Challenges of Adapting to a Changing Climate

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In Brief:

- Terms and context
- Example: adapting to a changing hydrograph
- Adaptation: how, what, where, and when
- Taking action and coping with uncertainty
- Tactics and strategies
- Closing thoughts

How? – Go Beyond Routine

Adaptive capacity is a critical dimension in understanding of organizational performance

"… organizations increasingly face adaptive challenges requiring them to abandon the familiar and routine. Instead, they need to develop the capacity to harness knowledge and creativity to fashion unique responses, stimulate organizational learning and sometimes embrace transformational change."

Carl Sussman, "*Building Adaptive Capacity: The Quest for Improved Organizational Performance"*

Adaptation Demonstration (time permitting):

1. Identify the structural/transformation change?
2. Is the change evidence of reactive adaptation or Pro-active adaptation?

Terms and Definitions

Adaptation is a deliberate change in system design, function or behavior in response to or anticipation of external events or changing conditions.

Consider the following two adaptive strategy paradigms

1st Reactive (autonomous) adaptation

disturbance occurs and systems absorb impacts and attempt restoration to pre-disturbed conditions

2nd Proactive (anticipatory) adaptation

nature and timing of disturbance is anticipated and systems are appropriately reorganized to improve their capacity to avert adverse damages and to leverage resulting opportunities

Adaptation is <u>successful</u> if, following a change or disturbance, the level of services and functionality (i.e., social value) is approximately maintained or restored.

Context for Adaptive Action

- Climatic change can cause significant harm to societies and ecosystems
- Reducing GHG emissions (aka mitigation) will likely reduce both the **degree** and **likelihood** of adverse conditions
- Longevity and inertia of atmospheric GHG forcing means some degree of climate change is **unavoidable**
- Therefore, adaptation is not a question of 'if' but rather of

How? What? Where? and When?

