SAND2012-3616C

Climate change impacts through water shortages across the United States

How policy and technology share a role in offering solutions

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SAND # 2012-3515C

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Main take-away message

We need a deeper and broader collaboration between the technical and policy communities to address the very serious challenges climate change will pose to human society.

(I'm going to illustrate this through two specific examples of economic and security impact through water shortages in the US)

The freshwater shortage…

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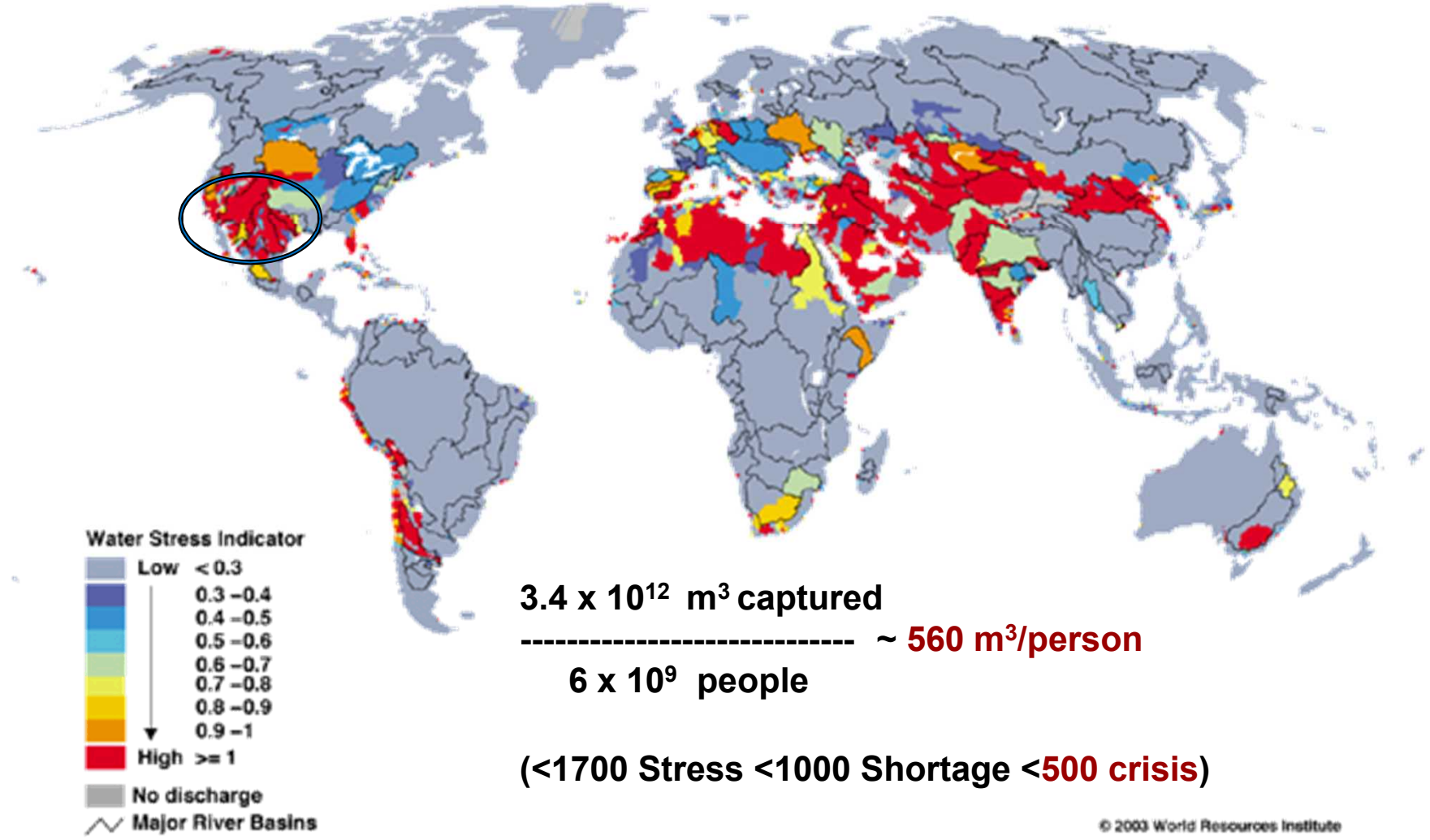
… is globally acute



3.4×10^{12} m^3 captured

6×10^9 people ---------- **~ 560 m^3/person**

(<1700 Stress <1000 Shortage <500 crisis)

