. Future flood resilience requires more holistic and robust approaches to flood risk management that can cope with complex changes. The Government of Tamil Nadu and the GCC have accorded top priority to urban flood management, calling for structural and nonstructural measures to strengthen resilience, including better stormwater drainage, protection for urban wetlands, water harvesting, and risk-sensitive land-use planning. The city aims to increase the coverage of stormwater drainage networks from 65% to 100% by implementing various investment projects.⁴ Interventions could be adaptive to future uncertainty by optimally combining (i) structural measures to reduce flood risk by controlling the flow of water through hard-engineered structures and green solutions; and (ii) nonstructural measures to keep people safe from floods, with improved preparedness planning and behavioral change promoted to build resilience over the long term. Water, sanitation, and hygiene (WASH) intervention will mitigate health and water-related disaster risks to vulnerable people in flood-prone low-income communities.

2. Government's Sector Strategy

6. **Sector strategy for urban flood management in India.** The National Guidelines for Management of Urban Flooding list the actions that city administrations must carry out for flood management.⁵ The Ministry of Housing and Urban Affairs, designated the national nodal ministry,

³ Most drains in the Chennai–Kosasthalaiyar basin were constructed 2 decades ago. A nearby canal in low-lying coastal areas is elevated above the lowest part of the catchment, worsening floods in 2015.

⁴ Greater Chennai Corporation. 2019. *Declaration of Service Level Benchmarks Notification Format for the Year 2018–2019*. Chennai.

⁵ The actions include (i) establishing urban flood early warning systems; (ii) mapping cities and towns, including their stormwater drainage networks, on a geographic information system platform with contour mapping at a 0.2–0.5 meter interval; (iii) desilting drains before 31 March every year, before the onset of the wet monsoon; (iv) involving residents' welfare associations and community-based organizations in monitoring urban flood disaster management; (v)

recently enumerated in its *Manual on Storm Water Drainage Systems 2019* its planning, design, and operational policies; and frameworks for stormwater management. It establishes a national benchmarking system for urban services that includes two benchmarks on stormwater drainage: (i) 100% coverage of roads with stormwater drains, and (ii) zero incidence of waterlogging in flood-prone urban areas.

7. **Sector strategies and investment priorities for urban flood management in Chennai.**

The Tamil Nadu Vision 2023 and the Tamil Nadu Sustainable Water Security Mission envisage a more resilient future by ensuring more strategic, holistic, and integrated interventions that address the interconnected problems that cause floods.⁶ The GCC envisions in its City Disaster Management Plan enhanced disaster preparedness to maximize its ability to cope with disasters and significantly reduce the loss of lives, livelihoods, and property.⁷ It prioritizes the restoration and protection of water bodies, by recharging the groundwater aquifer, to boost their capacity to retain stormwater. The GCC has prepared plans for providing comprehensive stormwater drains throughout the city. Proposed works include rehabilitating existing stormwater drains, building new stormwater drainage networks, improving primary drainage channels, and rejuvenating water bodies. The estimated intervention cost is ₹40.3 trillion. The GCC prioritizes 210 water bodies for rejuvenation. Channels—including 30 canals and primary drains, known as primary channels, which carry surplus discharge from water bodies to rivers—require urgent rehabilitation to increase their capacity. Another GCC priority has recently been to expand stormwater drainage infrastructure, with support from the governments of India and Tamil Nadu and development partners, at 121 locations at a cost of ₹1.5 trillion under Smart Cities Mission financing and at 359 locations at a cost of ₹2.9 trillion using Chennai Metropolitan City Development Mission funds, as well as rejuvenating 183 of 210 water bodies with support from the state budget and some corporations. Other investments include mechanizing the O&M of drainage systems.⁸ The Government of Tamil Nadu also accords high priority to COVID-19 infection prevention and control, having issued guidelines in March 2020 and implemented enhanced control measures.

B. Major Development Partners: Strategic Foci and Key Activities

8. **Urban development in Tamil Nadu.** The World Bank, German development cooperation through KfW, the Japan International Cooperation Agency, and the Asian Development Bank (ADB) are major development partners of the governments of Tamil Nadu and Chennai in urban development. The World Bank is financing the Tamil Nadu Sustainable Urban Development Project, whose three components are (i) urban governance, which aims to improve urban management practices in three model cities (Erode, Vellore, and Hosur); (ii) urban sector technical assistance, which includes municipal e-governance and public financial management and geographic information systems, knowledge and institutional strengthening, and a project preparatory fund; and (iii) urban investment. Further, the World Bank is processing the Chennai

ensuring that rainwater harvesting is an integral component of all buildings; (vi) removing encroachments on drains and in floodplains and providing alternative accommodation to poor residents; (vii) establishing incident response systems for a coordinated response; (viii) capacity development in communities and institutions to enhance urban flood disaster management capability; and (ix) massive public awareness programs on solid waste disposal, encroachment, and their technical and legal implications.

