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Report on a Study of International Cooperation in the Water Supply Sector

International Cooperation as Countermeasures against the Impacts of Climate Change

March 2023

Japan International Corporation of Welfare Services
JICWELS

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Abbreviations

AAD	Advanced Anaerobic Digestion
AC	Aggregation Coordinator
ADB	Asian Development Bank
AFD	Agence Française de Développement
Anammox	Anaerobic ammonium oxidation
BEV	Battery Electric Vehicle
BTM	Behind-the-meter
CAKE	Climate Adaptation Knowledge Exchange
CCD	Climate Change Department
CDC	Council for the Development of Cambodia
CHP	Combined Heat & Power
CoE	Center of Excellence
COP21	Conference of Parties 21
CRDB	Cambodian Rehabilitation and Development Board
CWA	Cambodian Water Supply Association
DMA	District Metered Area
DR	Demand Response
DX	Digital Transformation
EAC	Electricity Authority of Cambodia
EDC	Electricite du Cambodge
EIB	European Investment Bank
EPC	Engineering, Procurement and Construction
ESG	Environment, Social and Governance
EU	European Union
FOIP	Free and Open Indo-Pacific
FWP	French Water Partnership
GCF	Green Climate Fund
GHGs	Greenhouse Gases
ICT	Information and Communication Technology
IEA	International Energy Agency
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
JMP	Joint Monitoring Programme for Water Supply, Sanitation and Hygiene
JWRC	Japan Water Research Center
KPI	Key Performance Indicator
LED	Light Emitting Diode
MAFF	Ministry of Agriculture, Forestry and Fisheries
MIME	Ministry of Industry, Mines and Energy
MISTI	Ministry of Industry, Science, Technology & Innovation
MME	Ministry of Mines and Energy

MOE	Ministry of Environment
MPWT	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
NCCC	National Climate Change Committee
NCSD	The National Council for Sustainable Development
NEPCO	National Electric Power Company
NFWR	National Framework for Water Resources
NGO	Nongovernmental Organization
Nitrite-Shunt	Nitrite-Shunt
NOAA	National Oceanic and Atmospheric Administration
ODA	Official Development Assistance
PE	Polyethylene
PHEV	Plug-in Hybrid Electric Vehicle
PPA	Power Purchase Agreement
PPWSA	Phnom Penh Water Supply Authority
PVC	Polyvinyl chloride
RE100	Renewable Energy 100%
SAWACO	Saigon Water Corporation
SBTi	Science Base Targets Initiative
SDGs	Sustainable Development Goals
TCFD	Task Force on Climate-related Financial Disclosures
TNFD	Task Force on Nature-related Financial Disclosures
THP	Thermal Hydrolysis Pretreatment
UHC	Universal Health Coverage
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
US EPA	U.S. Environmental Protection Agency
VPP	Virtual Power Plant
WDF	Water Development Fund
WHO	World Health Organization
WSAA	Water Services Association of Australia
ZEB	Net Zero Energy Building

Chapter 1 Policy for the FY2022 Study of International Cooperation in the Water Supply Sector

1-1 Descriptions

(1) Background and history

In September 2015, the Sustainable Development Goals (SDGs) were unanimously adopted by the member nations of the United Nations General Assembly. The goal of the water and sanitation sectors was to secure availability and sustainable management of water and sanitation for all people. Under this goal, the UN set SDG target 6.1, which is, *by 2030, achieve universal and equitable access to safe and affordable drinking water for all*. Currently, efforts to achieve this target are being made around the world. The latest report from the Joint Monitoring Programme (JMP) managed by the United Nations International Children's Emergency Fund (UNICEF) and the World Health Organization (WHO) titled *Progress on Household Drinking Water and Sanitation and Hygiene 2000-2020* pointed out that billions of people around the world will still have no access to safely managed drinking water, safely managed sanitation, or basic hygiene services at home even in 2030 unless the rate of progress quadruples, calling for even further efficient as well as effective efforts. Climate change is predicted to have a significant impact on water facilities, water quality, and water volume. There is also a concern for the impact on water business. Effects presumably of climate change have already been witnessed in many parts of the world. Citizens' daily living and urban activities are seriously affected when a massive flood severely damages water facilities, causing extensive water stoppages that put limitations on core infrastructure or lifelines. To respond to such effects, some water suppliers inside and outside Japan have included their climate adaptation measures in their water safety plans. In 2017, the WHO issued the Water Safety Plan Manual that would withstand climate change and is recommending individual countries develop resilience against climate change in order to appropriately manage future risks and stably supply safe and high-quality water. While many countries including Japan have pledged to achieve carbon neutrality around 2050, water business uses approximately 1% of all electricity in Japan, requiring significant efforts to reconsider the power source in the water supply sector. In February 2015, the Japanese government reviewed the Official Development Assistance (ODA) Charter and formulated the Development Cooperation Charter, which summarizes the philosophy and the basic principles of ODA. One of the important and priority tasks in this Charter is to address global issues such as climate change, and actions include creation of a low-carbon society, adaptation to adverse effects of climate change, and promotion of development assistance. Meanwhile, the Infrastructure System Overseas Promotion Strategy 2025 approved in December 2020 stated that, *in the area of climate change measures, achieving carbon neutrality in the medium to long term requires offering of various energy shifts and decarbonization solutions that match each country's economic developmental stage and issues*, and based on this notion, the strategy highlighted the importance of co-creating, with local partners, a project to introduce high-quality Japanese infrastructure that matches the need and the finance ability of the target area and also the importance of involvement in human resource development locally. As described above, there is a need for international cooperation also for climate issues, which all humans are facing and cannot be resolved by a single nation thus requiring joint efforts of the international community. In order to promote more effective and efficient international cooperation and contribution in the water supply sector under these circumstances, we must review the past international cooperation and contributions and plan future actions.

(2) Purpose of the project

The objective of this project is to promote implementation of effective and efficient international cooperation and contribution to help the assisted nations achieve self-sustaining development of their water supply under climate change. For this purpose, experts from the business, university, and government sectors will collect, organize, and analyze information relating to climate mitigation and adaptation strategies requiring international cooperation by the water business domain as well as priority issues that must be addressed intensively in the area of international contribution, will study problem-solving approaches and assistance policies based on the needs of the assisted nations, and will share the study results with the parties concerned.

(3) Previous studies

The Ministry of Health, Labour and Welfare (MHLW) has been carrying out studies and providing recommendations with the primary focus on intangible aspects of the study theme through the Study Committee on International Cooperation in the Water Supply Sector, which was formed in this project. In FY2018, it conducted a field study in the Democratic Republic of East Timor to examine the liaison between the water and sanitation sectors from the Universal Health Coverage (UHC) point of view. Based on the study result, it concluded that both the urban and rural water supply needed improvement and recommended encouragement of local government-funded quasi-public sector entities and private sector companies in the water service management and maintenance field to participate in future international cooperation of water suppliers and preparation of the environment for Japanese companies to enter the overseas market. The FY2019 study reported that, in the area of international cooperation by the water supply sector, assistance to African regions as the key regions for international cooperation was at the stage of building the foundation and examined in great detail specific measures to be implemented to address their priority issues and how the outcomes would be monitored.

In the FY2020 study, MHLW organized the background of efforts made in this project in the past and recommendations it made for the past 10 years to review the positioning, direction, and outcome of this project. Also, since the 9th session of the Pacific Island Leaders Meeting was planned for 2021, MHLW organized information on the water supply situations of the Pacific Island nations, their issues arising from the uniqueness of the Pacific Island region, and their issues to be addressed by the entire region. It then proposed how international cooperation should take place, taking into consideration the situation of each country.

The FY2021 study focused on collaboration of water suppliers in international cooperation in the water supply sector. In this study, past activities carried out through collaboration of multiple water suppliers were examined and detailed issues about effects and implementation of international cooperation through water supplier collaboration were sorted out for each project. The study result confirmed that international cooperation through water supplier collaboration allowed for development of human resources, establishment of relationships with other water suppliers, and support for local companies in expanding their business overseas. At the same time, it also indicated that such international cooperation reduced burdens on local governments, expanded the support menu for assisted countries, and gave the first opportunity to water suppliers who planned to participate in international cooperation in the future. Based on this result, MHLW made efforts to promote collaboration of water suppliers, which was considered effective in promoting future international cooperation in the water supply sector and made

recommendations for building relationships with assisted countries whose importance was confirmed in this study.

(4) Policy for the present study

The effects of climate change are the result of a wide variety of factors creating complex causal relationships and mutually feeding into chain reactions. For example, the effects of climate change on the water supply are not just disasters such as floods or droughts due to changes in the precipitation rate; they cover a wide range of events such as changes in the ecosystem including forests and biota caused by rising temperature or disasters like floods, changes of the volume or quality of water in lakes, reservoirs, or rivers, deterioration of the water quality due to saline groundwater, and changes in water demand due to people changing where they live. Efforts to combat these events are divided into climate mitigation and climate adaptation. Climate mitigation involves reduction of greenhouse gas (GHG) emissions and GHG absorption in order to suppress climate change as much as possible. Climate adaptation is a strategy to avoid or reduce damage caused by the impact of climate change.

Efforts taking into consideration the impact of climate change have already been made in international cooperation activities carried out in various countries. In order to promote more effective efforts and to establish the sustainability of such efforts, however, it is necessary to review and assess the past efforts.

Based on the above, the present study was treated as the basic study for exploring international cooperation activities that the water supply sector could carry out as measures against the impact of climate change. By summarizing and assessing case examples of past climate change measures, the focus of the study was to gain insight for future international cooperation in the water supply sector.

1) Examination and organization of case examples of climate change measures in international cooperation in the water business domain

- Check press releases from the Japanese government and relevant ministries and agencies and outline trends in the international community and summarize Japanese government policies on climate change measures.
- From the information checked in the preceding point, extract climate change measures in the water supply sector and introduce specific case examples of efforts made.
- Study references and gather information from interviews to summarize the issues, direction of improvement, and sustainability assessment of: climate mitigation strategies related to water supply facilities; and international cooperation in the water supply sector, which takes into account climate adaptation strategies for water supply systems that withstand the impact of climate change.

  Specifically, the following projects were examined:

  ① Climate mitigation strategies
  - Grant Aid: Project for Improvement of the Zai Water Supply System in the Hashemite Kingdom of Jordan
  - Grant Aid: Project for Energy Conservation through Upgrading the Water Supply Network in the Hashemite Kingdom of Jordan
  - Grant Aid: Project for Introduction of Clean Energy by a Solar Electricity Generation System in Cambodia

- Grant Aid: A Micro-Hydroelectric Power Generation Project in the Metropolitan Area of Tegucigalpa in Honduras

② Climate adaptation strategies

- Grant Aid: Project for Improvement of the Water Reservoir at Majuro Atoll in the Marshall Islands
- Collaboration Program with the Private Sector for Disseminating Japanese Technology: Water Supply Equipment Construction Technology Dissemination and Promotion Project in Vietnam
- SME Overseas Business Expansion Support Program: Project for Reducing Non-Revenue Water and Promoting and Demonstrating Water Service Pipe Management Using a Water Leakage Detector Designed for Resin Pipes (e.g., PVC Pipes, PE Pipes) in Indonesia
- Grant Aid: Project for Improvement of the Water Supply System in Villa Hayes City, Paraguay
- Grant Aid: Project for Improvement of the Water Supply in Pokhara in Nepal
- Grant Aid: Project for Development of Water Supply Facilities of Small Towns in the Oromia Region in Ethiopia

2) Examination of Japanese water suppliers' activities to achieve carbon neutrality

Japanese water suppliers' activities to achieve the carbon neutrality goal was examined using websites of the subject water suppliers and relevant companies as well as open sources including trade papers. The types of climate mitigation and adaptation strategies they implemented were organized, and the effects of applying these strategies to developing nations was studied. At the same time, how the impact of climate change was perceived and positioned in their business strategies and plans was also studied.

3) Examination of case examples of water supply sector's activities to address the impact of climate change by water suppliers outside Japan

Using information collected through committee member interviews on case examples of water supply sector activities to address the impact of climate change by water suppliers outside Japan, case examples of projects to address the impact of climate change and the direction of business were summarized and submitted.

4) Idea development for future international cooperation under climate change

Activities by Japanese and overseas water suppliers were compared with the contents of past international cooperation, and activities not yet implemented in international cooperation were identified. Also, by grasping climate change predictions by Japanese and overseas water suppliers, ways of thinking that should be incorporated into future international cooperation were identified.

1-2 Study Task Force

(1) Committee structure

The period of the present study was one year. The Study Evaluation Committee was formed, and the study result was reported at the committee meeting, which was held three times. The committee members for the FY2022 study are listed below.

(Honorifics omitted; committee member names are in Japanese alphabetical order)

[Committee members]

Taikan Oki	Professor, Department of Civil Engineering, School of Engineering, University of Tokyo
○ Hidetoshi Kitawaki	Professor, Faculty of Global and Regional Studies, Toyo University
Masao Shibuya	International Director, Training and International Department, Japan Water Works Association (JWWA)
Keisuke Sonoda	Assistant Manager, Management and Planning Division, Operation Department, Saitama City Waterworks Bureau
Yoko Nakamura	Deputy Director for the International Affairs Team, Planning and Coordination Section, General Affairs Division, Bureau of Waterworks, Tokyo Metropolitan Government
Yusuke Hayashi	Manager, International Project Division, International Project Department, Water and Sewer Bureau, City of Kitakyushu
Kenichi Matsumoto	Manager, Shijonawate Water Supply Center, Osaka Water Supply Authority
Shigeyuki Matsumoto	Deputy Director General, and Group Director for Water Resources, Global Environment Department, JICA
Takayuki Miura	Senior Researcher, Department of Environmental Health, National Institute of Public Health
Tatsuo Morimoto	Senior Advisor, Federation of Japan Water Industries, Inc.

(○: Chairperson)

[Administrative office]

Tetsuya Itani	Director, Office of Global Health Cooperation, International Affairs Division, Minister's Secretariat and Deputy Director, Water Supply Division, Pharmaceutical Safety and Environmental Health Bureau, MHLW
Moeko Yoshitomi	Deputy Director, Office of Global Health Cooperation, International Affairs Division, Minister's Secretariat, MHLW
Takeo Yamaguchi	Technical Advisor, JICWELS
Toru Tomioka	Technical Advisor, JICWELS
Akihiro Toyama	Executive Director, JICWELS
Hiroya Yaguchi	Manager, International Cooperation and Training Department, JICWELS
Mai Isohata	International Cooperation Section, International Cooperation and Training Department, JICWELS
Sachiko Ochiai	International Cooperation Section, International Cooperation and Training Department, JICWELS
Orie Nakagawa	International Cooperation Section, International Cooperation and Training Department, JICWELS

[Observers]

Hiroyuki Yakushiji	Deputy Director, Water Supply Division, Pharmaceutical Safety and Environmental Health Bureau, MHLW
Haruka Kubota	Section Chief, Water Supply Division, Pharmaceutical Safety and Environmental Health Bureau, MHLW
Ippei Kawamoto	Intern, Water Supply Division, Pharmaceutical Safety and Environmental Health Bureau, MHLW

(2) Committee meeting schedule

The Committee meeting was held three times in FY2022. The meeting dates are listed below. Due to the novel coronavirus situation, all three meetings were held online.

[Meetings]

The 1st meeting: July 1, 2022

The 2nd meeting: November 4, 2022

The 3rd meeting: February 7, 2023

[Domestic study]

From May 2022 to February 2023

[On-site study]

September 25 to 28, 2022

Chapter 2　Japanese Government's Policy on Climate Change Measures

This chapter outlines trends of the international community and extracts information related to the Japanese government's policy on climate change measures from information materials including press releases from the Cabinet Secretariat and relevant ministries and agencies.

More specifically, Section 2-1 outlines trends of the international community and Section 2-2 provides a summary of information related to the Japanese government's policy on climate change measures collected from the Cabinet Secretariat, websites of relevant ministries and agencies, and other information sources.

2-1　Trends of the International Community

Climate change has become a threat to all countries around the world. Unless the international community quickly implements appropriate and sufficient climate change measures, climate change has a high risk of causing severe global economic and social damage through an increase of natural disasters and infections, depletion or scarcity of natural resources and food, a decrease or loss of species and natural ecosystems, and loss of national land due to a rise in the sea level. For this reason, climate change measures are one of the essential criteria for sustainable development.

Climate change measures are roughly divided into mitigation and adaptation. Mitigation strategy includes efforts to reduce greenhouse gas (GHG) emissions in various sectors of society, saving energy, GHG emissions reduction through the use of low-carbon energy such as renewable energy, and absorption of carbon dioxide (CO_2) by plants. Adaptation strategy, on the other hand, is an effort to prevent or reduce already existing adverse effects of climate change such as a rising sea level and drought.

Many developing nations are unable to implement sufficient climate change measures within their limited funds and abilities while working on their own economic development. Adaptation in particular may be a make-or-break issue to island nations and the least developed nations. For the international community as a whole to combat climate change, developed nations must provide assistance to countries that need it.

In the international community, the Conference of the Parties (COP) has been held annually since 1995 based on the United Nations Framework Convention on Climate Change (UNFCCC) signed in 1992. Active discussions have been taking place to achieve effective GHG emissions reduction on a global scale. At COP 21 held in December 2015 in Paris, France, parties signed the Paris Agreement as the new international GHG emissions reduction framework for 2020 and onwards. It set the goal of holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.

At COP 24 in December 2018, the Paris Rulebook was adopted, and parties agreed to apply the same rules to all COP member countries including developing nations. Meanwhile, the Special Report on Global Warming of 1.5ºC released by the Intergovernmental Panel on Climate Change (IPCC) in October 2018 reported that human activities have already caused warming of approximately 1ºC (between 0.8°C and 1.2°C) above pre-industrial levels, and at the current pace, the temperature is highly likely to reach 1.5ºC above the pre-industrial levels between 2030 and 2052. The report thus suggested the need for the international community as a whole to continue implementing climate change measures.

At COP 26, held from October to November in 2021 in Glasgow, Scotland, the United Kingdom, parties agreed on important issues that remained unresolved since COP 24, such as the guidelines for Section 6 (market mechanism) of the Paris Agreement, and as a result, the Paris Rulebook was completed. COP 26

also produced major achievements including an agreement on the importance of raising GHGs reduction targets.

In November 2022, COP 27 was held in Sharm el-Sheikh in Egypt where the Sharm el-Sheikh Implementation Plan, which called for intensification of efforts in all areas of climate change measures, and the mitigation action plan were adopted. The importance of making GHG emissions reduction efforts to achieve the 1.5ºC target was emphasized, and at the same time, the conference agenda focused on responses to losses and damage caused by the adverse effects of climate change, such as droughts and floods, for the first time. At the conference the parties agreed on establishment of a fund for supporting particularly vulnerable developing nations[1]. As of November 2022, the number of countries and regions that made commitments to achieving carbon neutrality by the set time limit such as 2050 reached 154 countries and one region, which accounted for about 80% of global CO_2 emissions[2].

SDG 13, adopted by the United Nation in 2015, is *Take urgent action to combat climate change and its impacts*. Under this goal five targets have been set in order to not only address climate change and its effects but also build resilience that allows responses to climate-related danger and natural disasters. Table 1 shows SDG 13 and its targets.

Table 1 SDG 13 and its Targets[3, 4]

Goal 13	Take urgent action to combat climate change and its impacts

Target	Descriptions
13.1	[Strengthening of resilience to climate risks] Strengthen resilience to and adaptive capacity for climate-related hazards and natural disasters in all countries
13.2	[Mainstreaming of climate change measures] Integrate climate change measures into national policies, strategies and planning
13.3	[Human resource development and strengthening of organizational and institutional capacity] Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
13.a	[Increase of climate funding] Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change for the goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible

[1] Ministry of Foreign Affairs: Outcome of COP27, CMP17 and CMA4
https://www.mofa.go.jp/mofaj/ic/ch/page1_001420.html

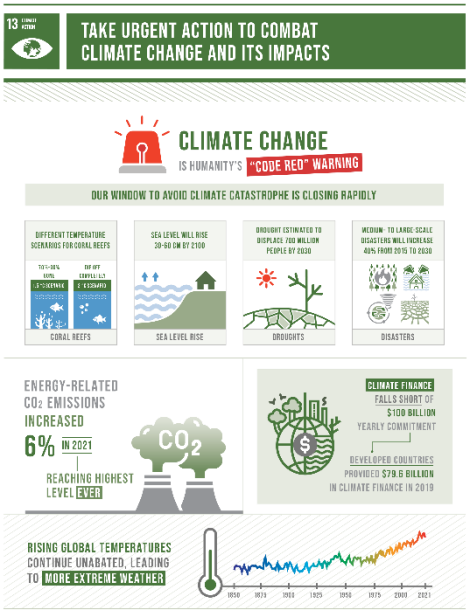
[2] FY2021 Annual Report on Energy (Japan's Energy White Paper 2022)
https://www.enecho.meti.go.jp/about/whitepaper/2022/pdf/whitepaper2022_all.pdf

[3] Ministry of Internal Affairs and Communications: Provisional indicator translation (last updated in June 2021)
https://www.soumu.go.jp/main_content/000562264.pdf

[4] Ministry of Foreign Affairs: JAPAN SDGs Action Platform (Goal 13)
https://www.mofa.go.jp/mofaj/gaiko/oda/sdgs/statistics/goal13.html

13.b	[Special consideration and support for vulnerable countries and groups] Promote mechanisms for raising capacity for effective climate change-related planning and management in the least developed countries and small island developing states, including focusing on women, youth and local and marginalized communities

According to the Sustainable Development Goals Report 2021 by the United Nations, it has been confirmed that climate finance has increased and that 125 out of 154 developing nations have formulated or are implementing their national climate adaptation plans. The climate crisis has hardly been, however, contained, and a shift to a carbon neutral economy is required in order to make the 1.5ºC scenario a reality. The Sustainable Development Goals Report 2022 released in 2022 reported that emissions of energy-related CO_2 increased by 6% in 2021, reaching a historic high, and the global temperature rise continued to induce even more extreme weather. To avoid the worse climate change impact, it is necessary to pass the peak of GHG emissions by 2025 and reduce them by 43% by 2030. However, the current level of commitment of countries would allow an increase close to 14% by 2030 and is insufficient for achievement of the 1.5ºC goal.



