Learning from Japan's Experience in Integrated Urban Flood Risk Management: A Series of Knowledge Notes

Knowledge Note 2: Planning and Prioritizing Urban Flood Risk Management Investments

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Cover Image: The Shibaura wastewater treatment plant in Minato Ward, Tokyo. This sewerage water detention facility integrates significant flood risk management functions with multipurpose urban amenities such as public green spaces, recreational facilities, and new commercial high-rises.

(Photo Credit: Kenya Endo)

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1. Summary

Careful planning and prioritization are critical in the selection of an appropriate mix of integrated urban flood risk management (IUFRM) solutions. An integrated approach to urban flood risk management[1] relies on a balance of structural (including nature-based[2]) and nonstructural measures. Building on the results of flood risk assessments (as explained in **Knowledge Note 1**), decision makers utilize various tools and methodologies to suit the local context and its specific flood hazards. Some of the criteria considered in the planning and prioritization process include: the probable frequency and strength of floods, potential damage to people and property, cost-benefit analyses (CBAs), social and environmental assessments, and the capacity of existing flood risk management measures. By analyzing the decision-making processes that take place at different governance levels in Japan, this Knowledge Note illustrates how the findings and conclusions of risk assessments are translated into urban flood risk management solutions through the process of planning and prioritizing related investment. **Knowledge Note 3** will build on this information and focus on the various aspects to be considered during the design and implementation of IUFRM solutions.

In Japan, IUFRM involves collaboration and role sharing among various sectoral departments—those related to rivers, sewerage and drainage, urban development, the environment, and disaster risk management (DRM)—and stakeholders. Together with these actors, the public and private sectors, academia, community and civil society organizations, and citizens work together and share responsibilities to achieve the common goal of mitigating and managing urban flood risks in accordance with national laws, policies, plans, and guidelines. Central and local authorities carry out the following steps as part of their various **planning and prioritization processes.**

Step 1: Goal setting considers the results of flood risk assessments, including the characteristics of the region and historic floods, as well as various other factors, such as national policies and guidelines, the consistency and efficiency of existing flood management measures, progress made toward past and/or existing goals, the timing and feasibility of implementing the proposed IUFRM investments, impacts on communities, results of economic evaluation, and so on. These factors inform overall flood risk management goals (both quantitative and qualitative) and a vision for flood risk management at the city level, reflecting societal preferences including acceptable residual risk levels. Various decision-making tools are used in determining citywide goals, including those addressing uncertainty and expected climate change impacts.

Step 2: Integrated planning and prioritization processes set an operational framework for implementing citywide flood management goals. This framework outlines the specific targets and responsibilities of the various sectors that will work toward achieving these goals. The distribution of roles and responsibilities among sectors depends on various enabling and limiting factors (i.e., land availability, financial resources, time, technology, and elevation). Once the sectoral allocations and targets are determined, the respective departments strategize how to combine structural and nonstructural measures, including innovative approaches and partnerships, to achieve their flood management targets. Increasingly, nonstructural measures are gaining in importance. Tools include multistakeholder and sectoral consultations, coordination, technical evaluation and feasibility assessments, and cost-benefit analyses.

Step 3: Consensus building and responsibility sharing enable engagement and agreement regarding how to determine and implement goals by distributing responsibilities and roles among stakeholders at various stages of IUFRM investments. Building consensus between sectoral departments and citizens can be accomplished through a participatory planning process that may involve a range of activities and initiatives such as conferences, research

1 This four-part series of knowledge notes uses the definition of integrated urban flood risk management put forward by Jha, Bloch, and Lamond (2012).

2 Structural solutions include nature-based solutions—that is, "solutions inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help resilience." Green infrastructure is a type of nature-based solution defined as, "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green or blue spaces and other features in terrestrial and marine areas" (European Commission n.d.).

and development initiatives, simulations, the exchange of experts, public hearings and consultations with the public and private sector, and the use of incentives and legal regulations. In the process, public authorities from national and city governments, private sector developers and operators, community groups, and citizens—including those from vulnerable groups—discuss and define roles and responsibilities for design, construction, and operation and maintenance (O&M).

Japan's experience in IUFRM points to a number of lessons learned, organized here by the particular step involved.

Step 1: Goal Setting

- **Base goals on evidence and regularly update them.** The planning process starts with setting citywide goals for flood risk management based on risk assessments of various types of floods that each city may be vulnerable to. Per **Knowledge Note 1**, risk assessments and associated citywide flood management goals require regular review and update, reflecting changes in climate and hazard risks, urban development contexts, and available data. Based on the evidence, an acceptable level of risk in the specific context needs to be set.
- **Align local goals with national ones.** The Japanese national government leads and coordinates the process, ensuring that local-level efforts reflect the latest thinking on and approaches to integrated flood risk management. While not all cities in Japan have individual flood management plans, given the recent increase in locally concentrated heavy rain (with large economic impacts in urban areas), and the diverse range of city-level solutions available, many cities are taking the initiative to set their own flood risk management goals and associated plans.
- **Set realistic milestones aligned with long-term goals.** Cities are often compelled to set ambitious flood risk management goals in the face of increasing extreme weather events and hazard risks. However, when goals are too ambitious, achieving them becomes a challenge. In response, many cities in Japan have set long-term citywide flood management goals with specific milestones, for the short term (around 5 years), medium term (around 10 years), and long term (around 30 years) that are also segmented by sectoral targets. In general, the long-term target for enhanced rainfall drainage varies between 20 and 90 millimeters (mm)/hour, which corresponds to flood events likely to occur once every 5 to 10 years. The most common target is around 50 mm/hour.
- **Consider climate change impacts.** Amid a rise in extreme weather events, cities are increasingly aware of the need to integrate climate change risks into flood risk management plans. While integrating city-level climate change risk and impact analysis within the planning process is still rare, Japanese cities are regularly reviewing goals, as well as integrating mechanisms to prepare for unprecedented events, by placing greater focus on nonstructural life-saving measures.

Step 2: Integrated Planning and Prioritization

- **Coordinate to meet shared goals.** Interinstitutional coordination and joint responsibility for meeting shared goals is critical in Japan. Sectoral departments (such as those related to rivers, sewerage, watersheds, urban planning, the environment, and DRM) are engaged, together with the community and private stakeholders, in setting citywide flood risk management goals. Once these are established, sector-specific targets are determined, considering the strengths and weaknesses of the given measures. This allows for a coordinated approach to flood risk management without any gaps or overlaps, while maintaining flexibility in how it is adopted to best suit the city's unique urban and institutional contexts.
- **Integrate structural (including green) and nonstructural measures.** A combination of solutions is used to meet sector-specific flood risk management targets. In Japanese cities, many sectoral departments first determine the structural measures that can be implemented through national and city government initiatives. This is because flood damage occurs all over the country almost every year, and thus structural measures to protect assets and infrastructure are urgently needed. Various factors such as geographic contexts, flood hazards, land availability, financial resources, and community support determine the levels and types of structural measures that can be implemented (as also explored in **Knowledge Note 3**). Nonstructural measures may be implemented by city governments (including land use planning, zoning and regulatory instruments, flood risk communication, and awareness raising), as well as by households and communities (such as rainwater harvesting and utilization, and community-based DRM) and the private sector (such as stormwater management, including the adoption of green or nature-based approaches).

- **Set priorities based on local contexts.** Urban flood risk management plans often designate priority areas within the city where flood risks are high–for example, in Japan, underground commercial areas or transport nodes are prioritized. These areas may have suffered severe flood damage, may be watersheds of large rivers and lakes, or may have commonly high precipitation rates. Higher standards are set for these areas and they are targeted first for investments. In the design phase, these priorities are translated into tailored solutions that provide the expected level of risk protection.

Step 3: Consensus-Building and Responsibility Sharing

- **City governments can help broker partnerships.** City governments engage a wide range of stakeholders in sharing responsibility for urban flood risk management. Cities rely on, and coordinate closely with, the national government to set the policy guidelines for flood risk management and to lead large-scale river and coastal structural measures protecting against urban floods. City governments also coordinate closely with the private sector, community groups, and citizens in setting the goals and targets for urban flood risk management and also to garner support and ownership for implementation and O&M.
- **Expand the role of the private sector and community actors.** When floods strike, they can disrupt services, production, and functioning of businesses, affecting the local and national economy, and even regional and global patterns. With increasing disaster exposure, the role of private firms and community members in flood management investments is increasing in cities in Japan in line with the increasing and diversifying risks of urban floods. Along with this, cities are exploring diverse incentive mechanisms to engage and coordinate with new actors. To do so, flood risk management priorities are tackled concurrently with various other emerging priorities such as environmental sustainability, livability, and social assets.

2. Urban Flood Risk Management in Japan: Evolution and Stakeholders

2.1 The Evolution of Urban Flood Risk Management in Japan

The rapid urbanization of the 1960s and 1970s increased the impacts of urban floods in Japan. In response, the concept of coordinating river, sewerage, and watershed measures was born. In 1979, Comprehensive Flood Risk Management Measures (CFRMMs) were developed to meet the urgent needs for river improvement and runoff management in watersheds running through rapidly urbanized areas. The measures were implemented along 17 rivers. The CFRMM encouraged river management authorities (mainly from the national government) and urban development authorities (mainly from local governments) to work collaboratively to enhance cities' resilience in the face of flood risks. Although many benefits were realized, initial targets were not achieved. Only 50 percent of watershed measures and 70 percent of river measures were implemented due to rapid urbanization and budget constraints. Furthermore, the CFRMM initially focused on river floods, to the exclusion of other flood types. Also, no comprehensive measures against inundation were implemented (Research Group of Specific Urban River Innundation Measures 2004).

With increasing extreme weather events, some local governments, as administrators of sewerage systems, developed independent city-level plans for heavy rain and flood risk management to address unique hazard, geographic, and urban contexts to better protect their communities. Examples include the Tokyo Metropolitan Government's (TMG's) Basic Policy for Heavy Rain Management, Shiga Prefecture's Basic Policy for Watershed Flood Management, and Setagaya Ward's Basic Policy for Heavy Rain. These take an integrated approach that includes structural investments needed for river and sewerage management, non-infrastructure urban planning and design tools, preparedness and evacuation measures, as well as green infrastructure solutions.

Innovative efforts in the Tsurumi River Watershed in 1981 were instrumental in advancing the watershed-wide approach to flood risk management in Japan.[3] This was the first initiative in Japan to establish a watershed-wide investment plan, integrating hard infrastructure improvement measures with softer nature-based solutions such as

3 Watershed measures include storage facilities such as detention ponds and reservoirs, stormwater infiltration inlets and trenches, and permeable pavements. Although sewerage systems are involved in watershed measures, they are discussed separately.

water retention ponds and retarding basins. In 2005, the Tsurumi River Watershed was recognized by the national Act on Countermeasures against Flood Damage of Specified Rivers Running Across Cities. This advanced watershed-wide collaboration across sectors and stakeholders featured targets based on the scientific modeling of risks using historical data and climate change forecasts. Tools and approaches to promote consensus building among various stakeholders, including citizens, were also developed and utilized.

The concept of an integrated approach to flood management was further advanced through the introduction of the Specific Urban Flood Damage Measures Law (SUFDML), enacted in 2003 for eight designated rivers. This mandated that river management authorities protect urban areas and take flood management measures within and beyond each watershed. The law instructed the development of an integrated flood management plan between river and sewerage management authorities. It led to not only horizontal collaboration between national and local governments, but also lateral engagements promoting collaboration between public and private sectors. The law also defined requirements for the private sector, including the installation of stormwater storage and infiltration facilities, and collaboration with river and sewerage administrators on planning and implementing flood management measures such as water discharge, the hydraulic analysis of river and surface water floods, and the operational rules of pumping stations.

In 2013, a 100 mm/hour Safety Plan was initiated by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to tackle the increasing impacts of concentrated heavy rain in urban areas. The plan clarifies the responsibilities of each local government department and authority, the participation of residential communities and the private sector, and flood management measures to prevent inundation in urban and residential areas. Responsibility for the safety plan is held by the local government and the public authorities for river and sewerage management. For private and public developers registered under the Safety Plan, eligibility criteria for MLIT's subsidy for stormwater storage and infiltration projects is relaxed.[4] These financial incentives help drive a multisectoral approach to urban flood risk management.

2.2 Institutional Arrangements and Key Stakeholders in Urban Flood Risk Management in Japan

IUFRM is based on collaboration and role sharing among various sectors and stakeholders. Urban floods caused by poor solid waste management are outside the scope of this study.[5] In accordance with national laws, policies, and guidelines, the departments managing rivers, drainage and sewerage, watersheds, urban planning and development, the environment, and DRM collaborate to determine and share responsibility for actions to address identified flood risks.[6] Furthermore, stakeholders such as national and local governments, the private sector, citizens, and academia work together to set and achieve shared goals for mitigating the risks and damages of urban floods. The key stakeholders involved and their roles and responsibilities for IUFRM in Japan are highlighted in **table 1**. This broad division aligns with the administrative context in Japan, as noted in **box 1**. In the following sections, this Knowledge Note focuses on examining the role of **local governments**—including at the prefecture and municipal levels—in advancing integrated flood risk management in Japan.[7]

4 Water storage and infiltration facilities with 500 cubic meters (m^3) or more capacity are eligible for MLIT's social capital improvement grant. This threshold is relaxed to 300 m^3 for entities registered with the 100 mm/hour Safety Plan.

5 For more information, please see: TDLC on SWM and Urban Flood case study from Kitakyushu City (World Bank 2017).

6 This series of Knowledge Notes does not include information on solid waste management. For a case study related to solid waste management and urban flood risk management, please refer to World Bank (2017).

7 Watershed-level efforts led by the national government across multiple municipal boundaries are beyond the scope of this note. Therefore, the Comprehensive Flood Risk Management Measures (CFRMM) and the Specific Urban Flood Damage Measures Law (SUFDML), led by the national government, are not included.

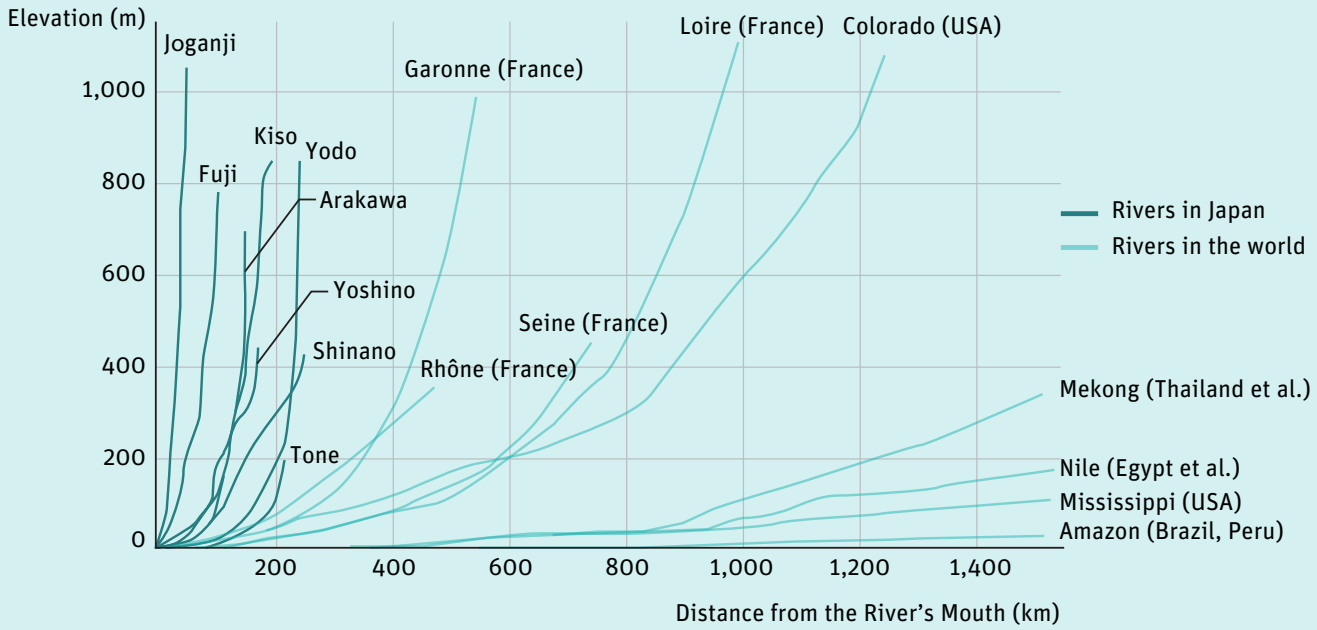
Box 1: Overview of Governance Structure and Geographical Features in Japan

The **local government system in Japan** consists of two tiers: prefectures and the municipalities that make up the prefectures. Prefectures and municipalities are both local public entities of equal status and cooperate in local administration according to their share of duties.

