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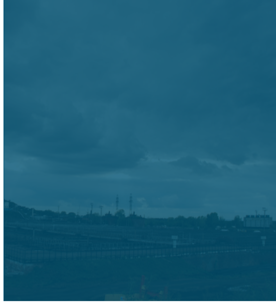


Climate Change and Urban Water Utilities: Challenges and Opportunities

The impact of climate change is increasingly important for the design, construction, and maintenance of water sector infrastructure. Average global temperatures are on the rise, causing cycles of extreme weather: droughts and flooding are becoming common; seawater levels are rising; and many locations are considerably drier, impacting water sources such as lakes and rivers. Groundwater supplies are under stress due to decreasing precipitation rates and increasing extraction rates. Urban water systems must meet the demands of expanding industry needs and rapid population growth. Pollution adds to the growing threats to water resources, increasing treatment requirements for providing safe water to city residents.

With two-thirds of the world's megacities located in regions that are vulnerable to the impacts of climate change, urban water utilities are facing an increasing need to improve the management of water resources and associated infrastructure. Diversifying sources of water supply will become increasingly important whether through the construction of new storage facilities, the appropriate and sustainable extraction of groundwater, water trading or conservation, or the use of recycled or desalinated water.

This Water Note, based on the input of 20 large utilities around the world presents the perceptions, experiences, and approaches to addressing climate related challenges of urban areas in developing, middle income, and developed countries (figure1).

Climate Change and Water Utilities

Even without climate change, urban water utilities face operational stresses—those in developing countries cope with basic issues of water management and service delivery, while in the developed world they face the challenge of repairing or replacing aging infrastructure. Dealing with a host of pressing short-term issues often interferes with a utility's ability to plan for future impacts associated with climate change.

Yet climate change is forecasted to render current operational designs of water infrastructure obsolete, given that maximum and minimum flow requirements will be exceeded or not met as a result of extreme weather events or droughts. Planning, so far, has been based on historic levels of water

Figure 1. Location of Participating Water Utilities

The following P-note summarizes key points of the Working Water Note 24, *Climate Change and Urban Water Utilities: Challenges and Opportunities*, by Alexander Danilenko, Eric Dickson, and Michael Jacobsen. The document was published in 2010 by the Water Sector Board of the World Bank Sustainable Development Network. Readers may download the complete document from www.worldbank.org/water.

availability and consumption, even though climate change is causing important shifts in these patterns. Thus, in the short-run, disruptions to service caused by climate are most frequently addressed through unpopular demand management strategies like rationing and service interruptions, which decrease revenues *and* increase costs of operation.

As a result, much so-called *planning* for dealing with climate related issues has been ad hoc in nature and not necessarily coordinated, nor based on sound principles of Integrated Water Resource Management (IWRM). While improvements do get made to existing systems, more comprehensive planning is needed to address the long-term economic, social, and environmental impacts of climate change.

Reality Based Analysis

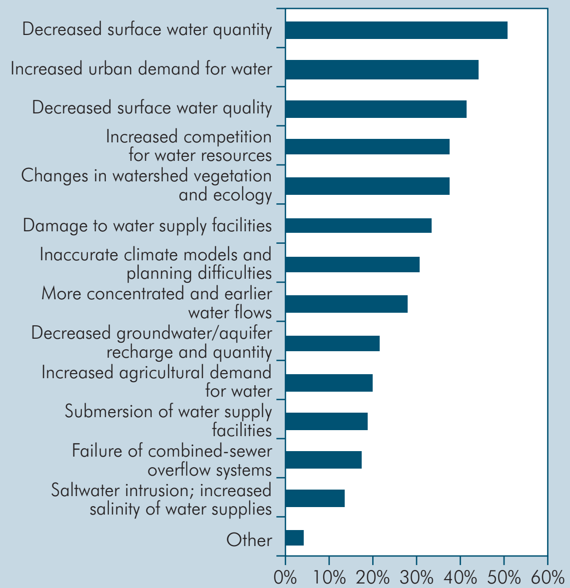
In an effort to document current trends and identify future requirements for dealing with the challenges of climate change, 20 large utilities participated in the global study highlighted in this Water Note. These were selected according to criteria such as the intensity of the climate risk they face, the size of the city they serve, and their ability to provide data on the current state of their water infrastructure in terms of key indicators (total water consumption, operational cost, rates of tariff collection, non-revenue water loss, etc.). The survey showed that:

