Improving the Assessment and Valuation of Climate Change Impacts for Policy and Regulatory Analysis

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Research on Climate Change Impacts and Associated Economic Damages:

Estimates of the Economic Impact of Changes in Climate and Water Availability

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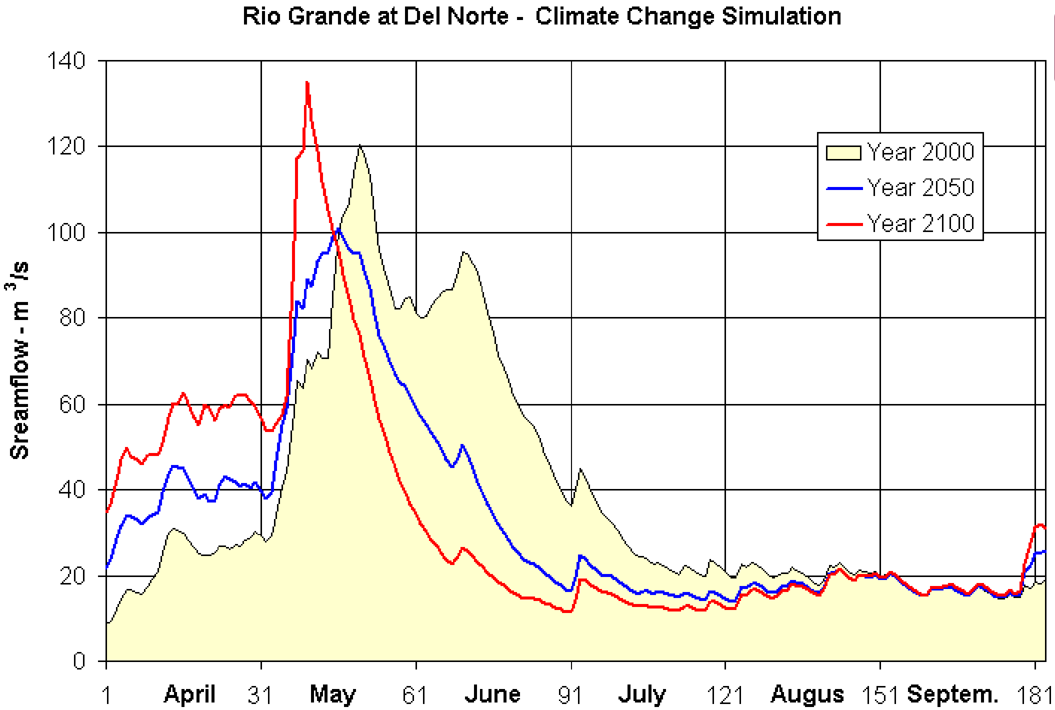
Overview

- Concepts and Complexities
- National Estimates
- Regional Estimates
- Issues, Gaps, and Next Steps

Water, Climate & Communities Form Complex Systems

- Estimating water resource impacts is tough
  - Lots of variability: spatial, temporal, uses, infrastructure, vulnerability
- What to measure?
  - Economic damages/benefits?
  - Changes in jobs, income & production?
- How to measure?
  - Statistical models?
  - Simulation models?
  - Optimization models?
- Adaptation & behavior

