United States Environmental Protection Agency

Precipitation Variability and Projection Uncertainties in Climate Change Adaptation: Go Local!

MSSC 2010 Salinity Summit – Water and Energy: "Preparing for Global Impacts"
Las Vegas, February 18-19, 2010

Dr. Y. Jeffrey Yang, P.E., D.WRE

USEPA, Office of Research and Development,
National Risk Management Research Laboratory

Office of Research and Development

Agenda

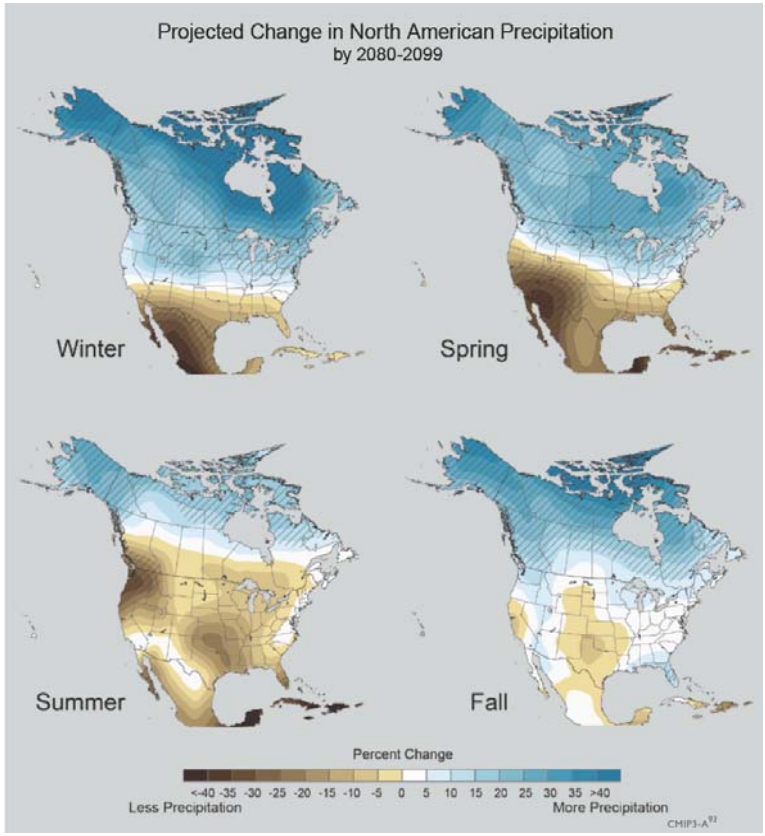
- **Regional and local climate change effects: The relevance**
- **Variability and uncertainty in decision-making and adaptation approaches**
- **Adaptation attributes for the U.S. Southwest: Water availability, storage capacity, and related**
- **EPA research and program actions**
- **Thoughts for next steps**

United States Environmental Protection Agency

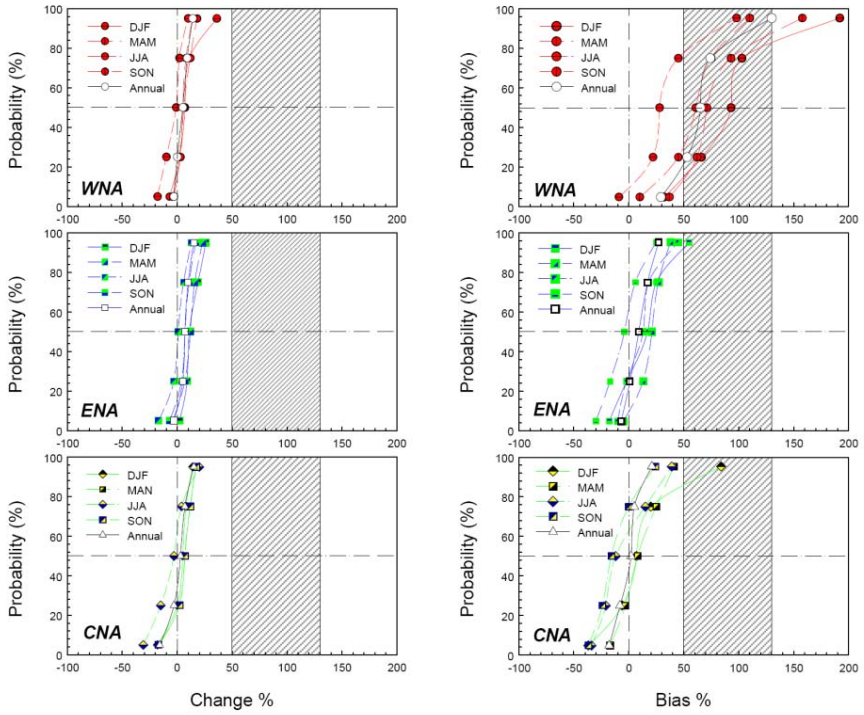
How Hydroclimatic Changes Affects Water Resources

- Continental precipitation and temperature
- Hydrologic changes:
  - Precipitation regimes
  - Storm intensity and drought frequency
  - Timing of snow melts and stream flows
  - Sea level rise, and meteorological extremes
- Soil moisture and ecological changes
- Water quality changes

