Climate Change is Difficult

We are dealing with a *wicked problem*:

- Complex scientific components
- No solution that is positive across values
- Challenges fundamentally planning assumptions

A “wicked problem” is when...

uncertainty about future conditions
(environmental, economic, and social)
and differences in social and economic values
make it impossible to define an optimal solution
at all scales and in all domains.

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Wicked Problems

Some problems are so complex that you have to be highly intelligent and well informed just to be undecided about them.

Laurence J. Peter
The Denver Water Story

• Probabilities based on history
  – You know the risk and can maximize the return
  – Planning in a perfect world
  – Traditional planning

• Shifting probabilities?

• What else could happen?
Projected Changes for Central Mountains in Colorado

Precipitation Change (%) vs. Temperature Change (Fahrenheit)

- 2040
- 2070

Projected Changes for Central Mountains in Colorado

Temperature Change (Fahrenheit)

- 1°
- 2°
- 3°
- 4°
- 5°
- 6°
- 7°
- 8°
- 9°
- 10°
“Revealing” uncertainties (Martyn Clark, NCAR)

Emissions Scenario(s)

Global Climate Model(s)

GCM initial conditions

Combined uncertainty

Downscaling method(s)

Hydrologic Model Structure(s)

Hydrologic Model Parameter(s)

“Revealing” uncertainties (Martyn Clark, NCAR)
What is the State of Science for Responsible Climate Adaptation???

**DW Challenges**
- Obligation to customers
- Risked loss of trust (or worse… your job!)
- Organizational buy-in

**Scientific Inquiries**
- What is the science telling us?
  - Warming
  - Variability
- What should we expect from science?
  - Precipitation projections?
The Denver Water Story

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New Planning Techniques

• Life without probabilities
  – Spend time determining what will happen or focus on preparing for whatever happens?
  – Predict or prepare?

Embracing Uncertainty
- Focus on tools and resources
- Flexible, adaptive
- Limits to what we can afford
Planners must determine how much, where, and when to make investments and changes

**Goal:** Robust adaptive strategies
- Low-regret near-term actions
- Conditions to monitor
- Decision triggers and longer-term actions
Robust Solutions

- Diversified portfolio
- Scalable options
- Preserving options
- Continuous & iterative planning

3-4°F with wetter winters, increased P

6-7°F with increased daily precipitation variability, no change in P

Weak Economy

Strong Economy

Warmer Climate

Hot Climate

New urban preference

Suburban preference
Inquiries to consider

- What do we need to know to be prepared?
- Are climate models and projections the right tools?
- Are we underestimating uncertainties?
- Does ‘concreteness’ blind decision makers to surprise?
Vision: Climate-resilient water utilities, thriving communities

Mission: Collaboratively advance water utility climate change adaptation
2017-2018 WUCA Projects

• Best Practices in Climate Adaptation
  – Defining climate adaptation
  – Phase 1:
    • State of the science for climate adaptation
    • BPs in climate assessment

• Business Process Mapping
  – Funding from WRF
  – Link to BPs
Mainstreaming Observations:

- Credible?
- Relevant?
- Legitimate?

1. Trust
2. Co-production
3. Understanding
4. Proof
5. Capacity
Portland Water Bureau Survey

EMBRACING UNCERTAINTY
A Case Study Examination of How Climate Change is Shifting Water Utility Planning

Prepared for:
Water Utility Climate Alliance (WUCA)
American Water Works Association (AWWA)
Water Research Foundation (WRF)
Association of Metropolitan Water Agencies (AMWA)
Project Manager: Laura Kaatz, Denver Water

Available at
www.WUCAonline.org

https://www.portlandoregon.gov/water/climatechange
The Society is a multi-disciplinary association of professionals working to improve methods and tools in this field, facilitate their use in practice, and ultimately encourage sound decision making in our rapidly changing world.

Learn more: www.deepuncertainty.org
Today's weather has been declared a one-in-a-hundred-year storm. More one-in-a-hundred year storms are expected on Tuesday, Thursday and Friday.
EXTRA SLIDES
Barriers to Climate Adaptation

- Politics and agendas
- Changing organizational priorities
- Stakeholders
- Immediate vs long-term
- Responsibility: Mission and Stranded assets
- Issues and actions are not black or white
- Vertical axis of uncertainty
- Careful who and what we ask for