

# Climate Change

## A Strategic Opportunity for Water Managers

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Water-related impacts associated with climate change are already evident in every part of the globe,<sup>1</sup> so water utility managers are faced with new challenges in providing the essential services on which the public relies. What types of skill sets and relationships must water resource organizations nurture to address the risks and opportunities associated with climate change? There is a strong tendency among water managers to rely on proven approaches and historical precedent because those approaches have worked in the past and are viewed as “safer” within the industry. But there are almost always multiple paths forward to address problems; some just require more persistence, innovation, and resources than others. The critical factor is to *embrace change* and expand adaptive capacity to prepare for change in building resilience as part of a professional code of conduct instead of relying solely on existing approaches.

The delivery of essential services while managing risks is the fundamental task of water resource managers, who have always worked in an uncertain environment. Their job is to make sure that water continues to flow through the taps in people’s homes and businesses, and critical infrastructure remains intact, despite floods, fires, droughts, freezing temperatures,

and heat waves. Water managers have always made decisions about the design and operations of water systems, reservoirs, and treatment plants without perfect information. They have not known how fast their community would grow, how much economic growth or contraction would occur in their area, or how much rain would fall in a given year. And they have always had to hedge their bets to protect public health and ensure a reliable water supply in the face of climate variability and numerous other sources of variability. Some of the sources of variability include changes that derive from the choices humans make, such as demographic shifts and changing economic patterns, as well as changes in natural systems, such as in the snowpack, ocean currents, and environmental water demands.

Historically, the tools for managing hydrological risk included reservoirs for flood control and water supply (to even out the peaks and troughs in precipitation and runoff), conservation (to limit peak or total demand), and a range of augmentation options, including importing water, the treatment and reuse of municipal wastewater, harvesting stormwater and storing it underground for future use, and desalination. The future, however, may require a broader set of water management tools, including more flexible institutional and regulatory arrangements. This is partly because of climate change, but also because many other factors are changing more rapidly than they did in the past. The combined effects of rapid changes in economies and land uses, in demographics and personal preferences about water use, and changing regulatory conditions and water rights issues, paint a picture of increasing sources of uncertainty even in the absence of climate change. The new reality is that climate change, which the U.S. Department of Defense has characterized as a “threat multiplier,” will lead to unanticipated feedbacks and new and amplified sources of both risk and opportunity.

Although demands on the twenty-first-century water manager are in many ways similar to those that faced water managers in the twentieth century, climate change does bring a new array of challenges and opportunities. One way to get beyond traditional training and work toward a future that is more prepared for both is through partnering with other utilities, as well as through working with local universities and research

networks. The opportunities that partnerships bring are dramatic and can be very useful in managing risk and encouraging innovation.

### **Adopting a Risk Management Framework**

Managing risk is about managing perceptions as much as it is about managing the “real” risks that might be identified by experts. Though many Americans are not convinced that climate change is real or that it is caused by humans, that is not a good reason to ignore it. The failure to acknowledge the implications of climate change increases the risk of system failure for water managers. Especially for those who are operating in the “reality gap” (that is, working with customers or board members who are not willing to consider the scientific evidence of climate change), one approach is to frame decisions in the language of due diligence and risk management. For example, even if there is only a small chance that change climate is occurring, being wrong can have serious consequences. Properly applying a risk management framework means that all risks need to be considered, especially those with severe consequences, even if there is a low probability of a particular extreme event occurring. This explanation should provide sufficient space to permit consideration of climate change in the context of varied political perspectives. Being prepared for a wide range of future conditions is simply best practice for water managers.

Given that 97 percent of climate scientists agree that climate change is already occurring,<sup>2</sup> and that changes in the water cycle have been documented on every continent,<sup>3</sup> water utility managers are on the front line of the climate conversation. Acknowledging the human-caused component of climate change is important, particularly in the context of longer-term decisions. This is because the human influence alters the nature of the future we need to be prepared for. For example, if we were to assume that every change we are now observing is due to natural variability, then we would expect a return to normal or historical average conditions as we understand them. This has totally different implications for long-term water management than acknowledging that there is a driver

of change (increasing total energy in the Earth's atmosphere) that is pushing the system out of equilibrium and potentially outside the envelope of historical variability. Understanding the changes we are seeing through this second lens tells us that the impacts we are now observing are likely to escalate over time unless total global emissions actually decline in the near future, which seems unlikely.<sup>4</sup> Understanding that there is a trajectory of change rather than simple variability around a "normal condition"—in other words, understanding that stationarity is dead<sup>5</sup>—leads to a very different kind of approach for a water resource manager.