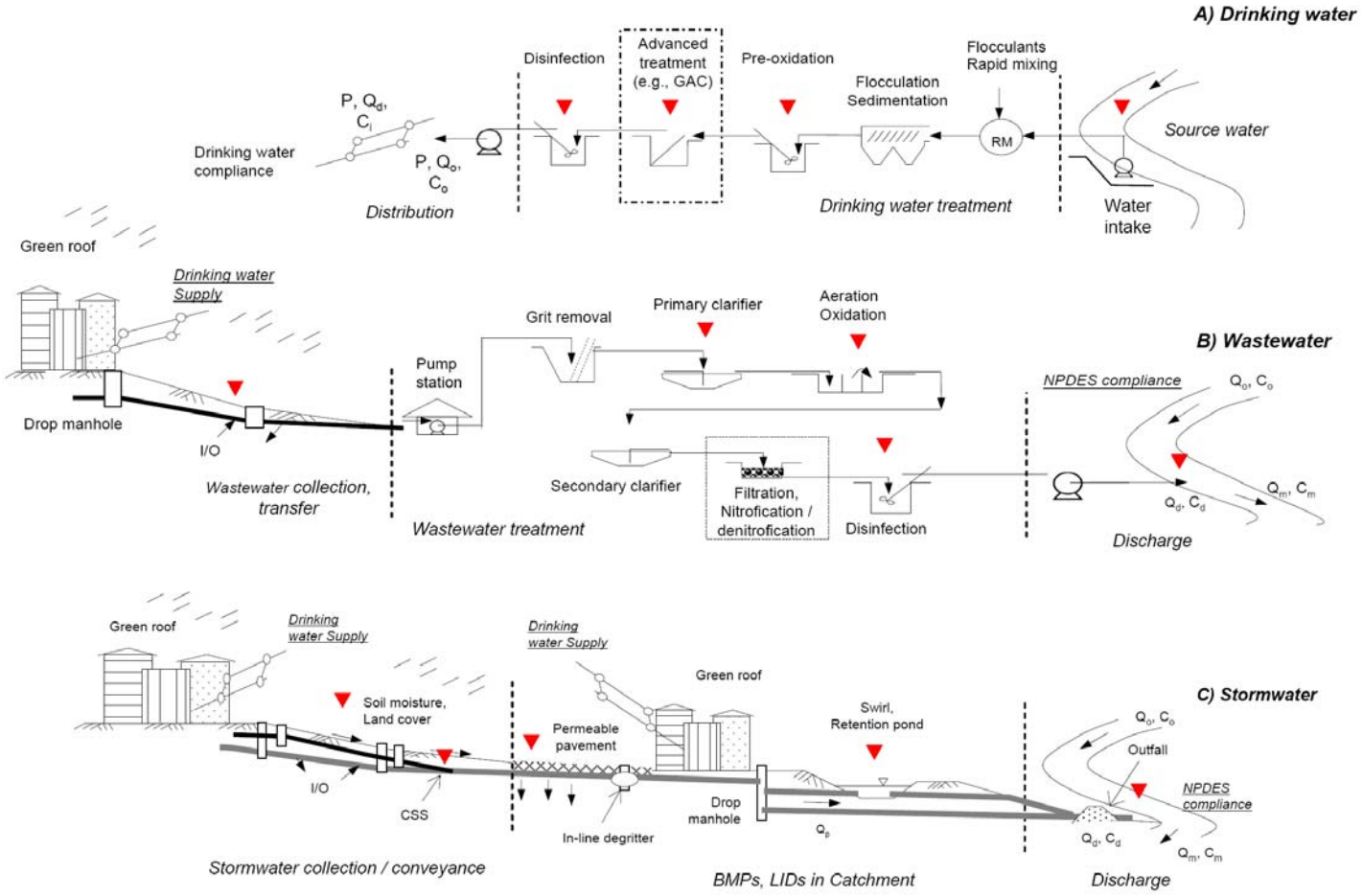
***AOGCM projections* (CMIP3, from USCCSP 2009)**



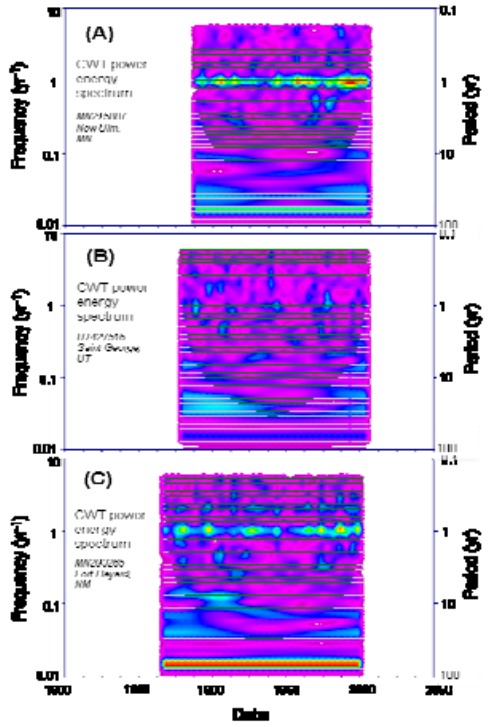
***AOGCM MMD vs measurements* (data from IPCC)**



