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RAPID ASSESSMENT: CAPACITY OF ASIAN WATER SERVICES PROVIDERS TO BUILD RESILIENCE AGAINST CLIMATE CHANGE IMPACTS



AUGUST 2012

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Summary

In cities across Asia, 340 million people lack access to safe water supply while more than 680 million do not have sustainable sanitation services. Intensifying weather events linked to climate change are likely to aggravate these access challenges. Potential climate-related impacts such as fresh water shortages due to drought conditions, water quality degradation, extreme rainfall and associated floods, and sea water intrusion from rising sea levels could disrupt the provision of services that affect the lives and livelihoods of urban inhabitants. Water and wastewater service providers in Asian cities, therefore, are working to strengthen their capacity to deliver effective services in a changing and increasingly uncertain environment.

To understand the “readiness” of these water services providers to respond to climate change impacts, Environmental Cooperation – Asia (ECO-Asia), a regional project of the United States Agency for International Development (USAID), and WaterLinks, a non-profit that promotes and supports twinning partnerships between water services providers, conducted a rapid assessment of the following 14 selected water services providers in the Asia region and Australia:

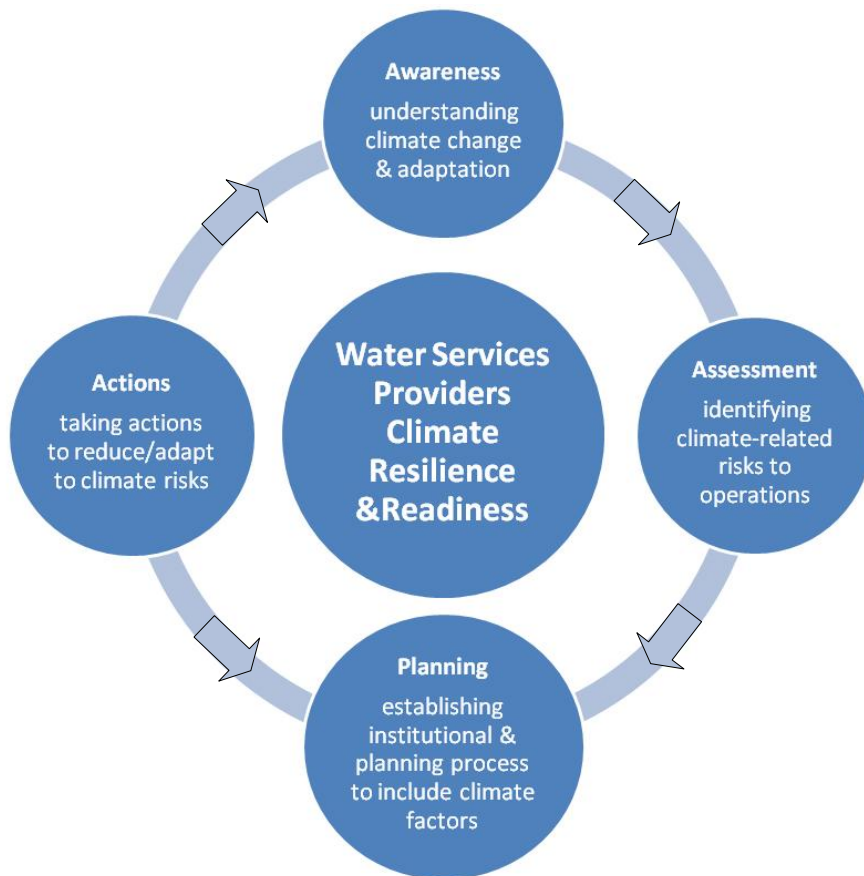
No	Services Provider	Country	Water Supply	Wastewater	Service Area
1	Indah Water Konsortium	Malaysia		X	National
2	SAJH/Ranhill Utilities Sdn Bhd	Malaysia	X		Provincial/State
3	PBAPP (Penang)	Malaysia	X		Provincial/State
4	Public Utilities Board	Singapore	X	X	National
5	PDAM Tirtanadi Medan	Indonesia	X	X	Provincial/State
6	Manila Water Company, Inc.	Philippines	X	X	Municipal
7	Maynilad Water Services, Inc.	Philippines	X	X	Municipal
8	Phnom Penh Water Supply Authority	Cambodia	X		Municipal
9	Provincial Waterworks Authority	Thailand	X		National
10	Bangkok Metropolitan Waterworks Authority	Thailand	X		Municipal
11	Saigon Water Corporation	Vietnam	X		Municipal
12	Korea Water Resources Corporation	Korea	X	X	National
13	Rajasthan Public Health and Engineering Department	India	X	X	Provincial/State
14	Water Corporation	Australia	X	X	Provincial/State

Consisting of a survey and two workshop consultations organized from November 2011 to May 2012, the rapid assessment (1) gathered and analyzed information to determine the level of climate change readiness or resilience of participating services providers; (2) identified challenges and potential actions to strengthen their adaptive capacities; and (3) documented good practices that contribute to building resilience. By design, the survey did not include a statistically representative

sample, but rather captured the experiences of the participating services providers. This report summarizes the assessment results and documents selected good practices and activities of services providers in Asia, Australia and the U.S. to address climate change impacts and build resilience.

To determine the level of readiness for addressing climate change impacts, the rapid assessment follows four stages that represent a continuous process for increasing adaptive capacities and resilience (see figure below).

- **Awareness:** how well providers understand climate change and potential impacts to services delivery;
- **Assessment:** efforts of providers to identify and mitigate climate-related risks that affect operations;
- **Planning:** provider plans that integrate climate change; and
- **Actions:** provider activities that contribute to strengthening adaptive capacities and building overall resilience.



Stages in the Climate Readiness Process*

*Based on "Climate Ready Water Utilities," a final report by the U.S. National Drinking Water Advisory Council (2010).

In general, the assessment results indicate that all participating services providers are building their climate resilience in some notable ways. Key results that highlight the level of readiness include:

- Of the 14 participating providers, Australia's Water Corporation and Singapore's Public Utilities were in the advanced readiness phase, having completed the four-stage cycle and continuing to build their adaptive capacities. They engaged stakeholders, including policymakers, internal staff and their customer base, to raise awareness of climate change and its impacts especially on delivery of water services. They have worked with the scientific community to gather data, identify and mitigate risks related to climate change, and develop plans that integrate climate change. They have also taken actions that yield not only improved operational efficiencies, but also increased resilience.
- Most services providers in the assessment were in the intermediate readiness phase, where they have undertaken some activities within each of the four stages but have not completed all four elements in their entirety. For instance, these providers have taken actions that improve operational efficiencies and at the same time build their adaptive capacities without being fully aware or having explicitly planned for addressing climate change impacts.
- Of the 14, five providers have increasingly implemented structural (e.g., infrastructure upgrades) and non-structural (e.g., capacity building) adaptation measures. Malaysia's Indah Water Konsortium and Penang PBAPP, the Philippines' Maynilad Water and Manila Water, and Korea Water Resources Corporation have begun to address climate change by recognizing the need to further strengthen their own awareness and determining climate-related risks.
- The unavailability of robust climate data, proper data analysis, and appropriate means to distill useful information for use by decision-makers and communities were significant limitations faced by many services providers.
- With limited resources and data, services providers recognized the value of scenario planning, in which they developed scenarios and risk-mitigation options based on available information and current capabilities to address climate-related risks.
- Water services providers emphasized that twinning partnerships with peer providers and/or the scientific/academic community would significantly support their efforts to build adaptive capacities and resilience. Partnerships enable sharing of good practices for awareness-raising, risk identification, planning systems, and implementation of structural and non-structural measures to adapt to climate variability and change.

In detail, the level of readiness identified in each of the four stages according to the assessment results is as follows:

Awareness

- Of the 14 services providers, 11 have undertaken activities to raise the awareness and understanding of their own personnel, customers, and relevant stakeholders such as local policymakers and governments.
- Nine services providers have developed structured programs on awareness-raising and advocacy by engaging consumers, schools, national/local policymakers; holding internal

seminars on climate change; and developing publications on how climate change may affect services delivery.

- Awareness-raising activities, such as those implemented by Manila's Maynilad Water Services and Western Australia's Water Corporation, included watershed protection programs, community outreach on water conservation, and seminars involving climate change and its potential impacts, and technical visits to facilities.
- Barriers to designing and implementing effective awareness-raising efforts included the lack of robust data and information, unclear target audiences representing government agencies and policymakers, and the lack of resources to sustain efforts.

Assessment

- Of the 14 services providers, 11 had a formal risk assessment process in place, but only seven have integrated climate change into their ongoing risk identification and mitigation systems.
- The top four identified climate change-related risks to operations and delivery of services were the lack of water, flood incidence, water quality deterioration, and increasing operations and maintenance costs.
- In assessing these climate-related risks, only a few services providers have collaborated with relevant agencies such as meteorological departments, academic institutions and local/national governments. These included Singapore's Public Utilities Board, Malaysia's Indah Water Konsortium, and Korea Water Resources Corporation.
- Constraints that limit proper assessment of climate-related risks included the lack of robust baseline data; the lack of transparency or data sharing; the lack of equipment, tools and methodologies for capturing, analyzing and validating data on climate variability; limited expertise and skills to conduct assessments and analysis; and limited funding to develop new or improved risk assessment systems.

Planning

- Six respondent services providers have mainstreamed climate change into their planning systems by applying new planning tools, strengthening internal units to recognize climate change impacts and connecting with the academic and scientific communities. For instance, a twinning partnership facilitated by WaterLinks between the U.S. Palm Beach County Water Utilities Department, the U.S. National Center for Atmospheric Research and Manila's Metropolitan Water Supply and Sewerage Administration (and its two concessionaires – Manila Water and Maynilad Water) led to the use of an innovative water resources planning tool that includes climate variability. Korea Water Resources Corporation meanwhile has planned for adaptation measures by developing a long-term strategy.
- Barriers to mainstreaming climate change into the planning process included competing priorities (e.g., for operational efficiency improvements); poor coordination between multiple agencies (local and national) and regions; and unavailability of planning tools/systems.

Action

- All survey respondents reported having prepared or taken actions that contribute to building their adaptive capacities through the “no regrets” approach. The most common and effective actions were those that facilitated operational efficiency improvements and ensured the sustainability of operations regardless of climate-related changes and risks.
- Two of the four most common actions – water loss reduction and water demand management –were prevalent for water suppliers while the other two – infrastructure upgrades or expansion and disaster management – applied to both water supply provision and wastewater services management.
- Services providers also noted the need to correlate disaster risk management and preparedness actions with those that address climate change impacts.
- Services providers faced challenges in improving, expanding and sustaining actions due to limited support from management and communities to make the necessary investments; lack of expertise; overlapping and uncoordinated plans of government agencies; and difficulty in prioritizing actions.

To address the challenges in developing and implementing **Awareness, Assessment, Planning** and **Action** stages, service providers identified several key actions as summarized in the following table:

Stage	Key Action	Possible Steps
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">AWARENESS</p>	<p>Increase understanding of climate science and potential climate-related impacts on operations and services delivery</p>	<ul style="list-style-type: none"> • Engage senior management and elected officials on understanding climate science and potential impacts on facilities and operations through study tours, twinning partnerships, strategic dialogue • Develop targeted messages for different groups using various communication tools and media channels • Involve “champions” to help disseminate information • Work with the climate science community to gather climate data • Dedicate a team that can explain climate change information and adaptation measures to decision-makers and peers • Partner with other organizations and/or peer water services providers to support awareness raising efforts and advocacy
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">ASSESSMENT</p>	<p>Strengthen climate risk identification and mitigation approaches</p>	<ul style="list-style-type: none"> • Build strategic partnerships and collaborative activities to understand what to assess and to develop better forecasting tools/methodologies • Engage the climate science community to translate the data and extract useful information • Partner with national/regional water associations and organizations such as through WaterLinks

Stage	Key Action	Possible Steps
PLANNING	Help integrate climate change into planning processes and systems and develop plans that address climate change impacts	<ul style="list-style-type: none"> • Use Integrated Water Resources Management as a planning framework to include climate change in the process • Create a climate services industry and engage the assistance of experts/peers to help institutionalize standard procedures for developing climate scenarios, forecasting impacts, and improving planning capabilities • Seek government support and create buy-in to plan for climate change, including promotion of public-private cooperation • Establish a well-defined process for stakeholders to discuss and structure a planning framework for decision-making • Find support and create partnerships and collaborative arrangements with scientific communities and partnership facilitators such as WaterLinks
ACTION	Implement plans and activities that build adaptive capacities and resilience in-line with services delivery improvements	<ul style="list-style-type: none"> • Prioritize the implementation of planned actions into smaller activities to leverage management buy-in and support • Start with “no regrets” solutions that support operational efficiency improvements while at the same time build resilience • Strengthen disaster risk reduction programs/preparedness as part of climate change adaptation efforts • Form alliances with NGOs, consumer and business groups, and the scientific community to lobby for support from local governments • Establish linkages and partnerships with peer services providers to learn and apply innovations and proven systems that build adaptive capacities and resilience

I. Introduction

Climate change-induced effects in Asia and the Pacific region can impact the delivery of urban water supply and wastewater management services. Recent extreme events in the region such as the 2010 drought in Vietnam, the late 2011 floods in Thailand and Cambodia, and the 2011 typhoons in the Philippines demonstrate the impacts on human lives and water resources from increased vulnerability, climate variability and change. A 2009 study by the Asian Development Bank (ADB) on the economic impacts of climate change in Southeast Asia reveals that Indonesia, Thailand and Vietnam will be generally drier in the next 2-3 decades while the Philippines will be generally wetter until the end of this century¹. Climate modeling indicates temperature increases in Asia and the Pacific region of 0.5–2°C by 2030 and 1–7°C by 2070. Figure I shows the climate vulnerability map of Southeast Asia². As a result, water services providers will likely face service delivery challenges from water scarcity due to prolonged drought, heavy flooding due to extreme precipitation, sea water intrusion from sea level rise, degrading raw water quality, and other impacts.