Climate and Rivers



Model assumptions

temperature ↑ 4°C

Precipitation ↑ 10%

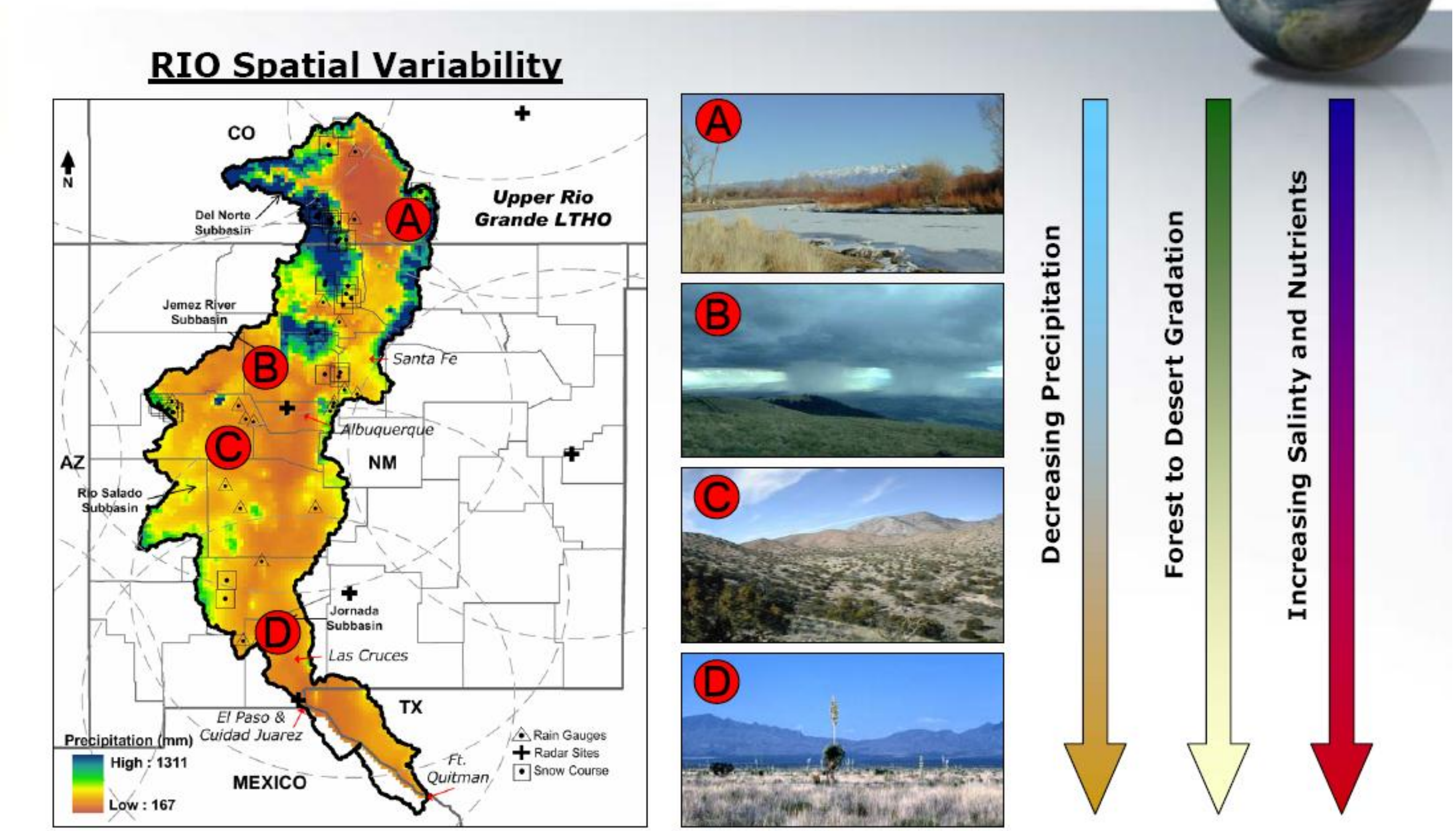
source: Al Rango (usda/ars)
using Snow melt Runoff Model (SRM)

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?