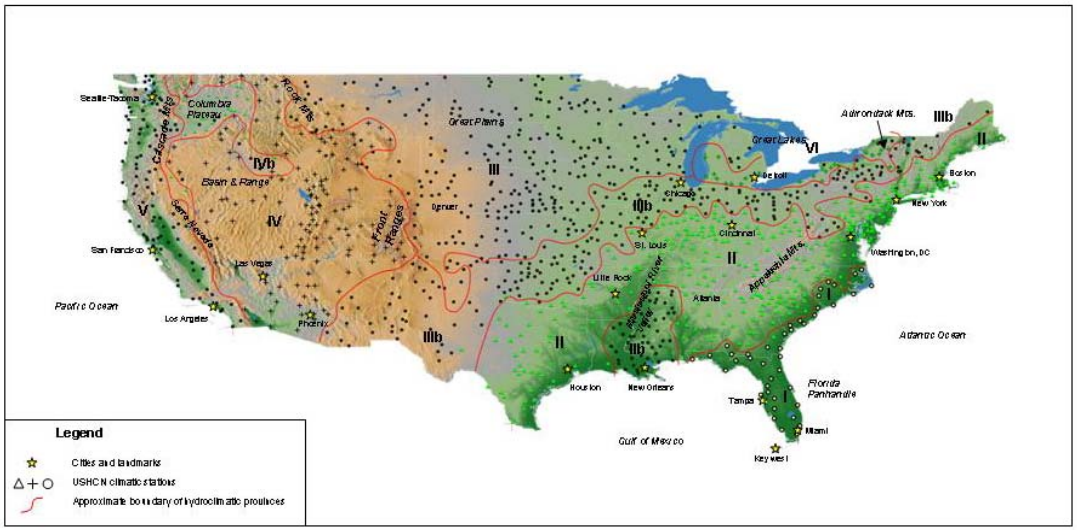
How Hydroclimatic Changes Affects Water Infrastructure



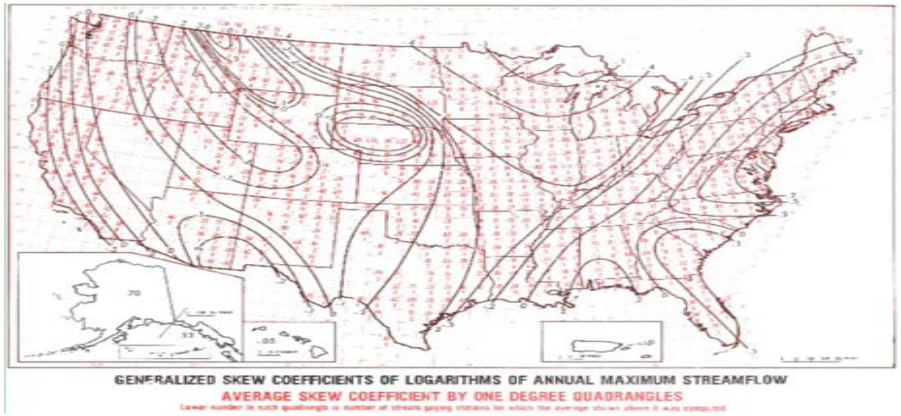
Understanding the Precipitation Variability



Precipitation hydroclimatic provinces



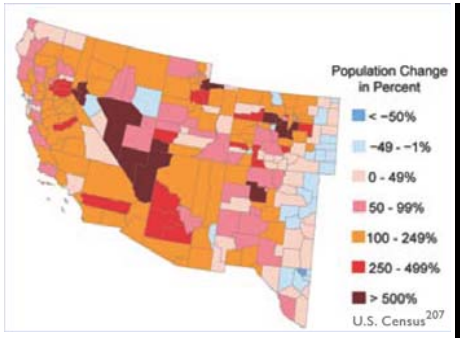
Regional Skew Map for Flood Occurrence (Bulletin 17B)



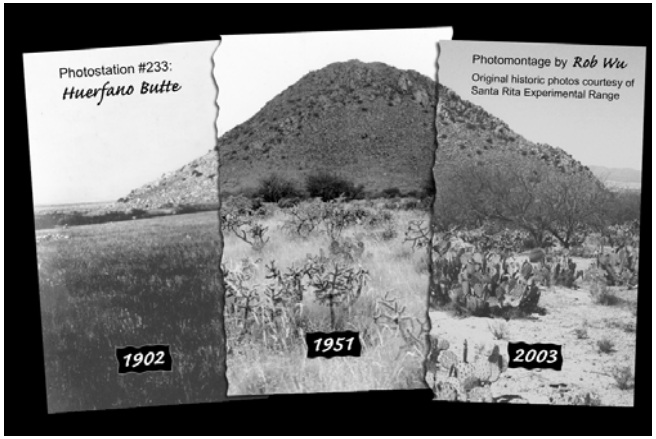
- High frequency precipitations are broadly classified into Type-A and Type-B. Their spatial distributions consistent with major physiographical divisions;
- Local precipitation variability is affected by local-regional variables.