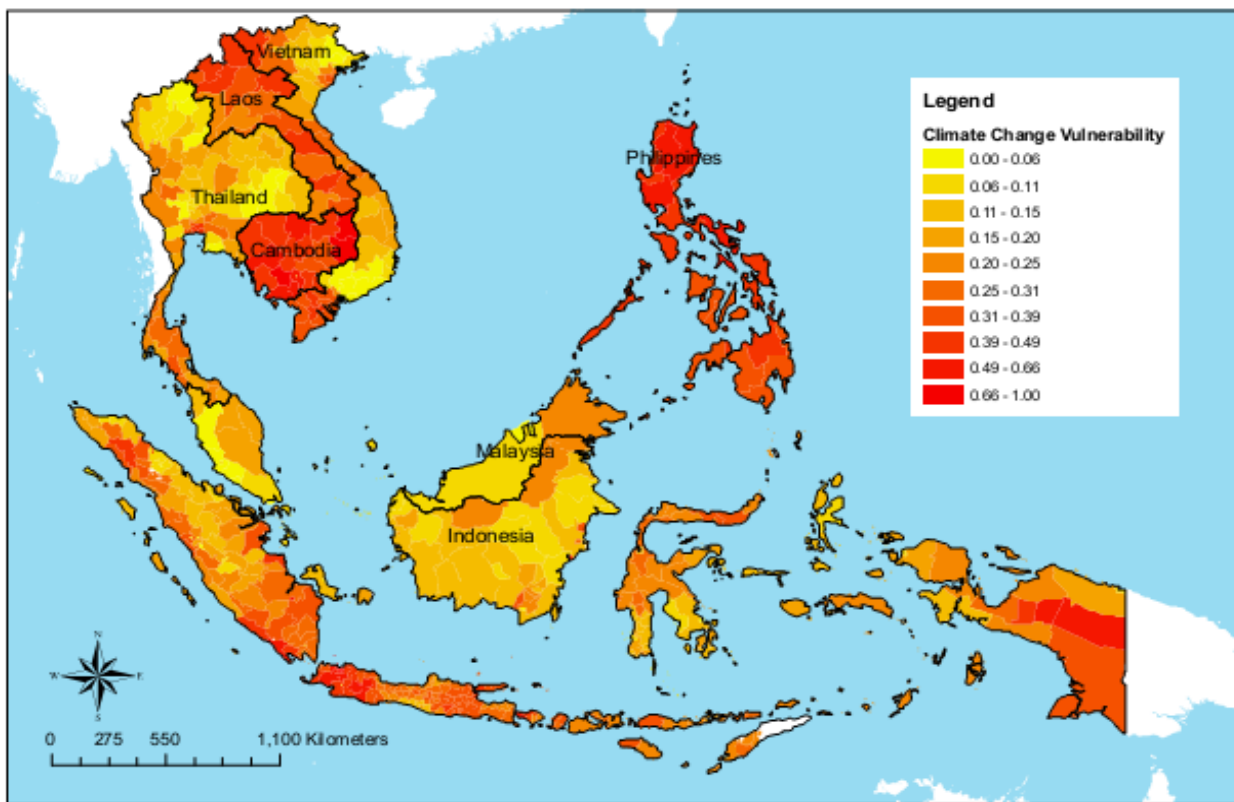


Figure I. Climate Change Vulnerability Map of Southeast Asia

¹ “The Economics of Climate Change in Southeast Asia: A Regional Review” by the Asian Development Bank, April 2009.

² “Climate Change Vulnerability Mapping for Southeast Asia” by Arief Anshory Yusuf & Herminia Francisco, January 2009.

Water supply and wastewater management service providers (or services providers) in the region are therefore working to strengthen their understanding and capacity to address the impacts of climate change on their systems. While some providers have taken steps to increase their understanding, assess needs and develop plans and new systems to address climate impacts, others are just beginning. Most providers look forward to better understanding the impacts to their operations, assessing climate-change related risks, and managing those risks by integrating practical adaptation approaches into long term strategic or investment plans that will ensure effective delivery of services in a changing and increasingly uncertain environment.

To identify how water and wastewater service providers are responding or planning to address the impacts of climate change and build their resilience through adaptation measures, Environmental Cooperation – Asia (ECO-Asia), a regional project of the United States Agency for International Development (USAID), and WaterLinks, a non-profit that supports and promotes twinning partnerships between services providers (www.waterlinks.org), have conducted a rapid assessment of 14 selected water services providers in Asia and Australia (see Table 1). ECO-Asia and WaterLinks selected the assessment respondents based on (a) the relative vulnerability of the cities/regions they operate in and (b) involvement in past WaterLinks activities.

Consisting of a survey and two workshops, the rapid assessment (1) gathered and analyzed information to determine the level of “readiness” or resilience of participating respondents; (2) defined challenges and potential actions to build adaptive capacities; and (3) documented good practices that contribute to building resilience and promote peer-to-peer cooperation. Assessment results form the basis for supporting future knowledge sharing and capacity building efforts of services providers in Asia and the Pacific through WaterLinks to help strengthen climate readiness and build climate resilience. The following details the assessment development and validation process:

1.1 Inception Workshop

ECO-Asia and WaterLinks jointly organized an Inception Workshop in Kuala Lumpur, Malaysia in November 2011 to introduce participating services providers to the assessment framework; familiarize participants with the concepts of climate readiness and mainstreaming climate change adaptation; and identify criteria for a rapid assessment of the levels of climate readiness in relation to water and wastewater services provision. Participants also discussed and confirmed the assessment framework to define the process for becoming climate ready or resilient.

1.2 Survey

Based on the Inception Workshop results, ECO-Asia and WaterLinks conducted a survey of the 14 services providers from February to March 2012 to obtain more detailed information on their understanding and experiences with regard to climate change adaptation (see Appendix 3 for sample questionnaire survey). By design, the survey did not include a statistically representative sample, but rather captured the experiences of the participating water services providers in the region and their levels of readiness.

Table I. Participating Services Providers

No	Services Providers	Country	Water Supply	Wastewater	Service Area
1	Indah Water Konsortium	Malaysia		X	National
2	SAJH/Ranhill Utilities Sdn Bhd	Malaysia	X		Provincial/State
3	PBAPP (Penang)	Malaysia	X		Provincial/State
4	Public Utilities Board	Singapore	X	X	National
5	PDAM Tirtanadi Medan	Indonesia	X	X	Provincial/State
6	Manila Water Company, Inc.	Philippines	X	X	Municipal
7	Maynilad Water Services, Inc.	Philippines	X	X	Municipal
8	Phnom Penh Water Supply Authority	Cambodia	X		Municipal
9	Provincial Waterworks Authority	Thailand	X		National
10	Bangkok Metropolitan Waterworks Authority	Thailand	X		Municipal
11	Saigon Water Corporation	Vietnam	X		Municipal
12	Korea Water Resources Corporation	Korea	X	X	National
13	Rajasthan Public Health and Engineering Department	India	X	X	Provincial/State
14	Water Corporation	Australia	X	X	Provincial/State

Note: see Appendix I for detailed profiles of each participating services provider

1.3 Regional Workshop

To discuss and validate survey findings, ECO-Asia and WaterLinks organized a regional workshop in May 2012 in Manila, Philippines, attended by the 14 original survey respondents and more than 60 representatives from services providers throughout Asia (including many from the Philippines), Australia and the U.S. Selected providers shared their innovative practices, tools and systems to understand how climate variability may impact planning and operations, and implement practices that build their climate resilience. Participants also discussed challenges and potential interventions to raise understanding and awareness of, plan for, and undertake actions to address climate change impacts. Finally, the workshop included networking sessions for participants to initiate linkages to exchange information and good practices, and learn how different platforms, such as WaterLinks and the U.S. Water Utility Climate Alliance (WUCA), could facilitate knowledge sharing.

Key findings of the workshop discussions included:

1. In Asia, there is a general gap in local expertise, technology, and approach to better understand how climate change could affect water services delivery in urban centers and to plan for addressing climate change impacts and building adaptive capacities;

2. Continued advocacy and engagement of various stakeholders – including the academic community, local and national government, policymakers, and communities – are critical to raise awareness of climate change and its impacts;
3. Limited or lack of climate-related data, and associated know-how to distill useful information from those data, restrict water services providers from fully comprehending how climate change may impact their operations and sustainability of services delivery; and
4. Learning from peers or other practitioners that have undertaken activities to become climate resilient is an ideal capacity building approach to plan and take action for addressing climate change impacts.

**Water Utility Climate Alliance (WUCA):
Providing a Platform for Building Climate Resilience**

Established in 2007 and consisting of ten U.S. water services providers, the WUCA aims to provide leadership in assessing and adapting to the potential effects of climate change through collaborative action. It seeks to enhance the usefulness of climate science for the adaptation community and improve water management decision-making in the face of climate uncertainty. It focuses on “actionable science” or data, analysis, and forecasts that are sufficiently predictive, accepted and understandable to support decision-making (including capital investment). The WUCA also emphasizes peer-to-peer learning by establishing partnerships between climate science providers and users; informing each other about the changing state of climate science and its application to decision-making; developing adaptation strategies that prepare for ranges of potential impacts; and advocating the development of flexible and adaptive regulations that accommodate uncertainties and the need to transparently prepare for climate change. Its activities strengthen communication with regulatory agencies, the public and customers. For more information, see www.wucaonline.org.

1.4 Final Report

This report summarizes the assessment results from the 14 respondents and workshop discussions with various services providers from Asia, Australia and the U.S in five sections:

Background. Provides key concepts on vulnerability to climate change and adaptation as context for the rapid assessment.

Climate Readiness. Explains principal elements and framework of “readiness” to prepare for and address climate change impacts.

Assessment Findings. Summarizes the key assessment findings, documents good practices on how various providers are responding to climate change impacts, and highlights challenges and potential interventions to build climate resilience.

Building Climate Resilience. Demonstrates the process of water services providers to become climate resilient.

Conclusions. Summarizes assessment results and highlights key action agenda to strengthen adaptive capacities and build “readiness.”

2. Background



Extreme events linked to climate change disrupt lives of urban inhabitants and provision of services.

Highly dependent on historical climate patterns and the future condition of ecosystems, water services providers in Asia and the Pacific remain generally uncertain about specific climate change impacts on their operations and long-term delivery of services, and even less certain about appropriate responses or adaptation measures to address these constraints. For many, understanding climate change adaptation itself is a challenge since adaptation is not a simple, uniform process. It takes place at different levels with actions and inputs by a

range of stakeholders applying a variety of approaches and tools. “Mainstreaming” adaptation into a services provider’s planning and decision-making processes is one approach for building adaptive capacities and becoming ready for potential impacts.

Defining Climate Change Adaptation

Climate change adaptation is a process of “adjustment in the ecological, social or economic systems in response to observed or expected changes and their effects and impacts in order to alleviate adverse impacts or take advantage of new opportunities” (Intergovernmental Panel on Climate Change, 2007).

“**Climate vulnerability** is a function of location and capacity to cope”

(Cooperative Program on Water and Climate, *Climate Changes the Water Rules*, 2003)

“**Adaptation** is a process through which societies make themselves better able to cope with an uncertain future”

(United Nations Framework Convention on Climate Change, *Impacts, Vulnerabilities and Adaptation in Developing Countries*, 2007)

Key adaptation aspects relevant to water services providers include³: (1) reducing the risks and vulnerability of their infrastructure, water sources and operations; (2) mitigating adverse impacts from climate change on their operations and service areas; and (3) ensuring that their operations continue to deliver services during extreme events likely caused by climate change. Adaptive actions that enhance the resilience of vulnerable systems within a services provider’s operations typically focus on:

³ Based on “Climate Ready Water Utilities”, a final report by the U.S. National Drinking Water Advisory Council (2010) and “Adapting Urban Water Systems to Climate Change” handbook by the European Union-funded SWITCH project (2011).

- ‘Planned adaptation’ - the proactive identification of potential climate change impacts and associated, carefully targeted, steps to respond
- ‘Autonomous adaptation’ - spontaneous reactions to climate-related pressures that commonly are not considered as adaptation measures to climate change

Risk is a central element in the adaptation process. For a water services provider, understanding risk requires the analysis of the source of the risk (e.g., climate variability and sea level rise); the impact of the change (e.g., affects on operations and infrastructure); and the frequency of the risk (e.g., temporary, permanent, periodic, etc.).

A related element to risk is **vulnerability**, which identifies the likelihood of impacts of the risk affecting water services providers. The three elements of vulnerability are: (i) exposure, which relates to the degree of damage anticipated to services providers; (ii) sensitivity, which is the capacity of services providers to anticipate and/or cope with the stress; and (iii) resilience, which relates to the ability of services providers to recover from adverse impacts and to buffer against and adapt to future stresses.

