HB0295/SB0227
Written Testimony
Karen Metchis

My name is Karen Metchis and I am a resident of Montgomery County, Maryland. I am writing to submit information in support (with amendment) of HB0295 (E&T – Love, Henson) and SB0227 (EH&EA - Elfreth, Hester, and Pinsky).

HB0295/SB0227 requires the Department of the Environment to review and update certain regulations at least once every 5 years; requiring the Department to propose the first update to certain regulations on or before January 1, 2022; requiring the Department to review and update certain regulations in a certain manner; requiring the Department to take certain actions at least 6 months before the proposal of regulations under the Act; altering the time by which the Department must hold a certain public hearing; etc.

I retired from USEPA about 18 months ago, where I worked on adaptation of EPA's water programs to climate change. Since then, I have been consulting with NOAA on similar issues. I have sat through many workshops where state and local water and infrastructure managers have described the challenges they are facing, and how they are working to address these new impacts that is costing taxpayers money and putting lives and livelihoods at risk. I also co-chaired the Montgomery County Adaption Workgroup which prepared recommendations for building resilience. I have also been recently participating as a citizen member of the Maryland Climate Change Commission's Adaptation and Resiliency Workgroup. I offer my suggestions speaking as a citizen, not representing a particular organization.

<u>Amendment 1: Require DEP and DOT to adopt a method for incorporating future risk.</u>

The first critical step is to use updated data and statistics, and to update them at regular intervals. **Section (b) (3) (I)** of this bill effectively stipulates that requirement. Thank you for this.

I would also add, importantly, that we can no longer rely on historical data. Climate change is affecting the nature of the hydrological cycle. Maryland may get similar annual quantities of rain, but the pattern of rainfall nationwide is shifting, with rain falling in more intense bursts over shorter durations, thereby overwhelming our physical infrastructure that is designed for a more steady rain.

It is well known that the effect of climate change on precipitation is difficult to model with high confidence, and there is no best solution at this time. But it is also widely recognized that doing nothing is not an option. Rather, the conventional wisdom is to adopt robust risk management strategies

Step 1 is to use the most updated data and to review them regularly, e.g., every 5 to 10 years, as this bill requires. In addition, based on my experience, I suggest that Step 2 is to develop a method for accounting for risk of more intense rainfall in stormwater and drainage systems. This is important because, once infrastructure is built, and settlement patterns are in place, it is very difficult to change. Best to plan for the future now.

Therefore, I request that an additional requirement be added to this legislation, requiring Maryland DEP and DOT to study this issue and develop a state-wide method for building in future hydrological shifts into our stormwater, drainage, and building codes.

I am attaching a list of examples of what other cities, counties and states are doing – I am not suggesting the exact method we should adopt, I leave that to State staff to work out.

Amendment 2: Add language addressing overland nuisance flooding.

The second important amendment to this legislation derives from the fact that flooding is not only the result of out-of-bank riverine flooding. And that kind of flooding relates to FEMA floodplains and the like. When it comes to stormwater and drainage management, we are talking overland flooding and the design of infrastructure. Currently, b (2) [8] (ix) (9) reads:

> *[(ix)] 9. Implement quantity control strategies to prevent increases in the frequency and magnitude of out–of–bank flooding from large, less frequent storm events.*

I'd like to see an additional item, label it b(2)[8][x]10, to "Implement quantity control strategies to prevent increases in the frequency and magnitude of runoff to adjacent residential properties **that causes nuisance flooding, and that cumulatively contributes to overwhelming the stormwater system in the storm-sewershed."**

Additional Amendments and Clarifications:

Below are additional suggestions for this legislation, for your consideration.

The following comments are based on addressing the last 'whereas' of this legislation that states:

> *WHEREAS, Outdated precipitation and storm design standards result in insufficient stormwater controls that fail to protect households and communities from precipitation–based flooding; now, therefore….*

Section (1) (b) (2)

Section b (1) (1) (i): Does this include when an old small house is torn down and a new larger one built? What does 'predevelopment' mean? Is it only for previously unbuilt properties? If it contemplates re-development, then the rest of that section is pretty good. But if it relates only to greenfields (previously vacant land), it falls short of the goal to protect current households from flooding.

> *[(1)] (I) Indicate that the primary goal of the State and local programs will be to maintain after development, as nearly as possible, the predevelopment runoff characteristics.*

b (4) (iv) [(4)] (IV) should be more specific about limiting the ability to give exemptions, including requiring notice to nearby property owners, *especially residential property owners*.