Source: Overview, the Sustainable Development Goals Report 2020 by the United Nations Information Centre

Water is essential in all aspects of our lives. It has social, cultural, environmental, economic, and political value, and it helps with achievement of the SDGs across areas of society while being closely related to climate, energy, cities, the environment, food security, poverty, gender equality, and health. Water plays a very important role in deciding the ability to respond to climate change and sustainable and comprehensive development and advancement, and the current situation urges us to quickly implement efforts toward achievement of SDG target 6.1. This led the United Nations to plan the 2023 Water Conference for March 2023 in New York. Five themes (Water for Health; Water for Sustainable Development; Water for Climate, Resilience, and Environment; Water for Cooperation; and Water Action Decade) have been chosen for the conference, and the Japanese government will co-chair the Theme 3 conference ‘Water for Climate,

Resilience, and Environment: Source to Sea, Biodiversity, Climate, Resilience, and Disaster Risk Reduction (DRR)[5].'

2-2 Japanese Government Policy on Climate Change Measures

(1) Policies and efforts by the Japanese government, ministries, and agencies

Table 2 summarizes climate-related actions in each policy and major efforts by the Japanese government and relevant organizations.

Table 2 Policies and efforts in climate change measures by the government, ministries, and agencies

	Item	Action related to climate change measures
Commitments by the Japanese government	Pledge to become carbon neutral	In October 2020, Japan pledged to become carbon neutral by 2050. The government announced its policy to actively implement anti-global warming measures to make changes to the industrial structure and economic society as a path to economic growth.
	The FY2030 goal	At the Leaders' Summit on Climate in April 2021, the government announced that, in order to achieve the FY2030 GHG emissions reduction goal, it will aim at a 46% reduction from the FY2013 level and continue its endeavor to reach 50%. The government decided on the policy to lead global decarbonization efforts and fulfill its responsibility for future generations[6].
	Commitment on climate finance	At COP 21, the Japanese government announced Actions for Cool Earth: ACE2.0 a contribution plan consisting of assistance to developing nations and innovation. Based on this plan, the government provided climate change-related private-public joint financial support of about 1.3 trillion yen annually from 2016 to 2020. At the G7 Summit in Cornwall in June 2021, the government announced private-public joint financial support equivalent to 6.5 trillion yen from 2021 to 2025 and also an increase of climate mitigation support. In November 2021, at the World Leaders Summit during COP 26, the government announced it was ready to provide additional financial support of up to 10 billion dollars over five years from the private and public sectors. The government added that it planned to double the support for climate mitigation, making it a total of 1.6 trillion yen-worth of support from both the private and public sectors. The government commitment was the largest of all developed nations[7].

[5] UN 2023 Water Conference https://sdgs.un.org/conferences/water2023

[6] Expert Panel on Climate Change Report (October 2021) https://www.cas.go.jp/jp/seisaku/kikouhendoutaisaku/pdf/houkokusyo.pdf

[7] Japan announced a renewed commitment of JYP 6.5 trillion on public and private climate finance over the next 5 years, from 2021 to 2025 https://www.mofa.go.jp/mofaj/ic/ch/page24_001405.html

	Item	Action related to climate change measures
	Kumamoto Initiative for Water	At the 4th Asia-Pacific Water Summit held in Kumamoto on April 23 and 24, 2022, the government described its contribution plan to realize high quality societies in the Asia Pacific region through two approaches: promotion of efforts in both climate adaptation and mitigation strategies, and promotion of efforts to improve the basic living environment. For this purpose, the government announced financial support of about 500 billion yen over the next 5 years and a plan to accelerate global water efforts primarily in the Asia Pacific region to achieve SDGs by 2030 and carbon neutrality in 2050[8].
Climate-related laws and plans	Act on Promotion of Global Warming Countermeasures	As a response to the Kyoto Protocol adopted at COP 3 held in Kyoto in 1997, this legislation was enacted in 1998 to establish a framework of efforts against global warming to be made by the national and local governments, business operators, and citizens working together. After going through revisions, the act was revised most recently in October 2020 when the Japanese government made a pledge to become carbon neutral by 2050. The revised act introducing 2050 carbon neutrality as the fundamental philosophy was approved by the Cabinet (March 2, 2021).
	Plan for Global Warming Countermeasures	It is the government's comprehensive plan based on the Act on Promotion of Global Warming Countermeasures. This plan, approved by the Cabinet on May 13, 2016, as a response to adoption of the Paris Agreement at COP 21, was revised for the first time in five years and was approved by the Cabinet on October 22, 2021. The revised plan was formulated with a new GHG emissions reduction target announced in April 2021. It covers all aspects of GHGs and draws a path toward achievement of the new FY2030 target with supporting measures and strategies[9].
	Climate Change Adaptation Act	The Act was issued in June 2018 with the objective to promote climate adaptation (Act No. 50 of 2018). It requires formulation of the Climate Change Adaptation Plan by the government, assessment of the climate change impact by the Minister of the Environment, implementation of work to promote climate adaptation by the National Institute for Environmental Studies, and collection and submission of climate adaptation information by the Local Climate Change Adaptation Center.

[8] The 4th Asia-Pacific Water Summit https://www.4apws-kumamoto2022.jp/

[9] The Ministry of the Environment: The Plan for Global Warming Countermeasures https://www.env.go.jp/earth/ondanka/keikaku/211022.html

	Item	Action related to climate change measures
	Climate Change Adaptation Plan	The plan was formulated based on the Climate Change Adaptation Act with the goal to comprehensively and systematically promote climate adaptation measures. Changes were made to the plan in light of the Climate Change Impact Assessment Report published in December 2020 (approved by the Cabinet on October 22, 2021). Chapter 1 describes the basic direction of climate adaptation measures, Chapter 2 introduces area-specific measures, and Chapter 3 lists the fundamental measures. The plan also explains progress management using the PDCA cycle by setting the KPI* for area-specific and fundamental measures and setting of other indicators from the perspective of establishing and spreading climate adaptation at the national government, local government, and citizen's levels[10, 11].
International relations	Infrastructure System Overseas Promotion Strategy 2025	The strategy was decided on in December 2020 and was revised in June 2021. The supplementary edition was then released in June 2022 in light of the changes in the situation in the international community. The strategy has three pillars, or objectives: *achieve economic growth through carbon neutrality and digital transformation, contribute to resolving social issues and achieving SDGs in partner countries, and realize a free and open Indo-Pacific (FOIP)*. Treating promotion of infrastructure to overseas as one of the growth engines and taking into consideration environmental changes, the strategy clearly lays out priority actions and proposes specific measures from three perspectives: *a steady and better recovery envisioning the post-pandemic era, acceleration of the transition toward a decarbonized society, and promotion of a partnership based on the FOIP purpose*. Specific measures for acceleration of transition toward a decarbonized society include: realization of the Asia Zero Emissions Community concept, extending technical support to overseas such as Japanese high-level decarbonization technology, and integrated use of various support policies[12].

[10] The Climate Change Adaptation Information Platform (A-PLAT): The Climate Change Adaptation Plan https://adaptation-platform.nies.go.jp/plan/government/npcca.html

[11] The Climate Change Adaptation Plan https://www.env.go.jp/press/110115/1tekioukeikakuR3.pdf

[12] Infrastructure System Overseas Promotion Strategy 2025 (supplementary edition in July 2022) https://www.kantei.go.jp/jp/singi/keikyou/dai54/infra.pdf

	Item	Action related to climate change measures
	Development Cooperation Charter	This charter was formulated in February 2015 after the ODA Charter was reviewed. *Building a sustainable and resilient international community through efforts to address global challenges* has been chosen as the third priority task, and in this context, the charter lists *actions against climate change including the creation of a low carbon society and adaptation to adverse effects of climate change, promotion of a sound water cycle, and sustainable access to resources and energy* among others as areas of efforts. For implementation of development cooperation, the charter points out development-caused environmental and climate change impact as the grounds for the basic principle of securing appropriateness of development cooperation. In order to strike a good balance of the environment and development and to realize sustainable development, the charter requires sufficiently eco-friendly development cooperation while paying due attention to a wide variety of development-caused environmental impact and climate change measures[13].
	Green Climate Fund (GCF)	It is a fund commissioned to manage the UNFCCC-based funding programs for the purpose of supporting developing nations with GHG emissions reduction (mitigation) and responses to the climate change impact (adaptation). Directors and deputy directors both include Japanese members. Japan initially contributed 1.5 billion USD, and in 2019, announced another 1.5 billion USD as the first additional contribution[14].

[13] Ministry of Foreign Affairs: Development Cooperation Charter https://www.mofa.go.jp/mofaj/gaiko/oda/seisaku/taikou_201502.html

[14] Ministry of Foreign Affairs: Japan's Climate-Related Support https://www.mofa.go.jp/mofaj/ic/ch/page23_001646.html

	Item	Action related to climate change measures
	Joint Crediting Mechanism (JCM)	It is a mechanism in which a developing and developed nation work together on GHG emissions reduction and share the reduction outcomes. Its basic concept is to contribute to achievement of the ultimate objective of the UNFCCC by accelerating climate mitigation activities and spreading use of products, systems, services, and infrastructure using excellent decarbonization technology, by contributing to sustainable development of countries including developing nations, and by promoting global-scale GHG emissions reduction and absorption actions. The July 2021 government press release stated that the mechanism would be implemented in accordance with Section 6 of the Paris Agreement[15]. Japan so far has signed the partnership agreement with 25 countries in Asia, Africa, island nation regions, Central America, South America, the Middle East, and Europe (as of November 28, 2022)[16]. The Japanese JCM Implementation Manual and JCM Project Register have been created. The Ministry of Economy, Trade and Industry is carrying out JCM support projects and demonstration projects, and the Ministry of the Environment is implementing multiple support projects.
	Decarbonization Infrastructure Initiative	In June 2021, the Ministry of the Environment developed the Decarbonization Infrastructure Initiative in order to strengthen and expand the private-public collaboration to further promote overseas expansion of environmental infrastructure through JCM. The initiative targets, by FY2030, reduction of about 100 million t-CO_2 cumulatively as planned for GHG emissions reduction in JCM projects through public-private collaboration and creating a 1-trillion yen business also through private-public collaboration taking advantage of fund diversification to accelerate business creation[17].
	Climate Solutions Technologies Initiatives	It is a mechanism in which one of the ODA schemes of the Japanese government, the Grant Aid for Japanese NGO's Project, is used, Japanese companies and NGOs cooperate with each other, and high-level decarbonization technology of Japanese companies is provided to developing nations that need assistance. This is a newly launched mechanism with the objective of promoting Japanese decarbonization technology overseas. Overseas introduction of Japanese decarbonization technology will be promoted through this mechanism[18].

[15] The Latest State of the Joint Crediting Mechanism (July 2021) http://carbon-markets.env.go.jp/document/20210712_JCM_goj_jpn.pdf
[16] Ministry of Foreign Affairs: Joint Crediting Mechanism (JCM) https://www.mofa.go.jp/mofaj/ic/ch/page1w_000122.html
[17] Ministry of the Environment: Decarbonization Infrastructure Initiative (June 15, 2021) https://www.env.go.jp/content/900517638.pdf
[18] Ministry of Foreign Affairs: Climate Solutions Technologies Initiatives https://www.mofa.go.jp/mofaj/files/100192078.pdf

	Item	Action related to climate change measures
Policies and activities by Japanese organizations	Japan International Cooperation Agency (JICA)	JICA has announced JICA Global Agenda with the cooperation policy of implementing co-benefiting climate change measures. More specifically, it promotes carrying out of actions required by the Paris Agreement (help governments of developing nations enhance their capabilities to implement climate change measures) and carrying out of development tasks and climate change measures at the same time[19]. JICA uses a climate change measure support tool (JICA Climate-FIT) when implementing climate change measures. In the project creation and proposal stages, it plans climate mitigation and adaptation strategies, with an attempt to mainstream climate change measures.
	Agency for Natural Resources and Energy, the Ministry of Economy, Trade, and Industry	The agency has created and published the Renewable Energy Business Support Guidebook Online Edition (FY2022 version) that unifies information on the energy-saving policy, new energy policy, and support programs provided by the national and local governments and relevant laws and regulations for companies and municipalities working on introduction of renewable energy[20].
	Local Public Finance Bureau, Ministry of Internal Affairs, and Communications	The bureau promotes decarbonization efforts by public enterprises in accordance with the Plan for Global Warming Countermeasures (cabinet approval on October 22, 2021). It has put decarbonization project expenses under the Appropriate Public Facility Management Promotion Expenses and created a local financial support program to support decarbonization of public enterprises. For both cases, the project term is FY2022 to FY2025. Eligible projects are introduction of solar power generation, building of Net Zero Energy Building (ZEBs), building renovation to increase energy efficiency, and introduction of LED lights[21].

* Key Performance Indicator: it is an important indicator to measure the achievement level of measures for the goal and effects as quantitatively as possible with the objective of checking the short-term progress of the government's climate adaptation efforts.

(2) How the water business views and implements climate change measures

As mentioned earlier, climate change measures are roughly divided into climate mitigation strategy and climate adaptation strategy. Among climate change measures, the Act on Promotion of Global Warming Countermeasures clearly defines the legal position of climate mitigation strategy, and the Climate Change Adaptation Act specifies the legal position of climate adaptation strategy. Both are legal frameworks in which the national and local governments, companies, and citizens collaborate and cooperate to promote climate change measures. Climate mitigation strategy and climate adaptation strategy in climate change measures work like wheels of a vehicle. With the Act on Promotion of Global Warming Countermeasures

[19] JICA Climate Change https://www.jica.go.jp/activities/issues/climate/index.html

[20] Agency for Natural Resources and Energy, the Ministry of Economy, Trade, and Industry: Renewable Energy Business Support Guidebook Online Edition https://www.enecho.meti.go.jp/category/saving_and_new/saiene/guide/

[21] Ministry of Internal Affairs, and Communications: Public Enterprise-Related Information Material by the Local Public Enterprise Division https://www.soumu.go.jp/main_content/000790316.pdf

and the Climate Change Adaptation Act as the foundation, further promotion of climate change measures is expected[22].

In the water sector, according to the data released in November 2022 by a global water market consulting firm, Global Water Intelligence, the amount of GHG emissions from the entire water sector, including water supply and sewerage, was estimated at 8.47 million t-CO_2, accounting for 1.8% of total global emissions. Water supply accounted for 38% and sewerage (sewerage treatment: 30%; on-site emissions from septic tanks, for example: 32%) accounted for 62% of global emissions. Unlike sewerage, GHG emissions from the water supply does not contain methane or N_2O; they are CO_2 emissions due to energy consumption. Water distribution is responsible for the largest emissions followed by water intake, water purification, and desalination in this order[23].

In Japan, too, power consumption by motors and pumps in water supply equipment accounts for a large portion of total energy consumption; annual power consumption in water business accounts for about 0.8% of all power consumption in Japan[24, 25]. Reduction of this energy consumption will be a climate mitigation strategy that suppresses GHG emissions that cause warming. Japan's Fifth Biennial Report under UNFCCC (December 2022) lists future water supply measures, which are introduction of energy-saving and high-efficiency equipment, introduction of energy-saving equipment such as inverter-controlled pumps, promotion of energy saving through wide-area expansion, consolidation, and reallocation of energy-saving facilities, and introduction of renewable energy generation facilities including small-scale hydroelectric and solar power generation. Meanwhile, development of reservoirs to prepare for droughts, reduction of water pipe leaks, and preparation for floods will be climate adaption strategies to avoid or reduce damage from the impact of climate change that has already surfaced or that may occur in the future[26].

Below are the water business-related items included in the Plan for Global Warming Countermeasures and Climate Change Adaptation Plan and case examples of water business-related actions in climate change measures implemented by the government.

1) Plan for Global Warming Countermeasures

The Plan for Global Warming Countermeasures, whose revision was approved by the Cabinet on October 22, 2021, states that introduction of energy-saving equipment and renewable energy will be promoted in both the water supply and sewerage (Promotion of Energy-Saving and Renewable Energy Measures in Water Business).

Specific actions to save energy and introduce renewable energy in the area of water supply include introduction of energy-saving and high-efficiency devices, introduction of energy-saving equipment such as inverter-controlled pumps, promotion of energy saving through wide-area expansion, consolidation, and reallocation of energy-saving facilities, and introduction of renewable energy generation facilities including

[22] Ministry of the Environment: Global Environment and International Environmental Cooperation https://www.env.go.jp/earth/tekiou.html
[23] GWI Mapping Water's Carbon Footprint (November 2022)
[24] Water Supply Statistics 2019
[25] Energy White Paper 2021
[26] JICA: Topics (June 16, 2021) https://www.jica.go.jp/topics/2021/20210616_02.html

small-scale hydroelectric and solar power generation. They also include a long-term effort of pursuing the possibility of waterworks facilities contributing to adjustment of demand and supply of power.

Although the water supply has a target of reduction of 216,000 t-CO_2 in FY2030 (about 5% reduction from the FY2013 level), FY2018 reduction was only 7,000 t-CO_2. Achievement of the FY2030 target seems unrealistic[27].

Furthermore, the government formed the Renewable Energy Regulation Review Task Force. The task force has presented the Renewable Energy Introduction Target and Roadmap under Water Cycle Policy and has instructed each ministry and agency to further promote generation of renewable energy. In addition to stable supply of drinking water, implementation of climate change measures has been newly added as an important water business target.

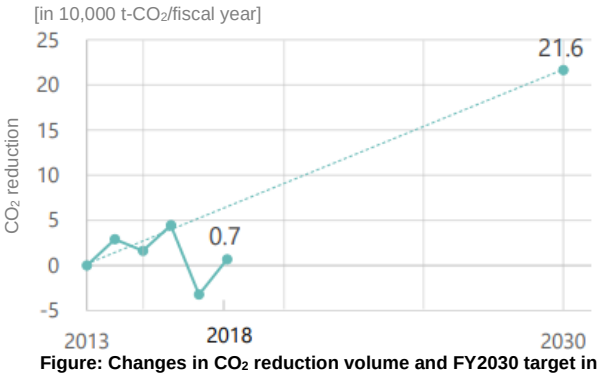


Figure: Changes in CO_2 reduction volume and FY2030 target in the water business

Source: Ministry of Health, Labour, Welfare: Recent State of Water Supply Administration (December 15, 2021)

2) Climate Change Adaptation Plan (Cabinet approval on October 22, 2021)

The impact of climate change in terms of water supply is predicted to cause, for example: rising water temperature to change raw water quality for algae, space-time distribution of precipitation, and droughts due to shifting of the snowmelt season; intensified severity of downpour-caused damage; saltwater intrusion due to rising sea level; and salination of ground water.

The impacts of climate change are rated high for surface water in terms of seriousness, urgency, and certainty. As for ground water, seriousness is also rated high. For this reason, the climate adaptation strategy includes water supply safety and draught risk assessment for existing facilities and implementation of measures to prevent and reduce drought-induced damage.

Seriousness, urgency, and certainty are all rated high also for the water supply infrastructure. Specific actions to address this situation are promotion of facility development to strengthen water supply facility resilience against disasters based on flood disaster measures in the Five-Year Acceleration Plan for Disaster Prevention, Disaster Mitigation, and Building National Resilience (December 11, 2020), creation of a risk management manual, and forming of an organizational structure that allows quick and appropriate emergency measures and recovery in case of water reductions or stoppages. For area-specific climate adaptation measures, the plan requires setting of KPIs to manage the progress of important ones[28].

[27] Ministry of Health, Labour, Welfare: Recent State of Water Supply Administration (December 15, 2021) https://www.mhlw.go.jp/content/11130500/000866664.pdf

[28] Climate Change Adaptation Plan (Cabinet approval on October 22, 2021) https://www.env.go.jp/content/900449799.pdf

3) Green Climate Fund (GCF)

GCF projects for the water business often take place as climate adaptation strategies for the rural water supply. An example of a climate adaptation strategy for the urban water supply is the Fiji Urban Water Supply and Wastewater Management Project[29, 30].

This project includes both water supply and sewerage measures. The water supply measure is implemented as a climate adaptation strategy in response to floods, droughts, and saltwater intrusion due to sea level rises. In this project, a new river water intake station with a pumping station, wastewater treatment plant, clear water reservoir, and pipeline is being designed and created on the River Rewa to improve the water supply by increasing water production by 30,000 m^3 per day. At the same time, the water intake station will take water from further up the river system to avoid salinity due to sea level rises. Non-revenue water will be reduced through meter replacement and leak detection as well as repair. As for sewerage, the project will play a role of both a mitigation strategy, through the use of high energy efficiency technology and sewer coverage improvement, and also an ecosystem conservation strategy.

4) Joint Crediting Mechanism (JCM)

Table 3 lists case examples of JCM-based water business[31]. All three projects are climate mitigation strategy case examples to reduce GHG emissions by improving pump energy efficiency.

Table 3 Case Examples of Water Business Using the Joint Crediting Mechanism (JCM)

Partner country	Type	Selected year	Sector	Project type	Entity	Expected GHG emissions reduction (t-CO_2/year)
Vietnam	Equipment support	2018	Energy efficiency	Energy Saving by Introduction of Inverters for Raw Water Intake Pumps	Yokohama Water Co., Ltd.	602
Cambodia	Equipment support	2016	Energy efficiency	Energy Saving by Inverters for Distribution Pumps in a Water Treatment Plant	METAWATER Co., Ltd.	406
Vietnam	Equipment support	2016	Energy efficiency	Introduction of High Efficiency Water Pumps in Da Nang City	Yokohama Water Co., Ltd.	738

[29] BCF Project portfolio https://www.greenclimate.fund/projects
[30] BCF Fiji Urban water Supply and Wastewater Management Project https://www.greenclimate.fund/project/fp008
[31] Introduction of JCM case examples https://gec.jp/jcm/jp/projects/

5) Climate Solutions Technologies Initiatives

Table 4 lists drinking water-related technologies from the decarbonized product and package list released in the Climate Solutions Technologies Initiatives, which is a program for supporting developing nations in the area of climate change. These technologies are considered climate mitigation strategies to reduce CO_2 emissions through the use of renewable energy.

Table 4 Decarbonized Product and Package List in the Climate Solutions Technologies Initiatives (February 8, 2022)
(Drinking water-related technologies are cited; all three case examples were selected in June 2021)

Product	Company	Applied technology	Target area	Use example in detail
Shipping container-shaped hybrid power system with a sea water desalination device (product name: N^3)	NTN Corporation	• The power generation system in the shipping container-shaped structure produces electricity from renewable energy sources (wind, water, and sunlight), charges the electric storage device, and feeds electricity to the sea water desalination device to filter sea water or contaminated water to supply safe water. • Size: 12 to 20 ft container (information below is for a 20 ft container) • The system secures 600 L of water per day • Power generation reduces 11.4 t-CO_2	• Areas without electricity or unstable electricity supply • Areas with electricity infrastructure vulnerable to natural disasters • Areas with poor access to safe water	This product can provide electricity (for charging cell phones, lighting, and so on) and safe water for residents of areas without electricity. It can also be used as an operation base or rest station for development projects, environmental projects, or healthcare practice in areas without electricity. Since all devices are in the container, transportation of the product is easy. Once it is installed, it can immediately start generating electricity and provide water.

