

Water Rising: Equitable Approaches to Urban Flooding



Preface

The year 2020 marks a significant moment for the nation's water security and the planet. Across the globe, there is a burgeoning call for climate action: from communities and youth to businesses, farmers, and others. Climate change is one of the greatest challenges of our time, and dealing with it is of the utmost importance for the One Water movement. Climate change is often felt through water—whether it's in the form of droughts, flooding, hurricanes, storm events, or rising sea levels. In the United States, climate impacts are compounding and tend to show up most profoundly in vulnerable communities.

Our waters are rising around the nation. Flooding is the most common, costly, and deadly disaster we face. From the record-breaking Midwestern floods of 2018 to the aftermath of Hurricanes Sandy, Katrina, Maria, and Harvey, the threats are growing and remain somewhat unpredictable. While climate models have improved, many utility resilience plans fall short in their consideration of social vulnerability and climate justice.

Yet the One Water community is rising to this challenge. Throughout the US Water Alliance network, there are promising examples of cities coming together in new and exciting ways. They are building upstream-downstream partnerships for flood control. They are retrofitting urban infrastructure to new design standards to withstand rising sea levels and changing precipitation patterns. They are working with residents, community-based organizations, and environmental groups to root solutions in equity and through ground-up approaches.

One thing is clear: Utilities and communities make better progress on flood management and other climate challenges when they work together. To this end, and with support from The Kresge Foundation, the US Water Alliance worked with nine cities around the United States to investigate equitable pathways to flood resilience. As a result, this report offers five priority actions to advance this work across the nation.

At the US Water Alliance, we are committed to bringing all stakeholders together to use the best available science, utility management, city planning, and frontline efforts to address climate impacts. Our cities are resilient when all communities have the capacity to prepare for, withstand, and bounce forward from climate events. We hope utilities and communities see themselves in this work, inspired by these remarkable stories to work together. Now is the time to choose a brighter future and act on climate. We must tackle our sector's greatest threats with our greatest strength: each other.



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Finally, this report leans heavily on the extraordinary work of the nine **Urban Flooding Bootcamp City Teams**. We thank them for sharing their insights and experiences with us. We stand in awe of their tireless efforts to build a viable, safe, and resilient future for us all.

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- Des Moines, Iowa (IA)
- Detroit, Michigan (MI)
- Hampton, Virginia (VA)
- Houston, Texas (TX)
- Jackson, Mississippi (MS)
- Philadelphia, Pennsylvania (PA)
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Climate Resilience, Water, and Equity: An Urban Flooding Bootcamp

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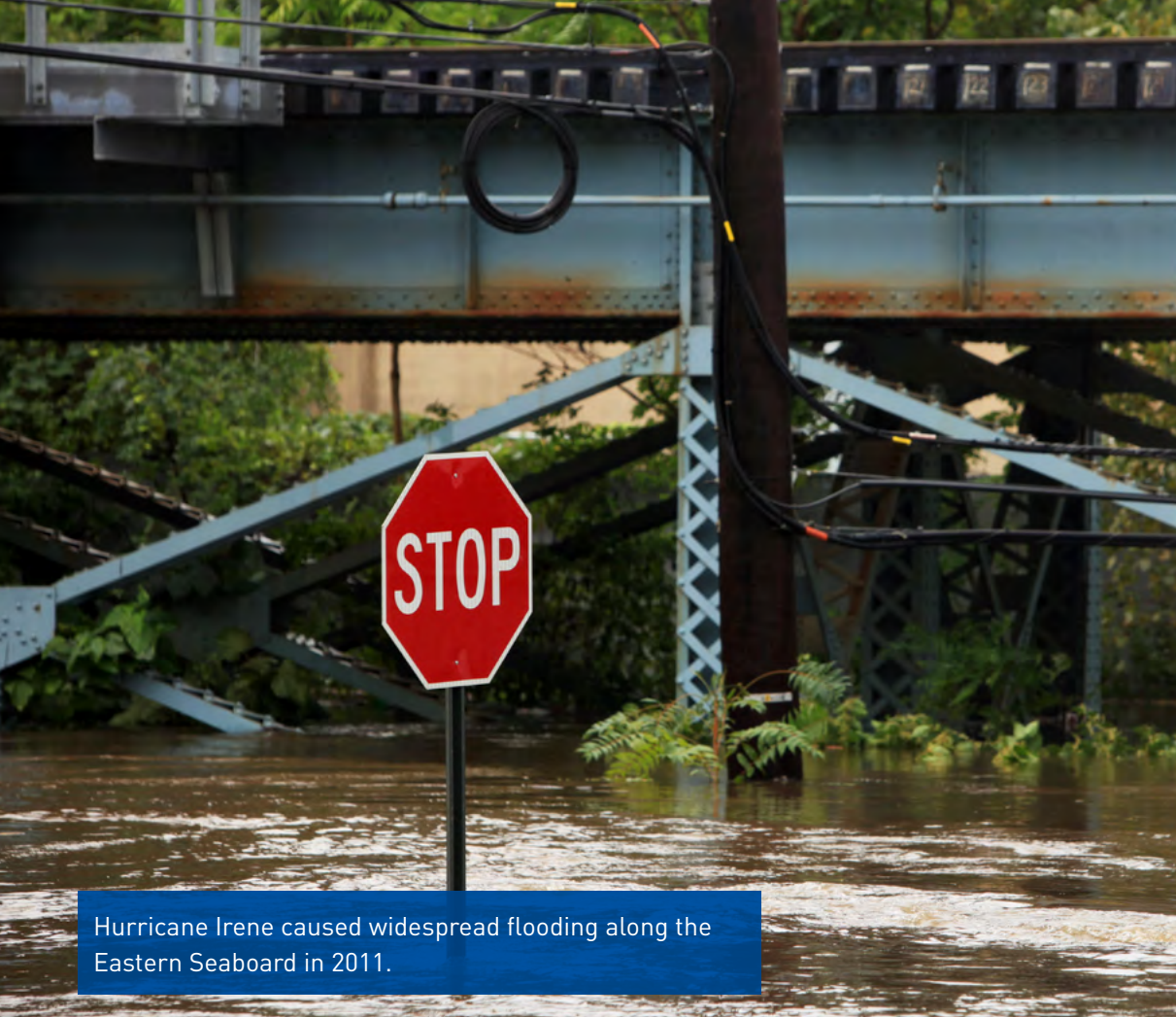
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Hurricane Irene caused widespread flooding along the Eastern Seaboard in 2011.



In 2011, heavy storms generated 240 tornados across the US and flooded the Potomac River in Montgomery County, MD.

Introduction

Velva Goodman's home in Hampton, VA, has flooded three times in the past few years. When it rains, the longtime Hampton resident and president of Briarwood Terrace Community Association throws on her boots and runs to the creek behind her house. If the waters rise past a certain marker, she alerts her neighbors. Briarwood Terrace, a historically African American neighborhood, is in the city's number one hurricane evacuation zone. It is also home to a large population of senior residents, many of whom face mobility issues that make it difficult to evacuate when an extreme weather event hits. Velva has become one of her neighbors' primary sources of information and safety guidance.

In Houston, TX, floodwaters shifted Iris Gonzalez's career trajectory from community development to climate resilience. As a resident of a community hit by Hurricane Harvey, she was motivated to work with the Coalition for Environment, Equity, and Resilience (CEER), an organization that sprang to life in the hurricane's wake. The 2017 storm dumped a remarkable 52 inches of rain on the city. More rain fell on Houston in four days than Seattle receives in a year. This devastated communities throughout Houston, hitting communities of color and low-income populations the hardest. Iris now spends her days helping communities recover from events like flooding, while also working with a host of city agencies to develop policy solutions and infrastructure projects that better serve all populations.

These stories—and so many others—demonstrate the everyday realities of how flood disasters shape individuals and communities. The facts also tell this staggering story. Flooding is the most common natural disaster in the United States. It is the most expensive—costing the nation upwards of \$8 billion every year—and it kills the most people.¹ Over 30 million people in our country reside in high-risk flood zones; changing precipitation patterns and rising sea level rise affect even more.² Smaller storms and localized flood events impact an even greater number of people. The 2019 floods in the Midwest broke precipitation records, following an already record-breaking year of flash floods and hurricanes along the Eastern Seaboard

in 2018 and the devastation of Puerto Rico during Hurricane Maria in 2017. Flooding—both in extreme events and daily occurrences—is becoming more frequent, intense, and unpredictable as the climate changes. In all cases, the hardest hit are low-income people, communities of color, and other vulnerable populations.

Water professionals, city agencies, community-based organizations, and residents are all responding to the growing challenge of urban flooding. They are working on **strategies to adapt** to live with the new normal of more extreme flooding. In many cases, they are initiating **efforts to mitigate** or lessen the occurrence and impact of flooding by building barriers or restoring natural buffers, retrofitting infrastructure, and relocating to safer ground. Stakeholders are **building resilience**—the capacity for people to prepare for, respond to, and recover from flood events.

There is, however, a disconnect in how these responses take place. Climate justice advocates are working to **document flooding impacts in vulnerable communities** and **lift voices from these communities into decision-making processes**. Community-based and environmental organizations recognize these inequities and use strategies informed by those most negatively affected. But these stakeholders often lack the resources to deploy solutions fully. Local governments, water professionals, utilities, and city agencies are building new infrastructure and flooding barriers, though often without engaging the very communities most affected. The lack of communication among stakeholders is a missed opportunity to coordinate and leverage efforts.

Annual cost of flood disasters in the US:

\$8 billion+

US population that lives in high-risk flood zones:

30 million+

Now is the time to bring the knowledge, resources, and efforts of all these stakeholders together to help ensure that all people are safe and resilient. Water professionals, public agencies, and community organizations **can more rapidly make progress on effective and equitable solutions to flooding when they work together.** Local government agencies and water professionals must root their practices in community-driven efforts to advance policies and practices that benefit all residents. Communities must recognize the complicated nature of flooding and flood management, and they must work with public agencies to find solutions. Solving these problems will require new technological approaches and management strategies. It will also demand coordinated efforts on a scale we have never seen. Many localities are ready to do this work, but initial steps remain unclear or are difficult to take.

Water utilities have a significant role in this endeavor, and much of this report refers to their specific involvement as it relates to stormwater management and urban flooding. There is, however, a broad range of water professionals across local, state, and federal agencies who deal with flooding. The lessons from this report apply across this spectrum. All actors must prioritize equity in their approach, incorporating social considerations alongside improved climate models and the best available science for investments, infrastructure, and policy decisions.

Across the US Water Alliance member and partner network, we see promising examples of diverse stakeholders coming together in new and exciting ways to address urban flooding. We see city managers and chief resilience officers visiting neighborhoods and garnering community input for flood solutions. We see community advocates collecting and publicizing data, or working with local governments to develop strategies. We see water and wastewater utilities stepping up to invest in vulnerable neighborhoods in their service areas.

We must accelerate and expand these efforts across the nation. This report puts forth five priority actions for a resilient and equitable future. These actions will bring water professionals, public agencies, and communities together to address vulnerabilities head-on, prioritize investments, and become resilient to flooding exacerbated by climate change.

The five actions draw from our collaboration with nine cities working to implement urban flooding solutions in historically marginalized or vulnerable communities. Our methodology began with background research and a literature review on flooding inequities, urban flooding, and climate change adaptation. We then engaged cross-sector teams from the nine cities in the **Climate Resilience, Water, and Equity: An Urban Flooding Bootcamp** (the Bootcamp).

