Building Resilience to a Changing Climate:

A Technical Training in Water Sector Utility Decision Support

WUCA
Water Utility Climate Alliance

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
- Discuss methods for assessing adaptations
- Review “decision” support
- Address non-climate variables of concern

University of Arizona. Credit: John C. Palumbo

Climate Change is a “Wicked” Problem

- It is far reaching in its effects
- The impacts can happen for decades to centuries
- We will all be affected, as will all ecosystems
- We know changes are coming but we cannot make forecasts
- Where we are confident on the direction of change (for example, temperature, sea level rise, intense precipitation) we cannot predict the magnitude of change
- For some key variables such as annual precipitation, even the direction of change may not be certain

“Deep Uncertainty” is a Key Factor

- Deep Uncertainty
  - Parties to a decision do not know or do not agree on the likelihood of alternative futures or how actions are related to consequences
- Probabilities are not known and cannot be assigned with confidence
- For example we do not have probabilities on:
  - Greenhouse gas emissions
  - Distribution of climate patterns for a given RCP

One Strategy – Wait for Better Information

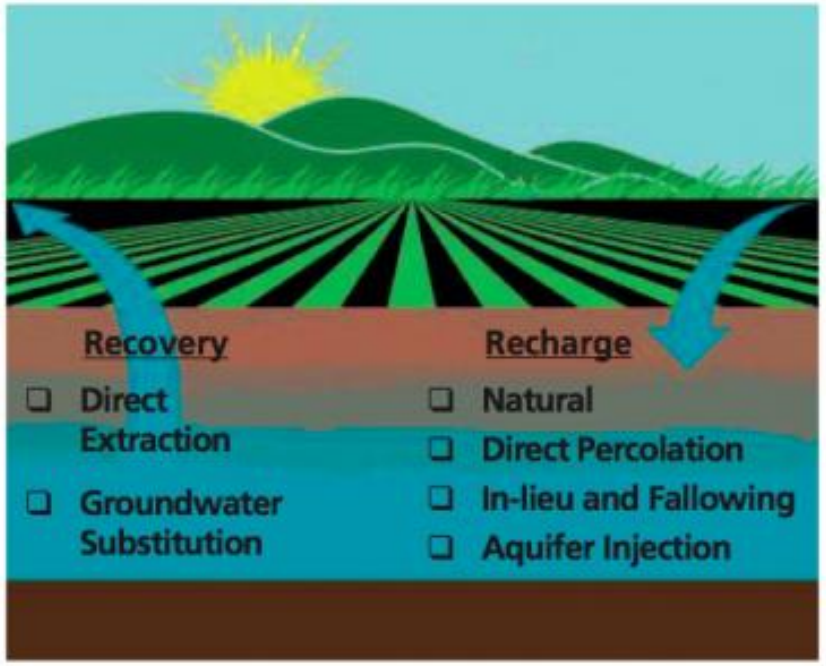
- The science is unlikely to improve dramatically
  - Even after 30 years, some fundamental uncertainties such as climate sensitivity remain
- Decisions which can be affected by climate change, such as infrastructure and development, still have to be made
  - Either they incorporate climate change considerations 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
  - Flexibility
  - Robustness
  - Resilience
- Economics
  - Basically, benefits should exceed costs
  - Complicated when benefits (avoided impacts) may not happen or be much larger decades into the future
    - Discounting
    - What this means is one should not spend **a lot** now to avoid risks many years from now

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. Optimization
   - Traditional approaches search for the optimal solution
   - Work best when uncertainties are well understood

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

Optimization Approaches

1. Benefit-Cost Analysis (BCA) - King of optimization
   - Express all benefits and costs in common unit, typically money
   - Seek to maximize
     - Net Benefits
     - Benefit cost ratio
   - Triple Bottom Line (TBL) splits out financial, social, and environmental benefits
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

- **Optimization approaches work best when uncertainties are well-characterized**
  - Can also be applied when they are not

Challenge of Applying BCA to Climate Change

- Probabilities of outcomes are not known
  - To begin with there are no reliable probabilities on GHG emissions
  - Particularly 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

Cost to adapt		Adaptation Benefits	
$$	<	$$$$$	✓
$$$$$	>	$$$	✗
$$$	=	$$$	?

Cost-Effectiveness

- Compare relative cost of achieving same or similar objectives
- Key is that objective must have similar value
- 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