- 80 percent of the utilities had already experienced severe droughts, and half had endured severe rain events. The utilities identified their greatest problems as decreased surface water, increased urban demand for water (for industrial and household use), and decreased water quality (figure 2).
- More than 30 percent of the utilities raised concerns about the limited accuracy of climate modeling for their long-range planning, while the vast majority of utilities' responses to climate change have relied on short-term strategies to reduce water consumption, improve watershed management, and reduce non-revenue water losses rather than focus on comprehensive planning for the long-term consequences of climate change.

The first step for a utility to meet the water resource and service challenges posed by climate change is to assess the vulnerability and adaptive capacity of existing systems to its effects. There are two common assessment approaches: the *top-down* approach utilizes General Circulation Models (GCMs) of climate patterns to determine the implications for local water systems. It is difficult, however, for such models to predict the micro-level impacts of these global climate models on localized water catchments, especially since the data required for accurate forecasting is often incomplete or even non-existent. The *bottom-up* approach addresses that issue: utilities use their own water resource planning models to assess their critical vulnerabilities to climate change. Extrapolating from the general findings of climate change research, utilities can identify the likely effects of climate change on their particular situation so they can begin defining appropriate solutions.

There are, however, inherent uncertainties associated with forecasting future water demand in urban areas due to changes in urbanization rates, employment, technology, population, irrigation and industrial demands, consumer behavior, and overall economic development. With this in mind, managing future risks becomes yet more important for all medium and long term planning. Inter alia, this applies to the introduction of new technologies, whether for water intake, distribution networks, household use, or wastewater treatment.

Figure 2. Exposure to Potential Climate Change Impacts



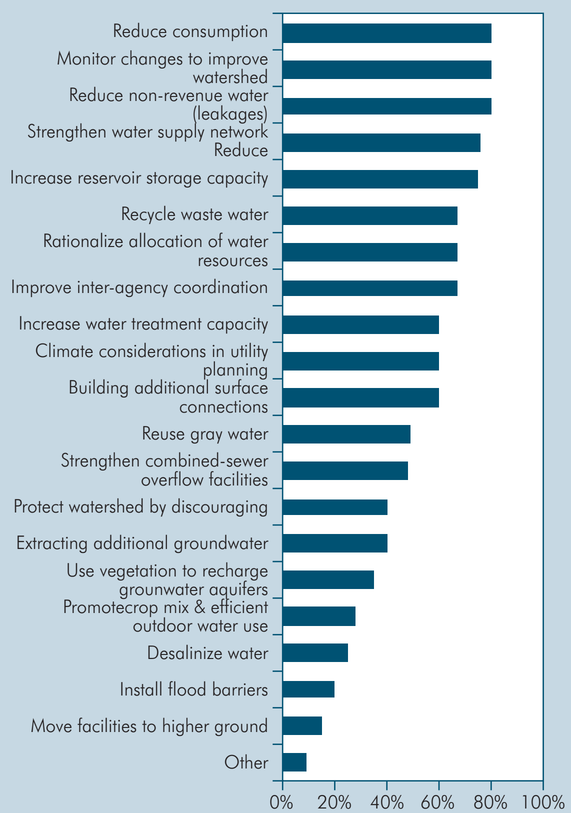
Utilities Taking Action

The key difference between forecasting with and without climate change is that the latter introduces fundamental uncertainty into the forecast. In response, the participating utilities in this study are responding through unique combinations of measures (Figure 3). These are covered at length in the full report, with descriptions of each utility and its climate-change activities.

