Resilient Connecticut Climate Adaptation Summit

Climate and Public Health Breakout: Session A

Water Systems: Preparing for a Changing Climate in Connecticut

By:

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CONN

MILONE & MACBROOM

CIRCA

Connecticut Institute for Resilience and C

Topics

Key Questions:

1. What are climate trends and future changes of interest to water management?
2. How have extreme storms & drought impacted water systems & how have systems responded?
3. How can water systems prepare for future changes?

Approach

- Collaboration with DPH, MILONE & MACBROOM, RWA, and SRCOG
- Collaboration with Drs. Wang, Seth and Anyah on climate analysis
- Research methods to be outlined briefly with each key question

QUESTION 1: CLIMATE TRENDS & FUTURE CLIMATE

1: What are key climate trends & future changes?

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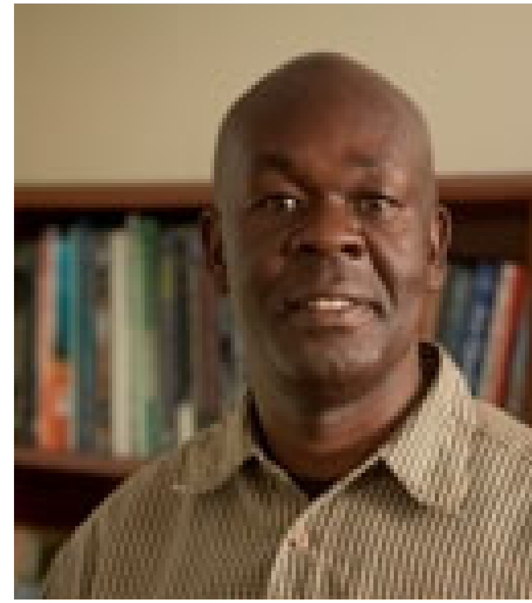

Dr. Richard Anyal
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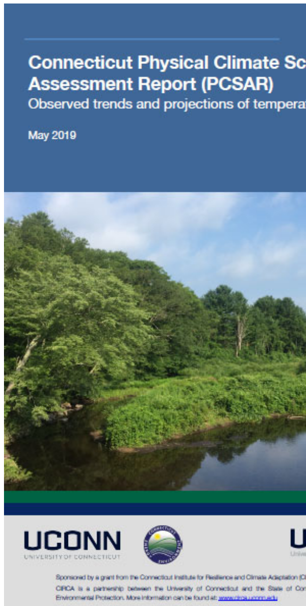
What are observable trends from historical clima

Methods:

– Weather station data from the Global Historical Climatology Network (GHCN, 1950-2005)(Menne et al. 2012), National Climatic Data Center (NCDC, 1895-2015)(Karl and Koss 1984), 4km gridded observations METDATA (1980-2017), and 6km Livneh et al. (2015) data (1950-2013)



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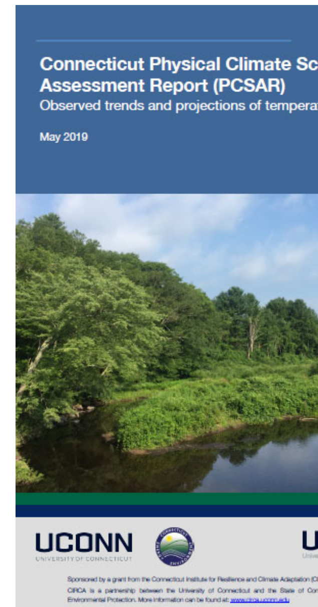
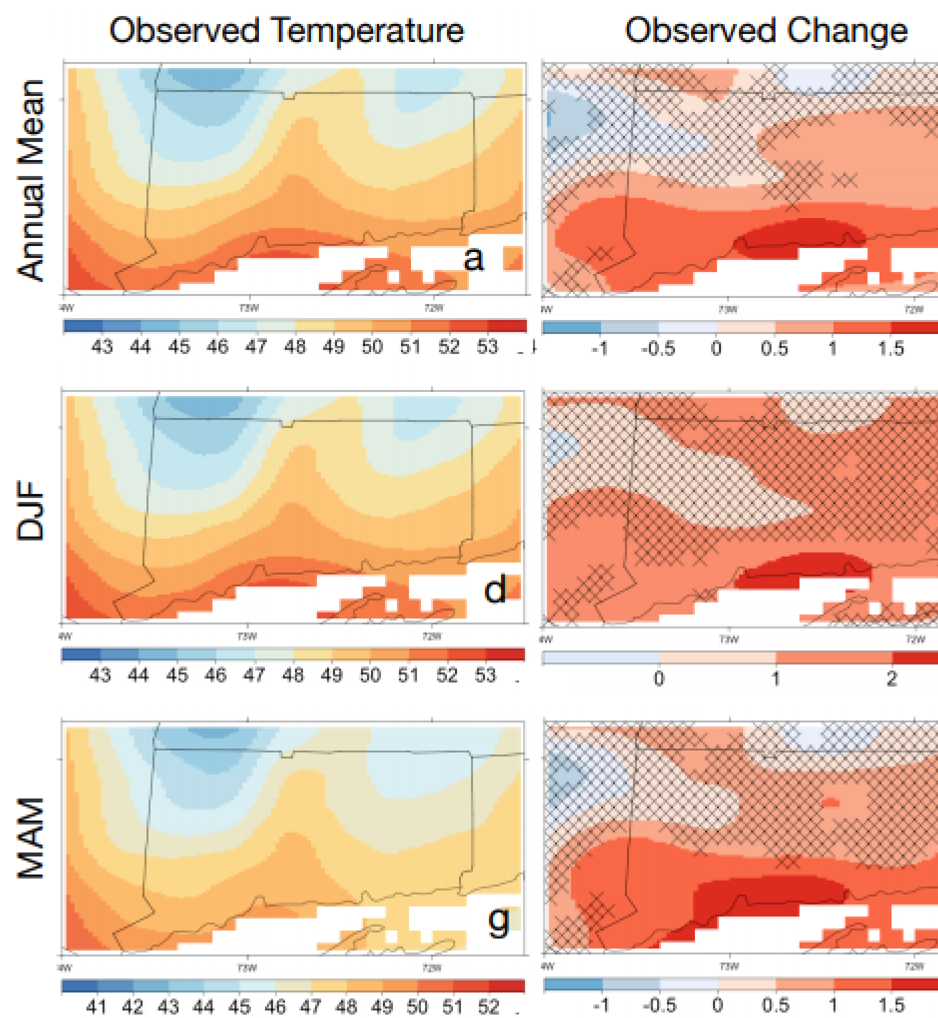
– Station observations averaged across the state, maps of change are examined, temperature and precipitation indices (e.g., max and min, frost days, consecutive dry days, rare events)