Prefectures are regional authorities comprising municipalities, and are in charge of broader regional administration. Japan is made up of 47 prefectures and Tokyo, governed by the Tokyo Metropolitan Government (TMG), is one of these regional authorities. **Municipalities are local public entities** that have a strong and direct relationship with local residents and handle affairs directly related to them, such as disaster risk management. As of January 1, 2015, there are 790 cities, 745 towns, and 183 villages in Japan. There are no essential differences between cities, towns, and villages in their responsibilities. A municipality with a population of 50,000 or more and meeting various other requirements is recognized as a city. In addition to ordinary local public entities such as prefectures and municipalities, there are **special local public entities** that have been established for specific objectives relating to local government. These include special wards, cooperatives, and public property districts. Tokyo's 23 special wards are, in principle, subject to the same regulations that apply to cities. The special ward system, however, has been designed to meet the distinctive needs of a large metropolis. For more information, please see http://www.metro.tokyo.jp/ENGLISH/ABOUT/STRUCTURE/structure01.htm.

Geographically, compared with other countries in the world, Japan has a large share of mountainous terrain within its small land area, which inevitably makes each river's watershed area small and its overall length short. Rivers run a short distance while the height difference from the upper to lower stream is significant. Such relatively steep rivers have fast water velocity, and this is likely to cause sudden changes in water levels downstream after heavy rain events. For more information, please see https://www.mlit.go.jp/river/pamphlet_jirei/kasen/gaiyou/panf/gaiyou2005/pdf/c1.pdf.

Figure B1.1: Selected Rivers' Elevation and Distance: An International Comparison



Source: National Institute for Land and Infrastructure Management 2004.
Note: m = meter, km = kilometer

Table 1: Sharing Responsibility for the Integrated Management of Flood Risk in Japan

Stakeholders		Major Roles and Responsibilities
Public	National Government	•Developing a basic national framework of laws, policies, programs for implementation, flood risk management targets, and technical standards; instructing and supervising implementing entities. •Developing a basic policy for river improvement plans; conducting effective and efficient improvements as the administrator of Class A rivers as stated in the River Law. •Conducting disaster risk assessment in areas under its jurisdiction; publishing and disseminating risk information. •Collecting and communicating disaster warnings and information. •Conducting disaster recovery activities promptly. •Assisting and arranging disaster prevention activities of prefectural governments and related organizations. •Establishing and enhancing flood prevention systems and organizations; advising and supervising municipal governments. •Promoting awareness of flood risk mitigation and river management.
	Prefectures	•Developing a basic prefectural framework of ordinances, programs, policies, management goals and targets in line with national guidelines; instructing and supervising implementing entities. •Developing a basic policy for river improvement plans; conducting effective and efficient improvements as the river administrator of Class B rivers. •Participating in the process of developing the national government's river improvement plans. •Developing and implementing urban planning and land use plans (that, for example, indicate where construction may be promoted, and enforce building regulations). •Installing and conducting O&M of stormwater storage and infiltration facilities in areas under their jurisdiction. •Supervising municipal governments in stormwater drainage and treatment. •In coordination with the national government, conducting disaster risk assessments in areas under their jurisdiction; publishing and disseminating risk information. •Collecting and communicating disaster warnings and information. •Conducting disaster recovery activities promptly by coordinating with national and municipal governments. •Assisting and arranging disaster prevention activities of municipal governments and related organizations. •Establishing and enhancing flood preventions systems and organizations; advising and supervising municipal governments on flood prevention. •Promoting awareness of flood risk mitigation and river management.
	Municipal Governments (cities, wards, towns, villages, etc)	•Developing a basic municipal framework of ordinances, programs, policies, management goals and targets in line with prefectural and national guidelines; instructing and supervising implementing entities. •Developing basic policy for river improvement plans; conducting effective and efficient improvements as the administrators of small rivers. •Participating in the process of developing the national and prefectural governments' river improvement plans. •Developing stormwater drainage improvement plans; conducting effective and efficient drainage improvements as the sewer administrator. •Installing and conducting O&M of stormwater storage and infiltration measures at facilities under their jurisdiction. •Aligning flood management with urban planning and land use plans. •Developing and implementing municipal master plans. •Supervising stormwater treatment in development areas. •Proceeding with watershed measures and assisting citizens. •Communicating with citizens. •Collecting and communicating disaster warnings and information. •Directing evacuation, guiding evacuees, and establishing shelters. •Developing flood response organizations and preparing emergency equipment and stocks. •Developing and distributing hazard maps. •Promoting awareness of flood risk mitigation and river management.
Academia		•Providing academic knowledge and analysis to inform tools and solutions for flood risk assessments, target setting, and standards and guidelines for investment design. •Leading discussions in committees to inform laws, policies, and standards.

Private Sector	•Understanding and cooperating in river improvement and requirements and targets for watershed measures. •Installing and conducting O&M of stormwater storage and infiltration facilities. •Conducting R&D of industrial technology on disaster prevention, damage risk mitigation, and related fields. •Investing in and installing stormwater storage and infiltration measures and promoting green infrastructure in the development sites.
Citizens	•Participating in the process of developing river improvement plans. •Understanding river improvement and watershed measures, and cooperating in the design and implementation processes. •Understanding, cooperating, and implementing household and community level stormwater management initiatives. •Leading the O&M of stormwater storage and infiltration facilities at each household and in communities. •Participating in local disaster prevention activities, including those related to urban floods.

Source: Authors' compilation.

2.3 City-Level Flood Management

In Japan, city-level flood management plans are formulated and implemented by sectoral departments in coordination with river departments to ensure the consistency of city drainage planning with river management plans.[8] Sectoral departments include those responsible for rivers, sewerage and drainage, watersheds, urban development, the environment, and DRM. The risk of storm surge floods is limited to cities located near the coasts, and landslides happen only in cities located in mountainous areas. Measures against storm surge floods, landslides, tsunamis, and typhoons are treated in different plans developed by various departments and sectors.[9] However, in local governments' DRM and preparedness plans, all flood risks mentioned above are integrated comprehensively, along with other disaster risks. This Knowledge Note focuses on the lessons learned from IUFRM planning for river floods, surface water floods, and a combination of the two.[10]

At the planning stage, flood risks are categorized by their source: river, surface water, storm surge, or multiple sources.[11] In many cases, planning is intended to tackle risks of both river and surface water floods. Policies and plans that consolidate river, sewerage, and watershed improvement measures include the Tokyo Metropolitan Government's (TMG's) Basic Policy for Heavy Rain Management, Shiga Prefecture's Basic Policy for Watershed Flood Management, and Setagaya Ward's Basic Policy for Heavy Rain.[12] A recent initiative, the **100 mm/hour Safety Plan**, actively coordinates role sharing between various local government departments as well as between civil society and private companies. Many Japanese cities have also developed sewerage or stormwater management plans in

8 The national government formulates legal frameworks (such as the Flood Prevention Act, Landslide Disaster Prevention Law, River Law, and acts involving special measures for tsunamis, earthquakes, volcanic activity, and nuclear power) and guidelines for both prefectural and city-level governments to develop specific and localized disaster prevention plans.

9 Although different prefectures and municipalities have unique organizational structures, in general, storm surge flood, tsunami, and typhoon measures are normally led by agencies and departments responsible for ports. Typhoon and earthquake predictions and preparedness are normally led by departments and units responsible for DRM and/or weather forecasting. Landslides are often led by the construction or road department's DRM division. Surface floods are often led by a sewerage management division, and river floods by river management / construction divisions (though large-scale rivers are led by MLIT).

10 This series of notes does not deal with the challenge of flash floods in depth; for a short case study, please refer to **Knowledge Note 1**.

11 Broad categories of urban flood risks are: river floods (caused by river overflow); surface water floods (caused by poor drainage of heavy rain in urban areas); and storm surge floods (caused by raised sea level due to low air pressure).

12 Cities base their independent flood management plans on several factors. Some cities are prone to surface water floods, and so cannot rely only on the national government for support managing river floods. Many of these are big cities with a high concentration of people and assets that require protection, and are led by a strong administration. In addition to the examples detailed in **box 2**, cities with independent flood risk management plans include Osaka, Yokohama, Kyoto, Fukuoka, and Sapporo.

accordance with national flood management policies. Approximately 1,400 cities, wards, towns, and villages in Japan (about 80 percent of all municipalities) have sewerage management plans, and about 900 of them also have stormwater management plans (Japan Sewage Works Association 2018).

Considering Change and Uncertainty

Changing rainfall patterns have increased the frequency of locally concentrated heavy rain, which is now one of the major causes of urban floods in Japanese cities. This is in large part due to the limited water retention and infiltration capacities of the urban landscape. For example, in July 2018, 19 prefectures and 88 municipalities in central-western Japan were severely impacted by surface water floods, largely due to concentrated heavy rain (see **table 2**). Of the 29,000 houses inundated nationwide, approximately 19,000 were due to surface water floods (see MLIT 2018a). A combination of short-term locally concentrated heavy rain, together with long-term rain that continued for multiple days, led to an overflow of surface water, exceeding sewerage and rainwater management capacity. Between June 28 and July 8, 2019 (11 days), 102 of Japan's 1,600 rainfall stations recorded a heavy maximum hourly rainfall of more than 50 mm/hour. Additionally, 189 rainfall stations observed a very high cumulative rainfall of more than 300 mm over 48 hours.

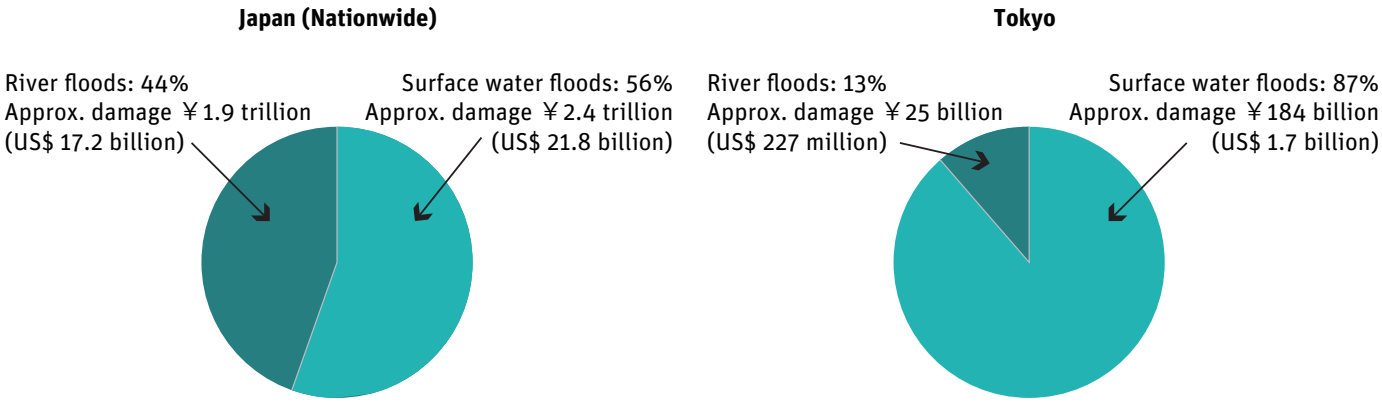
Table 2: Overview of Flood Damages Caused by Heavy Rain in July 2018

Prefecture	City	Damage (number of houses)		
		Flood above Ground Floor Level	Flood below Ground Floor Level	Total
Okayama	Okayama	1,687	3,728	5,415
Fukuoka	Kurume	423	1,011	1,434
Hiroshima	Fukuyama	751	638	1,389
...	...			
Total (88 local governments)		6,104	12,749	18,853

Source: Authors' compilation.

Improving cities' capacity to manage the risks of surface water floods is increasingly important, and local governments have a critical role to play in understanding these risks and coordinating an integrated solution. Compared with river floods, surface water floods have less impact but occur more often in Japan. And their frequency is increasing amid the rise in extremely concentrated heavy rains due to climate change. Nearly 70 percent of building damage caused by floods in Japan over the past decade is due to surface water (210,000 of the 310,000 total buildings damaged over the past 10 years) (MLIT n.d.[a]). In terms of economic damage, around 46 percent of flood damage costs in Japan, and 80 percent of flood damage costs in the Tokyo Metropolitan Area between 1993 and 2002, were due to surface water floods. **Figure 1** illustrates the economic costs of floods in Japan in general and Tokyo in specific due to surface and river floods.

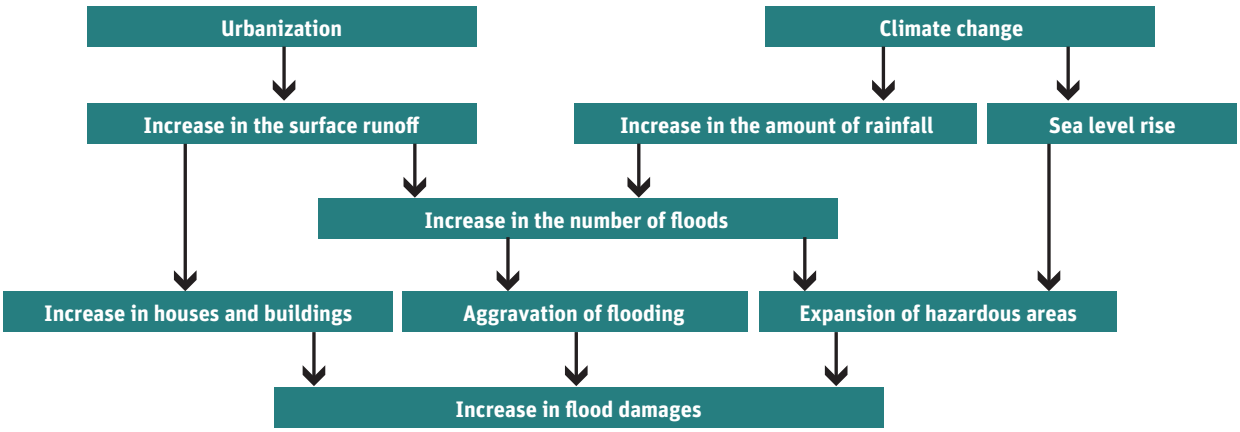
Figure 1: Share of Total Flood Damage Due to River and Surface Water Floods, 1997–2006



Source: Modified based on information from MLIT (2009).

Cities, in collaboration with the national government and research institutes, are exploring various ways to understand and integrate climate change risks within their flood management plans. Climate change impacts, combined with urbanization, can exacerbate the risks of urban floods. Climate change tends to make rainfall patterns more extreme and unpredictable, often increasing short-term (concentrated) and long-term (cumulative) rainfall. This increases the frequency of floods, especially in urban areas due to the higher occurrence of surface water runoff. As sea levels rise, vulnerable low-lying areas are increasingly exposed to flood risks (Ishiwatari 2016). **Figure 2** illustrates the interaction of these elements. By the end of the 21st century, the MLIT estimates that the amount of rainfall in Japan will be approximately 1.3 times greater, the frequency of floods about 1.4 times higher, and the probability of flood occurrence nearly 4.0 times higher than today (see **table 3**) (MLIT 2018b).[13] These climate change projections, together with recent experiences of unprecedented and extreme flood events throughout Japan, are compelling Japanese cities to further advance their flood risk plans.

Figure 2: Relationship and Effects of Climate Change, Urbanization, and Increasing Flood Damages



Source: Modified based on information from Ishiwatari (2016).

Table 3: Future Rainfall Levels, Flood Frequency, and Probability of Flood Occurrence According to Different Climate Change Scenarios

(Approximate numbers)

Assumed Climate Change Scenarios	Change in Rainfall Volume	Change in Flow Volume	Change in Flood Occurrence Probability
RCB8.5 (Equivalent to 4°C higher)	1.3 times	1.4 times	4 times
RCB2.6 (Equivalent to 2°C higher)	1.1 times	1.2 times	2 times

Source: Authors' compilation, based on MLIT (2018c).
Note: These scenarios consider the ratio of change in rainfall volume and flow volume between (i) 1951–2011 and (ii) 2090.

13 The Intergovernmental Panel on Climate Change (IPCC) forecasts climate change and evaluates environmental assessments using Representative Concentration Pathway (RCP) scenarios. RCP 8.5 is characterized by a continuous upward trend in radiative forcing after 2100. In RCP 2.5, by contrast, this would peak by 2100 and decrease thereafter.

3. Planning and Prioritizing Investments in Urban Flood Risk Management

The planning and prioritization process in Japan generally involves three key steps, detailed below.

Step 1: Goal Setting

How do Japanese cities determine the overall goals of urban flood risk management?

In Japan, urban flood risk management plans and objectives are developed in line with the national Disaster Countermeasures Basic Law (DCBL). This law clarifies the roles and responsibilities of the national, prefectural, and municipal governments, and public entities for DRM, and mandates that these entities develop and implement individual DRM plans. Citizens are also required to implement voluntary preparedness and mitigation measures under this law. Therefore, the cities' urban flood risk management goals are also set to directly contribute to the cities' mandate under the DCBL—and to work with various stakeholders to protect citizens' lives and assets and maintain public order and social welfare in the event of natural disasters, including floods.