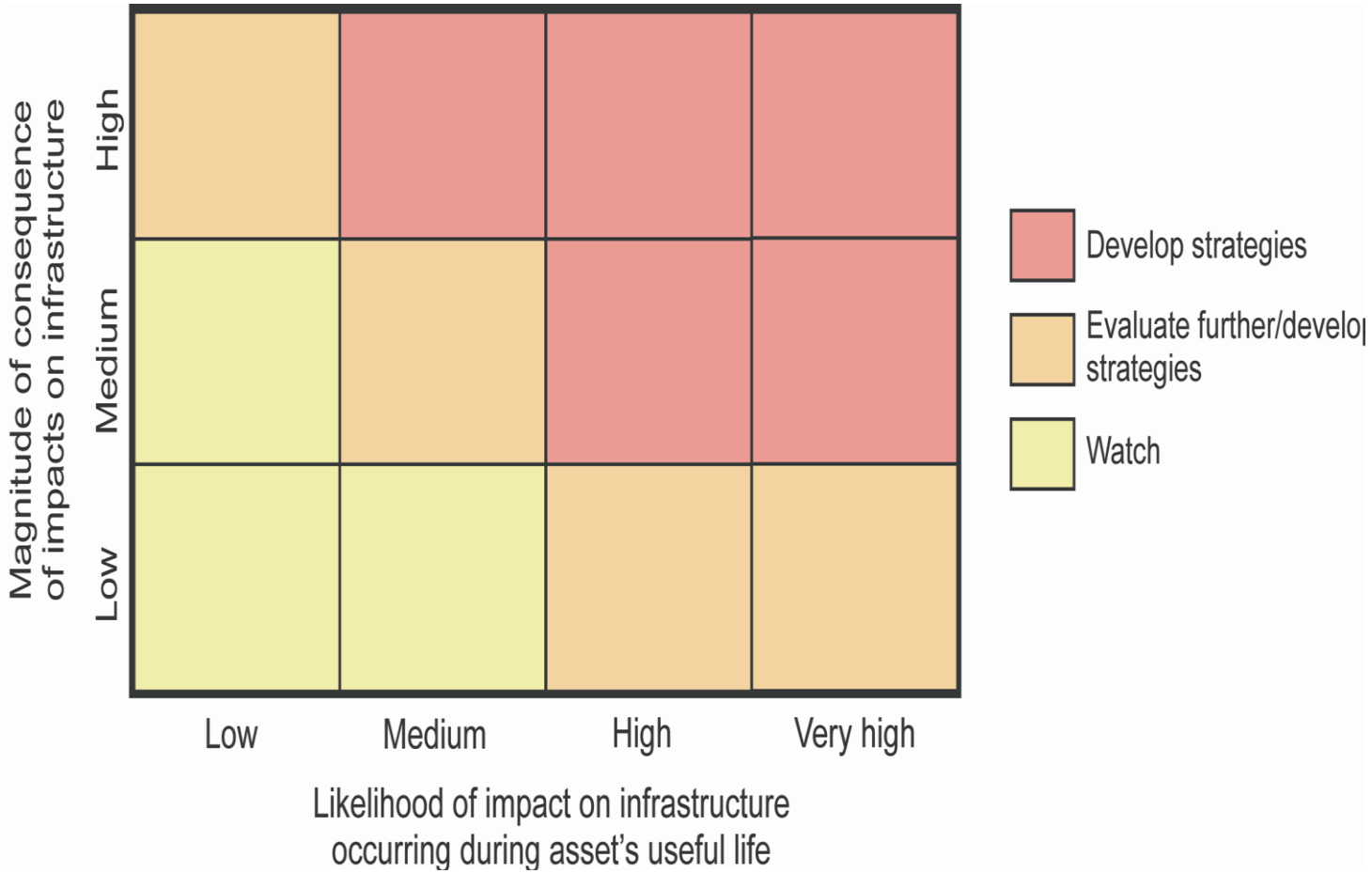
Option	Description	Evaluation criteria and score			Recommended approach
		Effectiveness	Feasibility	Cost	
Create and implement a climate monitoring and communication system	Create and implement a system to monitor and communicate both indoor and outdoor climate variables, including building temperatures so staff can dress accordingly and lightning and outdoor temperature predictions for outdoor safety	Fair	Fair	Fair	Do now
Add conventional backup air conditioning	Add conventional coolers and backup air conditioners for use during periods of prolonged or intense humidity or heat	Good	Fair	Fair	Continue evaluating
Retrofit high-performance computer	Retrofit the high-performance computer so that it is not cooled by chillers that rely on water	Fair	Poor	Poor	Remove from consideration

Uncertainty Approaches

- Philosophies
  - Risk Management
  - Adaptive Management
- Types of Adaptations
  - No Regrets
  - Low Regrets
  - Incremental Adaptation
- Decision Support Methods
  - Robust Decision Making
  - Scenario Planning
  - Decision Scaling

Philosophy: Risk Management

Consider likelihood and consequence of outcomes



Source: Major and O'Grady, 2010

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

- One prominent example is the Thames River barrier to project London from storm surges
  - Designed to incorporate decisions for the rest of this century

Types of Adaptations: 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
  - But 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

Decision Support Tools

- Emphasis is on **“Support”**
  - Tools do not tell you the “right” decision
  - But can help organize information in a complex situation
    - Perhaps enable users to get insight on adaptation options
- Advantage is they can serve as a mechanism to bring stakeholders together to work through understanding risks and options
  - Do so in a systematic way that can:
    - Reduce conflict
    - Identify key uncertainties
    - Suggest approaches or strategies that can work

Decision Support Example Tool: Climate Resilience Evaluation & Awareness Tool (CREAT)