## Water and Climate

The water cycle integrates social, environmental, and physical systems in multiple ways. Alterations in the water cycle are driving the impacts of climate change through changes in snowpack, precipitation, flooding, seasonality of runoff and other events. For example, a reduction in total snowpack (due to more rain and less snow) and earlier snowmelt are having significant impacts on water-supply conditions across the U.S. West—in California, the Pacific Northwest, and the Colorado River basin. More intense precipitation has been observed in every region of the United States,<sup>6</sup> even in places where the total rainfall is declining. More intense heat and drought conditions have also been linked to climate change in multiple parts of the country. These changes have a range of cascading effects on ecosystems, water supply, water quality, flood control, and economic sectors such as forestry, agriculture, and coastal and marine systems. Of course, there have been floods and droughts in the past, but the combination of the social, ecological, and physical changes that are occurring now means that the pace of change is accelerating and the challenges for water managers are also growing.

What does "stationarity is dead" mean in a water management context? It means changes in average conditions are occurring, but, more important, it means changes in extremes, which could have dramatic consequences. It means that historical conditions are no longer a reliable basis for future planning and that static standards, such as engineering

rule curves for dam operations or intensity/duration/frequency curves for sizing drainage systems, are no longer optimal. It means more uncertainty, perhaps more variability, but also the opportunity to think broadly about water-supply reliability and the secondary implications for the full range of water resource management business practices, planning approaches, and decision-making processes, in the context of a range of other factors.

Climate is a driver of water-supply conditions, and changes in snowpack, temperature, and precipitation intensity, seasonality, or volume lead to a wide range of potential risks that ripple across economic sectors and communities. These changes affect demand for water, assets and infrastructure of utilities, and the capacity to provide reliable services, but they also have implications throughout and beyond the water sector. They affect energy supply and demand, agricultural productivity, and both natural and urban systems. The crosscutting, multifaceted implications of climate change mean that water resource managers will not only need to consider the associated technical and scientific issues but will also need to engage in understanding and managing the strategic, policy, political, and organizational implications of climate change across multiple sectors as well. It is imperative that water resource managers reimagine their roles and responsibilities in light of the challenges of a changing climate.

## **Institutions and Water Governance**

Institutions, rules, regulations, and operating procedures (collectively known as the “decision context”) can be a way to facilitate better outcomes. In many cases, however, the decision context is a serious constraint on available management options. The multiple layers of regulatory authority and intersecting and overlapping jurisdictions in the water world result in complex water governance in most regions of the United States. For example, there may be as many as 5,000 water management entities in the state of California.<sup>7</sup> There are advantages to some of this institutional complexity—institutions do provide stability and certainty in many cases—but complexity can also limit flexibility to respond in a rapidly changing world.

The long-lived implications of many water management decisions, such as constructing flood-control or water-supply infrastructure, also affect the options available to water managers. Though significant complexity in the legal, institutional, regulatory, and policy environments constrain the solution options that are available, there are important benefits to constraining the options. For example, water rights systems protect existing investments while limiting access of new users to water supplies. There are also some well-designed regulatory systems that explicitly constrain current options in order to provide future flexibility in times of severe shortages, such as the shortage-sharing criteria for managing the reservoirs on the Colorado River.<sup>8</sup>

The climate is not the only thing that is changing; the expectations of society are changing too. In some cases, changing societal values can be seen in the reallocation of water supplies and new challenges for water managers. For example, water that is now dedicated to tribal water settlements might previously have belonged to an irrigation district or a city. In Arizona, roughly half of the annual allocations of Central Arizona Project water have recently been dedicated to Indian water rights settlements.<sup>9</sup> Flow requirements to protect fish species in the San Francisco Bay–Sacramento–San Joaquin River Delta region have also affected California’s water supplies in recent decades. Changing recreation patterns affect seasonal demands for water, including pressure for more in-stream flows in the summer. And changes in cropping patterns, for example more irrigation of agriculture in the Midwest and Southeast, are also affecting water-supply availability for the environment and other water users.