⁶ Government of Tamil Nadu. 2012. [Vision Tamil Nadu 2023: Strategic Plan for Infrastructure Development in Tamil Nadu](#). Chennai; and Government of Tamil Nadu. 2015. *Tamil Nadu Sustainable Water Security Mission*. Chennai.

⁷ Greater Chennai Corporation. 2017. [City Disaster Management Plan](#). Chennai.

⁸ Government of Tamil Nadu, Municipal Administration and Water Supply Department. 2020. [Policy Note, 2020–2021](#). Chennai. To keep garbage and floating trash from entering the river and the sea, the city installed 75 trash arrestors at strategic locations and plans to install 154 more. One amphibious vehicle is deployed to remove water hyacinth, other vegetation, and other floating material from major canals; and three robotic multipurpose excavators remove blockages from minor canals.

City Partnership Program, which aims to strengthen institutions, financing, and the quality and sustainability of selected urban services in Chennai metropolitan area.

9. The KfW-funded Sustainable Municipal Infrastructure Financing—Tamil Nadu program is in the second of two phases, for implementing urban infrastructure projects, enhancing technical capability in urban local bodies, and facilitating the issuance of municipal bonds to finance loans and capital grants for these bodies. ADB-financed the Tamil Nadu Urban Flagship Investment Program to develop priority water supply, sewerage, and drainage infrastructure in strategic industrial corridors in the state; support innovative pilot projects; improve urban governance; and strengthen capacity in state and local institutions to enhance environmental sustainability, climate resilience, and urban livability. The Japan International Cooperation Agency is financing the installation of efficient traffic information systems, traffic management systems, and bus systems through the Chennai Metropolitan Area Intelligent Transport Systems Installation Project.

10. **Urban flood management in Chennai.** The GCC prepared plans to provide stormwater drainage in the basins of the city's four rivers: the Adyar, Cooum, Kovalam, and Kosasthalaiyar. The World Bank provides financial support for integrated stormwater drainage works in the Cooum and Adyar basins, which includes constructing 406 kilometers (km) of stormwater drains costing ₹13.9 trillion and providing an early flood warning system. The Chennai City Partnership: Sustainable Urban Services Program, being processed by the World Bank, will include operationalizing mechanisms for integrated water resources planning and management to enhance water security. KfW is in advanced appraisal for a proposed loan for integrated stormwater drainage in the Kovalam basin.

11. The governments of India and Tamil Nadu requested ADB financial support for stormwater drainage works in the Chennai–Kosasthalaiyar basin. This basin, added to the city in 2011, has very poor roadside storm drain coverage and inadequate capacity in existing drains, and is prone to flooding. Parts of it are lower than the major channels, which requires pumping to drain stormwater. The proposed project adopts an integrated approach that includes upgrading 175 km of stormwater drains, constructing 588 km of new drains and stormwater pump stations, improving four primary channels, and facilitating rainwater harvesting via several nonstructural measures.⁹

Table 1: Major Development Partners

Development Partner	Project Name	Duration	Amount ^a (million)
Urban Development (Water and other urban infrastructure and services)			
ADB	Tamil Nadu Urban Flagship Investment Program, MFF	2017–2026	\$1,268
World Bank	Tamil Nadu Sustainable Urban Development Project	2015–2022	\$600
	Chennai City Partnership: Sustainable Urban Services Program	2021–2026	\$430
KfW	Sustainable Municipal Infrastructure Financing—Tamil Nadu, Phase 2	2014–2021	€188
JICA	Installation of Chennai Metropolitan Area Intelligent Transport System Project	2018–2028	¥10,670
Urban Flood Protection			
ADB	Integrated Urban Flood Management for the Chennai–Kosasthalaiyar Basin Project (the proposed project)	2021–2027	\$471
World Bank	Tamil Nadu Sustainable Urban Development Project: Greater Chennai Storm Water Drainage ^b	2015–2022	\$180
KfW	Sustainable Urban Infrastructure Development Program—Integrated Storm Water Management System in Kovalam Basin	2019–2024	€213

⁹ The GCC has prepared a detailed project report for rejuvenating eight major water bodies and 71 minor water bodies in the Chennai–Kosasthalaiyar basin, which will be undertaken with budgetary support from the Government of Tamil Nadu. Further, the state public works department will upgrade 29.11 km of three of the seven primary channels.

ADB = Asian Development Bank, JICA = Japan International Cooperation Agency, MMF = multitranches financing facility.

^a Project cost is as indicated in project documents or on the Tamil Nadu Urban Development Fund website.

^b One subproject in the Adyar and Cooum river basins of the Tamil Nadu Sustainable Urban Development Project is mentioned under urban development.

Source: Government of Tamil Nadu, Municipal Administration and Water Supply Department. 2020. [Policy Note, 2020–2021](#). February. Chennai.