What are observable trends from historical clima

- Temperature trends:
  - From 1895-2015, annual increase of 0.3°F/decade with greatest warming in winter
    - In 1900's annual average was 47°F now 50°F while winter was 26°F now 30°F



l. 2019, Figure 3.2

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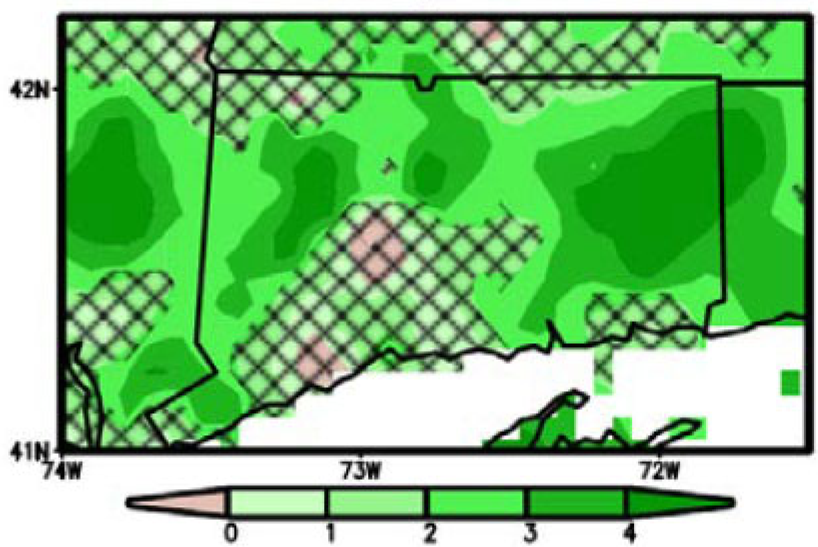
- Temperatures of the warmest and coldest days of the year have increased
- Increasing number of summer days and tropical (humid) nights and fewer frost days

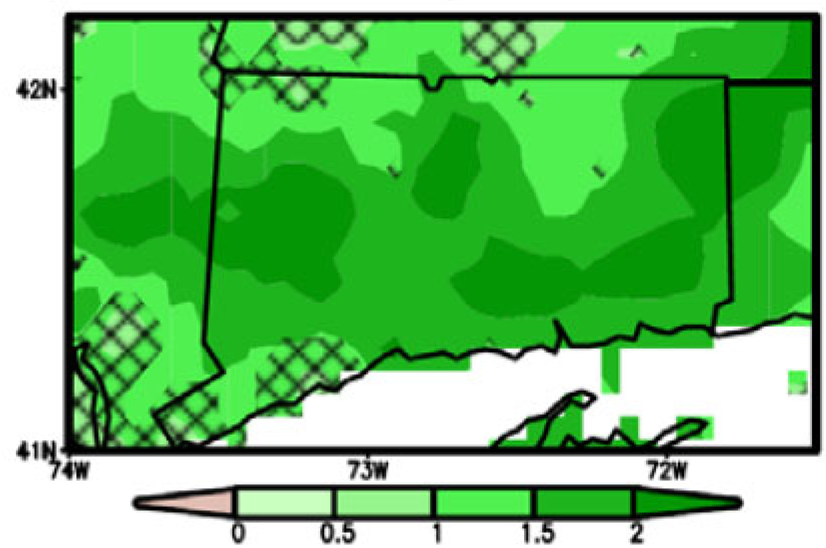
What are observable trends from historical clima