The report is organized in the following manner:

The Urban Flooding Bootcamp—Highlights nine cities that have experienced flooding and describes their participation in the Bootcamp.

Key Urban Flooding Challenges—Summarizes the complexities and challenges surrounding urban flood management within the context of climate change.

Flooding Inequities—Describes why the effects of urban flooding hit some communities harder and offers key considerations for developing solutions.

Priority Actions for Equitable Resilience—Lays out five priority actions that cities, utilities, and communities can take together to address urban flooding.

Urban flooding exacerbated by climate change is daunting. But it also presents an opportunity to build resilient communities where people live, work, and play. Water professionals, utilities, public works departments, city agencies with decision-making authority around stormwater or flood management, climate justice leaders, community advocates, and local governments all have a place in this work. We invite you to use these actions to collaborate for a more just, climate-safe future.

Defining Key Terms

Here we provide definitions on some key terms used in this paper related to equity and urban flooding.

Vulnerable or Historically Marginalized Communities.

Those who face historical or contemporary barriers to economic and social opportunities and a healthy environment. For example, communities of color, low-income people, immigrants, seniors, children, people with disabilities, people with limited English-speaking ability, tribal communities, those living in public housing, and currently or formerly incarcerated people.³

Water Equity. Equity refers to just and fair inclusion—a condition in which everyone has an opportunity to participate and prosper. Water equity occurs when all communities have access to safe, clean, affordable drinking water and wastewater services; are resilient in the face of floods, drought, and other climate risks; have a role in decision-making processes related to water management in their communities; and share in the economic, social, and environmental benefits of water systems.³

Urban Flooding. Urban flooding occurs when stormwater exceeds the capacity of a city's infrastructure to drain it, either by carrying it away in pipes and tunnels or allowing it to infiltrate into the soil or ground. This can result in **localized flooding** (sometimes known as **nuisance flooding**) or larger-scale flooding. Urban flooding often happens when heavy rainfall or precipitation collects on the ground or causes rivers or streams to overflow; or storm surges, hurricanes, and high tides push coastal waters into cities.¹

Flood Risk. The probability of a hazardous event occurring plus the consequences in a given community determine the “risk” of flooding. Altering one or more factors affects risk. Moving people out of hazardous areas can eliminate risk. Increasing development density can double risk even without changes in the natural hazard.^{1,2}

Combined Sewer Overflow. A combined sewer system collects and transports rain runoff, domestic sewage, and industrial wastewater to a treatment plant prior to discharge. When the system exceeds capacity (often during a heavy rainfall or storm surge), untreated stormwater and wastewater may discharge directly into a nearby water body or contribute to localized urban flooding.⁴

Flash Floods. These occur when heavy or excessive rain falls in a short period (generally six hours or fewer). They are dangerous and often characterized by raging torrents that rip through riverbeds, urban streets, or mountain canyons sweeping up everything. Occasionally, flash floods occur even if no rain has fallen—for instance, following levee or dam failure or the release of water by a debris or ice jam.⁵

Inland Flooding. When moderate precipitation accumulates over several days or heavy precipitation falls in a short time, inland flooding on a river or other water body may occur in non-coastal areas. Dam or levee failures, as well as an ice or debris jam, can also cause overflows and result in inland flooding in urban or rural areas.⁵

Riverine Flooding. Rivers may flood when water levels rise over the top of riverbanks due to excessive rain. This is often the result of tropical systems making landfall, persistent thunderstorms for an extended time over a given area, rainfall combined with snowmelt, or an ice jam. Riverine flooding is a type of inland flooding.

Coastal Flooding. This occurs when water inundates land areas along the coast, usually from high tides, worsened by “heavy rainfall and onshore winds (i.e., wind blowing landward from the ocean).” Shallow coastal flooding can occur multiple times a year for low-lying houses or businesses in coastal areas.⁵

Storm Surge. An “abnormal rise” in tides along the coast, caused by extreme wind, waves, and low-pressure systems, can result in a storm surge. They are extremely dangerous since they often flood large coastal areas.⁵

Sea Level Rise. Rising sea levels are caused by warmer ocean temperatures that expand water and the addition of water from melting ice and glaciers into the ocean. Sea level rise worsens storm surges and tidal flooding in coastal communities. It can exacerbate saltwater intrusion, threatening groundwater quality.⁷

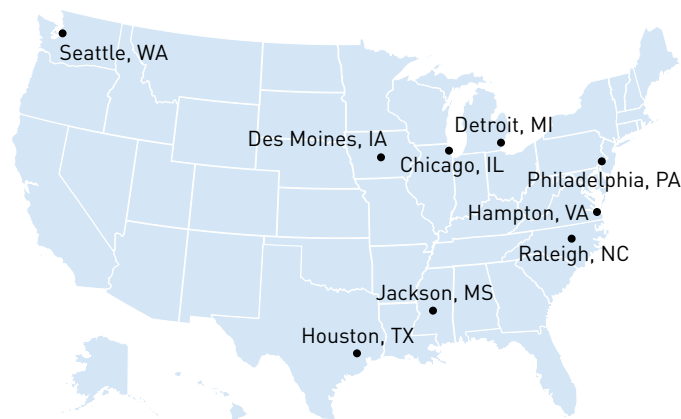
Managed Retreat. Managed retreat is “the purposeful, coordinated movement of people and assets out of harm’s way.” It is primarily a coastal adaptation strategy used to protect populations from climate-related impacts such as flooding. The Federal Emergency Management Agency (FEMA) has funded small-scale managed retreat since 1989. It remains controversial due to private property rights, insurance rates, funding shortfalls, and equity concerns.⁶

The Urban Flooding Bootcamp

This report draws heavily on the results from a US Water Alliance partnership with The Kresge Foundation to host the **Climate Resilience, Water, and Equity: An Urban Flooding Bootcamp**. The Bootcamp was part of The Kresge Foundation's Climate Resilience and Equitable Water Systems Initiative (CREWS), which aims to advance climate-resilient and equitable water systems in US cities. CREWS envisions cities where urban and wastewater systems are resilient to climate-driven flooding and provide reliable and equitable water services to communities.

The Bootcamp brought together cross-sector learning teams in nine US cities to better understand how cities, utilities, and communities are collaborating to address flooding challenges and bolster community resilience. We explored what works, what the challenges are, and how to improve collaboration across all stakeholders. The goal was to accelerate existing efforts in these nine cities and share their insights with others to advance the field of equitable climate resilience.

The nine cities included:



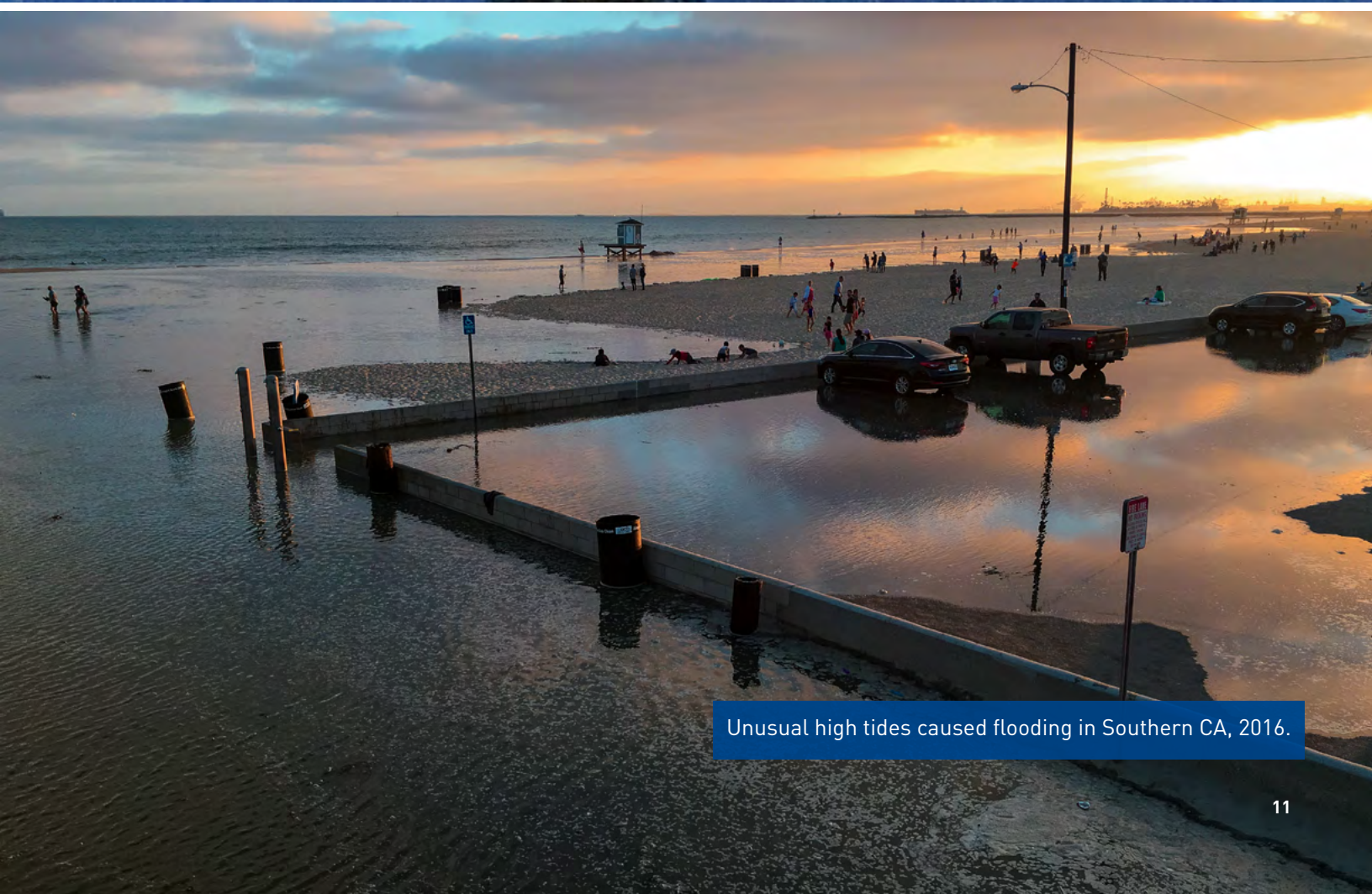
Each city formed a team with representatives from water utilities, local government officials such as mayors' offices and planning departments, environmental groups, community-based organizations, and residents in flood-prone areas. Together, each team visited a priority neighborhood to learn about how flooding affects residents' lives and identify key adaptation and mitigation opportunities in the area. The neighborhoods visited were particularly prone to flooding due to **location, geographical factors, and infrastructure**. They were chosen to reflect the social vulnerabilities that can affect flood recovery and mitigation.

Over a two-day convening that brought the city teams together, the Bootcamp provided peer exchange and expert learning on the latest science on climate and flooding, equity considerations for water management, and federal tools and national resources available for resilience planning. Teams concluded the Bootcamp by setting priorities for equitable flood resilience and making commitments to action to continue their work together.

These nine cities represent geographic diversity and face a variety of challenges, from localized flooding to erratic precipitation events, hurricanes, and sea level rise. Their governance structures for stormwater and floodplain management differ. Their priority neighborhoods included places with **concentrations of seniors, immigrant communities, low-income people, communities of color, or other vulnerable populations**. Their stories and case examples, illustrated in this report, chart a collective commitment to building community resilience for all residents. The report describes the following five priority actions for equitable flood resilience, adapted from their experiences.