Product	Company	Applied technology	Target area	Use example in detail
A mobile water purifier-electricity storage package consisting of a 500 W micro waterpower generating system ‘Seseragi’ and a compact electric water purifier ‘Cyclo Clean Portable SPX’	Nippon Basic Co., Ltd. MNJ Co., Ltd.	• A hydropower generation system operates a water purifier 24/7 to provide up to 7,200 L (for about 3,600 people) of drinking water and about 7,000 Wh of electricity (equivalent 70 LED lamps × 10 hours of use) daily. • Annual CO_2 reduction is about 12 tons from diesel power generation • Movable product (power generation unit: 504 × 500 × 700 mm, 65 kg; water purifier: 550 × 370 × 230 mm, 11 kg; intermediate power storage device: 600 × 600 × 650 mm, 150 kg)	Bangladesh	In an area without electricity or an area affected by a natural disaster, Seseragi generates and stores electricity by being placed in a waterway wider than 55 cm. The pump water purifier draws raw water from the waterway, purifies the water, and produces drinking water at the rate of 150 L per hour (for 75 people on average). The remaining electricity is used for LED lamps and charging smartphones to secure water, lighting, and communication. The hybrid power storage device can also store solar power.

Product	Company	Applied technology	Target area	Use example in detail
Yamaha Clean Water Supply System	Yamaha Motor Co., Ltd.	• Water purification method: physical filtration, biofiltration, and chlorination • Power supply: solar power generation • Water source: surface stream water (sea water, agrichemicals, heavy metals are not subject to removal) • Purified water production: 8,000 L per day • Target population: up to 2,000 people (assuming 4 L of drinking water is used per person per day) • Footprint: 8 × 10 m • The product is a slow filtration water purification system. Since it does not use flocculants or membranes, the product has a low environmental impact caused by maintenance or disposal. The attached solar power generation system can cover electricity needed.	Countries in Southeast Asia, South Asia, and Sub-Saharan Africa	To rural areas with poor access to safe water, the company introduces a water purifier run by solar power, which is renewable energy. While securing safe drinking water, the product at the same time contributes to decarbonization by reducing firewood used for sterilization of water through boiling. Furthermore, revitalization of the rural area can be expected when residents use time previously spent on water collection for learning or other productive activities.

6) Case examples of good climate adaptation practice by Japanese companies

The Ministry of Economy, Trade, and Industry carried out the FY2021 Global Warming Measure Survey (Project to Visualize the Contribution of Japanese Companies in the Climate Adaptation Area in Developing Nations), which included creation of the booklet Climate Change Adaptation Good Practices by the Japanese Private Sector in Developing Countries (Feb 2022). Of 39 climate adaptation strategy case examples listed as good practices, those that are related to water business are listed in Table 5[32]. Yamaha Motor's clean water supply system is also listed as a decarbonization product in Table 4 and therefore uses technology that works as both climate mitigation strategy (use of renewable energy) and climate adaptation strategy (addressing of water pollution due to floods).

[32] Climate Change Adaptation Good Practices by the Japanese Private Sector in Developing Countries (Ministry of Economy, Trade, and Industry) (Feb 2022)
https://www.meti.go.jp/policy/energy_environment/global_warming/pdf/JCM_FS/R3FY_adaptation_practice_Japanese.pdf

Table 5 Climate Change Adaptation Good Practices by the Japanese Private Sector (citing the water supply sector's practices)

Title/product	Company	Technology used	Target country	Business model
Water projects for realization of a cooperative and rich society	Kubota Corporation	Highly-durable ductile iron pipes, pumps that work in floods or droughts, drain pumps, septic tanks, environmentally conscious total water solution, and so on.	UAE, Bangladesh, Thailand, Vietnam, Myanmar, etc.	The company designs, builds, and delivers equipment for projects by international organizations or governments of developing nations.
Bicycle-type water purification system for securing a clean water supply	Nippon Basic Co., Ltd.	The bicycle-type water purification system uses pedaling power thus not requiring any electric power.	Bangladesh	The company has disclosed its technology to a local bicycle manufacturer so that a Bangladesh model can be manufactured locally. It sells filters periodically. It aims at local production and local consumption.
Securing sufficient and clean water through an ion exchange membrane	AGC Inc.	It is an electro dialysis purification system that uses the ion exchange membrane and electricity to separate ionic substances dissolved in water for desalination.	Israel, China, and India	The company designed the electrodialyzer, which is the heart of the system, and exports the ion exchange membrane, which is the core technology. Local engineering companies build the system using the electrodialyzer and peripheral units to deliver them to their clients.
Development of a tourism city through water treatment	Sanicon Co., Ltd. and Accrete Inc.	Water treatment using the UF (ultrafiltration) membrane and providing guidance on Japanese style maintenance and management methods.	Vietnam	The companies established a local company to export the core technology from Japan. They send engineers regularly from Japan to promote sales activities and provide technical guidance.

Title/product	Company	Technology used	Target country	Business model
Contributing to the reduction of non-revenue water and stable supply of safe water by detecting leaks from buried water pipes	Suidou Technical Service Co., Ltd	Water leakage monitoring equipment and intangible assets, such as knowledge, sound hearing skills, know-how, and the process to detect a water leak.	India and Vietnam	The company provides a local water leak inspection service by inspectors, provides non-revenue water reduction training to water suppliers, and sells water leakage monitoring equipment.
Reducing flood damage and solving water shortages with a rainwater storage system	Sekisui Chemical Co., Ltd.	A rainwater storage system that helps with stable water supply and flood prevention. A plastic storage material is used to store rainwater in the underground tank to reuse rainwater or control its outflow.	India	A local subsidiary of the company in partnership with local consulting firms leads projects and sells the system through distributors. The system is produced locally in India but is exported from Japan to other countries.
Stable water supply using a water purifier that can handle high turbidity raw water	Tohkemy Corporation	The equipment consists of a fiber filtration system and a sand filtration system. This compact equipment purifies river water with turbidity of over 1,000 NTU to 5 NTU or lower.	Laos	This is a project through a public-private partnership with relevant Lao government parties, such as the water bureau, JICA, and other stakeholders.

Title/product	Company	Technology used	Target country	Business model
Producing safe drinking water from saline and highly-turbid surface water	Mitsubishi Chemical Aqua Solutions Co., Ltd.	A water treatment system characterized by a customized design combining pre-treatment technology and membrane filtering technology suitable for the raw water quality, a remote monitoring system in the water treatment system, and a consistent management structure including operation ranging from water quality analysis to maintenance and management.	Myanmar	The company established a venture capital firm in Myanmar and uses it as a base for its service operation with the key focus on water treatment engineering (EPC), water quality analysis, and environmental consulting.
Addressing water pollution caused by floods	Yamaha Motor Co., Ltd.	The system uses the slow sand filtration method in which sand and gravel are used to purify water. Water is treated using the actions of algae and microorganisms. The system does not require coagulants or filter replacement and therefore is easy to use and maintain. This allows local residents to independently use and manage the system.	Indonesia, Madagascar, Senegal, Benin, etc.	The company introduces the system to hospitals, schools, and villages through the local government or NGOs. It recommends recipients set up a water committee, which may create new business and employment. The company creates a system that helps with the entire social and economic growth of the community.

7) Other carbon neutrality-related activities

The Japanese government's National and Regional Decarbonization Realization Committee released the Regional Decarbonization Roadmap in June 2021. The roadmap includes upgrading, integration, and reorganization of water supply and sewerage facilities. In response to this, the Japan Water Research Center (JWRC) announced that it will collect information and propose strategies by choosing 'equipment maintenance, repair, and upgrade' and 'rebuilding of facilities' as the themes for Aqua-MODELS, the 10th joint water purification research project that continues until September 2024, with strengthening of the water business foundation and achieving carbon neutrality in 2050 in mind[33].

[33] Aqua-MODELS joint research (Japan Water Research Center) http://www.jwrc-net.or.jp/chousa-kenkyuu/aqua-models.html

Chapter 3 Specific Case Examples of the Water Supply Sector's International Cooperation Activities to Address the Impact of Climate Change

3-1 Study Policy

In this chapter we organize and provide information, which we collected through reference study and interviews, on specific case examples of the water supply sector's international cooperation designed while taking into consideration climate mitigation strategy for water supply facilities and climate adaptation strategy for water supply systems that have resilience against the impact of climate change among various factors. For each project, we hypothesized issues and the direction of improvement and assessed the sustainability of the effects of climate change measures. Projects 1) through 4) were looked at as case examples of climate mitigation strategy, and projects 5) through 10) as case examples of climate adaptation strategy. Table 6 categorizes climate mitigation and climate adaptation strategies by the objective and type of measures, and Table 7 describes the study policy for each project.

[Case examples of climate mitigation strategy]

1) Grant Aid: Project for Improvement of the Zai Water Supply System in the Hashemite Kingdom of Jordan

   A case example of reducing electricity consumption by realizing a stable water supply and creating a water distribution system with high operational efficiency

2) Grant Aid: Project for Energy Conservation through Upgrading the Water Supply Network in the Hashemite Kingdom of Jordan

   A case example of reducing electricity consumption by improving the operational efficiency of the pump station

3) Grant Aid: Project for Introduction of Clean Energy by a Solar Electricity Generation System in Cambodia

   A case example of meeting higher electricity demand by promoting the use of renewable energy (solar power)

4) Grant Aid: A Micro-Hydroelectric Power Generation Project in the Metropolitan Area of Tegucigalpa in Honduras

   A case example of promotion of renewable energy use (hydropower) and efficient water purification plant operation

[Case examples of climate adaptation strategy]

5) Grant Aid: Project for Improvement of the Water Reservoir at Majuro Atoll in the Marshall Islands

   A case example of improving rainwater storage facilities to handle drought situations

6) Collaboration Program with the Private Sector for Disseminating Japanese Technology: Water Supply Equipment Construction Technology Dissemination and Promotion Project in Vietnam

   A case example of contributing to reduction of water leakage by improving water diversion valve construction techniques

7) SME Overseas Business Expansion Support Program: Project for Reducing Non-Revenue Water and Promoting and Demonstrating Water Service Pipe Management Using a Water Leakage Detector Designed for Resin Pipes (e.g., PVC Pipes, PE Pipes) in Indonesia

   A case example of reducing the non-revenue water rate by using a water leakage finder designed for resin pipes to detect points of leakage

8) Grant Aid: Project for Improvement of the Water Supply System in Villa Hayes City, Paraguay

   A case example of reducing vulnerabilities by achieving a stable water supply by developing a new water purification plant and improving a water purification plant that uses surface stream water as the water source, which is prone to the impact of climate change

9) Grant Aid: Project for Improvement of the Water Supply in Pokhara in Nepal

   A case example of improving the water supply service by overhauling water purification facilities, distribution reservoirs, conduits, water pipes, distribution pipes, and water meters and improving water quality in the rainy season from the disaster prevention perspective

10) Grant Aid: Project for Development of Water Supply Facilities of Small Towns in the Oromia Region in Ethiopia

    A case example of developing a conduit-based water supply facility using groundwater as the water source in the area often impacted by droughts and having groundwater with high fluorine concentration.

Table 6 Positions of the projects in terms of climate change measures

Large category	Middle category	Small category	Project
Climate mitigation strategy	Energy saving	Improvement of pumping efficiency	1) Zai, Jordan
		Creation of a water distribution system that avoids pump use whenever possible	2) Zarqa, Jordan
		Reduction of water leakage	Many
	Renewable energy	Generation of renewable energy using the land where a water supply facility is located (solar power, wind power)	3) Cambodia
		Generation of renewable energy using the water supply facility itself (hydropower)	4) Honduras
Climate adaptation strategy	Drought	Securing of a climate change-resistant water source: water storage, use of groundwater, design of a water intake facility	5) Marshall Islands, 8) Paraguay, 10) Ethiopia
		Reduction of water leakage	6) Vietnam, 7) Indonesia, and many more
		Promotion of water-saving	Technical Cooperation Project “Model Planning Project for a Water Saving Society in China (Efficient Water Resource Management)”
	Downpour	Preparation for climate disasters such as floods (mainstreaming of disaster prevention)	9) Nepal

Table 7 Study Policy

Item	Description
Study method	Collect information from reports and related documents.
Study activities	• Summarize project overview: project title, aid type, grant amount, period of cooperation, implementing entity, cooperating entity on the Japan side, objective, issues, regional characteristics, implementation items • Summarize issues: background of implementation, reason for project selection (e.g., regional characteristics, price of electricity) • Summarize evaluation indicators: outcome of the project implementation, data as the basis for evaluation, and so on • Sustainability assessment: hypothesis about the issues and the direction of improvement, assessment of sustainability of the effects of the implemented climate change measures
Information to organize	Project overview Project outcome as a climate mitigation strategy/climate adaptation strategy Basis for calculation (as needed) Hypothesis about the issues and the direction of improvement Assessment of sustainability of the effects of climate change measures Lessons learned

To understand the project outcome, we looked at the target value (usually set three years after project completion) against the reference value. To indicate the effectiveness of the project as a climate adaptation strategy, we used JICA's climate change measure support tool (for adaptation strategy) (JICA Climate-FIT (Adaptation)) and checked the elements of the climate risk for the project.

We made a hypothesis about the issues and the direction of improvement by organizing information included in project reports.

Sustainability of the effects of climate change measures for projects whose ex-post evaluation has not been carried out was considered based on how the target value was set and also the hypothetical scenario. For projects whose ex-post evaluation has already been carried out, the target achievement level and how it deviates from the actual measurement value were examined in their ex-post evaluation reports. Project 7) was an SME Overseas Business Expansion Support Program. Therefore, assessment must include the perspective of business expansion.

Furthermore, from the perspective of exploring efficient climate change measures, we calculated the project cost effectiveness based on the amount paid for cooperation and the amount of CO_2 emissions reduced in order to examine the evaluation indicators. Based on the result above, we summarized the lessons learned from the projects as climate change measures.

Note that information used for outlining and examining each project is provided as Information Material 1.

3-2 Sustainability and Cost Effectiveness of Each Project

We organized information on the implementation background, issues, activities carried out, and evaluation indicators for each project to examine the sustainability of its climate change measures from the perspective of the effects of the climate mitigation/adaptation strategy that could be determined from the hypothesis about the issues and the direction of improvement as well as project implementation. Here, the effects of a climate mitigation strategy is defined as GHG emissions reduction, and the effects of a climate adaptation strategy is defined as its effectiveness in preventing or reducing the impact of climate change. When a project treated as a climate adaptation strategy was also effective as a climate mitigation strategy, GHG emissions reduction was also examined.

From each project's report we extracted items that would help us decide the sustainability of climate change measures. As for the level of GHG emissions reduction, we referred to the expected effects in numerical values for projects whose ex-post evaluation was not yet carried out. For those whose ex-post evaluation was complete, we extracted measurement values for the evaluation indicators and the reason for these values differing from the expected target values. To find out the sustainability of maintenance and management, we mainly extracted information on the maintenance and management structure of the implementing entities and whether or not they carried out skill development for maintenance and management. Table 8 shows the result of sustainability examination and Table 9 lists the result of cost effectiveness examination.

Table 8 Sustainability of the Effects of Climate Change Measures in the Subject Projects

Project	Item	Relevant information and notes
1) Project for Improvement of the Zai Water Supply System in the Hashemite Kingdom of Jordan	GHG emissions reduction	• Electricity consumption per 1 m^3 of water is between 5.10 and 4.91 kWh, which will lead to about a 3.7% reduction. • Since the use of pumps is required geographically and pumps lift water to elevated locations, improvement of pumping efficiency is effective as a climate mitigation strategy and significantly contributes to improvement of management of water suppliers. • Methods of preventing pump degradation as much as possible are under consideration including updating of traveling screens that come before the pumps and choosing of materials taking into consideration the raw water quality. This suggests that pumps will remain efficient for a long period time.
	Maintenance and management	• Procured equipment is a newer version of the existing equipment. Therefore, the partner company has sufficient techniques to use it.

Project	Item	Relevant information and notes
	Others	• Reduction of electric power costs depends on the electric rate. In Jordan, the electric rate tripled over 10 years from 2008. As of the time of report creation (August 2018), the electric rate for a pump was 0.126 JOD/kWh (2.7 times higher than the 2011 level). As of December 2022, it is 0.094 JOD/kWh (NEPCO website). • Jordan is making large efforts to introduce renewable energy (solar and wind power). Renewable energy accounted for 0.9% (of all electricity generated) in 2015, but it rose to 6.7% in 2017, and 14.6% in 2019 (IEA statistical data). It reached about 20%, meaning generation of 2,063 MW of electricity at the end of 2020 (NEPCO). In November 2021, the Minister of Energy and Mineral Resources announced that the country will target the renewable energy rate of at least 50% by 2030. Jordan has favorable conditions such as many clear days in a year and vast deserts where the wind will blow at a speed suitable for wind power generation. Although introduction of renewable energy in the water business domain is uncertain, it may influence the future electric rate.
2) Project for Energy Conservation through Upgrading the Water Supply Network in the Hashemite Kingdom of Jordan	GHG emissions reduction	• In ex-post evaluation, the project achieved the target reduction of electricity consumption. • Another Grant Aid project, whose development policy was to use a gravity flow system, was already implemented. In addition to making the maximum use of the overhauled core water supply facilities and moving forward the shift to an efficient gravity flow system, the basic policy of this project was to save energy in the water supply and distribution and to stabilize water delivery. • As a prerequisite for the energy improvement measure at the pump facility, setting of water distribution scenarios was under consideration as a preparation for the shift to the gravity flow system. Assuming that the scenarios are realistic as water supply plans and make the maximum use of the distribution reservoir and conduits overhauled by the Japanese party, the scenarios will be assessed from the technical point of view and the probability that water source development progresses. Therefore, the project is expected to have a long-term effects as an energy reduction strategy for the entire system instead of simply improving device energy efficiency.
	Maintenance and management	• The operation maintenance and management structure is in place.
	Others	• Further improvement is expected if there is additional electric system repair work in the future.

Project	Item	Relevant information and notes
3) Project for Introduction of Clean Energy by a Solar Electricity Generation System in Cambodia	GHG emissions reduction	• Two years after project completion, the amount of generated power is far exceeding the target. • Equipment capabilities, including the panel type, system connection, installation location (on the roof of an existing facility for which a structural drawing exists), and technology used (use of technology with a proven record in Japan), suggests high sustainability of the effects of climate change measures.
	Maintenance and management	• For maintenance and management, the organizational structure, techniques, and finances are all maintained as stated in the goal. • Technical assistance is provided for daily maintenance and management and developing the ability to make a quick repair of problems. • From the long-term operation perspective, the number of reserves necessary for maintenance and management, including equipment repair and replacement, is being discussed.
	Others	• Under the current system, the power generation system cannot connect to the electric system of Electricite du Cambodge, making it difficult to determine the cost benefit.
4) A Micro-Hydroelectric Power Generation Project in the Metropolitan Area of Tegucigalpa in Honduras	GHG emissions reduction	• The annual electrical power production at Concepcion Hydroelectric Power Plant used to be estimated based on the effective drop, obtained from the daily dam water level and the friction head loss, and the daily discharge. As the population increased in the city of Tegucigalpa, demand for the water supply increased and Conception Water Purification Plant continued to be improved and expanded due to delayed development of a new water source by the government, the amount of water sent from the reservoir increased, the friction loss of the conduits increased, and effective drop decreased accordingly. Concepcion Hydroelectric Power Plant was then stopped in order to prioritize the water supply business. • The scale of power generation for Picacho Hydroelectric Power Plant was studied during distribution planning taking into consideration the measured flow rate and the maximum amount of water distribution. The plant's power generation however has not reached the target because the decreased precipitation due to climate change led to a decreased dam water level and water supply restrictions. • The expected GHG emissions reduction effects has not been produced.
	Maintenance and management	• Concepcion Hydroelectric Power Plant is not operating, and no personnel have been allocated. The plant is not maintained or managed. • Picacho Hydroelectric Power Plant has been maintained and managed with the organizational structure and techniques maintained.

Project	Item	Relevant information and notes
5) Project for Improvement of the Water Reservoir at Majuro Atoll in the Marshall Islands	Prevention and reduction of the impact of climate change	• Since the primary task of the project is to strengthen the water storage capability to withstand droughts, reservoirs have been added to extend, as long as possible, the number of days of water supply available during a drought. (The period in which water can be supplied continuously has been extended by 19 days.) • For water sources, advantages and disadvantages were compared. For reservoir structures, workability, construction fees, economic performance, and the impact on the environmental society were compared and studied. Finally, for revetment design, 1) the analysis result of on-site observation data, 2) the IPCC report, and 3) NOAA's publicly available data were comprehensively studied. The sea level rise rate that was appropriate for revetment design was chosen. The tidal data was also analyzed to set the highest point of the revetment. This project, also as a climate change measure, selected ways to solve both development issues and climate change issues.
	Maintenance and management	• It has been confirmed that maintenance and management basically follows the operation method of the existing reservoir and that the local organizational structure for maintenance and management has not been changed. The timing and frequency of revetment inspection have been set. The same maintenance and management method as the existing facilities will be applied to the raw water transmission facility and the reservoir.
	Others	• The amount of water evaporated from the reservoir surface in this plan is equivalent to a water depth of 0.37 ft (11.3 cm) per month. Since this is a business plan for solar power system development funded by loans from the World Bank (introduction of a solar power system mainly using floating solar panels on the surface of five existing reservoirs), introduction of a cover such as a shade ball is outside the scope of effects and sustainability assessment. It is desirable that this plan will be carried out to reduce the amount of evaporation.
6) Water Supply Equipment Construction Technology Dissemination and Promotion Project in Vietnam	Prevention and reduction of the impact of climate change, GHG emissions reduction	• SAWACO officers deepened their understanding of the actual operation status and the effects of the construction technology licensing system and that water diversion saddle valves had high quality and durability. This led them to heightened recognition that updating valves to high-quality water diversion saddle valves and learning correct construction technology were effective for reducing the water leakage rate.
	Maintenance and management	• The project produced a certain level of result since the implementation entity developed human resources from SAWACO who could become lecturers and prepared SAWACO to continuously and voluntarily hold lectures.

