Tokyo Climate Change Adaptation Plan

CLIMATE
CHANGE
DAPTATION

Table of Contents

Reference

1. Introduction

Background

As a result of extreme heat, heavy rains, and increasingly larger typhoons, there have been natural disasters, and increased risk of heatstroke, and deterioration in crop quality. These phenomena, which are considered to be impacts of climate change, are occurring throughout Japan and appearing here in Tokyo as well.

In recent years, natural disasters have occurred frequently, due to typhoons and heavy rains in particular. For example, record rainfall was observed during Typhoon Hagibis in 2019, particularly in eastern Japan, causing enormous damage. In Tokyo, damages included flooding and the collapse of roads due to rivers overflowing. In July 2020, many linear precipitation zones[1] occurred to cause heavy rains in Kyushu, resulting in flooding of large rivers.

In August 2020, 41.1°C, on par with the highest temperature in Japanese history, was observed in Hamamatsu City, Shizuoka Prefecture, records for daily maximum temperatures were broken at 11 points nationwide, and the number of patients seeking emergency care for heatstroke reached a record high for August. Furthermore, these impacts are expected to expand for extended periods.

For these reasons, we have to focus on adaptation measures, with the aim of avoiding or reducing damage caused by the impacts of this inevitable climate change as well as working on, more than ever, mitigation measures to reduce greenhouse gas emissions, a factor of global warming.

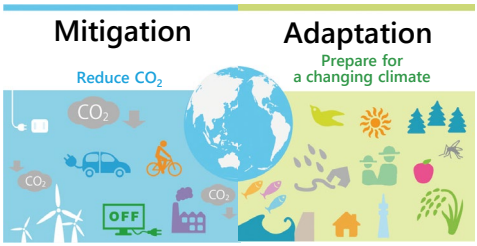


Illustration by A-PLAT

The Paris Agreement, an international movement concerning climate change, was adopted in December 2015 under the United Nations Framework Convention on Climate Change, and came into effect in November 2016. The Paris Agreement aims to strengthen the global response to the threat of climate change. In addition to the mitigation goals of holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, the agreement also sets the adaptation goal of increasing the capacity and resilience to adapt to the impacts of climate change.

In Japan, the Climate Change Adaptation Act came into effect in December 2018 to clarify the legal status of climate change adaptation and encourage all stakeholders to further promote climate change adaptation. In December 2019, the Tokyo Metropolitan Government (TMG) announced the Tokyo Climate Change Adaptation Policy to organize the basic principles of this plan.

With the spread of COVID-19, there are concerns about the threat of climate change and the combined damage caused by infectious diseases to vulnerable communities. In addition, the delay in digital transformation (DX) has become apparent in Japan—we need to respond to these new issues as well.

1 A rain area with strong precipitation having a length of 50 to 300 km and a width of 20 to 50 km generated by a group of cumulonimbus clouds occurring one after another which pass over or remain in almost the same place for several hours

Purpose of Formulating this Plan

Severe impacts of climate change, such as extreme heat and heavy rains in recent years, already affect our daily lives.

In light of this situation, TMG is promoting concrete efforts to realize a Zero Emission Tokyo that will contribute to the goal of global net zero CO_2 emissions by 2050, based on the Zero Emission Tokyo Strategy formulated in December 2019.

In conjunction with these efforts, and taking into account the impacts of climate change in Tokyo, we have formulated the Tokyo Climate Change Adaptation Plan in line with the concept of a sustainable recovery, incorporating perspectives, such as the promotion of digital transformation (DX) in addition to the ideas indicated in the Tokyo Climate Change Adaptation Policy. The purpose of this plan is to avoid or reduce as much as possible the impacts on or damage to the lives of Tokyo residents and the natural environment in a broad range of fields, including natural disasters, human health, and agriculture, forestry, and fisheries.

By implementing various initiatives based on this plan in addition to efforts to realize a Zero Emission Tokyo, we will comprehensively develop both mitigation and adaptation measures for climate change to build a robust city that protects the lives and property of Tokyo residents from extreme changes in climate.

Positioning

This plan has been formulated as TMG's Local Climate Change Adaptation Plan based on Article 12 of the Climate Change Adaptation Act. To overcome two major crises, the threat of infectious diseases and the climate crisis, TMG will promote the plan by considering it as an initiative based on the "Tokyo in the Future" Strategy formulated in March 2021 as a new guiding principle for TMG.

Climate Change Adaptation and SDGs

Sustainable Development Goals (SDGs) are the international goals for 2030 adopted at the United Nations Summit in September 2015. These SDGs consist of 17 goals for a sustainable world and are common to all countries, including developed countries.

A fundamental principle of these SDGs involves creating an inclusive society which "leaves no one behind," with efforts being expected not only at the national level but also at the municipal level.

TMG aims to contribute to the realization of these SDGs by promoting adaptation measures in various fields.

Source: Website of United Nations Information Centre

Relevant SDGs include:

- 3 Ensure healthy lives and promote well-being for all at all ages
- 6 Ensure access to water and sanitation for all
- 11 Make cities inclusive, safe, resilient and sustainable
- 13 Take urgent action to combat climate change and its impacts
- 15 Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss

The icons of the SDGs closely related to each policy area are shown in Chapter 4.

2. Past Conditions and Predicted Future Changes in Climate

The following is an outline of past conditions and predicted future changes in climate in Tokyo. The details are available on the website of the Bureau of Environment, Tokyo Metropolitan Government.

Past Climate Conditions

Temperature

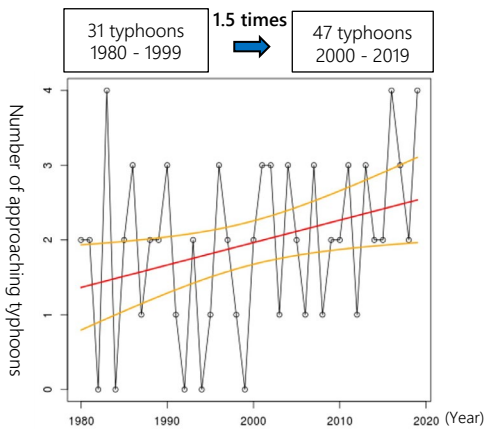
- The annual average temperature has been increasing in the 23 wards, Tama area, and islands.
- The annual average daily maximum temperature and daily minimum temperature have been increasing in the 23 wards, Tama area, and islands.
- The number of sweltering days (a day on which the temperature rises above 30ºC) and sweltering nights has been increasing in the 23 wards, Tama area, and islands.
- The number of extremely hot days (a day on which the temperature rises above 35ºC) has been increasing in the 23 wards and Tama area but such days have not been observed on the islands.

Precipitation

- Precipitation has fluctuated greatly year by year, showing no clear trend in the 23 wards, Tama area, or islands.
- The number of days with no precipitation has been increasing in the 23 wards, while there is no clear trend in the Tama area or islands.
- For the number of the annual occurrences of torrential rains (precipitation of 50 mm or more per hour) at 1,300 locations throughout Japan compiled by the Japan Meteorological Agency, the average during the past 10 years is approximately 1.4 times that for the first 10 years of statistics being compiled.

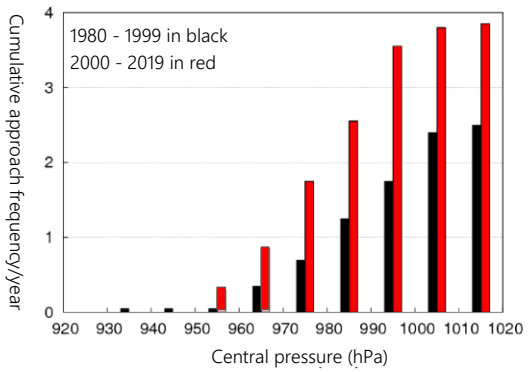
Typhoons[1]

- The number of typhoons approaching Tokyo has been increasing according to observation data for the 40 years from 1980 to 2019. The effects of typhoons are being felt for longer periods as strong typhoons are approaching more frequently and moving more slowly.



Changes in the number of typhoons approaching Tokyo

(Addition made to a figure in a press release[1] from the Meteorological Research Institute)



Cumulative frequency distribution of central pressure of typhoons approaching Tokyo

(Based on a figure in a press release[1] from the Meteorological Research Institute)

Sea levels[2]

- The average sea level along the coast of Japan has been on the rise since 1980, in contrast to the stability of its level over the preceding 100 years.

1 Press release from the Meteorological Research Institute, "More Typhoons on the Pacific Ocean Front in the Last 40 Years" (August 25, 2020)

2 Climate Change in Japan 2020 - Report on Observations and Projections Assessment on Atmosphere, Land, and Oceans (Detailed Version) (December 2020)

Predicted Future Changes of Climate

Temperature

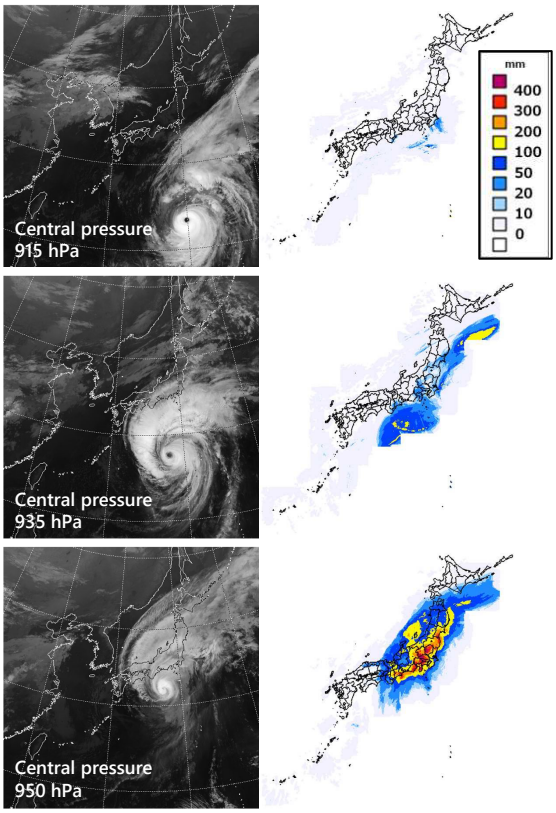
- In the 23 wards, Tama area, and islands, temperatures in the future are expected to be higher than those at present. It is also predicted that daily minimum temperatures in all areas will increase more sharply than average temperatures and daily maximum temperatures.
- It is predicted that there will be more sweltering days, extremely hot days, and sweltering nights in the future than at present.

Precipitation

- Annual precipitation in the 23 wards and islands shows a decrease in the future while that in the Tama area shows an increase, indicating different trends between the areas.
- Torrential rains and days with no precipitation show an increase in all areas.

Typhoons

- Although there is much uncertainty when it comes to future projections of typhoons, it is predicted that:
  - Fewer typhoons will approach Japan as fewer typhoons will be formed in the Northwest Pacific and the zone responsible for forming the highest number of typhoons will shift east from the Philippines.
  - Typhoons near Japan will become stronger, making landfall on Japan at an intensity classified as "Super."[2, 3]
  - The annual total amount of precipitation associated with typhoons will not change, as fewer typhoons will approach Japan although the precipitation intensity of individual typhoons will increase resulting in larger amounts of rainfall.[3]
  - The frequency of extremely heavy precipitation associated with typhoons will be higher as the effect of an increase in the precipitation intensity of individual typhoons is greater than that of the decrease in the number of approaching typhoons.[3]



Weather satellite image (infrared) of Typhoon Hagibis in 2019, Daily Precipitation Distribution Map (rainfall analysis) (Editing made to a figure in the Report on Natural Phenomena at the Time of Disasters No. 3 in 2020, the Japan Meteorological Agency)

Sea levels[4]

- It is estimated that the average annual sea levels for coastal areas around Tokyo will rise by 0.70 m by the end of the 21st century.

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1 Integrated Report on Observation, Prediction, and Impact Assessment of Climate Change 2018 - Climate Change and Its Impacts in Japan (February 2018)

2 In the context of typhoons, "Super" is the maximum intensity class set by the Joint Typhoon Warning Center (JTWC) of the United States, equivalent to an average maximum ground wind speed per minute of 130 knots (approximately 67 m/s) or more.

3 Climate Change Impact Assessment Report (Details) (December 2020)

4 Climate Change in Japan 2020 - Report on Observations and Projections Assessment on Atmosphere, Land, and Oceans (Detailed Version) (December 2020)

3. Basic Approaches to Adaptation

Basic Approaches

With the increasing severity of climate change impacts, we have to steadily promote mitigation to reduce CO_2 emissions. To avoid or reduce climate change impacts that still remain after strict mitigation efforts, we must also develop adaptation at the same time.

TMG will realize a city that continues to attract people and businesses by being committed to protecting the lives and property of Tokyo residents.

Basic Strategies

(1) Implement climate change adaptation into all of TMG's initiatives.