> *(4) (iv) Specify the exemptions a county or municipality may grant from the requirements of submitting a stormwater management plan;*

b (6) (VI) Related to the above, says this, but I don’t understand what it means. I want to ensure that redevelopment doesn’t worsen existing conditions ***at least for residential areas*** and hopefully improves it:

> *[(6)] (VI) Indicate that water quality practices may be required for any redevelopment, even when predevelopment runoff characteristics are maintained;*

Section (c) (1) (II (2) - The item about consulting with stakeholders - maybe amend to say ‘including but not limited to” or something more explicit that includes an environmental NGO or someone from the Metropolitan Washington Council of Governments or from the Baltimore area (major urbanized area).

Circling back to **Section (b) (3) (I)** above, perhaps we should add a requirement to add precipitation monitoring gauges so MD has a denser gauge network for understanding variation in precipitation both spatially and temporally, beyond what is collected by NOAA and represented in NA14. This will assure Maryland has the spatial data needed to fully understand the causes and effects of climate change’s many impacts.

Thank you for your consideration of these suggestions. And thank you for all the work you are doing during this horribly challenging times.

Sincerely,

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Attachments:

1. **Investigation into approaches to address impacts of climate change on stormwater management**
2. **Filling the Gaps: Climate and Weather Information for Small- and Medium-size Water Utilities. Project Summary (NOAA 2020).**

Attachment 1: Investigation into approaches to address impacts of climate change on stormwater management

This document is a brief collection of examples of State and local efforts to address flooding and stormwater management in the U.S. It is not comprehensive, but provides a window on the ways communities are addressing resilience against current and future impacts despite limitations in future projections.

Compiled by Karen Metchis for the Maryland State Legislature
January 19, 2021

Anecdotally, we find that some cities adopt a 20% margin as rainfall has changed in their areas, some are adopting higher standards because their old standards were failing to handle the amount of rain falling, several are attempting to downscale and recalculate precipitation statistics, some consider the rule of thumb that every 1 degree of temperature increases atmospheric moisture 7% or more (and hence, downpours), some adopt the 500 year (for floodplains vs. the 100 year to abate risk. My own observation about using the NOAA Atlas 14 statistical central tendency makes me think that the least we can do is use the high end value in combination with using updated data. Also, there is general recognition that rain is falling in shorter duration, larger cloudbursts and precipitation models are not good about capturing that…and most codes assume the rain falls over 24 or 48 hours - rather than in sub-daily bursts.

Other communities are conducting sensitivity analyses to identify points of highest vulnerability to changes in intensity and/or duration, some are creating integrated dynamic hydraulic models to assess system performance in different 'worst case' scenarios, and others are creating visualization tools to communicate implications of flooding.

Information contained here is drawn from attendance at workshops, telephone conversations, and summaries including:
Filling the Gaps: Climate and Weather Information for Small- and Medium-size Water Utilities. Project Summary, at https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/Water-Resources/Water-Utility-Study

Recent Studies

- **NOAA Study: Filling the Gaps: Climate and Weather Information for Small- and Medium-size Water Utilities** https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/Water-Resources/Water-Utility-Study

- **US EPA Study: Improving the Resilience of Best Management Practices in a Changing Environment: Urban Stormwater Modeling Studies**
https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NCEA&count=10000&dirEntryId=339576&searchall=&showcriteria=2&simplesearch=0&timstype=

State Level IDF Statistic Investigations

- **Illinois State Water Survey – State Bulletin 70 -** rainfall frequency studies for Illinois and the Midwest. https://www.ideals.illinois.edu/bitstream/handle/2142/103172/ISWS-CR-2019-05-REVISED.pdf?sequence=4&isAllowed=y
  This study used updated data through 2017 and techniques (L-Moments) to provide an update to the original Bulletin 70,published in 1989. Compared with the original Bulletin 70 (Huff and Angel, 1989), the results of this study generally show increasing precipitation amounts at selected frequencies for most of the sections [of Illinois] with some relatively smaller decreases in the southern and western sections of Illinois. The present study shows consistent increases compared with NOAA Atlas 14 (Bonnin et al., 2006) and better reflects the current risk of heavier precipitation events. The changing climate of heavy precipitation observed in Illinois and the Midwest presents a significant challenge for storm water management. The observed increases noted in this report, along with the expectation of continued increases over the 21st Century (Easterlinget al. 2017), will necessitate more frequent assessments of precipitation frequency, as suggested by Winters et al.(2015). To help plan for future climate change, this analysis, representing the present time, should be accompanied with frequency analysis of climate model-generated data for future time horizons (Markus et al., 2017, 2018)

- **New York and New England** http://precip.eas.cornell.edu/ - Some states have adopted this as their reference source

- **New York State:** https://www.dec.ny.gov/docs/water_pdf/swdm2015entire.pdf

- **New York State** – IDF curves – future projections for a changing climate. http://ny-idf-projections.nrcc.cornell.edu/index.html