Project	Item	Relevant information and notes
	Others	• Long-term effects can be expected if the following tasks are all completed. 1) Establishment of a follow-up system for SAWACO to continue holding lectures The local affiliate of the implementing entity will continue to support SAWACO. 2) With relevant ministries and agencies, adjustment of the effects of the license to be given to lecture participants To expand the license eligibility to the general public from just SAWACO officers requires approval of the People's Committee and procedures take time. SAWACO will make adjustments with the committee so that the license can be included in bid criteria. 3) Revision of lectures and practice contents to reflect the actual construction sites more 4) Revision of the textbook to include safety management and construction process management 5) Development of measures to plan activities that involve third-party companies and the water bureau of other provinces Technology dissemination and promotion to the water bureau of other provinces were planned from FY2020. The leakage rate reduction effects would spread to surrounding areas. • Spread of the method of installing water diversion saddle valves without stopping water could become a solution that directly lowers the water leakage rate. Since it is not realistic to choose a high-quality water supply system within SAWACO's budget, it is desirable to consider the possibility to partner with an ODA project.
7) Project for Demonstrating Non-Revenue Water Reduction Measures Using a Water Leakage Search Device	Prevention and reduction of the impact of climate change, GHG emissions reduction	• Water leakages were detected at 117 locations, and the non-revenue water rate in the study area was reduced by about 17%. Therefore, the effectiveness of the proposed device was highly rated in the Indonesian environment. Since detection of water leakages directly helps with leakage reduction, dissemination of the detection method is highly effective.

Project	Item	Relevant information and notes
Focusing on Resin Pipes (e.g., PVC Pipes, PE Pipes), Creating a Water Leakage Survey Plan, Creating an Old Pipe Renewal Plan, and Maintaining and Managing the Water Distribution Network	Maintenance and management	• Tasks for continuous reduction of water leakages are as follows: • Maintenance and updating of water distribution network drawings for commercial areas where many pipes split and building of an organizational structure for checking where the splits are beforehand. • Cultivation of gas supplies (gas cylinder distribution network) for the hydrogen-operated ultra-high-performance water leakage search device. Or, development of equipment that can be used in any area with the vision of using it with distribution pipes. • Arrangement of sluice valves for distribution pipe maintenance and management, including reduction of non-revenue water, in areas where contact with residents is impossible or in commercial districts. (Currently, water leakages cannot be searched for places other than near the water meter because it is impossible to use the water shut-off valve inside a house or to temporarily stop the water in the inspection area.) • Overall enhancement of techniques to prevent water leakage recurrence (e.g., PDAM Tirtanadi develop thorough knowledge about basic pipe installation and repair techniques and make contractors use such techniques). • To realize systematic non-revenue water reduction, creation of DMAs quickly in districts where there are no DMAs and accurate understanding and analysis of the non-revenue water rate for the entire subject area.
	Others	• Issues for business expansion are establishment of a backup, repair, and maintenance system for the water leakage survey device, lobbying the provincial government to allocate a budget to each PDAM for purchasing the water leakage survey device, expensive transportation and logistics costs, and soaring purchase prices due to taxes that are nearing 30% overall. • To demonstrate and spread the use of the water leakage survey device, promotion of the device in cooperation with PDAM Tirtanadi, the Ministry of Public Works, and the Indonesian Water Supply Association to heighten the recognition and credibility of the device in Indonesia. • To realize a stable and safe water supply, water quality improvement and securing of water pressure requires further water leakage surveys and replacement of old pipes through an appropriate and systematic repair and construction procedure.

Project	Item	Relevant information and notes
8) Project for Improvement of the Water Supply System in Villa Hayes City, Paraguay	Prevention and reduction of the impact of climate change, GHG emissions reduction	• Technical assistance for facility and equipment maintenance, water purification plant operation, maintenance, and management, water distribution network management, and promotion of water meter installation was provided. It had a quantitative effects; both the water supplied population and the average amount of water supply both increased. This water supply system is believed to continue saving energy in the future and can be resilient to climate change for the following reasons: • The system was decided based on the 50-year probability of extreme droughts and floods through examination of the future climate change. • In the new facility planning stage, the location was planned to maximize its potential energy. • Considerations were made to facilitate future system expansion.
	Maintenance and management	• Technical assistance to improve the operation, maintenance, and management techniques is provided. • As a measure to reduce non-revenue water, technical assistance was provided to teach distribution network management techniques and to promote installation of water meters.
9) Project for Improvement of the Water Supply in Pokhara in Nepal	Prevention and reduction of the impact of climate change, GHG emissions reduction	• Consulting services for facility construction, equipment procurement, and detailed facility design are offered. Technical guidance for facility operation, maintenance, and management is also provided. As a result, it is expected that the water quality (turbidity, residual chlorine) and water supply frequency will improve. • The future impact of climate change (vulnerabilities to disasters such as floods) was taken into consideration for facility improvement, and conduits were replaced. It should also be noted that the water facility uses the gravity flow system to reduce the use of electricity as much as possible.

Project	Item	Relevant information and notes
	Maintenance and management	• In this project, basic technical guidance for effective use of the constructed facility and procured equipment is provided within the technical assistance scheme. To enhance the water supply service of Pokhara City and realize sustainable water supply and healthy water business management, a technical cooperation project is implemented simultaneously with the objective of strengthening the operation and technical capabilities[34]. • For sustainable operation, maintenance, and management of the facility, it is desirable to effectively use the knowledge about operation, maintenance, and management of the existing facility (slow filtration method), check cautions for operation in case of a power failure for some devices that use electricity but are operated manually for a few hours per day as needed, and secure consumables required for facility operation, maintenance, and management.
10) Project for Development of Water Supply Facilities of Small Towns in the Oromia Region in Ethiopia	Prevention and reduction of the impact of climate change, GHG emissions reduction	• The new water supply facilities are built independently from the existing pipeline-based water supply system. The basic policy is that the new facilities will not be connected to the existing facilities and will cover the entire water supply area. • The target area, which is the midpoint of Awash River, is quite vulnerable to climate change. It has suffered from damage of droughts and floods from time to time. The facilities built in this project use deep groundwater and therefore are relatively immune to the impact of rainfalls. It is however necessary to continue to closely watch how the groundwater situation changes due to climate change. • In Kamise, where no electrification is planned, a hybrid of solar power generation and diesel power generation is used as a power source. The hybrid method is expected to have a larger CO_2 emission reduction effects compared to when only diesel power generators are used, thus contributing to the climate mitigation strategy.

[34] Ex-Ante Evaluation for the Project on Capacity Development of Nepal Water Supply Corporation to Improve the Water Supply System in Urban Cities
https://www2.jica.go.jp/ja/evaluation/pdf/2021_1903645_1_s.pdf

Project	Item	Relevant information and notes
	Maintenance and management	• The maintenance and management system has an issue. Among the organizations that operate, maintain, and manage water supply facilities in four small towns with pipeline-based water supply facilities, the Water Association has a weak structure. For this reason, operation, maintenance, and management organizations subject to this project should, based on the operation, maintenance, and management framework of Oromia Region, establish a water corporation integrated with a town administration office.
	Others	• Unstable electric supply is an issue. Among the small towns that are target areas of this study, six excluding Kamise have been electrified by the electric power corporation. Power supply in these towns however is unstable. Unexpected power outages occur frequently even in major cities. The average monthly power outage duration in five small towns where data was available was 18.71 to 142.69 hours. The average monthly power outage frequency in the same areas was 18.67 to 44.5 times. The average monthly power outage rate was about 8.5% at the five sites.

Table 9 Examination of the Cost Effectiveness of Each Project

Project	Effects	Grant amount (in 100 million yen)	Element of the project examined as a climate change measure	Cost effectiveness (t-CO_2/year per 100 million yen)
1) Zai, Jordan	Less energy per unit quantity of water From 5.10 kWh/m^3 to 4.91 kWh/m^3 Reduction of power consumption by 12,249 MWh/year Reduction of GHG emission by at least 6.97 kt-CO_2 year Note) (all target values)	Limit 23.79	Updating of equipment such as pumps to high efficiency models	Target 293.0 Ex-post evaluation not implemented yet

Project	Effects	Grant amount (in 100 million yen)	Element of the project examined as a climate change measure	Cost effectiveness (t-CO_2/year per 100 million yen)
2) Zarqa, Jordan	Less energy per unit quantity of water ① From 1.88 kWh/m^3 to 1.48 kWh/m^3 ② From 0.62 kWh/m^3 to 0.50 kWh/m^3 ③ From 1.20 kWh/m^3 to 0.63 kWh/m^3 ④ From 0.78 kWh/m^3 to 0.40 kWh/m^3 Reduction of power consumption by at least 8,687 MWh/year Reduction of GHG emission by 5,386 t-CO_2/year	Limit 11.32 Result 11.09	Management of the volume of water supplied and leaked by grasping the flow rate, reduction of water leakage by correcting the water distribution pressure to the appropriate level, and system development for use with the gravity flow method	Target 475.8 Ex-post evaluation 485.7 or more
3) Cambodia	Expected power generation: 1,087 MWh/year Reduction of GHG emission by 1,115 t-CO_2/year	Limit 7.2 Result 7.17	Solar power generation by installing solar panels on facility roofs	Target 55.8 Ex-post evaluation 155.5
4) Honduras	Concepcion: power generation terminated Picacho: power generation 126.9 MWh/year Reduction of GHG emission by 49.62 t-CO_2/year	Limit 9.52 Result 9.52	Small-scale hydroelectric power generation using unused equipment energy	Target 89.1 Ex-post evaluation 5.2
5) Marshall Islands	Extension of continuous water supply time during a drought by 19 days	Limit 17.57	Designing of a revetment and transmission facility while taking into account the impact of climate change such as future sea level rises	—

Project	Effects	Grant amount (in 100 million yen)	Element of the project examined as a climate change measure	Cost effectiveness (t-CO_2/year per 100 million yen)
6) Vietnam	Lowered water leakage rate Understanding of the quality of Japanese products	Not disclosed	Aiming at promotion of high-quality Japanese products, dissemination of construction techniques, and continuation of licensing system operation	—
7) Indonesia	Reduction of the non-revenue water rate by 17% (equivalent to 173,000 m^3/month) Realization of a stable and safe water supply	Contract value 0.655	Technical transfer and demonstration of water leakage search equipment for resin pipes	—
8) Paraguay	Increase of the water supplied population From 23,900 to 33,800 people Increase of the amount of water supply From 5,000 to 8,400 m^3/day Reduction of water leakage	Limit 19.36	Maximum use of potential energy and a decision on the head gate location based on the 50-year probability of droughts and floods	—
9) Nepal	Water quality improvement Between 4 to 419 NTU and 5 NTU or lower Maintaining of the residual chlorine concentration Improved water supply frequency	Limit 48.13	Use of the gravity flow system and designing of the facility while taking into consideration disasters such as floods	—

Project	Effects	Grant amount (in 100 million yen)	Element of the project examined as a climate change measure	Cost effectiveness (t-CO_2/year per 100 million yen)
10) Ethiopia	Increase of the amount of water supply From 109 to 1,952 m^3/day Increase of the water supplied population From 14,800 to 47,279 people The amount of water used per person From 7.4 to 40.0 liters/person/day Reduction of GHG emission by 114 t-CO_2/year	Not disclosed	Use of deep groundwater that is less likely to be impacted by climate change, use of hybrid power generation with solar power generation and diesel power generators at a site without an electrification plan	—

Note: Based on the understanding that the original Project 1) report had a mistake in the unit ('M' was used where it should be 'k') and therefore the value was corrected to 1/1000 (6.97 Mt → 6.97 kt).

Grant amount: "Limit" is the upper limit of a grant specified in an ex-ante project evaluation sheet or project outline sheet, "Result" is the amount of grant shown on an ex-post project evaluation sheet, and "Contract value" is the amount entered in a project completion report.

Cost effectiveness: "Target" is the value obtained from the upper grant limit and the annual CO_2 reduction target, and "Ex-post evaluation" is the value calculated from the "Result" grant amount and the amount of CO_2 reduction measured in ex-post evaluation.

This section has introduced the sustainability and cost effectiveness of each project for the purpose of providing references to the expected GHG emissions reduction effects, climate change impact prevention and reduction effects, activities required to maintain these effects, and the perspective to keep in mind when implementing similar climate mitigation/adaptation strategies in future international cooperation. If the target value for the effect indicator estimated at the time of planning and the value measured in the ex-post study do not match, caution is required since the difference may not be due to the project content but may be attributed to changes in the unique situation surrounding the subject water supplier or external factors. In particular, when evaluating the climate change measure of a project that did not reach its target, it is necessary to investigate the cause of the failure and consider if it will be relevant to implementation in other countries.

3-3 Lessons Learned from the Projects

Table 10 shows lessons learned from the projects, including important points and challenges for developing countries to address when carrying out measures against climate change, and the future outlook for them.

Table 10: Positioning of measures against climate change and lessons learned

Large category	Middle category	Small category	Project	Lesson
Mitigation measures	Energy saving	Improvement in pump efficiency	1) Zai, Jordan	• In a country where it is difficult to secure alternative water sources, it is important to maintain the amount and quality of water supplied from the current water sources. • In an area with geographic features that require pumps, pumps consume large amounts of electricity, resulting in electric power expenses making up a high proportion of the operating expenses. Improving pump efficiency is an effective mitigation measure, which also will greatly help improve the operations of water suppliers. • For sustainability, it is important to select materials and shapes suitable for the characteristics of the raw water so that the allow equipment can be used over an extended period of time. • When equipment is updated, it should be replaced with energy-saving types. Easy to carry out, this measure is likely to be highly effective. However, maintenance policies need to be developed that not only require equipment replacement but also realize facilities with low GHG emissions in the future.

Large category	Middle category	Small category	Project	Lesson
		Construction of a water distribution system that preferably uses no pumps	2) Zarqa, Jordan	• This measure is aimed at not only improving efficiency based on pump updates, but also saving energy associated with water supply and distribution by constructing a system based on gravity flow. In the future, building such systems will be an effective way to save significant amounts of energy. • When measures are reviewed to reduce energy consumption, they should be so designed as to require updates to high-energy-efficiency equipment, with a bird's eye view of the entire system in the first place that considers methods that make the best of potential energy along with relocation of facilities. This will lead to long-term effectiveness. • Regarding operational improvements, the indicator for the development challenge is how to reduce the electricity charges to be borne. However, this greatly depends on fluctuations in electricity charges and so as the indicator for measures against climate change, GHG emissions are used. The fluctuations in electricity charges are also affected by the power source structure in the country affected. • For sustainable measures to reduce GHG emissions, it is important to maintain constructed facilities and equipment and perform preventive maintenance on them. It is also best to consider and embody actions to the extent possible that can be kept up over an extended period, such as learning and training sessions, in time with the introduction of facilities and equipment and timely implementation of measures. • In many cases, facilities cannot be relocated until they are updated because doing so is very expensive.

Large category	Middle category	Small category	Project	Lesson
		Reduction of water leakage	Found in many cases	• In parallel with implementing measures (based on equipment and technology) to reduce water leakage, it is necessary to consider the environment and improve the housekeeping capability for long-term plans. • The effectiveness is only estimated in terms of reducing water leakage. The effectiveness of the mitigation measures must be evaluated as reduction in GHG emissions as the result of lowering water leakage.
	Renewable energy	Power generation based on renewable energy (solar and wind power) using the premises of water supply facilities	3) Cambodia	• With the application of solar power systems, the goals for reducing CO_2 emissions and electricity charges were achieved at a higher level than expected. This may be called a double-benefit project because it provides a solution to the challenges associated with both climate change and development. Under the situation where the electricity supply does not meet demand and as a national policy, focus is placed on the expansion of renewable energy, so this system is highly useful. • It only requires facilities to be installed, which is easy to do and is highly effective. However, it requires maintenance not associated with water supply. • Depending on the country's system, the cost-effectiveness may be low.

Large category	Middle category	Small category	Project	Lesson
		Power generation based on renewable energy (hydro-electric power) using water supply facilities themselves	4) Honduras	• Introducing small-scale hydroelectric power generation is introduced to one of the water supply authority's water purification facilities will prioritize water supply and provide power generation as a subordinate operation. It is desirable to check at the planning stage the possibility that the project will be significantly affected by trends in the priority operation (in this project, supplying water) and to consider more than one scenario from the viewpoint that it is a power generation facility attached to a water purification facility with target values set up and cost effectiveness identified for its operation, including that for maintenance, based on a practical water supply plan. • Specifically, it is necessary to develop a water supply plan assuming various scenarios incorporating, for example, higher demand for water supplies due to increased urban populations in the future, plans to develop new water sources by the host government, and increases and decreases in precipitation caused by climate change and the possibility of water restrictions caused by them, and with power generation conditions set up to be adaptable to changes over an extended period of time. • The equipment and materials used for small-scale hydroelectric power generation should be designed to satisfy the above requirements. Wherever possible, the same investigation and review should be undertaken for normal hydro-electric power generation projects as well.

Large category	Middle category	Small category	Project	Lesson
Adaptation measures	Water shortage	Securing water sources resistant to climate change: Use of stored water and ground water and design of water intake facilities	5) Marshall Islands	• When there is a primary challenge (for this project, increase in the ability to store water to defend against water shortages), the ability of the facility to solve the challenge must be maximized. • It is essential to foresee future changes in the climate. • It is necessary to evaluate the environmental impact of implementing the project (for this project, the mitigation measures and implementation system have been checked for the effects to be considered in the stages of building and operating the reservoir with a plan made for monitoring the mitigation measures). The lowest-load water sources and design method are selected. • Review the effects predicted to occur due to future climate change, including a rise in the sea level. • Considering the sustainability of the cost effectiveness requires coordination with other plans.
			8) Paraguay	• In designing intakes and facilities, it is necessary to review the impact of floods, droughts, etc. caused by future climate change. • In reviewing future climate change, it is possible to reduce vulnerability to its effects by making decisions based on 50-year probability. • If a new water supply facility is planned, making it an energy-saving facility can not only help solve problems but is also effective as both an adaptation and mitigation measure. • It is possible to increase the sustainability of the effects by improving the techniques for operational maintenance and management and the management engineering for measures to reducing non-revenue water and implement technical assistance for meter installation, etc.

Large category	Middle category	Small category	Project	Lesson
			10) Ethiopia	• For projects in areas vulnerable to climate change, water sources that are less likely to be affected by climate change (for this project, deep ground water) are used. • In areas where the power supply is unstable, selecting power sources (based on renewable energy) that emit less GHGs is also likely to be effective as a mitigation measure. • Increasing the sustainability of the measures for reducing GHG emissions requires improvement of operational and maintenance capabilities.
		Reduction of water leakage	6) Vietnam	• Technology for preventing water leakage provides measures against shortfalls in water supply caused by the future increase in population and risk of climate change, as well as adaptation and mitigation measures to reduce energy consumption for freshwater generation, chemical usage, and CO_2 emissions. Dissemination of the construction technique, rather than the ability to identify water leaks and provide equipment and materials, is effective from the viewpoint of sustainability. • In terms of business, it is necessary to evaluate and underline the effects arising from introducing Japanese-quality products and construction techniques from the perspective of measures against climate change in the situation where measures against climate change are going mainstream in various countries. • In the future, it may also be necessary to evaluate the effects of climate change on the product manufacturing stage and on materials. • The future challenge is to build a system. If a licensing system is realized, it is expected to have long-term effects.

Large category	Middle category	Small category	Project	Lesson
			7) Indonesia	• The reduction of water leakage leads to effective use of water resources and lower energy costs, so detectors are highly effective. • Measures for reducing the non-revenue water ratio are based on not only identifying and repairing water leaks, but also on daily facility maintenance and data management, which requires the entire organization to work on and steadily implement effective measures from a broad perspective. It is necessary to plan and budget various measures including improvement of control drawings and construction techniques to implement them in the medium to long term. <Lessons to address in terms of business> • It is important to select and introduce water leakage detectors appropriate for the situation and circumstances in the country concerned. • It is imperative that a person or persons who understand the local situation should be involved and act as an interpreter because of differences in language and culture. • Demonstration of equipment and materials in a difficult environment that is not seen in Japan leads to reverse innovation to Japan. • There is room to study the possibility of commercializing a service that packages the sale of equipment and technology transfer together with measures for reducing non-revenue water.
			Found in many cases	• In parallel with implementing measures for reducing water leakage, it is necessary to improve maintenance capabilities.
		Promotion of water conservation	Found in many cases	• Generally, demand controls can provide significant conservation effects without any cost. For this to work, habits need to be changed and ingenuity is needed when communication with customers to raise awareness.

Large category	Middle category	Small category	Project	Lesson
	Heavy rainfall	Preparation for weather disasters such as floods and inundations (mainstreaming of anti-disaster measures)	9) Nepal	• The number of water-supply truck and plastic-bottled water purchases can be cut by reducing the water leakage rate and non-revenue water through, for example, maintaining water pipes and procuring meters. • Construction of energy-saving water supply facilities that take the effects of future climate change into account can not only help solve problems but also be effective as both adaptation and mitigation measures (for example, studying the risks of disasters caused by floods and incorporating those risks into the design, and designing water supply facilities that use as little electric power as possible).

3-4 Summary

We learned many lessons from studying the sustainability and cost effectiveness of the effects of the measures against climate change carried out in the implemented projects. The lessons are summarized as follows.

[Mitigation measures]

- Energy-efficient equipment and solar power generation should be aggressively introduced because it is possible to foresee and measure the effects of such measures and that the effects are significant. In particular, the introduction of energy-efficient equipment is associated with water supply technology, so there is a strong need to consider it.
- For solar power generation, unused sections within premises and roofs of buildings are used, and solar panels are used as covers for settling ponds and the like. Small-scale hydroelectric power generation can provide a stable power source in areas where the electricity supply is poor, but it is suggested that having a view of how the facilities will be used in the future is important.
- Reducing water leakage improves the efficiency of water supply operations themselves, which should be proactively pursued from a management perspective as well. However, this must be strategically and continuously implemented, and a system must be established that enables the effect of the efforts to be measured and evaluated. Doing so will result in large-scale improvement activities that require an organization skills.
- For other measures, such as promoting water conservation, examples of implementation will be shared so they can be added as options for projects.

[Adaptation measures]

- The main adaptation measures in the water supply sector include adaptation to water sources destabilized or degraded by droughts or the like; water sources salinated by a rise in the sea level or the like; water supply facilities damaged by heavy rainfall.
- For measures against droughts, it is considered that Japan has not accumulated sufficient information about ideas to incorporate into water intake facilities in countries that have a distinct dry season (e.g., water intake technology adaptable to extreme water level fluctuations), so technical ideas must be shared.
- It considered deemed that further measures against salination of ground water will be needed in the future.
- Although Japan has expertise in preparing for heavy rainfall, there is still a wide variety of disasters that occur due to it. In particular, experience with measures that can be implemented with poor local disaster prevention facilities and recovery equipment and materials should be proactively shared.

[Determining cost-effectiveness by calculation]

- There is a view that cost-effectiveness determined based only on the annual reduction of CO_2 emissions estimated for each project does not take into account the sustainability of the effects of reduced GHG emissions, so it is not sufficient as an indicator for evaluating measures against climate change. It is therefore necessary to determine the time span for evaluation and to use evaluation indicators that take into account the duration of measures.
- It is necessary to determine the effects of the implemented projects based on not only reduced GHG emissions but also on achievement of the goals associated with water supply and development of human resources. Further reviews are required.