Considering risk factors and vulnerabilities, the rapid assessment highlighted the processes a water services provider can implement to prepare for the potential impacts of climate change and documents how selected water services providers are adapting to the current and projected impacts.



Becoming ready to adapt to climate change helps ensure effective delivery of services.

Climate change “readiness” is an emerging concept, and relates to whether the services provider has developed the capacity to adapt to climate change, including taking actions in advance of change, and has the ability to cope with increasing uncertainty over key operational conditions over time. In the context of the rapid assessment, readiness refers to whether water services providers have taken climate-change factors and parameters into account in their decision-making and planning processes to better identify potential barriers to operations. Readiness parameters include, among others: institutional awareness (e.g., political will, management support); assessment capacities (e.g., vulnerability review process, information collection); and adaptation planning/implementation capabilities (e.g., decision-making process, scenario planning, resources allocation). Specific related activities might include internal capacity building initiatives; stakeholder engagement (such as involving government agencies, academic institutions, private sector and local communities); and information collection and management. In this assessment, readiness

refers to being resilient and having adequate adaptive capacities.

Section 3 details the key principles and elements of readiness as defined in the rapid assessment.

3. Climate Readiness

Becoming climate ready or resilient is an iterative process, and will evolve as a services provider responds to changing circumstances and strengthens its adaptive capabilities. To describe this process, ECO-Asia and WaterLinks identified a framework⁴ that sets out four stages of readiness in a cyclical and iterative process: (1) awareness; (2) assessment; (3) planning; and (4) actions. Figure 2 shows the readiness framework applied in the rapid assessment. Detailed description of each stage within the framework is as follows:

Awareness is an improved knowledge and understanding of basic climate science and variability, and climate-related risks by key services provider staff and relevant stakeholders (such as local or national governments, line ministries and departments, academic institutions, business or private sector, and services provider customers). Building awareness of climate variability and change, their likely impacts, and possible adaptation solutions at the decision-maker and customer level is the fundamental first step to gather support for planning and taking actions that will enhance a services provider's adaptive capacities.

Assessment is the process that enables a services provider to predict, and over time improve predictive capabilities, how climate and hydrological changes relate to potential risks to operations and delivery of services currently and in the future. Strengthening the capabilities of a services provider to assess risks will reduce the inherent uncertainties typically associated with predictions and projections. Defining and assessing the likelihood of occurrence of any potential risks from climate change are essential for a services provider to build its climate resilience. Risks may include the result of permanent changes to background conditions (e.g., hydrological cycle, ecosystems, etc) and their increased variability like the intensity and seasonal distribution of rainfall. Risks could also arise from long-term trends and gradual change as well as sudden and disruptive shocks such as more frequent and more severe extreme events like cyclones and associated floods.

Planning relates to how a services provider takes climate change into account in its decision-making processes, for example by developing specific adaptation plans, making long-term strategic planning and investment decisions, and instituting necessary changes to day-to-day operational planning to reflect changing conditions. The planning stage also refers to how far a services provider has put in place and integrated effective disaster risk management and mitigation plans that link with increased incidence of extreme climate-induced events such as major storms, floods and droughts.

Actions are activities or interventions that a services provider has implemented in response to the increased risks and shifts to environmental (and operational) conditions resulting from climate change. Actions vary depending on the local conditions, priorities and projected climate change impacts. They may focus on securing the future sustainability of water supplies through structural measures such as increasing reservoir capacities and accessing new sources of water (e.g., new tube wells or desalinization) as well as non-structural interventions such as enhancing watershed management and improving cooperation with other stakeholders in an integrated water resources management framework. Typical operational efficiency improvements (such as reducing water losses, recycling wastewater, conserving water and optimizing water and/or wastewater treatment operations) are essentially "no-regrets" actions that not only enhance overall delivery of services but

⁴ The model reflects the findings and results from "Climate Ready Water Utilities," a final report by the U.S. National Drinking Water Advisory Council (2010).

also help prepare services providers against climate change impacts. Finally, actions that help decrease disaster risks through improvements in the overall disaster management system and physical interventions, such as flood barriers and relocating key facilities to higher ground, also represent climate change adaptation solutions.

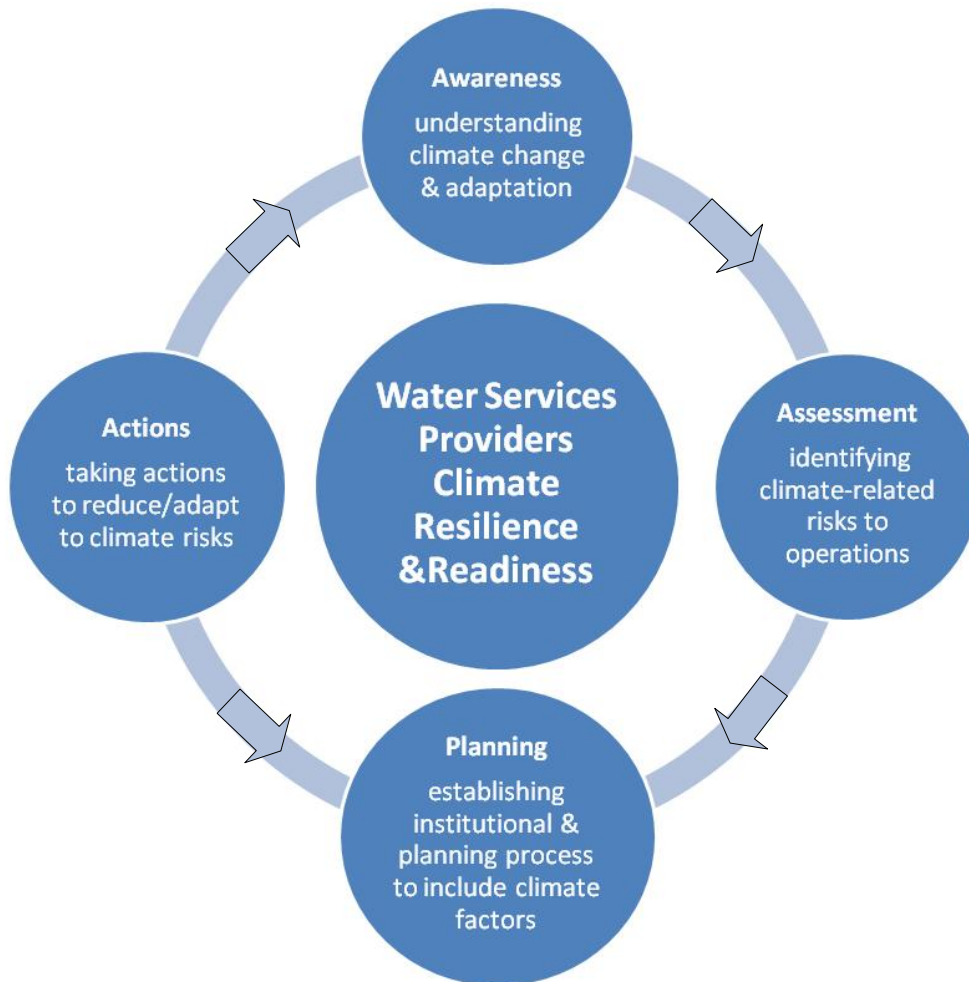


Figure 2. Stages in the Climate Readiness Process

In summary, being climate-ready requires a continuous process. Implementing the four stages iteratively helps services providers to become climate ready and resilient by strengthening their adaptive capacities over time through conscious steps to build capabilities, change internal systems, and establish stronger relationships with stakeholders.

4. Assessment Findings

The following sections highlight the assessment findings and document examples of good practices based on the survey conducted among the 14 services providers and the outcomes of the inception and regional consultation workshops that involved a wider range of services providers and stakeholders from Asia, Australia and the U.S. Appendix 1 shows the profiles of the 14 respondent providers and Appendix 2 lists participants consulted in the assessment process.

4.1 Awareness

For water services providers, becoming more aware of the nature and potential impacts of climate change is a starting point for building climate resilience. Recognizing the need to raise awareness and comprehension is just as important as increasing understanding of how regional/local climate variability may affect water resources and services delivery.

Services providers play a key role increasing the awareness of their customers as well as related local or national policymakers in order to advocate actions and processes that strengthen adaptive capacities. For example, managing water demand during or in anticipation of a drought largely depends on how a services provider communicates with its customers to conserve water. They also need to cultivate the understanding and awareness of their own staff so that any adaptation measures developed would remain operational within the organization. Effective awareness raising programs should focus on the following:

1. Development of a structured program of training and awareness-raising for **personnel** that will provide both an overall appreciation of the nature and understanding of climate change risks and the measures that will contribute to becoming climate resilient.
2. Collaboration with **other agencies and local communities** to create a better understanding of the nature of climate-related risks the services provider faces and the potential measures to adapt to or reduce these risks.

In the assessment, 11 respondents reported activities that helped increase the awareness of potential climate change impacts on their operations and the availability of water resources. Of the 11 respondents, nine services providers have implemented structured awareness raising programs that engaged their own personnel and, at times, local communities and other stakeholders. Some examples from the rapid assessment include:

- Malaysia's Indah Water Konsortium (IWK) had its staff attend a number of external training courses and seminars on climate change and establishing emergency response teams in its Kuala Lumpur head office as well as unit offices throughout Malaysia to respond to the perceived increase in climate-related risks.
- In the Philippines, the Manila Water Company implemented the 'Lakbayan,' or water trail program, that has engaged more than 500 community and school groups and 18,000 people to understand how greater Manila sources its water and the importance of water resources management (including wastewater treatment).
- The Metropolitan Waterworks Authority (MWA) in Bangkok organized annual conferences with the academic community to analyze climate-related risks for water resources.

- Malaysia’s Ranhill/Syarikat Air Johor Holdings (Ranhill) in Johor state has regularly conducted education and awareness activities through the ‘Mesra Pelanggan’ school children outreach program on water supply and management.
- Singapore’s Public Utilities Board (PUB) coordinated activities with relevant government agencies (such as the National Environment Agency) and especially with the Inter-Ministerial Committee on Climate Change to embark on a series of public consultations to seek feedback and ideas on climate change-related issues.

The assessment revealed a number of challenges to strengthening awareness. Limited budget and the lack of specific information pertaining to climate change impacts are barriers for developing a robust awareness raising program tailored to different audiences. Senior managers and decision-makers tend to prioritize improvements to operational efficiencies that reap immediate benefits rather than future climate change considerations that entail uncertainties, without recognizing the “no regrets” approach. The wide range of stakeholders involved and the uncertainty of organizations responsible for climate change adaptation also restrict the preparation of specific awareness raising activities.



Engaging communities to recognize the potential impacts of climate change on services delivery is a vital step for building awareness and resilience.

Thailand Provincial Waterworks Authority

In response to these challenges, services providers consulted in the rapid assessment have suggested several interventions. Carefully targeted messages for different stakeholders based on a clear scientific knowledge base are key to conveying the importance of climate change impacts for water services providers, local/national governments and

customers. Assessment participants also emphasized the value of strong partnerships (with government, academic community, NGOs and peer services providers) and the creation of dedicated teams to prepare and deliver awareness raising programs. Other identified actions included the need to involve “champions” (e.g., leading experts, politicians, celebrities) to serve as high-profile advocates, work with youth and students to reach their parents, and leverage mass media to disseminate information to a wide audience.

Table 2 summarizes the key challenges and potential interventions noted during the assessment.

Table 2. Challenges and Solutions for Raising Awareness and Understanding of Climate Change Impacts

Challenges	Potential Solutions
<ul style="list-style-type: none"> • Lack of data and information to warrant better understanding of climate change and its impacts on the water resources sector • Unclear audience within government due to fragmented coordination of agencies involved in climate change adaptation work • Lack of adequate or dedicated resources to sustain activities • Changing established mindsets and reducing skepticism of climate change and variability • Local government interest in conflict with the environment 	<ul style="list-style-type: none"> • Tapping the climate science community for data and information relevant to climate change and impacts on water resources • Working with the climate science community to analyze climate data that will help improve the understanding of climate change impacts • Having a dedicated local team, including senior managers, that can explain climate change information and adaptation measures to decision-makers and peers • Developing targeted messages for different groups (e.g., school children to reach their parents) • Partnering with other organizations and/or peer water services providers to support awareness raising efforts including advocating for a strong central government policy framework on climate change adaptation • Involving “champions” (e.g., politicians and celebrities) to help spread information • Adopting various communication tools and media to spread information

The assessment indicated a growing awareness by services providers of how climate change could impact their operations and delivery of services. All respondents have adopted the “no regrets” approach, implementing activities that not only reduce climate-related risks but also improve overall operational efficiencies whether or not climate change occurs. For instance, Malaysia’s Perbadanan Bekalan Air Pulau Penang (PBAPP) constructed intake pumps on raised platforms to more effectively protect them against flooding and increased raw water storage by building a new dam. Manila Water installed electromagnetic equipment for its sewage treatment plant in an elevated building that enabled it to sustain operations during the record-breaking floods caused by Typhoon Ondoy in 2009. Indonesia’s PDAM Tirtanadi in Medan responded to projected water shortages by expanding production capacity, working to improve the distribution system, and conserving water catchment areas.