Precipitation Trends:

– Since 1950, annual precipitation increased by more than 2 inches mostly due to increases in summer precipitation



Change in annual average precipitation from 1950-1979 to 1980-2009



Change in summer average precipitation from 1950-1979 to 1980-2009

from Seth et al. 2019, Figure 4.1

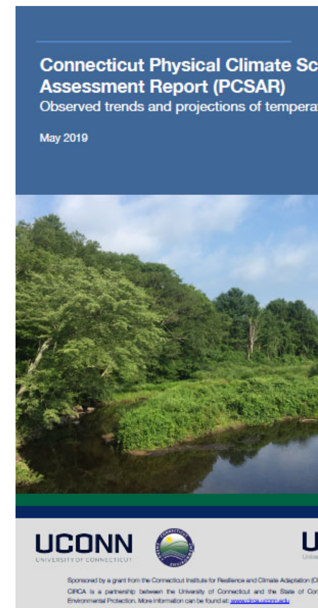
1a: What are projected climate changes?

Methods:

– Temperature increases depend on assumptions about what the future holds

– Scenarios help us imagine plausible futures

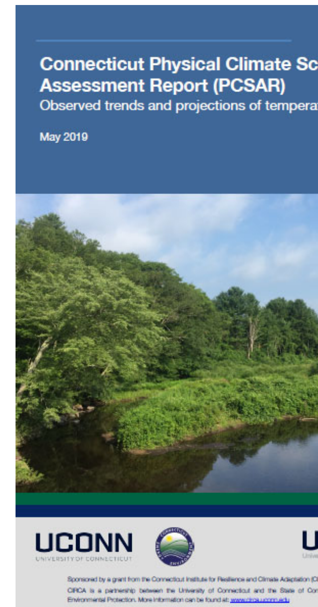
– For climate projections, scientists use Representative Concentration Pathways (RCPs) which paint different pictures about future global development



1a: What are projected climate changes?

Methods:

- For this project, Dr. Wang based projections on RCP 8.5, the ‘business as usual’ scenario, which closely tracks our current emissions trajectory
- Projections are based on differences between 1970-1999 and 2040-2060



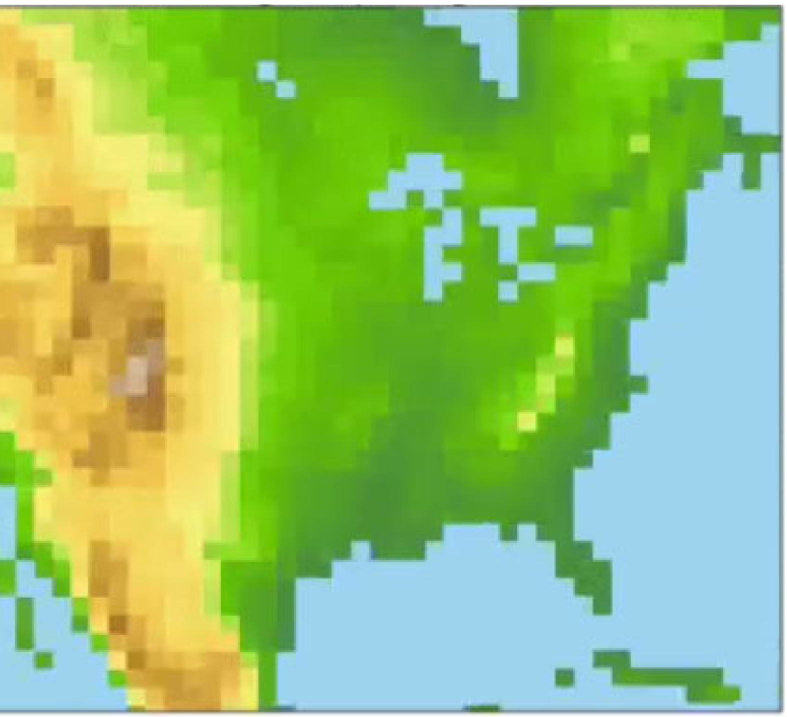
1a: What are projected climate changes?

Methods:

- The best tools for projecting future climate are 3-D numerical globa climate models (GCMs) but resolution of GCMs is coarse (100-300k
- To accommodate local level analysis, scientists use high resolution statistically downscaled multi-model climate projections applied to daily output from the latest gen models, CMIP5 GCMs

GCM (100km) ➔ Downscaled (4km)

100 km grid spacing



4 km grid spacing

2019)

1a: What are projected climate changes?

Methods:

- 8 downscaled GCMs, which represent the full range of uncertainty, climate sensitivity for CT, and overall performance simulating preser day, were used for analysis
- Standard statistical tests applied to determine if changes and trend are larger than would be expected from random variation alone

1a: What are projected climate changes?