To help manage this uncertainty, planners are distinguishing between two key types of measures to help drive decision-making and build the public and institutional support needed:

- ***No Regrets* Policy/Strategy/Measure**. The Intergovernmental Panel on Climate Change defines this as "A policy/strategy/measure that would generate net social and/or economic benefits irrespective of whether or not anthropogenic climate change occurs."

Figure 3. Actions Taken by Utilities to Address Climate Change



Many of these options have an inherent value to the utility and its customers, regardless of climate change. In many cases it is not a question of whether or not to implement a policy (or a measure), but the degree.

- **Climate-justified Strategies**. *Climate justified* investments are beneficial only if climate change impacts actually do occur and the overall benefits of taking a specific action exceed the marginal cost (based on a cost-benefit analysis). Undertaking such analyses can serve as a major input into the formulation of climate action plans for short and medium terms.

Searching for Solutions: Framework for Adaptation

From the experiences of the participating utilities, a two-stage framework for adaptation to climate change is recommended—one that indentifies the risk factors to existing water systems and then assesses the technical and institutional complexity of adapting to those risks. Adaptation measures are classified by how they respond to five areas: climate monitoring; water availability; water quality and distribution; wastewater collection; and wastewater treatment and effluent discharge. To screen adaptation measures for potential effectiveness and feasibility, five criteria should be considered:

1. Is the *no-regrets* categorization applicable?
2. Is the measure controlled by the utility?
3. Is the level of technical complexity realistic for the utility?
4. Is the measure financially feasible?
5. What are the institutional complexities of implementing each action?

Climate monitoring is fundamental for every level of decision-making. It provides the necessary data to assess the impacts of climate change as well as the effectiveness of the adaptive measures taken. Adaptation actions should be monitored with system vulnerabilities defined and a baseline established, so actions and strategies can be tracked over a period of time to assess progress towards predetermined targets. For optimal efficiency, monitoring should measure:

- Hydrologic patterns and quality of pertinent water resources;
- Water systems sustainability;

- Demand for water services and the effects of demand management;
- Relative efficiency and cost of water utility operations and service; and
- Quality of wastewater operations and monitoring; and
- Adequacy of existing water treatment.

Building on the regrets framework, the report presents a comprehensive set of examples that utilities may consider defined by the technical, institutional and financial complexity of the proposed measure and the extent to which it is controlled directly by the utility. The various actions are further categorized by focus area and include: climate monitoring, water availability, quality, and distribution, and wastewater collection, treatment and discharge.

Conclusions: Creating Opportunities and the Role of the World Bank

Resources must be strategically targeted to undertake climate vulnerability assessments and utility specific climate action plans in order to begin streamlining adaptive responses. Care must also be taken when considering climate change and its impact on urban water services, that it does not become a justification for overdesigning capital projects and seeking unwarranted financing in the name of adaptation. As the survey of 20 urban water utilities suggests, urban water services can strengthen their capacity to implement climate adaptation measures, but it will require that a utility consider how factors outside traditional operations (such as spatial development, pollution control, and solid waste and storm water management) may influence service delivery.

In preparing for climate change, utilities may consider a number of priority areas, such as: intelligent and flexible infrastructure design and operation; technology to monitor and assess efficiency improvements and demand management; increased uncertainty and risk-based project economic analysis; and the financing of adaptation, such as risk insurance for systems and for customers, notably the poor.

The implications of climate change may strongly affect the development impact of World Bank projects in the urban water supply and sanitation sector. Similarly, climate change can reduce a nation's capacity to recuperate economic and financial losses incurred from related impacts. In the short term, the World Bank is well-positioned to facilitate knowledge exchange and disseminate emerging best practices. This will advance the objective of strengthening urban water utilities' capacity to undertake climate vulnerability assessments, improve monitoring of technical and financial performance, and prepare viable climate action plans.