Chapter 4 Field Survey in Cambodia

4-1 Overview of the Field Study

(1) Study objective

The aim of this study is to collect information on the current situation regarding the relationship between climate change and water supply operations in the partner country and problems associated with them. It also covers information on cooperation activities that take into account Japan's measures against climate change in order to recommend measures, based on such information, to promote international cooperation in the water supply sector.

(2) Details of the study

The study is conducted to collect information, for example, on how water supply operations in the country are related to climate change and the associated problems; the effects and current state of the facilities and schemes installed based on grant aid from Japan; and ripple effects on other water suppliers. In addition, a fact-finding study based on interviews is conducted about cooperation activities by other countries in response to climate change and about the need for Japan's future international cooperation activities.

Interviews were conducted with the Phnom Penh Water Supply Authority (PPWSA), which is responsible for implementing the Plan for Introducing Solar-based Clean Energy based on grant aid; the Ministry of Industry, Science, Technology and Innovation (MISTI) (Former Ministry of Industry, Mining and Energy (MIME)), which is the responsible body that has jurisdiction over water supply in urban areas; and the Ministry of the Environment (MOE), which is responsible for coordinating ministry and agency departments associated with climate change. Field studies were conducted at PPWSA's Phum Prek Water Treatment Plant, which carried out the cooperation activities concerned, and at the Koh Dach private water supply facility, a privately operated facility where a Japanese company is conducting water supply business in Cambodia.

(3) Study group

The field study was conducted with the assistance of members of the Study Committee on International Cooperation in the Water Supply Sector. The group mainly consisted of experts rich in rich, who, for example, have assisted the water supply sector or have participated in the training project carried out in Japan. The group members are listed in Table 11.

Table 11: Members of the field study group

Member	Organization	Special field
Tatsuo Morimoto	Federation of Japan Water Industries, Inc.	Globalization of the water supply industry
Takeo Yamaguchi	Japan International Corporation of Welfare Services	Water supply planning and business management

(4) Study itinerary

As the target country, Cambodia was selected from among those that have carried out international activities that take into account mitigation measures for water-supply facilities and adaptation measures for water supply systems resistant to the effects of climate change. This is because it is a country where the political situation, public security, and COVID-19 infection status are relatively stable and an expert from a Japanese water suppler is stationed. Table 12 shows the field study itinerary.

Table 12: Field study itinerary

Study period	September 25 through 28, 2022	
Organizations visited and concerned	PPWSA MISTI MOE PPWSA's Phum Prek Water Treatment Plant Koh Dach private water supply facility	
Study itinerary	September 25	Leave Japan and arrive in Phnom Penh
	September 26	Visit PPWSA's Phum Prek Water Treatment Plant
	September 27	Interviews with MISTI Visit Koh Dach private water supply facility
	September 28	Interviews with MOE Interviews with PPWSA Leave Phnom Penh
	September 29	Arrive in Japan

(5) Collecting information in the target country

In the field study, we collected information about water supply operations in the country from relevant parties. We interviewed people associated with water supply who were involved in the project about the project's results and challenges as well as the cooperation activities associated with climate change in other countries being carried out in the target country. We also interviewed people in the ministries and agencies responsible for addressing climate change about general measures against climate change in Cambodia's water resources sector. In the on-site study, we collected information about the details of the activities and challenges associated with climate change.

Table 13 shows the items investigated in the field study. We sent questionnaires to the interviewees (PPWSA and MISTI) in advance and based on their answers, we checked the details and asked further questions. We then sent to the MOE a document summarizing the study and objective of the visit. In conducting the interviews, we received assistance from people associated with a water supplier in Japan involved in international cooperation activities and the Japanese embassy in Cambodia.

The answers to the questionnaires received in advance are shown in Document 2.

Table 13: Items in the field study

Item	Questions
Climate change's effects on water supply operations	Effects of climate change on water supply operations
	Recognized climate change risks
	Whether a strategy has been developed to deal with the effects of climate change and carbon neutrality
	Mitigation measures currently underway
	Adaptation measures currently underway
	Problems to address in carrying out measures against climate change in water supply operations, and their priority level
	Current state of electrical power in Cambodia (power source structure, electricity rates, and stability) and its impact on water supply operations
	Requests to Japan for international cooperation to address the effects of climate change on water supply operations
Japan's International cooperation activities (Plan for Introducing Solar-based Clean Energy) to address the effects of climate change	Special notes about the background and history behind implementation
	Sustainability of the project's outcomes
	Improvements to and maintenance of equipment
	Subsequent horizontal development (awareness building and dissemination to other water treatment plants) and reasons for it
	Idea about the effects of introducing solar-based clean energy to water supply operations (particularly in countries where the power supply is unstable)
Cooperative activities associated with climate change in other countries	Activity details
	Involvement of Japan in the international cooperation activities
Other questions about operations in general	Relation of SDGs to the operation strategy and plans
	Responsible entities for monitoring SDGs 6 and 13 with respect to water supply operations
	Most important current issue
	Challenges relating to human resource development
	Other comments

4-2 Results of the Field Study

(1) PPWSA

Table 14 and Table 15 show the interview record and study results, respectively. We obtained views about the effects of climate change on water supply operations from PPWSA and the current state and subsequent development of the Plan for Introducing Solar-based Clean Energy implemented at the Phum Prek Water Treatment Plant. Also obtained was information that solar power generation has been incorporated as a measure against climate change in the Bakheng water-supply project currently being carried out by Agence Francaise de Developpement (AFD), European Investment Bank (EIB), and PPWSA.

Table 14: Interview record (PPWSA)

Item	Descriptions	Remarks and information overview
Date and time	14:00, September 28, 2022	
Organization (location)	PPWSA	Organization responsible for carrying out the project
Interviewee	Mr. Samreth Sovithia, Deputy General Director	
Other attendees	None	
Information provided	Answers to the questionnaire	Shown in Document 2
Information provided	Chapters 9 (Organizational Development) and 10 (Human Resource Development) of the Report on the Survey for Collecting Data on Water-supply Development in Phnom Penh, capital of the Kingdom of Cambodia	Updated version of the master plan developed by JICA, which summarizes the present situation and directions of organizational and human resource development as well as main measures
	Study Report on Solar Power Generation Systems for the Bakheng Fresh Water Generation Facility (September 2020)	A report in which a French consultant estimated the cost-effectiveness of the solar power generation system for Bakheng Fresh Water Generation Facility

Table 15: Study results (PPWSA)

Item	Question	Answers
Climate change in water supply operations	Effects of climate change on water supply operations	• Shortfalls in water supply during the dry season (5 years in a row) • Fall in river levels (1- to 1.5-m fall in the Tonle Sap River) • Degraded water quality during the dry season (algae and shellfish grow at intakes; although lime is added, the water gains a smell) [Phenomena that are not clearly caused by climate change] • Widespread growth of water weed (water hyacinth) • Increased turbidity (housing-land development in upper reaches caused sandy water to flow in)

Item	Question	Answers
	Risks recognized	Natural disasters: degraded raw-water quality, floods, and droughts
	Whether a strategy has been developed to deal with the effects of climate change and carbon neutrality	• Master Plan 2017-2030 and Updated Master Plan 2021-2030
	Mitigation measures currently underway	• Use of solar energy • Introduction of an energy-saving inverter system for pumps as a way to improving energy efficiency • Measures against climate change are incorporated into the Bakheng water-supply project being carried out by AFD, EIB and PPWSA • There is a provision defining that initiatives to combat climate change will reduce the mortgage rate. This provision applies to the introduction of solar power generation (a 3.8-MW solar panel array will be installed).
	Adaptation measures currently underway	• Improvement to intakes. They are designed considering possible effects on, for example, hydrology, hydro-electric power, sediment from the Mekong River, and transport. • Water treatment plants are designed considering the water intake location (so that water can be taken in at a deep location to prevent shellfish from propagating). • Measures to prevent inflow of shellfish
	Problems to address in carrying out measures against climate change in water supply operations and their positioning	Energy consumption and pressure control
	Current state of electric power in Cambodia (power source structure, electricity rates, and stability) and its effects on water supply operations	• Sufficient power is supplied (24 hours/day). • The power supply is cut from time to time. • Electricity charges make up 25% of the operating costs, which is the highest percentage of PPWSA's operating costs

Item	Question	Answers
	Request to Japan for international cooperation to address the effects of climate change on water supply operations	Organizational and human resource development (Updated Master Plan 2021-2030)
Japan's international cooperation activities (Plan for Introducing Solar-based Clean Energy) to address the effects of climate change	Special notes about the background and history behind the implementation	PPWSA's introduction of clean energy based on a solar power generation system has been useful as expected.
	Sustainability of the effects of the project	Sustaining
	Improvements to make to equipment, and maintenance	Nothing in particular
	Subsequent horizontal application (awareness building and dissemination to other water treatment plants) and reasons for it	• Examples of introduction: 50-KWp small-scale solar power generation incorporated into the M'Leach water treatment plant and a 3.8-MWp solar power generation system introduced at the Bakheng Water Production Facilities with a capacity of 390,000 m^3/d (the WPF is scheduled to start operating in 2023) • Reason for introduction: the energy efficiency was found to be excellent. • Awareness building: SDG 13 is under the jurisdiction of other ministries and agencies, and PPWSA is not particularly aware of it.
	Effects of introducing solar-based clean energy to water supply operations	• Solar power generation systems are useful to PPWSA. • The solar power generation system at the Bakheng Fresh Water Generation Facility is estimated to save $450-480,000, providing more than a 5% internal rate of return given that its service life is 20 years. • However, if the power generation system is connected to an EDC grid instead of an independent system, an additional charge is required; this system is disadvantageous.

Item	Question	Answers
Cooperative activities associated with climate change in other countries	Activity details	Measures against climate change were introduced with a financing agreement for the Bakheng water-supply project by AFD, EIB, and EU.
	Involvement in Japan's international cooperation activities	No involvement
Other questions about operations in general	Relationship of SDGs to the operating strategy and plans	• SDG 6: While the master plan defines that the goal of supplying clean water to all people in the service area should be achieved in 2030, PPWSA expects to achieve it by 2025. The government is continuously expanding the city of Phnom Penh and the expanded water-supply area may reduce the penetration rate; however, the goal can be achieved for the current area of Phnom Penh city. With the completion of Bakheng Fresh Water Generation Facility, PPWSA will have a capacity of 1 million tons/day. • SDG 13: PPWSA is not particularly aware of it.
	Entities responsible for monitoring SDGs 6 and 13 in water supply operations	• SDG 6: The MISTI, Ministry of Rural Development (MRD), MOE, the Council for Development of Cambodia (CDC), and Cambodian Rehabilitation and Development Board (CRDB) • SDG 13: The MOE, MAFF, and NCSD
	Most important current issue	Phnom Penh is undergoing fast and furious development without an appropriate urban plan, which has produced a gap between water supply and demand.
	Challenges relating to human resource development	Statements contained in the Third Master Plan 2016-2030 The issues include increasing the number of staff members associated with the expanded scale of operation and greater workload on the administrative department, as well as improvements to operating efficiency and adaptation to and management of new technologies. In particular, these include: cultivation of technical staff and next-generation top management; training for new employees; enhancement of the administrative department's capabilities; and inheritance of an organizational culture to carry on after current managers retire.

(2) MISTI

Table 16 and Table 17 show the record of the interview with MISTI and study results, respectively. We interviewed the director and obtained detailed materials and information about the effects of climate change on water supply operations; guidelines for a water supply resistant to floods and droughts developed by the MISTI with the assistance from UNICEF and the Cambodia Water Supply Association (CWA); and guidelines for water safety plans adaptable to climate change.

Table 16: Interview record (MISTI)

Item	Description	Remarks and information overview
Date and time	10:00, September 27, 2022	
Organization (location)	MISTI	Organization responsible or the project (former MIME)
Interviewees	• Dr. Sim Sitha, Secretary of State • Dr. Sreng Sokvung, Director of D/TPM, GD/WAT • Mr. Kim Chanrithy, Officer of D/TPM	GD/WAT: General Department of Potable Water D/TPM: Department of Technics & Project Management
Attended by:	Mr. Kazuhiro Sasada (water supply administration technical corporation project)	
Information provided	• Answers to the questionnaire	Shown in Document 2
	• Guideline on Flood-Resilient Measurement for Water Supply (2022) • Guideline on Drought Resilient Measurement for Water Supply (2022)	The guidelines focus on water supply services in areas particularly vulnerable to floods and droughts, indicating what should be done before, during, and after a flood or drought at water sources and intakes, water treatment plants, reservoirs, and the water supply and distribution network. For floods and droughts that may affect the water supply system, the guidelines are aimed at preventing them and reduce the effects, perform monitoring and measures for urgently solving problems during a flood/drought, and conducting verification, planning, and recovery after a flood/drought.
	• Guideline of Climate Resilience Water Safety Plan for Water Supply Service (2022)	This guideline is for water safety plans adaptable to climate change, developed by the Technology and Business Administration Department, Drinking Water General Office with support and cooperation from UNICEF and the CWA. It defines an extension of the techniques of the water safety plan developed in 2015 to address risks associated with climate change, consisting of six steps with addition of water source evaluation, climate risk evaluation, and decisions for options resistant to climate changes.
	• PPWSA water rates	A list of water rates for household, government, commercial/industrial uses. For household and commercial/industrial uses, the meter-rate system is used.

Item	Description	Remarks and information overview
	• General Power Conditions in Cambodia (March 2022) Adviser of the Energy General Office, Ministry of Mines and Energy (JICA expert)	The development of power plants to meet the sharp increase in demand for power depends on independent electricity generation utilities. The household and rural electrification rates are 86.4% and 97.5%, respectively (2021). While power failures due to insufficient power generation were eliminated in 2014, the amount of power generated decreased in 2019 due to droughts. Since then, supply has been secured through the development of power sources and increased imports. The household electricity rates are still higher than in neighboring countries. The differences between regions and between households are decreasing.
	• Photo of the solar panels at Phum Prek Water Treatment Plant	

Figure 1: Interview with MISTI

Table 17: Study results (MISTI)

Item	Question	Answer
Climate change in water supply operations	Effects of climate change on water supply operations	• Occurrence of droughts and floods and an increase in their frequency [Insufficient water sources in the dry season] • Some water supply operators have no choice but to cease operation due to insufficient water sources. • Decreased river level (the Mekong River, the same trend in the other regions) • Reduced amount of ground water taken. Some water supply facilities plan to relocate due to difficulties in the dry season (e.g., Battambang Water Supply Facility, based on a grant aid by JICA). Small-scale water supply facilities respond to the situation by, for example, excavating ponds and/or wells and taking water from upper reaches. • Some facilities were not able to take water from their water sources (water intake points) planned at the time of feasibility study, so used a different water source or reapplied for a license (for example, a facility changed its plan to take water from a lake to a plan to take water from a river due to a change in water quality). [Floods] • Fresh water generation is suspended (not many operators temporally stop fresh water generation). • Water sources declined in quality or were contaminated. • In case of a heavy rainfall, facilities cannot appropriately drain water, so water flows into manholes in water distribution blocks, which damages equipment and allows water to enter water meters, making them difficult to read. The difficulty in reading meters affects their revenues. • Flooded water treatment plant. A plant in a rural area was flooded. In designing water treatment plants in the future, flooding must be taken into account. • Flood damage becoming more severe (for example, roads that had never been submerged were flooded)
	Risks recognized	• Droughts and floods. In particular, it is important to secure water sources in the dry season. • It is difficult to separate development for increased demand from effects of decreased rainfall.

Item	Question	Answer
	Whether a strategy has been developed to deal with the effects of climate change and carbon neutrality	• Focus is placed on problems associated with water sources, in particular. • Under the World Bank's Water Supply and Sanitation Improvement Project, MISTI plans to review the national policies on water supply and sanitation to update them. It expects this to provide a good opportunity for all relevant organizations and stakeholders to work closely together. • The government is making investments to develop water sources, which are planned to be used for multiple purposes including water consumption. • A guideline was published on water sources resistant to floods and droughts, and another guideline was summarized for water safety plans resistant to climate change. • These guidelines are provided to applicants when a license is issued. • MISTI and MRD have been responsible for urban and rural areas, respectively. They negotiated with the prime minister to come to an agreement that both organizations should work together in upgrading water supply until 2030. • A water supply law is under preparation.
	Mitigation measures currently underway	MISTI encourages operators to comply with the recommendations based on the guideline on resistance to floods and droughts and water safety plans resistant to climate change.

Item	Question	Answer
	Adaptation measures currently underway	[Changes to the water intake methods and facilities] • To counter water shortages in the dry season, sandbags are used to hold water due to a lack of dams, water is taken from ponds, waterways from lakes are arranged, and other measures are taken. MISTI tacitly permits temporal water intake methods because no other choices are available. • There is a case where a facility sets up a water intake cabin (pontoon) in a river because it was no longer able to take water using a water intake facility installed along a riverside. Although changes can be made, suppliers must negotiate with the MPWT and Ministry of Water Resources and Meteorology. This requires permission from relevant ministries and agencies. • Among PPWSA's water treatment plants, the plant in a Cham village changed its design to take water using a pontoon, which was installed at a location even 5 m deeper than originally designed for the plant in Niroth, and the design of the plant in Kampong Thom was changed to a floating type. For even a non-floating water treatment plants, the installation of intake pipes requires an application because they are placed in rivers. • When a flood occurs, river structures do not experience a problem if the water intake is appropriately designed. Structures are not significantly affected for lakes but may experience a problem in a large river. • For floating-type water intakes, high-turbidity water may be taken in depending on the water depth because intake pipes are fixed.
	Problems to address in carrying out measures against climate change in water supply operations and their positioning	Building a water supply system adaptable to climate change may require a larger investment than a normal water supply system. On the other hand, the water sector, especially the private sector, in Cambodia is already facing investment restrictions, even in normal projects.

Item	Question	Answer
	Current state of electric power in Cambodia (power source structure, electricity rates, and stability) and its effects on water supply operations	• Although power conditions are unstable and there are still restrictions such as the fact that three-phase electricity cannot be used, the state of the power supply for water supply operations has substantially improved. • The power supply is almost sufficient. Public water suppliers do not face significant problems because they largely receive power from the electric power corporation. Those that cannot do so receive power from private suppliers or generate power for their own use. Electricity charges are high. • The problem is that while the low-rate policy is adopted for water supply operations, the electricity rate is high. Compared with neighboring countries, Cambodia's water rates are low and electricity rates are high. • The electricity rate makes up 25% of operating costs for PPWSA and 30% for facilities in rural areas.
	Request to Japan for international cooperation to address the effects of climate change in water supply operations	• The sustainability of the water supply sector requires funds for developing water resources. • The proposed water supply law intends to set up a water development fund (WDF). MISTI expects Japan to contribute to and support the WDF to address climate change and insufficient investments in the water sector, especially in the private sector.
Japan's international cooperation activities (Plan for Introducing Solar-based Clean Energy) to address the effects of climate change	Effects of introducing solar-based clean energy to water supply operations	• Solar power generation has an advantage that it can reduce the power rate, but also brings some disadvantages. While solar panels cost less than they used to be, public water suppliers have a rule that requires the power line for solar panels to be separated from the normal power line. This requires an additional transformer, which is expensive. • Small-scale panels require batteries, which are expensive. • At present, using solar power is expensive. • As far as they know, no subsidy system is available.
Cooperative activities associated with climate change in other countries	Activity details	• UNICEF: Support for developing guidelines for a water safety plan resistant to floods, droughts, and climate change • World Bank and ADB: Consideration of climate change when new projects are prepared
	Involvement in Japan's international cooperation activities	No involvement

Item	Question	Answer
Other questions about operations in general	Relationship of SDGs to the operation strategy and plans	• Although MISTI is doing its best to help Cambodia to achieve its SDGs in 2030, it has many things to do and many challenges, which require assistance from development partners (Japan, in particular).
	Entities responsible for monitoring SDGs 6 and 13 in water supply operations	• MISTI is responsible for SDG 6, watching the status of water supplies (MISTI and MRD are responsible for water supply in urban areas and rural areas, respectively). • Toward the goals for 2030, it is investigating to what levels the goals are being achieved across the country. The approach is determined based on cooperation between relevant ministries and agencies instead of a questionnaire survey. Currently, MISTI is considering diverting a World Bank system, called the LSMS (Living Standards Measurement Study). It is aiming to store data using a cloud platform, which still has some problems. When the platform is completed, data can be shared. The intention is to rebuild a database in MISTI's data center.
	Most important current issue	Sustainability of water sources and investment funds for private companies in particular
	Challenges relating to human resource development	• For the entire water sector, human resources are not a very significant issue. PPWSA is a top-class public utility even by international standards, and MISTI believes that its staff can support the water sector in Cambodia. • However, this requires proper procedures and mechanisms to be developed.
	Other comments	• The capabilities of private operators must be also improved. This will lead to effective measures for raising the awareness of all stakeholders about clean water.

(3) MOE

Table 18 and Table 19 show the record of the interview with the MOE and study results, respectively. From Mr. Hak Mao, a climate change expert who has studied in Japan, we received information about the role of the Ministry of Environment and the effects of climate change on water sources as evaluated by the MOE.

Table 18: Interview record (MOE)

Item	Descriptions	Remarks
Date and time	8:30, September 28, 2022	
Organization (location)	MOE	The Climate Change Section, General Policy and Strategy Office is responsible for measures against climate change[35, 36]. At the relevant ministries and agencies, measures against climate change went mainstream with a section associated with climate change set up at more than ten ministries and agencies. The Ministry of Environment plays a coordinating role, cooperating with international society[37].
Interviewees	• Hak Mao, Ph.D., Director, Department of Climate Change, The General Directorate of Policy and Strategy • Two other people	As a foreign student in Japan, Mr. Hak Mao was involved in a CO_2 emission reduction project in a doctoral program at Kyoto University. He also studied in the U.S.A. and was involved in Kyoto Climate Change Protocol 1996. Due to the shortage of human resources associated with climate change, as a doctor, he wants to help reduce CO_2 emissions in the future based on the knowledge obtained through the studies he conducted in Japan.
Attended by:	Mr. Takanori Kuribayashi (First Secretary at the Japanese Embassy in Cambodia)	

Table 19**:** Study results (MOE)

Item	Question	Answer
Climate change in water supply operations	Effects of climate change on water supply operations	• In association with water resources, a report summarized by MOE evaluates droughts and floods along with contagious diseases associated with them. • MOE evaluates whether residents have access to clean water. There is a fact that during the rainy season, some areas are flooded and other areas experience water shortages.