Analysis of future change focused on understanding changes important to water management

– Drought risks

– Flood risks

1a: What are projected climate changes?

Changes in drought risks

- Based on the difference between precipitation (P) and potential evapotranspiration (PET); defined as low seasonal, annual, or two-year precipitation with return periods (e.g., 5, 10, 15, and 20 years)

Findings

- Despite increase in annual rain, rising temperatures mean severe summer droughts are likely to become more frequent
  - E.g., past 1 in 20 year summer drought likely to occur every 3-10 years
- 1960s drought is comparable to a 125 yr drought and was driven by decadal low P; this kind of event may be less common (1 in 1000 years) in the future but insufficient data to be confident

1a: What are projected climate changes?

Changes in flood risks

– Based on changes in severity and frequency of extreme precipitation
    - Daily maximum for small watersheds and 5-day max for large watersheds again wi return periods of 5, 10, 20, 50, and 100 years

Findings

– On average, increased flood risk
    - More severe and more frequent extreme precipitation expected with overall incre in number of days with 1+ inch of rain

– Daily max precipitation projected to increase 50%+ for all return periods
    - E.g., the ‘100-year storm’ becomes more common; rather than 1% chance of occurrence each year, increases to 2% to 10% chance occurrence each year by mid century

What does climate change mean for future water qua

Past & Future Water Quality

Cristina Mullin, ABD

GAANN Fellow, Kirchhoff Lab Group

UCONN, Dept. Civil & Environmental Engineering

What does climate change mean for future water qual

Methods:

- Derive lake specific predictive models for lake temperature and relative thermal resistance to mixing (RTRM)
- Use daily air temp and monthly in-situ depth profile temps for 6 reservoirs in southeast CT
- Use downscaled daily air temperature projections from multiple GCMs (MACA-v2 METDATA) using RCP 8.5, and comparing mid-century (2041-2070) to reference (1971-2000)

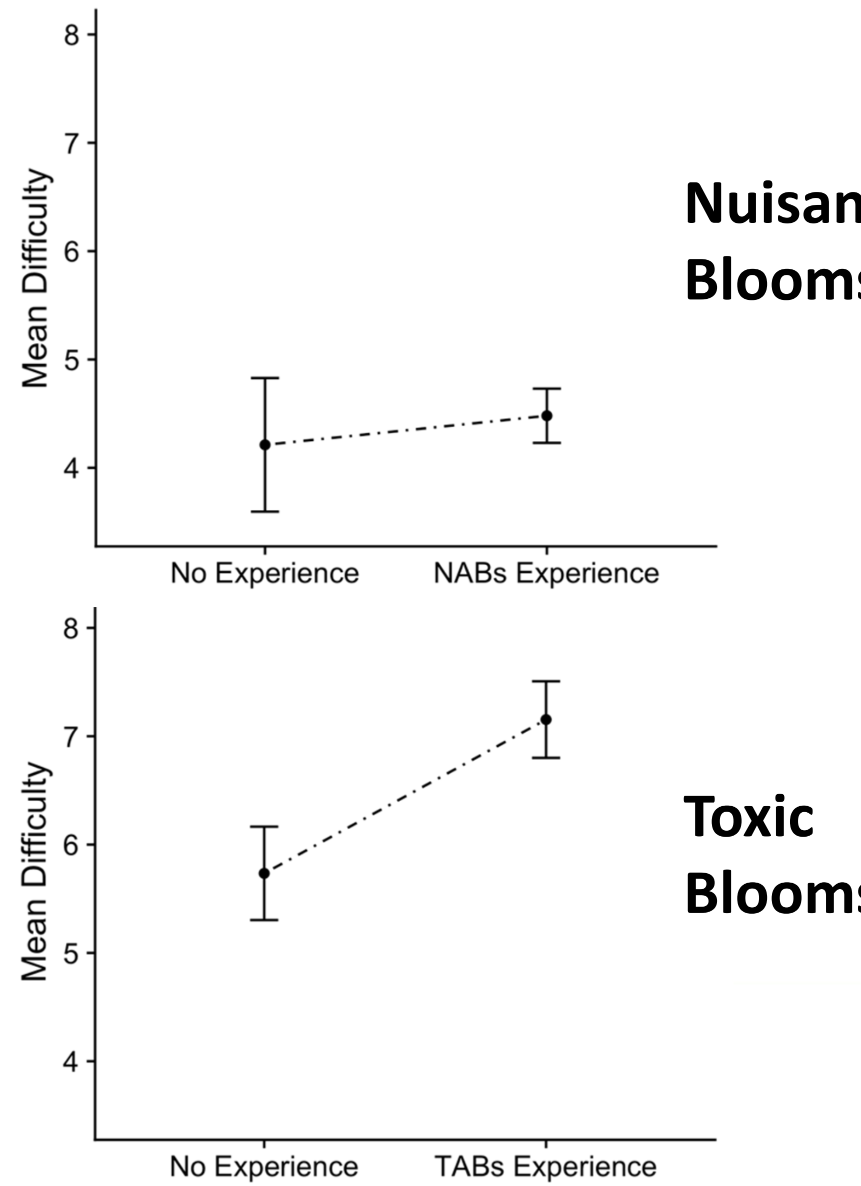
What does climate change mean for future water qual