The effects of climate change adaptation are appearing in a broad range of fields, including natural disasters, human health, and agriculture, forestry, and fisheries. TMG will address climate change impacts at present and in the future by incorporating climate change adaptation into all relevant initiatives.

(2) Promote climate change adaptation based on scientific knowledge.

Scientific knowledge, such as future projections of climate change and its impacts, is constantly renewed in parallel with advancements in research and study. TMG will promote adaptation measures based on the latest scientific knowledge. In addition, we will actively utilize the latest technologies related to climate change adaptation.

(3) Support local efforts in cooperation with municipalities.

It is essential to develop policies according to local circumstances as the impacts of climate change vary greatly, depending on regional characteristics. TMG will support local efforts by actively providing information so that municipalities can develop their community-based initiatives.

(4) Promote dissemination of information, including risks, to facilitate understanding of Tokyo residents.

The understanding of Tokyo residents is indispensable for promoting initiatives for climate change adaptation. This poses the necessity of aggressively raising awareness of climate change adaptation. TMG will develop a system to collect and provide information on climate change adaptation and actively disseminate the information.

(5) Promote international cooperation in C40 and other organizations to accelerate intercity collaboration.

The impacts of climate change and countermeasures for the impacts have become a global challenge. TMG will accelerate intercity collaboration by utilizing organizations in which TMG has membership, such as C40[1], in order to share knowledge.

1 C40 Cities Climate Leadership Group. C40 was established in 2005 as a network for cities around the world to work together to reduce greenhouse gas emissions. TMG joined C40 in December 2006.

Roadmap for Strengthening Adaptation Measures

Visions for 2050

u Minimize risks from climate change impacts

■ **Protect the lives and property of Tokyo residents and realize a city that continues to attract people and businesses**

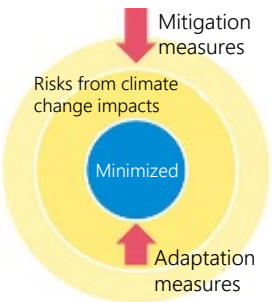
The environment in place is able to avoid or mitigate flood inundations and landslides caused by heavy rains or typhoons

Adverse health effects due to temperature rise, including heatstroke and infectious disease as well as health problems due to air pollution, are minimized

Agriculture, forestry, and fisheries industries resilient to temperature rise and disasters, such as typhoons, are realized

Risks, such as droughts and deterioration of water quality, are reduced, and a stable supply of high-quality water and a comfortable water environment are realized

Impacts on biodiversity are minimized, and the luxuriant natural environment is safeguarded



Challenges for 2050

- Promotion of efficient and optimal adaptation measures by utilizing innovative technologies, such as highly accurate climate change forecasts
- Establishment of Tokyo residents' behavior and business activities that take adaptation into consideration

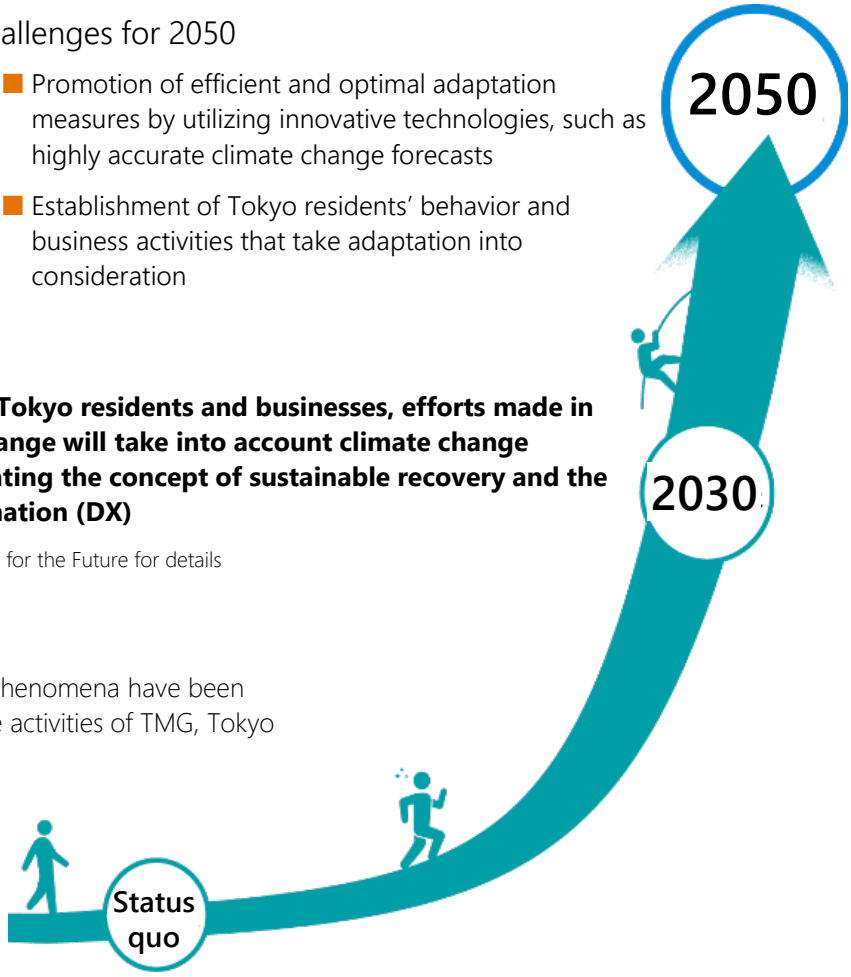
Targets for 2030

Through the activities of TMG, Tokyo residents and businesses, efforts made in all fields affected by climate change will take into account climate change impacts in the future, incorporating the concept of sustainable recovery and the perspective of digital transformation (DX)

* See 4. Climate Change Impacts and Efforts for the Future for details

Status quo

Unprecedented, extreme weather phenomena have been increasing, having an impact on the activities of TMG, Tokyo residents and businesses



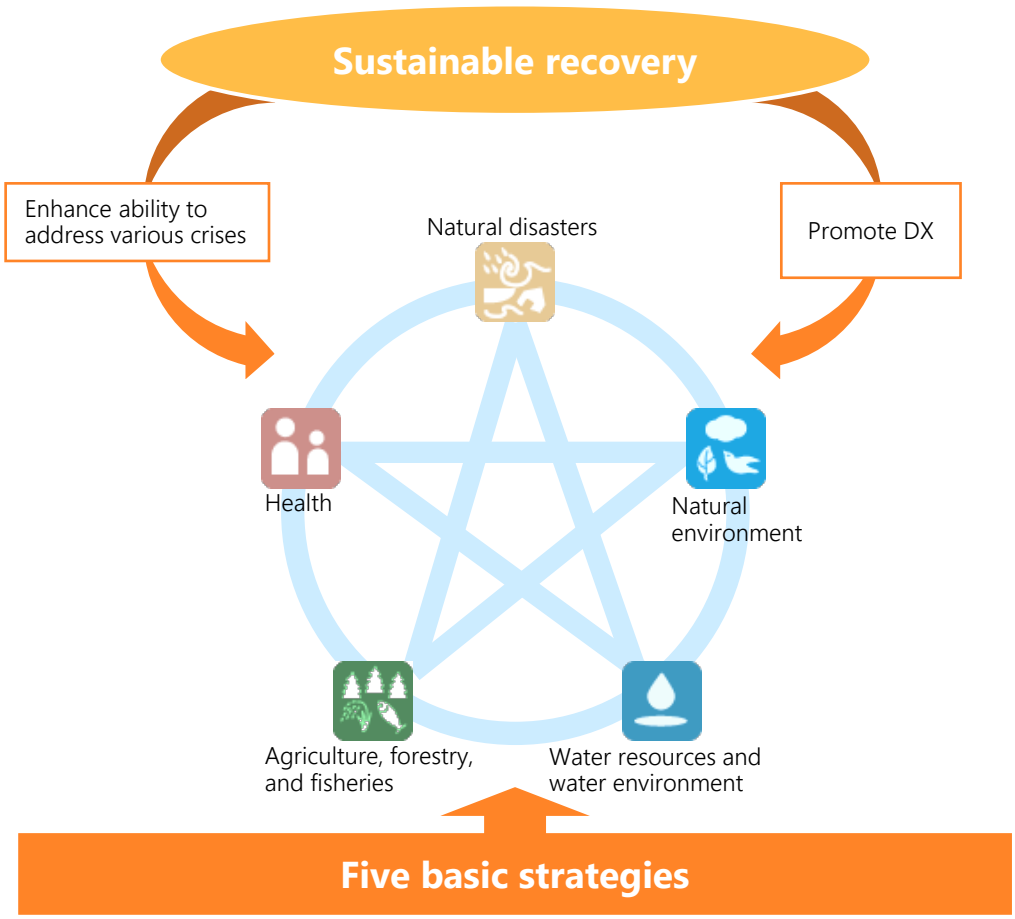
4. Climate Change Impacts and Efforts for the Future

This chapter summarizes climate change impacts and efforts for the future for each of the following five fields: ① natural disasters, ② health, ③ agriculture, forestry, and fisheries, ④ water resources and water environment, and ⑤ natural environment.

In responding to climate change impacts, TMG will enhance not only our response to threats caused by climate change, but also our ability to address various crises affecting the lives of Tokyo residents, such as those related to new infectious diseases, economy, and society. The enhancement will be based on the basic approaches and five basic strategies in the previous chapter as well as the concept of sustainable recovery aiming for reconstruction for the future while recovering the economy and society, and the mindset of people exhausted by COVID-19.

We will promote our initiatives by incorporating, in particular, the potentialities of digital transformation (DX).

Climate change impacts are described mainly based on the national government's Climate Change Adaptation Plan of November 2018 and Climate Change Impact Assessment Report of December 2020.



Icons for five areas provided by A-PLAT

* The schedule for efforts for the next three years is posted as an action plan on the website of the Bureau of Environment, Tokyo Metropolitan Government.

Natural Disasters

Climate Change Impacts

Floods and inland floods

Increased heavy rains, rising sea levels, and increasingly larger typhoons are likely to cause more enormous and frequent flood inundations.

On low-lying areas near rivers or coasts, it is anticipated that the likelihood of inland floods will increase causing longer inundation times as river water levels will rise more frequently or sea levels will rise, resulting in difficulty in draining rainwater from the sewer system[1].

Storm surges and high tidal waves

The rising sea levels and increasingly larger typhoons will increase the risk of inundation due to storm surges[2].

In addition, it is predicted that the risk of high waves along the Pacific coastal area may intensify due to increasingly larger typhoons, and breakwaters at harbors and fishing ports will be damaged due to an increase in wave height and larger tide level deviations.

Landslides

Increased heavy rains are likely to cause more frequent landslides.

There is a concern that an increase in sudden and localized heavy rainfall will cause more landslides with shorter lead times for alerts or evacuation, and record rainfall due to typhoons will cause more deep-seated landslides.

1 Report on the Evaluation of the Impacts of Climate Change in Japan and Challenges in the Future (offering of opinions), March 2015
2 Integrated Report on Observation, Prediction, and Impact Assessment of Climate Change 2018 - Climate Change and Its Impacts in Japan, February 2018

Efforts for the Future

In response to natural threats, such as floods, inland floods, storm surges, and landslides due to intensified heavy rains and typhoons, TMG will promote the utilization of state-of-the-art technologies and the development of urban facilities in both structural and non-structural aspects.
To cope with increasingly larger typhoons and more frequent heavy rains in recent years, TMG will further improve our initiatives.

(1) Structural measures	(2) Non-structural measures
1) Infrastructure development i Development of rivers, sewerage systems, and coastal conservation facilities ii Protection of functions of urban facilities iii Promotion of urban development with disaster preparedness iv Landslide measures	1) Preparation i Improvement of awareness of disaster preparedness ii Development of the system
2) Development of materials and equipment	2) Response in the event of a disaster i Collection, analysis, and provision of information ii Enhancement of the system

(1) Structural measures

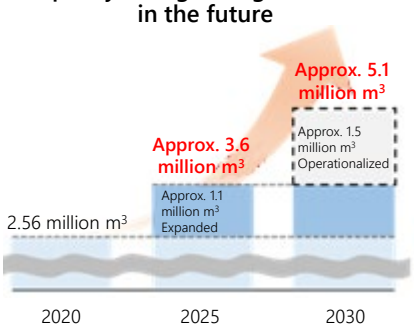
1) Infrastructure development

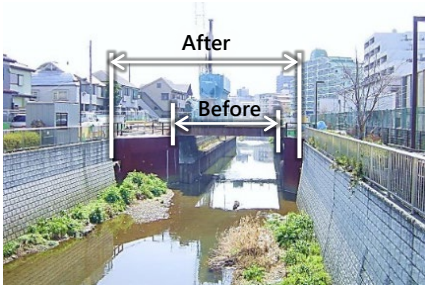
i Development of rivers, sewerage systems, and coastal conservation facilities

Measures for rivers against heavy rains

- Promote the development of regulating reservoirs under construction, such as the Wide-Area Regulating Reservoir under Loop Road No. 7, in parallel with that of river revetment.
- Proceed with the study to operationalize new regulating reservoirs and extend the Wide-Area Regulating Reservoir under Loop Road No. 7 by making it an underground river.
- In the Tama area damaged by Typhoon Hagibis in 2019, TMG will improve the discharge capacity of rivers through local improvements.