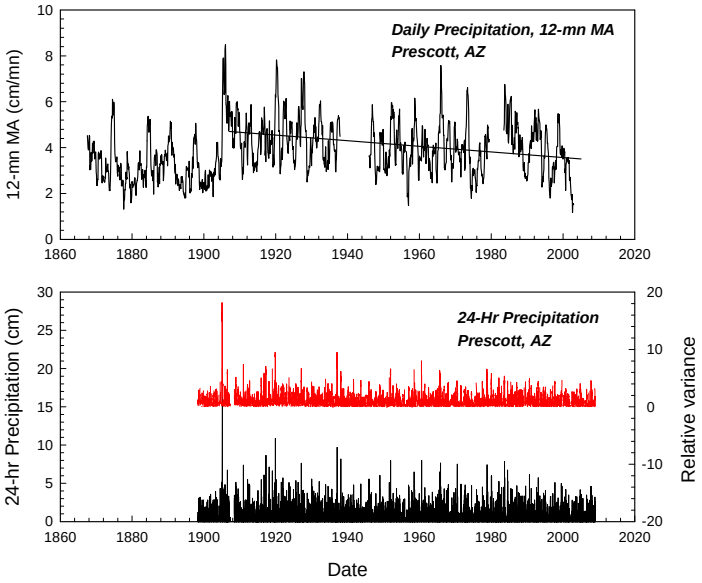
EPA
United States
Environmental Protection
Agency

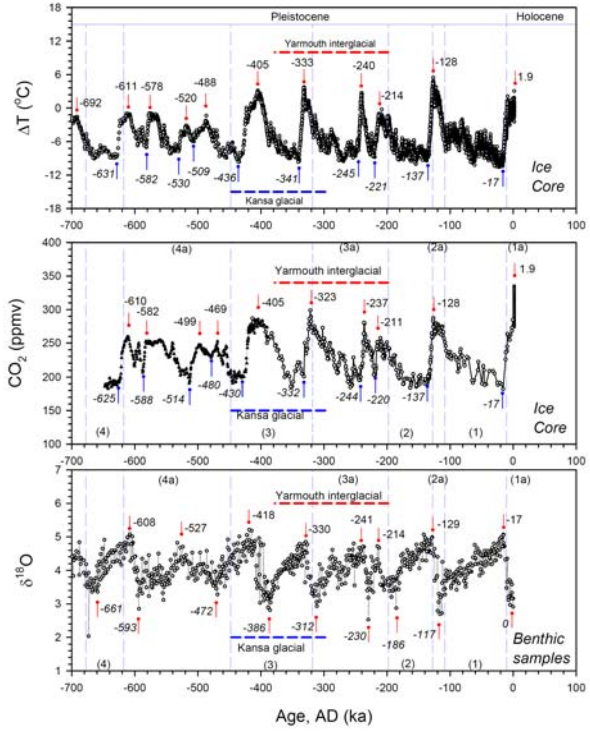
Observed Changes in US Southwest



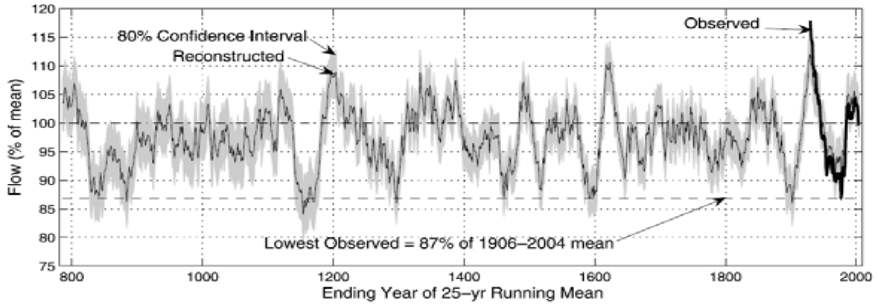
(from USCCSP, 2009)