Flooded streets in New Orleans, LA, 2017.



Unusual high tides caused flooding in Southern CA, 2016.



Hurricane Sandy left many residents stranded in New Jersey. Total damages cost the nation nearly \$70 billion.



Major flooding blocks traffic and damages roadways.

Key Urban Flooding Challenges

Flooding is one of the most significant water and climate challenges facing urban communities. The state of stormwater infrastructure and urban flood management strategies is key to determining whether a community directly experiences flooding. All kinds of flooding, however, are a growing threat, from “sunny day” and localized flooding events to more extreme storms and sea level rise. Several trends influence cities’ capacity to respond and build equitable flood resilience.

Flooding is the most common, costly, and deadly disaster in the United States.

In 2018, the first nationwide assessment on urban flooding declared flooding a significant and hidden threat.¹ Over 10 percent of the US population currently lives in designated floodplains. These 30 million people live along the coast or inland in urban cities, areas that are growing in population. But flooding also commonly occurs outside these floodplains. Over 83 percent of respondents participating in the national assessment said their community had experienced urban flooding.¹ In fact, 13 of the 14 disasters that cost the US more than \$1 billion in damage in 2019 were flood-related events (hurricanes, tropical cyclones, severe storms, and others).⁷

Climate change is making it worse.

Changing precipitation patterns and sea level rise cause flood events to occur more frequently, with more intensity, and sometimes in unpredictable ways. Nationwide, heavy precipitation has increased by 40 percent in the past five decades.^{8,9} Hurricanes are getting stronger and lasting longer.¹⁰ Seas are rapidly rising. Some coastal cities in the United States are already experiencing an inch of sea level rise per year.¹¹ These changing conditions are causing around 18 percent more extreme flood events per decade.⁸ Some estimate that localized flooding has increased by a total of 300 to 900 percent.¹² Climate change also creates a degree of uncertainty about *what*, exactly, to manage. Storms are more frequent, but they are also more unpredictable and erratic. Regardless, climate change is costing the nation more. From 2016 to 2018, the number of inland flooding and severe storm events with

costs exceeding \$1 billion doubled.⁶ Flood hazard zones are getting larger as a result of climate change, placing more people in danger.^{11,13}

Who Manages Flooding?

A complicated and vast ecosystem of city departments, public agencies, and others hold various authority to address aspects of urban flooding. This includes, but is not limited to:

- Water utilities (water, wastewater, or stormwater)
- Municipal public works
- Municipal environment departments
- Elected officials
- Floodplain managers
- Flood control districts
- Regional planning agencies
- US Army Corps of Engineers (USACE)
- Federal Emergency Management Agency (FEMA)

Comprehensive planning with climate data does not always occur.

Climate resilience specialists, scientists, and planners using climate data are not always thinking about the specific needs of communities. Meanwhile, water professionals around the nation face technical and governance challenges in the regular, nuanced use of climate data in their planning efforts. **Incorporating good data requires accessing and scaling down climate information into a meaningful local context.** This is expensive, time-consuming, and requires technical expertise. Smaller and under-resourced cities have a limited capacity to navigate this kind of climate planning or may have difficulty accessing the right data.

Finally, climate resilience does not sell easily across electoral cycles in many localities. Massive adaptation investments can take years to implement and are costly. It can be hard to find support from elected officials for these plans, especially as data constantly evolves, so there is some degree of uncertainty. Mitigation efforts can be packaged into near-term wins, making it easier to gain the support of elected officials in some cases. But there remains a need for better use of climate data in the water sector and to streamline its use across city agencies and governance structures that affect flood management.

Flood management is complicated.

Numerous factors influence flooding, managed through a complex web of city and regional agencies. The factors that exacerbate flooding include population growth, land development patterns in metropolitan areas or along coasts, impervious surfaces (e.g., pavement), disruption of natural habitats and drainage patterns, aging infrastructure, infrastructure that is undersized for current needs or future changes, development in metropolitan areas and along shorelines, changing weather patterns (e.g., increased amount and/or frequency of precipitation), and sea level rise. Many of these factors are outside the control of one agency or utility. Standard engineering practices seek solutions that protect overall wellbeing and reduce overall flood risk for a city. But there is a need to move beyond “one-size-fits-all” solutions to develop infrastructure and plans that do not, intentionally or unintentionally, sacrifice vulnerable communities in favor of those that are more advantaged.

Governance in the water sector is fragmented, and flood management is not well regulated.

A utility or the Department of Public Works often manages stormwater, whereas the Flood Control District may oversee large flood infrastructure or manage open space outside urban areas. The US Army Corps of Engineers may control levees or dams upstream that affect flooding downstream. These governing structures lack a coherent regulatory regime to incentivize or enable coordinated action among multiple actors. Current regulatory structures focus on issues such as combined sewer overflows, which can leave urban flood management neglected. Even at the local level, there remains a siloed approach that city departments take to planning and project delivery. Some coastal cities have policies for considering sea level rise in capital projects at water utilities, but they have not applied guidance across all city departments. If a transportation or parks department is working on

projects in vulnerable communities, it may not adequately consider sea level rise. The lack of cohesive guidance can result in inconsistent approaches for flood-prone areas. Even when water professionals and communities work together, processes to navigate decision-making for flooding may be unclear and circuitous.

Aging water infrastructure poses a significant risk.

Every year, more critical infrastructure is at risk. Dams and levees outside urban areas remain a primary line of defense for flood control, yet most are 50 or more years old. As of 2009, over 2,000 dams in the United States fell under the “high-risk” category for failure.⁸ Stormwater infrastructure in many cities is also aging or inadequately sized for current events. Many drainage systems were built nearly a century ago, with improvements for the management of stormwater discharges and treatment installed around the 1970s. Much of this infrastructure needs significant repair to keep functioning at current standards, let alone address new climate impacts. The American Society of Civil Engineers (ASCE) evaluates and rates infrastructure every year; water infrastructure received a D+ rating in 2019.¹³

Nearly 860 municipalities in the US have partially or fully combined sewer systems, where wastewater and stormwater flow into one pipe.⁴ During heavy rains, snowmelt, or flash flooding, these pipes can easily exceed capacity and discharge untreated or partially treated human waste, industrial waste, toxic materials, debris, and stormwater into nearby streams, rivers, and other water bodies. Some overflows contribute to urban flooding if they reach streets, homes, or businesses. Existing infrastructure is aging; designs were also based on past hydrology before detailed climate data and advanced modeling were available. One study estimates proper upgrades to the nation’s wastewater and stormwater infrastructure would require \$300 billion to meet current needs and protect communities in the future.¹⁴ This estimate is likely to be higher when considering the full effects of climate change.

Flooding Inequities

Certain populations in urban environments experience flooding more frequently, or the effects hit harder. The reasons extend beyond challenges surrounding the technical complexity or governance of managing stormwater.

Historical development practices placed low-income people and communities of color in flood-prone areas.

Water itself may not follow jurisdictional or geographic boundaries, but flooding impacts often do. Historic development practices, market economies, and other factors cause vulnerable communities to concentrate in low-lying areas most at risk of natural disasters. Intentional policies—in domains ranging from housing to transportation and land use—have led to the development of cities in a way that has left low-income people and communities of color in areas with higher flood risk. One such policy is redlining, or “the systematic denial of various services by federal government agencies, local governments, as well as the private sector, to residents of specific, most notably Black, neighborhoods or communities, either directly or through the selective raising of prices.”^{15,16,17} Though outlawed, in its height, redlining included denying home loans to Black residents in many cities, enforcing residential segregation. Among the lasting effects, it has relegated many communities of color to neighborhoods with lower quality services and more environmental hazards, including flooding. Decades of these unjust development practices have left many communities of color living in low-lying areas, next to wastewater treatment plants, toxic dump sites, rivers, and other areas that pose heightened risks.

Infrastructure in economically distressed communities is often in worse condition.

People in vulnerable communities are more likely to live in neighborhoods with deteriorating infrastructure and have **aging homes** that are less able to withstand storms.¹⁸ Disadvantaged neighborhoods may also have historically suffered from a **lack of adequate cleaning and maintenance** of what infrastructure does exist. Cleaning sewers, especially combined sewer lines, is an important factor in whether flooding will occur. Combined sewer overflows contribute to the flooding of homes and properties. In many

cities, these overflows occur much more frequently in low-income areas, at times leaving children walking through puddles of sewage to get to their bus stops. Unequal maintenance levels exist today.^{19,20}

Part of the problem is that many municipalities have already built out their drainage systems and now focus on mitigating the water quality impacts caused by those systems to meet regulatory drivers. Further drainage enhancements or buildouts sometimes come only once a consent decree, or another regulatory mechanism, incentivizes investment in previously neglected areas. Even so, drainage systems will always have limits, and no community can be completely resilient to extreme events due to technical feasibility and costs.

In some cases, vulnerable communities are not located in formally designated floodplains or near a body of water, making it difficult to seek assistance through federal programs such as FEMA when a disaster strikes. These communities may also be at risk because many FEMA maps are outdated or based on previous conditions that do not account for climate change.

Poverty intersects with flood vulnerability.

Low-income residents tend to face increased safety risks during floods. Research suggests they are more likely to remain in low-lying areas, while wealthier families have the resources to move from neighborhoods prone to natural disasters. **Low-income residents are also less likely to have flood insurance and may have a harder time evacuating during dangerous circumstances,** as they are less likely to own cars.²¹

Public health is also a concern for low-income residents. Many low-income residents live in former industrial areas where there are brownfields and contaminated soil. Stormwater runoff in these areas can carry significant and historical pollution. **Human contact with sewage from combined sewer overflows or basement backups is particularly dangerous for individuals more prone to health issues, those who lack adequate health care, or those who are without affordable insurance options.**

When flooding damages drinking water treatment plants or distribution systems, the high cost of bottled and alternative water supplies can leave low-income residents without water. Unemployment due to business interruption from extreme flooding and hurricane disasters significantly affects low-income populations.

Social and environmental factors also leave some populations more vulnerable.

In addition to the geographic risks (location in low-lying areas) and infrastructure risks (from either a lack of or failing infrastructure) discussed above, other social and environmental factors can affect a person's ability to prepare for, respond to, or recover from a flooding event. Some groups lack social support networks to call upon for assistance. Others do not receive emergency messages due to language barriers or limited access to technology. People with disabilities or medical conditions can be at higher risk, especially if they depend on technology, living aids, or medication; have reduced mobility; are hospitalized; or reside in assisted living care. Senior citizens with medical conditions or compromised mobility are at greater risk during floods and natural disasters.²²

Climate change is leading to migration that exacerbates existing flooding inequities.

Cities are pursuing climate adaptation and flood mitigation efforts through infrastructure upgrades, land protection, green infrastructure, voluntary buyouts, managed retreat, and, in some cases, relocation. And as climate impacts worsen, people are beginning to shift where and how they live. In many cases, climate migration patterns are reinforcing the structural inequities that already exist.

In New Orleans, 10 times more African Americans than white residents fled their homes because of flooding during Hurricane Katrina, yet only a small portion have been able to return. This is in part due to an influx of recovery funds and rebuilding incentives in certain areas that drove up the cost of living, preventing low-income residents from returning.²³ In Miami, where sea level rise threatens prime coastal real estate, wealthier populations are purchasing additional homes in low-income neighborhoods at higher elevations, such as Little Haiti, systematically driving up prices and pushing Latinx communities out of safer areas.²⁴

Addressing the complicated nature of urban flooding in an equitable and effective manner requires a new approach. We must develop cross-sector, multi-benefit solutions that protect everyone under a changing climate. Around the nation, cities and communities are already rising to the challenge, demonstrating ways to advance resilience with equity in mind.