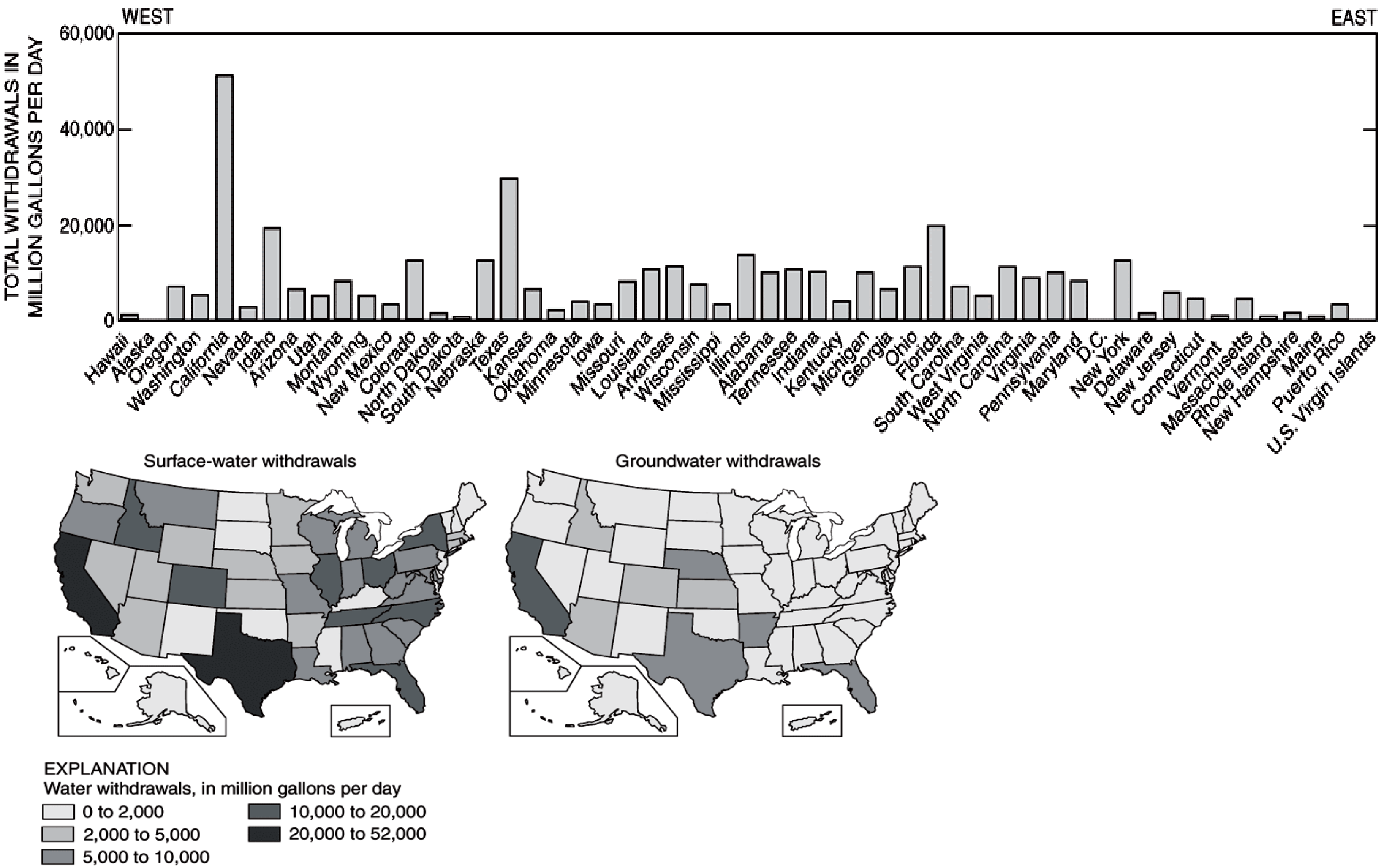
Spatial Heterogeneity: Climate, Vegetation, Environment