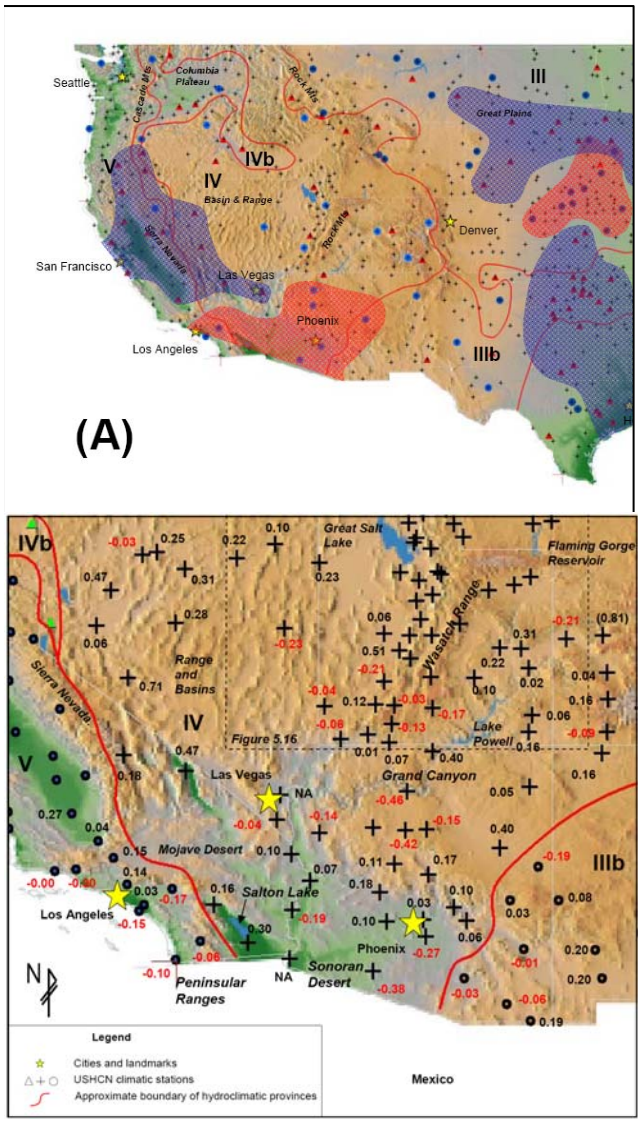




Colorado river flow change (from Meko et al., 2007)

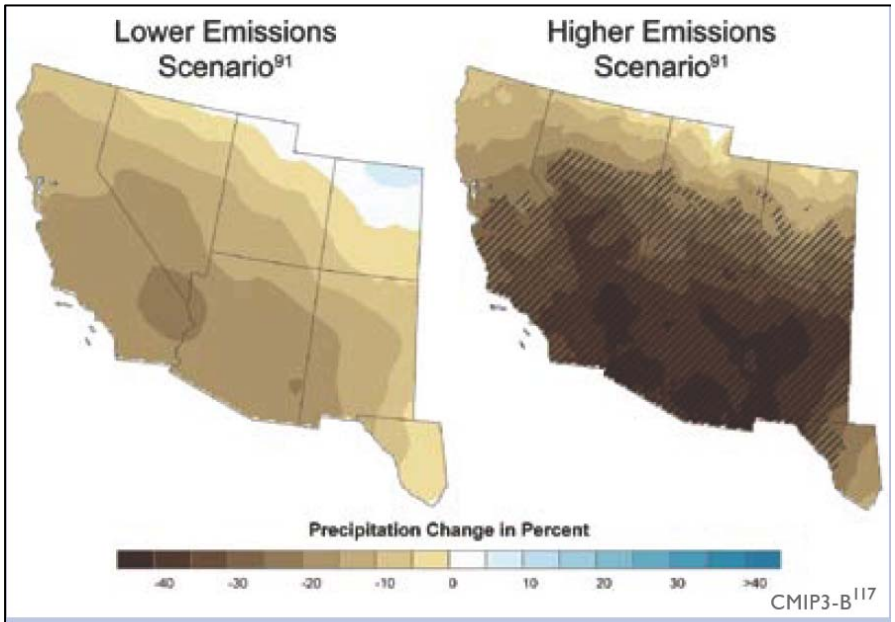


Future Precipitation Changes in US Southwest



- Long-term precipitation decreased as recorded historical measurements (left)
- Topographic factors enhanced spatial disparity of the change (lower left)
- Climate models (CMIP3) have projected a likely further decrease in the U.S. Southwest (below)

(from USCCSP, 2009 and references therein)



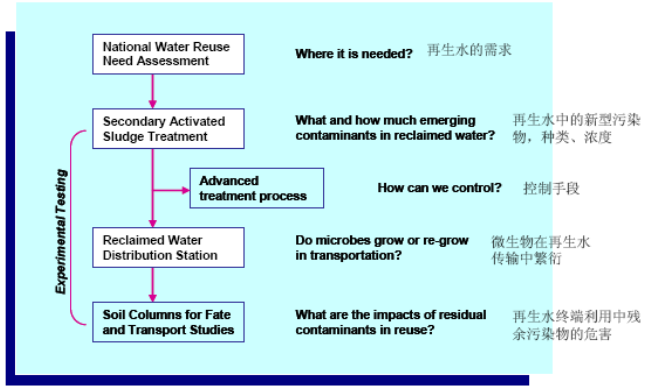
Percentage change in March-April-May precipitation for 2080-2099 compared to 1961-1979 for a lower emissions scenario[91] (left) and a higher emissions scenario[91] (right). Confidence in the projected changes is highest in the hatched areas.