Further, water systems do not function in isolation from other systems. For example, they are strongly tied to and dependent on the energy grid. This is primarily because pumping water requires enormous amounts of energy (the California State Water Project is the largest single user of energy in the state) but also because most modes of generating electric power require substantial amounts of water. There are multiple implications of this interconnectedness, but in a risk management context it is most important to understand that there can be cascading effects of a failure in one part of a linked system. For example, if the energy grid or the

communication system goes down in an extreme event, water availability may also be curtailed. Understanding the potential points of failure in the water system means understanding a much broader array of topics than has historically been the case and preparing for new kinds of risk, such as the risks that can cascade across interdependent “lifeline” sectors.

### **Implications of Politics and Public Perceptions**

Even though at first glance a lot of the rules and regulations in place today do not make sense, there is almost always a historical rationale for their existence. Understanding which rules and regulations are truly obsolete and which are actually linchpins in a broader set of protections for the public or the environment requires very sophisticated analysis. These subtleties often are not well understood by stakeholders, who may gravitate toward solutions that are difficult to implement from a technical, legal, or economic perspective (“Why not build more dams to control storm runoff rather than wasting it?” “Why can’t we do more with desalination?”). Some solutions that seem obvious to water management professionals are likewise nonsensical to the public even if they are technically feasible, for example, toilet-to-tap approaches to reusing municipal wastewater, or investments that might “strand assets” for a significant period of time while also providing a range of other benefits in the near term.

If climate change is seen as a lens through which to view the future, it allows the reframing of issues that have needed to be reconsidered for a long time. This reframing can help water managers and other decision-makers who historically have been isolated from broader policy discussions to enter the conversation for the first time. For example, a broad risk management strategy in a climate change context almost always requires discussion of land use, energy supply, public health, and environmental quality. The highly complex and integrated nature of climate change impacts means that discussions about solutions require an interdisciplinary and wide-ranging set of considerations. These broader conversations have led to very different kinds of planning for the future in places like New York, where “asking the climate question” has led to a much more integrated

approach to planning across agencies and disciplines. The disaster resilience community has also embraced a broader view of preparation for and recovery from extreme events. For example, the Housing and Urban Development Disaster Resilience Competition,<sup>10</sup> required an interdisciplinary, intersectoral approach to planning. In activities related to climate adaptation promoted by the National Oceanic and Atmospheric Administration (NOAA) and Department of the Interior (DOI) federal science networks,<sup>11</sup> there is evidence that climate change discussions open doors to new ideas and more inclusive approaches. Seattle's experience provides good evidence that planning for the long term also has short-term benefits, in part because the climate impacts projected long into the future are arriving more quickly than expected (see box 1-1).

### **New Solutions in a Changing World: The Role of Partnerships**

Tactics to enhance understanding and to assess the nature of climate change and its impacts on the water cycle and water resources include establishing collaborative relationships with the climate research community and strengthening peer-to-peer learning networks between utilities. Building relationships with the climate research community is one useful way to gain access to the best available science regarding how climate change may play out in the geographic area where a utility operates, without needing to employ a whole team of climate modelers. These relationships can and should allow for two-way conversations, serving as a means for researchers to disseminate relevant research and reports to utility managers but also allowing a reality check on that information as utility managers provide feedback on the topics and the usefulness of the outcomes. Funding university researchers to conduct original research to address specific information needs identified by the utility manager is one way to build these relationships. Investments in working with local research universities can reap greater rewards if the relationship between the utility and the researcher is maintained over time, enhancing both trust in the results and the ability to do longitudinal studies. There are also numerous cases in which utilities have collectively funded researchers



**BOX 1-1****Seattle: Managing Changing Hydrological Conditions**

For Seattle Public Utilities (SPU), the winter of 2015 foreshadowed what climate conditions might look like in the future. When observed temperatures in 2015 were compared with a range of projected temperatures for 2050 derived from downscaled climate models, the temperature in the winter of 2015 was at the warmer end of the projected temperatures; observed precipitation levels were also at the drier end of the range of climate projections. The exceptionally warm temperatures led to record low levels of snowpack. Recognizing the implications of these conditions, SPU shifted its operations from flood control to reservoir refill earlier than it typically would have. Dynamic reservoir management is an operational adaptation strategy that may have to be increasingly deployed by water managers as they strive to meet their multiple responsibilities and objectives in light of a changing hydrograph driven by climate change. While dynamic management can be a critical component of an adaptation strategy, utilities will most likely need to evaluate a full suite of adaptation options to develop a robust water management strategy in the face of climate change.

to respond to questions that have relevance to many parties, for example, through the Water Utility Climate Alliance.