Maynilad Water: Working with Stakeholders to Raise Awareness

Manila's Maynilad Water Services works with local communities to support environmental improvement and climate change adaptation activities. In its program, Maynilad involves its own staff in order to expand their appreciation of the need for environmental protection and a greater understanding of the communities it serves. The program's central element is watershed management protection. Maynilad engages local communities and indigenous people to plant and protect trees in water catchments that supply Maynilad's water sources. Local people residing in the watersheds and the company's staff gain an appreciation of the role of trees in conserving and securing Manila's water supply. Maynilad's "Green Teams" compile, track and address greenhouse gas emissions and have initiated an information campaign for children on water conservation. These activities have become an integral part of Maynilad's efforts to understand climate change and its impacts.

Assessment consultations showed that awareness raising efforts were more effective when services providers remain actively engaged in national or local deliberations on climate change impacts and policy-making. Established national policies and programs on climate change adaptation as well as extreme events have also brought forward an enabling environment that underpins awareness raising efforts. For instance, recent major flooding events in Manila caused by intense typhoons have stimulated national efforts to develop climate change adaptation policies and programs that will likely involve water services providers. Similarly, the heavy flooding that affected many parts of Thailand, including Bangkok, in 2011 has greatly strengthened national awareness of climate change impacts and is leading to more sustained efforts, including by Bangkok's MWA, to respond to these threats. Ho Chi Minh City, Vietnam, ranked as one of the most vulnerable cities to climate change, has developed an adaptation action plan in coordination with the Saigon Water Company.

TOOLKIT: Supporting Awareness Raising

WaterLinks and USAID, through the ECO-Asia project, developed a 10-Step Promotion Program Toolkit to provide a comprehensive guide to the design, development, implementation, monitoring and evaluation of promotion programs for water, sanitation, and/or hygiene activities. It offers guidance on how to develop a focused, audience-driven, research-based and creative campaign and initiatives to change behavior. It is flexible and can be tailored to specific situations and topics, including climate change and its impacts. ECO-Asia and WaterLinks worked with services providers in Indonesia, Philippines, Sri Lanka and Vietnam in applying the Toolkit to expand water services to low income communities, increase willingness to pay for services, and promote hygiene. For more information, see www.waterlinks.org/promotion.

4.2 Assessment

Climate change is likely to amplify existing operational risks for water services providers in terms of frequency and/or intensity. Recognizing how these risks change and integrating them into a services provider's risk assessment process is another important step for building climate resilience.

The rapid assessment showed that 11 respondents have a formal risk assessment process in place and a dedicated risk assessment unit within the existing management structure to identify and mitigate operational risks on an annual or semi-annual basis. For example, Thailand's Provincial Waterworks Authority (PWA) implements a five step risk assessment process consisting of objective setting, risk identification, risk assessment, risk assessment planning, and monitoring and

evaluation. MWA's Department of Risk Management reviews risks annually based on established indicators and systems. Manila Water's Enterprise Risk Management Program identifies business operation risks and integrates them into their strategic planning exercises.

Indah Water Konsortium: Practicing Risk Assessment Processes

Through its Risk Management Framework, IWK's operations units identify and assess risks to business operations. The Framework dictates 'asset profiling' to examine and audit data on all potentially vulnerable assets. The units undertake day-to-day activities with support from numerous other departments, supervised by a high-level Steering Committee that ensures the risk assessment outputs integrate with IWK's overall management systems. IWK in 2009 conducted a comprehensive asset risk assessment of its sewerage (including septage) collection and treatment systems. The process examined risks related to frequency of potential services disruptions, effects of any disruptions and the key factors that characterize those risks. Climate change-related risks were an integral part of this process, which included flood risks and the impacts of heavy rains to IWK's operations and their facilities and nearby residents.

Of the 11 respondents with formal risk assessment processes, seven have included climate change-related risks to reflect the evolving integration of climate and water availability as key risks, such as raw water availability and frequency of extreme events, in their overall systems. They have also improved their predictions and assessment capabilities by acquiring new analytical tools and data sets and developing performance criteria that reflect more effectively changes to risk patterns resultant from climate change. Examples include:

- Manila Water recognized climate change as a driver of other operational risks, and consequently shifted its corporate focus from climate change mitigation (e.g., energy efficiency and greenhouse gas accounting) to climate change adaptation through actions such as climate proofing of existing and future assets and increasing watershed rehabilitation efforts.
- Maynilad Water developed a comprehensive approach to respond to and mitigate potential climate change-related risks that included elevating facilities, increasing storage capacities, optimizing water treatment by taking account of drought conditions, and strengthening watershed management.
- PUB has annually involved all departments to review and analyze potential risks and included the failure to adapt to climate change as a defined risk, and drew specialists from the Singapore National Environment Agency into the process.
- Korea Water Resources Corporation (K-Water) trained staff to strengthen its predictive modeling capabilities using the General Circulation Model/Regional Circulation Model.
- The Water Corporation enhanced its demand pattern predictive capabilities and integrated the projection results into its risk assessment and business planning process.
- Rajasthan's Public Health and Engineering Department (PHED) in India worked closely with relevant departments such as the Department of Meteorology, Forest and Soil Conservation Department, Central Ground Water Department and the Irrigation Department to enhance its understanding of the state's overall water resources conditions.



Climate-induced effects such as temperature rise and degrading water quality can further increase already rising operations and maintenance costs.

Table 3 lists the risks assessment participants have identified and ranked in terms of severity to their operations. They consistently ranked high risks associated with sustainability of future water supplies, water quality concerns, likelihood of intensified floods and extreme events and their impacts on facilities, and cost increases related to higher energy requirements and increased operations and maintenance costs. Only three respondents ranked saline intrusion as a result of sea level rise a serious risk, while others considered it carrying little or no risk to operations and services delivery. Few respondents ranked planning and institutional challenges as high risks, indicating a general

level of confidence that organizational issues are relatively less significant than operational constraints.

San Francisco Public Utilities Commission: Assessing Climate Risks through a Chain of Models

SFPUC's assessment approach demonstrates that, where the data, models and capabilities are available, a 'high-technology' approach to risk assessment can be an invaluable tool. SFPUC has used a chain of models to strengthen its predictive capabilities and underpin its planning process. The approach includes climate models (both general circulation models and 'downscaled' models for the specified region), sophisticated hydrological models, and operational models of their infrastructure system. SFPUC runs these models through a series of scenarios to assess the implications of different possible future climate conditions for its water supplies and operational effectiveness, allowing it to make decisions on the most effective way to respond to likely future climate change impacts. SFPUC notes that the use of such an approach can be extremely effective but is also contingent upon the availability of high levels of resources and capabilities and good long-run data sets.

Table 3. Assessment of Climate Change-Related Risks

Climate Change-Related Risks	Rank (0 = no risk, 1 = low risk, 2 = medium risk, 3 = high risk)														
	Manila Water	PWA	PDAM Tirtanadi	PBAPP	Maynilad	PPWSA	MWA	K-Water	Water Corp.	SAWACO	IWK	Ranhill/SAJH	PHED	PUB	AVG
Hydrological Impacts															
Floods: increased incidence or severity	3	2	1	1	3	1	2	2	2	2	3	1	1	3	1.9
Surface water: overall reduced availability or increased seasonal shortages	3	2	1	2	3	0	2	3	3	2	2	2	3	3	2.2
Groundwater: overall reduced availability	1	2	0	0	1	0	2	1	3	2	0	0	3	0	1.1
Reduced carrying capacity of rivers/water bodies for wastewater disposal	2	2	0	0	1	0	2	1	0	2	3	3	1	0	1.2
Watershed: changes to the ecology/vegetation cover	3	2	0	1	3	0	2	2	1	2	0	2	2	2	1.6
Saltwater intrusion/increased salinity of water supplies	1	1	1	0	3	0	2	1	1	3	1	1	1	3	1.4
Deteriorating water quality	3	2	1	2	3	1	3	3	3	3	2	2	2	2	2.3
Sea level rise	1	1	1	1	3	0	2	1	1	3	1	0	0	3	1.3
Changes to Demand															
Increased demand from services provider customers	3	2	0	1	1	0	2	2	3	2	2	1	1	2	1.6

	Manila Water	PWA	PDAM Tirtanadi	PBAPP	Maynilad	PPWSA	MWA	K-Water	Water Corp.	SAWACO	IWK	Ranhill/SAJH	PHED	PUB	AVG
Increased competition for water resources from agriculture or other sectors	3	3	1	2	1	0	2	1	2	2	1	1	1	1	1.5
Physical/Operational Impacts															
Increased maintenance costs and/or complexities	3	2	1	2	2	0	2	3	1	2	3	2	2	1	1.9
Damage to water supply and/or wastewater disposal facilities	3	2	0	1	2	0	2	2	2	2	3	2	1	1	1.6
Increased power and/or other operational costs	3	2	1	2	2	1	2	3	3	2	3	2	2	2	2.2
Increased costs and risks that affect capital availability and/or investments	3	2	0	1	2	0	2	3	3	2	2	0	2	1	1.6
Planning/Institutional Failures															
Limited organizational capacity	2	1	1	1	1	0	2	1	1	3	2	1	1	1	1.3
Poor coordination with other organizations	3	1	2	1	1	0	1	2	1	3	1	1	1	1	1.4
Limited or inaccurate information on climate changes, impacts, hydrology	3	1	1	1	1	0	2	1	2	2	1	1	2	2	1.4
Limited institutional mandate: no control over vital factors that affect the services provider's ability to improve climate readiness	2	1	2	2	1	1	2	1	1	2	2	1	2	1	1.5

In the assessment, services providers expressed their challenges to strengthen climate change risk assessment capabilities. They universally concluded that the lack of available, reliable and comprehensive data on climate change make the assessment process difficult. In some cases, when data are available, accessing them is difficult due to administrative barriers. Organizations responsible for collecting and managing the data are occasionally unwilling to share them although they are public information. Data reliability is another constraint. Hydrological data for instance are often limited in both coverage and historical duration, while the lack of down-scaled climate projections restricts the ability to predict the likely impacts of climate change on specific locations. Some services providers also have limited access to models and predictive tools to analyze the data and, in some cases, lack the technical expertise to understand the full implications of such analyses. Table 4 lists other challenges noted during the assessment.

Table 4. Challenges and Solutions for Assessing the Risks of Climate Change Impacts

Challenges	Potential Solutions
<ul style="list-style-type: none"> • Lack of robust baseline data (e.g., only rainfall data, lack of temperature data in the watershed area, poor hydrological data, etc.) • Lack of transparency or effort in sharing data and information among relevant agencies • Lack of equipment, tools, and methodologies that are able to capture, analyze and validate data on climate variability • Low awareness and/or understanding of the types of risks of climate change impacts that a services provider should plan for or assess • Limited expertise and skills to conduct assessment and analysis • Divided responsibility across various agencies and lack of adequate data maintenance system for the repository agency • Limited funding and/or budget 	<ul style="list-style-type: none"> • Building strategic partnerships and collaborations to understand what to assess; develop better forecasting tools/methodologies; build capacity; validate outputs; and learn from other’s experiences • Engaging the climate science community to translate the data and extract useful information for water services providers • Integrating climate change considerations in preparing or revising the prediction of future scenarios; risk management program; business continuity plan; and the Water Safety Plan • Partnering with national/regional water associations such as the American Water Works Association, WaterLinks, and others

To address data gap and risk assessment challenges, services providers in Asia look to apply the scenario planning approach and to harness relationships with other peers that have capabilities and greater access to a broader range of climate information. Scenario planning is a useful approach in dealing with limited capabilities and resources (e.g., data) to apply in-depth risk assessment and mitigation processes. Scenario planning enables services providers to optimize the use of missing information by focusing on options development to make correct decisions. Services providers have noted interest in expanding the number and intensity of partnerships, including with peers from other countries, such as the U.S. and Australia, to better understand how to integrate climate-related risks into the assessment process and how to engage the climate science communities.

4.3 Planning

“Mainstreaming” climate change into a water services provider’s planning process helps enhance its adaptive capacity. Mainstreaming refers to how a services provider takes into consideration the changes and increased uncertainties resulting from climate change in all aspects of planning and function. The significance of mainstreaming relates both to *internal* decision-making processes and operations as well as how the services provider relates to *external* organizations and communities.



In mainstreaming climate change into the planning process, a services provider would need to consider “no regrets” actions and the “precautionary principle.” In the “no regrets” approach, a services provider plans for improving operational efficiencies based on priorities and available resources, and at the same time, benefits from building resilience. For example, reducing water losses not only enables more balanced distribution of water to households but also increases available water supply to avoid water shortages due to drought. Following the precautionary principle, a services provider considers identified risks, however small, as

potentially disruptive to its operations and delivery of services, thus compelling it to plan for immediate (and often costly) measures even though the outcomes may not completely mitigate the identified risks. Therefore, preparing to be climate ready and resilient is a process of understanding and making trade-offs between risks and costs.

The assessment identified six services providers that are mainstreaming climate change into their wider planning and decision-making process by either (1) creating climate change adaptation plans or (2) noting explicit references in their strategies and plans. Examples include:

- PUB incorporated the effects of climate change into its water resources planning and drainage master plan to guard against the potential effects of weather, with or without climate change, and defined a multi-pronged approach to encourage water conservation in the domestic and non-domestic sector and gain access to new and enhanced sources of water.
- Maynilad incorporated climate change impacts into its business planning process, which included climate proofing measures such as changing the design of new facilities and ongoing retrofitting of existing infrastructure.
- PBAPP has planned to combine structural measures such as increasing reservoir storage capacity and improving inter-connections in its water supply system with non-structural measures such as water conservation and watershed protection in response to potential impacts.