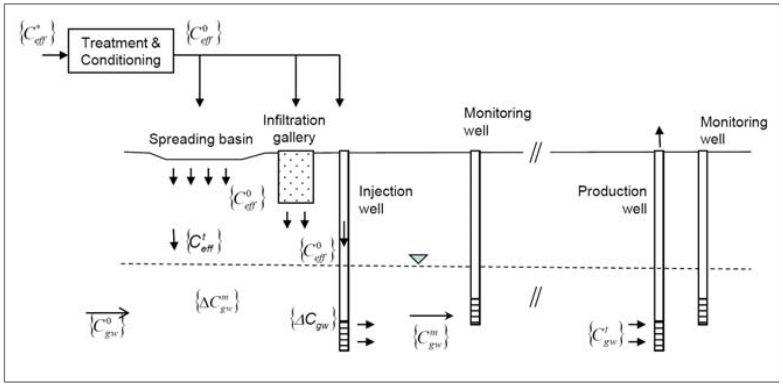
Considerations in Adaptation Planning

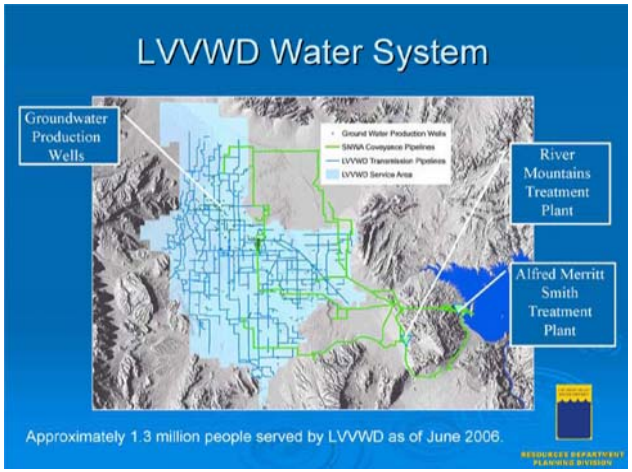
- Precipitation will likely decrease. Also these model projections have large degrees of uncertainty yet to be quantified
- The change trend is certain and the rate is small yielding a valuable time window for planning and engineering
- The large seasonal, interannual, decadal, and multi-decadal variations – natural background – are critical to water resources adaptation
- Precipitation is only one of the important controlling variables. The ability for a more accurate and precise projection is improving.
- We may need to consider adaptation now, before the time window closes.

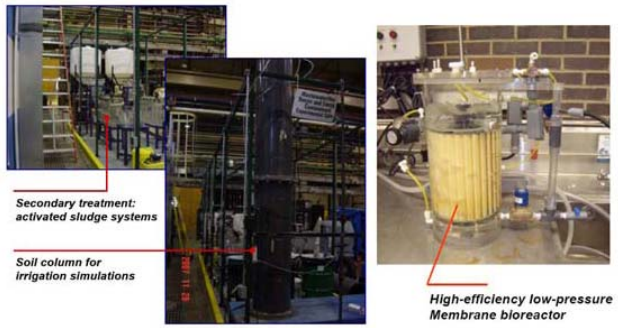
EPA WRAP Regional Studies: Las Vegas and US Southwest

- EPA WRAP regional adaptation study
- Adaptation in Las Vegas drinking water supply:
  - Hydrological and landuse changes
  - Water demand forecasting and management
  - Water treatment and distribution adaptation
- Water reuse and ASR application studies
- Conjunctive water use (domestic, ecological, etc.)





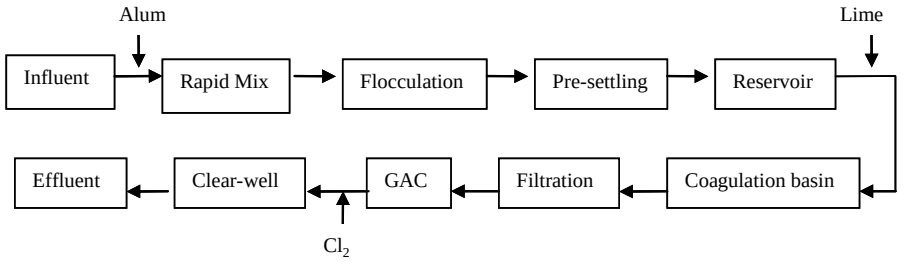


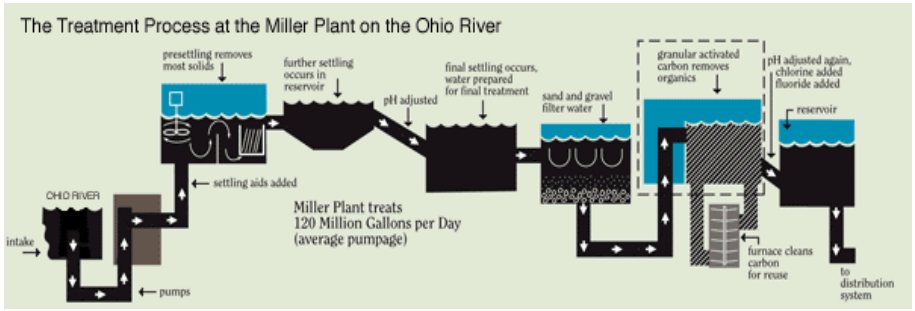


Infrastructure Adaptation – Miller Drinking Water Treatment Plant: Process engineering