Five Priority Actions for Equitable Resilience

Challenges at the intersection of climate change, urban flooding, and historically marginalized communities are significant. True resilience only comes when all communities have prepared for a changing climate. Yet, a study of 28 climate adaptation plans across the United States found that only a few made equity a primary goal.²⁵ Without an intentional focus on equity, climate resilience strategies may exacerbate existing disparities.

This section details five priority actions for efficient, resilient, and equitable water systems:

Priority Action #1:

Use data to identify risks, assets, and community vulnerabilities.

Priority Action #2:

Commit to ongoing and meaningful community engagement.

Priority Action #3:

Set a proactive vision and build strategic alignment.

Priority Action #4:

Fully incorporate equity into resilience planning processes.

Priority Action #5:

Target investments in vulnerable communities.

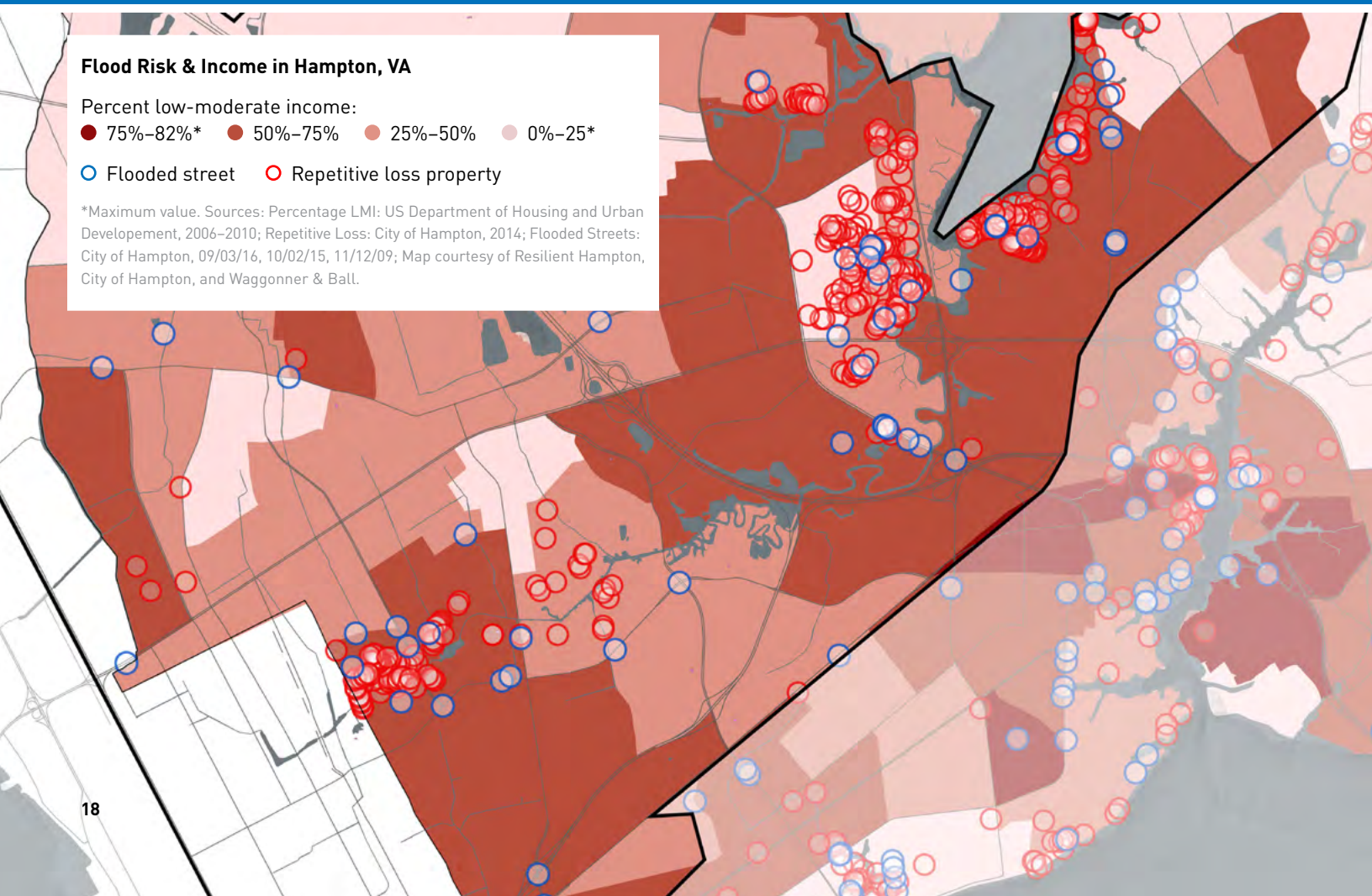
For each priority action, we summarize its importance, as well as key trends and considerations. We also include five case examples from the Bootcamp demonstrating these priority actions across the nation.

These actions lean on the experiences of the nine Bootcamp cities as they manage urban flooding and inequities within a changing climate. The actions aim to build a shared understanding of meaningful climate response by providing safe flood adaptation and mitigation strategies for all residents. Together, they present a practical path toward equitable flood resilience.

Priority Action #1:

Use data to identify risks, assets, and community vulnerabilities.

Like many cities, repetitive flood losses are more prevalent in low-income communities in Hampton, VA.



As a critical first step to protect all communities from flooding, water professionals must consider both infrastructure and social risks. Water utilities and city agencies have a general understanding of how the geography of an area contributes to flooding and what infrastructure needs may exist. Technologies to assess this information in the face of a changing climate are constantly improving. What is missing from the growing body of climate and water data is that this information is rarely overlaid with data on socio-economic disparities within a service area. Water professionals need to know which populations are most vulnerable to flooding and why. By collecting and integrating social data with climate data, they can work alongside high-risk communities to better inform storm-water management, emergency response, and flood mitigation.

Flood risk assessments look at geography and infrastructure over an entire service area.

Utilities manage risk over a broad service area. They are often responsible for stormwater in a metropolitan city, and sometimes in surrounding suburbs. Assessments from this geographic scale consider the risks posed overall to stormwater systems, capacity, and infrastructure assets. Utilities may include or coordinate with floodplain managers, who inform mitigation practices, including zoning, ordinances, and building requirements. Undertaking flood risk assessments at the citywide or regional scale can highlight inequities that may exist within a service area.

Given this, water professionals are starting to scale down climate data to better understand flood risk and improve resilience planning. While climate models are robust, they generally use precipitation (and other) data collected at a macro scale. Agencies must increase the resolution of this data to make meaningful local predictions for a high-level understanding of existing and future flood risk over a utility's entire service area. This scaling down process is tedious and time-consuming. But it better informs capital projects for gray and green infrastructure,

retrofits on existing assets, new operations and maintenance controls, and emergency management practices within the context of a changing climate.

It is important to augment flood risk assessments with analyses that reveal who is most vulnerable.

Because climate change and flooding impacts on specific populations are not inherent in technical assessments, it is also important to consider community vulnerability. Utilities should not rely on community groups alone to bring forth this information. Water professionals must actively identify social, economic, and environmental vulnerabilities. As discussed earlier in this report, there are many reasons certain groups may be more vulnerable to flooding. It is important to both identify these high-risk populations and understand the particular challenges they have with flooding.

The methods used in gathering this information are important. Social and economic data are commonly available only at a macro scale (such as census blocks) or include outdated information (for instance, augmented census survey data). Water professionals must work with communities to obtain and verify information, so it is as precise and complete as possible. This means meeting the community where its members live. For example, if a city agency holds a midday workshop to gather and understand information, very few people from vulnerable communities will be able to attend. Some cities, such as Seattle, have hired utility liaisons in vulnerable communities that connect with residents' day-to-day lives. This is proving an effective method to identify how flooding affects vulnerable populations.

Key populations to consider when assessing vulnerability include but not limited to:

1. The elderly
2. Families and individuals living in poverty
3. Individuals with disabilities or health conditions
4. Individuals with limited English proficiency
5. Renters
6. Racial, ethnic, and indigenous minorities
7. Young children

Water professionals can leverage social and demographic data collected by city agencies and community organizations.

Incorporating community vulnerability into flood risk assessments does not necessarily mean launching an entirely new data-gathering effort. Water utilities may need to coordinate with other water professionals, as well as housing departments, planning agencies, community development corporations, and community-based organizations to collect and cross-tabulate data. Many agencies already collect an array of social and demographic information that can be overlaid with climate data. In Richmond, CA, the City recently launched a **Climate Action Plan Open Data Dashboard**. The online portal serves as a convenient location to collect a wide array of social and demographic data in a transparent, accessible way. The portal is available for use by all communities in their resilience planning. The City is updating map tools to display data geographically for flood risk, infrastructure assets, and social vulnerabilities together.

Public health departments may also provide helpful vulnerability-related information. **These agencies can identify early warnings of illnesses related to water quality impairments** because they review data from healthcare providers, clinical laboratories, and hotlines, which are the first places where water-related illnesses become apparent. Tracking such public data can be especially important after unexpected water system failures occur from flooding, storm surges, or extended cold spells followed by rapid snowmelt. Public health data is also useful in anticipating cumulative impacts on communities facing multiple climate stressors. **Health officials can also help utilities conduct public outreach**, as they often have developed reliable methods of outreach for vulnerable and hard-to-reach residents.

Technical data paired with equally important social data drives resilient solutions.

Despite the vast amount of information out there, many cities lack specific details on where urban flooding occurs, the specific consequences, and who it affects the most.¹ **Water professionals should seek many types of information to fill this gap and build a comprehensive risk analysis.** The information can include data from climate models, topographical details of the watershed, information from both **federal and commercial insurance claims**, and data on social vulnerabilities. Few cities are collecting this social information and systematically overlaying it with flood mapping and infrastructure assessments.

Qualitative research can help supplement missing or incomplete information. Working directly with communities to collect *and* use vulnerability information helps build trust and ensure investments are cost effective, meet multiple objectives, and contribute to community resilience. As the needs of communities change with the impacts of climate change, this approach becomes even more important.

One example of where this is happening is in East Pittsburgh. Climate experts at the RAND Corporation are working with Pittsburgh Water and Sewer Authority to integrate technical and social data for innovative green infrastructure system design and policy evaluation. Advanced modeling of wet weather events in the Negley Run Watershed is identifying hilly areas that already experience regular flooding. Paired with social information, a more comprehensive approach to mapping risks emerged. The Larimer and Homewood neighborhoods have historically poor drainage systems. RAND is working with community outreach groups to develop **neighborhood-level runoff reduction strategies and target best management practices on individual lots.**²⁶

Case Example

City Management Partners with Residents to Identify Neighborhood-Friendly Solutions in Hampton, VA

Location

Hampton is a historic coastal city at the mouth of the Chesapeake Bay, which opens to the Atlantic Ocean.

Land Characteristics

The city is low-lying, with a highest inland elevation of about 20 feet. Much of the city has been impervious since 1610. Almost one-third of the city lies in FEMA flood zones. Most of these areas experience repetitive loss claims, or when an insurable structure experiences two or more flooding events in 10 years that cause \$1,000 or more in damage.