- Web-based tool for conducting **risk assessment** of potential impacts at your utility
- Multiple scenarios provided to help **capture uncertainty**
- Assessments will help inform **planning**
- Results from CREAT help utilities compare **risk reduction and implementation costs**

CREAT Process

CLIMATE AWARENESS

Provide basic utility information

Increase awareness of climate impacts

SCENARIO DEVELOPMENT

Understand utility risk

Design scenarios of threats based on climate data

CONSEQUENCES & ASSETS

Outline potential consequences

Catalog critical assets

ADAPTATION PLANNING

Inventory current actions that provide resilience

Design adaptation plans

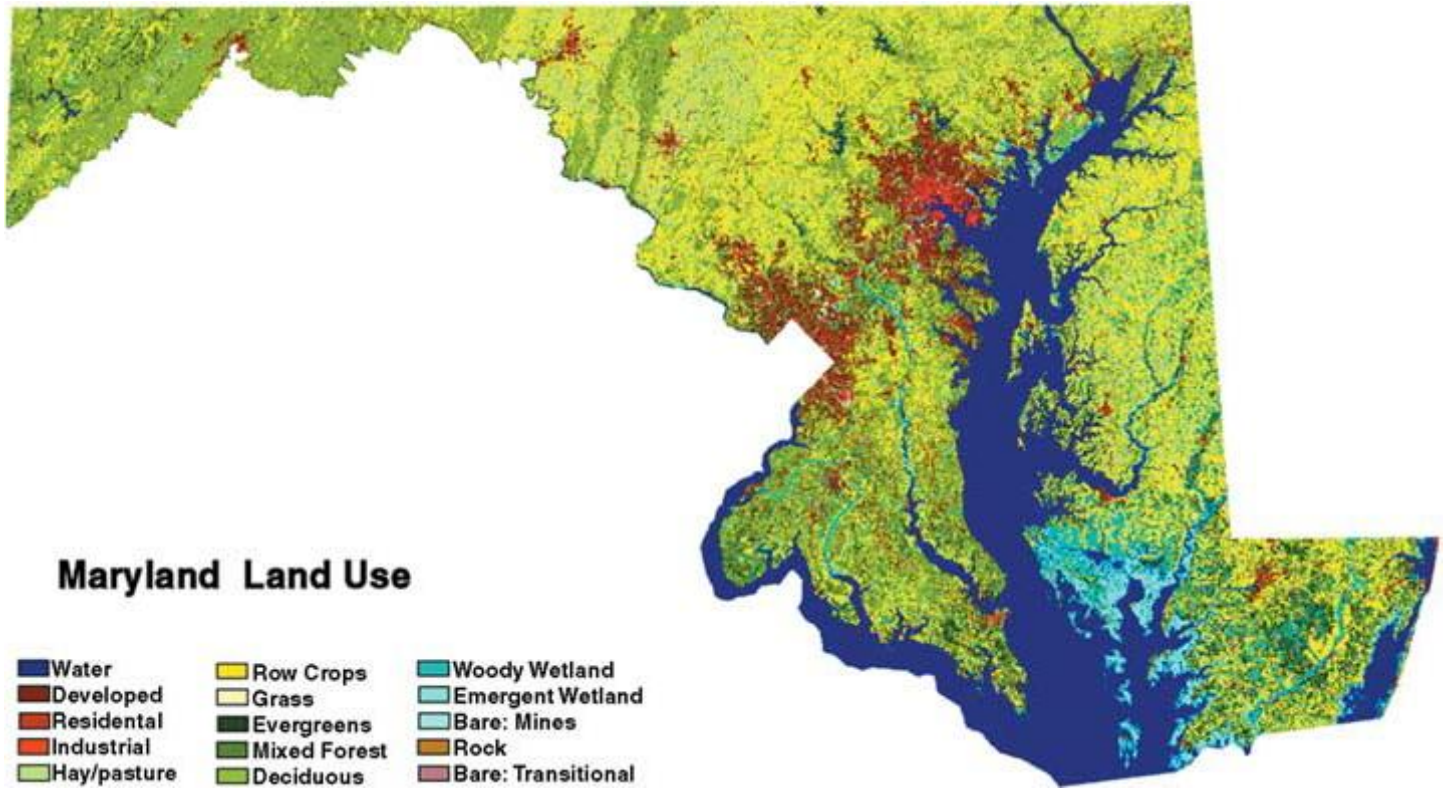
RISK ASSESSMENT

Assess risk from a changing climate

Evaluate adaptation plans

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

Key Takeaways

- The challenge of anticipating climate change is making decisions in light of uncertainty
  - That is the challenge of anticipating any future change
- There are philosophies and approaches to addressing adaptation
- Uncertainty approaches are better suited to identify and assess options for anticipation
  - Optimization approaches can still be useful
- Decision support can help in analyzing options
- Other factors besides climate are also changing and can be relevant

Final Thoughts

- Do not be paralyzed by climate science
- The uncertainties will not be reduced soon
- There are many decisions that are effective or provide benefits under multiple possible future conditions