Upper Rio Grande



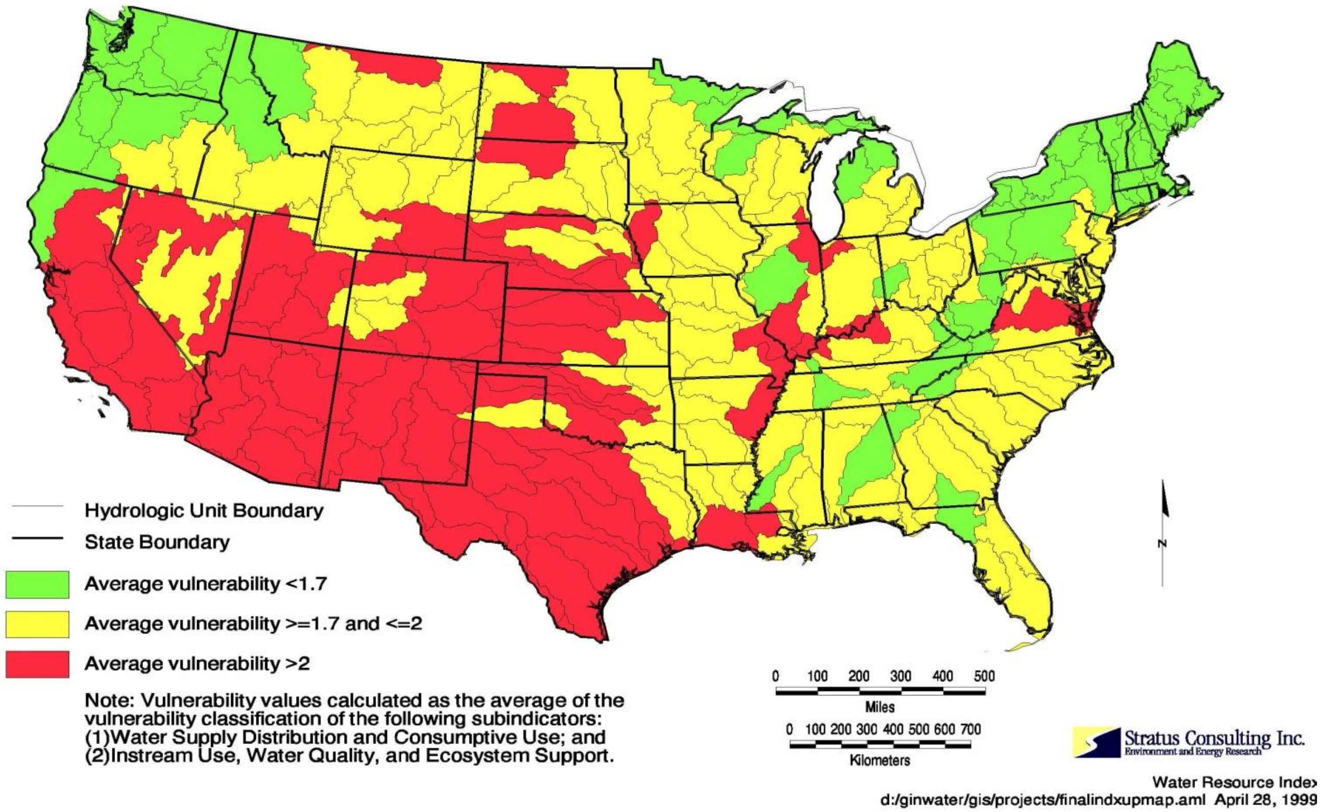
Source: Enrigue Vivoni, AZ State Univ.

Water Use Patterns



Source: USGS (2000).