Based on this high-level goal, specific long- and short-term targets are developed to address the unique flood risks and geographic contexts of each city. Cities often define their flood risk management targets as the level of rainfall (such as hourly maximum rainfall or return periods) they aim to manage without inundation and/or damage to citizens' lives and assets based on the results of risk assessments and flood forecasting and simulations informed by scientific data and expertise (see **Knowledge Note 1**). Japanese cities also review the damage records from the worst historical floods recorded. Additionally, ensuring coherence with national laws, directives, policies, standards, and programs is a key consideration for municipal governments as they determine their target level of risk management. City governments often put together a panel of experts from various sectors, including academia, to review technical viability, economic efficiency, social and environmental impacts, and alignment with legal and policy frameworks. For example, the goal-setting process undertaken by the Tokyo Metropolitan Area and Shiga Prefecture is summarized in **table 4**.

Table 4: Urban Flood Risk Management Goals and Decision-Making Tools and Processes in Tokyo and Shiga

	Tokyo Metropolitan Government (TMG)	Shiga Prefecture
Latest Policy	TMG Basic Policy for Heavy Rain Management (Update), 2014	Shiga Prefecture Basic Policy for Watershed Flood Management, 2012
Urban Flood Risk Management Goal	•No inundation from rainfall of up to 60(mm)/hour. •No above-floor flooding in residential areas from a 1-in-20-year rainfall (this translates to 75mm/hour in the more urbanized eastern areas and 65mm/hour in less urbanized areas, such as Tama). •No casualty caused by any rainfall, including when the amount of rainfall exceeds historical maximum target levels. •River, water, and watershed-wide disaster risk management (DRM) efforts, collectively managing up to 10 mm/hour rainfall.	•To avoid loss of lives from any type of floods (top priority). •To avoid flood damages and associated impacts to livelihoods from: -The maximum rainfall observed since World War II (equivalent to once in 50 to 100 years)—for the design of flood management measures for areas in the watersheds of large rivers[a] -1-in-10-year rainfall (50 mm/hour)—for the design of flood management measures in the watersheds of small rivers[b] -1-in-5-year to 1-in-10-year rainfall (50mm/hour)—for the design of storm-water drainage systems
Decision-making Tools & Processes	**Goals are decided through a technical committee consisting of relevant departments, academia, and public consultations attended by citizens and civil society groups.** During the revision process of the TMG's Basic Policy for Heavy Rain Management (Update), 2014, Tokyo updated its flood management goals based on recommendations from the Technical Committee, which comprised of TMG's Bureau of Urban Development (which manages urban development, watershed management, and relationships with academia), the River Management Division of the Bureau of Construction (the river administrator), and the Bureau of Sewerage (the sewerage system administrator). Consultations with citizens were conducted and views were integrated toward the finalization of the goals.	**Flood management goals within the Basic Policy for Watershed Flood Management (March 2012) were established by consultation and with inputs from:** (i) a practitioner's committee comprised of related government entities, (ii) a citizens' conference, and (iii) a technical committee comprised of academics.

Sources: Authors' compilation based on Shiga Prefecture (2012b) and TMG (2014).
[a] Rivers with a watershed area of 50 square kilometers (km^2) or more.
[b] Rivers with a watershed area of less than 50 km^2.

For cities to cope with uncertain climate change risks, having an integrated flood risk management goal that involves both structural and nonstructural approaches is critical. Cities are increasingly aware of the need to prepare for unprecedented floods that exceed the anticipated worst-case scenarios, an awareness that was heightened in 2015, when a series of large floods affected many cities in Japan. Many such cities now expect large-scale flood events whose impacts would not be fully manageable by infrastructure investments alone but would require non-infrastructural, society-wide approaches. According to one national-level guideline, "the capacity of structural measures has limits, and large-scale floods (that exceed the management capacities of infrastructure) will happen" (MLIT n.d.[b]). Therefore, the MLIT instructs cities to estimate possible inundation areas using probable maximum precipitation forecasts to develop city-level flood risk maps (MLIT 2015). This updated guidance is in accordance with the 2015 revisions to the Flood Prevention Act (Library of Congress 2015), and is based on lessons learned from the 2015 floods that exceeded the design level of existing structural measures (MLIT 2015). The range of rainfall intensities and associated management goals set in cities in Japan is summarized in **box 2**. **Knowledge Note 1** describes some of the nonstructural activities, such as climate-change informed risk mapping and evacuation planning.

Box 2: Stormwater Management Goals: Rainfall Intensity Used to Plan Sewerage Improvements

The median design rainfall intensity used for sewerage planning is around 50 millimeters (mm)/hour. The areas with rainfall intensity levels that exceed this include Okinawa, Kochi, Nagasaki, and Mie; these are regarded as heavy rain regions. Also, the following major cities have relatively high rainfall intensity levels and have set design goals above the national rainfall intensity average: Yokohama (74 mm/hour), Nagoya (60mm/hour), Osaka (60 mm/hour), and Fukuoka (79.5 mm/hour).

Source: Authors' compilation.

Step 2: Integrated Planning and Prioritization

How are flood risk management plans and priorities aligned across various sectoral departments and diverse regions?

As part of interinstitutional coordination, city planners and managers assign roles and responsibilities among relevant sectoral departments to achieve citywide goals. This distribution is based on various factors such as the city's development strategies, citywide and sectoral visions, and unique geographic contexts (proximity to a river, availability of permeable surface, etc.) and sociopolitical conditions. In the case of the Tokyo Metropolitan Government (TMG), the distribution of roles and responsibilities across departments was informed by technical feasibility and economic analyses conducted within municipal subdivisions. Based on the assigned sectoral targets, each department then develops its own investment plans, priority measures (structural and nonstructural), and schedules, according to department visions, budgets, the available range of opportunities, options and limitations (i.e., available land, etc.), and inputs from technical committees and panels. More specifically, under the citywide goal, each responsible sectoral department determines its individual runoff reduction target and forecasted rainfall levels. Based on these targets, each department then selects and prioritizes appropriate flood management measures by reviewing the technical effectiveness, economic efficiency, feasibility, and speed with which investments will have an effect. **Knowledge Note 3** provides a discussion of the specific factors and criteria considered by cities in designing and implementing IUFRM investments.

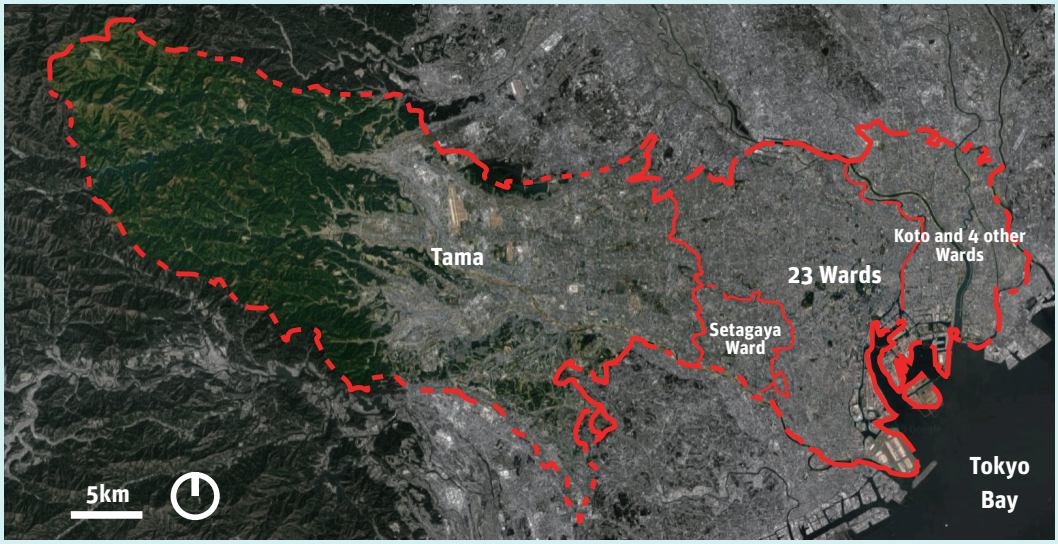
Wherever possible, departments coordinate with one another during the implementation of their flood management measures. Inter-institutional coordination extends to sequencing the construction of investments or integrating the flood risk management capacity of an investment implemented by another sector. To enhance coordination, many cities in Japan, including Tokyo, have departmental staff exchange programs, especially between the river and sewerage departments. These programs enable the interdepartmental coordination and collaboration necessary for integrated planning and prioritization through: (i) setting citywide shared goals for urban flood risk management; (ii) discussing and distributing roles and responsibilities among the relevant sectoral departments to achieve the shared goals; (iii) encouraging responsible sectoral departments to agree on their individual target runoff reduction and design rainfall levels; and (iv) encouraging departments to coordinate with one other during the implementation of their flood management measures.

Cities also prioritize certain regions or measures based on different regional flood risk contexts. For example, the Tokyo Metropolitan Area was divided into subregions based on similar geographic and rainfall patterns during the IUFRM planning and prioritization process. The process is described in **box 3.**

Box 3: Planning and Prioritizing Measures to Address Urban Floods in the Tokyo Metropolitan Area

The Tokyo Metropolitan Area can be divided into two areas based on flood susceptibility: (i) the eastern side (including the **Koto five-ward area**), which is undergoing rapid urbanization; and (ii) the western side (**Tama area**), which is relatively rich in forests and farmlands (**figure B3.1**).

Figure B3.1: Tokyo Metropolitan Area: Aerial Image



Source: Google Earth. *Note*: km = kilometer.

In the **Koto five-ward area** in East Tokyo, many neighborhoods are low lying, practically at sea level, with high ground water levels, making them susceptible to flooding. Given the geographic characteristics of the area, pumping facilities, together with enhanced flood risk preparedness and awareness-raising actions in communities, are prioritized as the most technically and economically efficient measures for the effective management of flood risks. Therefore, in this area, the sewerage and disaster risk management departments take on a large share of the responsibility for flood risk management. In locations where it is difficult to install pumping stations due to land scarcity, stormwater retention ponds are often implemented as an alternative.

The western **Tama area**, on the other hand, is characterized by high land elevation and frequent occurrence of concentrated heavy rains. Heavy rains of over 75 millimeters (mm)/hour frequently fall on small- and medium-sized rivers, including the Kanda and Shakujii rivers. Given land use restrictions, despite the need to expand urban drainage, it is impossible to widen the river channels. Therefore, the installation of retention ponds and underground storage facilities is often prioritized as the most technically and economically effective measure. Other priority measures include sewerage improvements underneath trunk lines. Given their geographic condition, neighborhoods in the Tama area also prioritize green infrastructure, an integral solution to flood risk; related efforts include conserving green spaces for infiltration and developing bioswales for temporary water retention.

In addition to prioritizing specific types of measures, Tokyo prioritizes the locations of interventions by designating "special management watersheds and districts." These priority areas are identified based on areas with historical flood events that caused significant damage to people and livelihoods.

What tools and approaches are used for planning and prioritization?

Risk assessments (discussed in Knowledge Note 1), cost-benefit analyses (CBAs), and engagement and consensus building with communities and stakeholders inform the planning and prioritization of flood risk management investments in Japanese cities. For example, in Tokyo, the metropolitan government conducts CBAs to inform the

sectoral allocation of flood risk management targets and responsibilities, as well as to compare options for flood risk management interventions within a site-specific investment project. When the TMG embarked on integrated urban flood risk management in the 1980s, a technical panel developed a report entitled "Visions for Comprehensive Flood Management in TMG (Report 61), 1986" (hereafter referred to as "Report 61"). This set a long-term citywide flood management goal of 100 mm/hour as well as an indicative allocation of targets and responsibilities between river and sewerage departments. To inform the allocations, a CBA was conducted comparing three different flood mitigation scenarios to achieve the long-term goal. These options were: (i) using conventional flood management measures such as widening river channels and expanding or bypassing sewerage pipes (river management); (ii) installing stormwater runoff management facilities such as retention ponds (sewerage management); and (iii) installing stormwater storage and infiltration facilities (watershed sewerage management). The flood management targets for the watershed and DRM departments were determined based on what was not addressed by the river and sewerage departments.[14]

Engagement and consensus building with communities and stakeholders are important steps in the planning and prioritization of flood risk management. In Japan, watershed committees discuss plans and priorities, and form agreements between the community members and the private and public stakeholders that are affected by proposed flood management plans and specific interventions. The committees often consist of relevant river and sewerage administrators, community members, and people in urban planning, housing, land property, farming, road departments, academia, and environmental and civil society organizations. TMG's consensus-building process is described in **table 4.**

How do cities decide between structural and nonstructural measures?

Cities are increasingly aware that flood risks cannot be managed effectively unless the strengths of both structural and nonstructural measures are combined to achieve their citywide flood management goals. Japan has recognized the importance of this integrated approach since the 1980s, and especially since experiencing numerous mega disasters. The Great East Japan Earthquake of 2011 highlighted the limits of relying on only structural measures,[15] as great damage occurred even in areas with high embankments. Consequently, nonstructural measures have been implemented in tandem with structural measures during the reconstruction. To prevent such damage from recurring, an embankment would have to be 30 to 40 m high (equivalent to the height of a 10-story building), which would not be acceptable from a financial, environmental, or social standpoint. In the reconstruction following the earthquake, a plan to make a mega dike (large embankment) was abandoned at an early stage. Various discussions have taken place about the construction of the embankment, as well as the acceptable level of risk to the community. In the end, the region has adopted nonstructural measures, such as prohibiting residents from living in tsunami-prone areas, relocating houses to higher ground, building evacuation centers, developing evacuation plans, and basing town restoration plans on the premise of flooding (Ishiwatari 2016).

Structural and nonstructural measures have their strengths and weaknesses, and cities must understand these to plan and prioritize such measures in an integrated manner. Structural measures, normally led by river and sewerage sectors, are often limited by geography, technical and political feasibility, construction time, and budget. In some cases, large structural investments can be modified only with difficulty, even as sticking with the original plan could in fact increase flood risk, given changes in the natural/hydrological or physical environment. On the other hand, nonstructural measures normally have much more limited flood mitigation benefits but can be adapted to a variety of risk contexts, and can respond to a changing natural or physical environment. Key nonstructural flood risk management tools and approaches considered by cities in Japan include the following:

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14 Cost-benefit analyses of various public investments in Japan, including those relevant to urban floods (such as rivers, sewerage, coastal embankments, urban planning, etc.), are consolidated in the Ministry of Internal Affairs and Communication Web Portal (in Japanese): http://www.soumu.go.jp/main_sosiki/hyouka/seisaku_n/koukyou_jigyou.html.

15 During the unprecedented earthquake, although coastal villages were protected with embankments that were 10 to 15 meters (m) high and extended around 300 km of the coastline, severe damage was caused by a tsunami that reached a maximum water level height of up to 40 m. In many places the tsunami was higher than the height of the bank, and about 190 km of the embankment collapsed. However, the embankment weakened the strength of the tsunami, which allowed citizens more time to evacuate. Areas that had good early warning and evacuation systems in place did well, while in many others, lives were lost. The incident revealed the problems of overconfidence in structural measures.

- **Water and land use management** is important in order to prepare for uncertainties such as the effects of climate change and consequent unexpected disasters. The first stage of water and land management is to protect important areas and facilities such as residential areas, roads, and power plants by river embankments. The second stage is to prohibit residents from living in vulnerable areas that cannot be protected by embankments. These areas can be used for facilities that can be shut down during a flood without negative consequences, such as sports facilities, parks, and parking lots. At the third stage, evacuation policies and approaches to empower communities for disaster prevention are planned (Ishiwatari 2016). It is important to consider flood risks in urban planning and development through building and zoning codes. Actual methods include urban planning, building codes, promoting awareness of flood risks, promoting relocation by providing risk information, and enhancing flood alert systems. In addition, there are cases where local governments establish land use policies combining road projects with efforts to improve the embankments protecting certain urban areas. Municipalities collaborate to conduct integrated projects for both flood control and land use.[16]
- **Japan's City Planning Act** regulates land use, urban facilities, and urban development projects in Japan. Existing urban areas and areas where urbanization is preferentially and systematically planned within approximately 10 years are set as Urbanization Areas. Areas where urbanization should be restricted are designated as Urbanization Control Areas. According to Article 8.2 (Ministry of Internal Affairs and Communications 2009) of the act, areas at risk of floods, tsunamis, and storm surges must not be included as priority areas for urban development over the 10-year city planning period.
- **Building Standard Law and Urban Planning Law and Ordinance.** According to the Building Standard Law (Ministry of Internal Affairs and Communications 2018), local governments can designate areas as vulnerable to disasters such as floods, tsunamis, and storm surges. The ordinance also allows local governments to prohibit construction of residential buildings in vulnerable areas and to set other development restrictions for disaster prevention. In some cases, this is specifically to reduce stormwater runoff (as shown in cases 1 and 10 of **Knowledge Note 3**). The case of Shiga Prefecture's land use regulation and water-resistant architecture (see section 3.2 of this Knowledge Note) is a representative example. Although these land use and architectural regulations may be difficult to apply in already developed areas, national efforts to do so are underway. For example, the MLIT established the Location Optimization Plan in August 2014 to foster the formation of compact and resilient cities by attracting development to areas with low flood risks through siting public facilities and amenities strategically (MLIT n.d.[c]). The plan excludes high-risk, flood-prone areas from public investments aimed to enhance livability, while focusing the implementation of flood management measures—including river and sewerage management facilities, stormwater detention and infiltration facilities, and public alert evacuation systems—in high-risk zones.
- **Disaster risk reduction and management.** Promotion of residents' awareness of flood risks through strengthening disaster risk reduction and management is also a key nonstructural measure. This is done through the public dissemination of flood risk information to enhance evacuation and early warning, as well as by encouraging residents to adopt voluntary flood prevention methods, such as using water-resistant building methods. Real estate transactions require the disclosure of flood risk information (see section 3.2 for Shiga Prefecture's regulation) and local ordinances require that real estate agents be kept up to date on the latest flood risk information in areas such as Kyoto Prefecture.