- Reservoir temperatures expected to increase and reservoirs expected to become more stable
- Largest temperature increases and greatest thermal stability increases in July and August
- Because cyanobacteria tend to outcompete in warmer waters, reservoirs that experience cyanobacteria blooms today, likely to have worse blooms in the future

n, Kirchhoff et al. (in preparation)

What does climate change mean for future water qual

- Research indicates that water managers may be unprepared to deal with toxic algal blooms (though toxic blooms not yet a concern for CT)

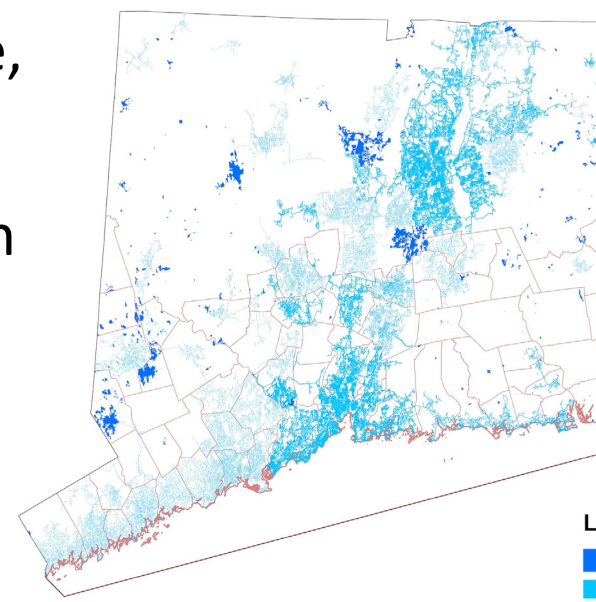


er, Kirchhoff et al. (in review)

QUESTION 2: IMPACTS AND RESPONSE TO PAST STORMS AND DROUGHT

Q2: How have extreme storms & drought impacted water systems & how have systems responded?

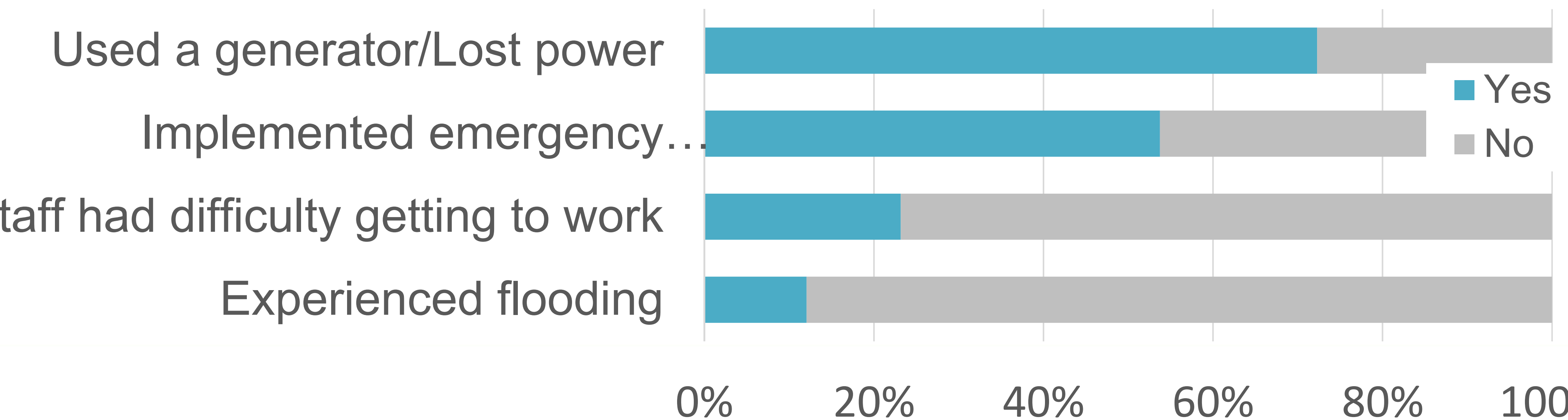
- Social science research methods (surveys & interviews)
  - Interviews conducted 2017-2018 each lasted ~1hr
    - N=24, answered questions about system, experience, and responses
    - Mix of coastal/inland, large/small, water source, own
  - Survey conducted 2018, ~15 minute online
    - N=87, CWS managers/owners
    - Mix of system sizes, water source, owner type