Key Water and Climate Challenges

- Nuisance flooding
- Projected sea level rise of at least three feet by 2100
- Land subsidence
- Coastal storms (nor'easters, storm surges)
- More intense rainfall
- More frequent hurricanes
- Increased groundwater levels

A unique partnership between two remarkable women is brewing in the Briarwood Terrace neighborhood of Hampton, VA. Mary Bunting, the City's first female city manager, and Velva Goodman, a long-time resident and the president of the Briarwood Terrace Community Association (BTCA), are bringing together technical data with social considerations to better inform flood management in a historically underserved area.

Briarwood Terrace is in an area of the city subject to heavy rainfall flooding compounded by tidal events such as hurricanes or nor'easters. Residents are predominantly senior and/or African American. It is also among the first for evacuation orders during hurricanes. Velva brought her neighborhood's flooding concerns to the city manager and Department of Public Works. The City put together the Resilient Hampton Initiative, an effort to prepare for climate-related water challenges, and soon began working with Velva through this effort. City officials, including Mary, visited the neighborhood and attended meetings to further learn about and document flood issues.

As Mary's team spent time with Velva and her neighbors, they quickly saw a need to look beyond the City's assessments. They had to consider the neighborhood's infrastructure, geography, and social vulnerabilities to ensure solutions fit the neighborhood's unique characteristics. The City, therefore, began actively using neighborhood demographics to inform where to focus mitigation, as well as what strategies make the most sense for the residing population. For instance, in Briarwood Terrace, relocation is very difficult for seniors who have lived in their homes for decades, many for 50 years or more. Residents in wheelchairs or with mobility issues also have trouble maneuvering around old building designs and tight spaces, making it difficult to evacuate on their own. Many rely on one another when deciding to evacuate or in the aftermath of a flood. Seeing their homes repeatedly flood frustrates Velva and her neighbors, yet the idea of moving is emotionally difficult and not financially feasible for some. Residents in Briarwood Terrace prefer to stay in their homes and work with the City to minimize flooding rather than relocate.

The pairing of this technical and social information led the City to prioritize the Newmarket Creek area, which includes Velva's neighborhood of Briarwood Terrace. But Mary's team is taking this approach a step further to better address the needs of those most vulnerable. They developed the *Newmarket Creek Water Plan* for a multi-faceted approach to stormwater management: slow, store, redirect, adapt. Pilot projects are underway to alleviate flooding and add community benefits such as greenways and recreation areas. The Big Bethel Blueway pilot will use a stepped weir approach to manage stormwater flows and improve water quality with green infrastructure. This will reestablish water as a key community asset by incorporating a linear park and trail system. The Blueway will run along the creek behind Velva's house.

Velva, Mary, and many other individuals working with them do not always agree. But they share a common goal of keeping the Briarwood Terrace a safe neighborhood for all residents. To do this, they are collaborating around efforts that identify vulnerabilities and working to find multi-benefit solutions.

Priority Action #2:

Commit to ongoing and meaningful community engagement.

Father Taylor discusses equity and sustainability with forestry students at a rain garden in front of St. Ambrose Episcopal Church in Raleigh, NC.



Community engagement is often talked about in resilience work. Too often, approaches to community engagement involve deciding on a strategy and *then* informing or garnering input from those most affected. To effectively communicate risk and design flooding solutions that work for communities, cities must go beyond this kind of engagement. They must identify problems and develop solutions in tandem with communities, involving residents from the outset *and* throughout the implementation of projects. This inclusive approach supports better prioritization of community needs and safety. It further allows cities to examine potential unintended consequences, such as how new inequities may emerge, and build toward long-term stewardship of flooding infrastructure as a public asset.

Information exchange creates a collective understanding of risk.

Resilience planning should incorporate all types of knowledge. Utilities, other city agencies, and communities all have useful knowledge that informs flood risk and recovery, and they need channels to share this information with each other. This may involve qualitative research, such as talking to residents or surveying vulnerable communities. People living in high-risk areas have extensive knowledge of the realities of chronic flooding. They know their neighborhood's specific challenges with floodwaters and have a better understanding of external factors, such as affordability concerns, that affect their ability to prepare, cope with, and recover from disasters. This lived experience can help evaluate appropriate flood mitigation. Citizen science techniques may be useful to fill data gaps. Some organizations use cell phone cameras and apps to document flooding impacts and provide localized information in a visual format.

Similarly, residents need a better understanding of climate uncertainty and potential infrastructure solutions. Utilities can provide educational resources to help communities understand what complex scientific information means in terms of localized flooding impacts, as well as emergency preparedness and what people can do to protect themselves. Information may need to be broken down or provided in multiple languages. Information exchange better positions communities to assess their risks and weigh in on decisions. This leads to local strategies that address residents' needs while contributing to broader urban flood management. It also leaves communities more prepared to activate emergency response during extreme events that can result in major flooding such as hurricanes and nor'easters.

Sharing multiple options with communities leads to comprehensive decision-making processes.

Since climate change means a range of possible futures that impact flooding, it is helpful to present communities with multiple mitigation solutions, allowing them to compare and contrast options. Understanding different scenarios and working with communities to evaluate various options helps vulnerable residents take control of their futures and build trust with cities and utilities.

When considering multiple scenarios, several alternatives emerge. Cities, utilities, and communities must work together to explore these alternatives. Together, they can arrive at a decision that meets the utility's regulatory mandate and reduces vulnerability in each neighborhood. This ensures that infrastructure investments, mitigation solutions, and supporting policies benefit everyone. For example, in the low-lying, low-income Proctor Creek neighborhood of Atlanta, GA, the Department of Watershed Management partnered with community-based organizations to gain intensive input from the community on what kinds of green infrastructure solutions would and would *not* be effective. They are also working to engage residents in the long-term maintenance of the planned green infrastructure facilities.²⁷

Communities need support to participate authentically.

Sometimes community representatives have the knowledge and willingness to work with water professionals but lack the time or ability to engage as deeply as they would like. Cities or utilities can support widespread participation by providing a stipend to compensate community members for their time, providing transportation to meetings and events, offering childcare, ensuring translation services are available, and providing healthy meals. Community

partners can offer advice on how best to engage their communities, and they can also recommend local vendors and services. Utilities or cities can hire community leaders as paid consultants to help develop these strategies, vet scenarios, or gather input on potential flooding solutions.

Building relationships with community leaders enhances trust in vulnerable neighborhoods.

Community-based organizations can make good partners for water professionals since they often have trust among residents. Utilities and city agencies can build relationships with these organizations to help gain trust in neighborhoods. They can invite leaders from these organizations to serve on advisory committees to help define the issues and co-develop goals, visions, and principles to guide planning processes.²⁸ Advisors may include people like neighborhood nonprofit staff, healthcare professionals, or block club leaders. Working through community organizations can help with course-corrections and finding alternative solutions for a neighborhood when unforeseen challenges arise. Such ongoing local feedback helps ensure that vulnerability information is not just collected but also used throughout the process. In turn, this helps build trust and ensure that investments are cost effective, meet multiple objectives, and enable community resilience.

For example, the Milwaukee Metropolitan Sewerage District (MMSD) was rehabilitating the Kinnickinnic River to increase flood capacity and meet public safety objectives. This \$80 million flood protection project would require a wide land footprint along some residential corridors. MMSD worked through local community health centers, trusted voices and spaces in neighborhoods, to reach Spanish- and English-speaking residents. Recognizing the critical link between environmental health and community health, MMSD also partnered with the Sixteenth Street Community Health Center to forge a coalition working to restore the river, and in so doing, helped to reinvigorate and revitalize the surrounding community. The team developed goals and objectives based on the list of critical design issues and stakeholder input.²⁹ Ultimately, residents helped decide how the project would daylight a river to restore green space and reduce flood risk. As part of this process, the utility and community worked together to purchase homes in the flood zone and relocate residents to safer areas.

US Water Alliance Water Equity Taskforce: Best Practices for Community Engagement

The US Water Alliance's Water Equity Taskforce is a network of seven cities across the United States that established cross-sector teams to work on water and equity challenges from 2017 through 2020. Though their work did not focus solely on climate issues, insights from these cities about how to invest in and maintain community engagement is useful for the context of urban flood resilience.

- **Acknowledge historic injustices as contributing factors to water challenges.** Many communities are already suffering from disproportionate climate impacts and have a distrust in local and government agencies that needs to be acknowledged and addressed.
- **Assume everyone has good intentions.** Many water professionals come from the communities affected by their policies. When navigating disagreements about what approach to take, all stakeholders should keep in mind the shared goals of public safety and resilience.
- **Honor lived experience, academic information, and technical expertise.** All are important forms of knowledge that can inform solutions to flooding.
- **Provide varied engagement opportunities and share power.** Multiple touchpoints with communities ensure people with schedule, resource, or participation challenges can still engage.
- **Slow down and build trust.** Relationships and co-creating take time. When possible, agencies can accept a slower pace for decisions or project timelines, identifying easy wins along the way.
- **Water always finds a way. Be like water.** Equity and resilience are hard work. Stakeholders may have to step outside their normal bounds to find a solution.

Case Example

Community Advises and Oversees Flood Mitigation Efforts in Raleigh, NC

Location

Raleigh is the capital of North Carolina. It is an inland city located in the eastern-central part of the state. With several universities and technology institutions, the city is part of the area known as the Research Triangle.

Land Characteristics

Raleigh lies where the coast meets a hilly region known as Piedmont. There are many parks and wooded areas. Impervious cover ranges from 20 to 65 percent throughout the city, which lies about 400 to 500 feet above sea level.

Key Water and Climate Challenges

- Alternating floods and droughts
- Extreme precipitation events
- More frequent and severe hurricanes
- Longer and more frequent droughts
- Hotter temperatures
- Risk of over 30,000 properties being inaccessible during inundation, and of road damage during flood events

When it comes to stormwater management, community engagement has taken on new meaning in Raleigh, NC. The City is pairing an aggressive, multi-faceted approach to address flooding with creative solutions residents have raised.

For neighborhoods such as Rochester Heights, this is important. In 1957, a local policy developed the area as an African American neighborhood.³⁰ Like so many communities of color across the nation, Rochester Heights is in an area with frequent sewer overflows and previously had been a garbage dumping ground. Many of the streets are in the floodplain, making them prone to frequent rising waters. The City has also historically underinvested in the neighborhood's infrastructure. As a result of these inequities, many residents have an inherent mistrust of city agencies and officials. Although there were some property buyouts following Hurricane Fran in the 1990s, recent gentrification means that affordable housing issues are adding another layer of vulnerability onto neighborhood residents.

Given these historical and continuing injustices, it is critical that residents have a central role in deciding how the City addresses flooding. One way this happens is through residents participating in the Stormwater Management Advisory Committee (SMAC). City Council backs the interagency group SMAC, which provides input on flood mitigation. Community advocates and residents work alongside utility and city officials through the committee. SMAC meets regularly to guide decisions and develop and implement projects. Their efforts are part of the City's broader *2030 Comprehensive Plan*, which directs infrastructure resilience. The City coordinates plans across stormwater, transportation, public utilities, housing, parks, and cultural resources departments. The plan includes several priorities in preparing for a changing climate: assisting with response and recovery, reducing sensitivity to climate impacts, building adaptive capacity, and reducing exposure.