As part of the urban flood risk investment planning and prioritization process, many cities in Japan first define the scope and scale of structural flood management investments that cities can implement during the planning period. They then determine the types and levels of nonstructural measures that are necessary to complement the structural investments so as to achieve the city's flood risk management goal, although increasingly, the consideration of structural and nonstructural investments is taking place in parallel. Considering the time required for investment design, consensus building, construction, and financing of structural measures, TMG's Basic Policy for Heavy Rain Management (Update), 2014, illustrates the city's plan to achieve the long-term goal of managing 100 mm/hour

16 City development in Japan is governed under the City Planning Act. Comprehensive strategies for urban development in designated area are planned, implemented and monitored. Zones are classified as either Urbanization Areas (also called Urbanization Promotion Areas) or Urbanization Control Areas. Urbanization Areas are already urbanized or should be systematically urbanized with high priority within the ten years, under associated land use and building code regulations, etc., that promote development. In Urbanization Control Areas, urbanization is controlled and limited in principle, and therefore, very little public infrastructure investments are made in these zones. For more information, see: https://www.mlit.go.jp/common/000997836.pdf and https://jica-net-library.jica.go.jp/library/jn334/UrbanPlanningSystem_all.pdf.

rainfall by a combination of structural and nonstructural measures over a 30-year period (see section 3.1).

In addition, the city's flood risk investment planning and prioritization process are complemented by other, related urban policies and plans. As part of their DRM and climate change adaptation strategies, Japanese cities are increasingly putting strong emphasis on nonstructural measures as the first line of defense to protect lives and livelihoods in the face of unexpected disasters. While they are relatively low cost and adaptable, the challenge of nonstructural measures, however, is the need for long-term and consistent engagement, awareness raising, and training that fits the needs of the specific social and environmental contexts of each community and stakeholder group. Experiences of the 2018 flood events in Japan reaffirmed the importance, as well as the challenges, of nonstructural flood management measures. In Mabi City, Okayama Prefecture, several lives were lost in an area where citizens were informed of the high flood risks. Most casualties were elderly citizens who were unable to evacuate in a timely manner, largely as a result of failure to receive flood warnings, lack of awareness and recognition of the risk levels, as well as limited means to safely move to shelters. This experience demonstrates that in order to save lives under unprecedented flood events, structural measures alone may be insufficient. Furthermore, to enhance nonstructural measure such as effective evacuation, significant efforts are required to not only communicate risk information but also to strengthen the capacity and knowledge of response and evacuation actions. **Knowledge Note 1** provides further information about outreach, communication, and evacuation activities led by Japanese cities.

Step 3: Consensus Building and Responsibility Sharing

How can cities build consensus and share responsibilities with various stakeholders by engaging them in the process of planning and prioritizing flood management investments?

Through the planning and prioritization process, cities actively engage the national government, local community, and private firms in order to not only build consensus on the proposed flood management investments, but also to garner support in sharing responsibilities for the implementation steps to follow, such as design and construction, financing, and O&M. Table 5 illustrates how the roles of various stakeholders are diversifying in planning, prioritizing, and implementing flood management investments in Japan, based on different flood risk types.

Cities in Japan rely on, and coordinate with, the national government to lead large-scale river and coastal structural measures against urban floods. Additionally, cities are supported by the national ministry, the MLIT, which provides guidance related to domestic laws, technical guidelines, expertise, and financial resources required for implementing structural measures for minor rivers, sewers, and drainage, as well as nonstructural measures, such as risk maps and early flood warning and evacuation systems. While being aware of unique regional contexts, the MLIT also plays a crucial role in ensuring the consistency of flood management measures across various local governments as it monitors their effectiveness and promotes an integrated approach. The national government supports local governments, which often have limited capacity and resources to plan, prioritize, and implement flood management investments independently.

Table 5: Major Stakeholders and Role Sharing, by Type of Flood Risk

Type of Flood Risk	Examples of Flood Management Measures	Key Stakeholders Engaged by Local Governments in Investment Planning and Prioritization
River flood	River improvement (levees)	MLIT (financing and standards); Local community (consensus building)
	Reservoirs / parks	Local community (consensus building, design, O&M); Private firms (design, construction, financing, O&M of facilities)
Surface water flood	Sewerage system improvement	MLIT (financing and standards);
	Underground cisterns	MLIT (standards); Public schools (construction of facilities, O&M); Private firms (design, construction, financing, O&M of facilities)
	Rainwater harvesting systems	Private firms (design, construction, financing, O&M of facilities); Community and households (consensus building, design, construction, financing, O&M of facilities)
	Water retention / detention ponds	MLIT (standards); Private firms (design, construction, financing, O&M of facilities)
	Green infrastructure	Local community and households (consensus building, design, construction, financing, O&M of facilities); Private firms (design, construction, financing, O&M of facilities)
Storm surge flood	Sea walls	MLIT (financing and standards); Private firms (implementation of codes, financing, including public-private partnership)
Combined / all flood	Early warning and evacuation	MLIT (standards); Local community (consensus building, awareness, implementation)
	Land use plans, zoning and building codes	MLIT (standards); Local community and households (consensus building and implementation); Private firms (design, construction, financing, O&M of facilities)

Source: Authors' compilation.

Private firms and communities are making greater investments in flood management to meet the increasing and diversifying risks of urban floods. While flood risks in urban areas continue to increase beyond a level that the public sector alone can manage, private firms and residents face significant economic and social costs due to increasing risks of inundation. With increasing costs facing also the private sector, new methods of actively engaging private firms and community are emerging, with new stakeholders playing roles in the design, implementation, financing, and O&M of flood management investments. Individual households and communities also play a significant role in implementing their own flood management measures, such as by installing stormwater storage tanks. Such a bottom-up approach can help build consensus among residents and communities and raise public awareness of flood risk management. Innovative ways of implementing, operating, and maintaining urban flood risk management measures are further detailed in **Knowledge Notes 3** and **4**.

4. Case Studies

This section offers three case studies of how IUFRM planning and prioritization are implemented by local governments in Japan. Key features and lessons learned are outlined below.

The case of TMG involves a highly concentrated population, set of assets, and economic activity. TMG's IUFRM approach shows how ambitious cityside flood risk management goals are set, together with sectoral targets and both structural and nonstructural measures, through a coordinated approach.

Shiga Prefecture is an example of a midsized city with a moderately concentrated population, set of assets, and economic activity. Its IUFRM approach highlights progressive land use planning and building codes.

Setagaya Ward,[17] the largest local government in TMG by population, is a residential and commercial area that has relatively abundant green space but is facing increasing urban flood risks due to development pressures. Setagaya's IUFRM approach is characterized by an active, bottom-up community-led approach, with wide application of green infrastructure solutions promoted not only as flood management measures but also as furthering urban and community development and environmental conservation.

4.1 Case of Tokyo Metropolitan Government

Context

Importance of IUFRM in TMG

While geographical differences exist across its subdivisions, the TMG area overall is highly exposed to many devastating floods from heavy rain. Tokyo can be divided into: (i) the eastern central ward areas, and (ii) the western Tama area. Around 90 percent of the land in the eastern wards has been urbanized, compared with between 30 and 80 percent in Tama, where land is primarily used for agriculture and forestry. Due to rapid urbanization, agricultural and forestry areas are disappearing rapidly throughout the city, especially in the eastern ward areas. As a result, stormwater in the city does not infiltrate into the ground; instead it flows into rivers and sewerage systems, thereby leading to frequent floods from overflow caused by concentrated heavy rains.

Tokyo has been increasingly experiencing heavy rains of over 50 mm/hour, and this recent trend is expected to continue due to climate change and the urban heat island phenomenon. Heavy rains are unevenly concentrated in the western parts of the central ward area and the Tama area. Especially, heavy rains of over 75 mm/hour frequently occur along small- and medium-sized rivers, including the Kanda and Shakujii rivers. Since the mid-1980s, small- and medium-sized rivers and sewerage systems have been improved (often widened) to be able to manage 50 mm/hour of rainfall, resulting in a significant decrease in flood damage. Since these changes, there have been no cases of floods damaging more than 10,000 buildings; however, once every few years, there are still floods that affect over 6,000 buildings and are a serious concern to the residents and businesses of TMG.

In September 2005, the western wards of the city experienced heavy rains of 100 mm/hour. Eight rivers flooded, including the Kanda and Shakujii rivers, and 5,827 buildings were damaged. Other recent incidences of urban flooding in Tokyo include: damage to approximately 300 buildings in Machida City in August 2008; to about 800 buildings in the Itabashi and Kita wards in July 2010; and to about 500 buildings in the Setagaya and Meguro

17 Tokyo is a regional government encompassing 23 special wards, 26 cities, 5 towns, and 8 villages. However, reflecting the dense population, urban contiguity, and other realities of the 23 special ward area, a unique administrative system exists between the metropolitan government and the wards, which differs from the typical relationship between prefectures and municipalities. This system balances the need to maintain unified administration and control across the whole of the ward area and the need to have the local ward governments, which are nearer to the residents, handle everyday affairs. Specifically, in the 23 wards, the metropolitan government takes on some of the administrative responsibilities of a "city," such as water supply and sewerage services, and firefighting, to ensure the provision of uniform, efficient services, while the wards have the autonomy to independently handle affairs close to the lives of the residents such as welfare, education, and housing (TMG n.d.).

wards in July 2013.

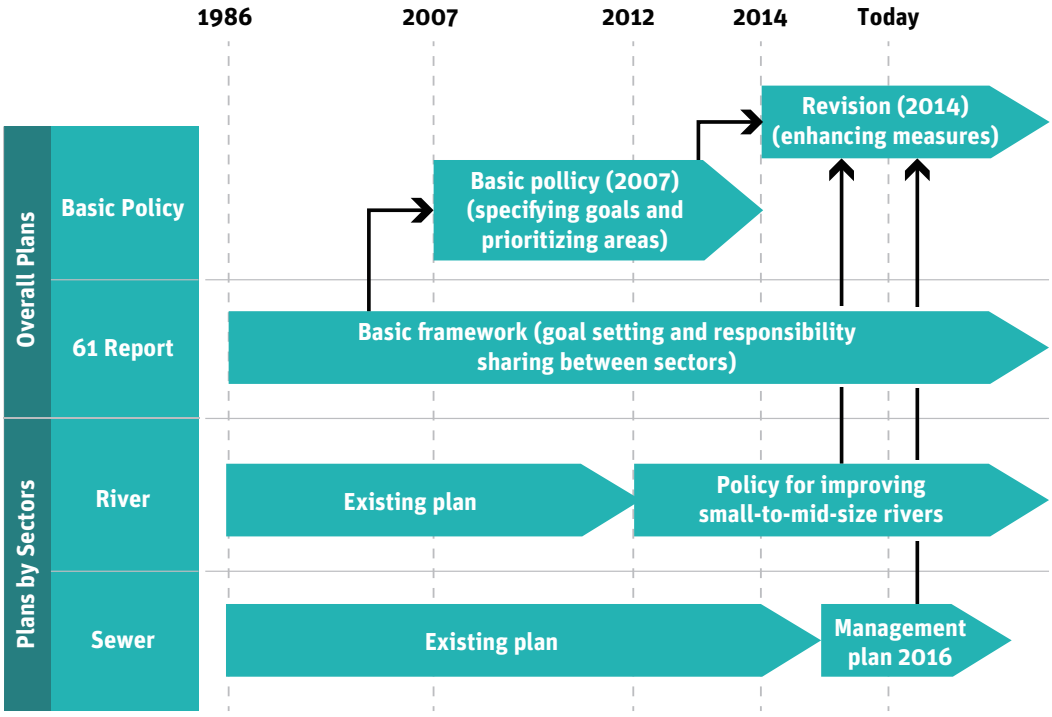
The potential economic and social impacts of inundation from a large-scale flood are immense; such a flood could disrupt key infrastructure and impair economic, social, and political functions at a citywide, national, and potentially global scale (MLIT 2017). For example, large-scale floods in Tokyo could damage or delay transportation infrastructure, leading to difficulties for commuters, as well as disruption to lifeline utilities (such as water, gas, power, and communication infrastructure), which could have a significant knock-on effect on business operations and homes. Recent studies (Japan Society of Civil Engineering 2018a) have estimated that total damages to assets and economic activities from a large-scale flood[18] in Tokyo could add up to an estimated ¥100 trillion (approximately $909 billion[19]), and in Tokyo's Arakawa district alone could be over ¥60 trillion ($545 billion), affecting 1.26 million people (Japan Society of Civil Engineers 2018b). Therefore, there is a strong economic and social case to be made for TMG to advance its capacity to manage floods.

In the light of this, TMG has been pioneering efforts to integrate flood risk management measures into its urban development strategy. These efforts include (i) close coordination and alignment with both national economic development policies and the city's urban development policies; and (ii) engagement of various sectors and stakeholders to facilitate a comprehensive approach to the planning and prioritizing of flood management investments.

Evolution of IUFRM Planning in TMG

TMG initiated its IUFRM efforts in 1986, and these have since evolved in stages, as illustrated in **figure 3** and detailed below.

Figure 3: Timeline of Plans for Managing the Risk of Heavy Rain in Tokyo



Source: Authors' compilation based on interviews with TMG authorities (Furuki 2018).

18 A 1-in-1,000-year river flood.
19 This and the figure that follows are based on an exchange rate of ¥110 = $1 (2018 average).

Visions for Comprehensive Flood Management in TMG (1986)
In the 1980s, TMG was experiencing frequent floods, exacerbated by urbanization. The national government had recently launched a general watershed management policy. TMG started discussions on flood damage mitigation in 1983 and compiled the results in the "Visions for Comprehensive Flood Management in TMG: Report 61 to the Governor of Tokyo," published in July 1986.

This report set TMG's citywide flood management target at 100 mm/hour, among other short-, medium-, and long-term goals; set general sectoral role-sharing targets to achieve this citywide goal between river, sewerage, watershed, and urban planning and development sectors; detailed the watershed management measures that the city would take; and set the general urban flood (or heavy rain) management planning and investment framework for the city. The report also established four stages of the river and sewerage management planning process: (i) reviewing an existing plan, (ii) drafting a tentative plan, (iii) developing a long-term plan, and (iv) establishing a basic timeline/phasing plan.

Policy for Managing Heavy Rains in Tokyo (2007)
In August 2007, TMG redefined heavy rain measures by releasing the Tokyo Basic Policy for Heavy Rain Management. The policy adopted the citywide flood management goals and sectoral role sharing targets of Report 61. Through this process, nonstructural measures were integrated as critical measures for urban flood risk management, as the implementation of the planned structural measures were facing delays due to difficulties in land acquisition and time-consuming coordination. The policy set a phased timeline of 10 years and a long-term outlook of 30 years, specifying priority areas (mainly river watersheds, sewerage watersheds, and underground facilities).

Guidance and Directions for Small and Medium Rivers in Tokyo (2012)
In response to a flood caused by heavy rains in 2008, TMG released the "Guidance and Directions for Small and Medium River Improvements in Tokyo" in November 2012. The report incorporates findings presented by an expert committee concerning "the state of future maintenance in small and medium rivers in Tokyo." The report pointed out the urgent need to consider local rainfall characteristics when enhancing the flood management goals for Tokyo's small- and medium-sized rivers. Based on this guidance, the methodology for flood management in Tokyo was updated, by setting individual targets based on observed historical rainfall.

Tokyo Sewerage Management Plan (2013, 2016)
In 1994, the sewerage system covered 100 percent of the population (9 million in 2013) in the central ward areas of TMG, and 99 percent of the population (4.16 million in 2013) in the Tama area (Bureau of Sewerage, TMG 2014). Tokyo's sewerage system comprised approximately 16,000 km of sewer pipes, 20 wastewater treatment plants, and 86 pumping stations as of 2016, when the Tokyo Sewerage Management Plan was prepared. Despite this extensive investment and coverage, new operation and management methodologies, including asset management, are needed to maintain the rapidly aging sewerage facilities so that they can effectively manage continued urban development and increasing disaster risks due to climate changes. The 2016 management plan is the city's latest five-year basic policy to enhance sewerage system management and address issues such as the renewal of sewerage pipes and facilities and inundation mitigation.