[35] GEOC Climate Action Talk about carbon neutrality in Cambodia #1 (points of the results of COP 26) https://www.youtube.com/watch?v=NLd7e8HnDNI

[36] GEOC Climate Action Talk about carbon neutrality in Cambodia #2 (such as carbon neutrality strategy and effects of climate change) https://www.youtube.com/watch?v=VM3N6cGeCHM

[37] GEOC Climate Action Talk about carbon neutrality in Cambodia #3 (including information about governance) https://www.youtube.com/watch?v=ekib7yeH9VM

Item	Question	Answer
	Risks recognized	• People in urban areas can use water services but some people in rural areas cannot. • In the dry season, water is in short supply. Rural areas are short of water for agriculture as well as water for daily life. People in rural areas must obtain water for daily life in some way or other.
	Whether a strategy has been developed to deal with the effects of climate change and carbon neutrality	• The government adopted measures to solve the water shortage problem. For example, the MOE is repairing and maintaining irrigation facilities. • MISTI is responsible for clean water only and MOE for water resources in general. When ministries or agencies develop guidelines, they receive advice from other ministries and agencies but they do not understand MISTI's guideline on droughts and floods.
	Mitigation measures currently underway	• MOE has developed policies for and measures against climate change. The policies up to 2023 include a policy for reducing CO_2 emissions. • Policy goals up to 2030 and long-term policies up to 2050 have been developed. • The basic policies for reducing CO_2 emissions are to increase forests and develop renewable energy. The MOE has adopted, for example, a policy to replace 35% of total energy production with renewable energy, with the goal of achieving a 12% share from solar power generation.
	Requests to Japan for international cooperation to address the effects of climate change in water supply operations	• Under the situation where the effects are becoming larger in the context of the Paris climate change agreement as exemplified by the fact that the climate change issue is developing to a climate crisis, MOE is required to submit many reports every year. Human resources are in short supply for preparing reports and conducting other tasks. Human resources must be developed in the short and long terms, and require various experts for vulnerability evaluation, etc. • Climate change is a long-term issue, which also requires short-term responses. These responses also require financial support. The hope is to receive support because the current funds are insufficient. MOE would like Japan to play a leading role. It expects that Japan will play a larger role in capacity building (capability development) for Development and Climate Alliance. • Many decisions must be made. Activities about support decisions and green government issues require support for measures and provision of funds.

Item	Question	Answer
Japan's international cooperation activities (Plan for Introducing Solar-based Clean Energy) to address the effects of climate change	Effects of introducing solar-based clean energy to water supply operations	• In Cambodia, no system is available for subsidies or the like to install solar power generation facilities. • A policy for green investments has been established. The Ministry of Mines and Energy (MME) is responsible for it.
Cooperation activities associated with climate change in other countries	Involvement in Japan's international cooperation activities	• MOE has been cooperating with many countries, with the involvement of Japan as the leader. To expand the cooperation, MOE thinks that it is better if Japan took part in the Development and Climate Alliance. • Climate change is an important issue, with problems already having come to the surface, so it should be addressed sooner rather than later.
Other questions about operations in general	Entities responsible for monitoring SDGs 6 and 13 in water supply operations	• MOE is mainly responsible for cooperating with relevant ministries and agencies to summarize reports to be sent to relevant organizations. • Another ministry associated with water is MRD. It carries out activities to ensure that residents can secure clean water. • The effects of climate change are becoming larger year by year, and the MOE must carry out measures at an early stage.
	Other comments	• The climate change issue, for which MOE is responsible, affects may areas in Cambodia. Every year, MOE summarizes the results of studies on the effects as National Communication Reports 2020 and 2022 and the like to disclose the results of scientific studies. It has just submitted a 2020 edition to the bureau of United Nations Framework Convention on Climate Change. • The report summarizes evaluations about five areas: water resources, agriculture, forests, sandy beaches, and health.

(4) PPWSA's Phum Prek Water Treatment Plant

Table 20 and Table 21 show the interview conducted when we visited the site of the Phum Prek Water Treatment Plant and study results, respectively. Although the day on which we visited the site was a Cambodian national holiday, we were able to observe the plant thanks to consideration given by the personnel officer. With the interview attended by site workers as well, we obtained information about the maintenance of the solar power generation facility and its electric-generating capacity, along with site staffs' views on the plant's design and measures against climate change under review.

Table 20: Interview record (PPWSA's Phum Prek Water Treatment Plant)

Item	Descriptions	Remarks
Date and time	11:30, September 26, 2022	
Organization (location)	PPWSA's Phum Prek Water Treatment Plant	
Interviewee	PPWSA personnel officer	Attended by site workers

Table 21: Study results (PPWSA's Phum Prek Water Treatment Plant)

Item	Question	Answer
Solar power generation facilities	Maintenance	• The facilities seldom go out of order. In the past, the facilities experienced panel breakage and the staff repaired them with replacement panels. • They clean the facilities once a month or so. In the rainy season, they do not need to be cleaned so often. • In the dry season, staff must open the panes to cool the panels as well as clean the facility, which is a demanding task.
	Power-generating capacity	• The facilities were installed in 2012 and the power-generating capacity has remained unchanged since then. • Electricity used for official work is from solar power generation; electricity from solar power generation is all consumed on site.
Phum Prek Water Treatment Plant	Design of the facilities	• The capacity is designed to satisfy the demand. At Phum Prek Water Treatment Plant, the distribution pipes were first installed properly. • It is important to properly develop a master plan. • Data is being collected to calculate the capacity of the facilities.
	Measures against climate change	• The measures were adopted in the ASEAN DX project. • They also looked at energy efficiency. • They are considering a shift to meter reading using smartphones. They will collaborate with the IT department at the Royal University of Phnom Penh.

Figure 2: Solar power generation facilities at the Phum Prek Water Treatment Plant (Provided by MISTI)

(5) Koh Dach private water supply facility

Table 22 and Table 23 show the record of the interview conducted when we visited the site of the Koh Dach private water supply facility and study results, respectively.

Table 22: Interview record (Koh Dach private water supply facility)

Item	Descriptions	Remarks
Date and time	15:00, September 27, 2022	
Organization (location)	Koh Dach private water supply facility	Soma Kobelco Water Supply Co. Ltd., a company jointly funded by Kobelco Eco-Solutions Co., Ltd. and Soma Group (a private company in Cambodia), obtained a right to exclusively operate the water supply business in Koh Dach in Phnom Penh (the capital city) and the Koh Oknha Tei district in Kandal province (license term: 20 years). It is the first water supply project conducted in Cambodia by a Japanese company. The population affected is approx. 20,000 and the company started water supply in December 2019[38].
Interviewee	• Mr. Susumu Ono, General Manager, Phnom Penh Branch Office, Kobelco Eco-Solutions Co., Ltd.	

[38] Topics of Kobelco Eco-Solutions Co., Ltd., https://www.kobelco-eco.co.jp/topics/news/2018/20190318.html, https://www.kobelco-eco.co.jp/topics/news/2019/20191216.html

Item	Descriptions	Remarks
Information provided	• Photo of the water intake at the Mech water treatment plant in Kampot Province • Photo of the water intake at the Koh Dach water treatment plant in Phnom Penh	

Table 23: Study results (Koh Dach private water supply facility)

Item	Question	Answer
Initiatives to address environmental issues	Introduction of energy-saving facilities (mitigation measures)	Most of the circulating pumps at the company's water treatment plants use inverter control (with inverters from Fuji Electric and Schneider). Inverters have also been introduced at the Siem Reap Water Treatment Plant (60,000 m^3/day), which is currently being constructed.
	Water intake resistant to fluctuations in water level (Adaptation measures)	A water intake facility (pontoon (floating water-intake system)) has been introduced. This measure is to withstand the difference in water levels between the rainy and dry seasons.
Other technological ideas	Introduction of on-site equipment for generating sodium hypochlorite	PPWSA and other organizations are promoting a shift to purified sodium hypochlorite from chlorine gas, which presents a risk of chlorine leakage. The Koh Dach water supply facility also plans to introduce purified sodium hypochlorite at the Ta Khmau Water Treatment Plant (30,000 m^3/day) undertaken by consortium members (construction is scheduled to begin in December 2024).
Other operational ideas	Factors that put the operation into gear	Contrary to expectations, the supply areas were expanded even to islands neighboring the Koh Dach district (island) along with an increased demand, which kept the operation rate at high levels. It was good that this made the project pay for itself in two years instead of the intended period of five years. To satisfy the demand, they are planning to expand the facility.

Figure 3 and Figure 4 show the water intake facility at the Koh Dach water treatment plant in the capital city, Phnom Penh, and the water intake facility at the Mech water treatment plant in Kampot Province, respectively. Both facilities are pontoons (floating water-intake systems) to handle the difference in water levels between the rainy and dry seasons.

Figure 3: Water Intake at the Koh Dach Water Treatment Plant in Phnom Penh (provided by Kobelco Eco-Solutions Co., Ltd.)

Figure 4: Water Intake at the Mech Water Treatment Plant in Kampot Province (provided by Kobelco Eco-Solutions Co., Ltd.)

4-3 Summary

The following is a summary of the findings obtained in the field study.

(1) Current state of the water supply sector in Cambodia and climate change in the water supply sector

[Current state of the water supply sector in Cambodia]

- Solar power generation facilities installed as mitigation measure are having an effect, and there have been cases of installing solar power generation facilities in projects outside of the ones being monitored. However, we confirmed that there are hurdles to large-scale adoption of solar power, such as the need to separate the power authority and the power supply system and rising prices of equipment.
- As adaptation measures, we confirmed that there is a high local awareness of the issues, as seen by the development of guidelines for floods and droughts, for example. It appears that the frequency and severity of these disasters are increasing yearly, and there is an awareness in Cambodia that a growing number of water suppliers are being affected by such disasters.
- Cambodia has a distinct rainy season and dry season and is therefore greatly affected by water level differences caused by droughts. The country lacks facilities to keep the water level from falling, for example having no intake weirs, and water intake pontoons (floating) are often used as the method for water intake utilizing changes in water intake level. Also, as a drop in water level results in a drop in water intake volume, water suppliers have built up experience with intake difficulties due to a drop in water level.
- When this problem cannot be overcome with intake techniques, some suppliers find water intake position changes challenging.

[Positioning of the water supply sector in national climate change policy and carbon neutral policy]

- Cambodia announced the Cambodia Climate Change Strategic Plan 2014-2023[39] as a national plan in 2013 in which it recognizes more frequent and intensified extreme weather events, floods, droughts, and storm surges as impacts of climate change. Targets related to the water supply sector are Strategic Objective 1, to promote climate resilience through improving food, water, and energy security (includes promoting renewable energy and energy efficiency, appropriate technology transfer, and repairing and building water infrastructure), and Strategic Objective 4, to promote low-carbon planning and technologies to support sustainable development of the country. MIME (now MISTI) that controls the water supply sector has a target of mobilizing resources through technical and financial support and supporting the establishment of laws, policies, technical guidelines, and technical manuals regarding climate change impacts. This can be considered the area for MISTI's formulation of guidelines for flooding and drought. The Climate Change Department (CCD) within the Ministry of Environment (MOE) serves as the Secretariat for the National Climate Change Committee (NCCC), and the statement in the plan that the CCD coordinates inter-agency activities is congruent with the responses we received in field study interviews.

[39] Cambodia Climate Change Strategic Plan (unfccc.int)
https://www4.unfccc.int/sites/NAPC/Documents/Parties/Cambodia_CCCSP.pdf

- Regarding adaptation measures, the National Council for Sustainable Development (NCSD) for which the MOE serves as the Secretariat announced a National Adaptation Plan Process in Cambodia[40] in 2017, stating that water resources and infrastructure are vulnerable to climate change. Management of the water sector is expected to become increasingly difficult with increased flooding and reduced water supply from rivers due to low water levels during droughts and the dry season. As a mitigation measure, the NCSD announced the Long-term Strategy for Carbon Neutrality[41] in 2021. The plan does not mention the waterworks sector, and wastewater treatment is positioned within the waste sector.
- In the PPWSA Annual Report (2021)[42], expanding the water supply to Phnom Penh's suburban areas and surrounding regions and increasing efficiency of the water supply (cutting costs) were set as strategic goals, and the focus was more on expanding water supply than combating climate change. In interviews as well, there was little awareness of SDG 13, and responses showed active engagement in activities to reach the targets of SDG 6. However, falling river water level in the dry season due to climate change impacts is known as a risk. This response falls under adaptation measures, while streamlining of processes and lowering of water loss rate to cut costs are mitigation measures.

(2) Japan's international cooperation activities in Cambodia to combat climate change impacts

- The amount of power generated with solar power generation facilities installed through assistance from Japan is being maintained, and power cost cutting effects are also being sustained. Water suppliers understand that projects to install solar power generation facilities bring profit.
- However, the cost merits are currently decreasing due to policies on power receiving division with the power authority. The effects vary greatly with the system settings in Cambodia.

(3) Cooperation activities with other countries

- As financial assistance from the AFD, EIB, and EU, we confirmed that there are cases of systems in place that prevent the receipt of favorable treatment for interest rates unless activities include environmental considerations.

(4) Other (business expansion potential)

- The water supply sector as a whole is still in the expansion stage, and the PPWSA is increasing its workforce to meet rising water demand as urban areas grow. As this combined is with experienced staff leaving, the PPWSA has a strong need for training of personnel.
- The frequency of floods and droughts is increasing, and there is a particularly strong sense of danger of a strain on water resources. The PPWSA wants assistance to respond to droughts.
    - Regarding impact assessment that is the responsibility of the Ministry of Environment, there is a noticeable lack of personnel with risk assessment expertise and therefore a strong need for personnel training. Additional cooperation from Japan for training of environment personnel was suggested.

[40] Cambodia NAP process document.pdf (unfccc.int)
https://www4.unfccc.int/sites/NAPC/Documents/Parties/Cambodia%20NAP%20process%20document.pdf
[41] Cambodia's Long-Term Strategy for Carbon Neutrality (unfccc.int)
https://unfccc.int/sites/default/files/resource/KHM_LTS_Dec2021.pdf
[42] PPWSA Annual Report 2021
https://www.ppwsa.com.kh/Administration/downloads/finance/PPWSA_Annual_Report_2021(EN).pdf

Chapter 5　Activities of Domestic Water Suppliers to Achieve Carbon Neutrality

5-1　Climate Change Impacts on Water Suppliers and Approach to Countermeasures

In Japan, a growing number of municipalities are declaring their commitment to reaching carbon neutrality by 2050. As of December 28, 2022, 823 municipalities (45 prefectures, 476 cities, 20 special wards, 239 towns, and 43 villages), and the total population of these municipalities is about 124.48 million people[43].

Climate change is recognized as affecting water sources and water supply infrastructure, and climate change impacts and respective measures presented by municipalities include items related to the water sector. Water suppliers are engaged in various measures linked to promoting carbon neutrality.

In this chapter, we cover a number of projects to show the extent to which water suppliers have included climate change predictions in their long-term plans and how they approach climate change impacts and respective measures in policies, strategies, and plans.

Table 24 shows examples of approaches to climate change by water suppliers in Japan. Some risks of climate change that have been presented are increasing intensity and frequency of natural disasters like torrential rain and droughts and resulting deterioration of raw water quality. Measures for disasters are presented as countermeasures in policies, strategies, and plans. On the other hand, there are also some municipalities that do not use language linking natural disasters and climate change.

For reduction in CO_2 emissions that is positioned as a climate change mitigation measure, among all suppliers surveyed, reduction in power usage and use of renewable energy are being pursued as measures to reduce GHG emissions with the ‘environment’ as a key word, and policies, strategies, and plans that have been newly formulated often use the terms ‘decarbonization’ and ‘low carbon.’ Almost all suppliers discussed environmental preservation.

There are no particular rules on how to approach climate change, and the positioning of and language used for climate change varied by municipality.

[43] Commitment to Net Zero Carbon Emissions by 2050 by Local Governments, Ministry of the Environment https://www.env.go.jp/policy/zerocarbon.html?msclkid=b566de14cf4011ecbaad27aeb2b62f6d

Table 24 Examples of domestic water suppliers' approach to climate change impacts

Supplier/ Municipality	Recognized risks	Approach in policies, strategies, and plans
Bureau of Waterworks, Tokyo Metropolitan Government	Drought Extreme proliferation of aquatic life due to rising temperature of reservoir and river water Sudden deterioration of raw water quality due to localized torrential rain	Long-term Strategy Concept 2020: Discusses measures to combat climate change impacts in water quality and water source measures and disaster control measures and discusses the impacts of those measures on fiscal administration. Master Plan (from 2021): Discusses predicted risks concerning climate change impacts. Business Plan 2021: As climate action, discusses water source measures, water quality measures, environment measures (reduction in carbon emissions, preservation of water conservation forests). Is creating a 5-year Environment Plan (2020-2024). Is creating an Environment Report and Environmental Accounting.
Public Enterprises Agency, Kanagawa Prefectural Government	Changes in raw water quality from temperature rise, short bursts of heavy rain, and increasing frequency of heavy rain	Water Supply Business Plan (2019): Discusses changes in raw water quality as climate change impact. Green activities include energy conservation, recycling, and efficient use. Is creating an Environment Report and Environmental Accounting including water supply projects and power projects.
Yokohama Waterworks Bureau	Sudden deterioration of raw water quality due to concentrated torrential rain	Long-term Vision (2016): Discusses proactive activities to reduce power usage as an environmental and energy issue. The desired future vision includes rearranging water facilities with wide-region cooperation and reorganization of purification plants. Medium-term Business Plan (2020-2023): Discusses addressing changes in water source quality under the heading, 'safe and high-quality water,' in the six policy objectives as well as environmental and energy measures under the heading, 'green waterworks.' Is creating an Environment Report and Environmental Accounting.
Saitama City Waterworks Bureau	Large-scale disaster such as major typhoon (treated as a disaster)	Long-term Concept (2021-2030): One part of measures is promotion of crisis management measures as disaster control measures. Environmental measures fall under Social Contribution Activities that is separate from the five measures and include activities to preserve the environment and reduce the environmental impact. Is creating Environmental Accounting.

Supplier/ Municipality	Recognized risks	Approach in policies, strategies, and plans
Osaka Water Supply Authority	Water issues manifesting in terms of both quantity and quality	Future Concept (2012, revised in 2015): Views climate change impacts as a global risk. Environmental preservation is included in the desired future vision, and energy conservation and new energy measures and reduction and efficient use of waste are listed as activities to combat environmental issues. Business Strategy (2020-2029): Environmental preservation is included in social responsibility within the 7 measures, and the strategy sets out a policy of aiming to be a green water supplier that endeavors to cut GHG emissions. Is creating an Environmental Plan and Environmental Accounting.
Kitakyushu City Water and Sewer Bureau	Increase in natural disasters such as localization and intensifying of torrential rains	Basic Business Plan (2021-2030): Key measures includes reinforcement of measures against disasters as well as preservation of water sources and reduction of the environmental impact. Actively engaged in activities as an ‘Eco-Model City” aiming to create a low carbon society and as a ‘Future City’ aiming to resolve problems in the environment, society, and the economy. Medium-term Business Plan (2021-2025): Discusses reinforcement of disaster measures, use of renewables to cut carbon dioxide emissions, promotion of energy conservation, and efficient use of resources.
Osaka Municipal Waterworks Bureau	Increasing severity and frequency of weather disasters and resulting shutdown of water facilities and increasing duration until recovery Deterioration of raw water quality (turbidity of raw water with rapid increases in water in rivers, impacts on the Lake Biwa ecosystem)	Management Strategy (2018-2027, revised in 2022): States the risks of climate change as the external environment. Is actively engaged in activities to build a decarbonized society towards climate action. Is creating a Waterworks Bureau SDGs platform to easily see its activities related to SDG 13. Discusses effective use of soil produced in water purification, hydroelectric power generation, and solar power generation as environmental measures. Is creating an Environment Report.

Supplier/ Municipality	Recognized risks	Approach in policies, strategies, and plans
Kyoto City Waterworks Bureau	Disasters from heavy rain, flooding (treated as a disaster)	Water Vision (2018-2027): Steadily advance activities to combat global warming as a sustainable city. Specifies their aim for low carbon, recycling-oriented community development with a low environmental impact. Business management with considerations for the global environment is included in one of the three perspectives, and the vision proposes activities in water supply and sewerage that include activities to create and conserve energy. Medium-term Management Plan (2018-2022): Specifies reduction of environmental impacts through the use of an environmental management system and sharing of information. Is creating an Environment Report. Kyoto also has a separate policy and plan related to environmental measures such as a Plan for Global Warming Countermeasures, an Eco-Model City action plan, and strategies to promote energy policy.
Fukuoka City Waterworks Bureau	Greater extremes of rainfall in two directions (intensification of natural disasters such as short bursts of heavy rain and increasing frequency of heavy rain as well as drop in the number of days with precipitation in the year)	Long-term Vision (2017-2028): Discusses torrential rain and droughts. Mentions that it can help stop global warming by promoting energy and resource saving, Medium-term Business Plan (2021-2024): There is a graph of change in precipitation patterns as climate change impacts. In a section on the water supply sector and the SDGs, SDG 13 is discussed. Of the four measure objectives, “promote crisis management measures” includes response to disasters and “stable and sustainable management” includes program management and green considerations.
Kobe City Waterworks Bureau	Rising temperatures, decrease in rainfall, concentrated torrential rain → Increasing risk of drought Deterioration of water source quality Sudden rise in water source turbidity Sediment disasters	Water Supply Vision (2016): Climate action is proposed as one type of change in the business environment. As building of a green water system, the vision proposes use of renewable energy, energy saving measures, activities to achieve a recycling-oriented society, and maintenance of a water distribution system based on gravity flow systems. Medium-term Business Plan (2020-2023): Discusses reinforcement of crisis management measures that take frequent natural disasters into account.

5-2 Example Activities of Water Suppliers

Among concrete activities of domestic water suppliers to meet carbon neutrality targets, reduction of energy usage directly contributes to CO_2 reduction. Activities concerning energy usage amount in water supply systems include efforts to conserve energy, effective use of energy, and use of renewable energy including new energy. Other activities are resource circulation including efficient use of resources and recycling, water leak measures to improve water source usage efficiency, energy and resource saving in work related to water projects, and activities to raise awareness about saving water in customers and protect the environment. Suppliers are also using environmental accounting in their water projects in which they calculate and publish the amount of CO_2 emissions cut through their activities. Some water suppliers are considering carbon offsetting when it is impossible to cut CO_2 emissions.