Water Corporation: Towards Climate Resilience

Facing critical water shortages as a result of climate change, the Water Corporation has prepared a strategy that presents its 50-year plan to deliver sustainable water and wastewater services (“Water Forever: Towards Climate Resilience”). The strategy highlights the challenge of a drying climate with data showing stream flows into reservoirs declining for the past decades, and ensures that the resultant strategy incorporates climate change risks as key factors in decisions about future investments and operations. This includes a portfolio of options focusing on improving water efficiency, increasing wastewater recycling and developing new water sources (including significant investments in desalination). The strategy development and implementation process also entails collaboration with government organizations, consumers and institutes. Taken together, the strategy provides a basis for greatly improving the Water Corporation’s resilience to existing and future climate change impacts.

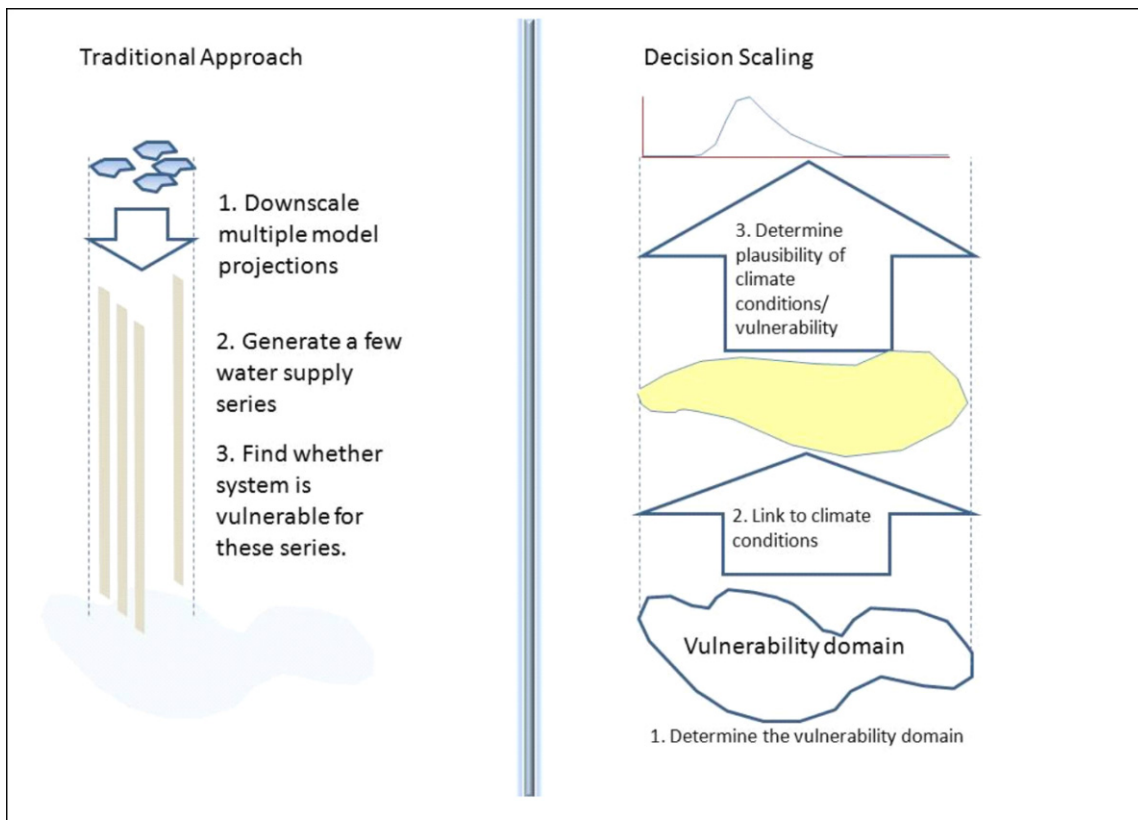
A number of respondents are beginning to mainstream climate change into their planning processes but recognize the need to further strengthen and build their capacities and enabling environment. Initial developments entail setting up new internal planning groups and/or developing new collaborations with external agencies, based on the understanding and support of senior management. Others include connecting with both the scientific community and the wider public and providing political support and needed knowledge to justify the new approaches. Malaysia’s IVK and Bangkok’s MWA for instance are strengthening collaboration with relevant government agencies to integrate water resources management. Manila Water has created a Strategic Asset Management Group that considers facility design on a life cycle approach to demonstrate costs and benefits over the long term. PHED, facing immediate challenges related to excessive groundwater extraction, has worked with the state government to pass a new water policy that bans new tube wells, increasing artificial aquifer recharging measures and the prioritization of domestic water supplies. PUB and K-water are both working with the scientific community to strengthen data gathering and analysis.

K-Water: Planning for Climate Change

K-Water manages all aspects of water resources in South Korea. Adaptation is a key element of its 5-point long-term strategy that emphasizes water value, low carbon and green growth. Its adaptation goals includes reducing flood risks, securing water supplies, improving water quality and public health and sustaining sound water ecosystems. Based on the goals, K-Water has prepared 11 action plans that range from increasing water reserves capacity to water ecosystem monitoring technologies. K-Water is already implementing these plans and has set aside substantial investments in several key fields that go beyond the normal mandate of a water service provider. This includes four major river restoration projects with a budget of \$7.1 billion and investments worth \$450 million on advanced water treatment using cutting edge technologies.

Many services providers also considered the use of scenario planning process given the greater levels of uncertainty and limited resources. Scenario planning or the “bottom-up” approach applies the decision-scaling method to determine vulnerabilities using options and scenarios as opposed to the traditional approach of modeling-intensive downscaling projections. Figure 3 shows the difference between the two planning approaches.

Figure 3. Planning Approach – Traditional vs. Decision Scaling



Slide courtesy of Casey Brown, University of Massachusetts-Amherst

U.S.-Philippine Twinning Partnership: Introducing Innovative Systems to Improve Planning

Through WaterLinks and support from the USAID ECO-Asia project, Manila’s Metropolitan Water Supply and Sewerage Administration, Manila Water and Maynilad Water partnered with the U.S. Palm Beach County Water Utility Department and the U.S. National Centre for Atmospheric Research (NCAR) on the application of the XLRM decision-making framework and the Water Evaluation and Planning Systems (WEAP) software to enable development of climate change prediction and adaptation capabilities. XLRM organizes the important elements of highly uncertain decision analysis by grouping them into four different categories. Palm Beach and NCAR shared their hands-on knowledge of WEAP and XLRM with the Manila services providers to anticipate changes to climate conditions and precipitation, water run-off and availability, and water quality changes. The partnership exposed the Manila services providers to available tools and technologies that can improve their planning processes in the future and facilitated closer connections between the Manila services providers and their counterparts at PAGASA (the national meteorological service) on data sharing.

Although many services providers described steps they are taking to mainstream climate change into their planning efforts, they also noted several constraints that limit their ability to adapt their planning systems (see Table 5). Climate change is a relatively lower priority to operational efficiency improvements that yield immediate results, and thus financial and human resources for building

climate resilience remain limited. In some cases, services providers are unclear about how to address climate change impacts; many consider climate change as a problem but are uncertain about how to develop and implement the appropriate responses for mitigating associated risks. These constraints illustrate the lack of awareness of how the “no regrets” approaches can benefit both adaptation and operations enhancements. Other challenges are the lack of a clear policy framework and poor coordination with other organizations or agencies that could assist with innovative new approaches to planning and investment decisions.

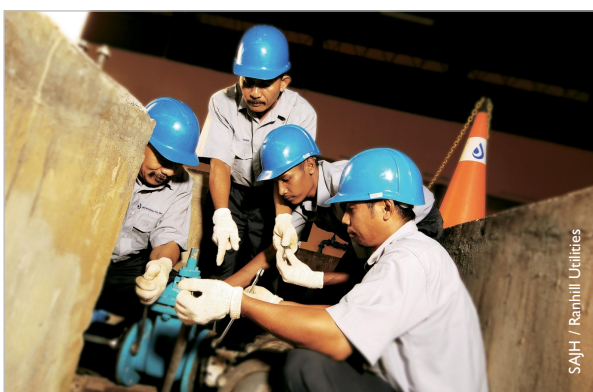
Table 5. Challenges and Solutions for Planning to Build Climate Resilience

Challenges	Potential Solutions
<ul style="list-style-type: none"> • Competing priorities diminish resource and budget allocation for planning to address climate change impacts • Lack of or poor coordination between multiple agencies (local and national), between regions, communities and stakeholders, among public utilities, and donor programs • Lack of or poorly managed historical data, availability of tools, training programs, experts, appropriate technologies, and planning standards • Difficulty in integrating plans due to frequent changes in land uses and rapid development 	<ul style="list-style-type: none"> • Use Integrated Water Resources Management (IWRM) as a planning framework to integrate climate change • Create a climate services industry and engage the assistance of experts/peers (twinning partnerships) to help institutionalize standard procedures for developing climate scenarios, forecasting impacts, and improving planning capabilities • Seek government support and create buy-in to plan for climate change, including promotion of public-private cooperation • Establish a well-defined process where stakeholders can discuss and come up with a planning framework for decision-making especially on zoning, land use and developments • Generate support and create partnerships and collaborations with scientific communities and partnership facilitators

TOOLKIT: Planning for Water Resources Management

Freshwater management challenges are increasingly common. Allocation of limited water resources between agricultural, municipal and environmental uses now requires the full integration of supply, demand, water quality and ecological considerations. Developed by the Stockholm Environment Institute's U.S. Center, the Water Evaluation and Planning system, or WEAP, is a user-friendly software tool that takes an integrated approach to water resources planning. WEAP facilitates engagement of diverse stakeholders in an open process and focuses on the water balance database approach to maintain water demand and supply information and calculates water demand, supply, runoff, infiltration, crop requirements, flows, and storage; and pollution generation, treatment, discharge and in-stream water quality under varying hydrologic and policy scenarios. It also evaluates a full range of water development and management options, and takes account of multiple and competing uses of water systems. WEAP is available in multiple languages (see www.weap21.org).

4.4 Actions



Adaptation actions should improve operational efficiencies and at the same time build resilience (i.e. “no regret” solutions).

Nearly all services providers in the assessment reported taking actions to address climate change impacts, either through the “no regrets” approach or more explicit adaptation efforts. Services providers often carry out these actions in parallel with awareness raising, risk assessment and planning initiatives because the necessary actions take time to develop and apply (e.g., watershed management). In developing and taking actions, water services providers consider specific factors including present socio-economic and environmental conditions such as established priorities; demographics; physical characteristics (e.g., coastal, arid, high seasonality in rainfall, etc.); type (e.g., private, public, water supply and/or sanitation/wastewater disposal); and others. The survey findings highlighted how respondents realize the different conditions in taking actions that contribute to becoming climate resilient.

Most assessment respondents reported already having developed or taken actions in areas that help them build their resiliencies and adaptive capacities through a “no regrets” approach. The reported actions vary, with several respondents implementing more activities than others, thus indicating their different needs, priorities, types of services and conditions (see Table 6⁵). The top four actions include water loss reduction (for water suppliers); water conservation or demand management (for water suppliers); infrastructure upgrades (for both water and wastewater service providers); and disaster management (for both water and wastewater service providers). Examples include:

- Malaysia’s Ranhill/SAJH and Penang PBAPP, Thailand’s PWA and MWA, Indonesia’s PDAM Tirtanadi Medan, Saigon Water Company, Phnom Penh Water Supply Authority, Manila Water,

⁵ The assessment reflects on more water supply-related actions than wastewater management. Therefore the number of actions taken for wastewater management is less than water supply, as indicated by the low number IWK (as the only wastewater management service provider in the assessment) has implemented.

and Maynilad Water have actively pursued and implemented water loss reduction programs that would save water, allow service expansion, and enhance overall water distribution.

- IWK introduced a continuous improvement program that harvests innovative ideas from its staff to improve efficiency and performance of wastewater collection and treatment facilities including substantially refurbishing and expanding infrastructure.
- PWA, Maynilad Water and PUB instituted programs to both conserve water and reduce consumption and systematically expand their storage and treatment capacity to meet expanding demand and reflecting increasing uncertainties over future precipitation patterns.

PUB: Developing New Sources of Water

Singapore's PUB is aggressively securing its future water supply needs by undertaking a comprehensive set of actions covering demand management, water quality improvements and reducing losses. In 2002, PUB introduced the "4 National Taps" strategy that extended its traditional reliance on surface water sources (with greatly increased storage capacity) to introduce extensive water recycling (including desalinization). The first recycling facility with a capacity of 30 MGD opened in 2005 while the second one with a capacity of 70 MGD is due to open in 2013. PUB has also developed a culture of water appreciation with Singapore's residents, and has created incentives for water conservation such as for the installation of low water use technologies in households and businesses.

The increasing perception of climate-related risks has led several respondent services providers to improve their disaster management and mitigation systems. Ten providers have acted to improve their corporate disaster management systems by strengthening links with relevant local/national agencies and line ministries. Seven respondents have installed flood barriers to protect infrastructure, while four had elevated or relocated facilities to less vulnerable flood sites.

Several respondents signified water reservoir storage expansion as a principal action to ensure operational viability and help prepare for potential drought conditions and increased demand attributed to climate change. Ten surveyed providers are making significant investments to increase their storage capacity given the increasing uncertainties over future water supplies. PHED has invested in raw water storage facilities that will ensure all rural and urban water supply systems have a minimum of 30 days requirement available. The Saigon Water Company, Ranhill/SAJH, and K-Water are working to make sure all service areas have sufficient water to meet dry season demand given increasing uncertainties over future rainfall patterns. Five respondents have developed their desalinization capabilities to secure water supply, including through major investments by the Water Corporation and PUB and smaller projects by K-Water, PWA and Maynilad.