Relative Regional Vulnerability of Water Resources



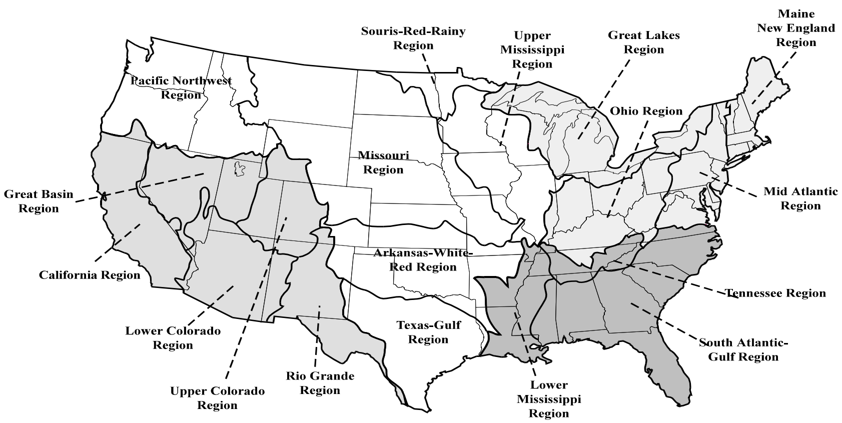
Overall Index

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.

National Estimates: Summary

Cline (1992)	$7 billion (~ 0.1% of 1992 US-GDP $6.3 trillion)
Titus (1992)	$21 - 60 billion (~ 0.3 - 0.9% of 1992 US-GDP $6.3 trillion)
Fankhauser (1995)	$13.7 billion (~ 0.2% of 1995 US-GDP $7.4 trillion)
Hurd et al. (1999a, 2004)	$9.4 - 43.1 billion (~ 0.13 - 0.58% of 1995 US-GDP $7.4 trillion)
Backus et al. (SANDIA, 2010)	$ 60 billion (~ 0.4% of 2009 US-GDP $14.1 trillion)

National Estimates: Aggregating Benefits and Costs
Hydro-economic Model Approach



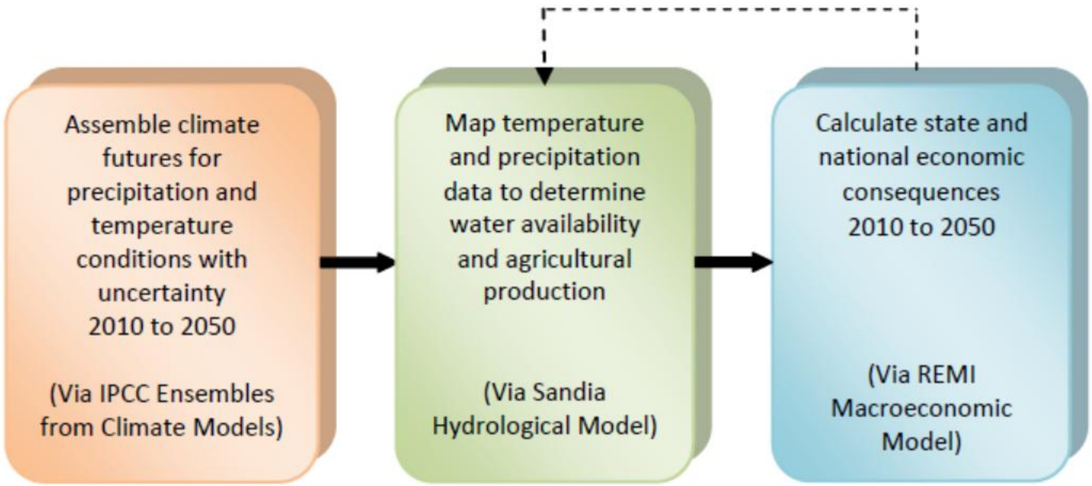
Estimated Total Economic Welfare Impacts on U.S. Water Resource Users (billions of 1994$)

Climate Scenario	Consumptive Use	Nonconsumptive Use		Total
		Hydropower	Other Nonconsumptive Sectors*	
Baseline	88.5	14.7	28.7	132.00
+1.5☜C +15%P	0.085	0.69	8.98	9.76
+2.5☜C +7%P	-0.98	-2.75	-5.68	-9.41
+5.0☜C	-4.29	-7.42	-31.4	-43.11

* Not including damages from thermal heat pollution.

Source: Hurd, B. H., J. M. Callaway, J. B. Smith, and P. Kirshen. 1999.
"Economic Effects of Climate Change on U.S. Water Resources."
In The Impact of Climate Change on the United States Economy. ed. Robert Mendelsohn and James Neumann
Cambride, UK: Cambridge University Press, 133-177. .

