

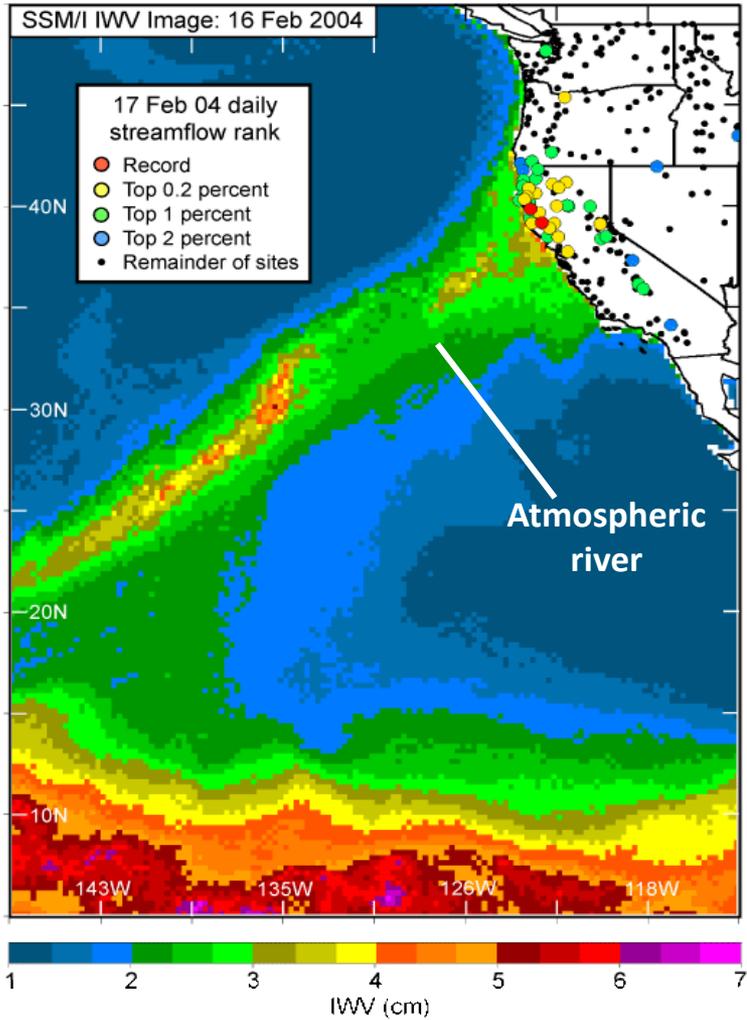
Topic 6:

Use-inspired Water Research Issues

Vince Tidwell, Dan Cayan, Phil Mote

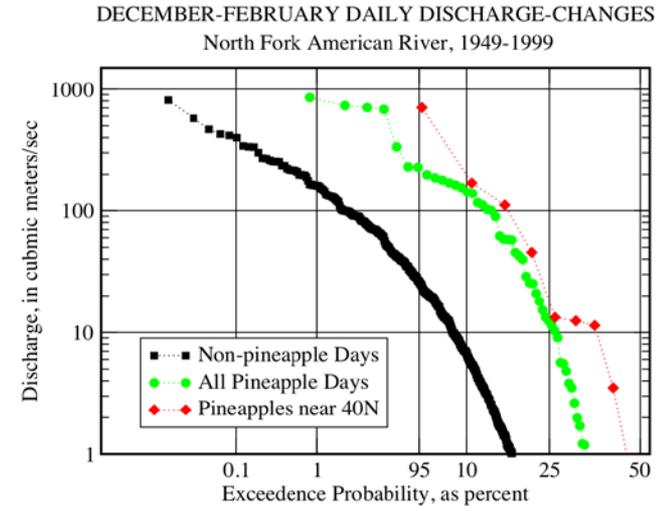
- What decisions related to infrastructure planning and management of the energy and water systems are most influenced by water cycle mean and extremes?
- What water cycle information is needed to support the relevant decision-making?
- What are the modeling, observation, and data system requirements to improve quality and use of the relevant water cycle information?
- How does uncertainty in water cycle predictions influence the relevant decision-making? What research is needed to characterize and communicate the uncertainty?
- Discuss case studies/demonstrations that highlight current capabilities and gaps in linking water cycle research with energy and environmental challenges.

Atmospheric Rivers are key to floods and water supply—



- All major floods of Russian River since 1997 have been **atmospheric rivers (ARs)** The 9 largest winter floods of Carson River since 1950 have been atmospheric rivers (i.e., **pineapple expresses**)

- annual peak flows in American & Merced Rivers are typically order of magnitude larger from ARs than from other storms



- ARs contribute greatly to California's water supply: 25 – 50% of all precipitation and 20 – 50% of all streamflow in centrl & northrn California, 1998-2008.

