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Refining the drinking water resilience gap

The effects of climate change, including storms and droughts, create challenges for the resilience of public drinking water systems. This transdisciplinary project brought together the Connecticut Institute for Resilience and Climate Adaptation (CIRCA), Milone & MacBroom Inc. (MMI), the University of Connecticut, and the Department of Public Health (DPH) to undertake research to asses the vulnerability and resilience of Connecticut's drinking water infrastructure. One component of the project was to examine the capacities of community water systems to absorb short-term shocks and learn from them, and to take action to reduce future risks. We investigated these capacities and how they interact using interviews (n=24) and a survey (n=85) of Connecticut community water systems. We found most systems have increased their capacity to short-term risks but, we know from the literature that increasing resilience to current threats does not guarantee long-term resilience. While some systems are learning from past experience, few are preparing adequately for future risks. We present opportunities for reducing this gap and call for more research on effective policy solutions.

The Challenge: Vulnerable drinking water systems

Connecticut's drinking water systems face challenges from a non-stationary climate. Droughts present long-term stress for systems.

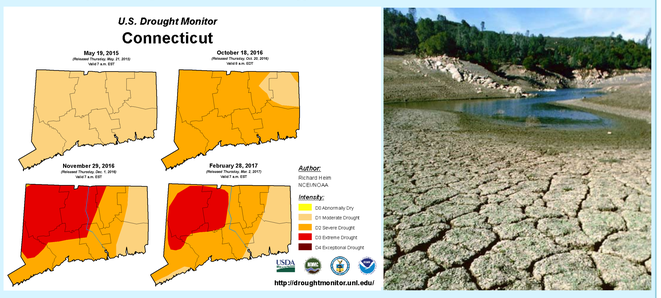

Fig. 1 2015-2017 severe drought imperils CT water supplies

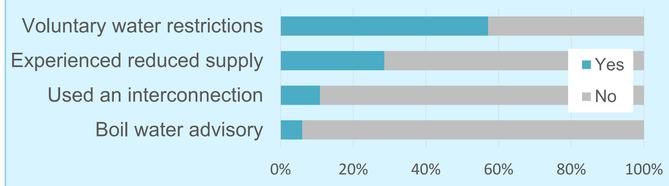

Fig. 2 Nearly a third of water systems experienced reduced supplies while two third ask residents to reduce water use

Power outages and flooding from extreme weather events represent acute stresses.

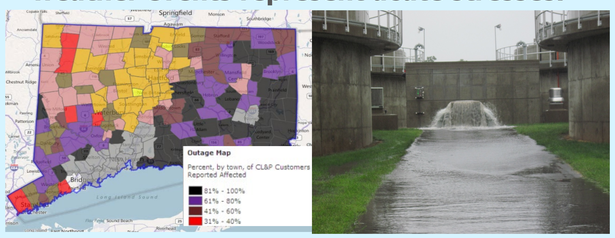

Fig. 3 Power outages and flooding 2011-2012

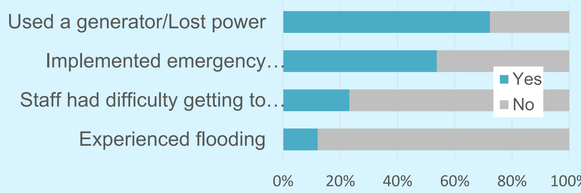

Fig. 4 75% of systems experienced power disruption

Climate change is likely to bring more frequent and severe drought and flooding in the future.

Methodology

Literature Review

- **Resilience literature** e.g., Campos and Darch 2015; Francis and Bekera 2014; Rudberg et al. 2012.
- **Water governance, adaptation, adaptive capacity** e.g., Berkhout et al. 2006; Eakin et al. 2014; Folke et al. 2002; Moser and Ekstrom 2010; Rudberg et al. 2012
- **Adaptive management** e.g., Baylis et al. 2016; Hess et al. 2012; Kirchhoff and Dilling 2016; Pahl-Wostl 2007

Core Findings

Fig. 5 Resilience encompasses physical/ natural and human dimensions and balances learning from the past with anticipating future change

Mixed Methods

Interviews

- 1 hour semi-structured phone interviews; recorded and transcribed
- N=24; 5 small, 7 medium, 9 large
- Independently coded; Nvivo qualitative analysis

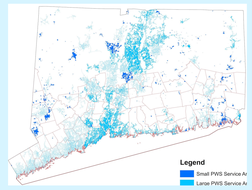

Fig. 6 Map of CT public water systems (2,500 PWS with ~500 CWS)

Survey

- 15 minute online survey administered using Qualtrics
- Multiple reminders and assistance from CT DPH in encouraging response
- N = 87; 40% small, 30% medium, 30% large
- Descriptive and non-parametric statistics; SPSS statistical software

Fig. 7 Survey landing page

Findings: A Resilience Gap

Results

Past Impacts

- Most systems experienced drought and storm impacts (See Figures 2 and 4)
- Impacts vary by water source, location, system age, and size (e.g., small systems more impacted by storms, larger systems more impacted by drought)

Response to Past Storms and Droughts

- Most systems found backup generators, funding, redundancy, and SCADA (for large systems) were helpful in managing past events as well as good operations and maintenance, a skilled workforce, communication with customers, and a healthy watershed are also rated as important.
- Responses varied by water source, location, system age, and size and typically included a combination of human and physical/natural dimensions of resilience (e.g., large systems have greater capacity to respond but have more exposure)

> *"I understand that the state wants generators. We don't have generators. That's an expenditure…we've always been able to afford the improvements that we need."*
> -- Public Utility Manager

Drivers of Change

- Regulatory compliance is the biggest motivator as is availability of funds (e.g., for generators)
- Climate change is not a huge driver or concern

> *"…in all honesty, that* [climate change] *really doesn't affect us. … As much as you know you want to say you're concerned about the environment or climate change, it's not affecting my water system."*
> --Public utility manager

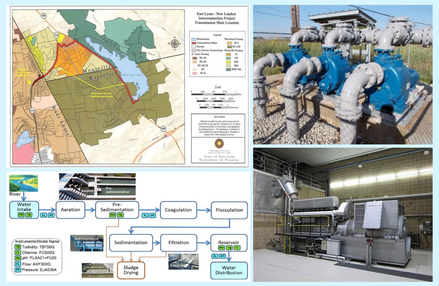

Fig. 8 Watershed investments, interconnections, backup generators, and SCADA systems among most common response to past events

Resilience to Future Change

- Most CWS aware that climate change will bring more frequent or severe droughts and storms
- Only high capacity systems are thinking about these changes and only in terms of strategic (very high level) planning

> *It's more thinking about and really trying to understand what is it that we really should start planning for. So we haven't gone far down that road, because like I said, you can probably be judged harshly in the regulatory world if you overreact. So it's finding the appropriate balance, as I said. Where's the prudent level of planning and investment."*
> *--Public utility manager*

Conclusions and Next Steps

- **Human Dimensions Matter** - While physical (technology, backup generators) and natural (watershed protection) dimension investments contribute to resilience, resilience is a human driven process
- **Resilience Gap -** Many community water systems lack resilience to extreme events now and are unprepared for future change
- **Flexible Policies / Ongoing Learning** – While CT is a leader on climate change, the uncertainty of future change requires flexible policy tools (Swanson et al. 2010) and encouraging ongoing learning (Mullin and Kirchhoff 2019; McDaniels and Gregory 2004)
- **Treuer, Kirchhoff and Mullin –** Manuscript in preparation detailing project approach, methods, and findings.

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