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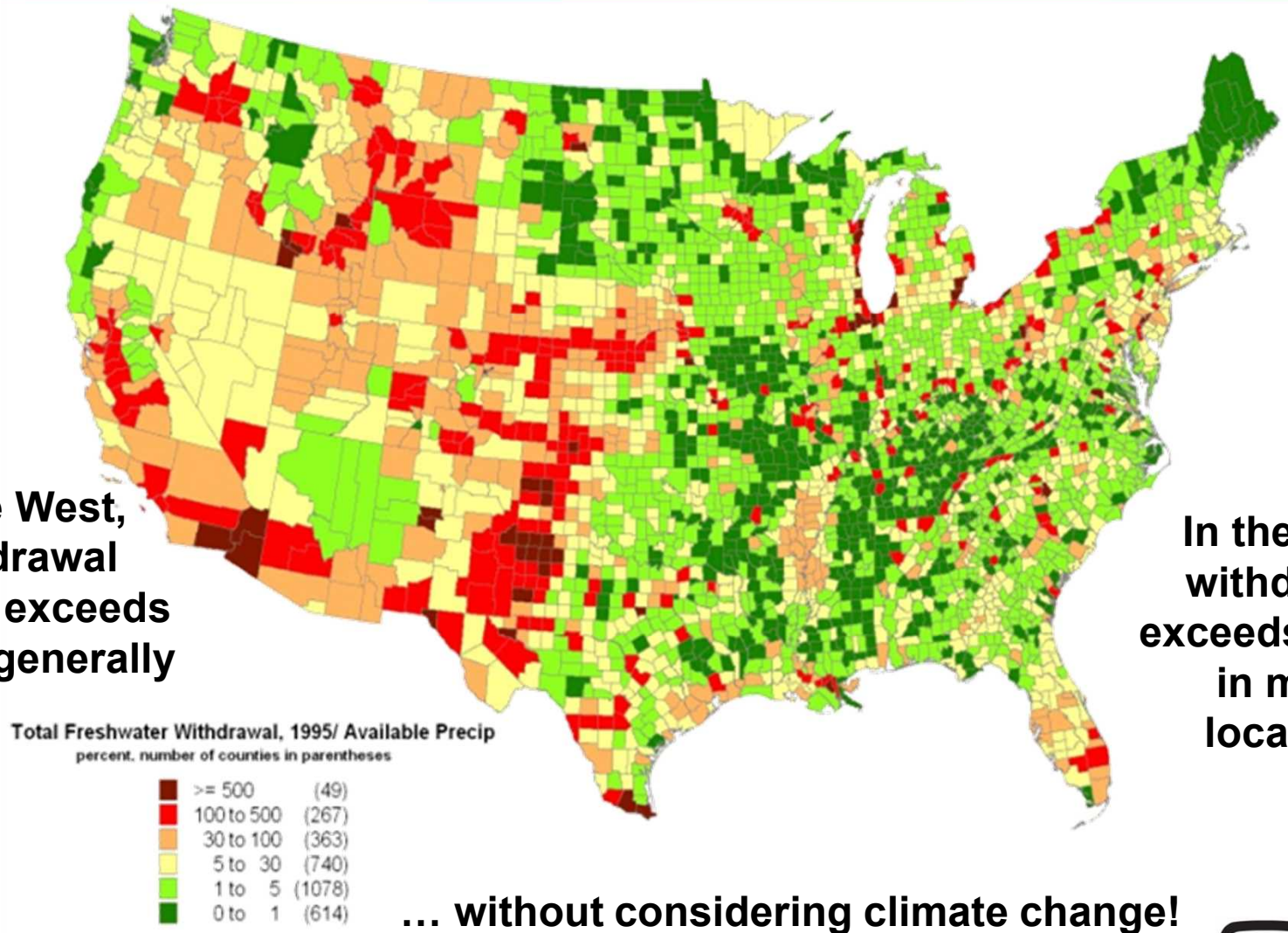
And is a even a serious issue for the US



In the West, withdrawal already exceeds supply generally

In the East, withdrawal exceeds supply in many localities

… without considering climate change!

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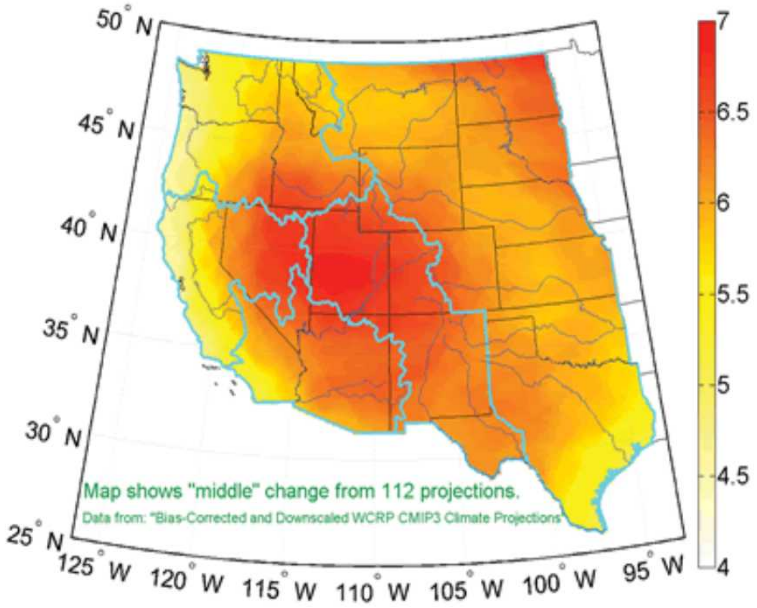
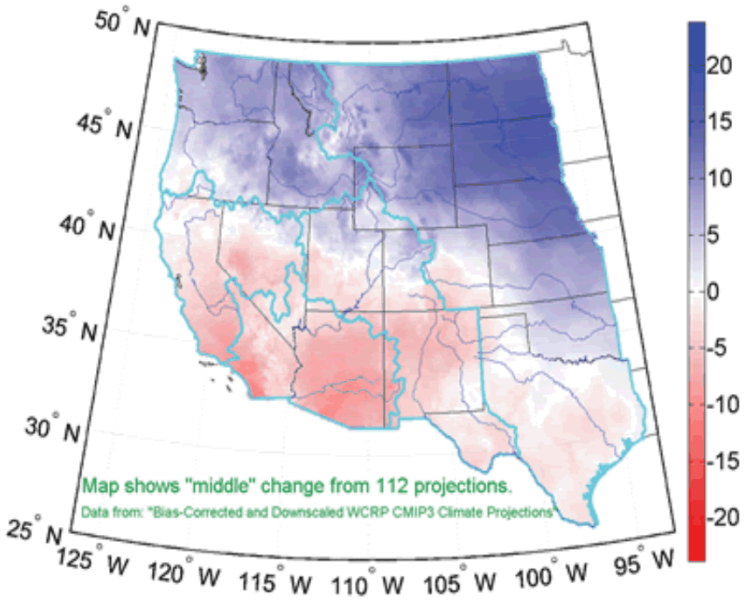
Climate change is likely going to make this worse



Projected median temperature change (deg. F) of 112 climate projections over the Western US, 2070–2099 relative to 1950–1979.