Capacity of regulating reservoirs in the future





Revetment construction (Shakujii River)

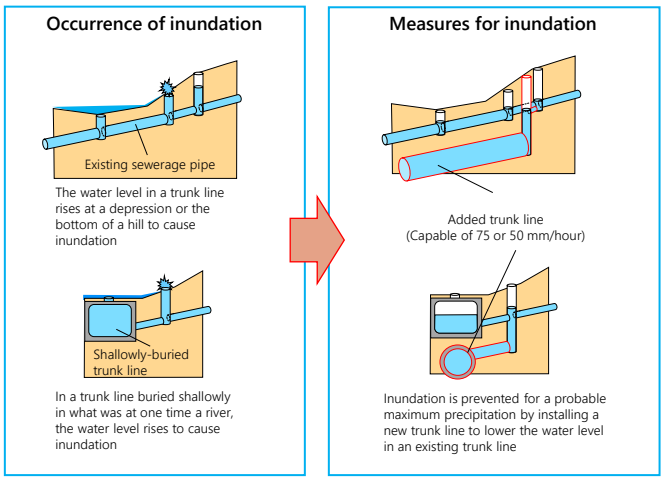
Regulating Reservoir under Kanda River/Loop Road No. 7

Promotion of strategic maintenance of rivers

- Steadily implement maintenance based on a preventive maintenance plan to ensure the activation of flood control/defense functions in the event of a disaster.
- Ensure more efficient and sophisticated inspections through the introduction of ICT/AI by retaining human resources with specialized knowledge.

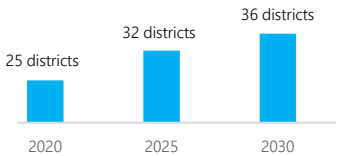
Development of sewerage facilities

- Develop large trunk lines and storage facilities that can handle precipitation of 75 mm/hour at large underground malls that will be greatly damaged by floods, districts that suffered great damage in the past, and districts where extensive inundations above floor level are expected.
- By utilizing runoff analysis simulation technology, TMG will verify the capacity of sewerage facilities in case of precipitation of 75 mm/hour, add new districts at high risk of inundation, and strengthen the relevant countermeasures.



Countermeasures using sewerage trunk lines

Sewerage storage pipe
(Wada-yayoi trunk line)
(Capacity 150,000 m^3)

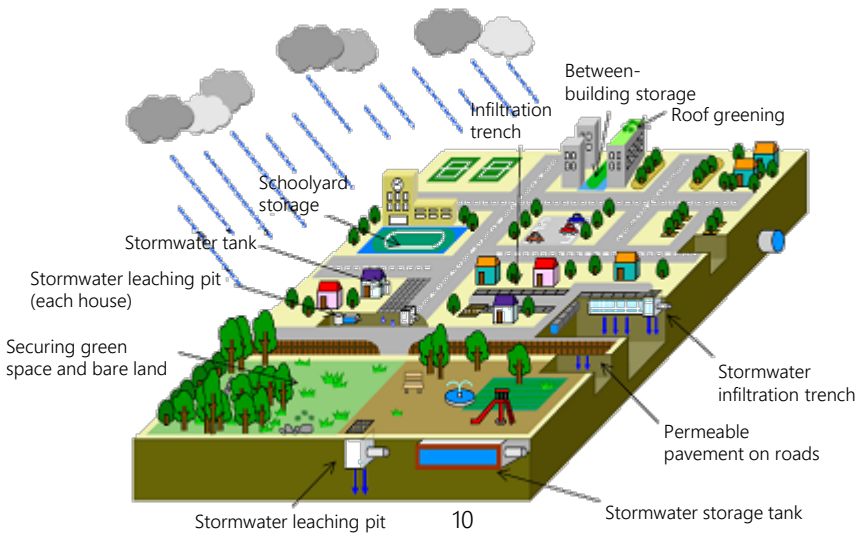


Number of districts at high risk of inundation for which additional construction of sewerage has been completed

Promotion of measures for river basins

- To encourage municipalities to make voluntary and systematic efforts to control rainwater runoff equivalent to precipitation of 10 mm/hour, TMG will set non-binding targets for the amount to be controlled and post information on progress made towards achieving such targets.
- Consider adding prioritized basins that will be subsidized in order to promote the installation of storage and infiltration facilities.
- Carry out model projects in cooperation with municipalities to verify methods of effective installation of facilities and raise the awareness of Tokyo residents.
- Promote efforts to create and conserve greenery and reduce flood damage through a rainwater drainage function.

Measures for river basins



Enhancement of agricultural infrastructure

- Utilize digital technology to improve the disaster preparedness function of reservoirs and intake gates of agricultural canals.

Measures for storm surges

- Promote the development of storm surge protection facilities to protect the lives and livelihoods of approximately 3 million people living in the eastern lowlands.
- Formulate the next Port of Tokyo Coastal Conservation Facilities Development Plan and promote the development of coastal conservation facilities taking into account the impacts of climate change.
- Prepare for emergencies by remotely opening and closing floodgates whenever possible and monitoring camera videos and information signals sent from facilities.

Floodgate

Storm Surge Information Center

Construction of coastal conservation facilities on the islands

- Promote the construction of coastal conservation facilities, such as detached breakwaters, to protect villages etc. along the coast from high tidal waves caused by typhoons and other natural disasters.

Policy Goals for 2030

Policy goals	Status quo	Specific goals
River safety achievement rate[1] Prioritized basins[2] General basins[3]	 62% (expected at the end of FY 2020) 79% (expected at the end of FY 2020)	 70% (FY 2030) 82% (FY 2030)
Operationalization of new regulating reservoirs	Two reservoirs operationalized	Operationalization of new regulating reservoirs with a total capacity of 1.5 million m^3 (FY 2030)
Promotion of the construction of sewerage prioritizing districts at high risk of inundation	24 districts (FY 2019)	36 districts (FY 2030)
Promotion and perceptibility of measures for river basins For precipitation of 10 mm/hour: Approx. 6.54 million m^3	Storage and infiltration facilities Approx. 3.98 million m^3 (end of FY 2017) Approx. 4.05 million m^3 (end of FY 2018)	Achievement of municipalities' non-binding targets
Promotion of efforts in prioritized basins	Subsidization coverage: Nine basins (FY 2019) Additional basins under consideration	Promotion of measures for river basins through subsidization in prioritized basins
Model projects of measures for river basins	—	Improved awareness of Tokyo residents
Creation of good greenery* on private land * Areas of land with greenery provided by trees and plants and open spaces including grounds and water surfaces	Insufficient good greenery in the downtown	Good greenery increased in the city in line with development by private sector
Designating or making publicly-owned additional conservation areas	Approx. 758 ha (FY 2019)	Expansion by approx. 100ha (FY 2050)
Construction of super levees	Completion in 43 districts in total (expected at the end of FY 2020)	Completion in 49 districts in total (FY 2023)
Promotion of the construction of coastal conservation facilities along the Port of Tokyo	Completion of 39.3 km of surrounding seawalls (end of FY 2019) 17 floodgates (end of FY 2019)	Promotion of their maintenance in line with future plans
Construction of coastal conservation facilities on the islands	Promoting construction along four coastal areas	Completion along four coastal areas (FY 2030)

1 An index showing the achievement of measures (construction of regulating reservoirs or revetment, excavation of riverbeds, etc.) corresponding to the target development levels of rivers

2 Nine basins, including those of the Kanda and Nogawa Rivers, for which measures are taken when there is precipitation of up to 75 mm/hour in 23 wards and 65 mm/hour in the Tama area (as of January 2021)

3 Basins for which river maintenance is carried out in response to precipitation of 50 mm/hour, excluding prioritized basins

ii Protection of functions of urban facilities

Promoting the removal of utility poles

- Promote the removal of utility poles to prevent their collapse during earthquakes, storms and flooding, and facilitate a smooth response to disasters.
- Work to strengthen support for municipality roads in addition to Tokyo metropolitan roads and efforts for urban development based on the Strategy for Accelerating the Removal of Utility Poles.

Before

After

Development of roads and bridges

- Build a highway network to ensure redundancy[1] in the event of a disaster.
- Promote the construction of new bridges along sections that border Chiba Prefecture as the current bridges are infrequently spaced, to better enable wide-area evacuation in the event of a large-scale disaster.
- Improve accessibility to the Tachikawa Wide-Area Disaster Management Base, which will be the center for emergency disaster control measures in the event of severe damage to capital functions, by developing city planning roads around it.
- Improve the disaster preparedness of Tokyo by enabling reliable rescue activities and maintaining cargo transport or evacuation routes in preparation for a disaster through the construction or replacement of bridges along emergency transport routes, the development of roads as alternative routes used in the event of a disaster, and the widening of emergency transport roads.

Strengthening the disaster preparedness function of roadside trees

- To strengthen the disaster preparedness function of roadside trees, TMG will focus on the diagnosis of roadside trees in areas with many fallen trees due to typhoons for their systematic renewal.

1 The quality mentioned in national land planning in which transportation networks and lifeline facilities are multiplexed or a spare means is prepared in advance so that disruption of certain sections or destruction of certain facilities does not lead to a total malfunction in the event of a failure due to a natural disaster or the like

More stable water supply

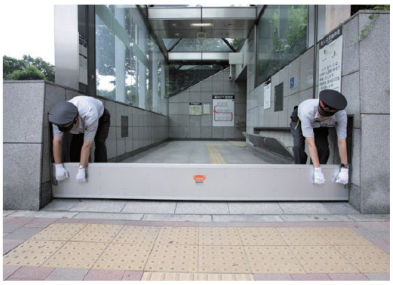
- Double water conveyance facilities to improve the stability of water supply.
- Construct wide-area water transmission pipe networks and promote a dual system for water transmission to water supply stations in order to ensure backup by another system.
- Bury pipelines that cross rivers, as surface pipes may be affected by river flooding, causing concerns about suspension of water supply or secondary damage.

Doubled water conveyance facilities

Networked water transmission pipes

Flood control in subways

- Take necessary additional measures for the Toei Subway in light of the announcement of new expected inundation areas that may assume the heaviest possible rainfall.
- Strengthen measures against inundation by examining more effective measures for early restoration from large-scale floods, such as overflowing of the Arakawa River.



Water stop plate

Water stop door

Policy Goals for 2030

Policy goals	Status quo	Specific goals
Removal of utility poles by utilizing the Special Development Areas for Urban Renaissance	Removing utility poles taking advantage of opportunities for urban development	Efforts by private businesses expanding more than ever
Removal of utility poles by utilizing the Urban Redevelopment Systems	Removing utility poles taking advantage of opportunities for urban development	Efforts by private businesses expanding more than ever
Removal of utility poles mainly from community roads for disaster preparedness	Efforts in progress in wards	Efforts in wards expanding more than ever
Removal of utility poles through urban district development projects implemented by TMG	Operation in four districts	Completion in FY 2024
Removal of utility poles through urban district development projects implemented by municipalities or private sector	Removing utility poles taking advantage of opportunities for urban district development	Urban development without utility poles or electric wires to be standard
No utility poles in building land development by private sector (or development permission)	Formulating technical guidelines for development permission (January 2020)	Proactive municipalities formulating rules (FY 2022)
Removal of utility poles from the first emergency transport roads (including the maintenance of Loop Road No. 7)	36% (FY 2019) (45% (FY 2019))	50% (FY 2024) (100% (FY 2024))
Having started the principal part of the removal of utility poles from all other emergency transport roads including harbor roads	Research and design underway in the Oi, Ariake, and Central Breakwater districts	Starting on all of the roads (2030)
Construction or replacement of bridges along emergency transport routes	Land acquisition/construction underway	Enhancement of rescue activities and cargo transport routes used in the event of a disaster
Development of roads as alternative routes used in the event of a disaster	Land acquisition/construction underway	Improvements in disaster preparedness with isolation avoided by widening existing roads, improving their alignment, and developing roads as alternative routes in the mountainous parts of the Tama area and on the islands
Widening of emergency transport roads	Land acquisition/construction underway	Enhancement of rescue activities and cargo transport routes used in the event of a disaster
Double water conveyance facilities	Construction at one facility Research and design at one facility Research at one facility (FY 2019)	Completion of one facility Construction at three facilities (FY 2030) Four water conveyance channels completed (FY 2036)
Networked water transmission pipes	Starting operation at three facilities	Development completed at four facilities Construction at two facilities (FY 2030) Completion of six facilities (FY 2036)

iii Promotion of urban development with disaster preparedness

Promotion of urban development with elevation

- Promote urban development with elevation to avoid catastrophic damage in the event of large-scale floods by continuing liaison meetings with the national government and promoting examination and operationalization in model districts in cooperation with the national government and wards.

