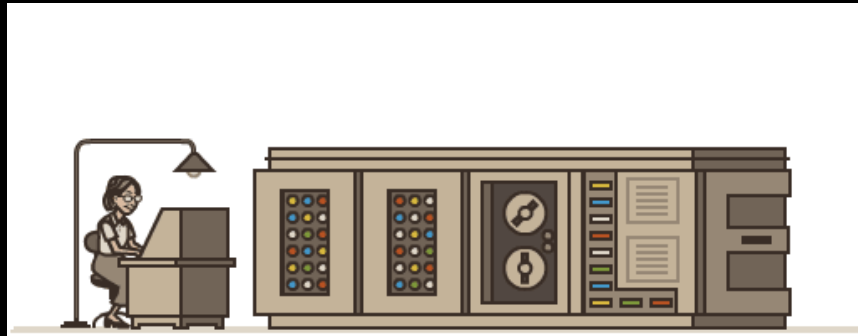


# From Hydroclimatic Prediction to Negotiated and Risk Managed Water Allocation and Reservoir Operation

Upmanu Lall  
Columbia University

# An almost traditional view

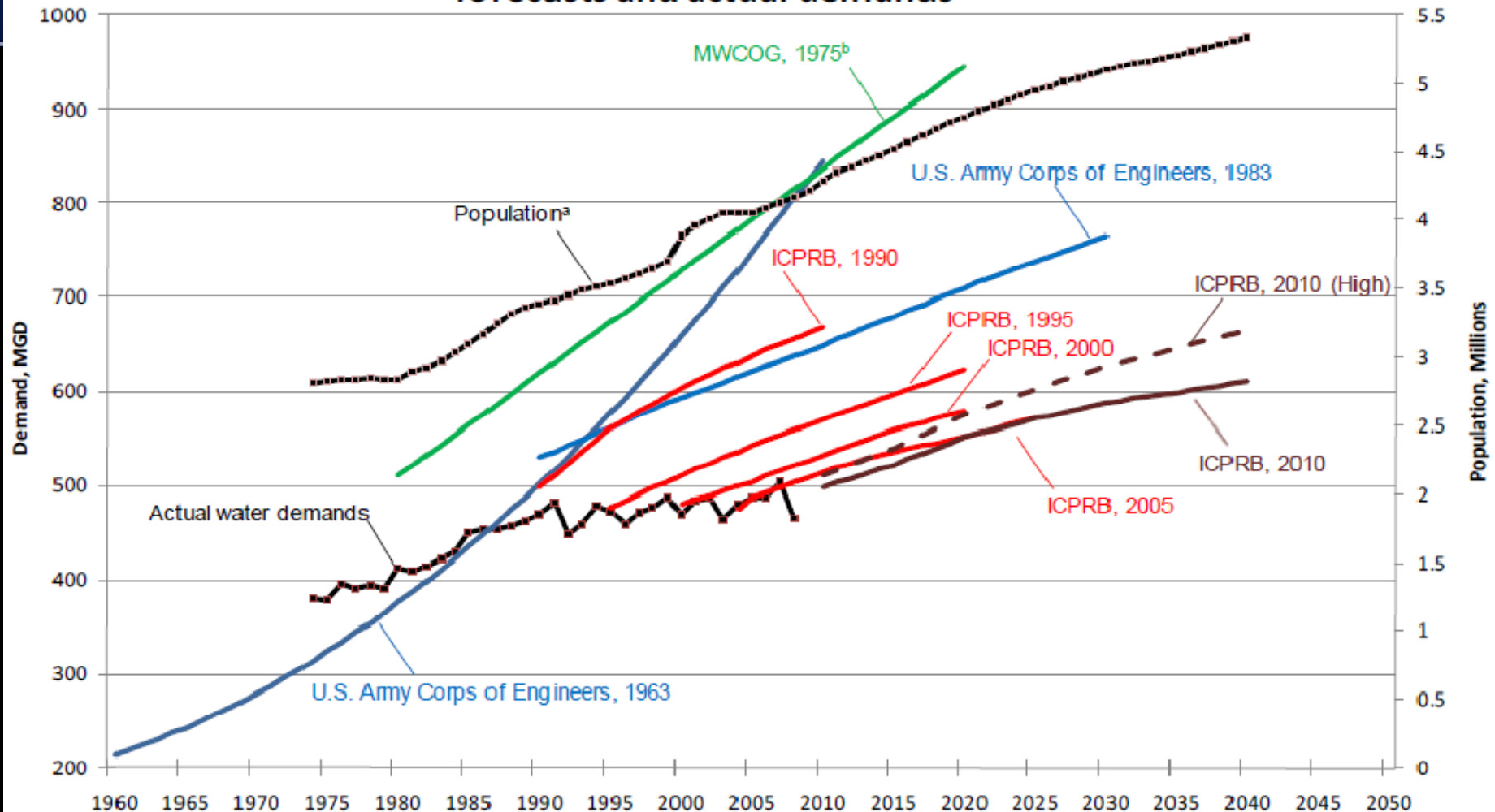
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- **Central Planner optimizes resource**
  - Water Rights & Allocations
  - Prediction and control systems for infrastructure design/operation
- **Primary challenge: supply uncertainty**
  - Use Seasonal and longer forecasts to improve system reliability to meet specified demand targets
  - Supply side? Demand Management? Financial impacts, equity?

