Water Utility Climate Adaptation and Resilience Planning: Some Guiding Principles

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Overview

• Review the challenge of climate adaptation
• Offer some basic principles for adaptation
• Discuss methods for assessing adaptation options
• Address non-climate variables of concern
The Challenge of Adaptation to Climate Change

• We cannot adapt to a specific forecast of future climate
  • At best we know the direction of change of key variables
  • Some key aspects are uncertain

• Challenge is how to make decisions about investments and other decisions with long lifetimes in light of the uncertainties?

• This situation is not unique to climate change adaptation

• There is a path forward!
One Strategy – Wait for Better Information

• The science is unlikely to improve dramatically
  • Even after 30 years, some fundamental uncertainties such as climate sensitivity remain

• Decisions which can be affected by climate change, such as infrastructure and development, still have to be made
  • Either they incorporate climate change considerations or they do not

• Sensible decisions can be made in light of uncertainty
Two Guiding Principles for Adaptation

- Make decisions that work or function over a wide range of possible conditions; what is desired is:
  - Flexibility
  - Robustness
  - Resilience

- Consider Economics
  - Basically, benefits should exceed costs
  - Complicated when benefits (avoided impacts) may not happen or be much larger decades into the future
    - Discounting – do not spend a lot now to avoid risks many years from now
Define Our Terms

• Flexibility
  • The adaptation can accommodate different conditions by adjusting

• Robustness
  • The adaptation can withstand widely varying conditions

• Resilience
  • Classic definition concerns capacity to recover from shocks
  • In context of climate change has been used to also include withstanding shocks

• The terms are often used interchangeably in the climate change context
Adaptation Examples that Satisfy These Principles

• Incremental investments
  • Low cost adjustments to infrastructure
    • Can buy additional protection now and into the future
  
• Maintain options
  • Buy land on which can build infrastructure in the future
  
• Diverse portfolio of options (for example, supply)

• Use resilient or flexible management systems
  • Water markets are responsive to changing conditions
How Do We Assess Adaptation Options?

Two basic approaches:

1. Traditional assessment approaches
   • Often used to help identify an optimal solution

2. Deep Uncertainty approaches
   • Recognize “deep uncertainty” is part of problem and try to identify adaptations that can work across an array of possible outcomes
Traditional Assessment Approaches

1. Benefit-Cost Analysis (BCA) - King of traditional approaches
   • Express all benefits and costs in common unit, typically money
   • Seek to maximize
     • Net Benefits
     • Benefit cost ratio

2. Cost-effectiveness
   • Seek the least costly way to achieve a common outcome

3. Multi-criteria assessment
   • It is typically applied where different metrics are used

4. Triple Bottom Line (TBL) splits out financial, social, and environmental benefits
   • TBL can be used in the above approaches

Traditional approaches work best when uncertainties are well-characterized
   • Can also be applied when they are not; for example, for individual scenarios
Challenge of Applying BCA to Climate Change

- Probabilities of outcomes are not known
  - There are no reliable probabilities on GHG emissions
  - Challenging with regional climate change
- Timing of impacts
  - How to assess risks to life and limb over generations
  - Property is more straightforward but even that has challenges

<table>
<thead>
<tr>
<th>Cost to adapt</th>
<th>Adaptation Benefits</th>
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<tbody>
<tr>
<td>$$</td>
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Cost-Effectiveness

• Compare relative cost of achieving same or similar objectives
• Key is that objective must have same quantifiable value(s)
• Examples:
  • $ per life saved
  • $ per Disability Life Year (DALY)
  • $ per unit of water supply
## Multi-Criteria Assessment: NREL Example