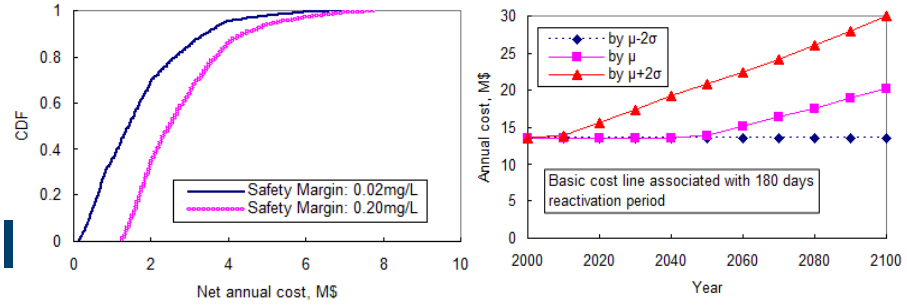
- EPA Water Treatment Plant (WTP) model to model 1) the impacts; 2) process adjustment for adaptation; 3) adaptation cost
- Prototype of the program under testing and final development
- It will be available at EPA WRAP website
- In 2050, the annual operation cost of GAC unit is $14.0 million. Or $0.18/1000gal at full capacity, and $0.35 at the 50% capacity. A large fraction of it related to adaptation