# Alan Roberson, AWWA

Washington metropolitan area average annual water demand, forecasts and actual demands

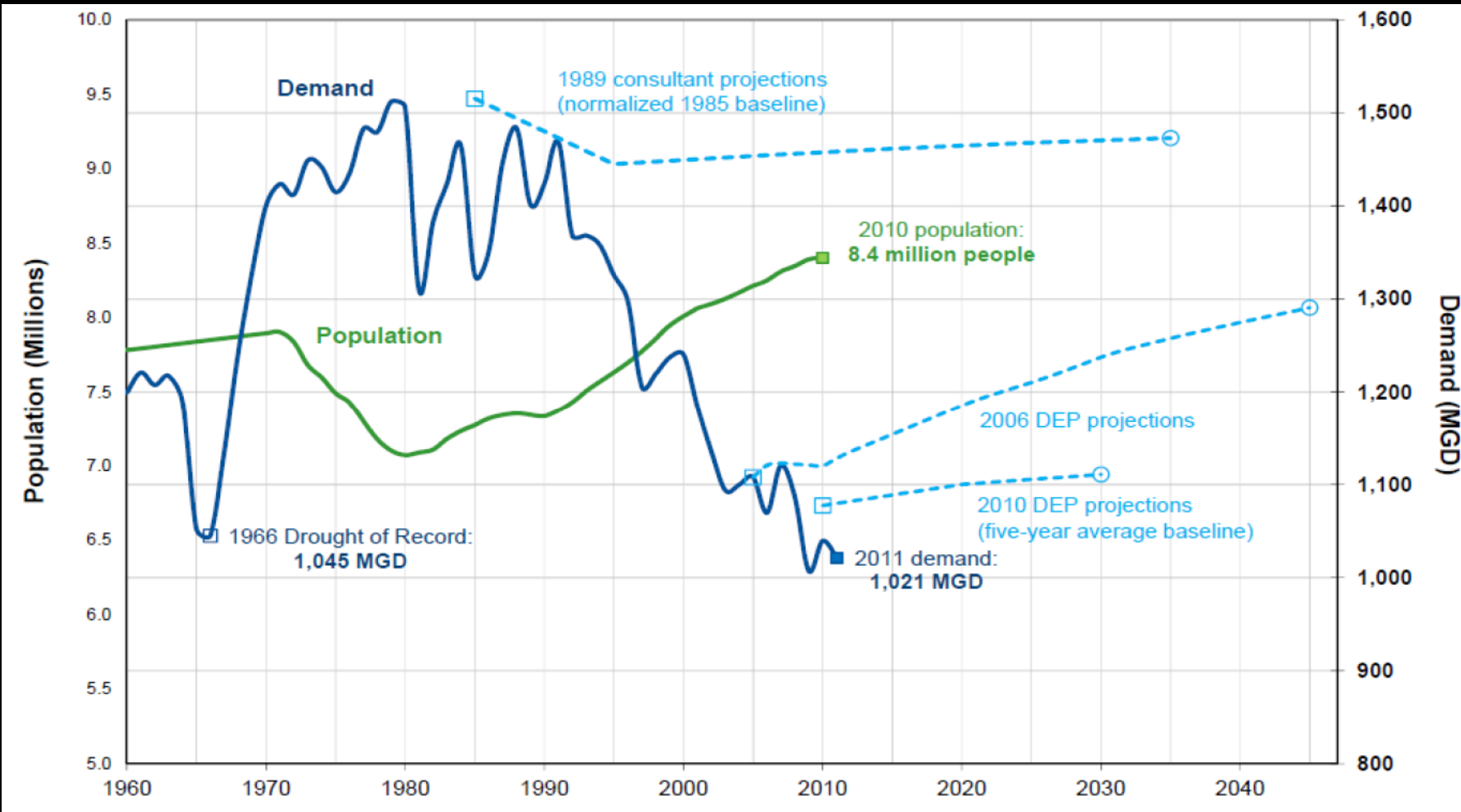


<sup>a</sup> Population is a sum of the populations within Montgomery, Prince George's, Prince William, Loudoun, Fairfax, and Arlington Counties, as well as the District of Columbia, according to data provided by the U.S. Census Bureau.

<sup>b</sup> As cited in U.S. Army Corps of Engineers, 1975

# New York City

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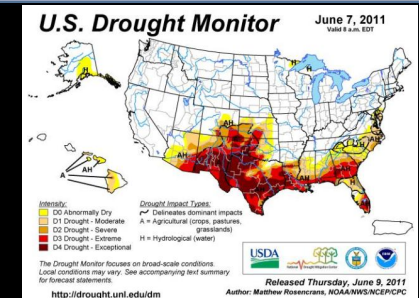


# Sectoral Demand?

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*NM farmers selling water to oil and gas developers*

[Drought-Stricken New Mexico Farmers Drain Aquifer To Sell Water For Fracking](#)



With a scant agriculture water supply due to the prolonged drought, some farmers in Eddy County with supplemental wells are keeping bill collectors at bay by selling their water to the booming oil and gas industry.

Davis said he sees no problem selling water to the industry, but the current drought conditions are having an impact on the amount of water that is being sold. He believes there has to be some personal accountability on how much is pumped out of the aquifer.

Davis alleges that some well owners are finding ways to apply for a commercial permit that allows them to pump up to 9 acre-feet for the year without advertising their change of use and advertising it in the legal section of the newspaper.



[www.water-alternatives.org](http://www.water-alternatives.org)

Larson, W.M.; Freedman, P.L.; Passinsky, V.; Grubb, E. and Adriaens, P. 2012. Mitigating corporate water risk: Financial market tools and supply management strategies. Water Alternatives 5(3): 582-602