Promoting the elevation of a park

- Elevate Shinozaki Park and secure evacuation routes to the Edogawa Levee.

Image of Tokyo Metropolitan Shinozaki Park in the future (bird's eye view)

Efforts for building land retaining walls

- Provide support for municipalities working on risk assessment to prevent damage caused by broken retaining walls for residential land.

Visual inspection

Geological survey

Risk research

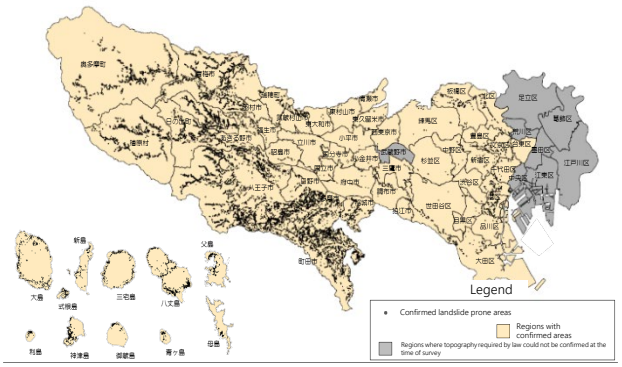
Policy Goals for 2030

Policy goals	Status quo	Specific goals
Promotion of urban development with elevation	Selecting model districts	Operationalization in model districts
Elevation of Shinozaki Park	Starting designing	Completion of part of elevation (FY 2030)
Promotion of disaster preparedness at building land	Supporting cliff/retaining wall risk research conducted by municipalities through a subsidy system established in March 2019	Spread of disaster preparedness measures for building land

iv Landslide measures

Implementation of erosion control work

- Prioritize erosion control work in landslide prone areas where evacuation centers are located and locations where landslides have actually occurred.



Locations of confirmed landslide prone areas

Erosion control facility

Preventive maintenance management of existing ground anchors

- Promote preventive maintenance management of various slope protection facilities, such as aged ground anchors, through surveys and planning for strategic maintenance.

Ground anchors

Strengthening the disaster preparedness function of forests

- Improve benefits to the general public from forests and water conservation forests in the Tama area by thinning and pruning and reduce flood damage by preventing the runoff of earth and sand and conserving water resources.
- Develop disaster-resistant forests through proper management using cutting-edge technologies, such as drones and lasers, and the promotion of forest circulation.

Making regional structure consolidated

- Promote efforts for making regional structure consolidated, including the formulation of location optimization plans by local governments. For example, in areas at a risk of landslides or other disasters, TMG will encourage relocation to safer areas taking into account demographics.

Policy Goals for 2030

Policy goals	Status quo	Specific goals
Consideration of the construction of erosion control facilities in the Tama area	20 locations in total (expected at the end of FY 2020)	Examination of all of 43 prioritized mountain streams to formulate an erosion control master plan (FY 2030)
Implementation of repair work for existing ground anchors	2 locations (FY 2019)	Continuation of repair work toward the completion on 179 applicable slopes (FY 2030) (Repair work on 58 surveyed slopes to be completed in FY 2025)
Implementation of a detailed survey of existing ground anchors on all slopes	58 locations (FY 2019)	Completion on 179 applicable slopes (FY 2030)
Establishment of a preventive maintenance management method for slope protection facilities	Not implemented	All slopes along mountain roads to be systematically managed according to guidelines
Conservation and management of water conservation forests	Properly managing water conservation forests	Conservation of 3,000 ha (600 ha/year during five years from FY 2020 to 2024)
Promotion of efforts for making regional structure consolidated, including the formulation of location optimization plans by local governments	Two local governments having formulated location optimization plans	Approximately half of local governments in the Tama area, whose population is declining, to be considering the plans

2) Development of materials and equipment

Strengthening disaster response in rescue activities

- Strengthen the flood prevention activity system by developing personal materials and equipment for flood disasters.

Waders

Development of personal materials and equipment for flood disasters

Expansion and installation of emergency power supplies

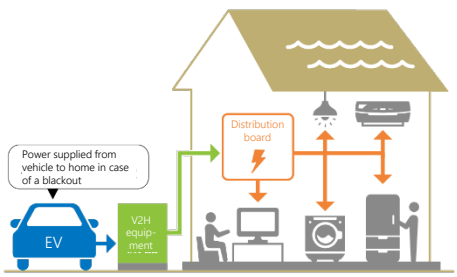
- To ensure electricity is available at residential buildings, private facilities, and public facilities, including evacuation centers, even in the event of a disaster, TMG will promote the spread of self-consumed renewable generation, such as solar power generation and storage batteries, as well as fuel cells, for better regional disaster preparedness.

- Promote the installation of emergency power supplies at TMG facilities, municipalities' buildings, and other important bases.

Promoting the spread of ZEVs

- Promote the spread of zero-emission vehicles (ZEVs[2]) as "moving storage batteries" in order to enable the supply of power and ensure power supply (V2H, V2B[1], etc.) at evacuation centers in the event of a disaster.

- Promote the installation of public chargers and hydrogen stations necessary for the spread, as well as the introduction of portable vehicle-to-load systems and V2H equipment necessary for the supply of power.



V2H (Vehicle to Home)

Better resilience in regions

- Improve the resilience of the islands by promoting the installation of solar power generation equipment and storage batteries on the islands.

- Consider the sharing of regional renewable energy and aim to strengthen regional disaster preparedness.

Æ See "Sharing of Regional Renewable Energy" on page 31.

1 V2H is an abbreviation for Vehicle to Home, a function that supplies power to home from the battery of ZEVs.
V2B is an abbreviation for Vehicle to Building, a function that supplies power to a building from a storage battery in ZEVs.

2 ZEVs include fuel cell vehicles (FCVs), electric vehicles (EVs), and plug-in hybrid vehicles (PHVs) that do not emit CO_2 or other exhaust gases during driving.

Policy Goals for 2030

Policy goals	Status quo	Specific goals
Enhancement of the security command structure and preparation of equipment and materials by utilizing advanced technology	Considering equipment and materials for disasters that may occur in the future based on the lessons learned from past disasters	By utilizing advanced technology, the command structure to be enhanced and on-site activities to be further facilitated by robots and other innovative equipment and materials
Installation of solar power generation equipment in Tokyo	572 MW in total (FY 2018)	1.3 GW (2030)
Adoption of residential fuel cells	Approx. 62,000 units in total (FY 2019)	1 million units (2030)
Adoption of commercial and industrial fuel cells	Approx. 2.5 MW in total (FY 2019)	30 MW (2030)
Rate of water supply capacity in a large-scale power outage	63% (FY 2019)	92% (FY 2030)
Market share of non-gasoline vehicles in new passenger car sales	39.5% (FY 2019)	Eliminating the sale of new gasoline passenger cars (2030)
Installation of public chargers (Installation of public fast chargers)	Approx. 2,500 units in total (FY 2019) (Approx. 300 units in total (FY 2019))	5,000 units (2025) (1,000 units (2030))
Development of hydrogen stations	17 locations in total (FY 2019)	150 locations (2030)

(2) Non-structural measures

1) Preparation

i Improvement of awareness of disaster preparedness

Raising awareness

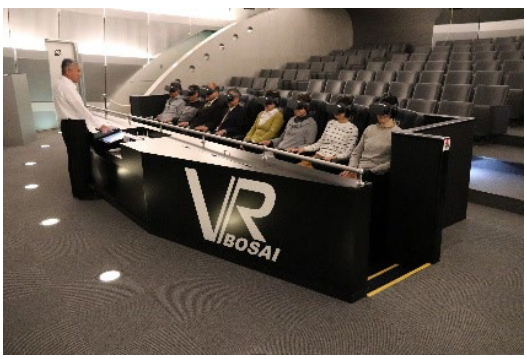
- Raise awareness of disaster preparedness fine-tuned to different generations to help households get fully prepared through the Tokyo Disaster Preparedness Trial Examination using the Disaster Preparedness Tokyo booklet and distribution of the Tokyo Disaster Preparedness App.
- Distribute Tokyo My Timeline as content in the Tokyo Disaster Preparedness App, link the completed My Timeline with disaster preparedness weather information, and introduce a reminder that urges a user to check their Timeline.
- Raise public awareness of floods by distributing a flood risk map that visually and comprehensibly describes the risk of storms and flooding in various parts of Tokyo and a VR video featuring river flooding, TOKYO VIRTUAL HAZARD - Storms and Flooding.
- Continue disaster preparedness drills for foreigners and strengthen activities for disseminating knowledge of disaster preparedness through plain Japanese so that foreigners living in Tokyo can live safely and securely.
- Promote awareness raising by providing information through the Condominium Portal Site and utilizing the Condominium Management Guidebook that contains seminar information and disaster preparedness measures.

Promotion of disaster preparedness education

- Develop all children's ability to anticipate and avoid danger as well as their capabilities to contribute to the safety of others and society.

Strengthening the functions of the Life Safety Learning Centers

- Encourage the use of the Life Safety Learning Centers as facilities where anyone can enjoy experience learning for disaster preparedness.
- Promote the multilingualization of the facilities so that we can provide foreigners with opportunities for more effective experience learning of disaster preparedness.



VR section in Ikebukuro, Tachikawa, and Honjo

Urban flood experience section in Honjo

ii Development of the system

Evacuation measures

- Strengthen the support system for welfare specialists in the event of a disaster by supporting municipalities and cooperating with related organizations through the timely and appropriate revision of the evacuation center management and operation guidelines and the guidelines for measures for supporting vulnerable communities based on the viewpoints of measures against emerging infectious diseases considering the various perspectives of women and vulnerable communities.
- Raise public awareness through books on disaster preparedness, such as the Tokyo Disaster Readiness Guide that makes use of women's perspectives, and develop female disaster preparedness human resources.
- Consider wide-area evacuation measures in the event of a large-scale flood in collaboration with the national government, related local governments and organizations to facilitate evacuation in case of a disaster.
- Support coordination for using TMG facilities and the utilization of hotels and inns in municipalities to have as many shelters available as possible.

Flood inundation area maps

- Promote the update of hazard maps created by municipalities using flood inundation area maps and storm surge inundation area maps based on the heaviest possible rainfall or largest possible storm surge.

Flood inundation area map for the Kanda River basin based on the heaviest possible rainfall

Flood control in large underground malls

- Promote further enhancement of measures against inundation in underground spaces, including closer cooperation among managers of underground malls, subways, and adjacent buildings, by helping relevant private managers and the administration work together through examination of countermeasures by the Council for Flood Prevention Measures for Underground Shopping Areas in Tokyo and formulation of countermeasure plans by each district.

Landslide measures

- Systematically review the designation of specific areas, including landslide prone areas, and provide technical support to municipalities for the development of alerts or evacuation systems.

Digitization of disaster measures

- Work to provide information and ensure a stable communication environment in the event of a disaster by utilizing digital signage capable of providing disaster information and smart poles with smartphone chargers.
- Promote the digitization of disaster preparedness, taking into account the utilization of public-private data platforms for disaster preparedness, in which various actors share various data through open APIs[1] etc.

Smart pole with 5G base stations in Nishi-Shinjuku

1 Application Programming Interfaces for calling and using functions of a computer program (software) or data under its control from another external program

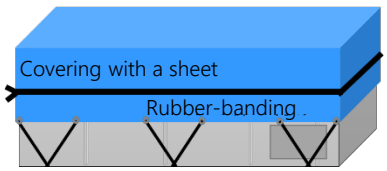
Ensuring business continuity

- Identify operations for which disaster response can be made remotely, and consider specific methods and systems for that purpose.
- Support small- and medium-sized businesses (SMBs) in formulating BCPs and working on crisis management measures and maintain the industrial base supported by SMBs by promoting the introduction of telework.
- Ensure the continuity of the market business by continuously verifying the Disaster Preparedness Manual (Central Market BCP) of the central wholesale market, which is a hub for fresh food distribution, and supporting the formulation of BCPs by market-related businesses.

Corporate support etc.

- To promote flood control measures taken by businesses handling chemical substance, TMG will provide technical and financial support for flood control measures implemented by SMBs based on the Tokyo Metropolitan Government Chemical Substance Control Guidelines.