The Reverend Jemonde Taylor of St. Ambrose Episcopal Church is a SMAC member. A mechanical engineer by training, he has long educated residents on stormwater and is working with the Walnut Creek Wetland Park to install rain gardens and develop "parks with a purpose" to help mitigate nuisance flooding. In Rochester Heights, Father Taylor's work with SMAC at the municipal level bolsters the neighborhood's green infrastructure projects. A proposed "no new development" in the floodplain restriction for commercial and residential properties is perhaps the most promising example. This emerged following a recent convening that looked at the city's floodplain regulations.

Stakeholders included differing interests from real estate developers, homebuilders' associations, commercial interests, residents, and the Public Works Department. They found common ground through a series of discussions that assessed all risks and vulnerabilities. The proposed restriction is in review by City Council. Meanwhile, the Stormwater Management Division and Office of Emergency Management are implementing a flood early warning system that combines stream gages with remote monitoring cameras. Water sensors at low-lying road crossings activate flashing lights to warn motorists. The next phase will include an advanced warning of flooding based on rainfall predictions and a streamflow model.

Through all these efforts, Raleigh is working to improve collaboration with the community and implement policies and systems that will improve its resilience and keep residents safe during flooding conditions.

Priority Action #3:

Set a proactive vision and build strategic alignment.

Water Trails design concept for Des Moines, IA.
Credit: Bolton & Menk, Inc.



A proactive vision for flood management enables water managers, public agencies, and community partners to align their capacities and resources. Flood resilience is not just one agency's purview. Floodwaters cross social, political, and geographical boundaries. It is important to build a strategy that considers needs and leverages opportunities across all these boundaries. In turn, this allows agencies and neighborhoods to enact cost-effective, multi-benefit solutions. Local alignment can achieve public safety, water quality, and regulatory goals while building coalitions to prioritize equity. This strengthens coordination for additional support from the government at the broader metropolitan region, state, and federal levels.

Innovative thinking around flood prevention can produce more equitable results.

Research shows that for every dollar invested in pre-disaster mitigation, society saves six dollars in recovery costs later.²³ Whether preparing for hurricanes or reducing nuisance floods, preventing flood impacts is more cost-effective than responding to them. Yet the nation's current federal disaster relief framework is reactive and does not encourage or enable proactive thinking and measures. The Federal Emergency Management Agency (FEMA) is the primary source of federal funding for flooding—and the resources almost always flow in the wake of a hurricane or flood disaster. As much as 85 percent of FEMA's public assistance dollars for disasters go toward flood-related losses, not prevention.³¹ From 2005 to 2014, the federal government spent nearly \$278 billion on disaster assistance, with limited and insufficient funds going toward preparation and mitigation efforts.³²

As the nation experiences more extreme events, federal attention is shifting toward the importance of flood mitigation. In 2020, FEMA will roll out a newly established **Building Resilient Infrastructure and Communities (BRIC)** program. BRIC's goal is to move "away from reactive disaster spending and toward research-supported, proactive investment in community resilience."³³ BRIC improves on FEMA's existing Pre-Disaster Mitigation program by allocating a set amount of funds—six percent—to this purpose and streamlining the process for communities to access those funds.

There are many ways that cities can also be proactive and unlock a focus on flood mitigation for historically marginalized or vulnerable communities. Some are specifically targeting equity in flood response. Others are infusing equity considerations in local and regional efforts. In Chicago, flooding is an increasing concern. Many residents in south Chicago neighborhoods commonly report localized flooding issues. In fact, "87 percent of flood damage insurance claims were paid in communities of color" between 2007 and 2016.³⁴ More recently, rising lake levels combined with significant erosion along the shore are causing additional flooding in these and other areas. The mayor recently appointed the city's first chief equity officer, charged with examining racial and other injustices, bringing an equity lens to policymaking and practices across city departments. This involves helping city agencies identify how to share decision-making power with communities. An alignment of equitable approaches across sectors will allow the City to address flooding proactively and other issues in vulnerable communities.

Alignment around flooding can occur across a neighborhood, a city, or even a region.

As water utilities prepare for climate change, many other agencies may be doing related work in parallel. Sharing social vulnerability data and aligning goals, approaches, and resources among agencies can make flood resilience processes more efficient and equitable. Water utilities can find opportunities to coordinate with other municipal or regional departments and agencies during their planning processes.

The New York City Department of Environmental Protection's green infrastructure program initially focused on reducing stormwater runoff to control combined sewer overflows. The utility, however, is now incorporating these projects into the design of public spaces and streets to better serve areas like Southeast Queens,

a historically disadvantaged neighborhood with predominantly communities of color. This is part of a \$1.9 billion investment in green and grey infrastructure projects throughout the city.³⁵ In Southeast Queens, investments will target drainage system improvements and rain gardens to mitigate nuisance flooding in homes and manage heavier rainfall events. The Southeast Queens program emerged from the mayor's 2015 *OneNYC Plan* that integrates equity, sustainability, and resilience across all sectors. NYCDEP's curbside rain gardens and drainage system projects align with broader city efforts to fight the impacts climate change has on vulnerable communities, including the City's Green New Deal and Climate Mobilization Act.³⁶

Coordinating efforts across sectors can extend benefits beyond flood management.

In addition to coordinating on flood management, water managers can also coordinate with agencies in other sectors who are planning projects in the same neighborhoods. Coordinating with transportation, education, clean energy, and public space projects that are taking place within vulnerable neighborhoods can help maximize benefits and minimize disruptions. As municipalities undertake improvements to roads or public transportation, utilities can partner with other city departments to make any below-ground infrastructure repairs and limit the disruption to neighborhoods. At the same time, utilities can develop above-ground assets such as green infrastructure in the public right-of-way.

Or there may be opportunities to add flood mitigation benefits to existing city improvement projects. In Jackson, MS, plans are underway to open the Museum-to-Market Trail. The 2.5-mile greenway will enhance walking and biking between the city's museums and farmer's markets. The project is a partnership between the Mississippi Department of Transportation and Central Mississippi Planning and Development District. City Council is working with the Department of Public Works and other water professionals to explore whether adding stormwater management components like bioswales and rain gardens along the greenway could reduce flooding for nearby neighborhoods.

Partnerships that leverage funding reduce the cost burden for single agencies.

Utilities can look for partners as an opportunity to leverage resources, from staffing to materials to outreach efforts. Flood resilience projects can serve to create public spaces and educational resources for vulnerable communities. For instance, projects could include designing and retrofitting schoolyards and public spaces to double as stormwater management assets and environmental education gardens. Park departments can work with utilities to fund community green space above water infrastructure components such as pumps and tanks. Many utilities have partnered with community groups and local artists to transform utility assets by incorporating local artwork into projects, as well as creating green space, recreational facilities, and educational training centers. Local philanthropic foundations are also potential partners.

There is an enormous opportunity to pool resources. San Francisco Public Utilities Commission (SFPUC), for instance, is partnering with San Francisco Unified School District for the city's first "stormwater schoolyard" at Robert Louis Stevenson Elementary School. This joint effort will manage 476,300 million gallons of stormwater per year through green infrastructure that further enhances nature play for kids.³⁷

Alignment and partnerships create a stronger pitch when applying for federal grants or loans for pre-disaster mitigation projects. Promoting partnerships to enable larger projects is one of the guiding principles of FEMA's new BRIC program. Such alignment may also further position stakeholders to navigate tricky federal programs and leverage future interventions.

Case Example

Regional Collaborations Drive an Equitable, Multi-Pronged Flood Strategy in Des Moines, IA

Location

Des Moines, Iowa's capital, is in the center of the state. It lies at the confluence of the Des Moines River and Raccoon River, where the two watersheds intersect.

Land Characteristics

Suburbs and agriculture surround this inland city. Ninety-five percent of native prairie ecosystems have been removed for development and agriculture across the state.

Key Water and Climate Challenges

- One of the fastest-growing areas in the Midwest, with increased development and impervious surfaces.
- More than 150 miles of waterways within the metro area.
- Precipitation has increased over the past 10 years, causing more frequent riverine and urban flooding issues.

Torrential downpours hit Central Iowa and the Midwest in the summer of 2018. Major flash and riverine flood damage occurred throughout the area, including Des Moines. The city also suffered severe river flooding in 2010, 2008, and 1993. Those affected during the floods included low-income communities, migrants, persons with disabilities, those over age 65, the single head of household families, and people of color. Standing in front of the collapsed basement wall of her now uninhabitable home, an elderly resident of the most heavily affected neighborhood reported, "I'm strong, I'm alive, I survived."

These impacts are driving stakeholders to take a broad, collaborative approach to flood management in the Des Moines area. Efforts are underway to build resilience for both riverine and urban flooding with a comprehensive strategy that crosses scales, sectors, and jurisdictions. Coordination occurs across water, transportation, agriculture, and emergency planning, as well as from the neighborhood level up to the regional scale.

For Jonathan Gano, director of public works, neighborhoods are a key focus in this push. As his team works to improve flood resilience along smaller tributaries in Des Moines, their proactive approach includes investments in a greenway system along the 500-year floodplain. Although FEMA previously provided funding for buyouts following

disasters, the City realized this was inequitable when the relief inventory removed affordable housing. Jonathan's team is working with communities to weigh decisions on voluntary buyout options to relocate residents to safer grounds. Current efforts include prioritizing funding for buyouts and flood resilience projects in previously underserved neighborhoods with immigrant and senior residents, such as in Fourmile Creek. The Department of Public Works is also installing in-field agricultural watershed improvements and large-scale detention basins upstream to slow and store water downstream to Fourmile Creek and other tributaries. Levees enhance flood protection in the downtown central business district.

The City of Des Moines' work aligns with much of the regional water-related efforts led by the Metropolitan Planning Organization (MPO) and MPO Associate Planner Allison van Pelt. She works with regional watershed management authorities and their member jurisdictions to establish and promote stormwater best management practices (BMPs) and cost-share programs for private properties through the Rain Campaign. She also works to develop and adopt cohesive regional stormwater ordinances and regulations across the metro area and other major watershed improvements throughout Central Iowa. MPO's recent *Greater Des Moines Water Trails and Greenways Master Plan* outlines opportunities to enhance 150 miles of regional waterways into recreational amenities that also provide flood mitigation, ecological and safety enhancements, and economic development opportunities. Many executives in the Des Moines area deemed the more than \$100 million regional project a "game-changer," to help raise awareness of the importance of water quality and watershed improvements among those in the mainstream business world. The MPO and its partners were recently awarded a \$25 million federal Better Utilizing Investments to Leverage Development (BUILD) grant that will significantly accelerate the project. Equity and inclusion are key components.

Together, these actions are building a suite of flood reduction measures that enhance equitable flood resilience. Allison and her colleagues are also developing a regional online mapping tool that will gather social, water, and climate-related data across jurisdictions. Communities are contributing information for the tool. After compiling data, an online education and engagement platform will be publicly accessible. A detailed database of practices, projects, funding, and more will be available to city and other staff to use in developing local and regional projects.

Priority Action #4:

Fully incorporate equity into resilience planning processes.

Green infrastructure helps mitigate flooding and offers multiple benefits in Philadelphia, PA. Credit: Philadelphia Water Department



Every step of the climate resilience planning process is an opportunity to consider equity. By incorporating social vulnerabilities, flood resilience strategies can be more reflective of all communities. When utilities and cities help the most vulnerable, they create more durable outcomes. In turn, it can boost efficiency, reduce costs, and improve project outcomes. This is even more important in the face of a changing climate.

Consideration of social vulnerability in planning activities across all operations provides a clear path for equitable flood management strategies.