(1) Switch to low energy in water supply systems

In its FY2020 Report on a Study into Building a Decarbonized Water Supply System[44], the Ministry of Health, Labour and Welfare is considering promoting activities of water suppliers to promote use of decarbonized water supply systems for the meeting of CO_2 reduction targets set in the Plan for Global Warming Countermeasures In our survey, effective CO_2 reduction measures are organized by water supply process and investment level, and we categorize which water supply equipment is adapted to which CO_2 reduction measure to quantitatively show the CO_2 and cost reduction effects for water suppliers and consider methods for promoting activities by water suppliers. Estimated items for amount of CO_2 reduction potential include adoption of inverters and high-efficiency motors, adoption of energy-saving devices and equipment, for example by upgrading substation facilities, priority intake from water sources with excellent potential energy, use of intake pressure, upgrading of water distribution blocks, and measures to use potential energy through facility reorganization and expansion. The calculation results show that it will be possible to meet 2030 CO_2 reduction targets in the water sector by carrying out these measures and using renewable energy.

Table 25 shows examples of measures to reduce CO_2 in water supply systems by domestic water suppliers, combining examples of activities shown in reports, reports by the JWRC, and information from water suppliers' websites[45].

As it is easy to adopt energy saving devices and equipment and they have a significant effect, many suppliers are following that route. However, use of potential energy by upgrading distribution blocks, changing intake position, and reorganizing and expanding facilities may have a large CO_2 reduction effect but does require detailed considerations and discussions with other water suppliers. Few have completed these activities, although many are considering them.

[44] Report on a Study into Building a Decarbonized Water Supply System (June 2020), Ministry of Health, Labour and Welfare https://www.mhlw.go.jp/content/10900000/000701258.pdf

[45] Environmental Programs Implemented by Water Utilities in Japan (September 2019), JWRC http://www.jwrc-net.or.jp/chousa-kenkyuu/comparison/domestic05.pdf

Table 25 Activities of domestic water suppliers to achieve carbon neutrality
(CO_2 reduction measures in water supply systems)

Process/equipment category	Measures	Implementing entity
Pump equipment (intake, channeling)	Effective use of pump suction pressure, increased efficiency of operation through reduction of pipeline resistance from leveling flow rate	Tokyo Water Co.
	Improved operation control system by adopting a unit number control system, movable blade control system, and system to control rotational speed through the use of inverters	Hiroshima
	Adjustment of pump capacity through modification of impellers	Nagoya
	Installation of high-efficiency pumps and highly energy-efficient motors	Hiroshima, many others
Intake process	Reduction in the volume of intake water by returning sludge dewatering supernatant from the drainage system to the receiving well to reduce power for water intake	Hiroshima
Coagulation basin facilities	Reduction in power for mechanical agitation through modification of the block formation into a shape that uses water flow (circuitous flow coagulation basin)	Sapporo, Kitakyushu City Water and Sewer Bureau
Sedimentation equipment	Improvement in efficiency of sludge scraper operation through adjustment of operation time and interval to match quality of raw water	Kesennuma
	Improvement in efficiency of sludge scraper operation through the use of an efficient drive system	Nara Prefecture
	Improvement in efficiency of sludge equipment through the use of a sludge control machine, pressurized water injection device, interface meter, and densitometer	Water Supply Authority of Southern Fukuoka Prefecture
Filter basin equipment	Improvement in efficiency of cleaning by revising the cleaning frequency and time and cleaning when reaching filtration resistance	Sapporo
	Self-countercurrent washing type natural equilibrium filter basin	Tsugaru Kouiki Suidou Kigyoudan (Water Supply Authority)
Membrane filtration equipment	Installation of a membrane filtration system that uses flow drop	Yokohama
	Installation of power recovery turbines that use drainage pressure from a reverse osmosis (RO) membrane	Fukuoka District Waterworks Agency
Chemical injection (sedimentation, filtration)	Installation of a gravity flow injection system to improve efficiency of chemical injection and automation of chemical injection control to match raw water quality	Shibata
	Installation of high-efficiency pumps	Kashiwazaki

Process/equipment category	Measures	Implementing entity
Granular activated carbon Filter basin equipment	Improvement in efficiency of cleaning by revising the cleaning frequency and time	Tokyo
	Water purifying using microorganisms	Kitakyushu
Ozonation facilities	Improvement in efficiency of ozone generator operation with ozone injection volume control	Hanshin Water Supply Authority
	Installation of a high-efficiency ozone generator	Chiba
	Exhaust heat recovery in discharged ozone treatment facilities	Osaka Prefecture
Sludge dewatering equipment	Improvement in efficiency of dehydration through adjustment of operation time and interval to match water	Chiba
	Selection of a drive system that is suitable for improved dehydration efficiency and heating of concentrated sludge with waste heat to increase dehydration efficiency	Osaka Water Supply Authority
	Improvement in efficiency of dehydration by using solar drying and a dehydrator	Chiba
Pump equipment (Water conveyance and distribution)	Compatibility with a wide range of demand volumes through the combination of large and small pumps	Tokyo
	Improved pump operation control system by adopting a unit number control system, movable blade control system, and system to control rotational speed through the use of inverters	Osaka
	Adoption of pumps with the appropriate installed capacity through modification of impellers	Sapporo
	Installation of high-efficiency pumps and highly energy-efficient motors	Hikari, many others
	Adjustment of pressure management through isolation of the water conveyance and water distribution channels	Higashiosaka (Osaka Prefecture)
	Use of inverter pumps to reduce energy lost from opening and closing of valves	Kitakyushu, many others
Overall facilities (Water conveyance and distribution)	Implementation of a block distribution system	Sendai, Saitama
	Advancement of water leak prevention measures	Chiba Prefecture, many others
	Optimization of water distribution, for example by changing the pipe bore	Saitama
Water operation management	Effective use, for example using a gravity flow system in water intake, channeling, conveyance, and distribution processes Equipping of facilities that use potential energy	Nagoya, many others
	Abandonment of purification plant and switch from own groundwater sources to purified intake water Water conveyance to distribution area using intake pressure	Fukushima

Process/equipment category	Measures	Implementing entity
	Adoption of a water operation system that considers factors such as energy consumption rate and pipeline loss	Kanagawa Water Supply Authority
	Adoption of a demand prediction system	Kanagawa Water Supply Authority
	Building of a rational waterworks system using IT	Yokohama, Osaka, many others
Monitoring and control Systems	Installation of wattmeters for each treatment process, each key piece of equipment, and each device to analyze energy consumption rate	Tokyo Water Co.
	Adoption of an energy management system	Kanagawa Water Supply Authority
	Adoption of an expansive operation system with centralization of equipment management and concentrated monitoring of equipment	Sendai

Sources) - Report on a Study into Building a Decarbonized Water Supply System (June 2020), Ministry of Health, Labour and Welfare
- Environmental Programs Implemented by Water Utilities in Japan (September 2019), JWRC
- Water suppliers' websites, information provided by committee members

(2) Use of renewable energy, effective use of energy, and other CO_2 reduction measures

There are many projects for effective use of energy in a waterworks system and use of renewable energy, such as promotion of small-scale hydroelectric power generation, adoption of solar power generation, power purchase agreements (PPA), virtual power plants (VPP) using waterworks facilities, and demand response (DR). Some other measures to cut CO_2 are resource saving in water supply related work with the use of information and communications technology (ICT), a shift to next-generation vehicles like electric vehicles, energy-saving measures outside of the water supply system like the use of LED lighting in government buildings, effective use of water resources, environmental preservation activities, and measures for resource recycling. system like the use of LED lighting in government buildings, effective use of water resources, and environmental preservation activities.

Table 26 shows examples of CO_2 reduction measures that are being carried out by suppliers and municipalities and activities that have been launched with the aim of carrying out such measures. Some municipalities have combined multiple activities to create comprehensive measures. Table 27 shows specific examples of resources saving measures in water supply related work using PPA, VPP, DR, ICT from among the measures listed in Table 26. It should be noted that these are only the measures we learned from the domestic suppliers and municipalities that we surveyed, and it is not a comprehensive list of all the measures being carried out in Japan.

Table 26 Activities of domestic water suppliers to achieve carbon neutrality (effective use of energy, use of new energy, other)

Category	Measure	Implementing municipality/entity
Use of renewable energy	Use of small-scale hydroelectric power generation Use of difference in elevation from clean water reservoirs and decompression tanks to distribution stations Use of surplus energy accompanying water conveyance from regulating reservoirs Use of water pressure in places along the water distribution path in a gravity flow system Use of surplus pressure arising from intake pressure in the pipeline flowing into the intake station from the water main	Kyoto, Tondabayashi, Higashiosaka, Toyonaka, Yao, Natori, Chiba, Saitama, many others
	Adoption of solar power generation (e.g. rooftop panels, unused land)	Many
	Solar power generation (comprehensive partnership agreement with power companies)	Osaka Water Supply Authority
	PPA project using solar power generation*	Niigata
	Equipping with batteries	Osaka Water Supply Authority
	Adoption of renewable energy and switch to low carbon power	Tokyo
Cooperation and use of renewable energy	VPP project using water facilities* - DR project*	Takatsuki, Niigata, Fukuyama, Shizuoka, Osaka Water Supply Authority, Kobe, Shirahama (Wakayama Prefecture)
Energy conservation (aside from water supply system)	Improvement in the efficiency of regular power generating facilities	Tokyo
	Switch to paperless with use of ICT (e.g. digital transformation), improvement in work efficiency*	Tokyo, Sakai, Otake
	Energy saving measures in government buildings, automatic control of outdoor compressor units	Saitama, many others
Efficient use of water resources	Effective use of rainwater (e.g. installation of rainwater harvesting facilities, subsidy system)	Saitama, many others
	Public messaging about saving water, distribution and recommendation of water-saving attachments for faucets	Many
	Implementation of water leak prevention measures (leak surveys, management with a water distribution management system)	Many
Other CO_2 emissions reductions	Adoption of electric vehicles and charging and discharging facilities	Osaka Water Supply Authority
	Adoption of zero emissions vehicles and electric vehicles	Tokyo, Saitama

Category	Measure	Implementing municipality/entity
	Shift away from plastic with reusable drink bottles	Tokyo, many others
Cooperation with customers	Holding of water supply courses	Many
	Sharing of information about environmental activities, for example by issuing environmental reports and environmental accounting	Many
	Release of CO_2 emissions calculation tools	Tokyo
Environmental preservation	Protection of water resources, preservation and improvement of function of water conservation forests	Many
Cycling of resources	Effective use of sludge from purification plants, effective use of surplus soil arising from water supply works	Kitakyushu
	Control of waste and recycling (effective use of soil produced in water purification, granulated active carbon, and scrap wood from construction work)	Tokyo, Yokohama, Saitama, many others
	Purchasing of recycled water meters, recycling of water meters	Yokohama, Saitama, many others
Carbon offseting	Use of the J-credit scheme (forest credit)	Tokyo
	Purchasing of carbon neutral gas	Joetsu
Comprehensive measures	Comprehensive projects that include river basin management, water supply projects, and environment and energy. Aiming to build a river basin and water supply system that can achieve carbon neutrality	Aichi Prefecture “Yahagi River Carbon Neutral Project”

Source) Suido Sangyo Shimbun, Nippon Suido Shinbun, Environmental Programs Implemented by Water Utilities in Japan (September 2019), JWRC, water suppliers’ websites

*Details in the following table

Table 27 Details of measures to reduce CO_2 (PPA, VPP, DR, and use of ICT)

Measure	Descriptions
PPA	This system allows power generation operators to enter contracts directly with users and has become very popular among private companies since around 2021. It is a business model in which the power generation operator rents a site from the facility owner who is also the user, installs power generating facilities on that site, and sells the portion of the power generated that is used by the facility owner to that owner. This system lets local governments use land and facilities so that they can use renewable energy without making an initial investment, and it enables power generation operators sell electric power stably over the long term. The power generation operator and the user can sign a contract even if it is off-site, enabling procurement of renewable energy through an off-site PPA even when there is not enough space on the premises of the power demand spot. This means that a PPA can potentially be adapted for water and sewage facilities from both the power generating spot and the power demand spot. However, for water and sewage facilities that use a large amount of power, it may make more financial sense to procure power from small electric utilities through a PPA with solar power[46].
VPP	In this system, energy sources like batteries owned by factories or residential homes, electric vehicles, and power generating facilities are remotely controlled in an integrated manner using advanced energy management technology that uses the Internet of things (IoT), functioning similar to a power plant. It offers promise for electric load leveling and absorption and supply of renewable energy in power systems. Water suppliers can operate their water supply equipment like a battery, stopping the pumps and using water from distribution reservoirs when they want to reduce power, and starting up the pumps and storing water in distribution reservoirs when they want to consume power[47].
DR	In VPP, DR optimizes operational planning of water conveying pumps without hindering the stable supply of water by responding to requests for power demand response from AC to reduce the number of water conveying pumps in operation or put more in operation according to an optimization algorithm while maintaining at least a certain water level in the distribution reservoir.
Use of ICT (digital transformation)	Installation of smart water meters and switching to online payment and procedures with an app. As work shifts online, CO_2 emissions are cut through less employee travel and a switch to paperless systems. Since FY2021, multiple water suppliers have been implementing or are considering moving towards ICT. Tokyo began using a Bureau of Waterworks Tokyo Metropolitan Government app since October 2022 with the start of an automatic water meter system using smart meters to further improve customer services, streamline work, and promote a switch to paperless and cashless systems. This system is compatible with electronic distribution of invoices and meter reading slips (paperless) and can cut CO_2 emissions.

[46] EY Strategy and Consulting Co., Ltd. (February 10, 2022) https://www.ey.com/ja_jp/government-public-sector/how-will-water-and-sewage-infrastructure-respond-to-climate-change-and-decarbonized-socialization

[47] Hitachi: Hitachi Review 2021 Vol. 103 No. 3 https://www.hitachihyoron.com/jp/archive/2020s/2021/03/03a06/index.html

(3) Switch to a water supply system that uses natural energy effectively

In Japan, switching to a water supply system that uses natural energy effectively has been set as a national policy. In the Basic Plan on Water Cycle that was approved by the Cabinet in June 2022, under the heading, 'Global warming countermeasures in processes such as water treatment and water conveyance,' it states that, "to cut energy consumption in transporting water, equipment will be adopted at waterworks facilities to conserve energy and use renewable energy, and efforts to use potential energy will be promoted through means such as sourcing water upstream[48]." In the Fifth Biennial Report for Japan under the UNFCCC that was published in December 2022, promotion of energy conservation through the expansion, reorganization, and rearrangement of facilities was added as a policy for waterworks.

The Water Cycle System Demonstration Model Project aimed at a move to Low Carbon in the Tokyo Metropolitan Area reported by the Federation of Japan Water Industries in March 2010[49] outlines investigation into a demonstration model that revises water supply systems in the Tokyo metropolitan area, including mutual service of water source dams and adjustment of capacity, sourcing of water and placement of purification plants upstream, efficient management of purification plants, wide area centralization of water supply systems, and use of renewable energy and other types of alternative energy sources (rainwater, reclaimed wastewater, irrigation water, industrial water, groundwater). It is estimated that reorganizing water supply systems, using high-efficiency devices, and adopting solar power generation and small-scale hydroelectric power generation can cut emissions to 64% of the 2005 level by 2050 (71% considering the reduction from the shrinking population). An expected effect of sourcing water and placing purification plants upstream is simplification of the water treatment system through purification of sourced raw water (eliminate the need for processes like ozonation and granular activated carbon treatment). A large portion of the reduction effects are from sourcing water and placing purification plants upstream and the use of high-efficiency devices, and expansion is significant for small and medium-sized water suppliers.

Among the examples shown in Table 25 and Table 26, the ones for Nagoya and Aichi Prefecture correspond to a switch to a water supply system that uses natural energy effectively.

With the aim of reducing water transport energy, the Nagoya water supplier is considering a scenario of comprehensive revision of water operations combining expansion of a gravity flow system, simplification of the water supply route, and revision of the distribution block zones[50]. In its most recent management plan, as an environmental measure in water supply projects, the Bureau is engaged in activities to reduce power usage by expanding the area sourcing water by gravity flow from distribution reservoirs on high

[48] Basic Plan on Water Cycle (June 2022) https://www.cas.go.jp/jp/seisaku/mizu_junkan/about/pdf/r020621_honbun.pdf

[49] Outline of 'Water Cycle System Demonstration Model Project aimed at a move to Low Carbon in the Tokyo Metropolitan Area' report and 'Tokyo Metropolitan Area Water Cycle Investigation Committee' report, Federation of Japan Water Industries (March 2010) https://www.suidanren.or.jp/cms/wp-content/uploads/%E9%A6%96%E9%83%BD%E5%9C%8F%E6%B0%B4%E5%BE%AA%E7%92%B0%E5%A7%94%E5%A0%B1%E5%91%8A%E6%9B%B8%E6%A6%82%E8%A6%81%E7%89%88.pdf

[50] Guidelines for Environmental Measures in Water Works Operations (revised edition) (July 2009) Volume 1: 3. Current environmental and energy measures in water supply projects, Ministry of Health, Labour and Welfare https://www.mhlw.go.jp/topics/bukyoku/kenkou/suido/jouhou/kankyou/dl/090729-1d.pdf

ground (launched in 2016, expected to complete in 2026), install energy-saving devices on during equipment upgrading, and use renewable energy effectively[51].

The Aichi Prefecture Yahagi River Carbon Neutral Project involves a variety of comprehensive crosscutting measures centered around the water cycle and proposes energy conservation in the water sector through reorganization of water supply facilities. The project aims to achieve carbon neutrality in individual river basins through activities like effective use of a gravity flow system by reorganizing purification plants (reducing pressurized pumping), upgrading of equipment device, efficient use of tap water (leak prevention, use of rainwater), and using smart processes for information. Aichi is also considering the possibilities of energy saving through partnership with water and sewage facilities to implement crosscutting river basin management[52].

It is necessary to consider reorganization of facilities to achieve as effective use of natural energy as possible in a wide range of sectors, and it is effective to make these considerations when doing expansions. We need to move to a water use structure in society in which we source raw water for water supply from far away using energy while using pumps to drain rainwater falling in urban areas, and it is necessary for not only the water sector, but for other sectors as well to consider what the ideal water cycle would look like for our society.

5-3 Summary

We confirmed that there are various types of environmental measures being carried out by water suppliers in Japan. Among the activities being carried out, there are some in strategies that we did not cover. The ones we did cover are those from published materials that we considered high priority or unique. The following is a summary of the overall characteristics.

- The positioning of and language used for climate change varied by municipality. As no guidelines have been provided for pursuing climate action, the activities seem to match the respective municipalities' characteristics and circumstances.
- Regarding the risks from climate change, measures are being proposed based on fears of torrential rain, drought, and poor water quality, but the impacts on which suppliers focus are based on the circumstances of each supplier, and there is little similarity among different suppliers' measures.
- Example activities of municipalities provide a good reference for the various individual techniques being used to achieve carbon neutrality. Installation of energy-saving devices is relatively easy but has limited effects. In contrast, radical measures like upgrading distribution blocks, changing the water intake position, and use of potential energy by reorganizing and expanding facilities may offer larger effects over the long term but require consistent action over a long period, making it difficult to measure the effects.

[51] Nagoya City Waterworks and Sewerage Bureau Business Plan 2028 (FY2019 to 2028) https://www.water.city.nagoya.jp/file/35921.pdf

[52] Yahagi River CN Project https://www.pref.aichi.jp/soshiki/kasen/kasen20210901-1.html (Overview of proposed measures) https://www.pref.aichi.jp/uploaded/life/389261_1709529_misc.pdf

- Main measures to use renewable energy and use energy effectively are promoting small-scale hydroelectric power generation and adopting solar power generation, but some suppliers are adopting systems to use power effectively through increased use of information technology.
- In this survey, we investigated water suppliers that are more active in environmental measures but did not find any that had independently set concrete net zero or carbon neutrality targets. The main decarbonization activities and measures being pursued by local governments that have declared their commitment to achieving zero CO_2 emissions in 2050 (Zero Carbon Cities) include decarbonization activities in water supply projects[53].

Those are the activities being carried out in Japan. Although there is a huge amount of variation in the activities being pursued makes comparison of the effects of individual projects difficult, the activities for which Japan has some experience can be used as a reference in international cooperation activities. We saw few examples of arrangement of facilities to enable as effective use of natural energy as possible as this requires long-term, broad-ranging commitment, but building water supply systems that minimize use of energy in developing nations is an obvious choice that is preferable both economically and in terms of combating climate change impacts, and the activities of suppliers in Japan can be used as a reference.

[53] Commitment of Local Governments to Zero Carbon in 2050, Ministry of the Environment (See 'List of Zero Carbon City Initiatives')
https://www.env.go.jp/policy/zerocarbon.html

Chapter 6　Key Points and Recommendations

We considered what makes up international cooperation activities as measures to combat climate change impacts that can be pursued in the water supply sector in accordance with this year's survey policy. We compiled Japan's climate action policies to obtain information that could lead to future international cooperation projects in the water sector, and then we compiled and assessed past cases of concrete international cooperation activities addressing climate change impacts, activities by domestic water suppliers to achieve carbon neutrality, and examples of activities to address climate change impacts by suppliers in other countries (Information Material 4 lists example activities to address climate change impacts by suppliers in other countries).

Based on the survey results, this chapter outlines the approach to implementation measures to resolve issues based on ideal perspectives and the needs of countries receiving assistance and summarizes the perspectives needed for future directions concerning international cooperation activities in the water sector that take into consideration mitigation measures related to water supply facilities and adaptation measures for water supply systems that are resilient to climate change impacts.

6-1　Summary and Analysis of Survey Results

The current status of activities in each sector of climate action according to the survey results are shown in Table 28. This gives an idea of the trends in climate change measures being carried out by domestic and international water suppliers as a benchmark and can be used to identify the ideal approach for future international cooperation projects and sectors where Japan is strong. Note that examples of activities are marked with a circle if they correspond to the respective category within the scope of this survey, even if they are outside the scope of climate action.

In the field survey in Cambodia, we were told that there is a shortage of personnel who can assess climate change impacts and that there is a need for such capabilities. In response, we added training of personnel in climate change to mitigation and adaptation measures.

The importance of building a water distribution system that uses gravity flow is recognized, and this is a sector in which such projects are recommended with Japan's unique topography and water resources. In our survey, we did not find any other countries proposing this policy in their water supply measures, and this may be a field in which Japan has a strength. Personnel training measures is an area that Japan has continued to prioritize in its international cooperation activities. Its importance is strongly recognized in view of the decrease in the number of engineers in Japan, and various measures are being carried out in response. It is therefore likely that such measures can be used to an even greater extent in future international cooperation activities.

As shown in Table 28, there are examples of activities being carried out in Japan's international cooperation in almost all of the categories, and these can be used as a reference for carrying out similar projects in the future.