Climatic Shifts in Hydrograph

Model assumptions

temperature ↑ 4°C

diurnal temp. range ↓ 1.4°C

Precipitation ↑ 10%

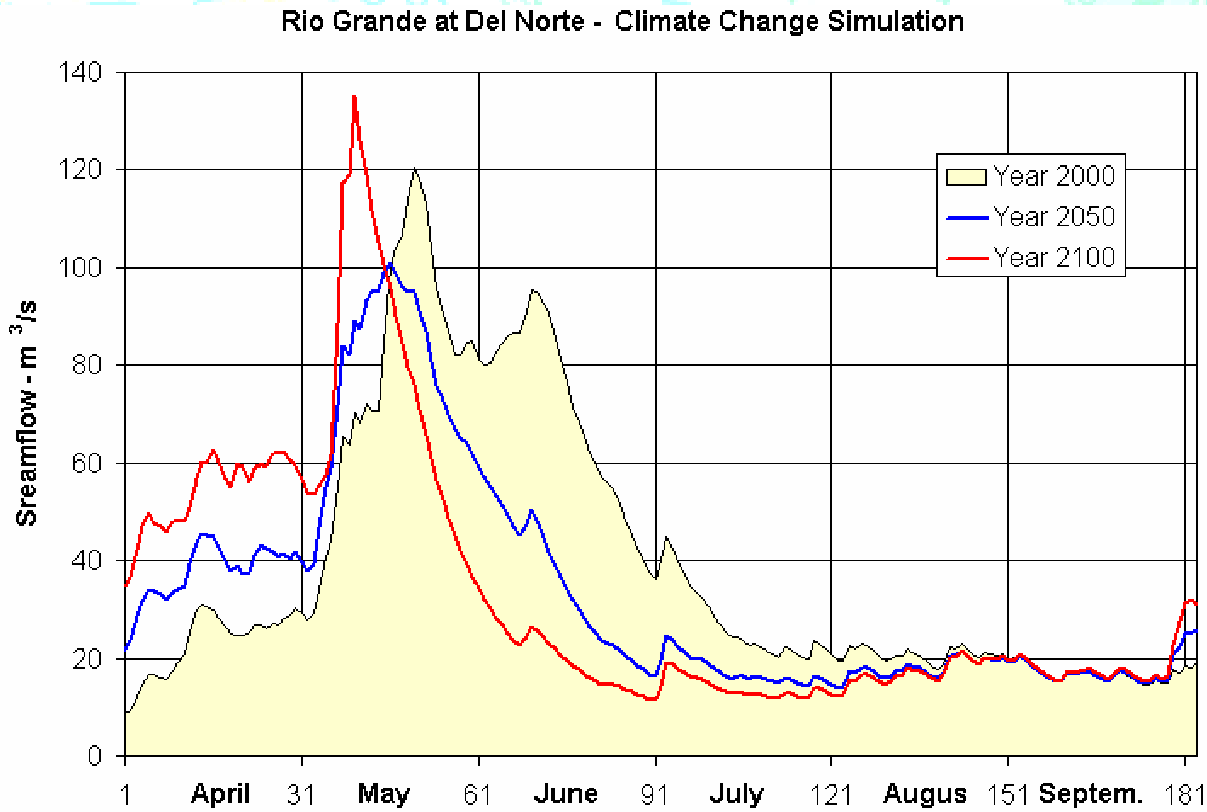
Results

Earlier snowmelt

Higher peak streamflow

Lower summer streamflow

Implications for Water Users?



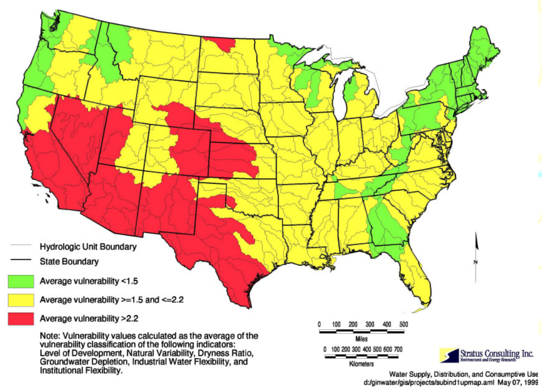
Days – April 1 to September 30

How? – Building Adaptive Capacity

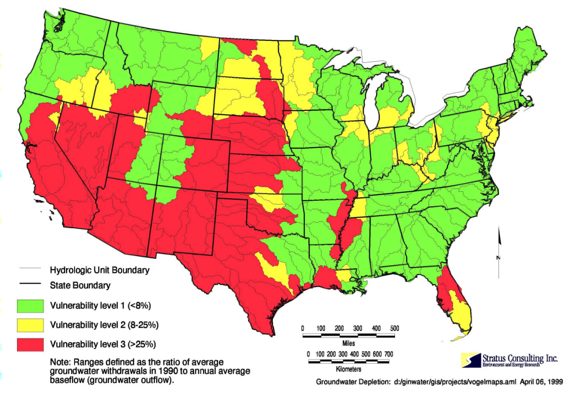
Adaptive Capacity is the ability of systems, organizations and individuals to:

- Adjust to realized and potential changes and disturbance events
- Take advantage of existing and emerging opportunities
- Successfully cope with adverse consequences, mitigate damages, and/or recover from system failures

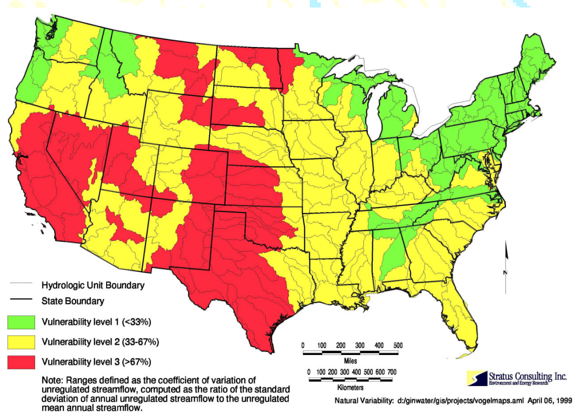
What? And Where? Identifying Vulnerable Systems: Water Resources Across the United States



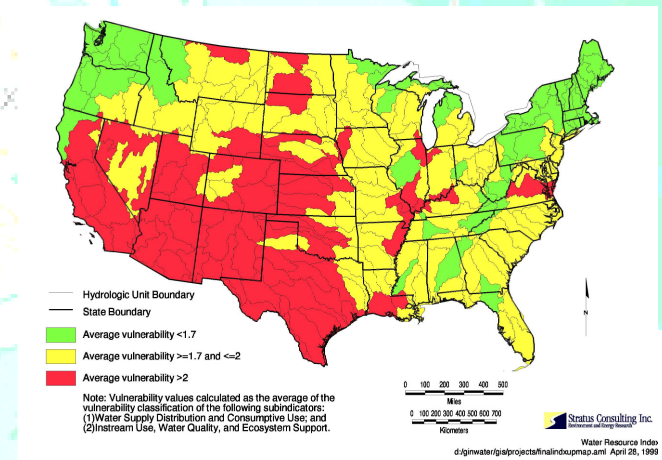
Rates of consumptive water use relative to surface supply