Sample

Climate Monitoring	Technical Complexity	Financial Complexity	Institutional Complexity	Regret	Measure Controlled By
Establishing Monitoring System for Climatic Effects	Low	Low	Low	No-regret	National authorities / utility
Downscaling of the GCM	Medium	Medium	Low	Climate justified	utility
Water Availability	**Technical Complexity**	**Financial Complexity**	**Institutional Complexity**	**Regret**	**Measure Controlled By**
Demand Management	Low	Low	Medium	No-regret	Utility
NRW Reduction	Medium	Medium	Low	No-regret	Utility
Water Metering	Low	Low	Medium	No-regret	Utility
Water Tariffs	Low	Low	High	No-regret	Utility
Consumer Behavior and Low Water Use Appliances	Medium	Medium	Low	No-regret	Consumer / Utility
Integrated Water Resources Management	Medium	Medium	High	No-regret	External stakeholders
Diversification of Water Resources	Medium	High	High	Climate justified	Authorities, utility and external stakeholders
Enhancing Storage Capacity	Medium	High	Medium	Climate justified	Authorities, utility and external stakeholders
Water Reuse and Desalination	Medium	High	Low	Climate justified	Utility
Adjustment to Operation Below Design Capacity	Medium	High	Low	Climate justified	Utility
Water Availability	**Technical Complexity**	**Financial Complexity**	**Institutional Complexity**	**Regret**	**Measure Controlled By**
Aquifer Recharge Using Recycled Water	High	High	High	Climate justified	Utility / External stakeholders
Relocation of Flooded Infrastructure	Medium	High	Medium	Climate justified	Utility
Market Based Instruments	Medium	Medium	High	No regret	Authorities, utility and external stakeholders
Water Quality	**Technical Complexity**	**Financial Complexity**	**Institutional Complexity**	**Regret**	**Measure Controlled By**
Protection of the Water Resource	Low	Low	Low	No-regret	Authorities, utility and external stakeholders
Integrated Water Resource Management	Medium	Medium	High	No-regret	Authorities, utility and external stakeholders
Water Distribution	**Technical Complexity**	**Financial Complexity**	**Institutional Complexity**	**Regret**	**Measure Controlled By**
Reduce Effects of Weakened Surface Crust on the Network	Medium	High	Low	Climate justified	Utility
Adjustment to Operation Below Design Capacity	Medium	High	Low	Climate justified	Utility
Wastewater Collection	**Technical Complexity**	**Financial Complexity**	**Institutional Complexity**	**Regret**	**Measure Controlled By**
Protection of Sewers from Overflow	Medium	Medium	Medium	Climate justified	Utility
Adjustment of Hydraulic Systems to Floods	Medium	High	Medium	Climate justified	Utility
Wastewater Collection	**Technical Complexity**	**Financial Complexity**	**Institutional Complexity**	**Regret**	**Measure Controlled By**
Reduce Effects of the Weakened Surface Crust on the Network	Medium	High	Low	Climate justified	Utility
Adjustment to Operation Below Design Capacity	Medium	High	Low	Climate justified	Utility
Relocation of Flooded Sewers	Medium	High	Medium	Climate justified	Utility
Wastewater Treatment & Effluent Discharge	**Technical Complexity**	**Financial Complexity**	**Institutional Complexity**	**Regret**	**Measure Controlled By**
Adjust Treatment Technology to New Effluent Composition	Medium	Medium	Medium	Climate justified	Utility
Adjust Treatment Level to Dilution Capacity of Discharge Point	Medium	High	Low	Climate justified	Utility
Relocation of Flooded Wastewater Treatment Facilities	Medium	High	Medium	Climate justified	Utility

WATER PARTNERSHIP PROGRAM

The Water Sector Board Practitioner Notes (P-Notes) series is published by the Water Sector Board of the Sustainable Development Network of the World Bank Group. P-Notes are available online at *www.worldbank.org/water*. P-Notes are a synopsis of larger World Bank documents in the water sector.

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