Modeled treatment process

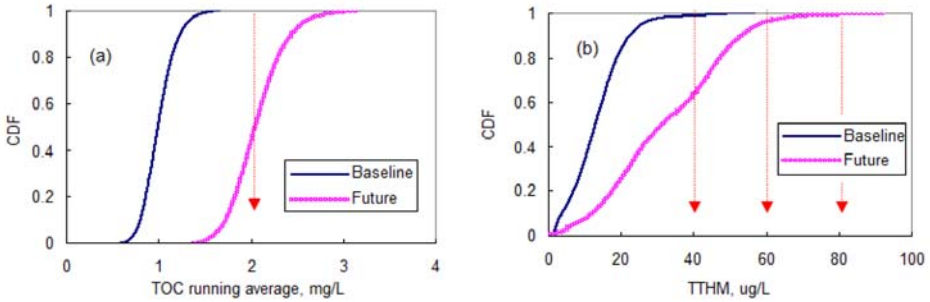




Adaptation and cost

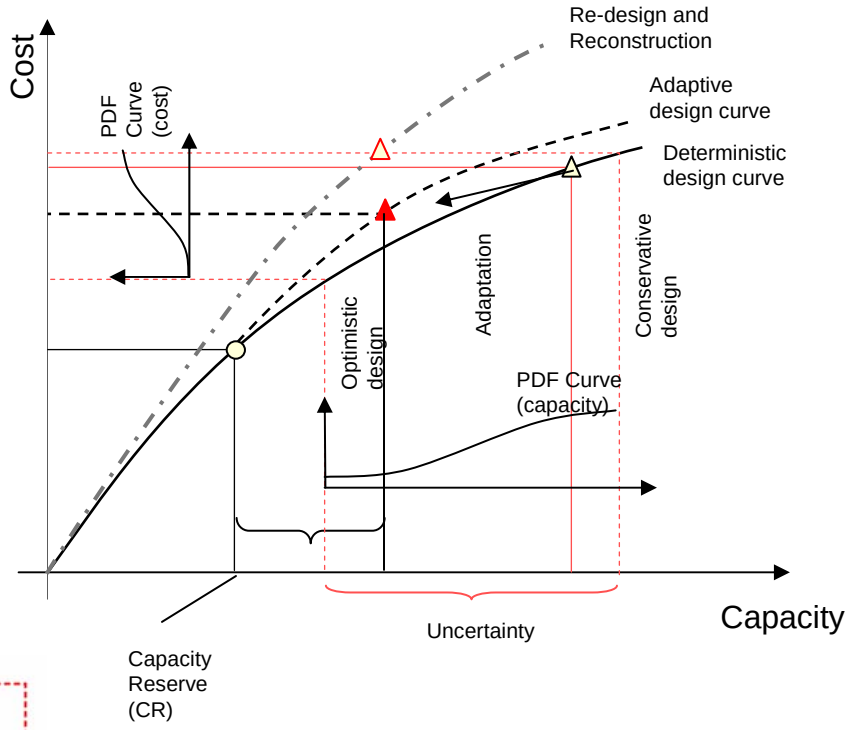


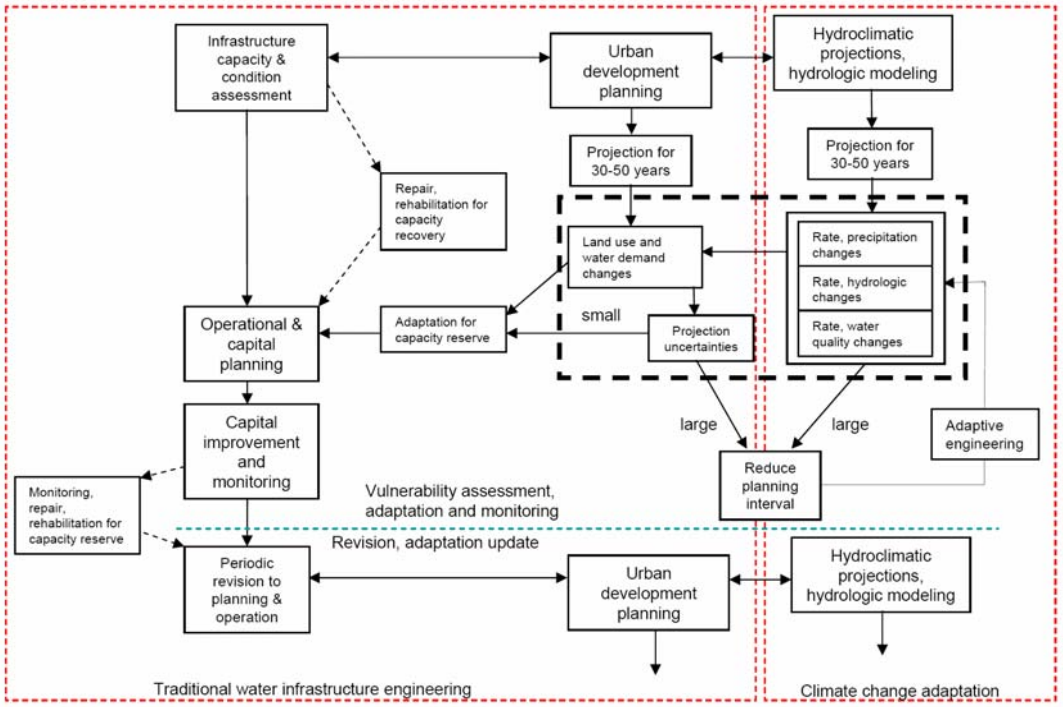
Probability of regulation variations



United States Environmental Protection Agency

Adaptive Engineering and Planning





Closing Thoughts

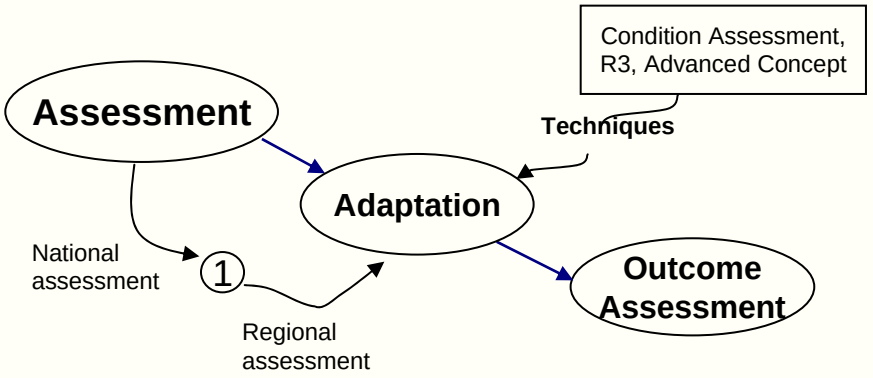
- Go local! Adaptation planning and engineering should consider the region-specific non-stationarity along with other major drivers (land use, socioeconomic, etc.)
- In US Southwest, likely precipitation decrease and increased variance make the water availability and storage capacity an adaptation priority
- Need to explore and reduce/quantify the projection uncertainties. At the same time, use adaptive or other engineering management approaches to reduce risk
- EPA is working hard to provide information and tools. http://www.epa.gov/nrmrl/wswrd/wqm/wrap/; http://www.epa.gov/water/climatechange/

http://www.epa.gov/nrmrl/wswrd/wqm/wrap/

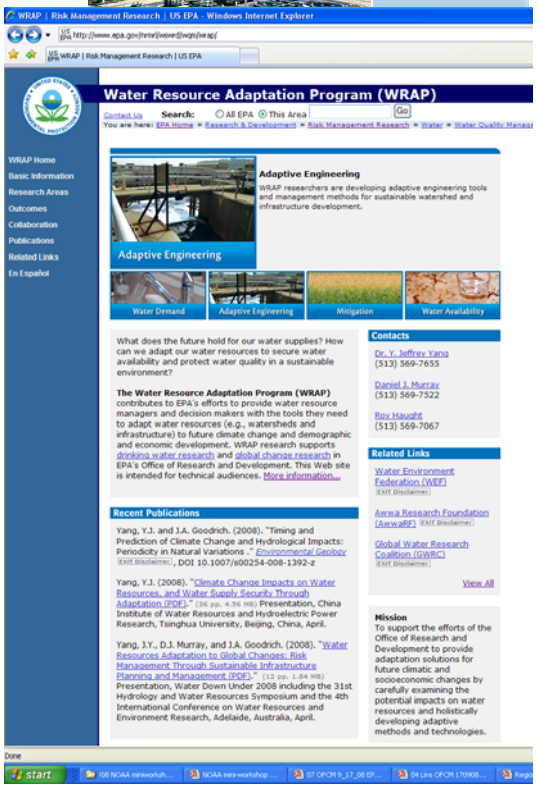
(Type in WRAP and EPA on www.google.com)

Research End-Points

- **Clear Water Act**
- **Safe Drinking Water Act**



- **End users**
- **Stakeholders**



United States
Environmental Protection
Agency

Thank You!

Dr. Y. Jeffrey Yang, P.E., D.WRE
US EPA National Risk Management Research Laboratory,
26W. Martin Luther King Dr., MS 690
Cincinnati, Ohio 45268
yang.jeff@epa.gov , (513) 569-7655

http://www.epa.gov/nrmrl/wswrd/wqm/wrap/