- **Maine:** https://www.maine.gov/dep/land/stormwater/stormwaterbmps/vol3/appendixa.pdf

- **New Hampshire:** Citation TBD
- **Colorado and New Mexico Dam Safety Regional Extreme Precipitation Study.** https://psl.noaa.gov/outreach/resources/handouts/co-nm-reps.pdf . Innovative “ensemble-of-methods” approach to test and evaluate a variety of new tools, methods, and datasets with which to update extreme precipitation estimates.
  - Produced updated deterministic "storm-based" probable maximum precipitation estimates (PMP)
  - Developed precipitation frequency estimates to inform the PMP estimates using a risk-based, annual exceedance probability framework
  - Applied state-of-the art weather prediction modeling to examine and inform the deterministic and probabilistic results

Local Level Investigations

- **Boston, Massachusetts Water and Sewer District (Charlie Jewell, Director of Planning and Sustainability).** The District developed a risk mapping tool to inform a multi-pronged approach to manage stormwater and protect against the risk of flooding, including during concurrent incidents of intense rain, storms, and storm surge.

- **Cambridge, MA Community Development Department - (John Bolduc, Environmental Planner).** Planners in this dense urban coastal town realized they couldn't build their way out of future flooding, so they adopted a multi-pronged approach, including planning all future development with the goal of upgrading design codes to withstand the future 10-year storm while being able to recover from a 100-year storm.

- **Chicago, IL (Cameron Davis, Commissioner, Metropolitan Water Reclamation District)** MWRD amended its Ordinance to incorporate Bulletin 70 – which is regularly updated to incorporate the latest science on increasing intensity of precipitation due to climate change - and to address the city's history of racism by factoring in disproportionately impacted areas.

- **Ann Arbor, MI (Jerry Hancock, Stormwater and Floodplain Programs Coordinator).** Ann Arbor designation as a Class V1 floodplain underlies a progressive program to control runoff and the City has proposed an ordinance to address increasing incidence of flooding, by changing flood plain elevation requirements from the 100-year storm to the 500-year.

- **Portland, OR (**Nishant Parulekar, Civil Engineer, Bureau of Environmental Services) Given the numerous different climate projections available and the complexities associated with their interpretation, Portland decided to take a different approach to assess their vulnerability to projected changes in precipitation. Their novel sensitivity analysis provides a basis for evaluating localized risk and conducting cost/benefit studies to prioritize investments.

- **Pittsburgh, PA (James Stitt, Sustainability Manager, Pittsburgh Water & Sewer Authority).** Recognizing that water quality and flooding issues were symptoms of ineffective stormwater management, the city eliminated silos and adopted a true integrated stormwater management plan closely tied to the city's development.

- **Virginia Beach, VA (Tom Utterback, Administrator and C.J. Bodnar, Technical Services Manager, Public Works Stormwater Engineering Center).** The Hampton Roads region of Virginia is experiencing the highest rate of sea level rise on the East Coast. In addition, rainfall rates in Virginia Beach have increased by 10% since the last publication of NOAA Atlas 14. This increased rainfall rates are causing recurrent flooding of roads, homes and business and creating water quality problems. These problems motivated the City

Manager to consolidate all stormwater functions into a single engineering center in order to comprehensively address the multiple causes of flooding and update the city's stormwater management plan, last completed in the 1990s. Under the leadership of the Department of Public Works, the Virginia Beach Sea Level Wise study was undertaken to lay out comprehensive city-wide strategies to reduce flooding and protect water quality.

- **Northeast Ohio Regional Sewer District (Frank Greenland, Director of Watershed Programs).** It took 15 years, but the 62 communities in the Sewer District's service area were convinced that stormwater management is an essential aspect of wastewater management – leading to a strategy with dedicated funding for a basin-scale plan, including emphasis on flooding in disadvantaged communities.

- **Anacortes, WA** ***:*** The wastewater utility would be at risk from increasingly extreme rainfall, especially as the city continues to grow that would increase runoff as well as demand for wastewater and sewer services. Heavy precipitation is expected to deliver over 20% more water that would impact the function of the city's combined and separate sanitary sewer systems. The City increased the capacity of their wastewater treatment plant from the legacy 3MGD capacity to 10MGD.