Projected median percentage precipitation change of 112 climate projections over the Western US, 2070–2099 relative to 1950–1979.

Climate Change will Affect Availability of Fresh Water Case Study: Bureau of Land Reclamation report, April 2011

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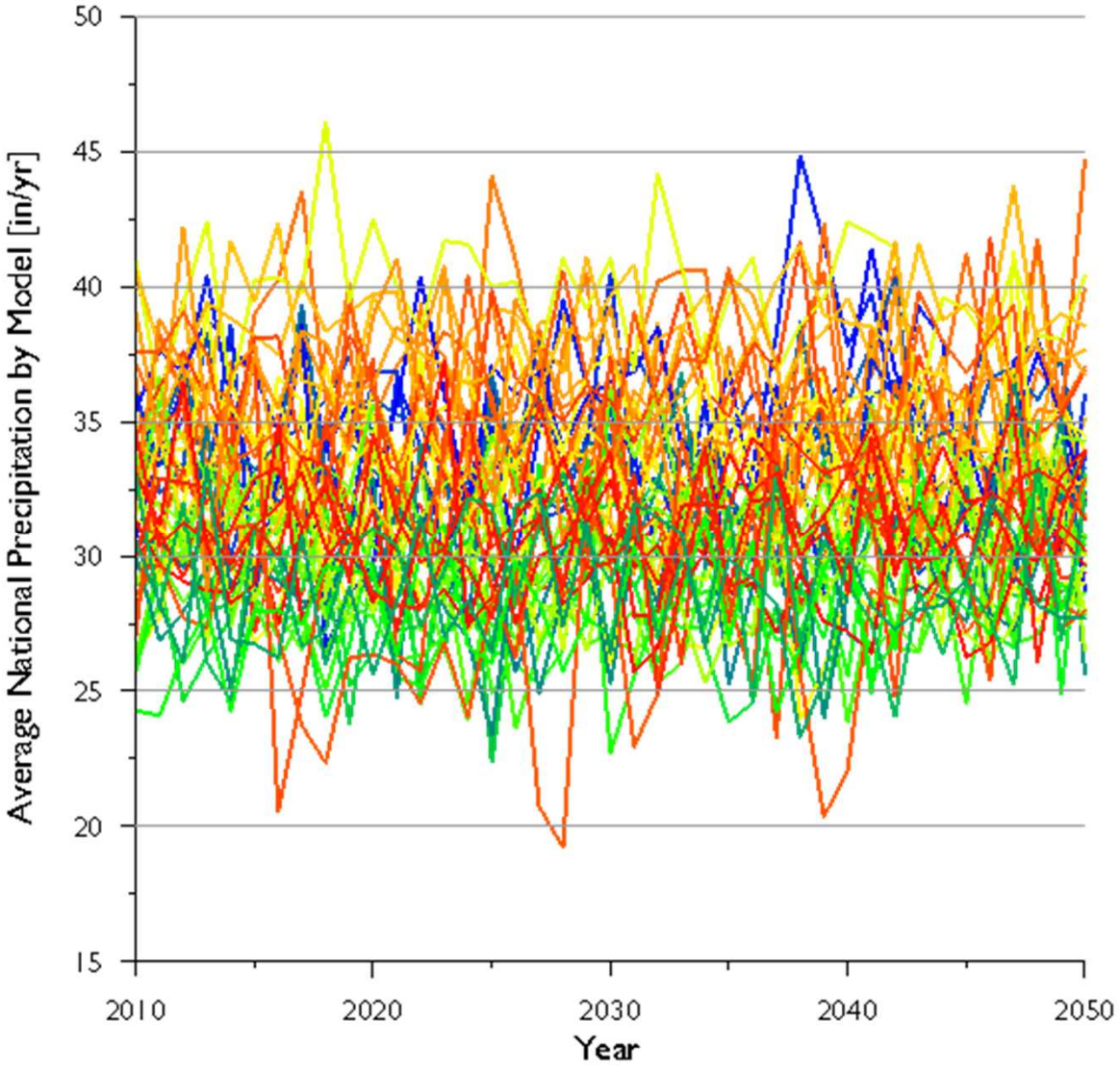
Model uncertainty makes the job of the policy maker a very tough one



IPCC Ensemble of 53 Climate model runs predicting precipitation

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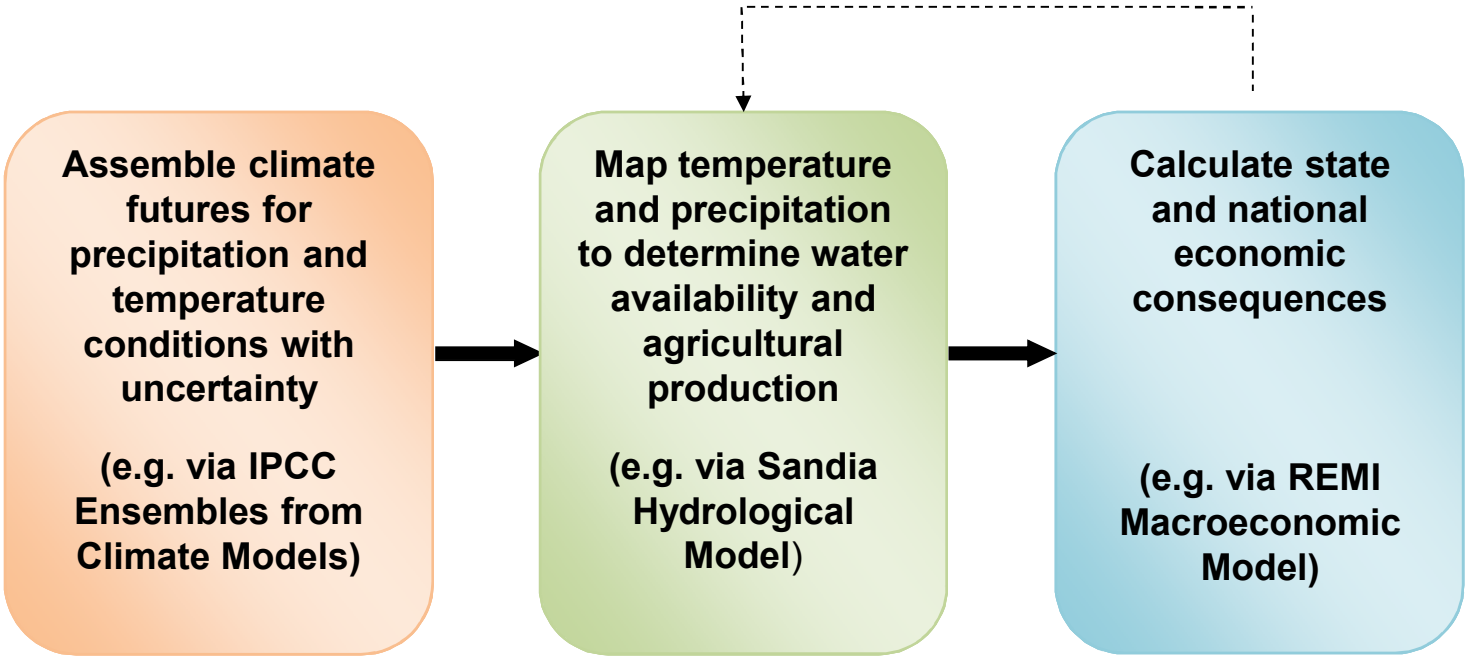
Can we make sense of all this?



