Building Resilience to a Changing Climate:

A Technical Training in Water Sector Utility Decision Support

WUCA
Water Utility Climate Alliance
10 YEARS · 2008-2018

Water Utility Climate Adaptation and Resilience Planning: Some Guiding Principles

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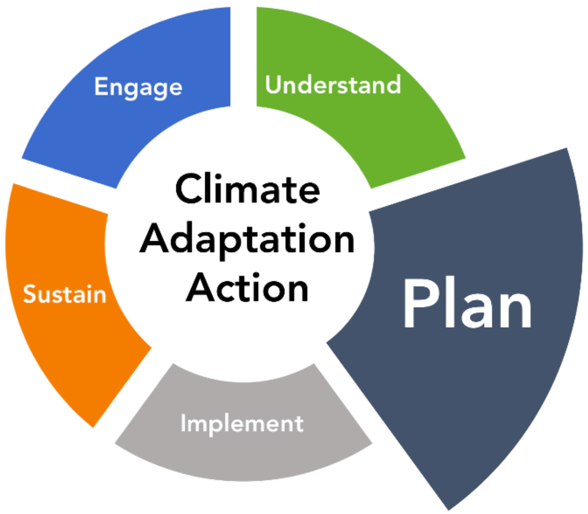


Overview

- 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

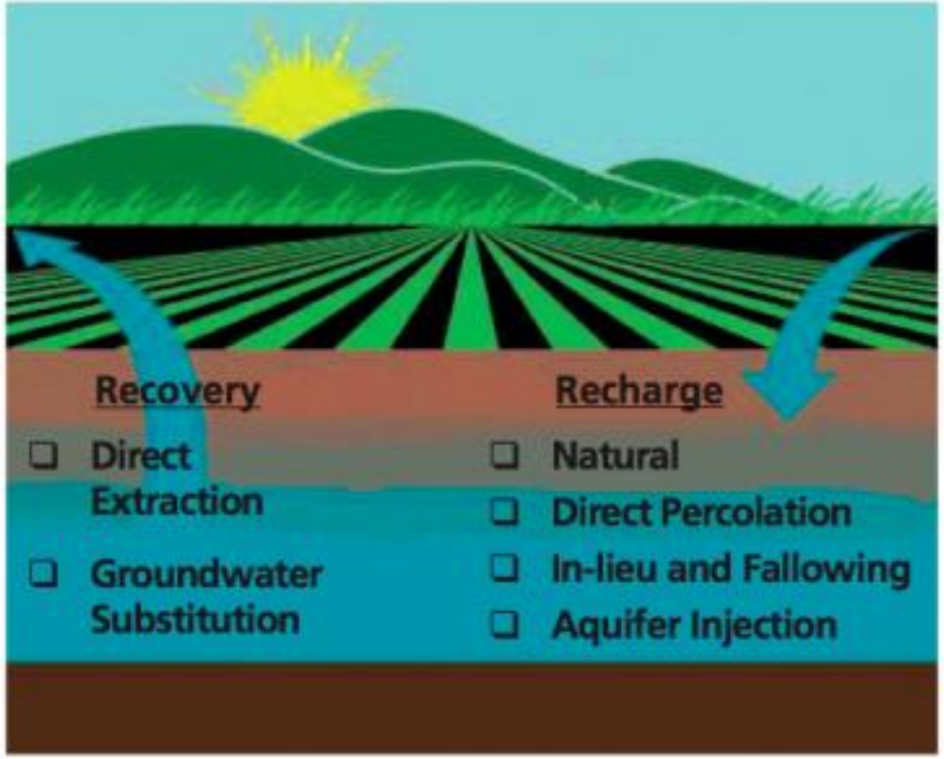
- Make decisions that work or function over a wide range of possible conditions; what is desired is:
  - Flexibility
  - Robustness
  - Resilience
- Consider Economics
  - Basically, benefits should exceed costs
  - Complicated when benefits (avoided impacts) may not happen or be much larger decades 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