### Inability to Continue Reliance on Evaporative Cooling and Chillers, Which Depend on Water

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Evaluation criteria and score</th>
<th>Recommended approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create and implement a climate monitoring</td>
<td>Create and implement a system to monitor and communicate both indoor and</td>
<td>Fair</td>
<td>Do now</td>
</tr>
<tr>
<td>and communication system</td>
<td>outdoor climate variables, including building temperatures so staff can</td>
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<tr>
<td></td>
<td>dress accordingly and lightning and outdoor temperature predictions for</td>
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<tr>
<td></td>
<td>outdoor safety</td>
<td></td>
<td></td>
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<tr>
<td>Add conventional backup air conditioning</td>
<td>Add conventional coolers and backup air conditioners for use during periods</td>
<td>Good</td>
<td>Continue evaluating</td>
</tr>
<tr>
<td></td>
<td>of prolonged or intense humidity or heat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrofit high-performance computer</td>
<td>Retrofit the high-performance computer so that it is not cooled by chillers</td>
<td>Fair</td>
<td>Remove from consideration</td>
</tr>
</tbody>
</table>
Deep Uncertainty Philosophies

• Philosophies
  • Risk Management
  • Adaptive Management

• Types of Adaptation
  • No Regrets
  • Low Regrets
  • Incremental Adaptation
Consider likelihood and consequence of outcomes
Philosophy: Adaptive Management

- Recognizes that we can make adjustments as conditions change
- Design systems/decisions so future conditions can be incorporated
  - Option to use land for investment in future such as a reservoir
- Examples:
  - Thames River barrier to protect London from storm surges over rest of century
  - MWD organized near-term investments in local supplies expecting some will need to expand and some be contracted as demand, regulations, climate, another factors change
- ASCE recommends adaptive management approach be applied
Adaptive Management for Uncertain Magnitudes of SLR in the Thames River

- Sea level rise scenarios:
  - Maximum water level rise:
    - 0 m
    - 1 m
    - 2 m
    - 3 m
    - 4 m

- Defra and upper part of new TE2100 likely range:
  - Improve Thames Barrier and raise downstream defenses
  - Over-rotate Thames Barrier and restore interim defenses
  - Flood storage, improve Thames Barrier, raise upstream and downstream defenses

- Top of new H++ range:
  - Flood storage, over-rotate Thames Barrier, raise upstream and downstream defenses
  - Flood storage, restore interim defenses
  - New barrier, retain Thames Barrier, raise defenses
  - New barrier, raise defenses
  - New barrier

- Previous extreme used in TE2100:

- Link to alternative measures:
  - Possible future adaptation route (or pathway), allowing for different degrees of sea level rise through time
  - Predicted maximum water level under each scenario

- Measures for managing flood risk indicating effective range against
Adaptive Management Over Time for Flood Risks in Rotterdam
Types of Adaptation: No Regrets and Low Regrets

• No Regrets
  • Adaptation can be justified without consideration of climate change
  • Greater benefits are expected with climate change

• Low Regrets
  • Done to incorporate risks of climate change
  • Typically small investment if only considering long term benefits
  • “Low regret” on cost side if invested too much
  • Might have higher regret if invested too little
Types of Adaptation: Incremental Adaptation

• Incrementally increase size of investment or make other incremental change to adapt to expected climate change

• Makes most sense when cost of incremental change is low

• Appropriate for decisions with long-life time

• Can be inappropriate if fundamental change is needed
Decision Support Tools

• Emphasis is on “Support”
  • Tools do not tell you the “right” decision
  • But can help organize complex information and get insight on adaptation options

• Advantage is they can serve as a mechanism to bring stakeholders together to work through understanding risks and options so as to:
  • Reduce conflict
  • Identify key uncertainties
  • Suggest approaches or strategies that can work
Other Key Factors Will Change And Should be Considered

• Population
• Income
• Technology
• Preferences/Culture

Key point is not to project these but understand how change in these and other factors can change vulnerability of a system to climate
How Precise Do We Need to Be in Our Projections?

Adaptations Often Incorporate Ranges or are Incremental

• Culverts can accommodate a wide range of flow and come in incremental diameters from 6” to 1’

• Decisions on sea level rise and flooding such as freeboard are often made in 1’ increments
Key Takeaways

• The challenge of anticipating climate change is making decisions in light of uncertainty
  • Note: that is the challenge of anticipating any future change

• Uncertainty approaches are better suited to identify and assess options for anticipation of climate change
  • Adaptive management, risk management
  • No regrets, low regrets
  • Incremental, modular (scalable), diversification

• Decision support can help in analyzing options
  • Traditional assessment approaches (e.g., BCA) can still be useful

• Other factors besides climate are also changing and can be relevant