$$Risk = \iint_{\tau,P} Consequence(t,p) \times dt \times dp$$

p = probability
t = time

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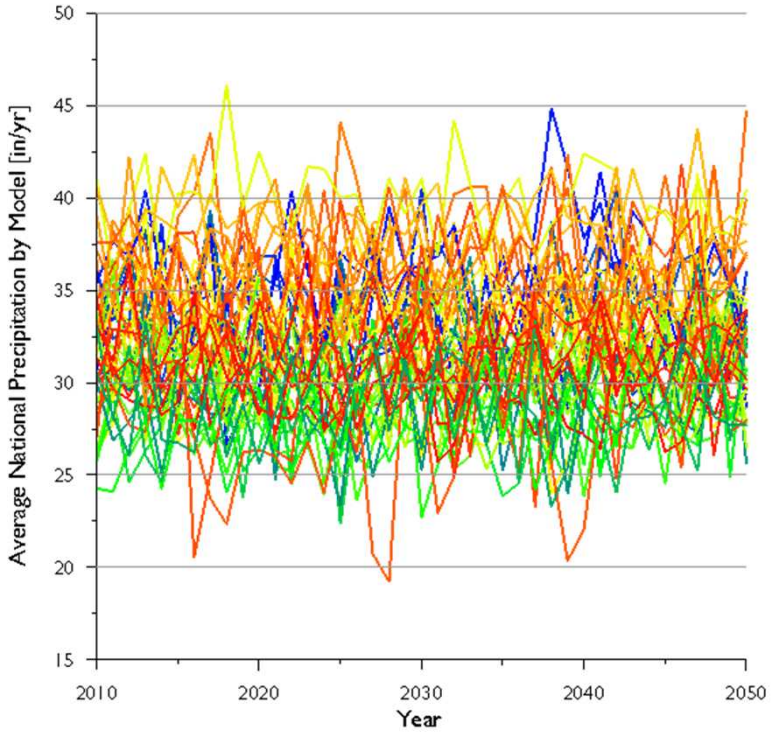
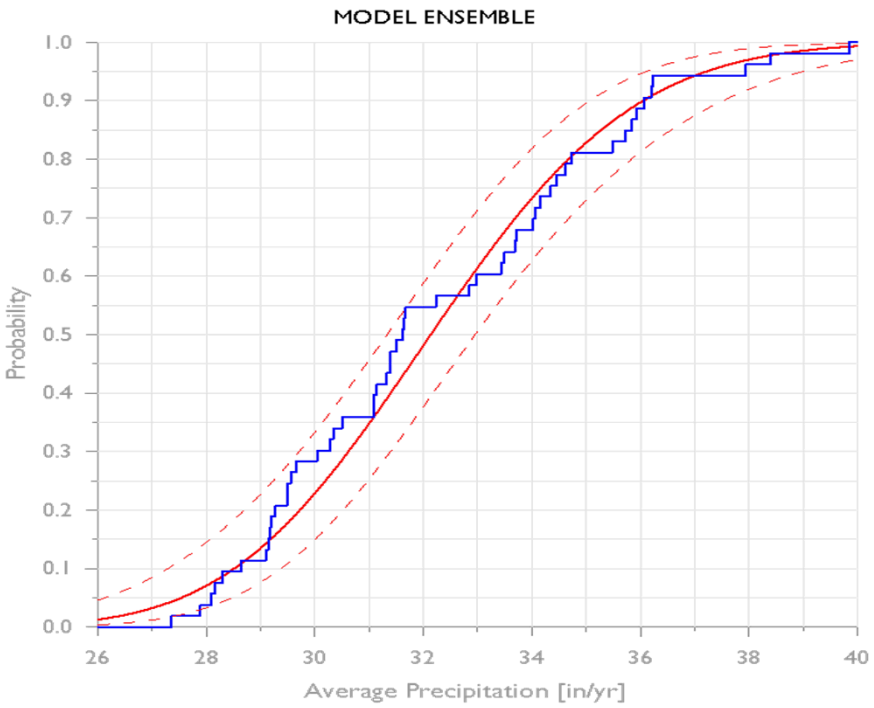
From “noise” to understanding





IPCC Ensemble of 53 Climate model runs
transformed to *cumulative probability distribution*