When utilities and researchers decide to enter into cooperative agreements to pursue research, it is critical that both the utility and the researchers be clear about their own objectives and about the needs and expectations of both parties. Historically in such endeavors, many unexpected challenges have arisen because of a failure to establish clear expectations. For example, while university-based researchers must publish their work in journals, utility managers may prefer not to have their climate-related risks and vulnerabilities characterized by researchers in journal articles, especially if they are not part of the author team. Most water managers are not focused on publishing a peer-reviewed article as an outcome of their work. Rather, they are typically looking for a technical report pertinent to their information needs, and they may or may not support releasing the information publicly. In effect, water utility managers and researchers need to determine whether their research

relationship is a consultant-client relationship, which utilities are most accustomed to, or a funder-researcher relationship, which is probably what researchers are most accustomed to. Clearly establishing the basis of a research arrangement and the various roles and responsibilities before the research begins will help manage expectations and avoid potential conflict.

Increasingly, the relationship between utilities and researchers is being viewed not as a one-way flow of information but as a two-way dialogue based on the coproduction of knowledge. With this framing, the applied and tacit knowledge that utilities have of their own systems is coupled with the deep science-based knowledge researchers have of projected climate change to coproduce knowledge that leverages the best of both kinds of information. Coproduction relies on joint learning, which usually means focusing research on the applied information needs of the utility so that the user of climate research is also the shaper of that research.<sup>12</sup> This requires both utilities and researchers to rethink their roles in the scientific enterprise. The utilities' role requires that they become adept at identifying and articulating their needs and be able to disclose and frame their system knowledge in the context of climate change as well as be able to conduct some of the analysis itself. Meanwhile, researchers must be responsive to the information needs of utilities, be willing to deviate from a predetermined research agenda, and learn how to translate their technical findings in a manner that resonates with the utility. Robust and meaningful utility engagement in coproduction may require that the utility conduct an honest assessment of its capacity to sustain this type of engagement over time and a determination of whether it has the personnel with the right skills to lead this effort.

Generating climate information based on user needs and developing and sharing findings with decision-makers is an example of how to provide climate services in a co-production mode. While efforts have been made to establish a national climate service for the United States, those efforts have not borne fruit for a number of reasons, including politics and economics. Short of a full-blown climate service, which seems unlikely to materialize in the near future, there are numerous federal and university-based research initiatives that water utilities can tap into to enhance their

understanding of climate impacts. NOAA's Regional Integrated Science Assessments (RISA) program and the DOI's Climate Science Centers (funded through the U.S. Geological Survey) are two of the leading applied federal climate research programs. Several other federal databases and tools exist, many of which are included in the U.S. Climate Resilience Toolkit created by the White House Office of Science and Technology Policy.<sup>13</sup> A particularly relevant example is the U.S. Environmental Protection Agency's CREAT tool, which assists water utilities in understanding climate impacts on their systems.

Collaborative relationships with the research community are only one approach to accessing climate information to support risk management efforts. Strengthening peer-to-peer learning and collaborative research projects with other utilities can open other paths to innovation. Sustained peer-to-peer learning provides an unrivaled opportunity to enhance understanding of climate-related challenges and develop approaches for managing them. It is clear that the trusted relationships that exist within professional societies are an excellent means of conveying information in ways that are useful, timely, and credible to water managers. Often, these approaches provide the professional "safe space" in which to explore new ideas without taking the personal risk often associated with unusual or untested ideas.