# Mitigating Corporate Water Risk

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*Hedge economics*

*Mitigate supply risk*



**Derivatives/hedging**

**Insurance**

**Water trading and water rights**

**Reduce, recycle, and reuse**

**Enhance supply**

Response

**Hedge** using commodity derivatives for water

**Insure** against adverse weather events that cause water scarcity

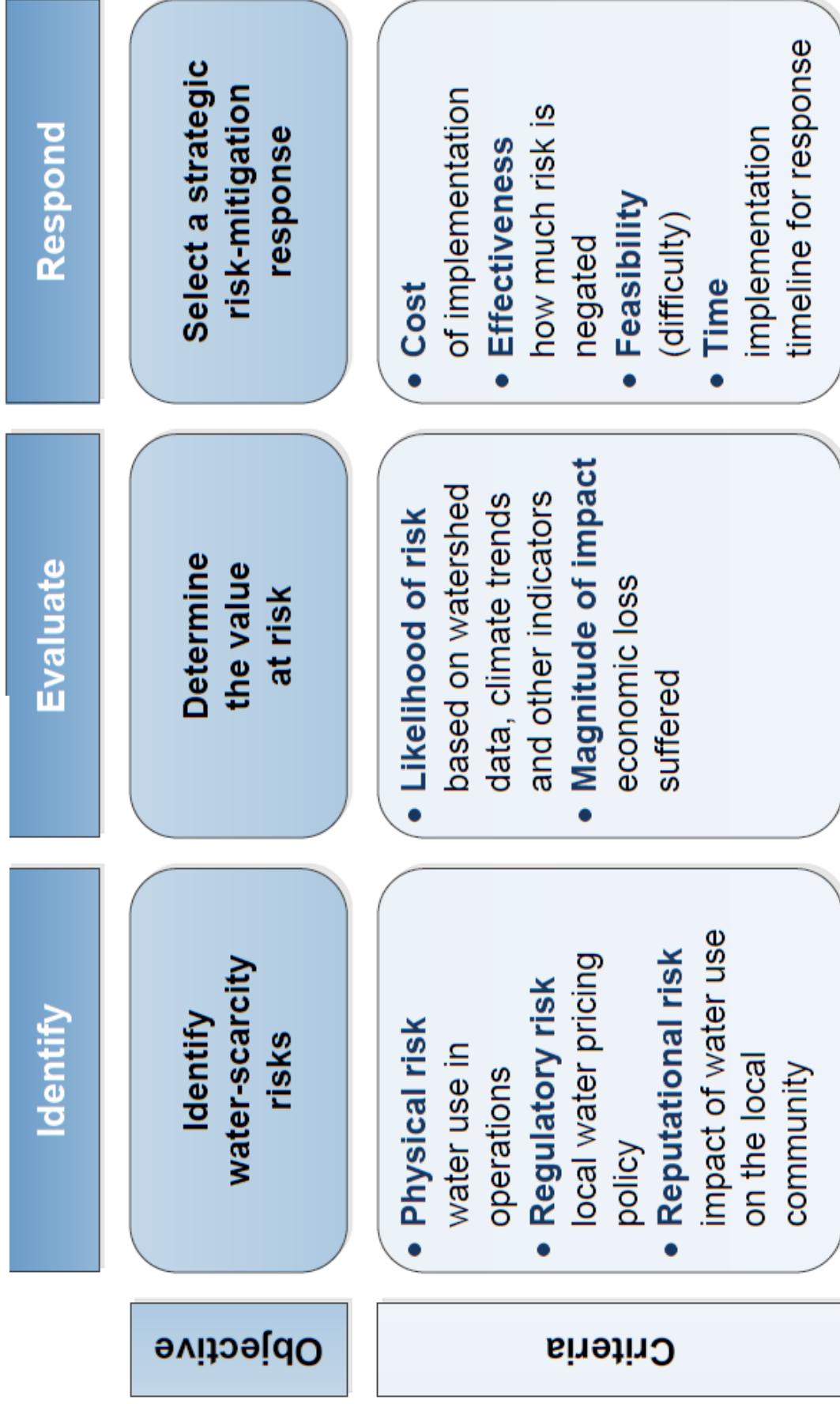
**Buy or trade** water rights and physical quantities of water

**Reduce** water use in the value chain and **Reuse** wastewater

**Enhance supply** in the value chain

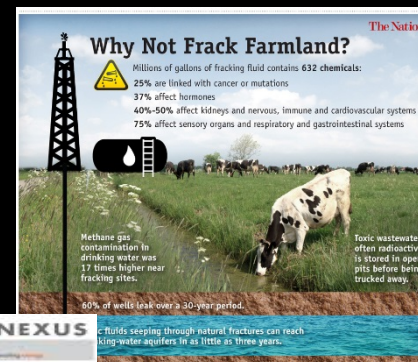
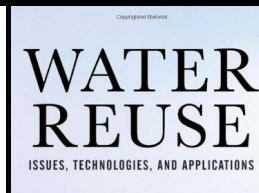
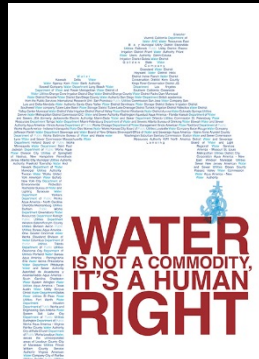
## RISK-RESPONSE DECISION FRAMEWORK