Updated Policy for Heavy Rain Management (June 2014)
In response to the increasing frequency of extreme weather events and concentrated heavy rain, TMG updated the Tokyo Basic Policy for Heavy Rain Management in 2014 to further strengthen the city's urban flood risk management capacity through promoting **role sharing between public and private sectors**.[20] The plan was updated based on consultations and engagement of various stakeholders including citizens, academia, the private sector, and various city departments. The process was coordinated by a special interagency committee on heavy rain led by representatives from TMG's Bureau of Urban Development (urban development and watershed measures), Bureau of Construction (river administration), and Bureau of Sewerage (sewerage administration).

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20 The updated policy encouraged the participation of the private sector and community members to implement flood management investments in urban areas by incentivizing the installation of rainwater harvesting and detention facilities in private commercial and housing development projects as well as enhancing the rainwater infiltration capacities of green spaces. Large-scale underground shopping centers and metro companies, in collaboration with the public sector, were to enhance their flood management and emergency preparedness and response plans.

It further **elaborates long-term (approximately 30-year) targets** by adopting **area-specific targets** based on rainfall probability (once in 20 years). It considers local rainfall characteristics, utilizing microclimate and geographical information, especially in the central ward area and Tama area of TMG. It also designates priority areas and elaborates on the **measures to be implemented in these areas** based on the frequency and severity of historical flood damages—mainly river watersheds, sewerage watersheds, and underground facilities. It enhances flood preparedness in targeted urban centers such as large-scale underground shopping malls. It details short- to medium-term investment priorities, including plans for the 2020 Tokyo Olympics and Paralympic Games as well as until 2024 (the 10-year plan).

Step 1: Goal Setting

TMG's IUFRM goals have evolved over time since their initial establishment in 1984. The goal-setting process is revisited every 10 to 20 years and is expected to continue evolving to adapt to the urban development context as well as to changing climate and disaster risks.

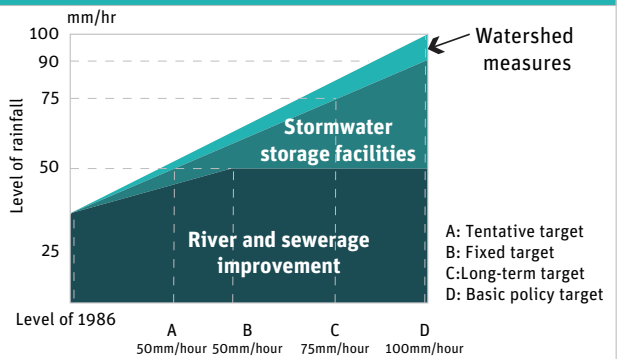
While the citywide flood management goal for TMG remains **100 mm/hour,** in Report 61 this overall goal was revisited and refined through efforts to accelerate and actualize progress toward it by setting short-, medium- (10-year), and long-term (30-year) goals. **Table 6** lists the goals and targets of TMG's three key policy frameworks.

Table 6: Evolution of Tokyo's Flood Management Goals

A Vision for Comprehensive Flood Management in TMG: Report 61 to the Governor of Tokyo (1986)

Flood Management Goals & Targets

- **City-wide flood management target:** set at **100mm/hour**, based on rainfall likely to occur once in a few hundred years
- **Combined flood management target for river and sewerage improvement:** to effectively manage (without overflow / flood) **50mm/hour** rainfall
- **Underground rivers, storage reservoirs, and under ground facilities:** to collectively handle rainfall of **40mm/hour**
- **Watershed measures:** to manage rainfall of **10mm/hour**



Tokyo Basic Policy for Heavy Rain Management (2007)

Flood Management Goals & Targets

10-year target (in priority area):
- **Preventing above-floor inundation** by promoting installation of water reservoirs and sewer and river overflow facilities
- **Saving lives under historical maximum level of rainfall** through enhancing evacuation

Long-term (approximately 30 years) (entire TMG):
- Preventing **any floods** from rainfall up to **60mm/hour**
- Preventing **above-floor inundation** from rainfall up to **75 mm/hour** by promoting installation of water reservoirs and sewer and river overflow facilities and water retention facilities within housing and urban development
- **Saving lives under historical maximum level of rainfall** through enhancing evacuation

Plan : Updated Tokyo Basic Policy for Heavy Rain Management (June 2014)

Flood Management Goals & Targets

Long-term (approximately 30 years) (entire TMG):
- Preventing **above-floor inundation** from rainfall events with up to **1-in-20-year probability (75mm/hour in central ward area and 65 mm/hour in Tama area)**
- Preventing **any inundation** throughout TMG from **60mm/ hour** rainfall
- No casualty at any rainfall level, including those in excess of historical maximum target levels

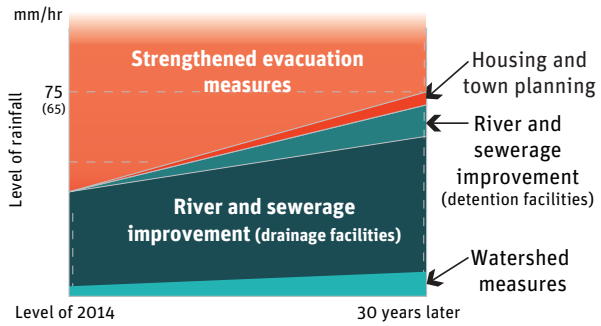
Sources: Authors' compilation based on TMG (1986, 2014).

Step 2: Integrated Planning and Prioritization

Planning

Under the citywide flood management goal, TMG integrates both structural and nonstructural measures for flood risk management to be implemented by various sectoral departments and stakeholders. The sectoral allocation was determined by various factors, including available land, time, technology, and finance through a CBA, which was conducted when determining the sectoral allocation under Report 61. Each sectoral department then reviews and determines various tools and approaches to fulfill its sectoral flood management targets. **Figure 4** describes the sectoral allocation of flood management targets within the Updated Tokyo Basic Policy for Heavy Rain Management (2014).

Figure 4: Heavy Rain Management Goals and Sectoral Allocation in Tokyo

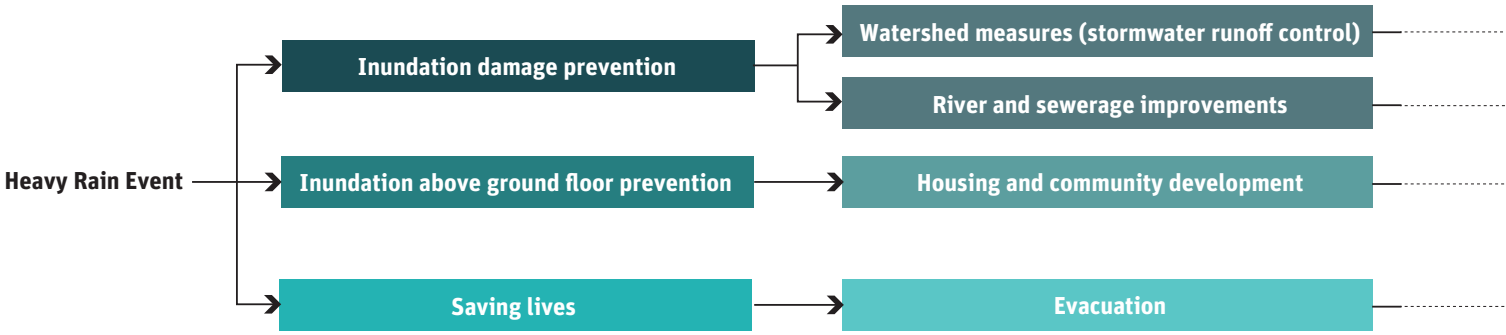


Source: Modified based on the Tokyo Basic Policy for Heavy Rain Management (updated June 2014).

Prioritization

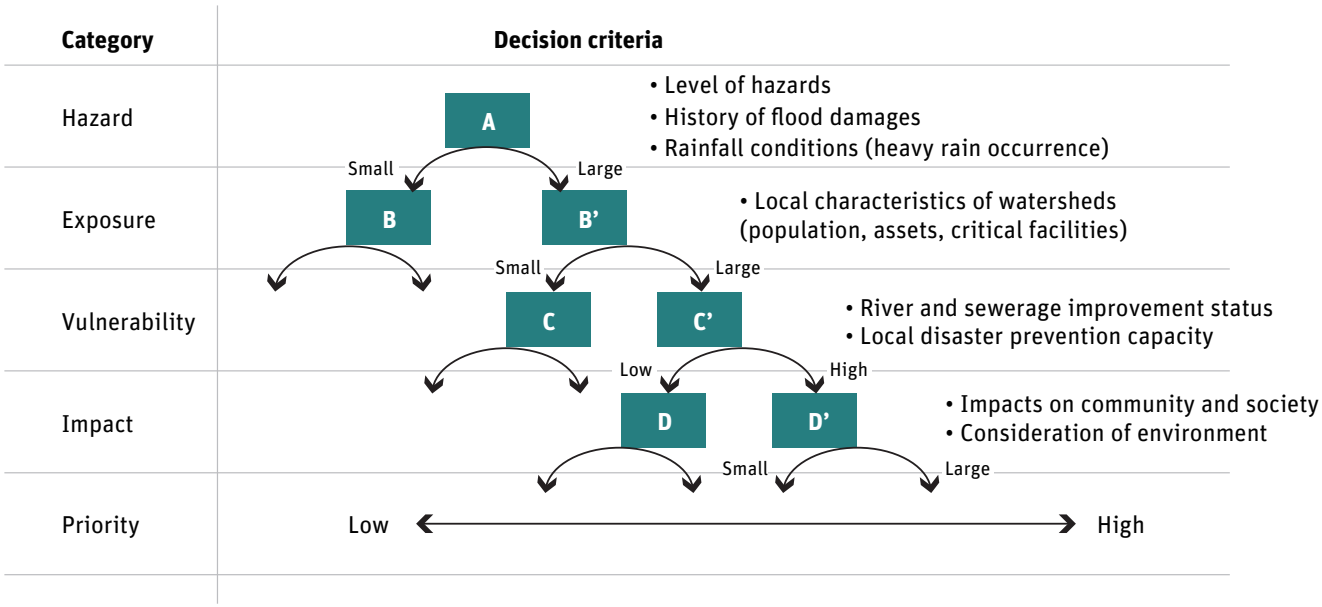
In TMG, prioritization of flood management measures takes place within, and not between, sectors. To meet the shared citywide flood management goals, sectoral targets are determined based on various factors (as described above). Within each sector, various options for flood risk management are reviewed and prioritized. The Updated Tokyo Basic Policy for Heavy Rain Management includes sector-specific structural and nonstructural measures (included in **figure 5**).

Figure 5: Types of Heavy Rain Measures Identified in the Tokyo Basic Policy for Heavy Rain Management (updated 2014)

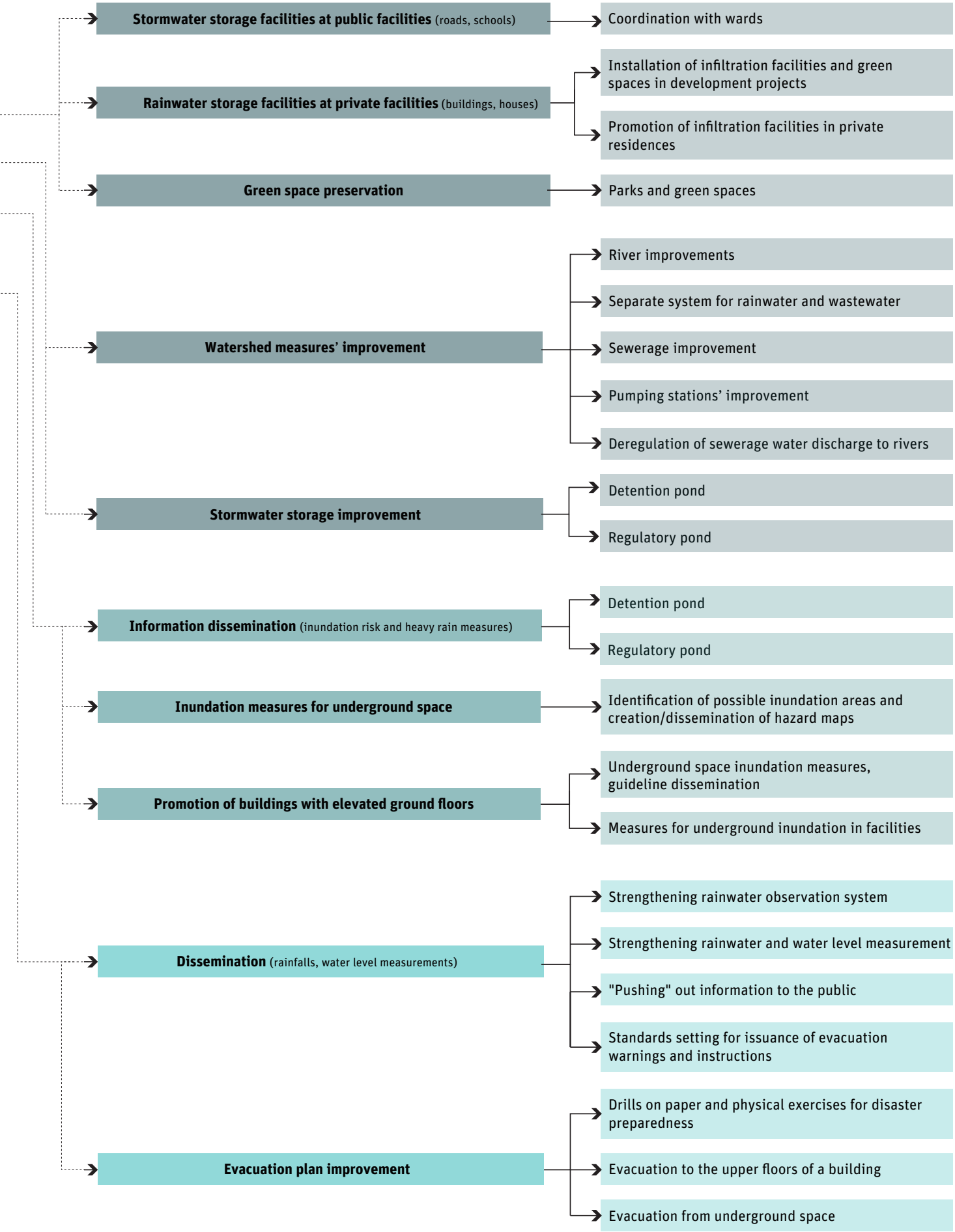


TMG also sets priority intervention areas based on various considerations regarding exposure and vulnerability to flood risks, such as historical data on past flood damage, forecasts of future damage, the population and assets in the watershed, maintenance status of rivers and sewerage systems, impact of flood management measures, and impact of floods on the region (**figure 6**). The identification of these areas also depends on sectoral approaches. In case of the sewerage sector, based on the characteristics of flood damage and rainfall, the areas that suffer from substantial flood damage are designated as "watersheds and districts targeted for intensified measures." **Figure 7** shows the combined prioritized areas for heavy rain measures designated by the river sector and by the sewerage sector. In Tokyo, surface water floods are caused by short-term heavy rain. Generally, the prioritized areas show similar rainfall trends and are concentrated in regions that have frequently experienced rainfall of over 50 mm/hour in the past.