Service areas of CT's CWS systems

Storm Impacts for CWS

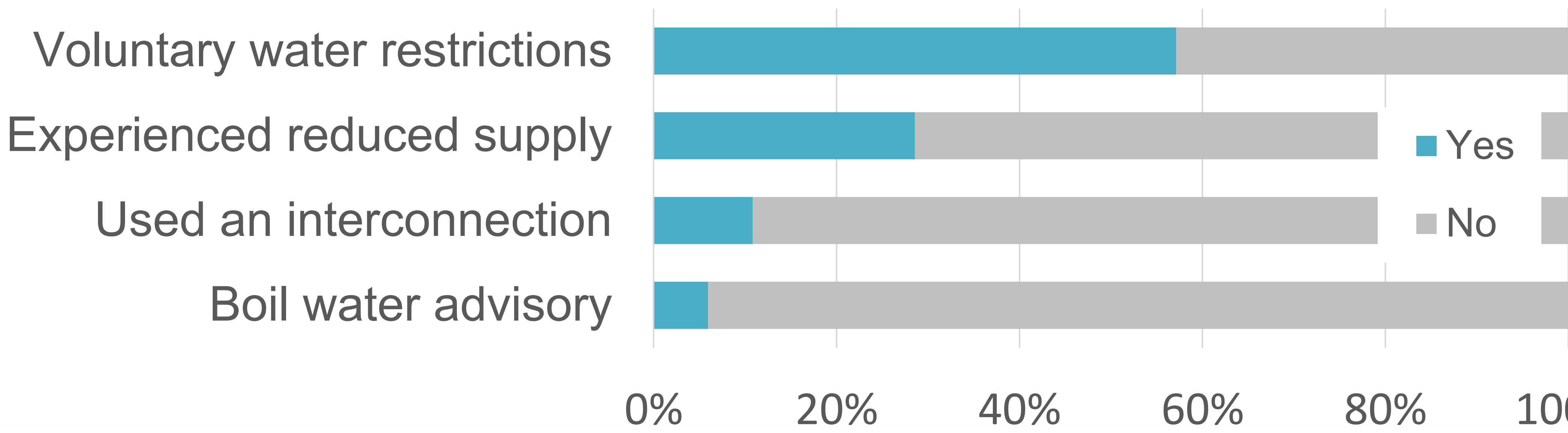
Most systems experienced some kind of storm impact; but, storm impacts generally less severe than drought impacts



Drought Impacts for CWS

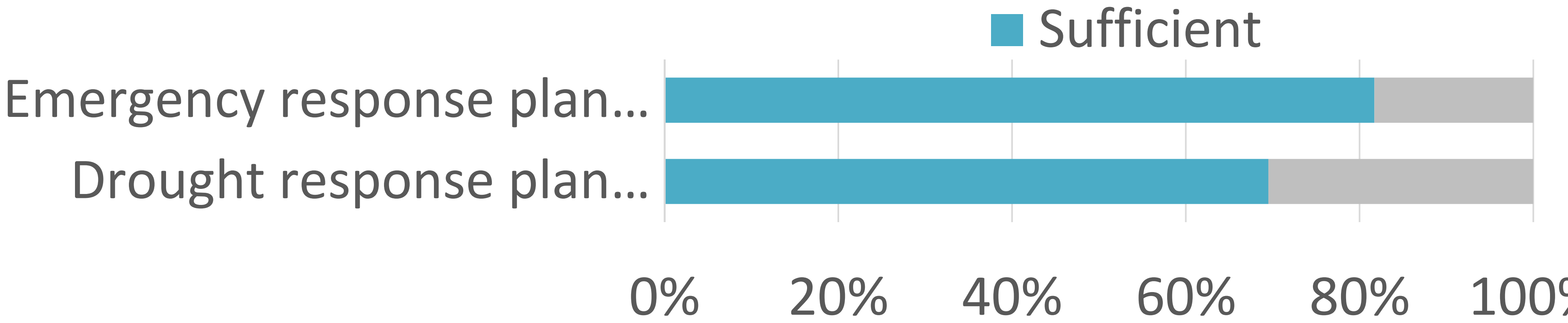
(e.g., from 2015 – 2016 drought)

Most systems experienced some kind of drought impact; but few experienced really severe impacts



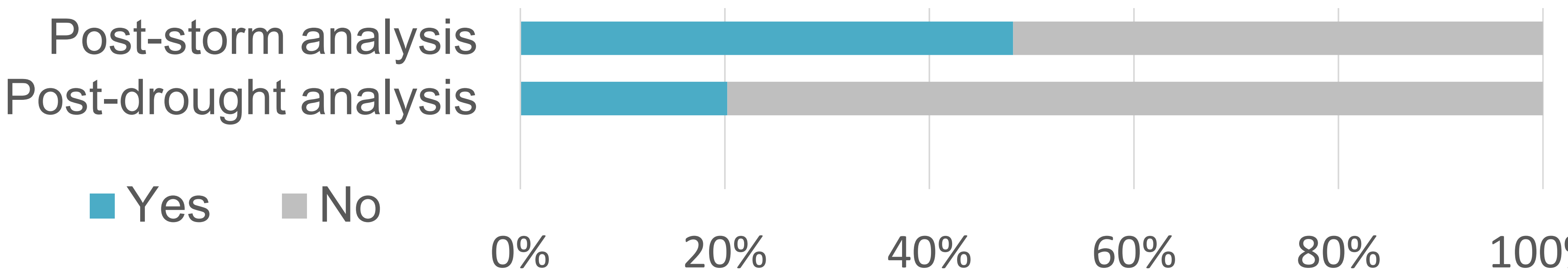
Sufficiency of CWS ERPs

Most CWS felt their emergency and drought response plans were sufficient



Post-Storm/Drought Analysis

50% of CWS conducted a post-storm analysis while onl
23% conducted a post-drought analysis (reflects greate
storm impacts?)