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

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

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

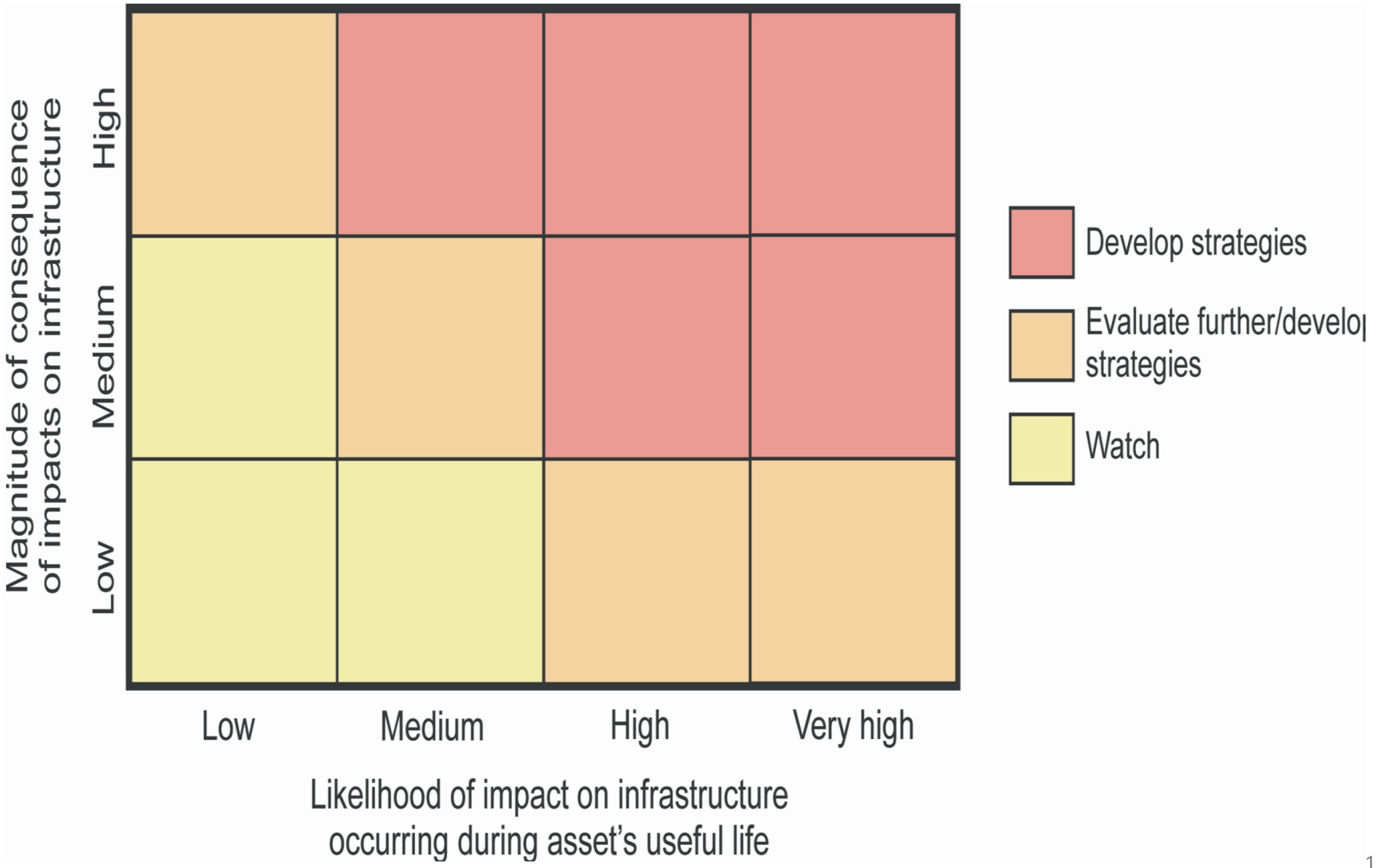
Deep Uncertainty Philosophies

- Philosophies
  - Risk Management
  - Adaptive Management

- Types of Adaptation
  - No Regrets
  - Low Regrets
  - Incremental Adaptation