Figure 6: Criteria for Designating Priority Areas for Flood Risk Management in Tokyo

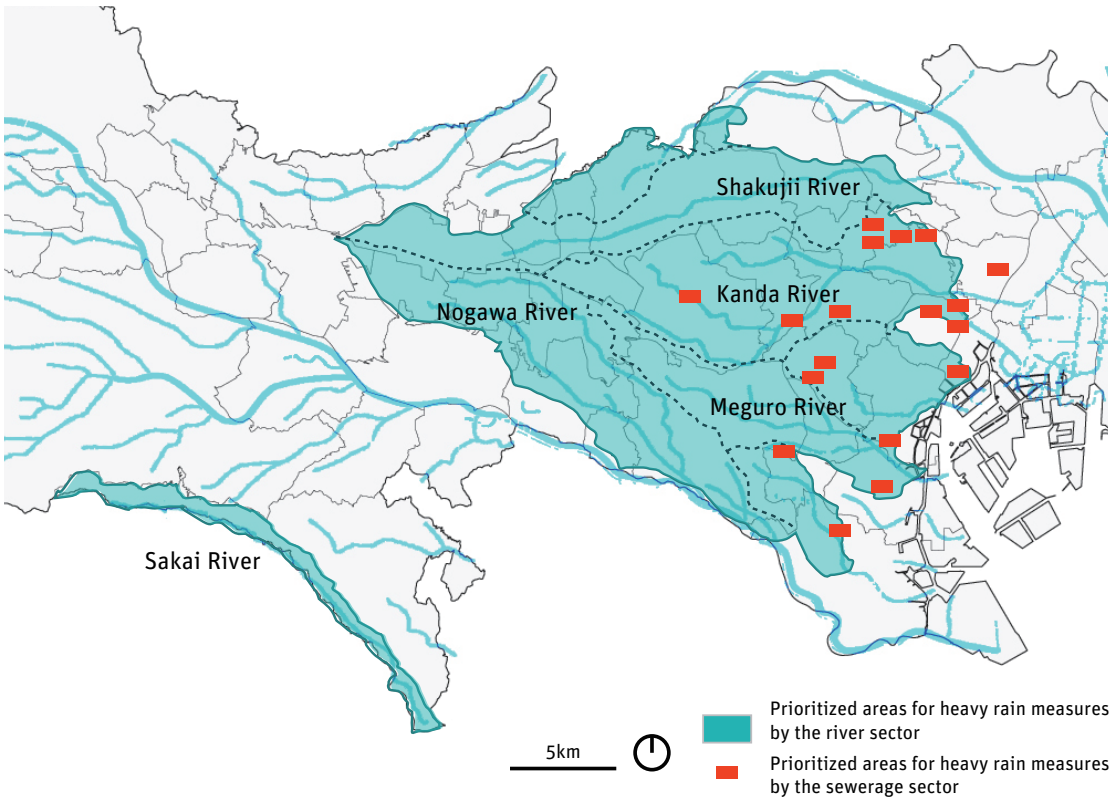


Source: Authors' compilation.



Source: Modified based on information from TMG (2014).

Figure 7: Watersheds and Districts Prioritized for Intensified Heavy Rain Measures in Tokyo, 2014



Source: Modified based on information from TMG (2014).
Note: km = kilometer.

In Tokyo, risk assessments and damage estimations simulate simultaneous river and surface water floods. Priority areas are set based on the outcome of the simulation and a CBA. Efforts in the prioritized watersheds and districts are then managed through a joint river and sewerage committee (Furuki 2018). Although the river and sewerage systems are managed by different public entities in Tokyo, an integrated approach—using a joint simulation and a joint selection of prioritized areas—makes efforts toward achieving the common goal of reducing urban flood risks and damages more efficient and effective.

Step 3: Consensus Building and Responsibility Sharing

As flood management goals have evolved over time to be more specific to local contexts, the process of goal setting in TMG has also progressed to engage various stakeholders. While revising the Basic Policy for Heavy Rain Management in 2014, consultations took place with various departments, wards, academia, river and sewerage facility operators, private sector actors, and citizens. For example, the need to set more ambitious targets based on not only past rainfall patterns but future rainfall projections in the face of climate change was one point of feedback received from the general public. The TMG Heavy Rain Management Committee—comprised of university professors, lawyers, and representatives from TMG's urban planning, construction (in charge of rivers), and sewerage departments—reviewed, responded to, and integrated these feedback points into goal-setting processes wherever possible (TMG 2014).

Along with building consensus to develop a common citywide goal for flood risk management, TMG has also been developing and implementing various programs that designate responsibility for flood management across a range of sectors and stakeholders. These efforts include the development of guidance and policies by river and sewerage

departments that are promoting self-help efforts and mutual assistance among citizens, providing financial incentives and grants, supporting new technology development, and gathering and sharing risk information to promote effective evacuation.

Additionally, TMG has developed and implemented various measures that foster intersectoral consensus building. Cooperation between the river and sewerage departments increased significantly, especially after the 2005 heavy rain of over 100 mm/hour in the Suginami and Nakano wards, which highlighted the need for cooperation to manage extreme heavy rain events. These intersectoral consensus-building mechanisms include: (i) having joint meetings regularly between the river and sewerage sectors to share updates and methodologies for risk assessment and planning; (ii) conducting flood risk modeling and simulations jointly for rivers and sewerage sectors, and integrating risks from both river and surface water floods; and (iii) periodic personnel exchange and secondment arrangements between river and sewerage departments.

Citizens also participate not only in the planning process but also in sharing the responsibility for mitigating urban flood risks. The roles of citizens and communities as a whole are also increasing amid growing awareness about the importance of nonstructural measures for urban flood risk management, such as individual- and household-level preparedness and evacuation. (Various ways in which citizens design, implement, monitor, and maintain various flood management investments are described in **Knowledge Notes 3** and **4**.)

Future Challenges

In light of Tokyo's continued urban development, coupled with increasing and changing flood risks, along with a rapidly aging flood management infrastructure, TMG will need to revisit its flood management plans and priorities approximately every 10–20 years and continue to adapt to the new urban flood risk management challenges the city faces. Current and future challenges that Tokyo faces in planning and prioritization are: (i) further analyzing the risks and setting targets for flood risk management at the watershed level; (ii) enhancing the stakeholder engagement and coordination mechanisms to scale planning and implementation of flood management measures; (iii) communicating and raising awareness regarding flood risks, preparedness, and evacuation with citizens; (iv) monitoring progress against plans and targets on a continuous basis; and (v) utilizing the latest technologies (risk models, etc.) to enhance flood risk planning.

To address these challenges, partnerships and coordination with additional departments and stakeholders will be important. Related efforts might include integrating flood management perspectives within the city's plans, and acting to support environmental sustainability, biodiversity management, parks and recreation, and climate change mitigation and adaptation. Furthermore, scaling and diversifying the methods and areas for engaging new stakeholders—particularly citizens, communities, and the private sector—is critical, as the budget and human resources for implementation and O&M of structural measures for flood management will continue to increase. Therefore, Tokyo, like other local governments in Japan, is exploring new ways to involve not only the public sector but also the private sector and citizens.

4.2 Case of Shiga Prefecture

Context

Importance of IUFRM in Shiga Prefecture

Shiga Prefecture has experienced serious flood damages over the last decade due to its geographical and topographical characteristics and abundant water resources, coupled with climate change and uncontrolled urban development. Shiga is renowned for its rich water resources, including Lake Biwa, the largest freshwater lake in Japan. Nearly 120 rivers (most of them less than 50 km in length) flow into the lake, each of which has tributaries and streams that cover the entire prefecture. Plains stretch out around the lake, and are surrounded by watersheds. The narrow and steep terrain characteristics and the large volume of sediment that flows into the rivers and raises the river beds further increases the risks of floods and droughts.

Despite its vulnerability to water-related disasters, urban planning and development in Shiga Prefecture historically took place without much consideration of flood risks. As a result, forested areas and rice paddies with water retention functions, as well as natural levees and vegetated areas for infiltration, were degraded or lost due to urban development pressures. With climate change, concentrated heavy rain as well as powerful typhoons threaten to increase the risk of floods in Shiga's urban areas.

These combined effects of geography, urban development, and climate change have resulted in significant flood damages over the past decade in Shiga Prefecture. For example, in 2008, Nagahama City was affected by concentrated heavy rain of more than 84 mm/hour, which inundated more than 11 households and commercial buildings above floor level, and 203 buildings below floor level (Shiga Prefecture 2012a). In 2013, Typhoon Man-yi, with a maximum hourly rainfall of 78 mm, caused one death, nine injuries, 49 above-floor and 497 below-floor level inundations, and damage to more than 1,500 hectares of agricultural land from both river and surface water floods (Shiga Prefecture 2014b, 2012a).

In light of this situation, in 2012 Shiga Prefecture developed the Basic Policy for Watershed Flood Management and in 2014 established an Ordinance on Promotion of Watershed Flood Management in Shiga Prefecture (Shiga Prefecture 2015) as an effort to mitigate urban flood risks. These enhanced the understanding and integration of flood risk management in the urban planning and development process.

Step 1: Goal Setting

The policy and ordinance set forth Shiga Prefecture's flood management goals and approaches. These include targets for both structural and nonstructural measures to manage flood risk. Related responsibilities are shared among all stakeholders—including individual households (self-help), communities (mutual assistance), and the government (public assistance). Two key flood management goals are to:[21]

1) **Save lives**—prevent inundation of more than 3 meters above floor level, and damages to houses from a 1-in-200-year rainfall level
2) **Avoid damages that disrupt the quick recovery and continuation of livelihoods**—prevent above-floor-level inundation from a 1-in-10-year rainfall level.

Shiga Prefecture's four key flood management approaches have the following objectives:

1) **Drain**: Use river channel flood control measures and flood control facilities such as dams to safely drain flood water down rivers and sewerage systems.
2) **Store**: Implement watershed storage measures to mitigate stormwater runoff. Relevant watershed resources include retention ponds, ground and soil in forests, paddy fields, and reservoirs.
3) **Contain**: Reduce overflow by containing water inside the watershed. Measures to mitigate damage in floodplains include the use of circle levees, double levees, open levees, forests, land use regulations, and flood-resistant construction.
4) **Prepare**: Enhance disaster preparedness through awareness raising efforts, disaster prevention drills, dissemination of disaster information, early warning systems, and risk assessments; and strengthen disaster responses such as evacuation and flood control activities.

For efforts to **drain** water, numerical targets are set for river and sewerage management interventions at the national minimum level. These consist of:

- River management and improvement interventions that seek to prepare relatively large rivers (with watershed areas larger than 50 km^2) for rainfall equivalent to the largest historical flood since World War II (an approximately **1-in-30-year rainfall level**).
- River management and improvement interventions that seek to prepare relatively small rivers (with watershed areas less than 50 km^2) for a **1-in-10-year rainfall** level (around 50 mm/hour).

21 A once in 10-year rainfall level is equivalent to approximately 50 millimeters [mm]/hour, a 1-in-100-year rainfall is approximately 109 mm/hour, and a 1-in-200-year is approximately 131 mm/hour (Shiga Prefecture 2018a).

- Sewerage management and improvement interventions that seek to prepare urban sewerage systems for a **1-in -5 to 10-year rainfall** level (around 50 mm/hour).

Additionally, through efforts to **store**, **contain**, and **prepare**, Shiga Prefecture aims to achieve the two goals of avoiding loss of lives (top priority) and damages that disrupt quick recovery and continuation of livelihoods in the face of any kind of rainfall (defined as a **1-in-200-year rainfall** level) through watershed-wide interventions.

Step 2: Integrated Planning and Prioritization

Planning

Watershed flood management measures in Shiga Prefecture are comprised of draining, storing, containing, and preparing. In alignment with the two key goals noted earlier, clear roles and responsibilities are specified for each stakeholder to promote flood management measures (**table 7**).

Table 7: Sharing Responsibility for the Installation and Maintenance of Stormwater Storage and Infiltration Facilities

Stakeholder	Role	Responsibilities
Prefectural government	Main body	• Installation and maintenance of stormwater storage facility and underground infiltration facility • Supervision of stormwater drainage in development areas of Class A rivers
City and municipal government	Main body	• Installation and maintenance of stormwater storage facility and underground infiltration facility • Supervision of stormwater drainage in development areas of Class B rivers
	Support	• General support for household-level flood control measures
Residents	Main body	• Installation and maintenance of stormwater storage facilities and underground infiltration facilities in residential houses
Private operators	Main body	• Installation and maintenance of stormwater storage facilities and underground infiltration facilities in commercial buildings

Source: Authors' compilation.

For watershed flood management in Shiga Prefecture, the river, sewerage, and watershed sectors cooperate and share responsibilities related to urban flood management under the common goal of reducing flood risks and damages in cities. Additionally, each stakeholder from the public, private, and industrial sectors cooperates, coordinates, and shares responsibilities to ensure an integrated approach.

Prioritization

Watershed-level measures in Shiga Prefecture are not prioritized across sectors, as are river and sewerage maintenance efforts, but are instead prioritized within each sector. Shiga Prefecture manages 506 rivers, which are ranked from Class A to D based on the level of need for emergency improvement. Among them, 85 rivers are Class A, and 42 rivers are Class B. The factors considered in order to prioritize and determine flood management measures include: the level of risk (degree of damage); characteristics of rivers (watershed size, presence of a raised bed, embankment, or excavation); level of emergency risk (history of flood damage, assessment of flood risks in the area); risk to human life (based on an assessment of the terrain and of the proximity and condition of residences); and impact on assets (based on an assessment of potential damage and reconstruction). The factors considered when deciding the efficiency of measures include their impact on local businesses and on regional development. Last, enabling environments needed for IUFRM investment are also considered; these include local demand for flood management assistance and statements of intent to cooperate in flood risk management investments and activities.

Additionally, Shiga Prefecture prioritizes several nonstructural measures for flood risk management. These include:

(i) Neighborhood safety assessments to inform and encourage citizens' flood preparedness activities
Collaboration between the government and local community is crucial to raise awareness of flood risk management, implement structural and nonstructural measures, and encourage the participation of residents. Shiga Prefecture has investigated the safety of different geographic areas in the local watershed and identified high-risk areas based on citizens' lifestyles. To estimate what is called the "neighborhood safety level," flood risk is assessed not only along rivers but also in waterways and nearby facilities. The maximum flood depth is determined using an inundation simulation at the maximum possible flood scale (1-in-1,000-year flood). Through its website, the prefecture provides flood risk information through neighborhood safety maps for each municipality (see **Knowledge Note 1** for details).

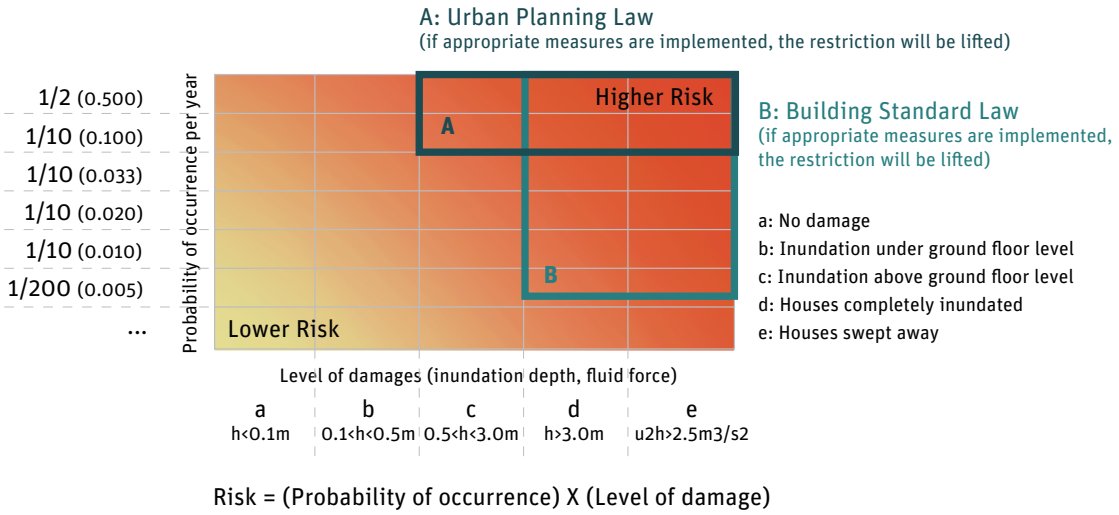
(ii) Land use planning and requirements for flood-resilient construction in high-risk areas
Shiga Prefecture's earlier urban development and land use plans did not take flood risk into consideration since quantitative assessments were not available at the time. Therefore, the prefecture has since revised land use regulations and requirements for construction based on the identification of high-risk areas from risk assessment results. These regulations ensure that higher standards of flood risk management measures are implemented in high-flood-risk areas. Article 39 of the Building Standard Law (Shiga Prefecture 2015; MLIT 2007) requires that:

- Areas where the inundation of houses is expected are regulated as high-flood-risk areas.
- The construction of public facilities such as hospitals, schools, government agencies, residential buildings, and so on, is essentially prohibited within high-flood-risk areas.
- Construction in high-risk areas is allowed only if safety measures for residents are implemented.

Areas within Shiga Prefecture are assigned to two flood risk categories (Shiga Prefecture 2015) (**figure 8**):

- In **Area A**, flooding above the ground-floor level frequently occurs and "urban development is limited to avoid critical damage to assets and increased burden of recovery" (Shiga Prefecture 2015). If there are a number of floods above the ground-floor level, it will lead to critical damage of assets and make reconstruction difficult. In Shiga Prefecture, river and sewerage improvements have successfully coped with floods caused by a 1-in-10-year rainfall (50 mm/hour) or more.
- In **Area B**, construction is restricted to avoid damage and loss of life. The prefecture has prioritized the protection of the lives of its citizens and actively works toward the prevention of all flood damage. Based on the flood strength of a 1-in-200-year probability and the design scale of the Yodo River, the prefecture designates areas with life-threatening risks of inundation and loss of houses as "districts with construction regulations," where the prefectural government sets certain criteria for approval related to construction. Buildings in the regulated areas must have evacuation floors above the possible height of inundation and stronger structures so that the buildings will "not be swept away by strong fluid force" (Taki 2018).