QUESTION 3: HOW CAN SYSTEMS PREPARE FOR FUTURE CHANGE?

CWS Perspective: What Actions CWS Find Most Helpful for Responding to Threats Now and Future

Now

- Funding
- Redundancy
- Equipment/Technology
  - Backup generator
  - Remote Sensing / SCADA
- Also important
  - Skilled workforce
  - Communication with customers
  - Watershed protection

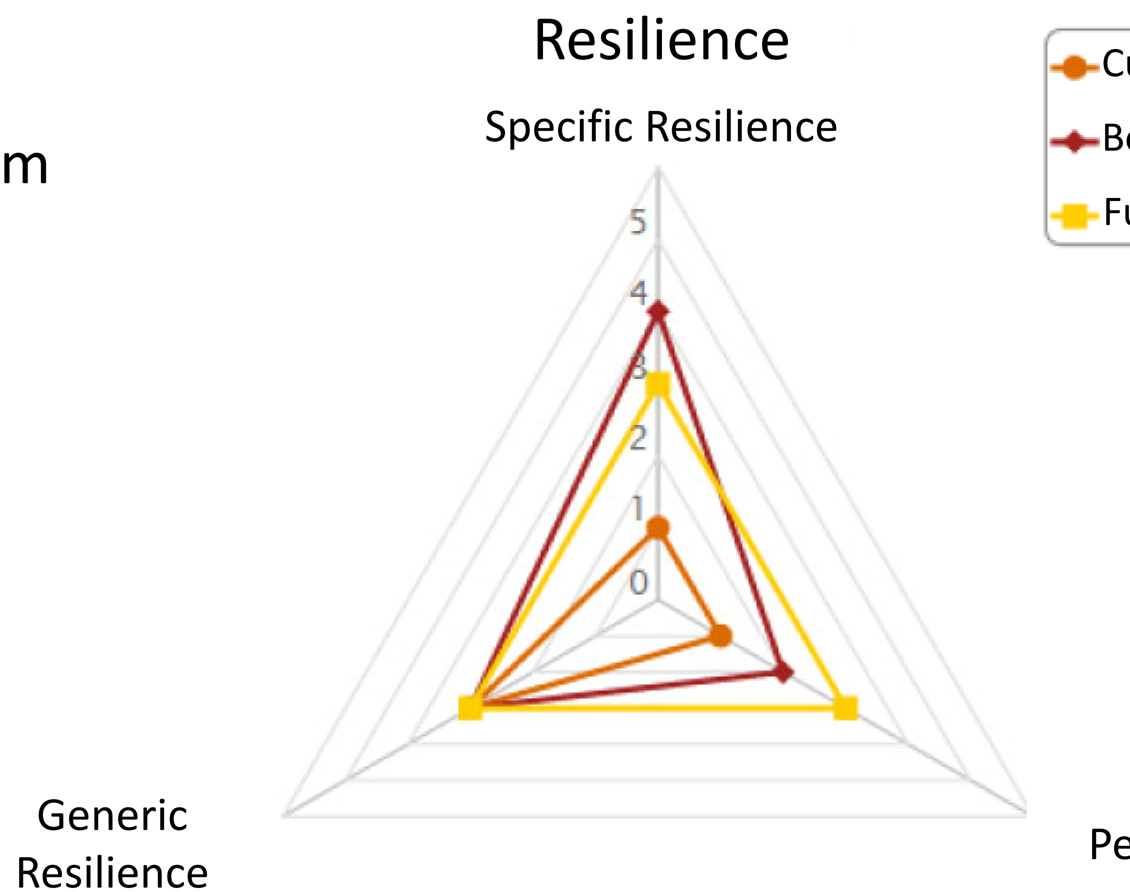
Future (20+ Years)

- Redundancy
  - Multiple sources of supply
  - Interconnections
- Adequate funding
- Increased investments
  - Conservation and watershed prote
  - Climate change action

Resilience Perspective: Bounce Back *and* Forward

Resilience as combination of two kinds of capacities/abilities:

- Ability/capacity to bounce back from known risks (specific resilience)
- Ability/capacity to bounce forward to accommodate unknown risks/surprise (generic resilience)



CWS Concern for Future Climate

Most CWS are aware that climate change will bring more frequent and severe droughts and storms; high capacity systems are thinking about these changes in strategic plans