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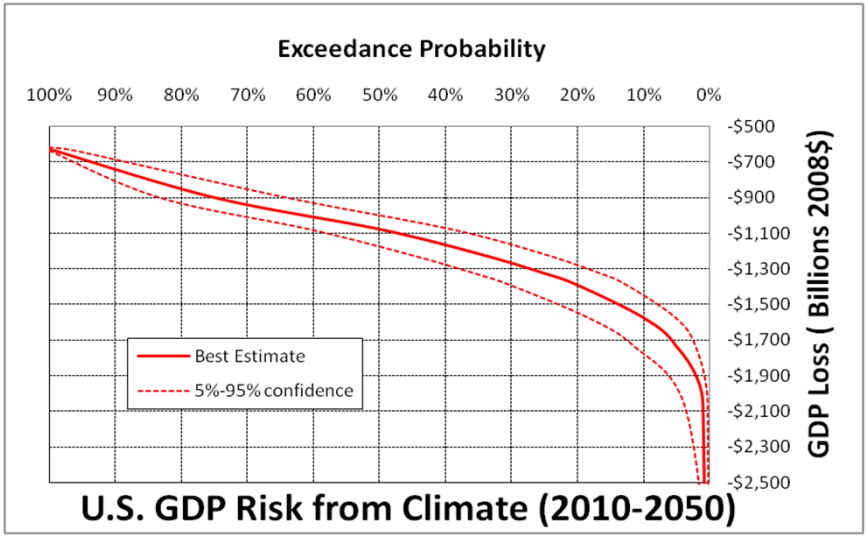
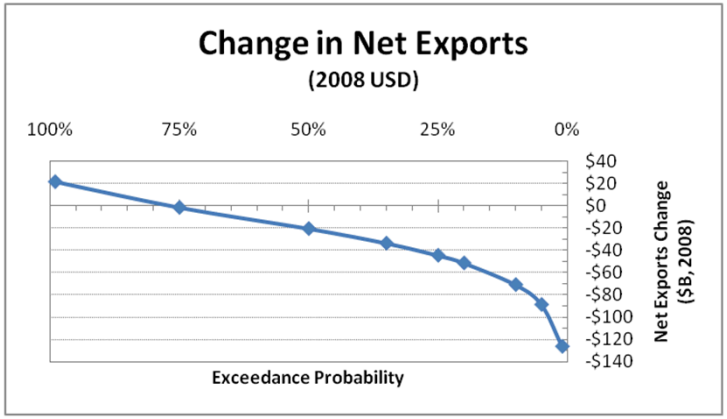
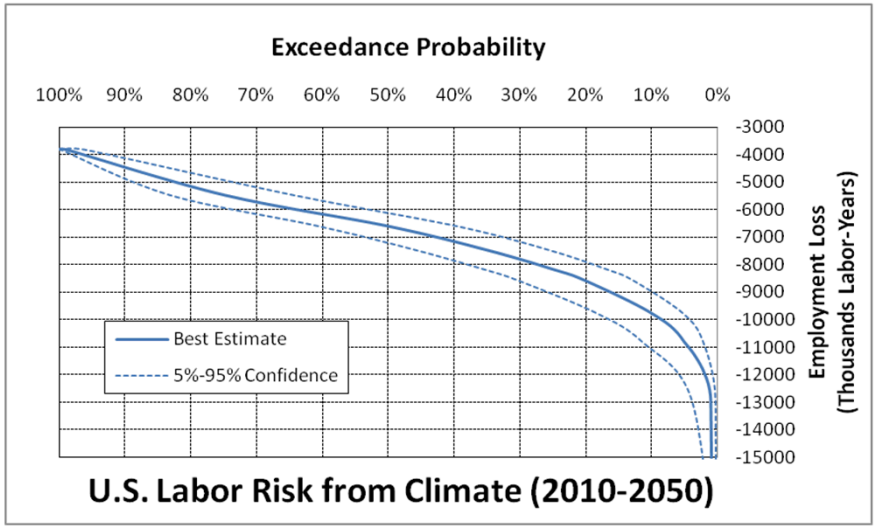
A prototype version of a climate change national risk assessment



- Continental US states; world fixed
- Precipitation only
- 70 economic sectors
- Business & population migration over 2010 to 2050