National Estimates: Jobs, Income & GDP Approach



Sandia National Laboratory (Backus et al., 2010) estimates there is a 50-50 chance that cumulative direct and indirect macro-economic losses in GDP through 2050 will exceed nearly $ 1.1 trillion (2008$), not including flood risks. That is approximately 0.2% of the cumulative GDP projected between 2010 and 2050.

On an annual basis: a 50-50 chance of non-discounted losses of $60 billion (2008$) by 2050.

Source: Backus, G. et al. ***Assessing the Near-Term Risk of Climate Uncertainty: Interdependencies Among the U.S. States***. SAND2010-2052, 1-259. 2010. Albuquerque, New Mexico, Sandia National Laboratories.

Regional Estimates: Hydro-economic Model Approach

Estimated Regional Changes in Runoff and Economic Welfare under Selected Incremental Climate Changes

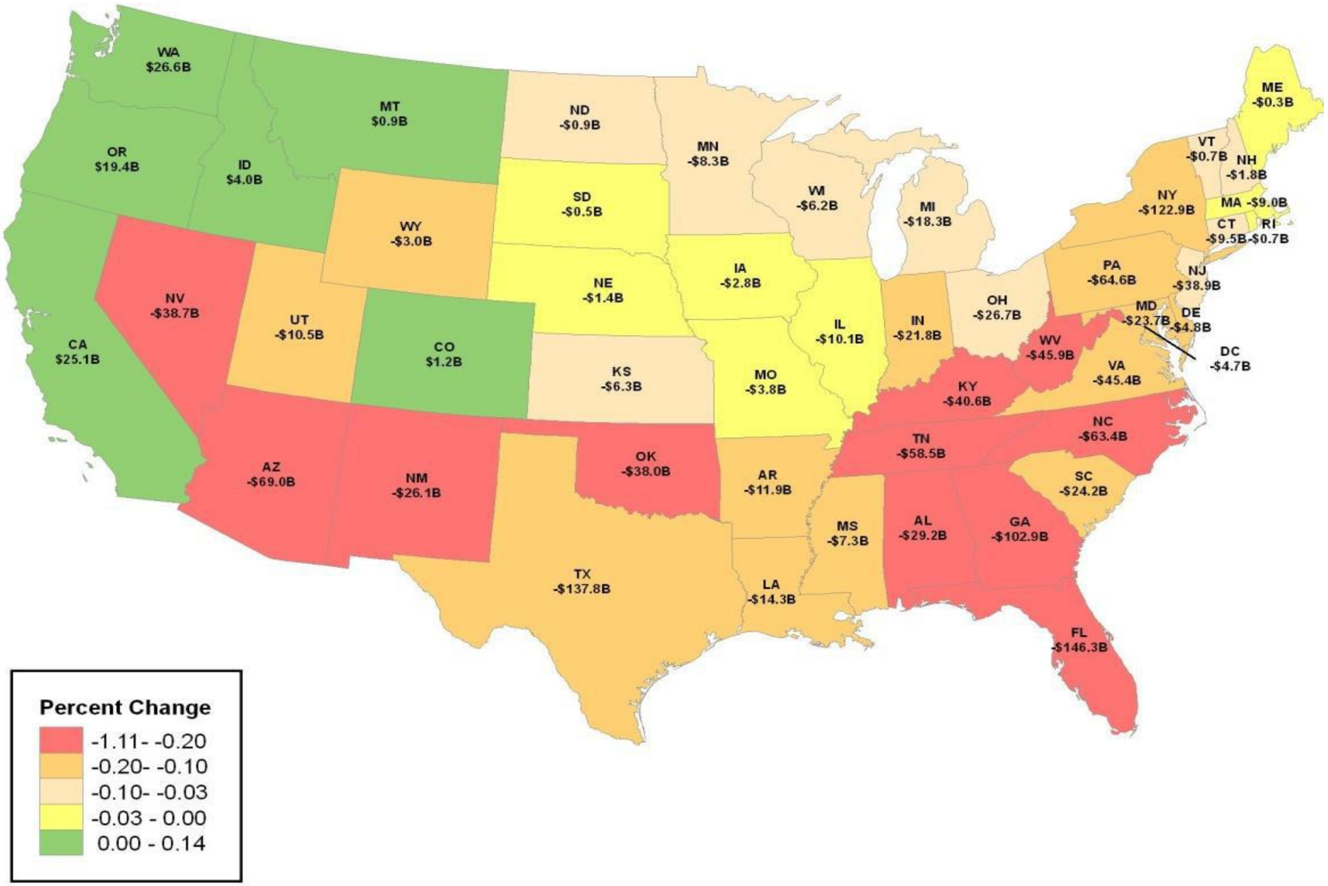
	Watershed			
	Colorado	Missouri	Appalachicola-Flint-Chattahoochie	Delaware
Baseline Runoff (kaf/yr) Welfare (million 1994$)	 17,058 $7,744	 56,651 $10,804	 24,363 $2,225	 13,660 $6,565
Climate Change Scenario and Changes from Baseline				
+2.5 deg C, +7% P % Runoff chg (kaf/yr) Welfare chg (M1994$)	 - 4.2% - $102	 - 9.1% - $519	 - 0.3% - $15 (1)	 - 4.1% - $22
+2.5 deg C, -10% P % Runoff chg (kaf/yr) Welfare chg (M1994$)	 - 37.9% - $1,372	 - 42.5% - $2,041	 - 27.5% - $12 (1)	 - 33.2% - $187
+5 deg C, 0% P % Runoff chg (kaf/yr) Welfare chg (M1994$)	 - 34.7% - $1,193	 - 42.4% - $2,239	 - 23.5% - $31 (1)	 - 33.9% - $207