- **King County, WA**: Updated precipitation statistics heavy-precip-and-stormwater; *Expanding the Ensemble of Precipitation Projections* https://cig.uw.edu/wp-content/uploads/sites/2/2020/03/TechMemo_KingCountyPrecip_2019.pdf

Attachment 2: Filling the Gaps: Climate and Weather Information for Small- and Medium-size Water Utilities. Project Summary. NOAA 2020. Available at: https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/Water-Resources/Water-Utility-Study

Filling the Gaps

Climate and Weather Information for Small- and Medium-size Water Utilities

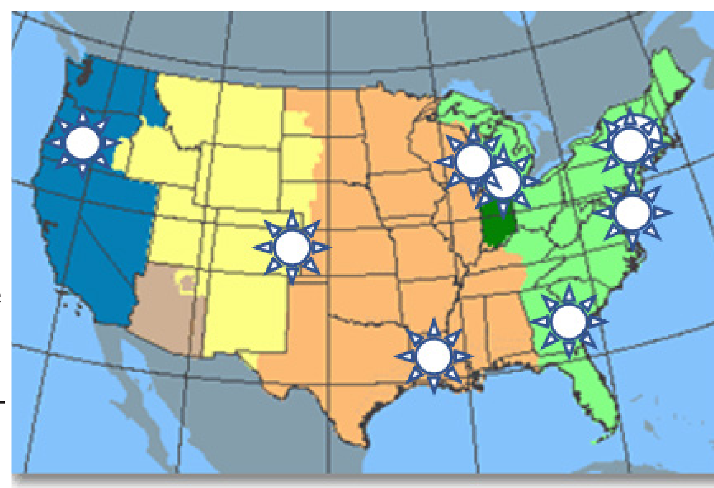
Project Summary

July 2019–October 2020 Workshop Series

Project Overview and Method

This workshop series was designed by the National Oceanic and Atmospheric Administration (NOAA) and the Water Research Foundation (WRF) to improve the delivery of climate and weather information resources for small- to medium-size water systems with the goal of building their resilience to climate change. Seven regional workshops were held. An additional stand-alone webinar on water equity was held in the Great Lakes Region, planned and held jointly by the US Water Alliance and NOAA.

Each workshop was organized by NOAA and its national and regional partners and were tailored to address issues identified by and for each region. Regional leads were asked to reach out to the water sector – community drinking water and wastewater utilities, stormwater managers, urban planners, public works departments, etc. – to design agendas according to regional interests and preferences. As a result, every workshop was different, varying in length, number of sessions, agendas, and in one case, one-on-one interviews in place of a workshop. Collectively, approximately 900 people participated in the workshop series.



Lessons Learned in the Water Sector

Managing Stormwater and Flooding

Planners almost universally expressed the need for updated, local scale information, including maps, statistics, forecasts, and projections - including precipitation statistics, floodplain maps, sea-level rise, high tide storm surge, and high river water levels. At a minimum, updated information is needed that: uses the most current observational data, including hourly and sub-hourly data; updates intensity-duration-frequency statistics including NOAA Atlas 14; and, ideally, provides methods to estimate future changes for long term planning. Updated precipitation and flood statistics are particularly needed for the 50- and 100-year events that appear to be happening more often in some communities.

FOR MORE INFORMATION, VISIT THE ***WORKSHOP SERIES WEBSITES*** *+ DOWNLOAD THE WORKSHOP FACTSHEETS*

NOAA WORKSHOP SERIES

- *cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/Water-Resources/Water-Utility-Study*

MARISA/CCRUN WORKSHOP

- *Download Factsheet*
- *rand.org/events/2020/03/05/webinars.html*

GLISA WORKSHOP

- *Download Factsheet*
- *glisa.umich.edu/stormwater-webinar*

SERCC WEBSITE

- *Download Factsheet*
- *sercc.com*

PNW WORKSHOP

- *Download Factsheet*
- *waterrf.org/research/projects/using-climate-information-water-utility-planning*

SCIPP WEBSITE

- *Download Factsheet*
- *southernclimate.org*

NRCC WORKSHOP

- *Download Factsheet*
- *nrcc.cornell.edu/workshops/mar_2020_utility/utility.html*

WWA WEBSITE

- *Download Factsheet*
- *wwa.colorado.edu*

EQUITY WORKSHOP

- *Download Factsheet*

APPENDICES

- *cpo.noaa.gov/Portals/0/Docs/Water-Resources/Project-Appendices.pdf*

State and local codes often do not reflect the most recent precipitation data that is available, resulting in the use of outdated information by engineers and planners. Engineers and planners are less likely to use updated information or future projections in system design until they are incorporated into state and local code and standards. Furthermore, updating stormwater policy to address extreme precipitation is encumbered by the wide range of approaches that are being discussed by the research community. Widespread adoption will rest on development of consistent methods and best practices for incorporating downscaling into hydrologic modeling and system design.