Table 6. Illustrative Actions Contributing to Climate Change Readiness and Resilience

Actions Developed or Implemented	Services Providers														TOTAL
	Manila Water	PWA	PDAM Tirtanadi	PBAPP	Maynilad	PPWSA	MWA	K-Water	Water Corp.	SAWACO	IWK	Ranhill/SAJH	PHED	PUB	
Reduce consumption and/or manage demand		X		X	X			X	X	X	X	X	X	X	10
Monitor, protect & improve watershed and promote increase aquifer recharging	X		X	X	X				X			X	X	X	8
Reduce water losses (physical and commercial leakages)	X	X	X	X	X	X	X	X	X	X		X	X	X	13
Strengthen or upgrade water supply and/or wastewater treatment infrastructure	X	X		X	X			X	X	X	X	X	X	X	11
Increase reservoir storage capacity		X	X	X	X			X	X			X	X	X	9
Recycle waste or grey water	X	X		X	X				X		X		X	X	8
Find and extract additional groundwater sources	X								X			X	X		4
Improve or optimize water treatment capability	X	X		X	X		X	X	X	X			X	X	10

Actions Developed or Implemented	Services Providers														
	Manila Water	PWA	PDAM Tirtanadi	PBAPP	Maynilad	PPWSA	MWA	K-Water	Water Corp.	SAWACO	IWK	Ranhill/SAJH	PHED	PUB	TOTAL
Improve/optimize domestic wastewater collection, treatment and management	X		X		X				X		X		X	X	7
Desalinize water		X			X			X	X				X	X	6
Install flood barriers to protect infrastructure	X			X	X		X		X			X	X	X	8
Improve disaster management system (for example: remote monitoring, disaster management plan development, etc.)	X			X	X		X	X	X		X	X	X	X	10
Move facilities to higher ground		X		X	X				X					X	5
TOTAL	9	8	4	10	12	1	4	7	13	4	5	7	12	13	

Malaysia's PBAPP: Moving to Action

Recognizing the increased risks to its operational viability from a variety of sources including climate change, PBAPP in Penang has taken various precautionary measures. It has a demand management program that includes tariff adjustments and public awareness activities. PBAPP has also taken significant steps to work with local communities and state authorities to conserve and improve the watershed servicing its supply sources and is actively reducing water losses through infrastructure refurbishment and new investments. It is securing water supplies in the long term by increasing water storage and treatment facilities and working with relevant agencies to introduce inter-basin water transfers to meet its needs. PBAPP also substantially improved its disaster management system through infrastructure upgrades and institutional improvements such as elevating key structures, installing flood barriers, and developing monitoring systems.

Services providers have also identified a range of challenges in implementing climate-related plans (see Table 7). As in the constraints noted in the planning process, differing priorities restrict additional attention to taking anticipatory actions to address potential future climate risks. Existing concerns, such as service improvements and increased coverage, take precedent. Services providers confront limited financial and technical resources, and face likely difficulties in justifying tariff increases or greater investment levels for addressing risks that remain uncertain. Finally, in some cases, the lack of enabling environment and policy direction in relation to national or local governments exacerbate the limited attention and awareness for water services providers to become climate ready.

TOOLKIT: Managing Non-Revenue Water (NRW) and Water Losses

Reducing NRW and water losses increases both financial resources and water supply for water service providers, and requires a long-term, continuous process that incorporates numerous operational improvements to water provision and builds resilience. Managers across a service provider, from administration to distribution to customer service, play key roles in decreasing water loss and NRW. WaterLinks, Ranhill/SAJH and ECO-Asia developed the Manager's NRW Handbook as a practical, field-tested guide to developing and implementing NRW/water loss strategies that includes knowing and measuring water losses accurately; breaking down NRW components and developing plans to address them; involving stakeholders to implement plans; addressing physical and commercial losses; establishing systems and processes to sustain and monitor water loss reduction; and highlighting twinning partnerships as an approach for building capacities. The Handbook is also available at www.waterlinks.org.

Table 7. Challenges and Solutions for Taking Action to Address Climate Change Impacts

Challenges	Potential Solutions
<ul style="list-style-type: none"> • Lack of support from management and communities to put plans into action and make the necessary investments • Lack of sufficient expertise, experience, and funding that lead to difficulty in sustaining the initial actions, scaling up, replicating and improving/adapting to changes in the environment • Overlapping and uncoordinated plans of government agencies making implementation of actions difficult • Difficulty in prioritizing actions that are specifically for climate resilience due to uncertainty of impacts 	<ul style="list-style-type: none"> • Engage senior management and politicians on understanding climate science and potential impacts to facilities and operations through study tours, twinning partnerships, continuous dialogue, etc. • Prioritize the implementation of planned actions into smaller activities to leverage management buy-in and support • Start with “no regrets” solutions that support operational efficiency improvements while at the same time build resilience • Involve the community in implementation of programs (e.g., preservation of watershed areas, building community core groups to build livelihoods, etc.) and provide incentives to the community core groups (e.g., medical missions) • Strengthen disaster risk reduction programs/preparedness as part of climate change adaptation efforts • Form alliances with NGOs, consumer and business groups, and the scientific community to lobby for support from local governments • Provide tax incentives and facilitate tariff increases for services providers implementing actions that build resilience

5. Building Climate Resilience: A Process-Based Approach

Consultations with various services providers during this assessment emphasized that the climate readiness framework outlined in Sections 3 and 4 for water services providers to build their adaptive capacities is a process. The process requires services providers to work iteratively through the four stages of the framework: Awareness – Assessment – Planning – Action. This section illustrates as examples how far water services providers have gone within the framework in building their adaptive capacities and climate resilience. These three examples are from providers operating in cities and sub-regions with very different levels of economic development and types of climate change-related risks, indicating that the approach has widespread resonance regardless of background conditions or the characteristics of the services providers.

5.1 Development Phase: Public Health Engineering Department (PHED), Rajasthan, India

Responsible for water supply provision in India's driest state of Rajasthan, PHED faces severe resource availability constraints. The widespread over-utilization of groundwater, particularly by agricultural irrigation systems, is leading to rapidly falling water tables and greatly exacerbating water supply provision, as over 90 percent of the State's domestic and industrial water supplies come from underground aquifers. The PHED and other state authorities are aware that climate change is likely to impact water resources, with climate models predicting a drying of the climate in the more arid areas of the Indian sub-continent, and has recently embarked on a process to more effectively understand and respond to the risks that climate change will bring to water supplies in the state.

Although water stresses are common, PHED is taking steps to become more **aware** of how climate change could exacerbate existing conditions. PHED recognizes its limitations in fully understanding climate-associated risks and is working to collaborate with other relevant agencies to strengthen its own awareness and develop a better perspective on how long-term sustainability can be balanced with short-term constraints that presently dominate Rajasthan's approach to water resources management. Its recently established Communications and Capacity Development Unit is instrumental in achieving this goal.

At present, the limited availability of data and analytical capacity mean that PHED's **assessment** of future patterns of climate variability and the risks for water supplies is at an early stage of development. It has identified areas to focus on, in particular the analysis of groundwater depletion and replenishment levels, the implications of reductions in surface water availability and water quality problems. At the same time, it is already undertaking GIS-based aquifer mapping and benchmarking of urban and rural water schemes.

Responding to the 2010 Rajasthan State Water Policy, PHED and other relevant agencies embarked on a process to improve **planning** capabilities to respond to climate change. PHED is coordinating with other agencies on water regulation and groundwater control and on a master plan for the artificial recharge of aquifers, supporting its efforts to plan for building adaptive capacities and climate resilience.

Despite its limitations, PHED has already started to take **action** to address the urgency and severity of the water availability constraints. For instance, PHED has implemented initiatives on demand management, water loss reduction, rainwater harvesting, and watershed management. It is also preparing investments to increase storage capacities, develop new water sources, and

improve water treatment facilities. PHED plays a key role in banning the construction of new tube wells and is introducing aquifer recharging measures such as check dams.

Many of PHED's efforts are "no regrets" or actions important for addressing the increasing challenges that Rajasthan will face as a result of climate change. Overall, while PHED is active in different aspects of the process of becoming climate ready and resilient, it is still in the initial stages and will likely need to systematically strengthen its initiatives.

5.2 Intermediate Phase: Maynilad Water Services Inc., Manila, Philippines

Based on the assessment results and consultations, a number of services providers are at an intermediate phase in terms of being climate ready and resilient. The intermediate phase refers to how services providers are taking significant actions in all four dimensions (with key actions especially in raising awareness and assessing risks) but would require additional support and efforts to become fully prepared and resilient. For instance, Maynilad Water in the Philippines is for some time **aware** of climate change impacts, given the major floods experienced by Manila in recent years. In response, Maynilad Water has developed programs, including the formation of a



Through twinning partnerships, peer services providers share innovations and practical knowledge that help build capacity to address climate change impacts.

"Green Team," to strengthen understanding of the implications of climate change, both for their own personnel and other stakeholders. Its programs include both carbon mitigation actions and, increasingly, adaptation measures especially in relation to "no regrets."

Maynilad Water has also enhanced its **assessment** capabilities recently. For instance, through collaborations and partnerships under WaterLinks, it is piloting sophisticated modeling capabilities by using the WEAP software and developing a range of scenarios to examine future possibilities for water availability. It has strengthened its risk

assessment processes, both overall and specifically to reflect enhanced risks resulting from climate change, in the preparation of a Business Continuity Management Plan.

In **planning**, Maynilad Water has worked to mainstream climate change into their overall corporate system but recognizes that further work is necessary. In all project plan preparations and the design of facilities, it is ensuring that facilities and operations are climate-proof. It is also working closely with other agencies such as the Climate Change Commission and the National Disaster Risk Reduction and Management Council. Maynilad Water's planning efforts have accelerated in recent years, indicating the wider national impetus to the development of coherent policy responses to climate change adaptation.

Finally, Maynilad Water has taken **actions** that contribute to the development of its climate change readiness and resilience. It has instituted demand management programs and watershed protection initiatives for its key water source, which is the Angat Watershed. It is also securing water supplies by actively managing water losses; upgrading and expanding its treatment and storage facilities; and assessing the potential of increased water recycling and wastewater reuse. Maynilad Water has also strengthened its disaster management system to align with climate-

proofing such as raising by one meter key infrastructure (e.g., pumping stations) that face potential flood threats.

5.3 Advanced Phase: Water Corporation, Western Australia

Water Corporation in Perth, Western Australia represents a relatively more advanced phase of having adaptive capacities and being climate resilient. It has undertaken a structured program of activities that made fundamental changes to corporate planning and management mechanisms in direct response to the increased risks and uncertainties that climate change represents. These responses not only anticipate future risks but also take into account past and present changes to climate and water availability that have jeopardized its ability to meet customers' needs. It has effectively integrated climate change into its business operations and decisions.

In **awareness** raising, Water Corporation has implemented outreach efforts over the 15 years since it first participated in the Indian Ocean Climate Initiative. The efforts entail close collaboration with government agencies, academic organizations and the general public to sensitize them to the implications of climate change on the sustainability of their water supplies. With extensive consultations, Water Corporation prepared its 50-year corporate plan titled "Water Forever: Towards Climate Resilience" that outlines strategies to cope with the impacts of climate change.

Water Corporation has also thoroughly **assessed** future patterns and implications of climate change for corporate risks and operations through the use of innovative monitoring and modeling systems. The process includes an approach that examines and accommodates worst case scenarios and provides a comprehensive analysis based on more sophisticated demand pattern predictive capabilities for corporate and business decision-making.



Continuous operations monitoring and improvements signify the advanced readiness stage.

The Water Forever document reflects the Water Corporation's approach to fully mainstreaming climate change in the corporate **planning** processes. All aspects of corporate planning now take account of climate change, with decisions taken on the basis of informed analysis of the long-term sustainability implications of climate change for the corporation's investments and operations. The planning process works through a number of scenarios to define and respond to likely risks and vulnerabilities, with a long-term perspective that characterizes the

uncertainties resulting from future climate change. It has acted to strengthen its planning capabilities, especially citing the growth of the Water Efficiency Projects and the Water Industry Policy Branches.

Implementing the Water Forever document demonstrates the various **actions** by the Water Corporation. Broad programs and public awareness campaigns to reduce water consumption, manage water losses and improve efficiency have resulted in a drop of per capita water consumption from 191 to 140 kL/person/yr over the last 10 years. In parallel, it has secured and

increased the supply of water through major investments on water source infrastructure upgrades and in desalinization plants.

5.4 Final Notes on Process

The three examples above illustrate that becoming climate ready and resilient is a process that integrates both immediate priorities and preparation of a long-term perspective. Building capacity to strengthen adaptive capacity requires time. The four-phase framework introduced in this assessment supports the process of becoming climate resilient and reflects the specific circumstances of individual services providers. The assessment results indicate that most of the participating services providers at one level or another are already embarking on the process to become resilient, although in general the approach relies on “no regrets” actions. In the process, these services providers are working with their customers and external partners on improving their understanding of climate change, identifying climate-related risks, planning to mitigate those risks, and implementing actions that contribute to building their adaptive capacity.

6. Conclusions



Partner services providers exchange practical solutions that increase resilience.