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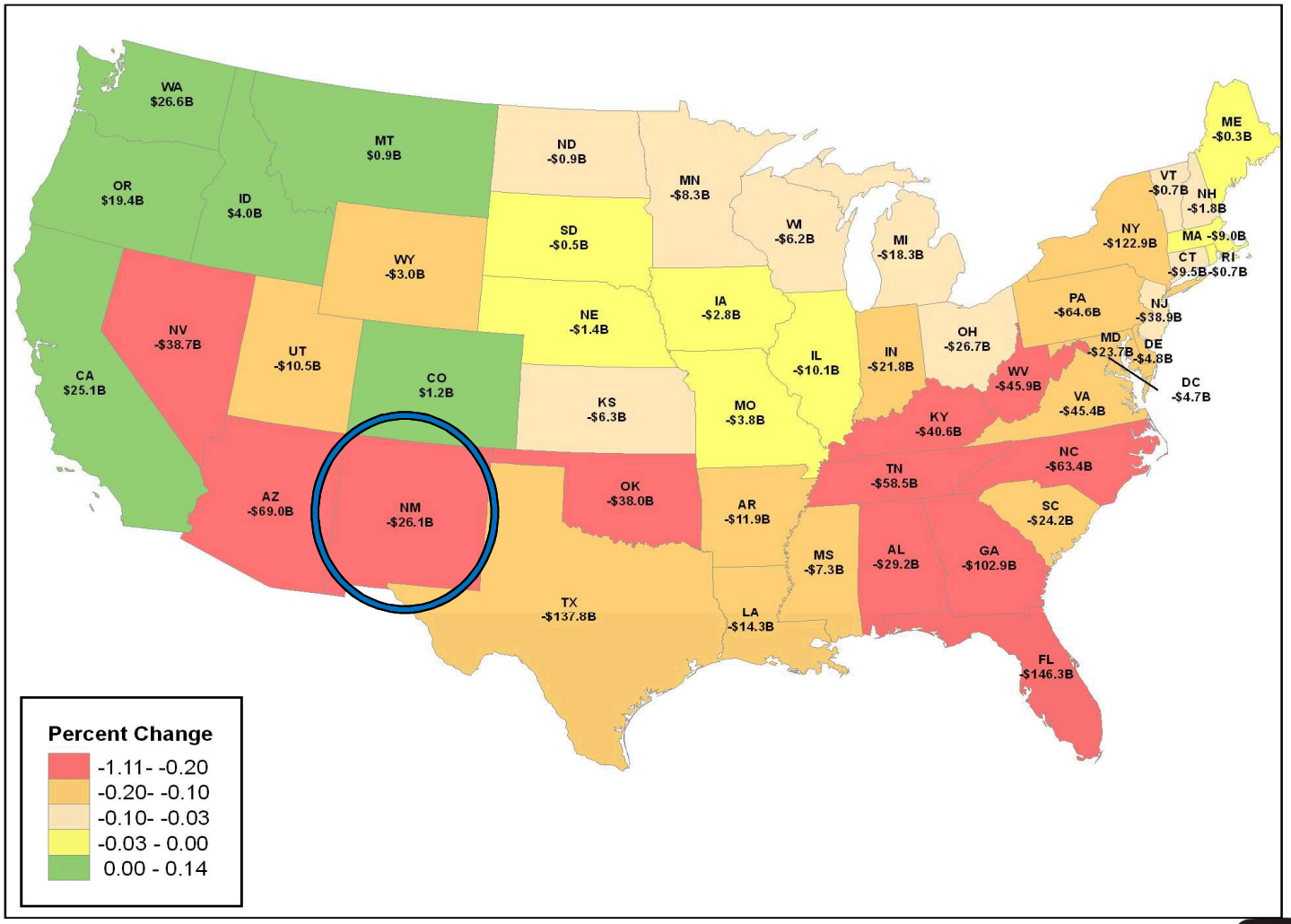
Predicted GDP impact due to water shortfalls (subject, of course, to study limitations)



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This model is able to quantify impacts and associated probabilities

New Mexico Risk From Climate Change 2010-2050*

New Mexico Risk **(2008$B)**	1% Exceedance Probability	50% Exceedance Probability
Construction	1.2	0.6
Manufacturing	1.8	0.7
Mining	13.5	6.5
Real Estate	2.6	1.3
Retail	5.2	2.5
Utilities	1.6	1.1
GDP	43.5	21.0
Employment (thousands)	370.6	175.6

Based on SNL Study: Backus, GA, TS Lowry, DE Warren, et., "Assessing the Near-Term Risk of Climate Uncertainty: Interdependencies among the U.S. States," *SAND Report,* April 2010. https://cfwebprod.sandia.gov/cfdocs/CCIM/docs/Climate_Risk_Assessment.pdf

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Behind the numbers, there are very real stories

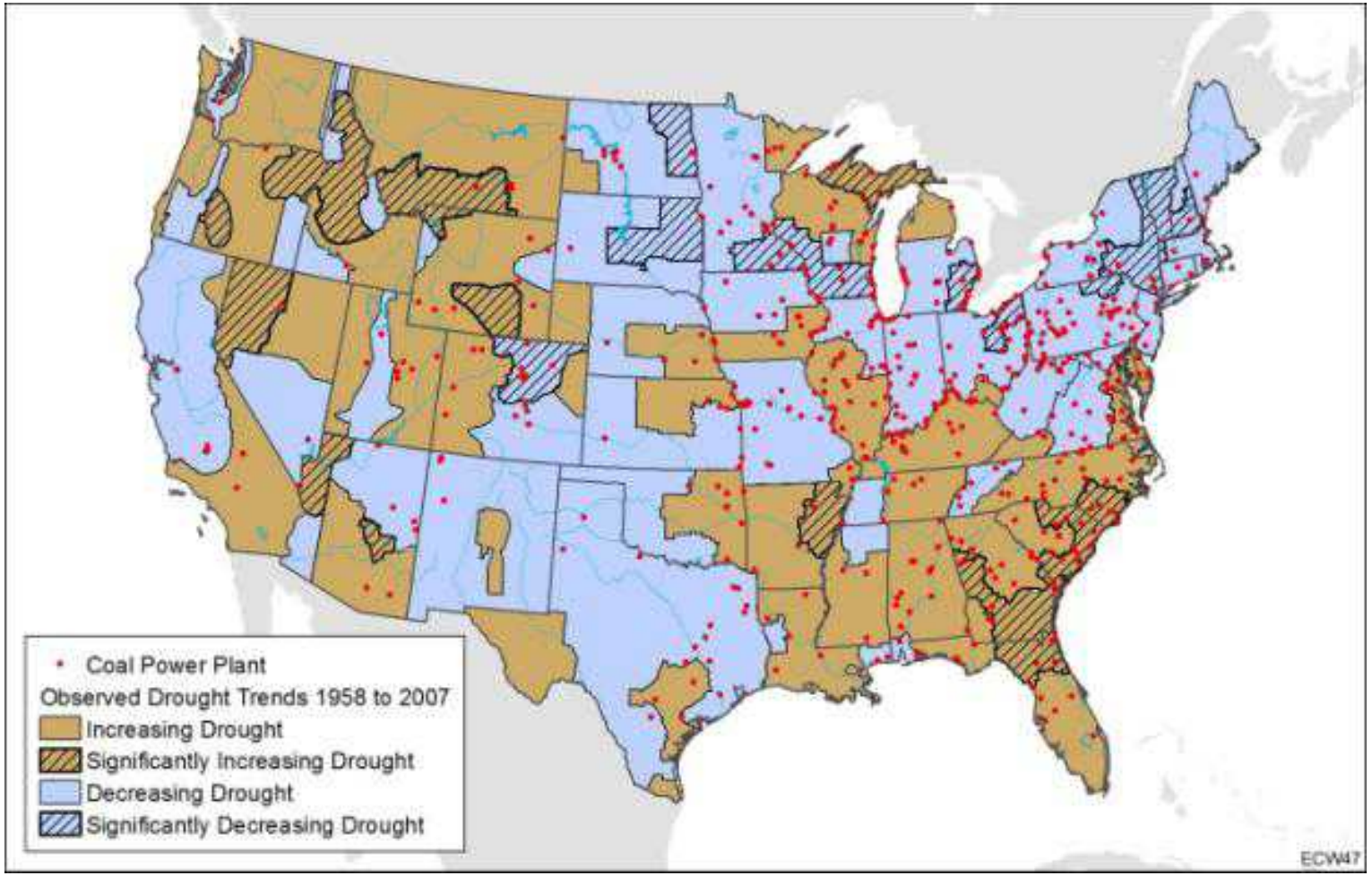
In 2011 the Las Conchas fire burned 150k acres, the largest fire in NM history.