Protecting chemical substances from immersion: Installation of sandbags



Preventing the outflow of chemical substances: Covering with a sheet

Policy Goals for 2030

Policy goals	Status quo	Specific goals
Promotion of flood control in large underground malls	Careful monitoring of evacuation routes	Enhancement of flood control plans and implementation of information communication training
Review of designation of specific areas, including landslide prone areas (whole of Tokyo)	1st round completed (September 2019)	2nd round completed (FY 2026) 3rd round completed (FY 2031)
80% of businesses in Tokyo introducing telework	57.8% (FY 2020)	80% (FY 2030)

2) Response in the event of a disaster

i Collection, analysis, and provision of information

Strengthening the system for consolidating and sharing disaster information

- For prompt information collection and smooth operation of a disaster relief office in the event of a disaster, TMG will research and verify the utilization of digital technology to promote efforts toward its commercialization.
- Rebuild the Disaster Information System (DIS), which is an important core information system for a disaster response in Tokyo, share disaster information in TMG and with related organizations, and improve disaster information provided to Tokyo residents.
- Consolidate information, such as congestion in municipal evacuation centers, by DIS to provide it through our website and L Alert, a Tokyo Disaster Preparedness App.
- Enhance the initial response system by considering a mechanism for collecting disaster information using SNS and our bureaus' drones.

Æ See "Using Drones in the Event of a Disaster" on page 30.

- Strengthen the information communication system between governments by redeveloping community radio systems, including the introduction of closed LTE[1] that enables stable communication in the event of a disaster.

Using AI at disaster sites

- Use AI for information collection to strengthen the security command structure.
- To strengthen the activities of volunteer fire corps and command activities in the event of a disaster and improve the ability to collect information, TMG will put the digital environment in place to collect and share information, hold web meetings, and provide training or guidance.
- Consider the utilization of drone videos at disaster sites.

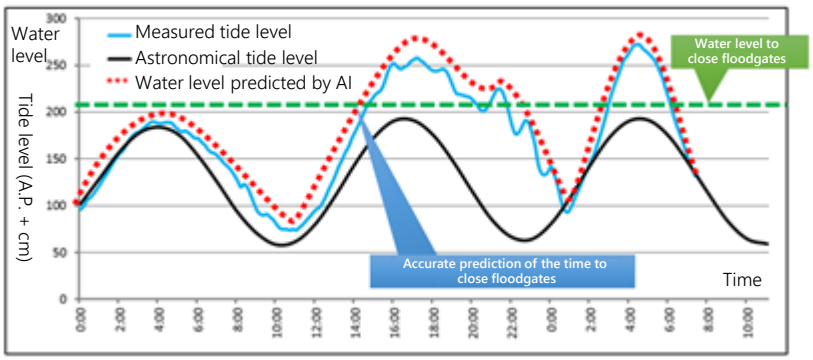
Æ See "Using Drones in the Event of a Disaster" on page 30.

1 One of the technical standards for mobile phones/mobile data communication, which has advanced 3G (3rd generation) technology to integrate voice calls with data and improve data communication speed

Using AI for predicting water levels

- Carry out research on how to build a system that supports the operation of floodgates etc. using AI to analyze various big data, such as water levels, typhoon paths, and pressure, to accurately predict water level fluctuations.
- Consider the development of inflow prediction technology that supports the operation of stormwater pumps.
- Encourage municipalities to take efficient measures for infiltration water in rainy weather by utilizing a multifunctional manhole cover that measures water levels in sewerage pipes in real time and sharing the measurements from the cover.

Water level predicted by AI when a typhoon is approaching (image)

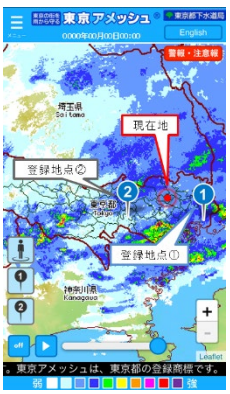


Improved provision of information on disaster preparedness

- To implement smooth flood prevention activities and encourage prompt evacuation, TMG will consider specifying additional flood forecast rivers[1] and water level information rivers[2] for which flood danger information is provided.
- Improve the provision of information on disaster preparedness to facilitate proper evacuation of Tokyo residents by strengthening the Flood Control Integrated Information System and starting the operation of the Storm Surge Disaster Prevention Information System.
- Continue to provide rainfall information through Tokyo Amesh.

Flood Control Integrated Information System

Image of a monitoring camera



Tokyo Amesh

1 Rivers at risk of flooding for which alerts are given to Tokyo residents

2 Rivers other than flood forecast rivers for which water levels are communicated to Tokyo residents in the event of possible flooding

Policy Goals for 2030

Policy goals	Status quo	Specific goals
Enhancement of the security command structure and preparation of equipment and materials by utilizing advanced technology	Considering equipment and materials for disasters that may occur in the future based on the lessons learned from past disasters	By utilizing advanced technology, the command structure to be enhanced and on-site activities to be further facilitated by robots and other innovative equipment and materials
Improvement of information sharing function using drones and advanced communication technology for better disaster preparedness on roads	Considering basic concept	Introduction to all office facilities and branch offices (end of FY 2030)
Inspection of coastal conservation facilities by drones	Basic examination and survey	Shift to full-scale operation while providing feedback on the status of test operation
Operational support for floodgates etc. by predicting water levels with AI	Analyzing learning data, creating AI models for two floodgates, evaluating prediction accuracy, etc.	Establishment of operational support for floodgates etc. by accurately predicting water level fluctuations with AI (FY 2030)
Improved provision of information on water disaster preparedness	Considering basic concept, including digital transformation, for the improved provision of information	Start of operation (FY 2023)
Installation of more river observation equipment Number of publicized river monitoring cameras Water level gauges	 38 locations (expected at the end of FY 2020) 119 locations (expected at the end of FY 2020)	 Approx. 200 locations (FY 2030) Approx. 280 locations (FY 2030)
Improved provision of information on disaster preparedness through the Storm Surge Disaster Preparedness Information System	Developing the Storm Surge Disaster Preparedness Information System	Start of system operation (FY 2021)

ii Enhancement of the system

Strengthening cooperation with related organizations

- Strengthen our seamless disaster response system by building a system to dispatch liaison staff to all municipalities in Tokyo as needed before a disaster occurs, and by improving networks for the prompt communication of information between disaster areas and the TMG Disaster Prevention Center after a disaster occurs.
- Actively implement the PDCA cycle in which we verify the cooperation with related organizations/municipalities and the operation of a disaster relief office through practical training assuming large-scale storms and flooding, and then reflect the results in various plans and manuals.

Enhancement of the cargo transport system

- Enhance the cargo transport system by concluding agreements with businesses that enable the procurement of new cargo, such as anti-infectious disease products, and conducting practical training with related organizations on the operation of logistics terminals.
- Carry out research and demonstration experiments in model areas to build a cargo transport system using drones.
- Develop a more efficient cargo transport system by building a system that enables bidirectional communication between TMG and cargo transport vehicles.

Ensuring an emergency water supply system to protect Tokyo residents in the event of a disaster

- Strengthen the emergency water supply system so that we can flexibly supply water to life-supporting medical institutions during the suspension of water supply due to a disaster.
- Carry out comprehensive training throughout the year to strengthen the crisis response capabilities of our organization and officials.

Emergency water supply from a water truck to medical institutions

Operation of HQR

- Continue to operate HQR (TFD Headquarters Rescue Operation Forces), which was established to respond to abnormal weather-caused catastrophic flood disasters, for immediate fact-finding and rescue activities.

Improvement of operation skills of disaster heavy equipment

- In addition to providing heavy machinery at disaster sites, TMG will increase the number of police officers with heavy equipment operation qualifications in order to make full use of the equipment. We will also provide guidance and joint training with operators from private businesses to improve these officers' skills and promote public-private emergency disaster control measures.

Disaster heavy equipment

Consultation system

- Set up a temporary help desk for victims in the event of a disaster to establish a system that enables us to properly deal with inquiries and requests for assistance.

Strengthening support of volunteer activities in the event of a disaster

- Train volunteer coordinators for disasters in collaboration with the Tokyo Voluntary Action Center (TVAC) to help support activities of volunteers and NPOs in the event of a disaster.
- Set up the Tokyo Disaster Volunteer Center in cooperation with TVAC in the event of a disaster to support volunteer activities in disaster areas.

Support for foreigners

- Establish a system to promptly provide multilingual disaster information through the Disaster Prevention Information website.
- Ensure faster and more streamlined work in the event of a disaster by offering training for disaster language volunteers and systematizing a matching process.
- If a disaster relief office is put in place, TMG will set up a Disaster Information Center for Foreigners to collect and provide information necessary for foreigners and offer interpretation and translation support at evacuation centers with the help of disaster language volunteers.
- For specialized consultation regarding laws and other issues typically held face-to-face, we will provide online multilingual consultation to deal with inquiries about continuing to stay in Tokyo frequently made after a disaster.

Efforts for early restoration and recovery

- To dispose of disaster waste properly, smoothly, and promptly, TMG will support the formulation of disaster waste disposal plans and manuals for municipalities and carry out wide-area collaboration and cooperation.
- Promote the development of a system to provide temporary housing and emergency repairs in the event of a disaster.

Officials dispatched for Typhoon Hagibis in 2019

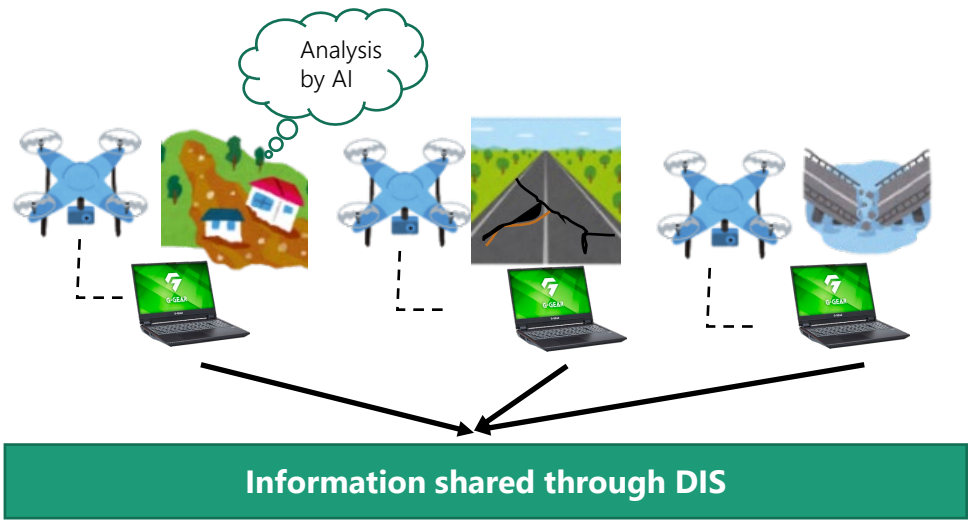
■ Using Drones in the Event of a Disaster

(1) Collecting disaster information throughout TMG

By consolidating drone image information collected by bureaus in the Disaster Information System (DIS) and sharing it in TMG and with related organizations, we will verify the information to use it for the planning and adjustment of quick-response emergency measures.

Based on the results of the demonstration experiments, we will collect landslide disaster information sent from drones, provide information analyzed and mapped by AI to related organizations, and consider a mechanism to use it for quick-response emergency measures.

Using drones for collecting information



(2) Using drones for inspection in different places

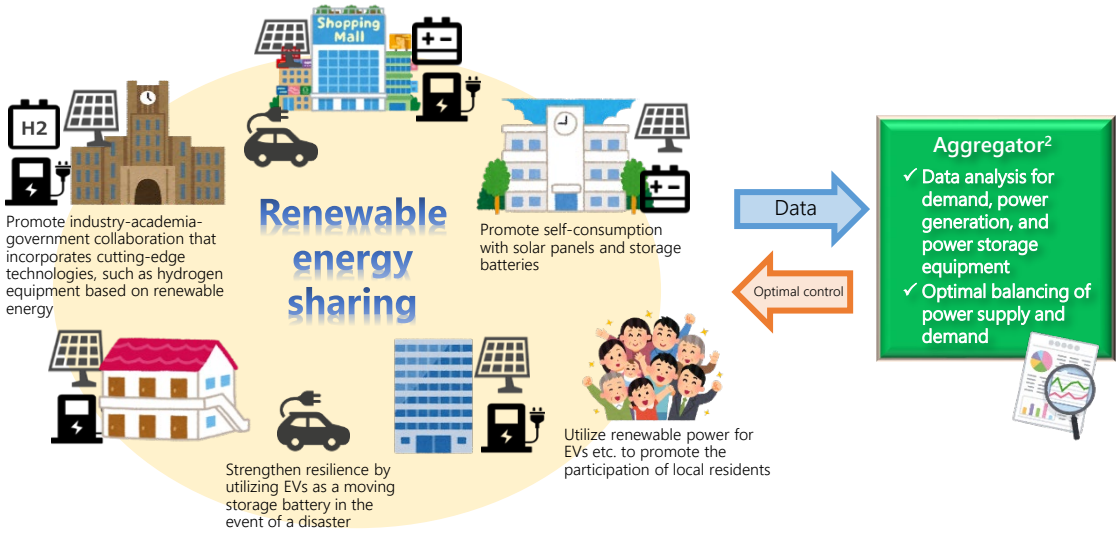
Introduce a drone video transmission system that can show drone videos from a disaster site at the Metropolitan Police Department Headquarters, and promote its operation and verification to enable the prompt deployment of our forces.