Philosophy: Risk Management

Consider likelihood and consequence of outcomes

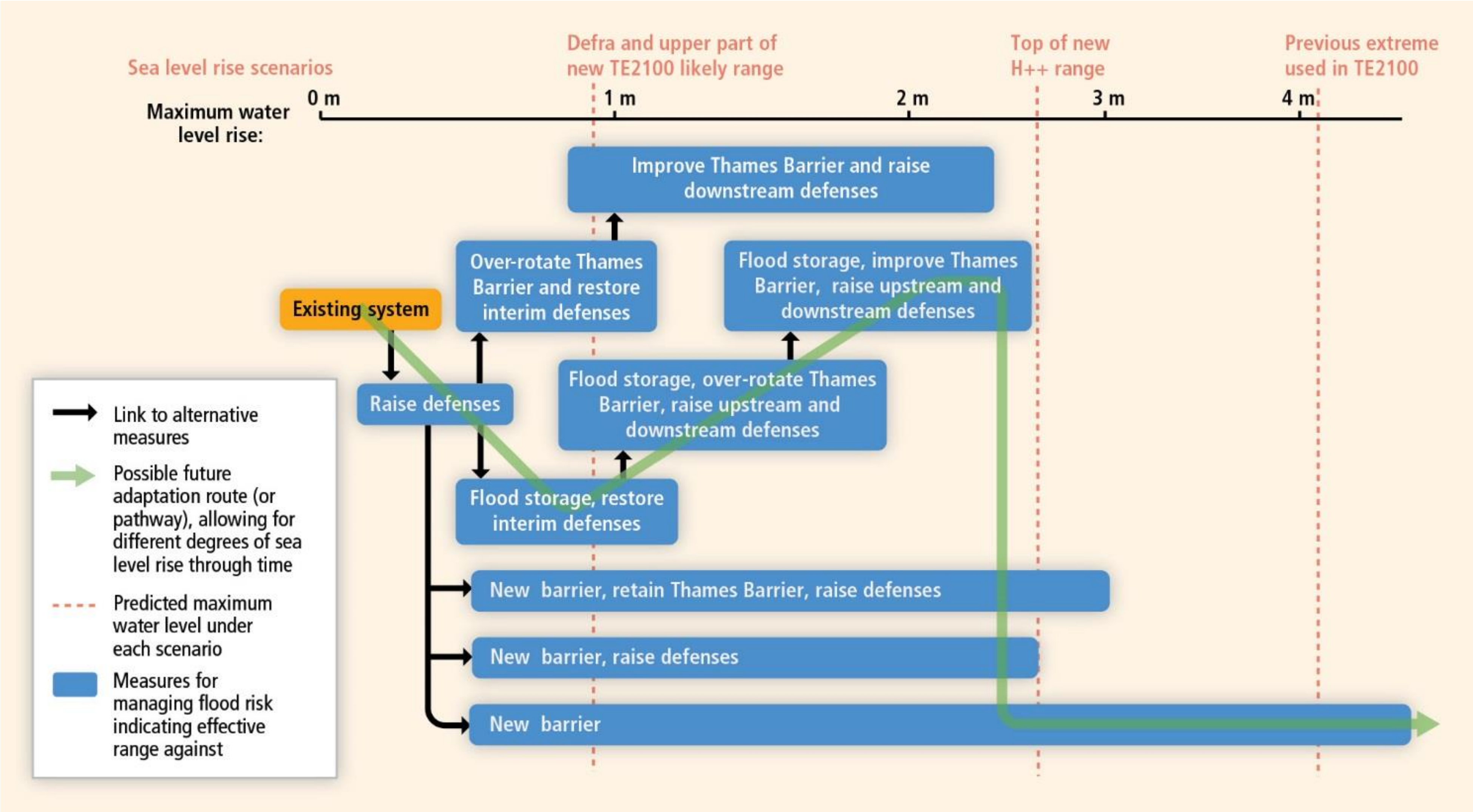


Source: Major and O'Grady, 2010

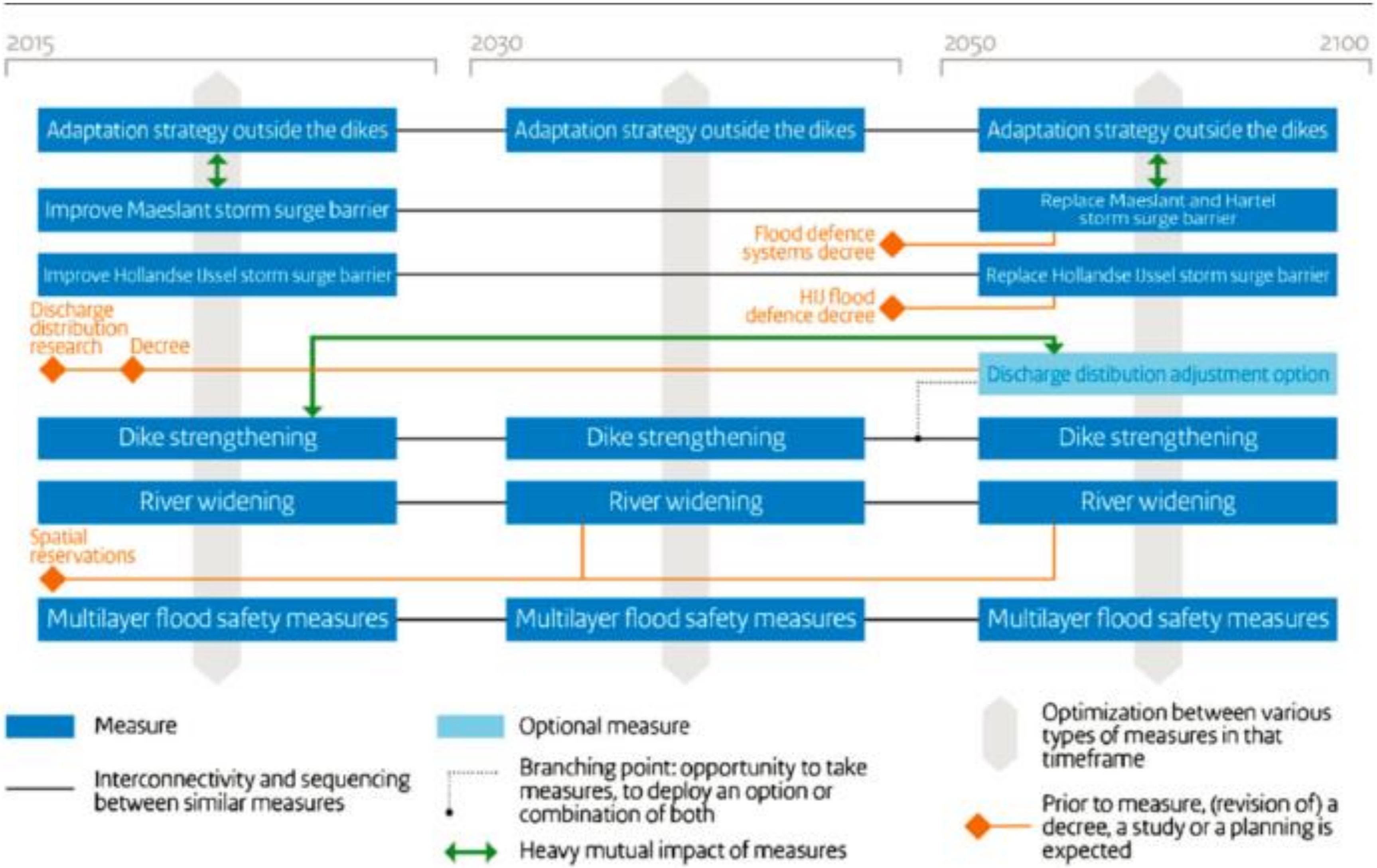
Philosophy: Adaptive Management

- 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
- 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



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