Consisting of a survey of 14 water services providers in Asia and two workshop consultations with various other providers throughout Asia, Australia and the U.S., the rapid assessment evaluated how services providers perceived the importance of climate change and its potential impacts, identified the associated risks to their operations, and planned for and took action to mitigate or reduce those risks through a four-phase framework. The framework – awareness, assessment, planning, and actions – defines the level of readiness of water services providers

to build adaptive capacities for and resilience against climate change impacts.

Key assessment results include:

- All participating water services providers in the assessment reported that they were already working to build their climate resilience and strengthen their adaptive capacities in various ways. Although all have also taken effective measures in one or more of the four elements defined as being climate ready, they expressed further need to better target and strengthen their efforts.
- *Awareness:* 11 of the 14 responding services providers have conducted activities to raise the awareness and increase the understanding of climate change among their own personnel, customers, and relevant constituencies such as local policymakers and governments. Only nine have developed structured programs on awareness-raising and advocacy such as engaging consumers, youth, schools, national/local policymakers; holding internal seminars on climate change; and developing publications on how climate change may affect services delivery. Barriers to designing and implementing effective awareness-raising efforts included the lack of robust data and information to warrant better understanding; unclear target audiences representing government agencies and policymakers; and the lack of resources to sustain the efforts.
- *Assessment:* 11 of the 14 respondents have a formal risk assessment process in place but only seven have integrated climate change into their ongoing risk identification and mitigation systems. The top four identified risks that climate change may pose to operations and delivery of services include lack of water, flood incidence, water quality deterioration, and increasing operations and maintenance costs. Only a few services providers have collaborated with other relevant agencies such as the forestry and meteorological departments, academic institutions, and local or national governments to assess risks. Constraints that limit proper assessment of climate related-risks include the lack of robust baseline data; lack of transparency or effort in sharing data and information among relevant agencies; lack of equipment, tools, methodologies that are able to capture, analyze and

validate data on climate variability; low awareness and/or understanding of the types of risks of climate change impacts; limited expertise and skills to conduct assessment and analysis; and limited funding and/or budget to develop new systems or modify risk assessment systems.

- *Planning:* Six respondent services providers have mainstreamed climate change into their planning systems by applying new planning tools, strengthening internal units to recognize climate change impacts and connecting with the academic and scientific communities. In a few cases, climate-related disasters facilitated the willingness and ability to integrate climate change into planning processes. Barriers to mainstreaming climate change into the planning process included competing priorities (for instance for operational efficiency improvements) that reduce resources; the lack of or poor coordination between multiple agencies (local and national), regions, communities and stakeholders; the lack of or poorly managed historical data and availability of tools/appropriate technologies; and frequent changes in land uses and rapid development.
- *Action:* All survey respondents have in one form or another prepared or taken action that contributed to building their adaptive capacities through the “no regrets” approach. The most common and effective actions are those that facilitate operational efficiency improvements and ensure the sustainability of operations regardless of whatever changes to circumstances and increases in risks that climate change might bring. Two of the four most common actions – water loss reduction and water demand management – are prevalent for water suppliers while the other two – infrastructure upgrades or expansion and disaster management – apply to both water supply provision and wastewater services management. Services providers also note the need to correlate disaster risk management and preparedness actions with those that address climate change impacts. Although actions are ongoing, constraints that services providers face to improve, expand and sustain them in terms of climate change include the lack of support from management and communities to make the necessary investments; lack of sufficient expertise; overlapping and uncoordinated plans of government agencies; and difficulty in prioritizing climate resilience actions due to uncertainty of impacts.
- For water services providers, building adaptive capacities and resilience to become climate change ready remains a process following the four-phase framework. Most services providers in the assessment were in the intermediate stage in which they were already implementing activities within each of the four phases. Only a few were in the development stage, increasingly undertaking structural and non-structural adaptation measures, and in the advanced stage, completing the four-phase cycle and continuing to build adaptive capacities.
- The availability of robust climate data, proper data analysis, and appropriate means to communicate the analysis results to decision-makers and communities are prerequisites for water services providers to integrate climate change considerations into their planning processes and operations on the way to becoming climate resilient.
- With limited resources and data, services providers recognize the value of the scenario planning approach in which they develop scenarios and risk-mitigation options based on available information and abilities to address climate-related risks.

- Water services providers emphasize that partnerships, for example with peer providers or the academic community, are key to overcoming the challenges to building adaptive capacities and resilience. Partners could demonstrate the process for awareness-raising, identifying and mitigating climate-related risks, using new tools and systems to mainstream climate change into planning systems, and taking structural and non-structural measures to adapt to climate change.

The assessment results also included an action agenda for water services providers in Asia to address climate change impacts. Table 8 summarizes the key actions and steps to become climate resilient under the readiness framework.

Table 8. Summary of Key Actions and Steps for Becoming Climate Resilient

Key Action	Possible Steps
Increase understanding of climate science and variability and their impacts to operations and services delivery	<ul style="list-style-type: none"> • Develop targeted messages for different groups using various communication tools and media channels • Involve “champions” to help disseminate information • Work with the climate science community to gather climate data • Dedicate a local team that can explain climate change information and adaptation measures to decision-makers and peers • Partner with other organizations and/or peer water services providers to support awareness raising efforts and advocacy
Strengthen climate risk identification and mitigation system	<ul style="list-style-type: none"> • Build strategic partnerships and collaborations to understand what to assess and develop better forecasting tools/methodologies • Engage the climate science community to translate the data and extract useful information • Partner with national/regional water associations such as the American Water Works Association, WaterLinks, and others
Help integrate climate change into planning processes	<ul style="list-style-type: none"> • Use Integrated Water Resources Management (IWRM) as a planning framework to integrate climate change • Create a climate services industry and engage the assistance of experts/peers to help institutionalize standard procedures for developing climate scenarios, forecasting impacts, and improving planning capabilities • Seek government support and create buy-in to plan for climate change including promotion of public-private cooperation • Establish a well-defined process for stakeholders to discuss and come up with a planning framework for decision-making • Find support and create partnerships with scientific communities and partnership facilitators
Improve targeted actions to address climate change impacts	<ul style="list-style-type: none"> • Engage senior management and politicians on understanding climate science and potential impacts to facilities and operations through study tours, twinning partnerships, continuous dialogue, etc. • Prioritize the implementation of planned actions into smaller activities to leverage management buy-in and support • Start with “no regrets” solutions that support operational efficiency improvements while at the same time build resilience • Strengthen disaster risk reduction programs/preparedness as part of climate change adaptation efforts • Form alliances with NGOs, consumer and business groups, and the scientific community to lobby for support from local governments

APPENDIX I

PROFILES OF PARTICIPATING WATER SERVICES PROVIDERS

Saigon Water Corporation (SAWACO)

Location	Ho Chi Minh City , Vietnam
Type	Public (municipal)
Telephone	+84 9 0391 1599
Fax	+84 8 38245848
Number of service connections	Households: 593,400 (69%) Commercial/Industrial: 180,600 (21%) Institutional: 86,000 (10 %)
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Groundwater
Water production capacity (m3/day)	1,570,000
Actual water volume produced (m3/day)	1,570,000
Actual water volume consumed (m3/day)	973,400
Wastewater volume treated (m3/day)	Not applicable
Water supply duration (hours/day)	24 hours/day
Number of staff	3,755
Number of facilities	1

Manila Water Company, Inc.

Location	Quezon City, Philippines
Type	Private (municipal)
Telephone	+63 2 9175900
Fax	+63 2 9285762
Number of service connections	Households: 807,770 Commercial/Industrial: 50,211
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Groundwater
Water production capacity (m3/day)	1,600,000
Actual water volume produced (m3/day)	1,276,000
Actual water volume consumed (m3/day)	1,133,000
Wastewater volume treated (m3/day)	135,000
Water supply duration (hours/day)	24 hours/day
Number of staff	1,600
Number of facilities	Water: 5 treatment plants; 46 pumping stations Wastewater: 38 sewage treatment plants

Korea Water Resources Corporation (K-Water)

Location	Daejeon, Korea	
Type	Public (national)	
Telephone	+82 42 870 7526	
Fax	+82 42 870 7549	
Number of service connections	Households: 40,000 Commercial/Industrial: 14	
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Surface water	
Water production capacity (m3/day)	17,462,400	
Actual water volume produced (m3/day)	6,049,077	
Actual water volume consumed (m3/day)	6,036,979	
Wastewater volume treated (m3/day)	364,000	
Water supply duration (hours/day)	24 hours/day	
Number of staff	4,072	
Number of facilities	Water: 40	Wastewater: 20

Phnom Penh Water Supply Authority (PPWSA)

Location	Phnom Penh, Cambodia
Type	Public (municipal)
Telephone	+855 977711115
Number of service connections	Households _____ Commercial/Industrial _____ (not provided)
Water sources	<u>Primary Sources</u> Surface water
Water production capacity (m3/day)	300,000 (initial)
Actual water volume produced (m3/day)	305,000 (improved)
Actual water volume consumed (m3/day)	287,160
Wastewater volume treated (m3/day)	Not applicable
Water supply duration (hours/day)	24 hours/day
Number of staff	600
Number of facilities	Water: 3

Indah Water Konsortium Sdn. Bhd.(IWK)

Location	Kuala Lumpur, Malaysia
Type	Private (national)
Telephone	+60 3 2780 1389
Fax	+60 3 2095 5110
Number of service connections	Households: 2,944, 879 Commercial/Industrial: 339,097
Water sources	<u>Main Sources</u> Surface water
Wastewater volume treated (m3/day)	4,284,939
Service duration (hours/day)	24 hours/day
Number of staff	2,856
Number of facilities	Public Wastewater: 5,749 (WWTP) Non-Point Sources: 892 Sewer line: 14,992 km

Maynilad Water Services, Inc. (MWSI)

Location	Quezon City, Philippines
Type	Private (municipal)
Telephone	+63 2 981 3481
Fax	+63 2 981 3481
Number of service connections	Households: 946,451 Commercial/Industrial: 58,899
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Groundwater
Water production capacity (m3/day)	2,500,000
Actual water volume produced (m3/day)	2,252,000
Actual water volume consumed (m3/day)	1,108,868
Wastewater volume treated (m3/day)	118,560
Water supply duration (hours/day)	24 hours/day
Number of staff	2,166
Number of facilities	Water: 3+ deep wells Wastewater: 4

Water Corporation

Location	Perth, Western Australia
Type	Public (state level)
Telephone	+61 8 9420 3006
Fax	+61 8 9420 2102
Number of service connections	Households: 857,815 Commercial/Industrial: 114,194
Water sources	<u>Main Sources</u> Groundwater, Desalinated Seawater, and Surface water
Water production capacity (m3/day)	Not defined
Actual water volume produced (m3/day)	983,548
Actual water volume consumed (m3/day)	885,852
Wastewater volume treated (m3/day)	410,400
Water supply duration (hours/day)	24 hours/day
Number of staff	3,015
Number of facilities	102 dams and weirs 490 water pump stations 266 water treatment plants 106 wastewater treatment plants

Metropolitan Waterworks Authority (MWA)

Location	Bangkok, Thailand
Type	Public (municipal)
Telephone	+66 2 504 0123
Fax	+66 2 503 9868
Number of service connections	Households: 1,580,000 Commercial/Industrial: 450,000
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Surface water
Water production capacity (m3/day)	5.50 million
Actual water volume produced (m3/day)	4.80 million
Actual water volume consumed (m3/day)	3.60 million
Wastewater volume treated (m3/day)	Not applicable
Water supply duration (hours/day)	24 hours/day
Number of staff	4,100
Number of facilities	Water: 4

PBA Holdings Berhad (PBAPP)

Location	Penang, Malaysia
Type	Private (state level)
Telephone	+60 4 2633736
Fax	+60 4 2633735
Number of service connections	Households: 449,892 Commercial/Industrial: 70,482
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Surface water
Water production capacity (m3/day)	1,386,843
Actual water volume produced (m3/day)	951,022
Actual water volume consumed (m3/day)	775,779
Wastewater volume treated (m3/day)	Not applicable
Water supply duration (hours/day)	24 hours/day
Number of staff	1,178
Number of facilities	Water: 81

Provincial Waterworks Authority of Thailand (PWA)

Location	Thailand
Type	Public (State Enterprise - national)
Telephone	+66 2 551 8320
Fax	+66 2 552 6039
Number of service connections	Households: 2,503,881 Commercial/Industrial: 657,869
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Groundwater
Water production capacity (m3/day)	3,929,232
Actual water volume produced (m3/day)	3,785,106
Actual water volume consumed (m3/day)	2,691,470
Wastewater volume treated (m3/day)	Not applicable
Water supply duration (hours/day)	24 hours/day
Number of staff	6,142
Number of facilities	Water: 231 waterworks

PDAM Tirtanadi Kota Medan, Indonesia (PDAM Medan)

Location	Medan, North Sumatera, Indonesia	
Type	Public (provincial)	
Telephone	+62 61 4571666	
Fax	+62 61 4572771	
Number of service connections	Households: 417,424 Commercial/Industrial: 42,009	
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Groundwater	
Water production capacity (m3/day)	518,400	
Actual water volume produced (m3/day)	512,818	
Actual water volume consumed (m3/day)	389,108	
Wastewater volume treated (m3/day)	10,000	
Water supply duration (hours/day)	< 24 hours/day	
Number of staff	1,200	
Number of facilities	Water: 11 units	Wastewater: 2