For roads, rivers, and coasts, TMG will use drones for remote inspection and sharing information in real-time, and consider developing a system to identify damage safely and promptly.

■ Sharing of Regional Renewable Energy

Promote self-consumption of renewable energy and energy sharing throughout a region for the use of regional renewable energy without any waste.

- Implement an energy sharing model project in part of the Minami-Osawa district for the efficient use of regional renewable energy, utilizing a VPP[1] mechanism to remotely control solar power generation, storage batteries, hydrogen equipment based on renewable energy, and electric vehicles (EVs) in an optimal manner.
- Effectively use renewable power for EVs etc. to promote a movement of renewable energy utilization that involves local residents and students.
- Build a model for the storage and utilization of renewable energy that realizes both energy management in normal times and resilience in the event of a disaster depending on regional characteristics, and balance supply and demand to contribute to local production and consumption of renewable energy.



*1 Virtual Power Plant. A mechanism for centrally controlling, as if it were a single power plant, demand, generation, and storage of electricity, utilizing IoT and the cloud

*2 A business that analyzes data on the demand, power generation, and power storage equipment for optimal balancing of power supply and demand

Health

Climate change impacts

Heat

The number of heat-related deaths is increasing, among the elderly in particular. While the number of heatstroke cases may differ from year to year, overall the number of people seeking emergency care, visiting a hospital, or dying from heatstroke is on the rise. While the risk of developing heat stroke largely impacts the elderly, the number of young people affected as they engage in outdoor activities is also rising due to an increase in the number of sweltering days/extremely hot days (those on which the temperature rises above 30ºC/35ºC). The effects of heat also result in poor sleep quality, fatigue, and has other health effects, including mental and physical stress.

It is predicted that rising temperatures will increase heat stress, causing more risk of heat stroke among the elderly.

It is also expected that in the 2090s the hours when it is feasible to work outdoors during the day in Tokyo and Osaka will decrease by 30-40% compared to the present, the number of days unsafe for outdoor work will increase, and the number of days when strict caution is needed for strenuous outdoor exercise will increase.

Infectious diseases

Temperature rise and changes in the spatio-temporal distribution of precipitation due to climate change may change the distributional range or active period of arthropods, such as mosquitoes, which transmit infectious diseases, and the rate of invasion or settlement of alien organisms which cause damage to humans. This may lead to a higher risk of arthropod-borne infectious diseases.

Combined effects of global warming and air pollution

For combined effects of global warming and air pollution, it is reported that the concentrations of various pollutants have changed due to the promotion of formation reaction caused by rising temperatures. For example, higher concentrations of fine particulate matter (PM2.5) and photochemical oxidants may worsen health hazards.

Efforts for the Future

TMG will further strengthen appropriate preventive and ex-post measures to minimize adverse health effects due to temperature rise, such as patients with heat stroke or infectious diseases and health hazards caused by air pollution.

(1) Heat countermeasures

Fostering momentum and raising public awareness of heat countermeasures

- Foster momentum for "Uchimizu" (water sprinkling) and other heat countermeasures through the distribution of "Uchimizu" goods and public relations activities.
- Communicate the knowledge and expertise in heat countermeasures gained by the Tokyo 2020 Games to Tokyo residents and businesses.

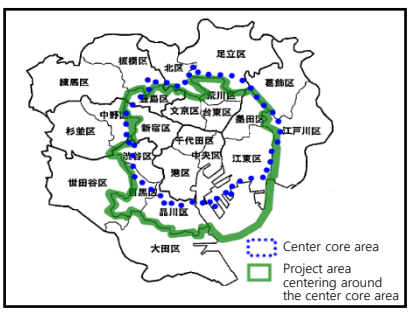
Example of installation of fine misting devices (OASE Shibaura, Minato-ku)

Creation of cool spots

- Install heat countermeasure equipment, including fine misting devices, in cooperation with municipalities.

Construction of heat blocking pavement etc.

- Construct a total of approximately 245 km of heat blocking and water-retaining pavements on Tokyo metropolitan roads in the priority area centering around the center core area by FY 2030.



Promotion of urban greening

- Steadily operate the Greenery Program in development and building plans aiming for the creation of high-quality greenery throughout the city and ensure greenery by encouraging active efforts of the private sector through the Urban Redevelopment Systems.
- To conserve agricultural land in urbanization promotion areas, which is in marked decline, TMG will promote the designation as productive green land or specific productive green land in cooperation with municipalities.
- To ensure the quality of roadside trees whose numbers have been doubled by the roadside tree enhancement project, we will utilize digital technology in the roadside tree project to manage them in a prompt and efficient manner. We will also maintain roadside trees as a green infrastructure suitable for street space in the future.

Heat countermeasures in residential buildings

- Increase the number of Tokyo Zero Emission Houses with high heat insulation and energy efficiency performance, furnished with highly insulated windows to block heat in summer and high-efficiency air conditioners, in order to diminish the high incidence of home-based heat stroke. Support the efforts of municipalities that apply heat-shielding paint to residential buildings or encourage the uptake of refurbished home appliances with high energy efficiency performance.

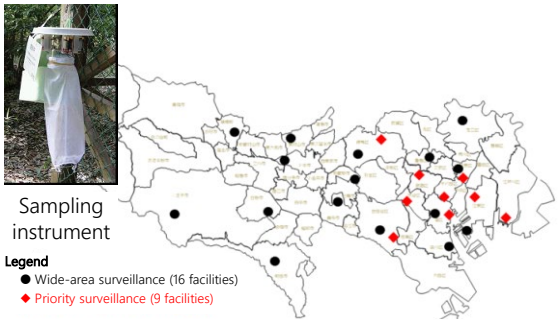
Development and utilization of smart poles

- Collect temperature and humidity data through smart poles to be used for heat countermeasures and other initiatives.

(2) Countermeasures for infectious diseases

Countermeasures for mosquito-borne infectious diseases

- Reduce the risk of infectious disease outbreak by providing information on the occurrence of mosquito-borne infectious diseases, infection prevention measures, and appropriate measures to control mosquito sources.
- Conduct surveillance of mosquitoes, which transmit infectious diseases, and ensure an inspection system for pathogens.



Map of surveillance points (priority and wide area)

Measures against alien species which cause damage to humans

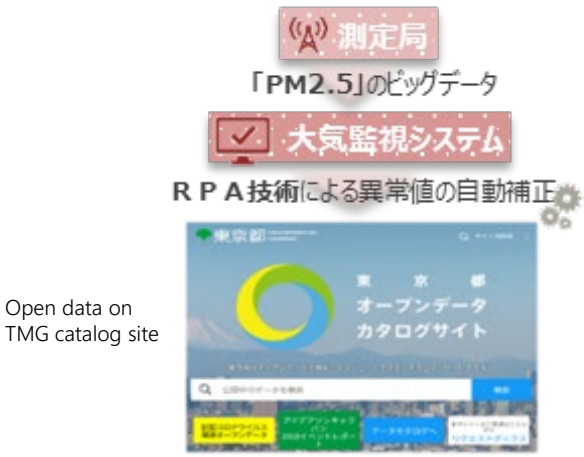
- Since there is concern about an increased risk of invasion and settlement of alien species, such as fire ants that breed in a hot and humid environment, TMG will reduce the risk to the lives and health of Tokyo residents by working with the national government and municipalities, conducting surveillance of fire ants, and raising awareness of Tokyo residents.

Fire ant

(3) Measures for air pollution

Reduction of air pollutant emissions

- To reduce the concentrations of PM2.5 and photochemical oxidants, TMG will reduce the emissions of causative substances by encouraging measures taken at factories, vehicle emission reduction measures, and voluntary efforts by businesses.
- Work with other members of the Nine Local Governments Coalition to analyze the mechanism and take measures accordingly as air pollutants and their causative substances move across prefectural borders.
- Make air quality data available as open data in order to link it with measures for air pollution that make use of 5G, AI, and other state-of-the-art technologies.



Open data on TMG catalog site

RPA[1] technology is used for faster publication of data for PM2.5 etc.

1 Robotic Process Automation. A technology that automates input and checking work manually performed on a personal computer according to a preset program

Policy goals for 2030

Policy goals	Status quo	Specific goals
Implementation of heat blocking pavement on Tokyo metropolitan roads	145 km (FY 2019)	245 km (FY 2030)
Creation of good greenery on private land (repeat)	Insufficient good greenery in the downtown	Good greenery increased in the city in line with development by private sector
PM2.5 concentration	Average of all monitoring stations = 10.8 μg/m^3 (FY 2019)	Average of all monitoring stations to be 10 μg/m^3 or less (FY 2030)
Photochemical oxidant concentration	Environmental standard achievement rate = 0% (FY 2019)	0.07 ppm or less at all monitoring stations (FY 2030)

Agriculture, forestry and fisheries

Climate change impacts

Horticultural crops (flowers and vegetables)

For open-field vegetables, leaf vegetables, such as komatsuna (brassica vegetable), and root vegetables, such as radish, are harvested earlier due to higher temperatures. Poor growth at early stages of development has been increasing under high temperatures and dry conditions. In addition, fruit and vegetables also suffer from poor fruit set due to high temperatures, which appears prominently in tomato cultivation at facilities.

Fruit

As for fruit in general, such as Japanese pears, germination and flowering have been accelerated because of warmer winter and spring seasons. This has resulted in damage, such as the death of flower buds and young shoots due to frost damage afterward. High temperatures in summer have caused problems, including poor coloration of grapes and sunburn on Japanese pears, kiwis, and other fruits. High temperatures and low rainfall following the fruit growth phase have brought about physiological disorders, including water core and cracking[1].

Stockbreeding

For dairy cows and laying hens, measures such as ventilation and watering can be taken to reduce impacts. However, it is predicted that global warming will cause a decrease in milk production, declined egg production rates, and more soft shell eggs. Depending on breeding conditions, it is expected that global warming will expand areas where the growth of hogs and poultry will slow down, as well as increase the levels of the slowdown.

Diseases and pests

Pests that prefer high temperatures, such as spider mites, codling moths, and thrips, have been occurring frequently and their periods of occurrence have been prolonged. There has been no increase in diseases clearly caused by climate change. However, damage to agricultural crops may be expanded due to the increased occurrence of pests or expansion of their distributional ranges.

Agricultural production bases

An increase in extreme weather phenomena, such as abundant rainfall and droughts, and annual average temperature rise, are expected to affect agricultural land that is the basis of agricultural production across Japan. In addition, it is predicted that more frequent heavy rains in recent years will increase the risk of flooding in agricultural areas.

Forestry

Temperature rise and changes in precipitation patterns may increase water stress due to a dry atmosphere, leading to a decline in planted cedar forests.

Fisheries

Catches of migratory fish may decrease due to sea temperature rising. For coastal and sessile species, it is predicted that catches of lefteye flounder, red sea bream, and black abalone will decrease in the long term. Seaweeds that make up seagrass beds are expected to be affected in the short term as well, depending on their species[2].

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1 Ministry of Agriculture, Forestry and Fisheries. Global Warming Impact Investigation Report 2020, October 2020

2 Hisami Kuwahara, Sadamitsu Aketa, Satoshi Kobayashi, Akira Takeshita, Hiroshi Yamashita, Katsutoshi Kido. Prediction of changes in the distributional ranges of aquatic organisms in Japan due to global warming. Global Environment Vol. 11 No. 1, 2006 (Japanese)

Efforts for the future

In response to concern about changes in suitable cultivation areas and deterioration in quality due to climate change impacts and damage caused by typhoons, TMG will realize robust agriculture, forestry, and fisheries industries by providing technical support for and promoting the spread of switching to items and varieties compatible with temperature rise, developing agricultural facilities, and researching the impacts of changes in the marine environment.

Promotion of Tokyo-Style Smart Agriculture

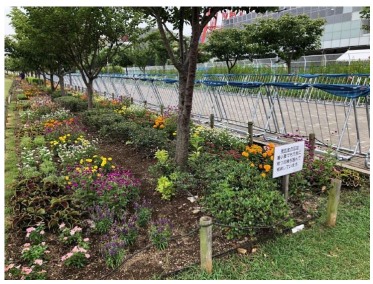
- Promote Tokyo-Style Smart Agriculture that maintains stable agricultural production even under climate change, including large typhoons and extreme heat, and realizes high profits even on a small scale.

â See "Tokyo-Style Smart Agriculture Project" on page 39.