Figure 8: Integrating Flood Risk Assessments into Land Use Plans, Shiga Prefecture



Source: Modified based on information from Shiga Prefecture (2015).

Step 3: Consensus Building and Responsibility Sharing

Shiga Prefecture has played a central role in IUFRM planning, specifically with regards to setting common goals across sectors and establishing the Basic Policy for Watershed Flood Management. Shiga Prefecture has been actively promoting river and sewerage improvement, setting guidance and policies, providing assistance and subsidies, establishing technological standards, and providing appropriate flood risk information.

Its legally binding policy promotes consensus building and the implementation of watershed flood management measures. This policy has two broad purposes: (i) to clarify the responsibilities of local governments, businesses, and residents and establish the legal groundwork for a watershed flood management plan; and (ii), by enforcing these policies, to protect residents' lives, health, and properties from flood damage.

The Shiga Basic Policy for Watershed Flood Management incorporates public opinions through a Watershed Flood Control Committee, known as a "residents' committee." Generally, 10 committee members from a variety of backgrounds such as academia, relevant divisions of public authorities, and residential areas are selected. In addition, the committee invites other experts. The committee studies flood management issues and develops policy recommendations. The committee clarifies residents' roles and responsibilities based on consultation and consensus building with the residents themselves.

In IUFRM planning, businesses form consensus by understanding and cooperating in plans and policies for installing stormwater storage and infiltration facilities in private facilities and large-scale developments. To encourage and enhance these measures, Shiga Prefecture leverages an incentive and assistance system. Residents participate in the policy-making process through the Watershed Flood Management Committee, which serves as a mechanism to promote consensus building.

Furthermore, the government established the Department for Watershed Flood Management Policy. Shiga Prefecture and other regions in Japan clearly define the responsibilities and duties of each participating organization according to the legal system, and the administrator of each sector cannot take measures beyond its authority or jurisdiction. In the past, Japan had not established a separate watershed authority despite the existence of river and sewerage administrators. The new department collaborates with a range of stakeholders and aims to promote comprehensive watershed flood management across the region.

Future Challenges

Shiga Prefecture sets neighborhood safety levels in innovative ways. Land use regulations and requirements for flood-resilient construction in high-risk areas, which are a major focus of the basic policy, have established a new precedent. In the rest of Japan, high-flood-risk areas are identified based on historic flood damages. However, Shiga Prefecture's designation is based on estimated future flood risks, the first such example in Japan's history.

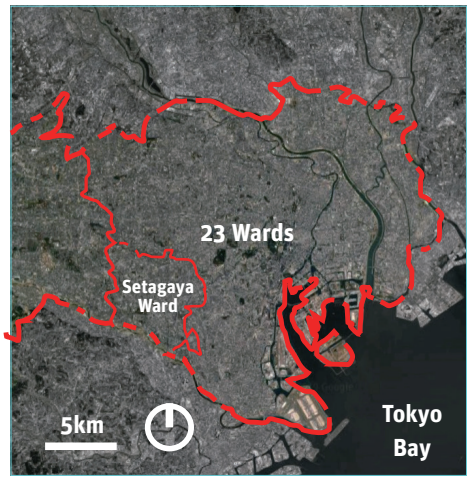
The redevelopment of existing houses is required under the regulations for flood-resilient construction in high-flood-risk areas. This raises the importance of consensus building among residents in targeted areas. Currently, in Shiga Prefecture, 50 areas that have residential buildings or are expected to plan developments are eligible for Area A classification. However, out of these cases, only two (Shiga Prefecture 2018b) have been designated as Area A.

In an effort to address the risks posed by the area's many rivers with raised beds, the Shiga Basic Policy for Watershed Flood Management estimates where houses could be inundated or swept away. Such areas might expect a certain level of fluid force, which led the prefectural government to consider restricting the construction of buildings. However, there is currently no sufficient scientific evidence of the impact of fluid force to buildings. Therefore, the "map of fluid force" is used merely as a reference, along with other maps indicating flood risk and safety, not as a criterion for high-flood-risk areas. Shiga Prefecture plans to make fluid force a criterion for high-flood-risk areas when sufficient scientific evidence is gained (Shiga Prefecture 2014a). However, gathering such evidence remains a challenge.

4.3 Case of Setagaya Ward

Context

Importance of IUFRM in Setagaya Ward



Source: Google Earth.
Note: km = kilometer.

Setagaya Ward is the most populated special ward[22] in Tokyo and is located at the southwestern corner of the TMG. Though higher in elevation and with more agricultural land and green spaces compared with eastern Tokyo, due to rapid housing development, Setagaya's dense urban fabric has significantly reduced its capacities to infiltrate, absorb, and store rainwater over the years.

With the intensity and uncertainty of rainfall increasing due to climate change, Setagaya has experienced various urban floods in recent years. In September 2005, torrential rain affected Tokyo and brought over 100 mm/hour of rainfall to the area. The stormwater runoff from rivers and sewerage systems inundated 221 houses above floor level, and 245 houses experienced basement flooding. Similarly, in 2013, multiple rainfall events exceeded 60 mm/hour, with many households affected by above-floor-level and basement flooding.

In light of this context, in 2009, the ward developed the Setagaya Ward Basic Policy for Heavy Rain (updated in 2016) and the Setagaya Ward Heavy Rain Measures Action Plan (updated in 2018) to strengthen flood prevention and protection measures. They share the overall goal of the TMG Basic Policy for Heavy Rain Management, while complementing it with specific targets and measures to be implemented at the ward level for IUFRM. They elaborate on how the ward and TMG coordinate and share responsibilities to protect the lives and assets of Setagaya's residents during floods.

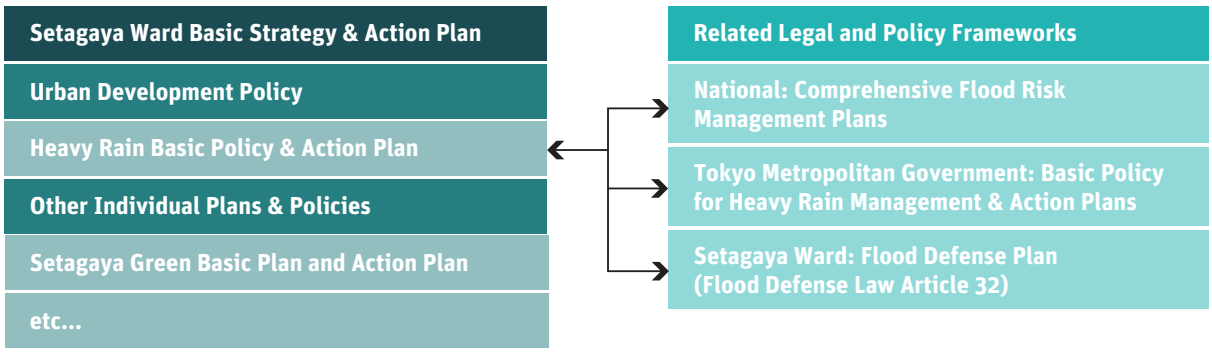
22 Setagaya Ward was home to approximately 909,000 people as of March 2019 (http://www.city.setagaya.lg.jp/kurashi/107/157/692/694/1888/d00121945.html).

Setagaya's policy and action plan for heavy rain were developed through a multistakeholder and citizen-led process, which took a unique approach to integrating various nature-based solutions for rainwater harvesting and management, as well as community-based solutions for increased flood risk awareness and preparedness. These complement infrastructural measures to improve river embankments and drainage.

Step 1: Goal Setting

The Setagaya Ward Basic Policy for Heavy Rain and Setagaya Ward Heavy Rain Measures Action Plan adopts the TMG's overall flood management goal, and clearly define how the ward's overall visions, plans, and legal frameworks link to other relevant policy frameworks (see figure 9). The Setagaya Ward Basic Policy for Heavy Rain was established as a sectoral policy under the Setagaya Ward Urban Development Policy, which is a key policy under the Setagaya Ward Basic Strategy and Action Plan. In close coordination with the national-, TMG-, and ward-level legal and policy frameworks, the Setagaya Ward Heavy Rain Measures Action Plan outlines the ward's specific measures to deliver goals with multiple priorities at various levels.

Figure 9: How Setagaya Ward's Heavy Rain Basic Policy and Action Plan Connects with Other Legal and Policy Frameworks



Source: Authors' compilation.

As part of TMG's Basic Policy for Heavy Rain Management and Action Plan, Setagaya Ward is a priority area for flood risk management given its geographic location within high-risk watersheds. Therefore, Setagaya Ward's goals are fully in line with TMG's targets for high-priority watersheds:

- **10-year goal:** to prevent flood damage during heavy rain of 55 mm/hour as much as possible. If a historic maximum rainfall were to occur, the ward aims to focus on protecting the lives of its residents.
- **30-year goal:** to prevent any flood damage from heavy rain of 60 mm/hour; and, second, to prevent inundation above floor level by rainfall of approximately 75 mm/hour in the ward area and 65 mm/hour in the Tama area. For rainfall that exceeds these levels, the policy seeks to focus on preventing casualties.

Additionally, the ward sets out three key principles:

1) **Living with rain.** This centers on an awareness of the importance of understanding and communicating the risks of heavy rain, river levels, and potential floods to inform and encourage citizens' own disaster mitigation, preparedness, and evacuation actions at the household and neighborhood levels.
2) **Storing rain.** This focuses on the importance of public and private investments in the installation of water storage facilities to retain or delay the flow of rainwater into urban drainage systems and thus avoid overflow.
3) **Utilizing rain.** This centers on the importance of restoring collected rainwater back into the ground, as well as recycling water for toilets, for the watering of plants, and as backup storage in case of an emergency.

Step 2: Integrated Planning and Prioritization

Planning

In full alignment with TMG's policies and action plans for flood risk management, the shared but differentiated roles and targets of the various sectors have been defined within Setagaya Ward's heavy rain policy and action plan. The four key sectoral approaches are:

1) Improving river and sewerage systems
2) Promoting infiltration, retention, storage, and utilization of stormwater as watershed-based flood management measures
3) Developing housing and neighborhoods so as to reduce inundation from floods
4) Saving lives through enhancing evacuation measures

Overall, river and sewerage management are led by TMG, in close coordination with the ward's responsible departments. On the other hand, "green" (nature-based) and nonstructural measures and targets for watershed management, saving lives, and evacuation are led mainly by Setagaya Ward and its various stakeholders. Setagaya's sector-based flood management targets are illustrated below.

River and Sewerage System Improvement

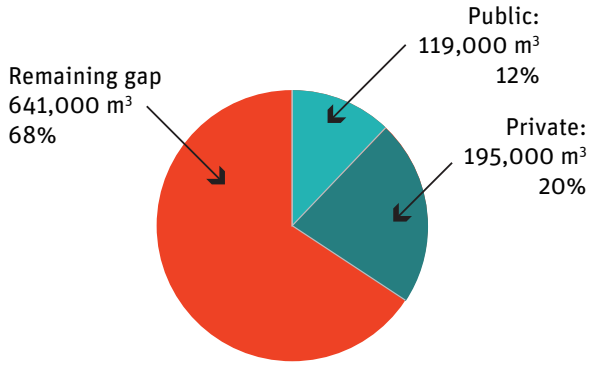
- **River.** Collaborating closely with TMG, Setagaya Ward aims to manage rainfall by river improvement measures, such as river drainage interventions (widening of channels, and so on) and retention ponds along the watersheds, to prevent above-floor inundation from rainfall of **75 mm/hour in the ward area** and **65 mm/hour in the Tama area**. In particular, Setagaya Ward, in close partnership with TMG, is prioritizing interventions along rivers without capacity for 50 mm/hour rainfall management.
- **Sewerage.** Collaborating with TMG, Setagaya Ward aims to manage rainfall of **50 mm/hour** by using sewer pipes and stormwater storage facilities, as well as avoid casualties caused by inundation in watershed areas by rainfall of 60 mm/hour.

Watershed-Based Flood Management Measures

- **10-year goal** (by 2021): to improve capacity to tackle a total of **480,000 m^3** of rainfall, the equivalent of **5 mm/hour** by promoting efficient infiltration, retention, storage, and utilization of stormwater.
- **30-year goal** (long-term goal): to manage approximately **960,000 m^3**, or the equivalent of **10 mm/hour** of rainfall, by promoting efficient infiltration, retention, storage, and utilization of rainwater/stormwater.

Since 1975, Setagaya Ward has been working with its residents and businesses to install rainwater harvesting, storage, and stormwater infiltration facilities throughout the city. As a result, as of March 2015, the ward-wide rain and stormwater management capacity achieved through these investments was reported as approximately **310,000 m^3**. New 10- and 30-year targets were also set, in line with TMG's target of achieving **600 m^3/ha** of rain and stormwater management. Setagaya Ward's achievements against proposed targets are illustrated in **figure 10**. A community-based rainwater harvesting campaign promotes household and community participation, which is described in **box 4**.

Figure 10: Setagaya Ward's Progress toward Watershed-based Flood Management Targets



Source: Authors' compilation based on Setagaya Ward (2016).

Box 4: Community Based Rainwater Harvesting Campaign in Setagaya

In response to increasing torrential rain and inundation damage, Setagaya Ward leaders and residents gathered to launch a campaign called **"Let's build a Setagaya dam together."** It is estimated that if each household in Setagaya installs a 300-liter stormwater retention tank, the collective retention volume of stormwater would be approximately 140,000 tons (or m^3), the equivalent of a small-scale dam in Japan.

The ward established a subsidy program in 2007, providing financial support up to 50 percent of the cost of both tank and construction fees, up to a maximum of ¥35,000 (approximately $318), to encourage the installation of small tanks by households. As of 2013, 384 cases were funded and 65,974 liters of rainwater harvesting tanks were installed for residents' nonpotable water usage, such as for irrigating garden plants and washing cars. Local residents and communities lead the O&M of the rainwater harvesting and storage systems installed in their businesses and in households.
Source: Authors' compilation based on information from Setagaya Ward (2015a).

Figure B4.1: Rainwater harvesting tanks installed in Setagaya Ward

Source: Setagaya Ward 2018b.

In order to fill the remaining gap, Setagaya Ward actively promotes "green" infrastructure as a major approach toward strengthening watershed management, focusing on measures that store, filter, and minimize runoff of stormwater. Setagaya Ward defines green infrastructure as "infrastructure and a way of thinking that promote stormwater storage and infiltration, flood prevention, water purification and use of underground water by effectively using functions possessed by nature such as green land and water" (Setagaya Ward 2018a). Through advancing green infrastructure, Setagaya Ward also aims to create an attractive living environment. Therefore, the promotion of green infrastructure in Setagaya furthers the goals of both flood and watershed management and urban design and development. Additionally, green infrastructure measures are also promoted through Setagaya's environmental plan, the Setagaya Green Basic Plan and Action Plan (Setagaya Ward 2015b). This plan highlights the value and importance of urban green spaces involving temples, houses, forests, watersheds, and agricultural land, and promotes the preservation of green spaces for water circulation, as well as to store and infiltrate stormwater.

To promote green infrastructure, Setagaya Ward is undertaking several awareness raising, capacity building, and cross-sectoral partnership efforts. Specific green infrastructure actions promoted through the basic policy are as follows.

Introducing the concept of green infrastructure through promoting:
- Residents' awareness of the importance of green infrastructure in watershed measures through pamphlets and other media
- The creation of "rain gardens" for storage and infiltration of stormwater from drainpipes at small-scale private facilities and existing houses

Advancing green infrastructure through public sector initiatives such as:
- Preservation and installation of green spaces or parks, or renovation of existing parks as well as development of new facilities and renovation of existing facilities managed by Setagaya Ward, Tokyo, and the national government
- Installation of green streets (streets that allow stormwater drainage from the sides of the roads and infiltration through planted zones) following the construction of new roads and renovation and maintenance of existing roads

Promoting engagement and implementation of green infrastructure by the private sector and households through:
- Installing "rain gardens" and "rainwater planters"[23] at public and private facilities for stormwater infiltration
- Requesting local landowners and managers to install stormwater storage and infiltration facilities

Monitoring, reporting, and assessing the performance of green infrastructure through:
- Quantifying the capacity of stormwater storage and infiltration systems such as green spaces

Implementing adequate maintenance and operations through:
- Inspection and cleaning of installed green infrastructure
- Cooperating with the related departments of the ward government to promote the preservation and installation of green space

Prioritization

Furthermore, Setagaya Ward's heavy rain basic policy and action plan prioritize the promotion of flood risk management, especially through green and nonstructural measures in vulnerable locations, public spaces, and buildings and private homes. These measures are a priority for Setagaya Ward as approximately 57 percent of its land area is publicly owned (excluding roads) and 49 percent is for residential use (Setagaya Ward 2016). The priority areas include those:
- That have experienced frequent flood damage in recent years (for more information, see **appendix, case 6**)
- Where public facilities are concentrated
- Where the installation of stormwater storage and infiltration facilities will be effective and is one of the goals of the community development plans
- Where installation of these facilities and promotion of watershed management is being considered

23 Rainwater planters are planter boxes normally located in households, as street furniture, or as landscaping features within commercial development, with a capacity to retain rainwater by storing it within its soil, gravel, and plant roots. It can be made from new or recycled materials, and excess stormwater is normally designed to overflow through pipes at the bottom of the planter, which drains back into the system.