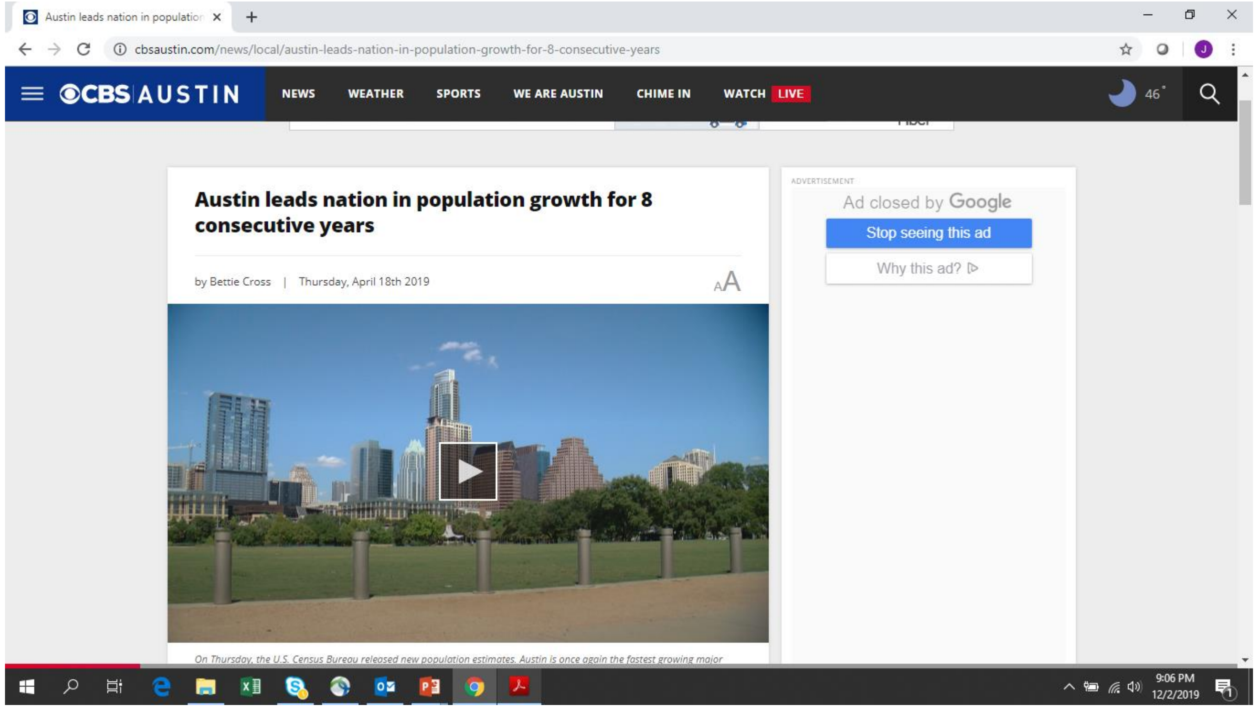
- Incrementally increase size of investment or make other incremental change to adapt to expected climate change
- Makes most sense when cost of incremental change is low
- Appropriate for decisions with long-life time
- Can be inappropriate if fundamental change is needed

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