C. Institutional Arrangements and Processes for Development Coordination

12. The Government of India coordinates the activities of its development partners to ensure effective and harmonized assistance in line with its development agenda and to avoid duplication. The Department of Economic Affairs in the Ministry of Finance oversees multilateral and bilateral funding agencies in India. A national screening committee that includes the Department of Economic Affairs and the Ministry of Housing and Urban Affairs reviewed and approved in January 2019 a proposal from the state government for the Integrated Urban Flood Management for the Chennai–Kosasthalaiyar Basin Project. The state Municipal Administration and Water Supply Department provides policy guidance on urban flood management and supports the convergence of various government programs and projects in coordination with the Public Works Department, Education Department, Health Department, and State Pollution Control Board, as well as state remote sensing application centers. In the field, urban local bodies play a critical role in managing and mitigating urban flooding and related risks. The GCC will implement the proposed ADB-financed project as the implementing agency, under the oversight of the Municipal Administration and Water Supply Department as the executing agency. The state government will establish a state-level steering committee chaired by the chief secretary to provide strategic guidance, facilitate coordination, and issue direction as needed for smooth project implementation.

13. The ADB project team consulted other development partners during project preparation to avoid any assistance overlap, maximize impact and results, and learn lessons from past initiatives and incorporate them into project design. A hydraulic modeling and integrated approach undertaken by KfW, for example, has been considered in the design of the proposed project. The project team avoided duplicating an early flood warning system for Chennai that is being considered under an ongoing World Bank investment. Experience from an ongoing World Bank-supported stormwater drainage project has been considered, especially in preparing procurement arrangements. Further, various partnerships are incorporated into the project design to enhance its outcomes. A project grant being processed from the Japan Fund for Poverty Reduction will assist the integrated management of risks from floods and the COVID-19 epidemic in low-income communities in the project area. A cofinancing grant with the Global Environmental Facility (GEF) is being processed to support GCC implementation of water body rejuvenation using nature-based solutions.

D. ADB Experience and Assistance Program

14. ADB has supported several initiatives in water and other urban infrastructure and services: (i) providing robust infrastructure, (ii) promoting environmental sustainability and inclusiveness through targeted poverty reduction and gender mainstreaming components, (iii) reforming governance, (iv) developing institutions and processes for innovative and sustainable infrastructure financing, and (v) capacity building in local agencies to improve service delivery.

15. **Lessons learned.** Global experience in urban flood management has shown the following: (i) flood risk management should be integrated with urban planning and management, (ii) combining structural and nonstructural measures is the most effective strategy to reduce flood risk, (iii) flood management measures can have multiple co-benefits such as increased amenity

value and biodiversity improved by the greening of urban spaces, and (iv) adequate O&M of flood management assets is key to sustainable management.¹⁰ An ADB working paper suggests an integrated urban management approach in which urban stormwater management is supported by the management of other urban utilities, such as sewage collection, and treatment and solid waste collection and disposal.¹¹ Urban flood management projects in Kolkata, supported by ADB, have shown that awareness campaigns effectively improve people's preparedness for flooding.¹² The proposed project design incorporates these lessons and those learned in designing and implementing the Tamil Nadu Urban Flagship Investment Program, including governance improvement through performance-linked incentives, enhanced municipal revenue mobilization, a plan for operational and financial sustainability, and greater citizen involvement and awareness.

16. **ADB assistance.** Urban flood protection aligns with ADB's Strategy 2030 by supporting key operational priorities related to addressing remaining poverty and reducing inequalities; accelerating progress in gender equality; tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability; making cities more livable; and strengthening governance and institutional capacity.¹³ It also aligns with water security policy recommendations in *Asian Water Development Outlook 2020* by promoting urban water security through investment in disaster risk mitigation especially for the urban poor, and by strengthening preparedness and resilience to counter water-related disasters.¹⁴ ADB's support to urban flood protection reinforces pillars 2 and 3 of the ADB country partnership strategy for India, 2018–2022 by supporting inclusive urbanization, and improving climate and disaster resilience.¹⁵ ADB promotes a more robust and adaptive integrated approach to cope with a wide range of climate change and disaster risks through innovative designs and interventions. ADB captures the experience and knowledge gained from the sector interventions into knowledge products, and disseminate these to the government through workshops and regional forums.

¹⁰ A. Jha, R. Bloch, and J. Lamond. 2012. [Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century](#). Washington, DC: World Bank.

¹¹ R. Osti. 2018. [Integrating Flood and Environmental Risk Management: Principles and Practices](#). ADB East Asian Working Paper Series. No. 15. Manila: ADB.

¹² ADB. 2019. [Transforming Kolkata: A Partnership for a More Sustainable, Inclusive, and Resilient City](#). Manila.

¹³ ADB. 2018. [Strategy 2030: Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific](#). Manila.

¹⁴ ADB. 2020. [Asian Water Development Outlook 2020: Advancing Water Security across Asia and the Pacific](#). Manila.

¹⁵ ADB. 2017. [Country Partnership Strategy: India, 2018–2022—Accelerating Inclusive Economic Transformation](#). Manila.