Agricultural technical guidance on climate change, including dissemination of flower seedlings that are resilient in summer and measures for summer heat

- To promote the use of heat-resistant flower seedlings, TMG will supply flower seedlings of excellent items that have passed verification tests in the production and supply project for summer-resistant flower seedlings.
- Work on important regional issues, such as measures against high temperatures for agricultural products, at the Agricultural Development Center, which provides consultation and raises awareness on issues based on the needs of farmers and production organizations

Supply of summer-resistant flower seedlings at Tokyo Metropolitan Mizumoto Park in July 2020

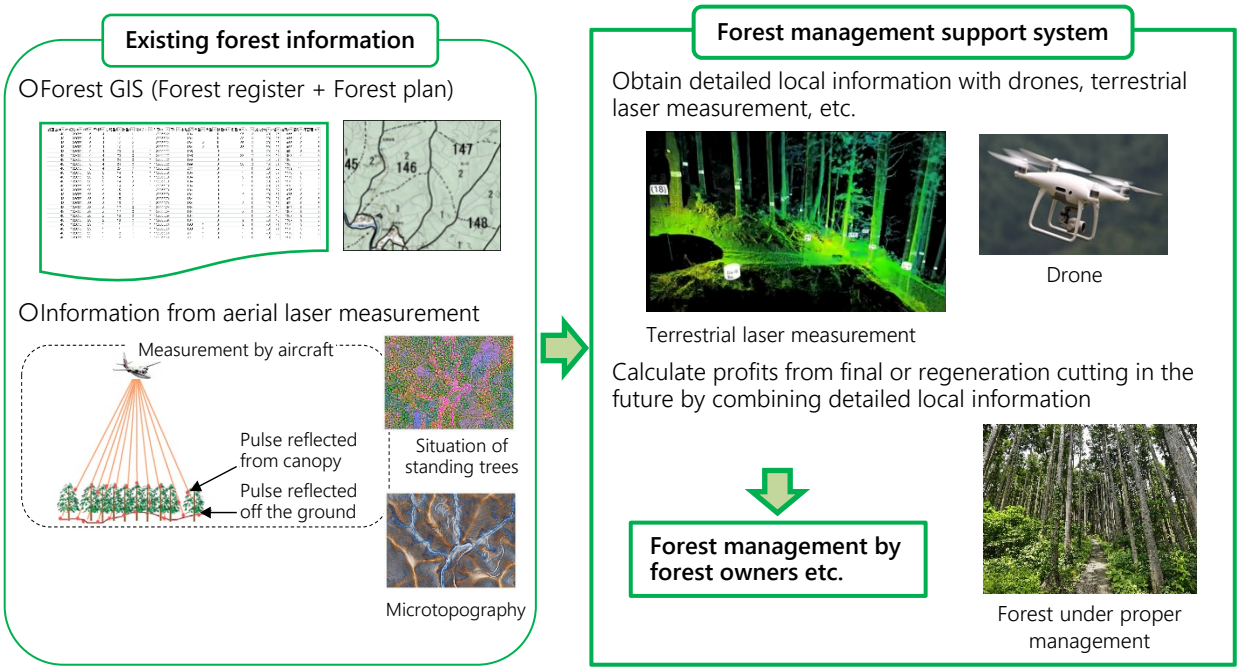


Supply of summer-resistant flower seedlings at Triathlon Pre-Tournament Venue in August 2019

Development of forests resistant to forest disasters (smart forestry)

- Build and operate a forest management support system that helps create a forest management plan, guidelines for the forest management by municipalities, forest owners, and forest management entities. Promote proper forest management and forest circulation by using the information obtained with cutting-edge technologies, such as drones and laser measurement, in the system.

Scheme of forest management support



Development of marine product supply infrastructure (smart fisheries)

- Using fishing ground environment observation services based on state-of-the-art systems, TMG will provide forecast information on conditions of each fishing ground, such as seawater temperature, direction and velocity of current, to assist fishermen in preparing for future impacts at their own discretion.

Policy goals for 2030

Policy goals	Status quo	Specific goals
Increased output per farmer	4.9 million yen (FY 2018)	8.0 million yen (FY 2030)

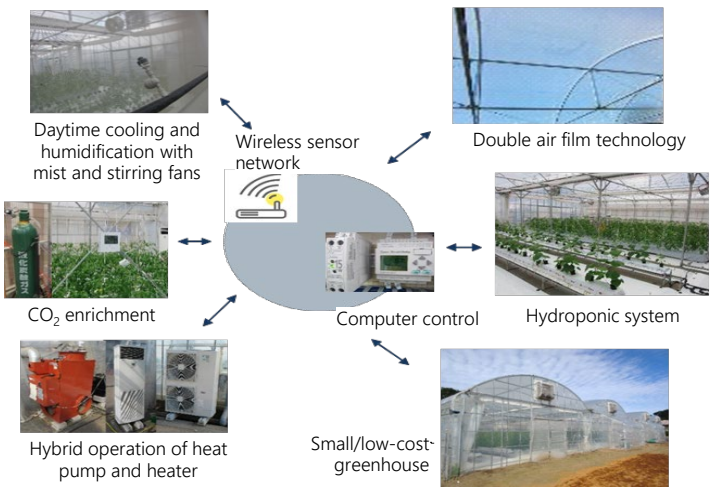
Major Efforts through DX

■ Tokyo-Style Smart Agriculture Project

To maintain stable agricultural production even under climate change, including large typhoons and extreme heat, and realize "agriculture that gains," TMG will promote Tokyo-Style Smart Agriculture that realizes high profits even on a small scale by making use of IoT, AI, and other advanced technologies. We will operate a research and development platform consisting of various sectors, such as private businesses, research institutes, and producers, and move ahead with research and development in the following three fields:

(1) Tokyo Future Agrisystem (small solar-powered plant factory)

Tokyo Future Agrisystem is an agricultural facility which realizes profitable agricultural management on small lots of agricultural land. It enhances wind resistance with thicker aggregates and allows more sunshine into greenhouses by reducing the number of aggregates. With an integrated environmental control system based on digital technology, it enables labor-saving control of temperature and other environmental conditions during extremely hot seasons. It incorporates a hydroponic cultivation system that does not generate waste liquid, causing a low environmental load. TMG will consider a verification test of expanding coverage to strawberries based on the knowledge of tomatoes and cucumbers we have developed and additional cost savings in facilities and equipment by taking advantage of small computers.



(2) Technical verification of new agricultural systems built on IoT, AI, and other advanced technologies

Based on the needs of producers in Tokyo and a nationwide survey of the utilization of advanced technology, TMG will conduct verification tests of new elements of agriculture, such as a farm stand support system, an environmentally controlled cultivation system for fruit tree root restriction cultivation, and systems using lightweight flexible solar cells.

(3) Development of new agricultural technologies based on local 5G

In collaboration with private businesses, TMG aims to implement new agricultural technologies using local 5G, which incorporate advanced technologies, such as ultra-high resolution cameras, smart glasses, and autonomous driving robots.

Water resources and water environment

Climate change impacts

Water resources

Nine droughts have occurred in summer and winter since 1989 along the Tone River system, a major water source for Tokyo.

The available amount of water resources is expected to decrease due to larger fluctuations in annual and seasonal precipitation, more frequent light rainfall, changes in seasonal precipitation patterns, decrease in the amount of snow, and earlier snow melting[1].

In addition, temperature rise due to climate change may increase demand for urban water, including potable water and cooling water.

Water environment

Climate change is expected to cause changes in water temperature, water quality, and outflow characteristics of nutrient salts from the basin.

Predictions for rivers include: the possibility of more frequent heavy rains and torrential rains to cause worsening turbidity through more outflow of earth and sand, less dissolved oxygen due to higher water temperature, promotion of organic matter decomposition by microorganisms, and increased algae.

For enclosed sea areas, an increase in surface seawater temperature has been reported. In addition, it is expected that saltwater will run up to broader coastal areas as the sea level rises.

1 Watanabe. Global Warming and Water Issues in the World and Japan. Water Resources and Environmental Studies Vol. 21 pp. 15-24, 2008

Efforts for the Future

TMG will reduce the risks posed by severe droughts and deterioration of raw water quality as much as possible to ensure stable supply of high-quality tap water.

We will create a comfortable water environment through improvements in water quality by enhancing the combined sewer system and developing advanced treatment facilities as well as through maintenance and improvement of the water quality of rivers and canals. In addition, we will continue monitoring.

(1) Stable supply of high-quality tap water

More stable water supply

- Double water conveyance facilities to improve the stability of water supply.

Conservation and management of water conservation forests

- Implement thinning, pruning, and other conservation tasks and take measures against deer damage in water conservation forests to enhance their capability.
- Purchase devastated privately owned forests and cooperate with local governments to restore such forests.
- Efficiently conserve and manage water conservation forests by using drones for checking forest conditions in ordinary times and on-site investigations in the event of a disaster.

A distant view of a collapsed area (Photo taken by a drone)

A close-up view of a collapsed area (Photo taken by a drone)

Using drones for checking conditions in ordinary times and on-site investigations in times of a disaster

Ensuring correct and effective purification for changes in raw water quality

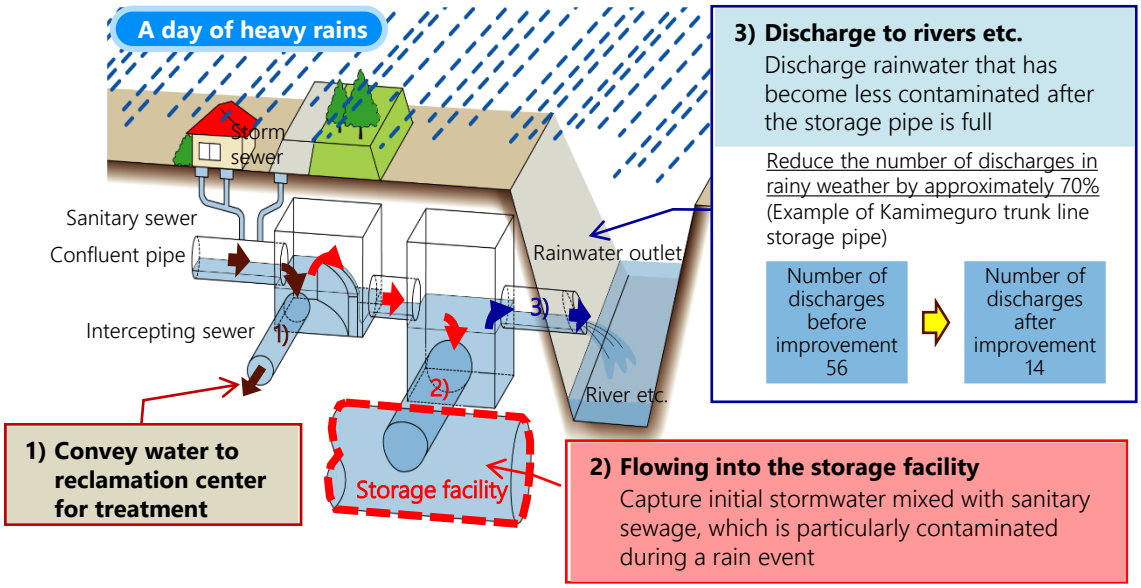
- Consider more efficient maintenance of purification plants by introducing new purification technologies, reducing the environmental load, and introducing ICT and other latest technologies.

(2) Measures for preservation of water quality of public water bodies

Improvement of the combined sewer system

- Strive to reduce pollution load discharged to rivers or the sea through the continuous improvement of the combined sewer system, such as the development of facilities to capture initial stormwater mixed with sanitary sewage, which is particularly contaminated during a rain event in a river section where water tends to accumulate, and the introduction of a separate sewer system for some public facilities and development districts.

Capturing initial stormwater mixed with sanitary sewage, which is particularly contaminated during a rain event



Improvement of quality of treated water

- Introduce advanced and semi-advanced treatment facilities at water reclamation centers to further improve the quality of treated sewage.

Dredging sludge from rivers and canals systematically

- Systematically dredge sludge from tidal rivers and canals, including Sumida River, to improve water quality and prevent bad odors.

Monitoring of water quality as well as research and study of aquatic organisms

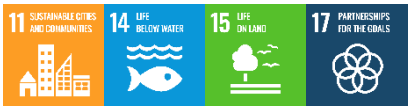
- Continue monitoring of water quality as well as research and study of aquatic organisms to verify the effects of initiatives and identify the improvements in the waterfront environment for better initiatives in the future.