Public Health Engineering Department, Government of Rajasthan (PHED)

Location	Jaipur, India
Type	Public (state level)
Telephone	+91 1412222183
Fax	Not specified
Number of service connections	Jaipur City Households: 286,566 Commercial/Industrial: 42,446
Water sources	<u>Main Sources</u> Surface water and Groundwater <u>Secondary Sources</u> Surface water Groundwater
Water production capacity (m3/day)	500,000
Actual water volume produced (m3/day)	380,000
Actual water volume consumed (m3/day)	228,000
Wastewater volume treated (m3/day)	175,000 (South: 100 MLD; North: 75 MLD)
Water supply duration (hours/day)	< 24 hours/day
Number of staff	2,460
Number of facilities	Water : 101 (Overhead Reservoirs) Wastewater: 3 STPs in operation & another 2 are under progress

SAJ Holdings Sdn Bhd (SAJ) part of Ranhill Utilities, Johor Baru, Malaysia

Location	Johor, Malaysia
Type	Private (state level)
Telephone	+60 7 2255511
Fax	+60 7 2233611
Number of service connections	Households: 845,348 Commercial/Industrial: 122,193
Water sources	<u><i>Main Sources</i></u> Surface water <u><i>Secondary Sources</i></u> Natural spring water
Water production capacity (m3/day)	1.8 million
Actual water volume produced (m3/day)	1.6 million
Actual water volume consumed (m3/day)	1.1 million
Wastewater volume treated (m3/day)	Not applicable
Water supply duration (hours/day)	24 hours/day
Number of staff	1,924
Number of facilities	Water: 45

Public Utilities Board (PUB) of Singapore

Location	Singapore	
Type	Public (national)	
Telephone	+65 97897503	
Fax	+65 67313132	
Number of service connections	Households: 1,200,078 Commercial/Industrial: 102,912	
Water sources	<u>Main Sources</u> Surface water <u>Secondary Sources</u> Reclaimed water	
Water production capacity (m3/day)	3,226,011	
Actual water volume produced (m3/day)	1,903,179	
Actual water volume consumed (m3/day)	1,768,732	
Wastewater volume treated (m3/day)	1,529,000	
Water supply duration (hours/day)	24 hours/day	
Number of staff	About 3,100	
Number of facilities	Water: 13	Wastewater: 4

APPENDIX 2

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APPENDIX 3

SAMPLE SURVEY TEMPLATE

- Questionnaire for Water Services Providers in Asia -

Introduction

Water and wastewater services providers in the Asia-Pacific region are increasingly strengthening their capacity to better understand the climate change impacts to operations, assess climate-change related risks, and to manage those risks by integrating practical approaches into their long term plans. For services providers, assessments and plans must lead to practical actions that will ensure they are able to continue to deliver effective services in a changing and increasingly uncertain environment.

To help support water services providers in the Asia-Pacific region to adapt to climate change impacts through WaterLinks (www.waterlinks.org), Environmental Cooperation – Asia (ECO-Asia), a regional project funded by the United States Agency for International Development (USAID) have prepared this questionnaire for services providers to: (1) establish current levels of their “readiness” to adapt to and address climate change impacts; (2) define possible actions to improve future climate readiness; (3) identify capacity building needs for adaptation efforts; and (4) document good practices that contribute to building resilience against climate change impacts.

To recap, climate “readiness” can be defined as a process through which organizations strengthen their institutional capacities and take appropriate actions to anticipate and respond to the risks of negative impacts from climate change on their operational conditions and investment requirements. There are four stages in this process that is cyclical and repeated: **Awareness – Assessment – Planning – Actions** (see Figure 1).



Figure 1: The Sequence of Stages in the Climate Readiness Process

The development of this questionnaire follows the discussions at the Inception Workshop in November 2011 in Kuala Lumpur, Malaysia with selected services providers in the region. **Information collected from this questionnaire will be analyzed, verified and presented in consultation with all respondents at a regional workshop tentatively set for the week of 7 May 2012.**

Structure

The structure of this questionnaire reflects the sequence of steps in the climate readiness process set out in Figure 1. The questionnaire consists of the following:

- First section: profiles your organization.
- Second section: asks about the understanding and assessment of risks that your organization perceives as essential to your operations.
- Third section: asks about how your organization may be involved in the climate readiness.

Please complete each section of the questionnaire in discussion with relevant departments and colleagues within your organization.

Please send the completed questionnaire to XXXX

I. Brief Profile

Contact Information

Name of Company	
Location (City, Country)	
Type	<input type="checkbox"/> Public (e.g. municipal, provincial) <input type="checkbox"/> Private (e.g. concessionaire)
Contact Person	
Title	
Telephone	
Fax	
E-mail	

Profile

Number of service connections	Households _____ Commercial/Industrial _____
Water sources (please tick all boxes for water sources that are used)	<i>Main Sources</i> <input type="checkbox"/> Surface water <input type="checkbox"/> Groundwater <input type="checkbox"/> Natural spring water <i>Secondary Sources</i> <input type="checkbox"/> Surface water <input type="checkbox"/> Groundwater <input type="checkbox"/> Natural spring water
Water production capacity (m ³ /day)	
Actual water volume produced (m ³ /day)	
Actual water volume consumed (m ³ /day)	
Wastewater volume treated (m ³ /day)	
Water supply duration (hours/day)	<input type="checkbox"/> 24 hours/day <input type="checkbox"/> < 24 hours/day
Number of staff	
Number of facilities	Water _____ Wastewater _____

II. Risk Assessment

A risk is defined as the likelihood of an event occurring. In relation to possible climate change-related risks, water services providers need to assess a wide range of potential impacts to build their climate readiness. In other words, they need to know and systematically evaluate which risks they are getting ready for based on the best information available. In most cases, the climate change-related risks are not separate from other forms of risk that in any case may be present; climate change is likely to aggravate those risks that reflect the services provider's existing operating environment.

The list below presents a series of potential climate change-related risks to water services providers, based on an extensive literature review and as part of the outcomes of the November 2011 Inception Workshop. The risks can be categorized into four groups: (1) Hydrological impacts; (2) Changes to demand; (3) Physical/operational impacts; and (4) Planning/institutional failures

Please rank the risks in relation to their relevance or impact to your operations, infrastructure and/or management on the following scale:

- 0 = No risk:** where the factor is not considered to be of any risk
- 1 = Low risk:** where some risk exists but it is considered to be of low probability and/or impact
- 2 = Medium risk:** risks identified to have a reasonable probability of occurring and having a significant impact
- 3 = High risk:** risk with a high likelihood of occurring and representing a serious likely impact

Climate Change-Related Risks	Rank (0, 1, 2 or 3)
Hydrological Impacts	
1. Floods: increased incidence or severity	
2. Surface water: overall reduced availability or increased seasonal shortages	
3. Groundwater: overall reduced availability	
4. Reduced carrying capacity of rivers/water bodies for wastewater disposal	
5. Watershed: changes to the ecology/vegetation cover	
6. Saltwater intrusion/increased salinity of water supplies	
7. Deteriorating water quality	
8. Sea level rise	
Changes to Demand	
9. Increased demand from services provider customers	
10. Increased competition for water resources from agriculture and other sectors	
Physical/Operational Impacts	
11. Increased maintenance costs and/or complexities	
12. Damage to water supply and/or wastewater disposal facilities	
13. Increased power and/or other operational costs	
14. Increased costs and risks that affect capital availability and/or investments	
Planning/Institutional Failures	
15. Limited organizational capacity	
16. Poor coordination with other organizations	
17. Limited or inaccurate information on climate changes, impacts, hydrology etc	
18. Limited institutional mandate: no control over vital factors that affect the services provider's ability to improve climate readiness	

1. Are there other risks that you consider to be important that are not on this list? YES/NO

2. If YES, please list and rank them in the table below:

Climate Change-Related Risks	Rank (0, 1, 2 or 3)

3. Does your organization have a formal risk assessment process (for any risks)? YES/NO

4. If YES, please briefly describe the risk assessment process (including: how often it is done, who or what department is involved within your organization, and how are the results used for planning and operations).

5. Has this process been adapted or extended to include climate change-related risks? Yes/No

6. If Yes, please briefly describe the changes made to include climate change-related risks

III. Stages of Preparation for Climate Readiness

Since building climate readiness is a process, following the sequence of stages in Figure 1 (**Awareness – Assessment – Planning – Actions**), the details of what needs to be and can be done will vary from organization to organization depending on a number of factors as follows:

- The specific risks related to the likely impacts of climate change that the services provider faces.
- The nature of the existing services provider’s risk assessment and planning systems and processes.
- The enabling environment (local or national laws, policies, regulations) which the services provider has to follow and abide by, which may restrict possible actions or prevent coordination.
- The investment and financial constraints, placing limits on investments and the ability to expand capacity or services.

To better understand the level of and preparation for climate readiness, please provide information and ideas based on the following questions on the questionnaire below:

1. Are the listed Areas of Action relevant for your organization?
2. Is it possible to take actions in this area or does your organization have the mandate to act in this area?
3. Do you have any existing plans to take action in this area?
4. Have you taken any actions in this area?

Please remember to elaborate the description of each Action Area. We would like to collect information on the selected “best practices” that each services provider is doing or had done in each of the four categories.

Climate Readiness Areas of Action

Area of Action	Relevant for your organization	Within your organization’s mandate	Actions already planned	Actions already taken
Awareness				
1. Improve the understanding and/or awareness of climate-related risks in your organization and/or amongst other institutions/consumers	Yes/No	Yes/No	Yes/No	Yes/No
If <u>actions are already taken</u> , please describe briefly:				
2. Reach out to other stakeholders (for example universities, other relevant government departments) to become more aware of local/national climate change adaptation efforts, programs, policies or new developments in climate change impact studies	Yes/No	Yes/No	Yes/No	Yes/No
If <u>actions are already taken</u> , please describe briefly:				
3. Understand or investigate low cost, “ no-regrets ” adaptation activities (NOTE: “ no-regrets ” means that the services provider is taking actions that would improve overall operational efficiencies whether or not climate change occurs)	Yes/No	Yes/No	Yes/No	Yes/No
If <u>actions are already taken</u> , please describe briefly:				

Area of Action	Relevant for your organization	Within your organization's mandate	Actions already planned	Actions already taken
Assessment				
4. Improve predictive capabilities for climate and hydrological changes and for demand patterns	Yes/No	Yes/No	Yes/No	Yes/No
If <u>actions are already taken</u> , please describe briefly:				
5. Prepare scenarios that look at a range of possible futures and assess their implications for your organization	Yes/No	Yes/No	Yes/No	Yes/No
If <u>actions are already taken</u> , please describe briefly:				
6. Define the likely risks and vulnerabilities you will face in terms of climate change impacts, including assessing their probability and severity	Yes/No	Yes/No	Yes/No	Yes/No
If <u>actions are already taken</u> , please describe briefly:				
Planning				
7. Mainstream climate considerations in your planning process (NOTE: this means to integrate climate change issues into the main planning and decision-making process of the organization rather than to treat climate change as a separate issue. This can mean that climate change is not seen as an issue in itself, but rather as a driver of change for important issues such as water resources and natural disasters that are already planning concerns).	Yes/No	Yes/No	Yes/No	Yes/No
If <u>actions are already taken</u> , please describe briefly:				

Area of Action	Relevant for your organization	Within your organization's mandate	Actions already planned	Actions already taken
8. Improve inter-agency coordination (or within the organization) on developing adaptation plans or programs	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
9. Collaborate or coordinate with relevant government departments and sectors to plan strategies/actions that affect water resources and/or wastewater management	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
10. Strengthen institutional or organization capacity for identifying, planning and implementing adaptation actions	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
11. Generate community understanding and support	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
Action				
12. Reduce consumption and/or manage demand	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
13. Monitor, protect and improve the watershed and use vegetation to promote increase aquifer recharging	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
14. Reduce water losses (physical and commercial leakages)	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			

Area of Action	Relevant for your organization	Within your organization's mandate	Actions already planned	Actions already taken
15. Strengthen or upgrade water supply and/or wastewater treatment infrastructure	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
16. Increase reservoir storage capacity	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
17. Recycle waste or grey water	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
18. Find and extract additional groundwater sources	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
19. Improve or optimize water treatment capability	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
20. Improve or optimize domestic wastewater collection, treatment and management systems (including septage management services or septic tank desludging)	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
21. Desalinate water	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
22. Install flood barriers to protect infrastructure	Yes/No	Yes/No	Yes/No	Yes/No

Area of Action	Relevant for your organization	Within your organization's mandate	Actions already planned	Actions already taken
(for example: treatment facilities, intake, discharge, etc)	If <u>actions are already taken</u> , please describe briefly:			
23. Improve disaster management system (for example: remote monitoring, disaster management plan development, etc)	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			
24. Move facilities to higher ground	Yes/No	Yes/No	Yes/No	Yes/No
	If <u>actions are already taken</u> , please describe briefly:			

1. Are there additional Areas of Action that you consider relevant for your organization? YES/NO
2. If YES, please list and describe briefly below.

Action Area:	If <u>actions are already planned</u> , please describe briefly:
	If <u>actions are already taken</u> , please describe briefly:
Action Area:	If <u>actions are already planned</u> , please describe briefly:
	If <u>actions are already taken</u> , please describe briefly:

Thank you for taking the time to complete this survey.

- END -

**United States Agency for International Development (USAID)
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