Most communities are not relying on climate downscaling to make decisions, but are taking many practical steps to evaluate system performance and adopt policies to limit vulnerability, such as using regional approaches to integrated planning; consolidating departments for stormwater management oversight; creating dynamic models to evaluate system performance; upscaling design storms; and conducting sensitivity analyses and vulnerability assessments to target investments for infrastructure upgrades.

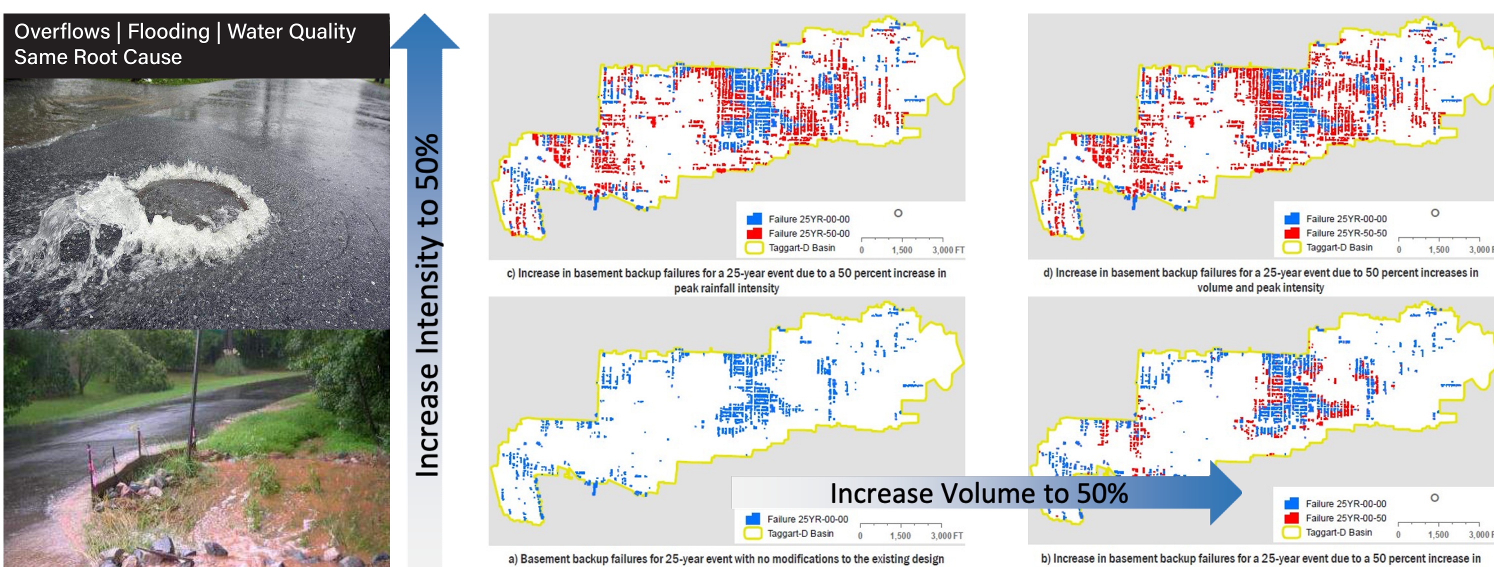
The differences in scale and resolution between climate model outputs and hydrological model inputs makes it extremely difficult for any but the most sophisticated modelers to merge the two. Without reliable and widely adopted methods, it is unlikely that there will be widespread use of climate models in local water utility management beyond some scenario planning, vulnerability assessments, and qualitative sensitivity analyses.

Assumptions about design storms are significant and affect the performance of stormwater and flood control systems. Anomalies were noted in three workshops where rainfall was notably different across the city or geographic region (i.e., Mountain West, Pacific Northwest, and Southeastern Coast). Some were attributed to micro-climates.

Many utilities have developed hydrologic and hydraulic (H&H) models, but extreme conditions may invalidate their calibration to historical precipitation. Furthermore, H&H models are typically simplified (e.g. conduit skeletonization, subcatchment aggregation) that limits their use in evaluating performance of stormwater systems. Despite the difficulties, larger cities are working with researchers to experiment with methods for improving H&H modeling including better representation of the constructed hydraulic system, creating dynamic models, and even incorporating climate projections.

Dynamic coupling of H&H models has helped some communities evaluate risk, visualize impacts, and align investments with hazard mitigation. Dynamic models include, for example, coastal hydrodynamics, tidal fluctuations, surges and sea level rise, inflow through storm sewers, overland rainfall-runoff, groundwater flow, etc.

More research is needed on understanding and preparing for cloudbursts (short duration heavy rainfall events). Stormwater systems are typically designed based on 12-hour or 24-hour rain values (occurring every 1-2 year) and street drainage is typically based on 24-hour rains (occurring every 10-years). However, rain is frequently occurring in intense, short duration (minutes to hours) bursts that cause stormwater, storm sewers, sanitary sewers, and streets to flood.