Extraction Rate of Groundwater Resources



Natural climatic variability



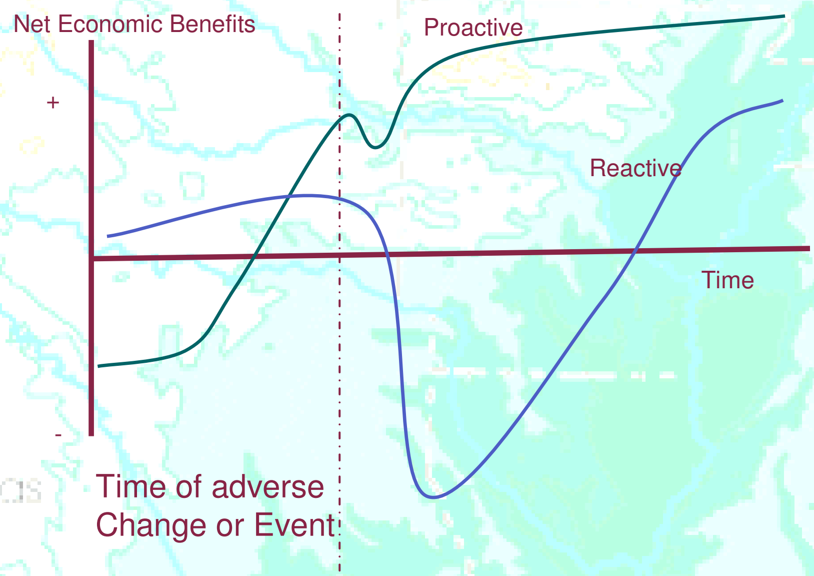
Overall Index

Source: Hurd, B.H., N. Leary, R. Jones, and J.B. Smith. 1999. "Relative Regional Vulnerability of Water Resources to Climate Change." *Journal of the American Water Resources Association*, December, 35(6): 1399-1410.

When? Timing Adaptations: the Relative Cost and Success of Reactive versus Proactive Adaptation

- Benefits of delayed action
  - Increased accuracy based on evolving knowledge and information
  - Postponed expenditures and possibly better technologies and lower unit costs

- Risks of delayed action
  - Less successful adaptation
    - More welfare losses and service disruptions
    - Greater likelihood of irreversible losses
  - Reduced adjustment time



How and Where to Begin?
Win-Win Strategies and Other Low Hanging Fruit

- Improve science and information development, integration, and dissemination
  - Integration of climatology, hydro sciences, and resource management
  - Strengthen institutional capacity, cooperation & collaboration
    - Establish strategic partnerships between State-Univ.- Nat. Labs. – Local Gov't

- Develop appropriate risk management institutions and policies
  - Climate-risk sensitive policies and regulations
    - Appropriate insurance and disaster recovery incentives
    - Greater 'risk sharing' rather than 'blanket protection' from climate risks
  - Enhance stakeholder awareness and decision-making participation

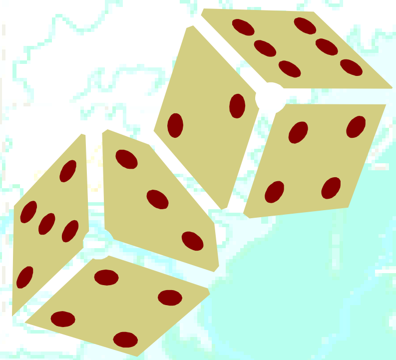
- Increase the use of resource markets and incentive-based policy designs
  - Increase voluntary and cooperative solutions to improve water use efficiency and compliance, conversely limit use of regulatory 'stick approaches'

- Add flexibility and safety to infrastructure design and assessment
  - Greater flexibility in design
  - Wider safety margins and tolerances
  - Enhance water supply opportunities – e.g., desalination, aquifer mgt.