View from the Space station, courtesy Vallescaldera.com

Shortly thereafter, the region experienced two drastic rainfalls leading to massive flooding which destroyed a well-loved local business.

Courtesy Richard Pipes,, ABQ Journal.com

Thermoelectric power generation is at risk due to drought



Argonne National Laboratory, 2010

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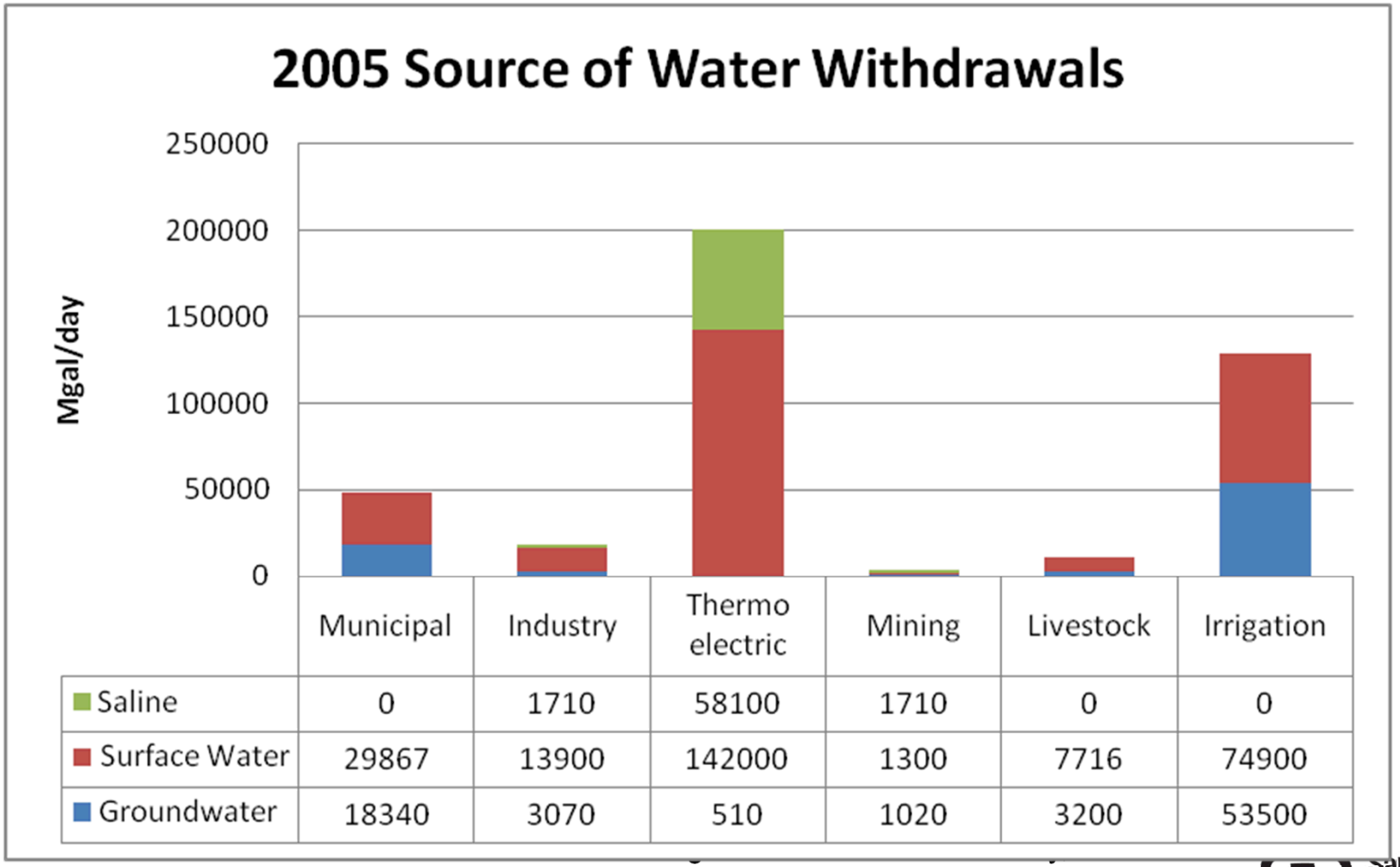
Thermoelectric power generation is at risk due to drought



	Municipal	Industry	Thermo electric	Mining	Livestock	Irrigation
Saline	0	1710	58100	1710	0	0
Surface Water	29867	13900	142000	1300	7716	74900
Groundwater	18340	3070	510	1020	3200	53500

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Dynamic simulation tools support stakeholder engagement in creating holistic solutions

- Policy experimentation through “what if” scenarios
- Creative, system level solutions
- Outcomes and risks quantified
- Public transparency
- Trust building process