The climate resilience field itself is still fairly new and rapidly evolving. It may not follow a linear path through agencies. Cities and states generally develop climate adaptation plans across several agencies, including water utilities. Large utilities may create their own plans. Efforts to integrate stormwater and flood management within this broader context are still emerging. Because responsibilities for stormwater, flood mitigation, and climate adaptation cross multiple local government agencies and utilities, all agencies and efforts should consider equity. The steps that each agency takes will vary. Successful processes generally move from risk identification and data gathering, through assessments and planning, to funding and implementation, building in monitoring and adjustment.

One way the San Francisco Public Utilities Commission—a water, sewer, and electric power utility serving 2.6 million people in Northern California—works to consider equity in all operations is through a community benefits assessment. Such assessments are guiding the utility's Sewer System Improvement Program (SSIP), a 20-year citywide investment to upgrade San Francisco's aging sewer infrastructure to ensure a reliable, sustainable, and seismically safe sewer system now and for generations to come. The SSIP calls for building new facilities using a climate change design criterion so that the sewer system will respond better to rising sea levels and other impacts. Community benefits and inclusion are an important level of service goal for these facilities, with strategies to ensure economic and job benefits to the communities they serve and maintain ratepayer affordability. The utility

also established a level of service goal tied to flooding—which is driving the use of innovative green stormwater projects together with upgrades to sewer pipelines to minimize how stormwater affects neighborhoods and the sewer system. By linking climate resilience, flooding, and equity goals, the SFPUC can maximize the benefits of the sewer system rebuild.

Scenario planning helps consider future climate possibilities and impacts on vulnerable communities.

Although climate data and models have improved significantly, there is still some uncertainty in how much the climate will change and what localized impacts will be. This is particularly true when looking at the compounding impacts of climate change on different vulnerable populations.

The Water Utility Climate Alliance (WUCA), for instance, is a collaboration of 12 utilities building leadership to better understand and address how the climate affects water resources and infrastructure systems. WUCA works with uncertainties through scenario planning to inform decision-making processes. WUCA conducts trainings for other utilities and water managers on how to incorporate climate science and manage uncertainty for no-regrets solutions.

Scenario planning can scale up equitable flood resilience efforts. Looking at a range of future scenarios can lend insight into what flooding challenges may arise and how flood risk might change in a given community. Incorporating equity considerations into the scenario planning process can provide an important opportunity for advancing water equity amidst uncertainty. Water professionals can work with community representatives to help determine which scenarios to consider, as they have a sense of how different circumstances may affect their neighborhoods. The assessment stage of risks and future uncertainties can include data collected on social vulnerabilities. Findings from this work can then inform planning processes to develop equitable adaptation strategies.

Strategies grounded in community solutions and shared decision-making improve outcomes.

Communities are increasingly taking it upon themselves to identify their own climate challenges, including flooding, and develop solutions from the ground up. Fully incorporating social vulnerability into resilience planning may involve integrating community efforts with utility

or citywide initiatives and plans. The National Association of Climate Resilience Planners notes that “processes grounded in community assets can amplify resilience strategies already in play and embody desired outcomes at every stage.”³⁸ This provides multiple touchpoints along the planning process for different “stakeholders to vision, experiment, reflect, and refine solutions [as they] reflect on habits and patterns that perpetuate inequities and limit resiliency.”²²

For example, in Philadelphia, an interagency Flood Risk Management Task Force (FRMTF) has been operating since 2015. Eight city departments—including water, emergency management, parks sustainability, and others—came together to coordinate resources and address flooding as it affects different neighborhoods. More than 15 other local and federal agencies advise on projects and provide technical assistance to the group. The FRMTF builds resilience through four key components: public information, mapping and regulations, flood preparedness, and flood damage reduction. The group has engaged communities throughout the process, tailoring flood management to the various challenges in different neighborhoods. To improve the involvement of vulnerable communities, the FRMTF began piloting a community-led sub-task force in 2020. The goals are to give voice to community leaders, empower stakeholders to guide decisions on flood resilience projects, and improve risk communication and information flow between the agencies and residents.

Equitable resilience is a new approach; utilities and communities learn as they go.

Embedding equity is a continuous, adaptive process with routine monitoring and adjustments. While the inter-sections of water, climate, and equity run deep, it is only in recent years that they have begun to challenge our existing ways of approaching flood solutions. Building a shared understanding of risks and finding cost-effective solutions that meet community needs and regulatory requirements can be challenging. Stakeholders are learning as they go about what works and what does not.

On the east side of Detroit, MI, torrential downpours combined with riverine flooding have caused property damage and flooded basements in the Jefferson Chalmers neighborhood. The neighborhood is predominantly African American and has a low median household income compared to other parts of the city. Most of the neighborhood’s houses built in the early 1900s also lack air conditioning systems. This poses a dual threat, as the community grapples with hotter summers and more frequent, heavy rains. The Detroit Water and Sewerage Department (DWSD) is working with the Housing and Revitalization Department; Buildings, Safety, Engineering, and Environmental Division (BSEED); and the community-based Southeast Michigan Long Term Recovery Organization to reevaluate disaster risks and a range of solutions to improve emergency response, while building out long-term mitigation strategies.

Across the nation, the stakes are high and both communities and utilities must remember that working together is an ongoing process and may change over time. As community needs change, or new flooding challenges arise, strategies may also need to evolve. Opportunities for continuous learning and course correction of strategies along the way allow water professionals to check in with communities regularly, re-evaluate risks and needs, and update management actions accordingly.

Case Example

A Focus on Equity Centers Communities in Climate Plans in Seattle, WA

Location

Seattle is among the fastest growing cities in the US and is located on Puget Sound in the Pacific Northwest.

Land Characteristics

This heavily urbanized city has filled natural ponds and wetlands over time, increasing impervious cover. Median home prices grew by 14 percent in 2018, compared to 4.1 percent nationwide.

Key Water and Climate Challenges

- Rise in the Puget Sound shoreline (already more than 6 inches in the 1900s).
- Sea level on Seattle's coastline, which may rise another 10 inches by 2050 and 28 inches by 2100.
- Localized flooding from intense rainfall, king tides, and high winds.
- Urban flooding in streets, particularly in areas lacking sufficient drainage.

In the Pacific Northwest, Seattle Public Utilities (SPU) is reorienting as an anchor institution in the city, a "community-centered utility." Three pillars guide this shift: risk and resilience, affordability and accountability, and equity and engagement. SPU is integrating these pillars throughout all services, with accountability metrics to institutionalize them in practice. SPU's ongoing robust approach to climate adaptation, based on extensive modeling and the use of climate data, prepares for sea level rise and reduces urban flooding risks.

Keeping equity front and center means the utility considers all factors that contribute to flood vulnerability. Affordable housing is one of the biggest issues in this rapidly developing city. SPU is considering how the housing crisis has a significant effect on public safety during water- and climate-related disasters in vulnerable neighborhoods. The utility is **overlaying the Racial and Social Equity Index**—a tool developed by Seattle's Office of Planning and Community Development to help all departments prioritize improvements—with a **comprehensive analysis of drainage system capacity and wastewater management**. The updated hydrologic and hydraulic models, coupled with environmental justice

information from the index, will drive infrastructure investments over several decades.

This is important for areas like South Park, an industrial neighborhood along the Duwamish River. **Many parts of South Park lack sidewalks, curbs, gutters, and sufficient drainage infrastructure.** The neighborhood experiences regular flooding from stormwater, water main surcharges, and extreme high tides along the Duwamish. The area has a high concentration of immigrants, many of whom face language barriers when it comes to flood risk communication from the City.

Climate resilience has not always been top-of-mind for South Park. As with many vulnerable populations, South Park is dealing with much more immediate and pressing challenges related to economic displacement and health disparities. **Therefore, SPU sees a need to integrate those challenges into their flooding solutions,** and Ann Grodnik-Nagle, SPU's climate policy advisor, works closely with the community to address this head-on. Robin Schwartz of the Duwamish River Cleanup Coalition is a key partner organizing grassroots efforts in the area to align community voices and prioritize environmental needs. One of those voices is Monica Duarte, a community health worker at Villa Comunitaria, a South Park-based community service organization. Her work did not primarily focus on flooding issues until she saw the connections between climate effects and public health, making Monica an important educator on flooding within the Latinx communities.

SPU's goal is to align citywide efforts with community priorities to increase resilience. One exciting project for South Park is an innovative virtual reality **(VR) experience of sea level rise.** SPU is developing this tool in coordination with Seattle Public Library and the University of Washington Climate Impacts Group, building on a VR history of the Duwamish River that Seattle Public Library developed in 2019. The new tool will bring maps showing the two-to-four foot high water mark to life, allowing Ann and Monica, plus local schools and community-based organizations, to articulate a visual representation of the risks to residents and help prioritize their adaptation needs. As the City extends beyond infrastructure improvements, it will continue to focus on leveraging utility investments by driving economic opportunities and anti-displacement measures across neighborhoods.

Priority Action #5:

Target investments in vulnerable communities.

Flooding from Hurricane Harvey was widespread and disproportionately impacted Black and Brown communities throughout Texas. Port Arthur, TX, 2017.



Equitable resilience will require a careful rethinking and, at times, a reallocation of resources to neighborhoods most affected by flooding. Along with the planning process, it is essential to dedicate funding sources for vulnerable communities, particularly since climate impacts can increase financial volatility for utilities. It can be unwise to defer investments in equity, even in times where budgets are squeezed. Preparing for an uncertain future calls for no-regrets solutions and strategies that provide multiple benefits. Creating targeted funds for equity and setting benchmarks for spending helps include vulnerable communities in flood adaptation and mitigation strategies. By working together, cities can address system risks and needs for all communities.

Considering social vulnerabilities reorients the prioritization of investments.

Water professionals have a range of tools and strategies at their disposal to strengthen the communities that are most vulnerable, such as different types of early flood warning systems or a blend of green and gray infrastructure upgrades. Because vulnerable communities are often in high-risk areas, they may have a greater need for investment in flood management measures. For example, Cleveland's *Climate Action Plan* placed neighborhood revitalization at the center of efforts to manage an increase in precipitation volume and frequency. The Office of Sustainability worked with over 50 organizations to assess risks, needs, and resilience strategies. It built a toolkit with residents to guide neighborhoods in developing their own stormwater projects. A Climate Action Fund was established to finance neighborhood projects. The City has awarded \$100,000 to 25 different projects to date, including rain barrels, community gardens, and programs to hire from within vulnerable communities.

When selecting sites for physical adaptation strategies, it is important to weigh the economic and social implications of different options like building seawalls or levees, expanding the natural infrastructure like wetlands and dunes, or increasing the capacity of stormwater drainage systems. In some extreme cases, housing, businesses, and some physical infrastructure assets may need to relocate to safer areas. FEMA has buyout programs that compensate people for homes and businesses that may need to relocate—but the process is lengthy and circuitous. Unfortunately, most flood-prone homes belong to low-income owners who are least likely to be able to navigate long, drawn-out federal processes.³⁹ To counter lag times in FEMA buyout programs, the Charlotte-Mecklenburg Storm Water Services in North Carolina created an innovative local voluntary buyout program. The utility funds the program through fees collected from impervious area charges at offices, government buildings, and homes. Many of the properties are then turned into retention ponds, greenways, and community gardens, or reforested, providing community amenities in addition to managing floodwaters.⁴⁰

In these situations, it is crucial to provide adequate funding for vulnerable residents to relocate in an equitable manner by buying out their homes at the market rate. Fair processes and compensation are necessary when flood resilience requires any kind of managed retreat.