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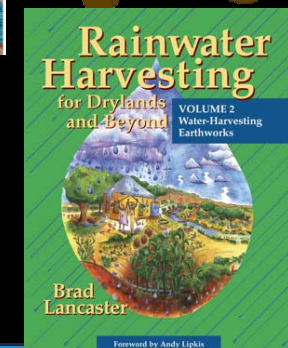
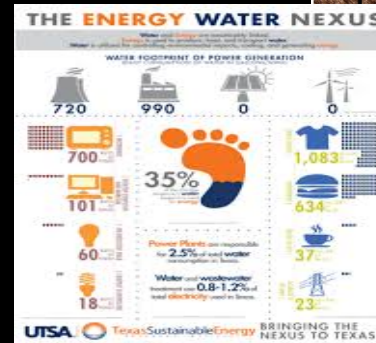


# The Emerging World

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- Public or Private
- Market or Monopoly
- Transactions



COLUMBIA WATER CENTER:

Global Water Sustainability Initiative



# Enter the Hydrologist

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- Is water the currency of climate or a bit more?

Actor\Period	Season/Year	5 years
Farmer	Crop Choices	Water Infrastructure Investments
Agro Corporation	Sourcing Strategy	Sourcing & Stock Strategy
City Manager	Drought Pricing Acquire Rights	Capacity Expansion Acquire Rights
Household	Conservation	
Energy Producer	Acquire Rights	
Manufacturer	Insurance	Water Reuse facility
Hedge Fund		
Insurance		
Investor		

Actors influence actions of other actors

Collective actions predict local, regional and global demand shifts

Some are climate related

Operator Predictability ?

# Application

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## Reservoir/Water Management



- **Provision of stochastic inflow forecasts and current reservoir levels**
  - Skill information disclosure = assurance of credible intervals, not mean
- **Insured Contracts with reliability and deficit control**
  - Insurer validates analysis and process reducing risk premium
- **Iterated, dynamic process for negotiated convergence for multi-time period contracts across sectors/players**
  - Demand and Price Discovery relative to projected reliability and shortage
- **Public Agency as facilitator & regulator, supported by fast optimization model to evaluate market contracts**
  - Institutional & Technical Support + Enforcement essential. Recover Transaction costs

# Questions

- **Subsidies: How is access to water for the poor managed under such a system?**
  - Direct cash subsidy + per unit charge?
  - Base access guarantee?
  - Tradability of access/right at market values?
  - Potential of exit from agriculture?
- **Does reduction in uncertainty through climate & agricultural forecasts help stabilize or aggravate such a market based system?**
  - Does the market process introduce volatility in drought /wet years?
  - Do coalitions form ex ante or ex poste to distort results?
  - How to manage trade-offs between short/long term contracts
- **Does the increased sophistication called for operations lead to increased transactions costs?**
  - Better science training and data collection/sensors?
  - Infrastructure operating cost recovery – increased re-use reduces revenue?
  - New strategies to allocate carry over and current storage?
  - Post allocation trades and delivery assurance?

# Summary

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- **It's the anthropocene**
  - The challenge is to understand, (predict) and manage processes that define the redistribution of the resource
  - Climate change is just one element of significant structural changes in the offing
  - Gaining experience with new instruments is essential to provide social balance and resource investment incentives
  - Emergence of new needs for hydrologic information
- **A new era dawns for the applications of hydrologic science, as the value of a most precious resource on earth emerges through competition and local constraints**
  - We need soft and hard technologies, but most of all understanding of the changing context in which we operate

**Friday**  
11:40 AM -  
11:55 AM

*H52G-06. Multi-time scale Climate Informed Stochastic Hybrid Simulation-Optimization Model (McISH model) for Multi-Purpose Reservoir*