Argonne National Laboratory, 2010

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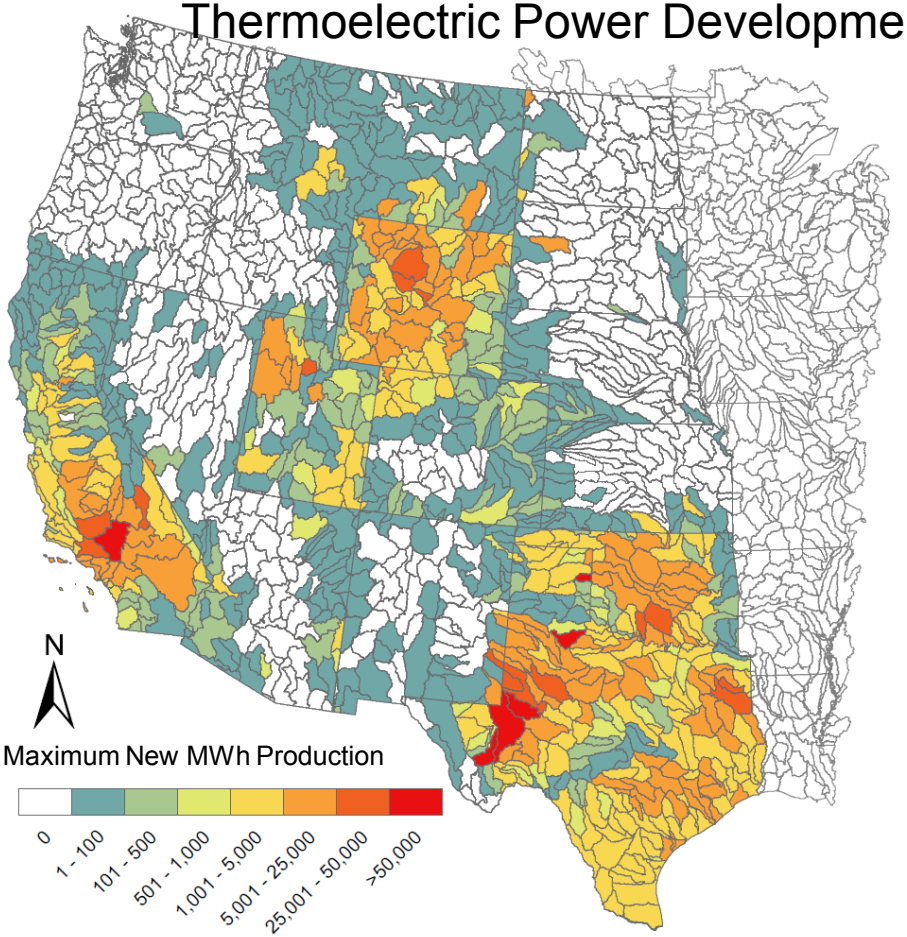
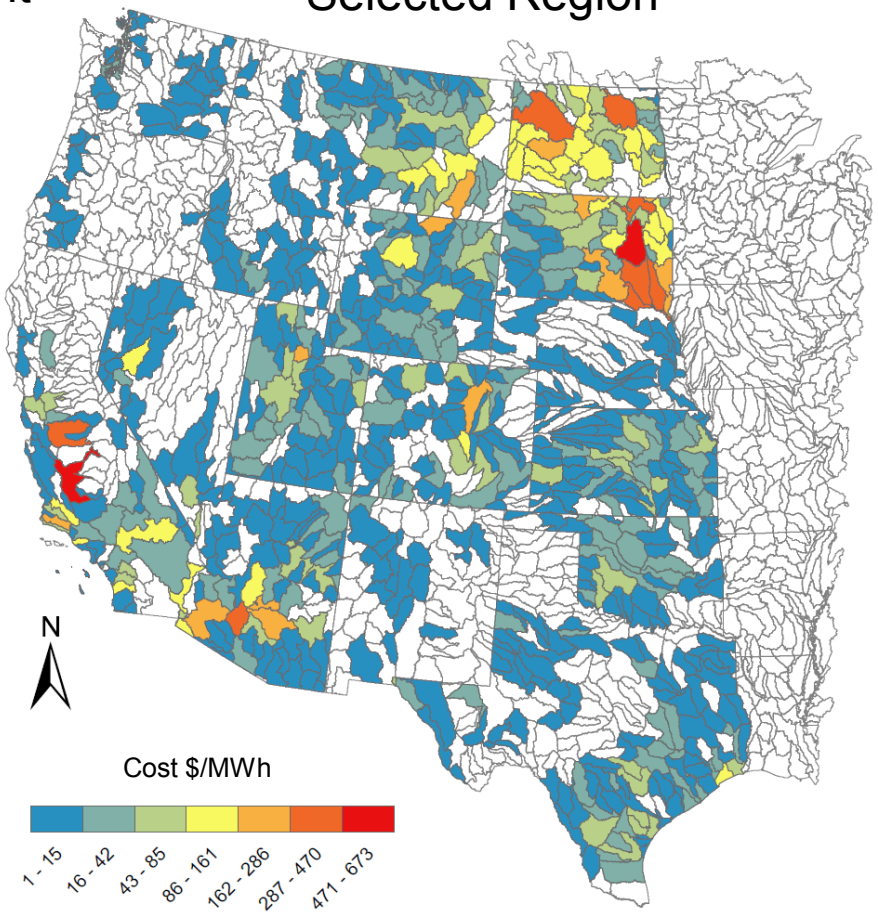
These models can have real impact on policy

Relative Constraint on New Thermoelectric Power Development



Relative Cost of Development in Selected Region



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Key messages in summary

- Climate change will pose very serious challenges to human society
- These challenges will manifest in environmental, economic and social problems with high impact on national prosperity and security
- Technically deep approaches to key problems can help to mitigate these impacts
- In isolation, these technical approaches will fail -- a deeper & broader collaboration between the technical and policy communities is needed