Capital investments balanced with affordability programs lead to benefits for all.

Building climate resilience will be an expensive process, on top of the rising costs of infrastructure development and maintenance. Utilities must repair and retrofit existing systems and build new infrastructure components to handle increased precipitation and better manage flash floods or extreme events. Emergency response, adaptation efforts, and mitigation projects all come at a significant cost to utilities and cities. As they prepare for these expenses, agencies should consider the ability of vulnerable populations to pay. Many low-income households have a hard time paying their water bills currently and cannot support rate increases. At the same time, rates are often the primary funding source for day-to-day utility operations and investments in system improvements. Utilities commonly raise rates to keep up with the rising costs of labor and materials and make debt service payments on bond-financed capital improvements—and this will only increase as they prepare for climate change.

As utilities plan for climate change, they should have robust affordability and assistance programs to ensure that the necessary rate increases to manage stormwater and flooding will not harm their most vulnerable customers. Affordability programs should tailor to each locality's circumstances and the characteristics of its low-income communities. For example, a city with a high proportion of residents below the poverty line may have different affordability needs than a generally affluent community with isolated areas of poverty. Key considerations may include the distribution of poverty, homeownership rates, and the community's existing social service network. Affordability measures should include specific measures for renters. In some jurisdictions, there are legal barriers to certain rate structures and bill assistance options. Stakeholders must understand and work together to address such barriers to develop viable approaches.

Projects designed to deliver economic benefits that reduce flood vulnerabilities boost resilience.

Capital investments in water systems can generate economic benefits to communities through contracting opportunities and job growth to help address underlying factors that contribute to overall resilience. As they become more resilient, utilities will need to expand their workforce to construct, maintain, and operate updated systems. At the same time, underemployment and unemployment are chronic issues for many communities.

For instance, the City of Columbus' integrated wet weather management plan has three major goals: removing stormwater from sanitary sewers, routing runoff to green infrastructure, and investing in the local economy. Over 30 years, the plan known as *Blueprint Columbus* will boost the local economy by creating an estimated \$3.3 billion in regional output, providing \$900 million in earnings, and creating 700 new jobs. The City established a Green Infrastructure Workforce Development Training Program, an innovative workforce development program, sponsored by a partnership between the City, T&M Associates, Columbus State Community College, and the Columbus Urban League. The program teaches students the skills to construct and maintain green infrastructure, like rain gardens and pervious sidewalks. It includes classroom instruction and field training on topics such as hydrology, soil basics, vegetated systems, and maintenance. Graduates are also issued an Occupational Safety and Health Administration (OSHA) Construction Safety Awareness card and a certificate in Green Infrastructure Construction/Maintenance, recognized as equivalent to work experience that provides eligibility for green infrastructure contracting.⁴¹

Utilities can partner with city and state agencies, schools, and trusted nonprofits to develop career pipelines for recruitment when permanent utility positions open. And as utilities invest in the neighborhoods that are most vulnerable to flooding and other climate-related impacts, they can commit to local hiring in those same areas. In doing so, they can generate multiple benefits from flood resilience to local economic vitality.

Case Example

New Policy Re-Focuses Spending on Flood Resilience to Advance Equity in Houston, TX

Location

Houston is a large metropolitan city in Southeast Texas. The city lies just northwest of Galveston Bay, which feeds into the Gulf of Mexico. It has a large land area and is the most populous in the state.

Land Characteristics

There are 22 bayous and watersheds within the metropolitan Houston area. The land has a relatively flat topography and clay soils.

Key Water and Climate Challenges

- Thirty percent of Houston lies in a floodplain.
- Overland sheet flow
- Riverine flooding
- Localized flooding
- Sixty percent of stormwater infrastructure fails to meet current standards.
- More erratic precipitation patterns
- Hotter temperatures

A series of extreme events in Houston has spurred a coalition of city agencies to join efforts to improve resilience. Jamila Johnson, an infrastructure policy manager, and Tanu Hiremath, the stormwater maintenance managing engineer, at Houston Public Works are working closely with Marissa Aho, the City's chief resilience officer, to prioritize investments and help communities better prepare for such events.

From 2015 through 2017, three storms exceeding the 500-year flood moved inland and made landfall in Houston. Although shallow, brief urban flooding is relatively common throughout the city, these events revived citywide flood management efforts, particularly in historically disadvantaged areas. Then Hurricane Harvey broke all storm records in 2017. Nearly 52 inches of rain fell in four days, an outcome that even advanced weather and climate models could not predict. Flooding affected nearly every area of the city, but the aftermath devastated vulnerable communities. Pre-existing vulnerabilities such as health disparities (life expectancy varies as much as 20 years from one area to another), housing and

transportation affordability, and a lack of adequate infrastructure investment have made flooding impacts worse and stalled recovery efforts.

In the Kashmere Gardens neighborhood, the storm damaged 42 percent of structures. The National Flood Insurance Program policy covered only 10 percent of these structures, largely due to homeowners lacking insurance. The average claim was around \$56,000. Most of the other homeowners had to recover with their own resources along with FEMA individual assistance payments, which only averaged \$4,300.⁴² The equity implications of this are staggering. Nearly 97 percent of residents in Kashmere Gardens are African American or Hispanic, and median incomes for the neighborhood are about one-third that of the rest of the city.

Situations like this have driven groups like the Coalition for Equity, Environment, and Resilience (CEER) to pursue a more equitable recovery approach. Iris Gonzalez, CEER's coalition director, led nearly 25 community and environmental organizations to advocate for better flood policies and infrastructure investments in communities like Kashmere Gardens. Iris has found support among local government agencies through a partnership with Jamila, Tanu, and Marissa. The group has also garnered allies in public institutions, such as Dr. Earthea Nance of the Houston Flood Consortium and Texas Southern University. Together, they are guiding recovery in Kashmere Gardens and raising the neighborhood's profile for a "complete communities" city project to streamline green and gray infrastructure for flood management.

On the one-year anniversary of Harvey, Harris County voters passed a \$2.5 billion flooding bond known as the "Harris Thrives" resolution in a three-to-two split along party lines. The resolution accelerates flood infrastructure spending in areas where people are in the greatest danger of flooding. But it was the first time a measure set a policy framework for advancing equity by using a "worst first" formula. The formula uses eight separate criteria, including the CDC's Social Vulnerability Index, to consider different stressors during disasters.^{43,44} The resolution will fund over 230 flood mitigation projects with "an equitable distribution of resources."⁴⁵ A community oversight committee is working to define equity and guide implementation. Iris is part of this committee and will work with Jamila, Tanu, and others on the selection and prioritization of projects in Houston. The committee is an accountability mechanism, ensuring that funding investments target vulnerable communities.



Water professionals, city agencies, and communities make better progress on equitable flood management when they work together.



Conclusion

The water sector can leverage this moment of a global crisis and transition to more resilient and equitable water systems and infrastructure. True resilience will only be achieved when all communities are prepared for a changing climate. Equitable flood resilience entails more than managing water and strengthening infrastructure assets. How quickly all communities can adapt, respond, recover, and bounce forward matters. Communities and cities with the strongest solutions are those leading with community leadership, participation throughout the process, and shared decision-making. As the waters rise, so too must water professionals and communities rise together to meet current challenges and whatever uncertainty the future holds.

The Bootcamp cities, and others, demonstrate such a path forward. They are beginning to show what is possible when cities embrace flooding adaptation and mitigation strategies that support all communities. Their efforts are a work in progress, with stakeholders learning from one another as they go.

At the heart of their work, water professionals, city agencies, and communities who are tirelessly working to address flooding care about the same thing: keeping people, property, and the environment safe. Because flood risk looks different from a hydrological, city, and resident perspective, water professionals must bring the work of all stakeholders together to co-create solutions and hold each other accountable. The dual mandates of protecting public and environmental health make equitable climate resilience an important frame for water utilities. Utilities and other water professionals can use their authority and established relationships to uplift community needs, recognize all forms of knowledge about flooding, and create a shared space for decision-making that strengthens communities.

As the nation looks toward an equitable and resilient future, the five priority actions offer tangible ways for water professionals, communities, and cities to begin this work. They challenge stakeholders to look beyond individual actors or sectors' actions and meet the complicated nature of urban flooding with holistic solutions that activate community resilience. As we learned from the Bootcamp cities, this will better inform both adaptation and mitigation efforts, minimize unintended consequences, and ensure all residents access to the same protections and benefits. Proactive planning for equity can build trusting relationships between water professionals and their communities. Communities will be more likely to support flood management measures, and cities as a whole will be better prepared for climate change.

Political will, leadership in the water sector, and funding all remain significant gaps.¹ Federal coordination is essential. We need regulatory frameworks that support proactive and equitable responses. Regulators need to encourage and work with utilities to consider these issues holistically alongside regulatory mandates to incorporate urban flooding into planning efforts. This goes hand in hand with stakeholder interests: regulators must learn from communities about flooding impacts to represent and address their challenges better. We also need utility leaders and elected officials willing to step up and challenge the status quo. Urban flooding will worsen in the absence of strong leadership and coordinated program efforts.

Rational long-term planning is also critical. Moving forward, the water sector must direct attention toward emphasizing the necessity for land planning and zoning to protect vulnerable communities in low-lying areas. Stakeholders must prevent future development in these areas where hazards already exist and that are further threatened by climate change impacts.

Finally, both structural and non-structural solutions require money. We need significant investments to address urban flooding in an equitable way. Climate and resilience funders can use these actions as a framework for continued investment in local projects. They can encourage the implementation of equitable resilience by supporting efforts that carry out priority actions. But water professionals also need more local, state, and federal funding to implement coordinated small-and large-scale flood management projects. Current federal funding is insufficient, and even with FEMA or other federal agency funding that has been around for years, too many people remain in harm's way. In many parts of the country, small drainage districts with no support system run levees that protect small housing clusters (often immigrant and low-income communities). Upgrading and expanding these protections require significant funding. Cities unable to get bonds will need innovative financing models or low-interest loans for climate resilience projects.

Funding structures, policies, and leadership must all work together to build more equitable pathways to urban flooding resilience. Each agency must use the best available climate data to invest in infrastructure and community assets that strengthen all residents' capacity to prevent flooding and prepare for unavoidable conditions. The five priority actions will not only improve flood management across the United States but may serve as an example of how equitable resilience strategies can solve other climate-related challenges across all sectors.

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About the US Water Alliance

The US Water Alliance advances policies and programs to secure a sustainable water future for all. Our membership includes water providers, public officials, business leaders, environmental organizations, community leaders, policy organizations, and more. A nationally recognized nonprofit organization, the US Water Alliance brings together diverse interests to identify and advance common ground, achievable solutions to our nation's most pressing water challenges. We:

- **Educate the nation about the true value of water and the need for investment in water systems.** Our innovative education and advocacy campaigns, best-in-class communications and media activities, high-impact events, and publications are educating and inspiring the nation about how water is essential and in need of investment.
- **Accelerate the adoption of One Water policies and programs that manage water resources to advance a better quality of life for all.** As an honest broker, we convene diverse interests to identify and advance practical, achievable solutions to our nation's most pressing water challenges. We do this through national dialogues, knowledge building and peer exchange, the development of forward-looking and inclusive water policies and programs, and coalition building.
- **Celebrate what works and spread innovation in water management.** We shine a light on those who engage in groundbreaking work through storytelling, cataloging and disseminating best practices, and spearheading special recognition programs that focus attention on how water leaders are building stronger communities and a stronger America.



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