Table 28 Current state of activities in each sector of climate action in water supply

Large category	Middle category	Small category	Japanese suppliers		Water suppliers, etc., in other countries		Past international cooperation
Mitigation measures	Energy conservation	Improvement in pump efficiency	○	Almost all water suppliers are using inverter control. When the supply volume is large, basic operation is by control of the number of pumps.	○	Inverter control and other types of energy-saving mechanisms for pumps are being used.	○
		Building of a water distribution system that uses pumps as little as possible (uses gravity flow instead)	○	Recognized as important because of the expectation of GHG emissions related to water distribution; offers promise as an activity in combination with expansion. Some suppliers are attempting integrated resource management. Good prospects for reduction of GHG emissions in water purification by sourcing water from upstream good quality water sources.			○
		Reduction in leaks	○	There is a licensing system for water supply construction work, and high precision work is carried out. There are many high-performance detectors and products. Various activities have been carried out in the past, including pressure management in water distribution networks.	○	Prioritized as one mitigation measure for its reduction in amount of energy used.	○

Large category	Middle category	Small category	Japanese suppliers		Water suppliers, etc., in other countries		Past international cooperation
		Improvement in energy efficiency of the facilities as a whole	○	Many activities have been carried out in the past, such as optimization of water intake and distribution, installation of facility equipment and adoption of systems to manage water operations, and adoption of energy management systems.	○	Activities like optimization of operation maintenance are being carried out.	○
	Renewable energy	Renewable energy power generation using land of water supply facilities (solar, wind)	○	Many activities with solar power and high reliability for both products and maintenance management have been carried out in the past.	○	Proposed as a type of mitigation measure.	○
		Renewable energy power generation using land of water supply facilities (hydropower)	○	Many activities have been carried out in the past with small-scale hydroelectric power generation. The activities vary in terms of installation location and energy used.	○	Proposed as a type of mitigation measure.	○
		VPP and DR using water supply facilities	○	Multiple activities in cooperation with companies.		Could not find any examples.	
		Buying and selling of green energy	○	Announced by a number of suppliers, but not many.	○	Many examples when combining purchasing, production, and sales.	
	Environmental	Protection and improvement of function of water conservation forests	○	Proposed by many suppliers as an environmental preservation measure.	○	Tree planting, reforestation, and carbon fixing of soil are proposed as types of mitigation measures.	

Large category	Middle category	Small category	Japanese suppliers		Water suppliers, etc., in other countries		Past international cooperation
Adaptation measures	Drought	Securing of water sources that are resilient to climate change: storage, use of groundwater, and design of intake facilities	○	Examples of development of dams and water sources, protection of water sources.	○	In countries with distinct rainy and dry seasons, we see techniques such as use of groundwater and use of floating water intake facilities.	○
		Reduction in leaks	○	There is a licensing system for water supply construction work, and high precision work is carried out. There are many high-performance detectors and products. Various activities have been carried out in the past, including pressure management in water distribution networks.	○	Viewed as an important adaptation measure as well for adaptation to shortages in water resources.	○
		Promoting water saving	○	Various products have been developed, such as water-saving attachments for faucets, water-saving shower adapters, and water-saving toilets. Suppliers are continuing to educate users on how to use water properly and encourage use of water-saving products, and some distribute products for free.	○	There are some projects such as government-led programs to certify water-saving products and coordinated messaging about water-saving measures by local suppliers (replacing water-saving devices, school programs, return services).	○

Large category	Middle category	Small category	Japanese suppliers		Water suppliers, etc., in other countries		Past international cooperation
		Reuse of water	○	Some suppliers are reusing water in applications other than drinking water.	○	Some suppliers are actively engaged in water reuse for drinking water and due to a sense of crisis about water resource shortages and for agricultural and industrial activities.	○
	Torrential rain	Preparation for floods and other weather disasters (mainstreaming disaster preparedness)	○	Guidelines and plans for disaster response are being formulated.	○	There is a strong sense of danger, and guidelines are being formulated.	○
		Measures for reconstruction after floods and other weather disasters	○	Several suppliers have experiences reconstruction after a major disaster.	○	Some countries have been impacted by major disasters.	○
Measures to train personnel in climate change	Maintenance of water supply projects	Reinforcement of the maintenance and management capabilities of suppliers and personnel training	○	Personnel training is seen as important due to highly experienced staff leaving and a lack of engineers in the younger generation. There is a framework for training and licensing systems.			○
		Long-term support framework (personnel, machinery)	○	Suppliers have secured a holding period for parts in accordance with the Japanese system. They are extending the life of equipment through maintenance. Suppliers that are linked to international cooperation activities are building long-term support frameworks.			○

Large category	Middle category	Small category	Japanese suppliers		Water suppliers, etc., in other countries		Past international cooperation
	Climate change measures	Training of personnel with climate action expertise	○	Local governments are being asked to formulate and implement climate action plans, and suppliers are responding individually. The Ministry of Health, Labour and Welfare has created a guidebook for water supplier personnel. It has stated the need for personnel training for the Climate Change Adaptation Plan and the Plan for Global Warming Countermeasures.		From initiatives of industry groups and water business associations, some suppliers have independently set targets for decarbonization, but personnel training plans are unclear.	○

○: Past project

6-2 Key Points for Deployment in Developing Nations

The following are ideal directions to take when implementing international cooperation projects to respond to climate change impacts in developing nations.

- Boost energy efficiency and lower the energy consumption rate.
- Use potential energy. Move from ‘raising from downstream’ to ‘dropping from upstream.’
- Control on the demand side.
- Generate power with renewable energy.
- Train personnel to enable long-term planning that includes climate change impacts.

Based on these points, Table 29 shows the projects from among those being carried out by Japanese suppliers to address climate change impacts that can potentially be used in support for developing nations as well as a summary of the feasibility and difficulties of activities for water suppliers. It also lists conditions required for projects and region based on the information obtained from survey results.

Table 29 Adaptation of activities to address climate change impacts into support for developing nations

Measure	Feasibility	Difficulty	Applicable conditions, region, etc.
(1) Energy conservation of pumps (inverter control, control of number of pumps)	• Can predict and measure effects and the effects are large. • Easy to do.	• Difficult to continue is maintenance after a failure and procurement of parts is difficult.	• Current equipment is old and energy effects are low. • Topography where pumps are essential. • Implementation contributes to distribution planning with high energy efficiency over the long term.
(2) Installation of energy-saving devices	• Can predict and measure effects and the effects are large. • Easy to do.	• Difficult to continue is maintenance after a failure and procurement of parts is difficult.	• Current equipment is old and energy effects are low. • Implementation contributes to distribution planning with high energy efficiency over the long term.
(3) Small-scale hydroelectric power generation	• Can be installed using existing facilities. • Can become a stable power source.	• As priority is given to water supply, forecast of future changes in water demand is important.	• There is surplus energy in water transmission and distribution processes. • Prospects for maintenance of surplus energy even when adapted to future fluctuation in water demand. • Power supply is not stable.

Measure	Feasibility	Difficulty	Applicable conditions, region, etc.
(4) Solar power generation	• Can predict and measure effects and the effects are large. • Adoption is easy as only requires installation of facilities.	• Requires long-term maintenance and management (costs, parts, etc.) and different techniques from water supply (personnel).	• Power supply is not stable. • There are some places where facilities can be installed inside or outside facilities. • Requires suitable weather conditions for power generation.
(5) Reduction in leaks	• Significant effects as both a mitigation measure and an adaptation measure.	• Need to create a budget for medium- to long-term activities and need understanding about cost-effectiveness. • Leak detection requires technology.	• High leakage rate. • There is data on water distribution and supply volume.
(6) Development of a highly energy-efficient waterline through efficient layout of facilities and long-term plan to achieve that aim	• Significant GHG emissions reduction effects, reduces dependency on power supply. • Effects are stable over the long term and can contribute to carbon neutrality. • Prospects for reducing GHG emissions related to purification processes by sourcing good quality water from upstream.	• Need to wait until the time to upgrade existing facilities. • Large cost and time requirements from planning to consideration. • Need to coordinate with other plans and suppliers. • Need basic data and personnel who can carry out planning.	• Has water resources that can be sourced using potential energy for the water supply area or has a topography that enables water distribution using potential energy. • Need a long-term plan.

Measure	Feasibility	Difficulty	Applicable conditions, region, etc.
(7) Promoting water saving (Control on the demand side)	• There is an excellent lineup of high-performance water-saving devices available, such as water-saving attachments for faucets, water-saving shower adapters, and water-saving toilets.	• Users need to change their habits, and it make take time without incentives. • From the perspective of international expansion of companies, some difficulties will be low prices of devices and the existence of similar products in other countries.	• Amount used per person is large. • Insufficient supply to meet water demand or predicted insufficient supply. • Water utility fees are expensive.
(8) Resource saving of projects using ICT	• Easy to implement if resource-saving applications are already available.	• Difficult to maintain if there is no framework for fixing system bugs.	• There is room for increasing efficiency in many work activities. • Expected decrease in the number of personnel with respect to the amount of work.
(9) Response to disasters caused by climate change	• Can share experience-backed knowledge.	• Unique regional characteristics (e.g. social landscape, topography, water resources, and population density) have a significant effect, and it may not always be possible to apply knowledge from Japan as is.	• There is room for improvement in disaster response. • There is a strong possibility of similar disasters to those that occur in Japan.

Measure	Feasibility	Difficulty	Applicable conditions, region, etc.
(10) Training of personnel in climate change	• Enables planning and reporting for long-term climate action.	• Takes time. • Although it is possible to determine the results with the number of people taking training courses, for example, there are no clear efficacy indicators with respect to climate change impacts. • Lack of resources such as instructors and teaching materials.	• Difficulty with planning and reporting due to lack of expertise required for climate change measures.

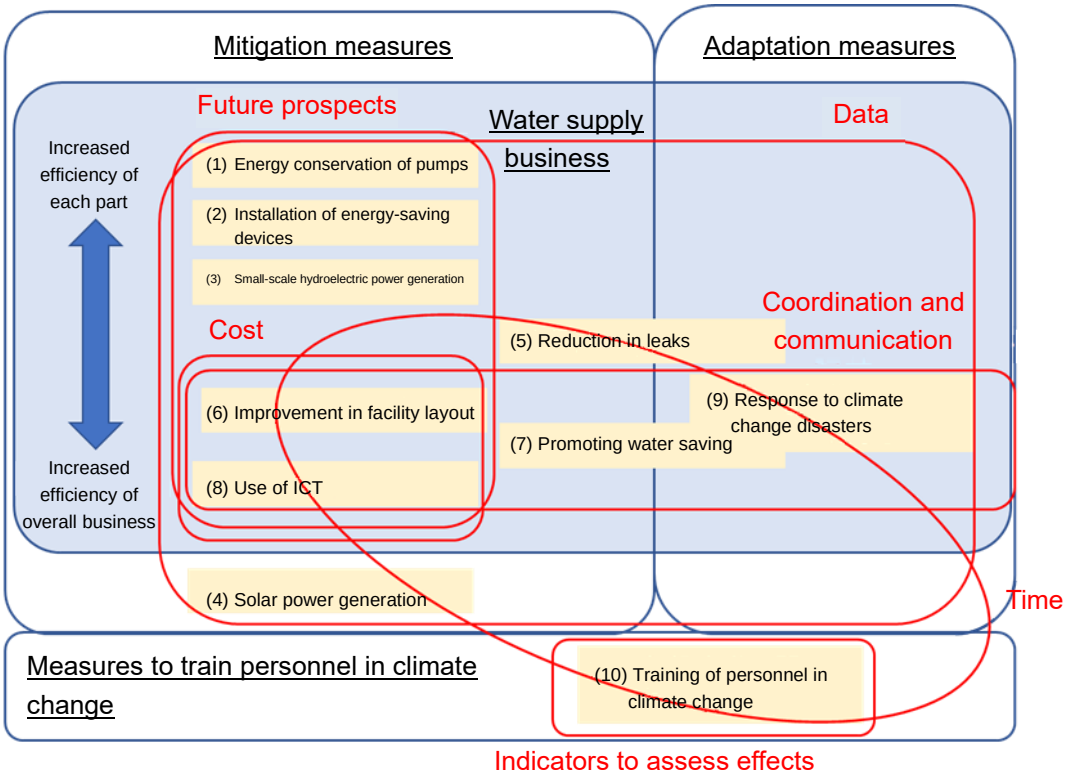


Figure 5 Positioning of activities as climate action in the water sector and key components

Figure 5 shows the positioning of the activities in Table 29 as climate action. Measures to train personnel in climate change are seen as the foundation for carrying out mitigation and adaptation measures effectively. The following is a summary of the components shown in red in the figure that are likely important for carrying out the various activities.

[Important components for implementation]

- Regarding (1) to (9): Highly accurate data needs to be obtained to increase energy efficiency (e.g. pressure on the water distribution network, amount of power used by each facility, amount of energy used in all processes from water intake to channeling, purification, and conveyance, and water distribution operation results that change with season and climate conditions and with time). Active implementation of data organizing activities will lead to effective implementation of measures.
- Regarding (6): Effective use of potential energy requires a comprehensive long-term plan that includes modification of distribution blocks and possibilities for relocation or new building of sourcing spots, purification plants, and distribution reservoirs. This makes it difficult to complete within the period of a single international cooperation project and requires a large amount of cost. It requires ongoing activities that adhere to a policy for transitioning to a gravity flow system.
- Regarding (6) to (9): Requires spreading of the approach and coordination as the use of different basic approaches from other projects being carried out by target supplier organizers or international cooperation projects being carried out by other donors would make implementation difficult or limit the effects.
- Regarding (5), (6), (7), (9) and (10): Implementation measures or confirmation of the results takes a long time, for example necessitating attitude or behavior modification or a long-term plan. However, some (5) water leakage and (7) water-saving projects show results in a shorter term of only a few years.
- Regarding (10): Requires formulation of a plan with a long-term perspective to ensure measures enable both a stable water supply and climate action and requires staff with coordination capabilities for implementing projects. Although it is a measure the supports all climate action, it may be affected by circumstances of the country receiving assistance, and it is difficult to measure the effects with quantitative indicators. Long-term activities and consideration of how to assess those activities is needed.

6-3 Proposals and Recommendations for Those in the Water Supply Business Involved in International Cooperation

Although international cooperation projects in the water sector are aimed at helping countries supply safe and affordable drinking and independently develop their waterworks, the projects must also address climate change impacts. Based on the results of this survey, regarding Japan's future international activities in the water sector that address climate change impacts, we proposed a view of assessment as climate action and summarized the points to remember when entities in the water sector in Japan that are involved in international cooperation projects carry out cooperation activities.

[Proposal of a view of assessment as climate action in the water sector]

In this survey, based on reports of international cooperation projects held in the water sector, we attempted to evaluate the projects from the perspective of sustainability of climate action effects and sustainability of maintenance and management and from the perspective of cost-effectiveness. When providing solutions for water supply issues that take into account measures against climate change impacts in future international cooperation projects, we summarized the results of our discussions on the ideal

perspectives to adopt as a method for assessing measures implemented as follows to ensure the information is useful for the consideration of the most appropriate measures. We believe that clarifying the perspectives needed will aid in the selection of measures needed in target regions for international cooperation and the setting of appropriate targets.

Also, as suitable conditions for projects, points to heed when pursuing projects, and points that had an impact could be limiting factors when starting out new measures, we included them as perspectives of assessment.

- **Effects as a climate change mitigation measure**: Degree of decrease in GHG emissions. Likely will be assessed from greenhouse GHG volume seen from the entire life cycle in the future.
- **Sustainability of effects**: Whether or not the measure itself can be sustained, regardless of the size of reduction in GHG emissions. Long-term supply of parts for devices purchased is also a factor. Effects are sustained through the continuation of measures.
- **Transferability**: Ease of adapting measures to other countries and regions.
- **Investment effects as climate action**: GHG emissions reduction effects with respect to investment amount. Assessment should include sustainability of effects.
- **Synergistic effects**: The synergistic effects of the effect of resolving water supply-related problems and climate action. Effects of other solutions to social issues, for example in personnel training.
- **Suitable conditions for implementation**: Conditions such as size of supplier, climate, water resources, electric power structure, and stability, and country or region that is thought to be suitable.
- **Points to heed**: Regulatory trends in the target countries, fluctuation in water demand, trends in neighboring suppliers, other measures that would have an impact or require coordination, and trends in international approach, laws, and regulations concerning climate change.

[Points to be aware of when implementing international cooperation projects in the water sector in response to climate change impacts]

- **Financing and economic situation**: Lack of funding is always a problem in developing nations. Priority is given to coverage of water utilities that is a basic need, and the challenge is often the extent to which climate action can be added on top of that. Water suppliers are continually faced directly with challenges like increasing frequency of droughts and floods that is thought to be by climate change. They are therefore aware that they should prioritize climate change adaptation measures, but the deciding factor for carrying out mitigation measures is likely whether it offers cost benefits. As the level of measures that are possible vary by economic situation of the partner developing nation, it is necessary to consider activities that are in line with economic conditions.
- **Carbon pricing**: At present, measures to save energy and advance carbon neutrality are linked to cost saving. As such, many suppliers presumably have the stance that they will carry out activities if they are financially reasonable. That said, it is likely that measures like carbon pricing will be adopted, and we need to keep in mind the possibility of soaring energy costs in the future when planning development of facilities. A carbon tax emissions trading prices are key factors, and profitability will vary greatly based on those trends.
- **Setting of targets for decarbonization, assessment and disclosure of environmental impacts**: With the advance of ESG financing including ESG investment, disclosure of management strategy

adapted to climate change (Task Force on Climate-Related Financial Disclosures: TCFD) and setting of targets for decarbonization (e.g. SBT, RE100) are spreading around the world, especially among global companies. The TCFD requires all companies to assess their own climate-related risks and opportunities, reflect them in management strategies and risk management, and disclose the financial impacts. There is a similar movement for impacts on the natural environment (Taskforce on Nature-related Financial Disclosures: TNFD), and water-related guidelines are being created. RE100 is an initiative that sets and certifies targets by companies to procure all the energy they use in business activities from renewable energy by no later than 2050. As a global trend, the need is arising for companies to assess and disclose the environmental impacts of their business and the environmental impacts of products in the supply chain, with respect to climate change risk. In water supply business as well, suppliers may eventually be required to set targets for decarbonization and to assess and disclose environmental impacts.

- **Carbon neutrality of industrial water:** A proposal was adopted by the EU in February 2022 that includes regulations mandating assessment of environmental impacts in the supply chain and action against those impacts[54]. In this system that is just starting out, the environmental impacts of products in the production phase also affect ESG investment in products and companies. From the viewpoint of water, the environmental impacts of the end product depend on how much electricity that exacerbates warming is used to make the water used in the production phase, for example. It requires accountability from an international framework and may eventually require the supply of carbon neutral industrial water, and there is concern that developing nations will be unable to export products to the EU unless they conform to such movements[55]. In countries receiving international cooperation assistance as well, it is necessary to consider how the environmental impacts of water will affect acceptance of products created using that water.
- **Carbon neutrality of materials and equipment**: In water supply business as well, it is expected that carbon neutrality will be required for materials and equipment from the view of material flow. For devices that do not need frequent replacing, it is likely that the age of carbon neutrality will have already begun when it comes time to replace them. It is important to consider the possibility of changes such as increased difficulty in procurement. Even in developed countries, we did not see projects in which the strategy formed takes that far of a view in water supply business. When comparing alternate proposals during plan formulation, it will likely be necessary to focus even more on environmental impacts in the life cycle of materials and equipment as a standard for assessing the effects of climate action.
- **Overseas expansion of disaster response projects**: Large-scale disasters such as water supply stoppages due to torrential rain have also been occurring in Japan in recent years, and Japan is taking prompt action to ensure stability of the water supply. These experiences may be used as a reference by other countries, and Japan should aim to provide its actions and lessons to other countries.

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[54] European Commission https://ec.europa.eu/commission/presscorner/detail/en/IP_22_1145

[55] JETRO: European Commission announces proposal for installing Carbon Border Adjustment Mechanism (CBAM) (July 16, 2021)
https://www.jetro.go.jp/biznews/2021/07/6f6d68c9f585c5b4.html

- **Responding to the deterioration in water quality**: In international cooperation, water supply is the main objective, and determining whether to pursue activities to improve water quality is difficult. However, deterioration of water quality and depletion of water resources have been confirmed and are likely caused by climate change, and so the need for water quality measures will increase going forward. Japan should utilize its technologies to increase coverage of safe and stable water supply as an adaptation measure.
- **Continuance of technology and collection of funds:** There is a need for discussions on the building of a framework to ensure technology provided continues to be passed on and a mechanism for collecting funds. There is also a need for discussions about monitoring with indicators and KPIs.
- **Follow-up and indirect support**: As there have been cases where recipients could not keep up with maintenance and management due to an incorrect understanding of the technology or products from donors, resulting in breakdown soon after the start of use, and cases where recipients could not keep procuring parts and equipment was left unused after failure. As such, ongoing support is also an important point. Detailed support such as installment of a distributor that can provide follow-up assistance, indirect support through local technology projects, and personnel training may be considered Japan's specialty.
- **Climate action by water suppliers in Japan**: Among water suppliers in Japan, there is a need for not only disaster response, but also climate action including mitigation measures to be positioned in suppliers' strategies. In international cooperation projects, achieving carbon neutrality from a long-term view requires the use of various perspectives to consider the potential events that could arise from future climate change predictions, identification of Japan's technology and product strengths matched to changes in the international community based on multiple potential scenarios, and use of that information in the deployment of climate action.
- **Development of technologies and products to reduce GHG emissions**: Some example activities to reduce the environmental impacts of products in the water sector are activities to reuse resources, such as an operation system that uses valve reprocessing (Morita Iron Works)[56] and reuse of ceramic membranes (Metawater)[57]. Maintaining international competitiveness in the global market requires the spread of more intense decarbonization activities in water production in line with international decarbonization trends and development of technologies and products that take international standards into account.
- **International deployment of the latest technologies and products**: Companies in the water sector are developing a variety of technologies from the perspectives of preventive maintenance, reuse of resources, energy conservation, and reduction of GHG emissions, and these are applicable to water suppliers in Japan. Japan's technologies and products also have potential for use in climate action in international cooperation projects.

[56] List of new technology projects related to maintenance and improvement including inspection of water supply facilities (Aqua-LIST), JRWC
http://www.jwrc-net.or.jp/chousa-kenkyuu/a-list/list.html
Morita Iron Works Co. http://www.jwrc-net.or.jp/chousa-kenkyuu/a-list/21-015.pdf

[57] 2022 Nagoya Suidoten Exhibition source materials, Metawater https://suidoten.jp/2022/product/mv219/