Source: Hurd, B. H., J. M. Callaway, J. B. Smith, and P. Kirshen. 1999.

Other Regional Estimates

Region	Study	Economic Impacts
California	Medellin et al. (2006)	$302 M/yr agricultural scarcity cost, $59 M/yr urban scarcity cost, $384 M/yr operating cost, $250 M/yr the costs of policies limiting interregional water transfers, which is $994 M/yr totally (less than 0.1% California's economy)
Pacific Northwest	Climate Impacts Group (2009)	Economic losses of between $23 million and $70 million are estimated, with significantly greater probabilities of annual net operating losses for junior water rights holders.
Rio Grande	Hurd and Coonrod (2007)	direct economic damages in 2080 were estimated to be $100 million/year
Colorado River	Christensen and Lettenmaier(2007)	Energy Production is estimated to increase during 2020s by the maximum of 120.5 GWh/Yr (1.4%) and experience a reduction during the rest of the century which will result in a maximum of 1573.6 GWh/Yr (18.5%) of negative production during 2080s.

State-Level Estimates: SANDIA/REMI Approach



Source: Backus, G. et al. ***Assessing the Near-Term Risk of Climate Uncertainty: Interdependencies Among the U.S. States***. SAND2010-2052, 1-259. 2010. Albuquerque, New Mexico, Sandia National Laboratories.

Issues, Gaps, and Next Steps

- Understanding changes in extreme events
  - Severe, sustained drought risk
  - Flood risk changes are not well understood and are often locally sensitive
- Water rights, federal & state regulation, and administration constraints confound assessment of impacts and adaptation
- Projecting market prices and trade flows of agricultural and other water-intensive products is difficult
- Groundwater. Measuring, monitoring, modeling.
- Water security and food security are conflated and stir deep emotions
- Water quality and environmental quality hard to assess and measure economic outcomes
- Coupling of hydro-economic and dynamic system simulation approaches could bridge some gaps

More information can be found at:
http://agecon.nmsu.edu/bhurd