Sensitivity Analysis of Stormwater System, Portland Bureau of Environmental Services, 2020

Water Supply

Soil moisture deficits are increasingly affecting runoff, especially in the intermountain west. Dry soil conditions are increasingly a dominant factor even in areas with adequate snowpack, and local water managers are starting to understand these connections. A simplified water budget analysis illustrates that streamflow may decrease by as much as 25% with a 10% increase in evapotranspiration. These deficits are creating more pressure on communities to conduct vulnerability assessments, improve community education, and develop drought contingency plans.

Understanding changes in snowpack is becoming more critical for water supply managers. More SNOTEL monitoring sites and methods to track mid- and high-elevation snow such as the use of airborne snow observations will increase planners' ability to manage water supply as well as potential flood conditions.

Some participants felt capable of managing water supply and demand but needed better local scale near-term forecasts for advance preparations, e.g., 2-3 week precipitation forecasts, alert of rapid switching between wet and dry periods and flash drought, and likelihood of extended number of El Niño-Southern Oscillation (ENSO) years.

Anacortes, WA Water Treatment Plant
Watertight Construction

Drought conditions have left the water level unusually low at Swan Lake, pictured here in late August, and other Maine waterways | Bill Baxter | BDN

Equity

Lower income areas are often located in areas with old and aged infrastructure and are subject to increased incidences of sewer backups and basement flooding as well higher vulnerability to catastrophic flooding. Providing equitable levels of service is challenging due to issues of affordability and lack of funds to replace aging infrastructure.

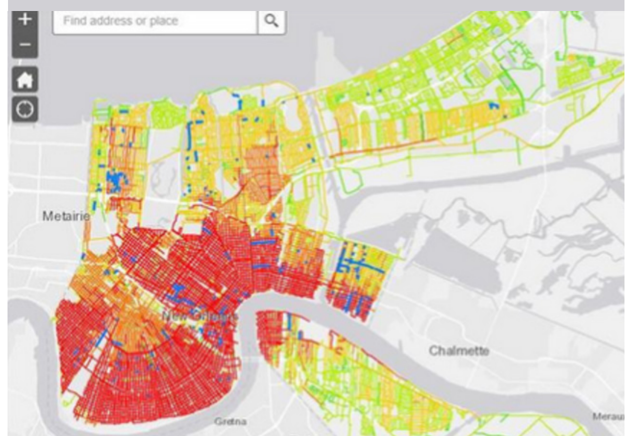
Adopting a community-based approach, while evaluating climate adaptation options, leads to more successful projects that benefit all residents and achieves triple bottom line benefits for social, economic, and environmental resilience

Engaging trusted neighborhood residents as champions and ambassadors fosters common understanding between city and utility staff and community members, and helps connect communities to resources for project funding and affordability.

To redress inequity, communities could: map the overlay of physical science, infrastructure condition, and social data to understand vulnerability in order to focus work where it is most needed; and adopt innovative and dedicated funding.

Participants identified a need for practical equity and inclusion training in order to break down institutional and systemic barriers to equitable resilience planning. Participants asked for peer-to-peer exchanges and conversations about equity to learn from counterparts in other cities about what's working and what's not, and how to build a shared understanding and communication with populations they serve.

Mapping Vulnerability in New Orleans



Milwaukee Metropolitan Sewerage District
Fox Rain Garden

Capacity Building and Financing

Small- and medium-sized water utility staff have limited expertise and technical capacity to use climate change information; and limited time and resources to be trained on available tools or to find and use existing information that could inform plans. Providing more context on the meaning of NOAA's climate and weather information would help small- and medium-sized water utilities to understand its meaning, take action, and communicate to their communities.

Barriers to using available tools and information include:

- Time to find the appropriate tool especially given how many there are;
- Discerning the relevance of the tool to the application, the scale, and the particular location;
- Understanding accuracy and reliability when the results look like a 'black box';
- Lack of confidence in non-standardized tools especially whether they would be approved by regulators; and
- Lack of context and perspective on how to use information.

Utilities repeatedly emphasized the value of learning from their peers. Seeing how peers use climate information and how they put adaptation into practice helps to integrate solutions with their areas of expertise, and lends credibility and confidence in using new information, tools, and methods. Many participants noted their engagement with existing regional water practitioner networks.