### **The Social and Economic Components of Climate Impacts: An Opportunity for Reframing**

Utilities need to be proactive in preparing for future changes and to manage risk. There are multiple components to anticipating future conditions and being resilient that extend well beyond projections of future water-supply conditions. They include robust communication strategies (internal and external); infrastructure investments; understanding the demand side of the equation (how climate may affect demand for water, for example); and the potential for behavior modifications, such as conservation; and robust approaches to strategic planning that consider a broad spectrum of plausible futures. Utilities must also consider climate impacts

through a service equity lens. The disproportionate impacts that climate change will have on different segments of society need to be understood and strategies to address those future impacts—and current inequities—need to be embedded into utility practices so that the essential services on which communities rely are equitable for all.

Understanding how climate change will alter the water cycle and how those alterations will physically affect supplies and resources is now an essential responsibility of an effective water utility. It is increasingly clear, however, that a water utility must also be comprehensively evaluating how climate change will affect its core functions—from strategy to financing to communications—to fully understand the implications of climate change and to be in the best position to manage the associated risks and leverage opportunities. In short, climate change should not be viewed as purely an environmental, technical, or water-supply challenge but as an issue that has crosscutting implications that must be understood by utility managers.

The intersection of water management and climate change brings additional considerations related to the role of water in supporting a wide range of economic sectors and activities. Climate change affects agriculture, electric power, forestry, transportation, industries, and recreational choices in a multitude of ways that may need to be considered when thinking about future water-supply needs, the potentially increasing competition for limited supplies, and changing demand patterns. It is now widely recognized that exported products contain “embedded water”; for example, grain or alfalfa that is grown in irrigated fields for export requires a certain number of gallons of water to be produced, processed, and shipped to a particular location. The globalization of the economy means that climate impacts that occur in one part of the world can affect production and product availability in other parts of the world. All of these considerations affect water management in one way or another.

One important way that perceptions around water and climate change are evolving is in how the risks of water crises and climate change are being characterized. For example, each year the World Economic Forum (WEF) issues an annual report documenting the top global risks from the perspective of 800-plus business, academic, government, and NGO leaders.

In 2015, water crises and the failure of climate adaptation were two of the greatest risks in terms of impacts and likelihood, with water crises being viewed as a societal risk rather than an environmental risk, as it was in the past. With the strong linkage between water crises and climate change, the inclusion of both these risks at the top of the list is telling.

The Risky Business Project, which documented the economic impacts of climate change in three different economic sectors in the United States, was instrumental in taking the extensive understanding of the physical impacts of climate change and translating it into economic impacts.<sup>14</sup> Although this project was necessarily limited in scope, the magnitude of the economic impacts of climate change within regions was dramatic. These findings, along with the WEF's framing of water crises as a societal risk, is an invitation for water managers to translate the myriad water-cycle impacts of climate change into something more meaningful for their constituents and board members: the potential economic costs to society of climate disruption of the water supply.

In a third recent example, the *Harvard Business Review*, in its April 2014 cover story, argued that being a resilient organization in the face of climate change requires rethinking corporate strategy.<sup>15</sup> The story refers to a big pivot in strategic thinking that emphasizes collaboration across the competitive landscape, the use of science to inform decisionmaking, and changes in valuation techniques. This reframing of climate change as a driver of fundamental repositioning rather than as just an environmental issue is echoed in a previous WEF Global Risk report from 2013. In that report, the term "climate smart mindset" was used to refer to the incorporation of climate considerations from the strategic level of an organization to the operational level.<sup>16</sup>

In light of this strategic and comprehensive framing of climate change in some quarters of the private sector, it is perhaps not surprising that climate change issues are now cropping up in the financial sector in ways that are of potential relevance to utilities. Some examples are the fossil fuel divestiture movement and the continued data gathering, surveying, and analytical activities of groups like the Carbon Disclosure Project. But closer to home for water utilities is the emergence of a significant increase in activity in the green bond or climate bond arena. HSBC, a large financial

services firm, projected that the issuances of green or climate bonds in 2016 would grow between 32 percent and 91 percent over 2015 levels.<sup>17</sup> Though such bonds are still only a small sliver of the total bond market, growing investor appetite for green or climate bonds indicates the emergence of a niche in which climate change and finance come together. In aggregate, these examples illustrate how climate change is increasingly being viewed through multiple lenses, from strategy to finance to operations, perspectives that a forward-looking water utility must be considering in addition to the physical impacts of climate change.