Climate change is not a huge driver or concern

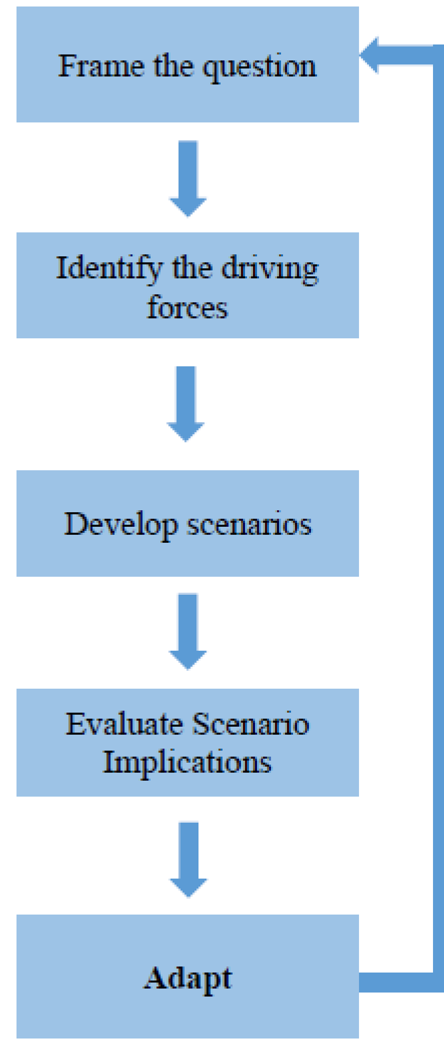
"…in all honesty, that [climate change] *really doesn't affect us. … As much as you know you want to say you're concerned about the environment or climate change, it's not affecting my water system."*

--Public utility manager

Ways to Incorporate Climate Change

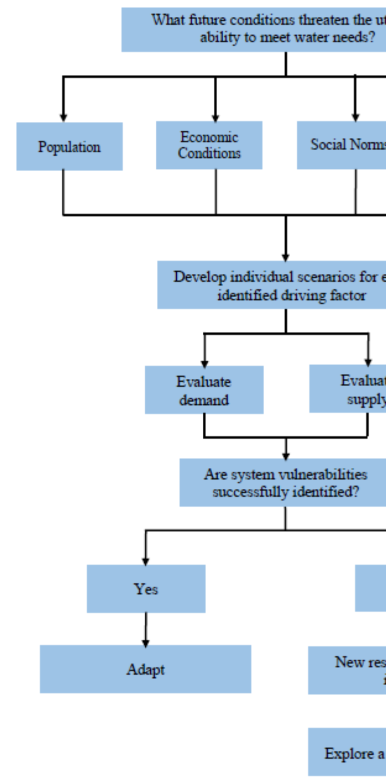
Scenario Planning

- Evaluate performance of system to different possible futures and identify key vulnerabilities
- Flexible approach, can be simplified or involve complex modeling



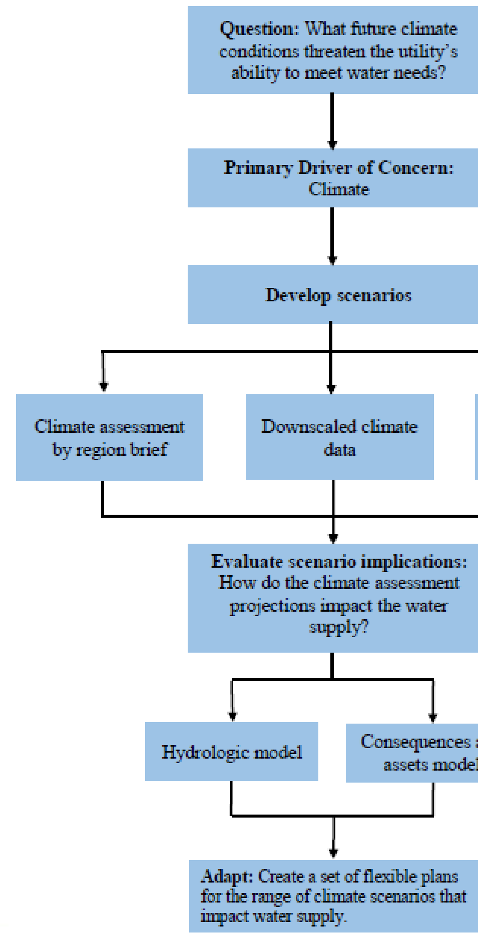
Ways to Incorporate Climate Change

- Robust Decision Making
  - Evaluate performance of system to different possible futures and identify key vulnerabilities
  - Uses water supply objectives and performance metrics and modeling to develop a robust set of actions that ensure success across many different future conditions



Ways to Incorporate Climate Change

- Chain of Models
  - Focused on climate change scenario development and requires intense climate, hydrology, and system modeling



Thank you

For more information, Christine.Kirchhoff@uconn.edu