Research and study of aquatic organisms

Policy Goals for 2030

Policy goals	Status quo	Specific goals
Double water conveyance facilities (repeat)	Construction at one facility Research and design at one facility Research at one facility (FY 2019)	Completion of one facility Construction at three facilities (FY 2030) Four water conveyance channels completed (FY 2036)
Conservation and management of water conservation forests (repeat)	Properly managing water conservation forests	Conservation of 3,000 ha (600 ha/year during five years from FY 2020 to 2024)
Development of a purification plant to compensate for the reduction in capacity due to renovation of the Higashi-murayama Purification Plant	Design at one facility Research at one facility (FY 2019)	Construction at two facilities (FY 2030) Completion of two facilities (FY 2036)
Capacity of storage facilities	1.50 million m^3 (FY 2019)	1.70 million m^3 (FY 2022)
Capacity of advanced treatment plus semi-advanced treatment	4.11 million m^3/day (FY 2019)	7.82 million m^3/day (medium- to long-term)

Natural environment



Climate Change Impacts

Terrestrial ecosystem

Regarding natural and secondary forests, the suitable habitat of many component species of cool-temperate forests is expected to shrink as it moves to higher latitudes and higher elevations while the suitable habitat of many component species of warm-temperate forests is expected to expand as it moves to high latitudes and high elevations.

It is predicted that the habitat of wild animals and birds, such as Cervus nippon, will expand due to temperature rise and shorter periods of snow cover.

Freshwater ecosystem[1]

In lakes, reservoirs and rivers, the algae production rate will increase due to temperature rise and an increase in CO_2. However, in a freshwater ecosystem with poor supply of nutrient salts, high trophic level production is predicted to decrease because the ecosystem's quality as feed degrades as algae increases.

Coastal and marine ecosystems

In subtropical areas, coral bleaching has already occurred due to sea temperature rising. It is predicted that sea areas suitable for the growth of reef-building corals may disappear by 2040 due to higher water temperature and ocean acidification.

In Tokyo Bay, wintering of southern hemisphere green mussels native to Southeast Asia has been confirmed. In addition, there have been changes, such as southern hemisphere butterfly fish, which used to be seen only in summer, now being seen after autumn.

Biological seasons

Impacts on various species are predicted, including earlier flowering dates of Somei-Yoshino cherry trees. It is expected that there will be impacts on not only individual species but also various interactions between species.

Changes in distribution and populations

A study mentions the possibility that there will be changes in distributional ranges and life cycles, changes in species interactions due to the migration or local extinction of species will cause further adverse effects, and habitat fragmentation will prevent species migration following climate change, resulting in the extinction of species.

It is predicted that climate change will lead to changes in the invasion and settlement rates of alien species.

1 Urabe J., J. Togari, and J. J. Elser, 2003: Stoichiometric impacts of increased carbon dioxide on a planktonic herbivore, Global Change Biology, 9, 818-825

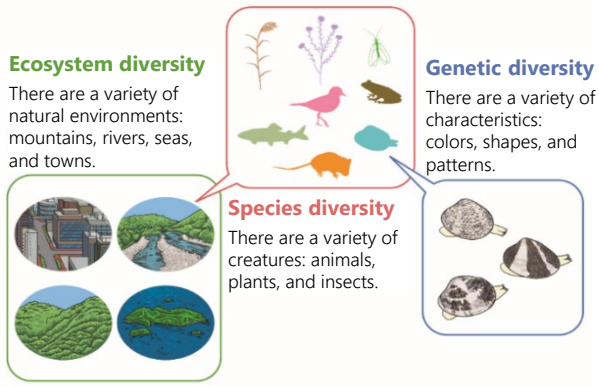
Efforts for the Future

TMG will minimize impacts on biodiversity, such as changes in the distribution of organisms, resulting from the impacts of climate change. In order to improve resilience, we will strive to enhance efforts to utilize and restore the functions of the natural environment.

Revision of a local biodiversity strategy

- Revise a local biodiversity strategy as a cross-bureau, medium- to long-term comprehensive plan for biodiversity in Tokyo, and encourage the sustainable use of natural resources, understanding of nature, and pro-environmental behavior.
- Through this strategy, TMG will reaffirm the various functions of the natural environment to actively use them in green infrastructure for the purpose of the conservation and restoration of nature.

Three levels of biodiversity



Expansion of conservation areas to protect valuable biodiversity

- By designating parcels of good natural land as conservation areas and appropriately conserving and managing them, TMG will maintain such areas to serve as a base for biodiversity in Tokyo and reduce flood damage through the drainage of rainwater.

Reforestation in the Tama area

- To restore public benefits of plantation forests of Japanese cedar and cypress in the Tama area that have been devastated, we will ensure their reforestation through thinning and pruning.

Devastated forest

No light enters the forest resulting in poor understory

Good forest several years after thinning

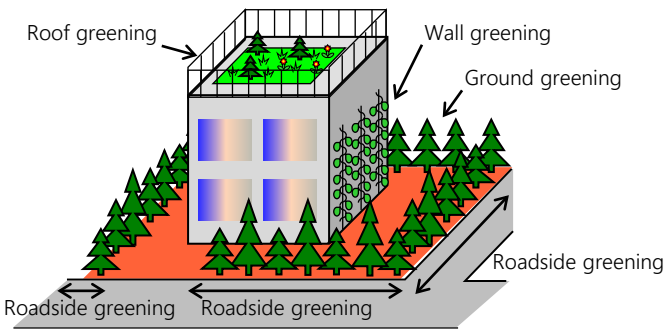
Light enters the forest allowing for plenty of understory

Creation and conservation of greenery

- Steadily operate the Greenery Program in development and building plans aiming for creating high-quality greenery in every space of the city, ensure greenery and improve its quality by encouraging active efforts of the private sector through the Urban Redevelopment Systems.
- To conserve agricultural land in urbanization promotion areas, which is in marked decline, TMG will promote the designation as productive green land or specific productive green land in cooperation with municipalities
- Secure green spaces by steadily operating the Development Permit System in development that involves alteration of natural land.

Create new greenery to promote greening in urban districts

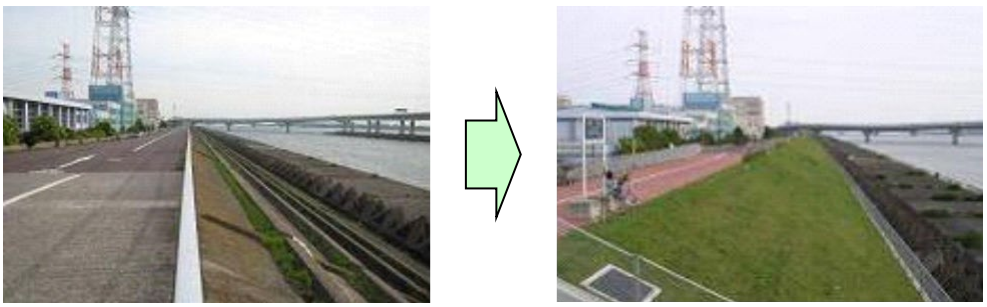
Greenery Program



- Systematically promote the greening of riverbanks, which are valuable waterfront areas in central Tokyo, and implement efforts to improve the quality of river facilities by making use of the natural environment.
- Promote appropriate maintenance of park forests to improve their comfort and safety according to the characteristics of each park. TMG will also improve the quality of greenery by efficiently maintaining roadside trees.

Cover the concrete levee with soil to green it with grass

Promotion of greening riverbanks and waterfront areas



Nakagawa River before greening　　Nakagawa River after greening

Environmental improvement of Tokyo Metropolitan parks and marine parks

- In 31 Tokyo Metropolitan parks, which are the bases of local ecosystems, TMG will carry out adaptive management[1] by focusing on environmental improvement, monitoring species, and facilitating cooperation and information sharing between stakeholders. To secure a habitat for wild birds and aquatic organisms in marine parks, we will not only promote the development and expansion of beaches, tidal flats, and rocky shores, but also monitor them.

A reservoir maintained in a Tokyo Metropolitan park

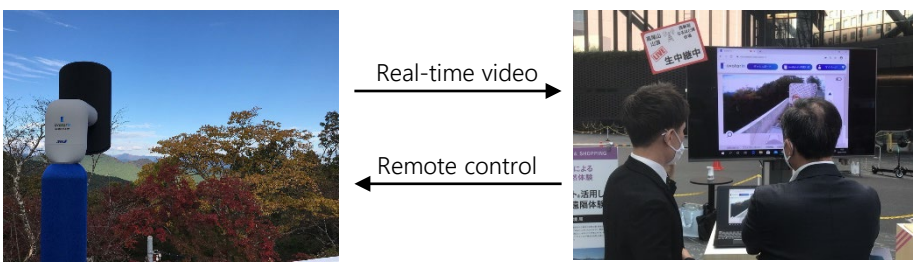
A Japanese brown frog (rare species) found in the reservoir

An example of the regeneration and conservation of tidal flats (artificial tidal flat in Kasai Kaihin Park)

Promoting the conservation and sustainable use of natural parks

- Promote the conservation and proper use of natural parks by deploying rangers and deepen users' understanding of the value of nature by using digital technology.

Using digital technology



Proper management of wildlife

- To prevent deer damage to agriculture, forestry, and ecosystems, TMG will, based on the deer management plan, conduct monitoring surveys, install and manage vegetation protection fences, and promote capture enhancement and damage control measures while verifying the progress and effects of the projects.
- Promote the protection of rare species in their conservation areas and strengthen measures against alien species in cooperation with municipalities.

1 A management method which considers in advance that natural uncertainties may cause a situation unexpected in an original plan, verifies the situation through monitoring, and flexibly responds to it based on consensus built with various actors

Policy Goals for 2030

Policy goals	Status quo	Specific goals
Designating or making publicly-owned additional conservation areas (repeat)	Approx. 758 ha (FY 2019)	Expansion by approx. 100ha (FY 2050)
Creation of good greenery on private land (repeat)	Insufficient good greenery in the downtown	Good greenery increased in the city in line with development by private sector
Promotion of greening riverside banks and waterfront areas	Approx. 2.7 ha (expected at the end of FY 2020)	Promotion of additional greening of approx. 17.7 ha (FY 2030)
Development of a waterfront environment in marine parks	Three parks developed (FY 2020)	Five parks developed (FY 2028)
Implementation of a regular monitoring survey on tidal flats	Two parks surveyed (FY 2020)	Continuation of the regular survey
Enhancement of rare species measures in their conservation areas	25 areas (FY 2019)	All 50 areas (FY 2024)

5. Promotion of Adaptation Measures

Implementation System

Cooperation within TMG

Climate change affects various fields. Since we need to consider and implement adaptation measures for the impacts of climate change for each sector and in a cross-sectoral manner, TMG will strongly promote adaptation measures under the promotional system throughout the government, by means of the progress management ensured with the PDCA cycle, and in cooperation with our bureaus.

Establishment of Local Climate Change Adaptation Center

For the establishment of a Local Climate Change Adaptation Center based on Article 13 of the Climate Change Adaptation Act, TMG is preparing to set up in FY 2021 the Tokyo Climate Change Adaptation Center (tentative name) in the Tokyo Metropolitan Research Institute for Environmental Protection of the Tokyo Environmental Public Service Corporation, which has been engaged in research on countermeasures for the urban heat island effect.

TMG will collaborate with the center to collect, organize, analyze, and provide information on climate change impacts and adaptation to climate change.

Role of the Center

- Collection, organization, and analysis of information

  Collect, organize, and analyze information on the actual conditions of temperature etc. in Tokyo and neighboring areas, impacts of climate change, and examples of climate change adaptation measures at home and abroad.

  Cooperate with related organizations by participating in councils established by the national government and sharing information with the Climate Change Adaptation Center in the National Institute for Environmental Studies and related research institutes.

- Providing information, raising public awareness, and giving advice

  Provide information and advice on climate change to local governments in Tokyo and raise awareness of Tokyo residents in cooperation with TMG.

Tokyo Metropolitan Research Institute for Environmental Protection

Role of Each Actor

Role of TMG

To encourage efforts for adaptation by Tokyo residents and businesses, TMG will actively provide information on climate change impacts and adaptation measures in cooperation with the national government, National Institute for Environmental Studies, and Local Climate Change Adaptation Center. TMG will address present and future climate change impacts by incorporating the perspective of adaptation into all of our initiatives.

At the same time, we will support efforts of municipalities developing community-based initiatives by strengthening cooperation with them.

Role of Municipalities

Municipalities are required to formulate a local climate change adaptation plan, ensure cooperation among related departments to actively incorporate climate change adaptation into relevant initiatives according to the natural, economic, and social circumstances of their local area, and promote policies regarding climate change adaptation in each field.

Role of Tokyo Residents

Tokyo residents are required to deepen their understanding of climate change impacts by utilizing information provided by the national government and TMG, and promote efforts to address climate change impacts by collecting information on the impacts by themselves.

Role of Businesses

Businesses are required to deepen their understanding of adaptation measures for climate change and climate change impacts on their business activities by utilizing information provided by the national government and TMG, and develop operations with the perspective of climate change adaptation embedded, keeping future climate change firmly in mind.

Tokyo Climate Change Adaptation Plan

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8-1 Nishi-Shinjuku 2-chome, Shinjuku-ku, Tokyo 163-8001

TEL (03)5388-3427