Step 3: Consensus Building and Responsibility Sharing

The Setagaya Ward Basic Policy for Heavy Rain sets out IUFRM roles and responsibilities for the ward and city government, and also encourages self-help and mutual help among residents, communities, the private sector, and civil society organizations. Therefore, engagement and consensus building with various stakeholders in the planning, implementation, and sustainability of these flood risk management measures are critical. Setagaya Ward works closely with existing community self-governance committees and business associations to conduct consultations, training sessions, requests for support, information sharing, and awareness raising throughout the flood risk management efforts. These efforts are implemented together and in line with Setagaya's community and citizens' engagement process for urban development, civil works, and DRM initiatives. (An example of a collaborative green infrastructure project, the Tamagawa Rise project, and the role and responsibility sharing between the public sector, private sector, and community is included in **Knowledge Note 3**.)

Consensus building and responsibility sharing with TMG and the national authority is very important for advancing Setagaya Ward's flood risk management efforts. This is done through clearly defining the relationship and roles of the ward, TMG, and the national government in the heavy rain policy and action plan. **Figure 11** illustrates how within the basic policy, stakeholders are responsible for specific flood management measures. This has led to close coordination during the development, operation, and maintenance of flood management measures implemented within the same location and/or watershed, such as coordinating the location of water storage or detention facilities (led by the ward) near the construction of new roads and underground discharge channels (led by the national government and/or TMG), and so on.

Figure 11: Setagaya Ward's Heavy Rain Measures and Responsible Stakeholders

Topic of Policy Measure	Focus	Tasks	Implementation Body					
			Nation-wide	Tokyo	Wards	Public Institution	Citizens	Business Operators
Promotion of rivers and sewerage improvements	River improvements	River improvement in the watersheds of Nogawa/Yazawa rivers		○	△			
	Sewerage improvements	Sewer improvement using a combined system		○	△			
		Sewer improvement using a separate system (stormwater)		○	△			
Enhancement of watershed management	Facilities managed by wards	Enhancement of watershed management in elementary and middle schools			○			
		Enhancement of watershed management in parks and open plazas			○			
		Enhancement of watershed management in offices and houses			○			
		Enhancement of watershed management in roads			○			
	Facilities managed by the national government and TMG	Enhancement of watershed management in roads and facilities managed by the national government and TMG	○	○	△			
		Enhancement of watershed management in facilities managed by public institutions			△	○		
	Private facilities	Enhancement of watershed management in large-scale private facilities			△		○	○
		Enhancement of watershed management in small-scale private facilities			△		○	○
		Enhancement of watershed management in private roads			△		○	○
		Enhancement of watershed management in existing houses			△		○	
	Promotion of rainwater use	Promotion of rainwater utilization facilities	△	△	△	△	○	○
		Promotion of rainwater tanks	△	△	△	△	○	○
	Promotion of green infrastructure		○	○	○	○	○	○
Promotion of measures for housing and urban development	Promotion of advance notice on flooding		△	△	○			
	Promotion of flood-resilient housing development				△		○	○
	Promotion of mechanisms for community and town development				△		○	○
Enhancement of evacuation measures	Promotion of advance notice on flooding				○			
	Promotion of flood-resilient housing development				○		○	○

○ Main body
△ Cooperation

Source: Authors' compilation based on information from Setagaya Ward (2018a).

Future Challenges and Next Steps

Monitoring and sharing the progress of implementation are critical actions. In order to continue and scale Setagaya's integrated approach to flood risk management, there is a need to continue to monitor the implementation of heavy rain measures to ensure close coordination and collaboration between various sectors and stakeholders. Key stakeholders are Setagaya Ward, local residents, businesses, the national government, and TMG. Furthermore, various sectoral departments—including sewerage, rivers, roads, urban development, environment, and DRM—all share roles and responsibilities in promoting heavy rain measures in Setagaya. To facilitate continued coordination and collaboration between these various groups, monitoring and sharing progress is key. Based on periodic progress reports, adjustments will need to be made to ensure effectiveness. Setagaya Ward has been using the "Plan, Do, See, and Action" cycle to monitor progress, and has been convening periodic committee meetings to review the progress of heavy rain measures, especially in high-priority areas.

Monitoring and evaluating performance are also important. In order to measure progress against targets, effective operation and maintenance of installed facilities, as well as the monitoring of their performance, are extremely important. Given that many green infrastructure investments are promoted in public facilities, Setagaya Ward aims to continue to closely monitor the performance of installed green infrastructure, such as rainwater infiltration and storage tanks, as well as ensure that effective monitoring takes place. Remaining challenges exist in the monitoring and maintenance of residential and private sector facilities. Some innovative initiatives for promoting the O&M and performance evaluation of green infrastructure are included in **Knowledge Note 4.**

Scaling flood management measures within the private sector and residential homes is essential to meet ambitious targets. Under the Setagaya Ward Heavy Rain Measures Action Plan, businesses and residents, especially new developments, are highly encouraged to manage stormwater through the installation of rainwater infiltration and storage measures. New developments having an area greater than 150 m^2 are required to submit a rain/stormwater management plan, but there is very little enforcement by the ward government. While most development in Setagaya and Tokyo so far complies with policy mechanisms to incentivize further uptake of stormwater management, raising awareness of the potential benefits of green infrastructure would help expand efforts to create it beyond the public sector. To this end, monitoring, evaluating, and quantifying the socioeconomic and environmental benefits of related investments (beyond flood risk management) are key.

5. Lessons Learned and Key Takeaways

This Knowledge Note explored Japan's process in planning and prioritizing related investments as part of an integrated approach to urban flood risk management. This included a description of the evolution of management of urban floods in Japan, in terms of policies and approaches, as well as a summary of the institutional arrangements and key roles and responsibilities of various stakeholders.

Related to the evolution of IUFRM in Japan, innovative efforts in the Tsurumi River Watershed in 1981 were instrumental in advancing the watershed-wide approach to flood risk management in Japan. The concept of an integrated approach to flood management was further advanced through the introduction of the SUFDML enacted in 2003 for eight designated rivers. In 2013, a 100 mm/hour Safety Plan was initiated by the MLIT to tackle the increasing impacts of concentrated heavy rain in urban areas. Responsibility for the safety plan is held by the local government and the public authorities for river and sewerage management. In addition, cities, in collaboration with the national government and research institutes, are increasingly exploring various ways to understand and integrate climate change risks within their flood management plans.

In terms of stakeholders, national and local governments, the private sector, citizens, and academia work together to set and achieve shared goals for mitigating the risks and damages of urban floods. Within the government, the departments managing rivers, drainage and sewerage, watersheds, urban planning and development, the environment, and DRM[24] collaborate to determine and share responsibility for actions to address identified flood risks.

The review of the planning and prioritization process focused on the role of local governments. In Japan, urban flood risk management plans and objectives are developed in line with the national Disaster Countermeasures Basic Law (DCBL). Based on this high-level goal, specific long- and short-term targets are developed to address the unique flood risks and geographic contexts of each city. Cities also prioritize certain regions or measures based on different regional flood risk contexts. During the process, cities use risk assessments (discussed in **Knowledge Note 1**), cost-benefit analyses, and engagement and consensus building with communities and stakeholders.

Cities are increasingly aware that flood risks cannot be managed effectively without considering structural and nonstructural measures. Key nonstructural flood risk management tools and approaches considered by cities in Japan include water, land use, and disaster risk management through urban planning, building codes, promoting awareness of flood risks, promoting relocation by providing risk information, and enhancing flood alert systems. Key urban development laws include Japan's City Planning Act, which regulates land use, urban facilities, and urban development projects in Japan, and the Building Standard Law and Urban Planning Law and Ordinance, according to which local governments can designate areas as vulnerable to disasters such as floods, tsunamis, and storm surges, and even prohibit construction of residential buildings in vulnerable areas and to set other development restrictions for disaster prevention. Throughout the process, cities actively engage the national government, local community, and private firms in order to not only build consensus on the proposed flood management investments, but also garner support in sharing responsibilities for the implementation of critical steps, such as design and construction, financing, and O&M. Private firms and communities are making greater investments in flood management to meet the increasing and diversifying risks of urban floods.

Based on the case reviews, this Knowledge Note identified a three-step process including goal setting, planning and prioritization, and consensus building. The lessons learned, outlined below, highlight aspects for other countries to consider. The **TMG**'s IUFRM approach shows how ambitious cityside flood risk management goals are set, together with sectoral targets and both structural and nonstructural measures, through a coordinated approach. **Shiga Prefecture** highlights progressive land use planning and building codes. **Setagaya Ward** demonstrates an active, bottom-up, community-led approach, with wide application of green infrastructure solutions providing multiple benefits simultaneously.

Finally, this Knowledge Note builds on the information about flood risk assessment and communication efforts presented in **Knowledge Note 1**; and prepares ground for information presented in **Knowledge Note 3**, which focuses on the design and implementation of specific solutions, as well as the operations and maintenance practices presented in **Knowledge Note 4**.

Step 1: Goal Setting

- **Regularly update goals based on evidence.** Goal setting is based on risk assessment simulations that take into account scientific evidence, including external forces such as historical rainfall in the targeted areas (see **Knowledge Note 1**) and known damages. Moreover, a city's integrated policy and improvement goals should be set based on comprehensive evaluations of their feasibility, efficiency, impact, and economy. Committees consisting of academic experts and local stakeholders are important in the course of decision making.
- **Align local and national goals.** Whenever available, the laws, guidelines, standards, and goals of the national government should be referenced to ensure alignment and consistency. At the same time, cities may foresee a need to develop their own city-level goals and plans for IUFRM, especially as flood risk management becomes more complex amid growing climate change risks. Cities in Japan have developed and utilized city-specific flood management plans, such as measures against heavy rains and watershed management, in order to understand the remaining risks and gaps that cannot be managed by large-scale structural measures led by the national government. They have sought to identify opportunities to develop flood management measures through engagement of various stakeholders (public, private, academia, and community), sectors (river, sewerage, watershed, urban planning and development, environment, and DRM), and approaches (structural, nonstructural, and green). In this way, cities in Japan are putting forth a framework for how to save the lives of people in the face of any type of expected or unprecedented flood event, and reducing damages to assets and economic losses.
- **Pair long-term goals with realistic milestones.** Citywide flood management goals, linked with cities' overall urban development priorities, are set based on the results of flood risk assessments, and consider the following factors: (i) characteristics of areas and floods; (ii) the efficiency of past flood management efforts; (iii) capacity and impact of each sector, including rivers, sewerage systems, and watersheds; (iv) clarification and segmentation of goals and indicators; (v) phased IUFRM development planning; (vi) consistency with the relevant river basin plan; and (vii) impact on society and the economy. The experience of Tokyo and many other cities in Japan demonstrates the importance of ensuring that overall long-term flood risk management goals be kept ambitious, in order to effectively plan for expected risks as well as worst-case scenarios (i.e., probable maximum precipitation, etc.). At the same time, realistic milestones set for a specific time frame (for the medium to short term) and sector can be helpful to monitor progress and evaluate the effectiveness of the plan.
- **Consider the effects of climate change.** Considering the uncertainty of climate change and unknown risks, stakeholders must recognize and prepare for external forces that exceed the capacity of planned measures, especially of structural measures. Additionally, it is important to simulate incidents in which facilities cannot prevent inundation, and share disaster risk information with all stakeholders to cope with increasingly intense floods. These simulations should consider a range of external forces based on flood design scales. The information gathered from risk assessments should be leveraged by all stakeholders in implementing all possible measures for flood risk reduction. Therefore, Japan has been communicating the risk of unprecedented events to citizens. Based on this understanding, communities should prepare for floods and publicize possible inundation areas according to the highest design scale. This management method is based on the Flood Prevention Act, which was partly revised in 2015.

Step 2: Integrated Planning and Prioritization

- **Share responsibilities to advance common goals.** Once a citywide flood risk management goal is set, sectoral targets are determined based on various factors including: (i) the city's strategy and vision; (ii) the nature of mandates and role sharing between each sector (river or sewerage bureau) for current flood risks; (iii) assignment, budget allocation, and inputs such as technical and social feasibility analysis of management goals; (iv) advice from academic experts sitting on committees; (v) assignment of planning and management goals; and (vi) prioritization of implementation steps. While sectoral departments commit to separate flood management targets, close coordination and collaboration enable the effective implementation of IUFRM. For example, given the close relationship between sewerage management and river improvement projects (as rainfall will drain into either river or sewerage systems), if the progress of a river improvement project is slow, then it impacts the stormwater management capacity of the adjacent sewerage systems. Therefore, the timing of construction should be closely coordinated.
- **Integrate structural and nonstructural measures.** Understanding the strengths and weaknesses of different IUFRM measures is important. Structural measures significantly reduce flood risk but require large budgets and ongoing maintenance. On the other hand, nonstructural interventions, such as the creation of hazard

maps and evacuation training, are comparatively low cost and can be started immediately. Thus, nonstructural measures complement structural measures, and are important in reducing flood risks and damages until appropriate structural measures are in place. Also, nonstructural measures such as land use planning, zoning, and DRM can help mitigate damages caused by floods that exceed design levels. Green or nature-based structural measures are normally multipurpose and can result in diverse benefits besides flood risk management, such as urban and community revitalization, environmental sustainability, and livability enhancement. The process of the site-specific selection and design of flood management measures will be further discussed in **Knowledge Note 3.**

- **Prioritize measures based on local contexts.** Prioritization of IUFRM within the sector and at the project level should be based on weighing the pros and cons as well as costs and benefits of various measures vis-à-vis local hazards and socioeconomic and cultural factors. Cities set different targets for flood risk management within their municipal boundaries based on different geographic and hazard risk characteristics, as seen in the case of TMG and Shiga Prefecture. Additionally, critical infrastructure, such as schools, hospitals, and transportation networks (e.g., the underground metro) may also require different approaches to prioritizing progressive and function-specific IUFRM measures and approaches. CBAs are often undertaken at the project level to compare various IUFRM approaches and tools appropriate for the site. As IUFRM approaches expand and diversify, there is a need to further develop CBA methods to effectively integrate the various nonquantifiable benefits that may go beyond flood risk management, particularly for nonstructural and green (nature-based) solutions.

Step 3: Consensus Building and Responsibility Sharing

- **City governments have a key role to play in brokering partnerships for IUFRM.** IUFRM is an integrated approach that is driven and implemented by a wide range of sectors and stakeholders, as described above. Therefore, the city government has a significant role to play in garnering consensus among a diverse and expanding set of stakeholders. There are several tools and approaches that can be used in the consensus-building process, including joint conferences involving academia, related governmental divisions, and residents; joint risk assessments and flooding simulations of river floods and surface water floods (as seen in the case of Tokyo's river and sewerage bureaus); public hearings; consultation with the private sector; incentive systems such as subsidy schemes and legal regulations; and periodic personnel exchanges within governmental organizations.
- **Roles and opportunities for the private sector and community members are growing.** Additionally, there is a significant need—and opportunity—for the private sector and community to take the lead in flood risk management. The public sector's capacity alone is not enough to mitigate expected and unprecedented flood risks that may put the lives and livelihoods of citizens in danger. Therefore, various financial incentives, technical assistance, human resource development, awareness raising, and information sharing with diverse stakeholders will be much needed to further expand various innovative IUFRM efforts in cities.

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UFCOP

Urban Floods Community of Practice is an umbrella program to share operational and technical experience and solutions for advancing an integrated approach to urban flood risk management, and leveraging expertise and knowledge of different stakeholders and practice groups and across the WBG. The program supports the development of an interactive space for collaboration and exchange on the subject, facilitating users' access to information and adaptation of knowledge to local conditions, and bringing together different stakeholders to enhance collective knowledge on integrated urban flood risk management.

World Bank Tokyo DRM Hub

The World Bank Tokyo Disaster Risk Management (DRM) Hub supports developing countries to mainstream DRM in national development planning and investment programs. As part of the Global Facility for Disaster Reduction and Recovery, the DRM Hub provides technical assistance grants and connects Japanese and global DRM expertise and solutions with World Bank teams and government officials. The DRM Hub was established in 2014 through the Japan-World Bank Program for Mainstreaming DRM in Developing Countries—a partnership between Japan's Ministry of Finance and the World Bank.

GFDRR

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerabilities to natural hazards and adapt to climate change. Working with over 400 local, national, regional, and international partners, GFDRR provides grant financing, technical assistance, training, and knowledge sharing activities to mainstream disaster and climate risk management in policies and strategies. Managed by the World Bank, GFDRR is supported by 36 countries and 10 international organizations.

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