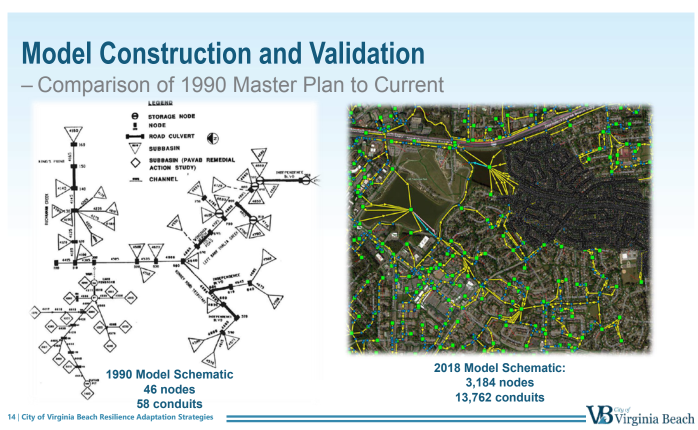
Some utilities are impeded by organizational culture that is resistant to new methods or community culture ambivalent about climate change. In addition, loss of institutional and watershed knowledge due to retirements is both a positive and a negative. In some cases, essential historical knowledge is lost; in other cases, retirements enable younger staff to embrace new methods and strategies.

Scientists can improve the useability of information and help organizations get buy-in to adopt new information and practices with appropriate:

- *Geographic Scale:* The right scale for the user.
- *Skill of info:* A track record of consistently and accurately projecting climate conditions.
- *Understandability:* Information is tailored to users' technical capacity.
- *Coproduction:* Actively engage users in development of new information products.
- *Organizational Factors:* Information is provided by trusted sources, a community of practice tests new methods, and the organization has resources to allow staff training.

Financing challenges are exacerbated due to changing conditions experienced by utilities, such as drought-induced water conservation that reduces revenue, decline in populations served leaving underused infrastructure, deteriorating conditions of infrastructure, and increased costs of maintenance and repairs. Affordability is especially an issue in small and low income communities, and in cities with aging infrastructure.

Overall, participants relayed that there is a perception that proactive adaptation is costly. However, utilities have estimated that investing in adaptation avoids costly future damages. Acceptance of climate change adaptation is increased when it is integrated into ongoing planning and operations, including during the scoping phases of new or upgraded systems.

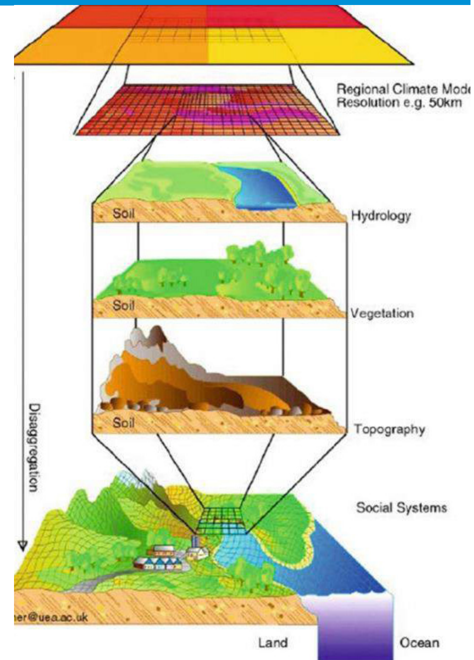


For long term planning, planners are trying to figure out how to integrate capital planning with climate models to ensure that projects are built to be future proof and are able to cope with multiple complex overlapping hazards. Integrating questions on climate risk into capital planning checklists can be one step to integration.

Information and Research Needs

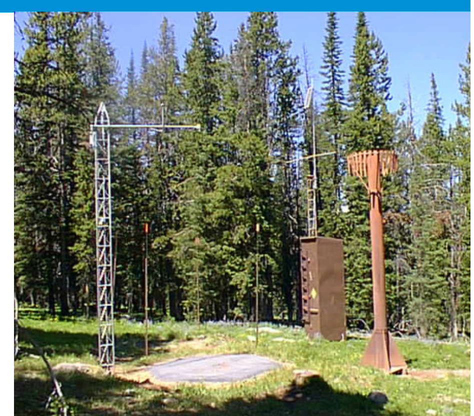
Stormwater and Flooding

- Collect more local scale hourly and sub-hourly data with rain gages
- Update local scale precipitation statistics
- Update precipitation and flood return periods, particularly 50- and 100-year events
- Update NOAA Atlas 14 or provide alternative intensity-duration-frequency (IDF) statistics
- Provide IDF curves incorporating climate change for long-term planning
- Improve understanding of precipitation variability, runoff, and flooding
- Quantify the range of uncertainty in forecasts and management and design decisions
- Provide local lightning and wind forecasts for maintenance crews
- Improve understanding of short-duration heavy rainfall events
- Improve prediction of local-scale heavy rainfall
- Provide probabilities of confluence of low probability, high impact events
- Conduct research and provide data on local-scale micro-climates
- Conduct research on past and future heavy rainfall