- Consider climatic factors in land use planning and building codes
  - Risk appropriate zoning
  - Conservative building code enforcement
  - Increase public awareness of risks and responsibilities e.g., flood plains and levee tolerances

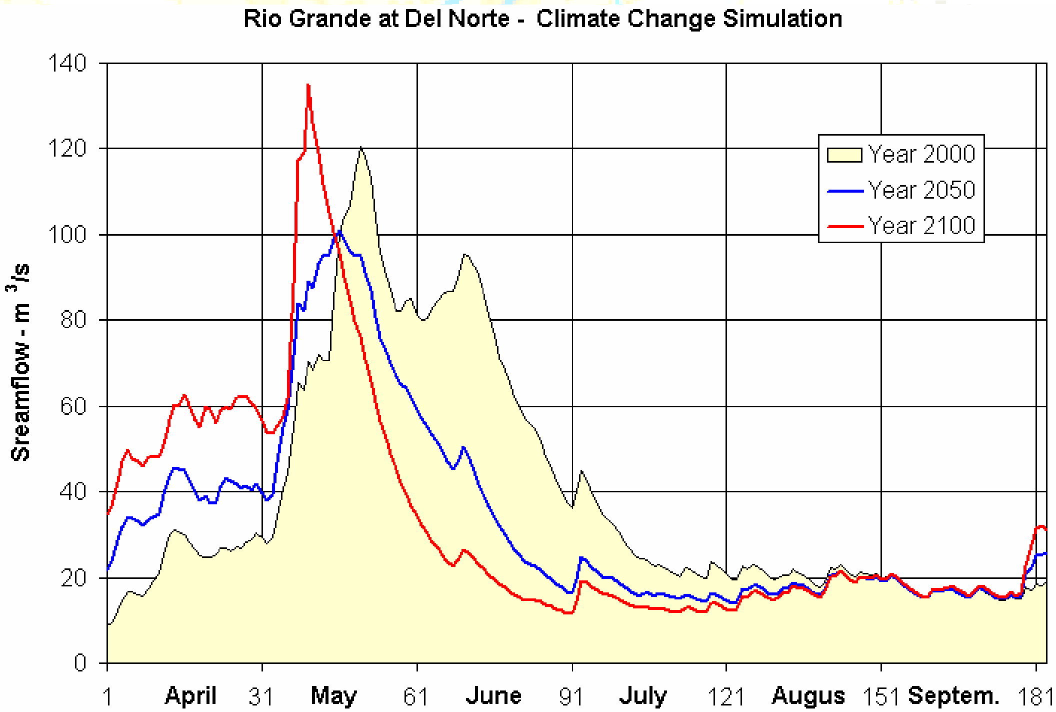
Coping With the Uncertainties of Climate Change

- Changing climates are like a game of chance where the deck is stacked and dice loaded
  - It is difficult and uncertain to assess changes in climatic probabilities
  - We can hope that they are gradual and incremental



- Decision heuristics may be necessary
  - Revise risk beliefs accordingly – using subjective or expert opinion as necessary
  - Play as if you knew how the odds were changing as though you were counting cards or playing with loaded dice
- Marginal changes in risk beliefs MAY only require marginal changes in strategies/actions
- However, anticipatory structural changes may be the ‘best’ overall strategy, enhancing system
  - Reliability, flexibility, failure tolerance

Implications?



What does it mean for …

- Water storage and distribution systems?
- Urban and rural water users?
- Water quality?
- Hydropower?
- Recreational and cultural functions?
- Riparian ecosystems and migratory patterns?

Tactics and Strategies

- Manage for desired future well adapted processes
- Adaptation strategies
  - Assist ecosystems to adjust to climate changes
- Mitigation strategies
  - Assist ecosystems to sequester CO2 and reduce GHG emissions

adapted from USDA Forest Service, Joyce and Millar

Framing Land Management Adaptation Strategies – 5 R's + 1

Resistance
defend valuable and unique

Resilience
promote balance
reduce stress

Response
anticipate change and risks
facilitate adaptive changes

Prioritize
Activities & investments
'triage approach'

Realign
restore and recover consistent with changing conditions

Reduce
GHG and ecology footprint
limit emissions and sequester carbon

adapted from USDA Forest Service, Joyce and Millar

Closing Thoughts

- Adaptation <u>complements</u> mitigation in a comprehensive and coordinated climate strategy
- Enhancing adaptive capacity reduces vulnerability, increases success likelihood, and may have non-climate benefits
- Look for ‘no-regret’ and ‘win-win’ opportunities to:
  - Strengthen capability and expertise in climate science, hydrology, and resource management
  - Foster partnerships and strategic alliances to harness capacities across organizations and institutions e.g., State-Labs-Univ-local gov’t-NGOs
  - Invest in education and economic development, the keys to unlocking the engine of adaptive capacity
- Managing land and ecosystem resources for successful adaptation will likely require a multi-faceted approach that is forward looking