Climate Change: Resilient Infrastructure or Infrastructure for Resilience?

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Recently I was invited to an informal dinner in Europe with investors and groups that interact with investors. I'm a freshwater scientist, working on climate change and water management issues for about 15 years. I had been seated across from a smartly dressed woman from southern Africa, affiliated with a group funded by British foreign aid to support resilient infrastructure in the region.

I was intrigued. Infrastructure is especially exposed to climate change risks. By its nature, infrastructure lasts a long time, but we typically evaluate success/failure and "sustainability" over much shorter periods. Worse, our ability to predict future impacts in a shifting climate with confidence and certainty is limited—especially for investments that interact with the water cycle, that require a quantitative evaluation framework such as engineering or economics, or that have low tolerance for failure. Climate models provide limited and often weak confidence and conflicting projections about conditions 10 years from now, much less 50 or 100. Worldwide, we see many pieces of twentieth-century infrastructure in cities, along rivers and on shorelines that no longer match their climate conditions. Some, like the Hoover and Glen Canyon Dams in the United States, require billions in retrofitting or demand adjustments in order to maintain their fit with current and emerging patterns.

Curious about the woman's work, I asked her, "What does resilience mean to your program?" She was eager for the question. "Resilience for us is about continuing to provide services even as climate conditions keep evolving, extreme events become more extreme, and we enter new and potentially unknown climate territory."

I nodded. "So resilience means that you're not just going back to normal but preparing for new normals?" She smiled: "You got it."

Most climate scientists would endorse her view. Southern Africa is trending towards less precipitation, though when rains come it is often in the form of serious flood events. Old operational and design "safety margins" are no longer sufficient when major cities such as Cape Town are experiencing droughts not seen for centuries. Worse, most definitions of resilience simply focus on returning to "normal" conditions after a disruption or shock rather than exploring how the overall system itself may be altering—how to track change rather than assuming a steady state.

Her answers also raise another significant issue: Do we fund projects that broadly build resilience for communities and ecosystems to reduce the impacts of climate change? Or do we ensure that *all* projects are themselves resilient to ongoing impacts, whether or not they provide broader resilience? In other words, do we need resilient infrastructure or infrastructure for resilience?

Of course, the answer must be both. But they also require different strategies. And new solutions are appearing, often in unexpected places.

Mexico City, one of the largest cities in the world with well over 20 million residents, sits in a sunken basin that 500 years ago was a lake and seat of the Aztec empire. Now the region is one of the driest major cities globally, dependent on groundwater and transfers from several surrounding basins. Extremely sensitive to floods as well as long-term declines in precipitation, city and regional administrative barriers work against a common solution.

Beginning in 2017, the World Bank has convened more than three dozen government and non-governmental groups to develop a common planning approach and vision for regional resilience that can be implemented across political and hydrological boundaries. Using an advanced approach called decision scaling to identify and prioritize climate and other types of risks, the taskforce works to understand the water system of the Valley of Mexico and its inherent limits—as well as how to reduce institutional and infrastructure vulnerabilities. Here, the emphasis is on infrastructure for regional resilience, at a planning scale to define long-term investment and management strategies. Mexico City's approach is extremely progressive by any standard.

Miami, Florida, is pursuing a similar approach that focuses more on resilient infrastructure. Here, flooding and more severe storms are the most visible threats, though uncoordinated growth, sea level rise and even droughts are also significant concerns. Testing a new methodology called the City Water Resilience Framework (CWRF), supported by the Rockefeller Foundation and The Resilience Shift, the global engineering firm Arup is helping Miami-Dade County's decision-makers define an integrated set of social, environmental and economic resilience indicators to help inform stakeholders and high-level decision makers about potential gaps and vulnerabilities, almost in real time. In effect, CWRF views water as both a systemic climate impact risk and a systemic climate adaptation solution, cutting across almost all regional departments and sectors and influencing day-to-day decision making.

In both Mexico and Florida, at both planning and operational scales, the emerging approach to defining resilience is to begin with the most important and most uncertain aspect of climate change: how shifts in precipitation, flows, recharge and other aspects of the water cycle may expose breaking points and vulnerabilities in water management decision making and stakeholder definitions of success and failure. Water is embedded throughout cities and sectors, not just in the utilities. Climate models come later in such a process—they can help evaluate credibility and likelihood. But comprehending the bottom-up risks and opportunities of current systems is most important.

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The United Nation's water science division (UNESCO-IHP, which is the International Hydrological Program) and the United States federal government's UNESCO research center (ICIWaRM, or the International Center for Integrated Water Resources Management) published in October of this year a complementary approach that spans both resilient infrastructure and infrastructure for resilience. Called CRIDA (*Climate Risk Informed Decision Analysis*; see http://AGWAGuide.org/CRIDA) the stepwise methodology is designed for engineering water decision makers interested in incorporating resilience into planning and operational decisions.

Reflecting on these trends with my dinner companion, I observed to her that southern Africa is facing the same kinds of economic development choices that the western United States navigated in the 19th century. Given scarce water resources, how do we grow from scattered farms and ranches to modern industrial, agricultural and service economies? In the United States, we chose to intensify water use, often concentrating investments in large projects. States like California and explosive urban growth in Los Angeles or Las Vegas show the fruit of that effort. But what happens when the climate exposes the flaws in our assumptions about that water? Perhaps they can learn from our past, even as we adjust course. ■

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