Water Supply

- Improve understanding of potential evapotranspiration (PET)
- Conduct more soil moisture tracking
- Improve information on soil moisture conditions and effects on runoff, water supply, and flooding
- Enhance mid- and high-elevation snow information
- Build better spatial resolution of Snow Water Equivalent (SWE)
- Deploy more SNOTEL monitoring sites
- Conduct more mid- and high-elevations observations from LIDAR, i.e., airborne snow observations
- Improve local-scale precipitation forecasts, including 2-3 week precipitation forecasts
- Explain ENSO projections, especially if expecting more than 2 consecutive years



Beartooth Lake SNOTEL site, Wyoming
Credit: NRCS

- Develop warnings of rapid shift between wet/dry conditions and flash droughts
- Provide better estimates of available groundwater data
- Provide guidance on water supply risk triggers; and storm readiness triggers
- Develop guidance on trigger levels for groundwater and surface water supplies

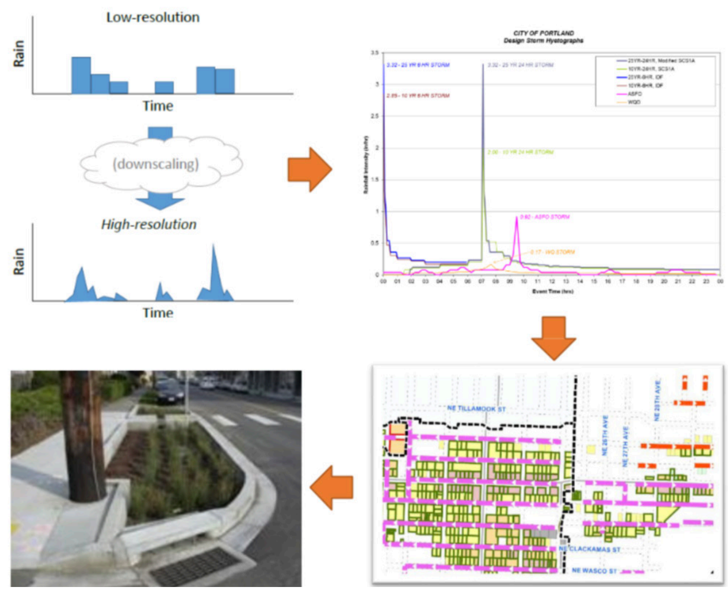
Milwaukee Metropolitan Sewerage District, Lincoln Creek, Milwaukee, Renaturalizing a Stream: Before and After

Equity

- Provide trainings to break down institutional and systemic barriers to equitable resilience planning
- Build understanding of what equity means for this sector, and how to do more equitable planning.

Capacity Building and Financing

- Disseminate information on how to finance adaptation and how to estimate cost-benefit and return on investment for stormwater and other water sector adaptation strategies
- Demonstrate how to integrate climate assessments into capital planning
- Provide methods for making decisions under uncertainty
- Provide technical assistance to overcome barriers to information use
- Provide opportunities for peer-to-peer learning and provide more case studies
- Leverage existing professional networks
- Leverage the relationships between small and large regional utilities to disseminate information, as small utilities often rely on larger utilities for information and guidance
- Build Communities of Practice to provide guidance and make information transferable
- Expand options for online workshops and trainings to meet demand and expand geographical reach



Testing downscaled models for system design, Portland, Oregon
Credit: Nishant Parulekar

Feedback on NOAA's Tools and Information

NOAA's websites contain a plethora of information and tools, much of which is useful for the water sector. However, NOAA's websites are overwhelming. Participants universally requested simplified access to information including simplified ways to find appropriate, usable, locally relevant information.

This sector needs scientific information that is more accessible and digestible and that conveys information to aid interpretation that is meaningful for the water sector.

Provide guidance and tools to help water professionals assimilate and communicate information - including guidance on communicating risk, uncertainty, and tradeoffs - to decision makers and the public would help get buy-in for adaptation.

There is a universal demand for updating NOAA Atlas 14. This need is driving some localities to invest in figuring out how to re-calculate IDF curves themselves, including how to create climate-adjusted IDF curves.

Lightning | Credit: NASA

Next Steps

Develop new tools and communication products, e.g.,

- Develop Case studies about water utilities' exceptional practices
- Update the NOAA Water Resources Dashboard and the Climate Resilience Toolkit
- Work with NOAA program offices to provide feedback on use of their information and resources
- Partner with water associations and regional organizations to promote peer learning and other activities to advance meeting user needs
- Produce peer-reviewed and trade journal articles about outcomes of this project, and present findings at conferences and meetings

For more information

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