### **Climate Communications: More Opportunities for Reframing**

Another surprising area of opportunity is communicating climate change impacts to the public. The conventional wisdom is that climate change is an issue to be avoided when engaging with the public. For example, in the 2012 presidential election, climate change barely surfaced as an issue because strategists advised against it. While polling results on the issue certainly vary, polling in early 2015 indicated that this conventional view may be shortsighted. A *New York Times*, Stanford University, and Resources for the Future poll from late January 2015 noted that an overwhelming majority of the American public, including half of Republicans, support government action to curb global warming, and that the number of people who believe climate change is caused by human activity is growing.<sup>18</sup> The same three organizations examined Hispanic views on climate change and found that 54 percent of Hispanics polled listed global warming as extremely or very important to them personally and 67 percent felt they would be hurt personally if nothing was done to reduce global warming.<sup>19</sup> According to a Clinton Global Initiative and Microsoft poll, 66 percent of millennials say there is solid evidence the Earth is getting warmer and 75 percent say human activity is responsible for it.<sup>20</sup> And with respect to the last two polling examples, there is the potential to embed climate considerations into a water utility's hiring strategies by including a proactive stance on climate change in the recruitment of millennial and Hispanic populations. Owing to the utility sector's current issues

with an aging workforce, employee retention and recruitment will likely take on greater importance as utilities grapple with succession planning.

The most startling poll results are from a study funded by the Water Research Foundation. Led by Stratus Consulting, the project worked with Tony Leiserowitz of the Yale Project on Climate Communications to survey 1,000 people on their views of climate change and water utilities. Some of the results were: (1) 73 percent of the respondents agreed with the statement that climate change will have a significant impact on the water cycle; (2) water utilities were viewed as trustworthy sources of information on climate change impacts on local water systems by 71 percent of respondents, more favorably than environmental groups were viewed and nearly on par with local or state colleges and universities; and (3) 92 percent of respondents wanted water utilities to play a leadership role in helping their community prepare for the impacts of climate change.<sup>21</sup> In short, water utilities have significant reputational capital on the issue of climate change, and that capital is most likely largely untapped and underutilized.

All of these developments—the consideration of climate change as it relates to strategic, financial, and operational issues, the growing support for climate action in the general populace, the extensive trust and support that the general public has for water utilities on climate change—are playing out in the context of an aging, deteriorating, and underfunded water infrastructure in the United States. This brings us back to the argument that utilities need to engage with, at least initially: understanding how climate change will affect the water cycle, its impacts on the assets and infrastructure utilities manage, and its effects on the essential services they deliver. It is now an imperative for any forward-looking water utility to understand the nature of these climate effects now and as it plans to replace aging infrastructure and address investment backlogs. But utilities also need to move beyond the physical implications of climate change for their assets and services to explore the implications for other, related aspects of utility decisionmaking and business practices. Understanding how to leverage utility reputational capital and public opinions on climate change to facilitate support for those investments and strategically reframe climate change as an issue that affects all of a utility's core functions is an opportunity not to be missed.

## Conclusion

Historically, water management decisions have often been made in reaction to extreme weather events or based on historical patterns and statistics. For a wide array of reasons, proactive consideration of the implications of climate change presents new opportunities to make investments in water management that will provide multiple benefits to water utilities and their customers. The opportunities discussed here include the positive benefits of an introspective utility-wide look at “whole-system” (socioeconomic, physical, ecological) health in the context of communities and ecosystems, the potential for partnerships and peer-to-peer learning to encourage innovation, and new ways to approach climate change impacts in terms of both managing risks and seizing opportunities. Finally, it is clear from recent work in climate communications and the obvious linkages between water supply and the economic health of communities and ecosystems that water utilities are well positioned to provide leadership on climate resilience issues.

To seize the opportunities and to avoid as many surprises as possible, it is important that utilities proactively start evolving and reframing their roles and responsibilities in light of climate change. Fundamentally, this involves building adaptive capacity, either through drawing on staff knowledge or fostering new areas of expertise, activating professional knowledge networks (peer-to-peer, researcher-to-practitioner, and so forth), or developing long-term relationships with local research universities. This explicit and sustained commitment to reframing the roles and responsibilities of a utility is likely to help address the various challenges and opportunities posed by climate change, as well as make the communities served by these utilities more resilient to broader societal issues as well.

## Notes

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