Atmospheric-total water vapor

global climate model to regional scale *downscaling*

decision maker increasingly request *fine scale* projections

Global Climate Model

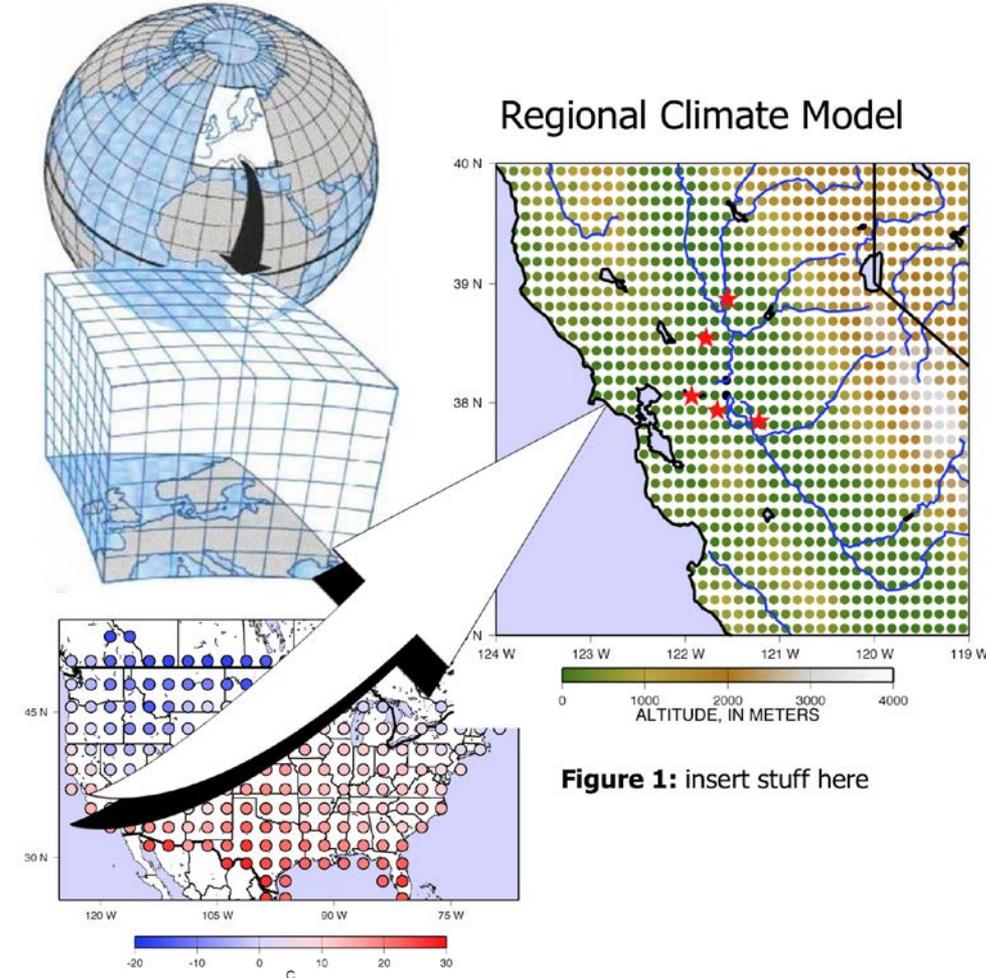


Figure 1: insert stuff here

GCMs ~150km
downscaled to
Regional models ~12km

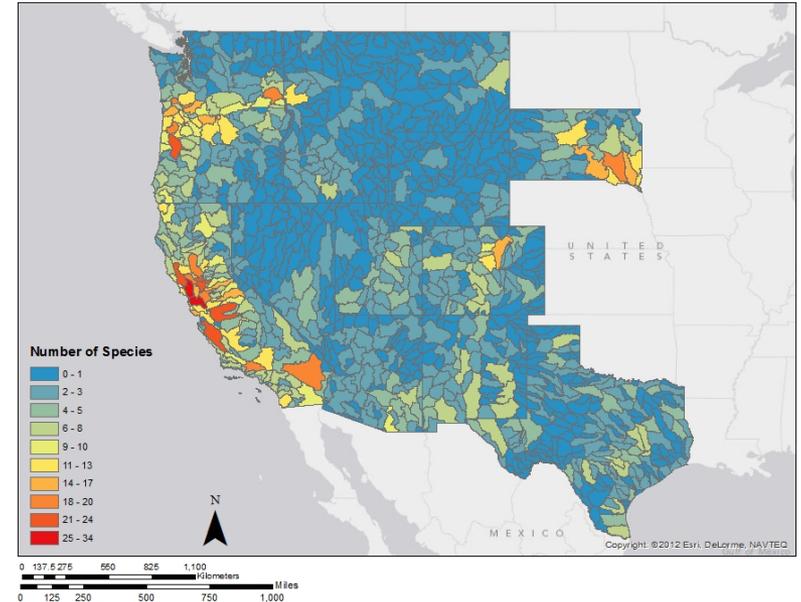
resource managers want
even higher resolution solutions

Environmental Demands

- Growing awareness of and management for instream and other environmental flows.



Number of Endangered Species

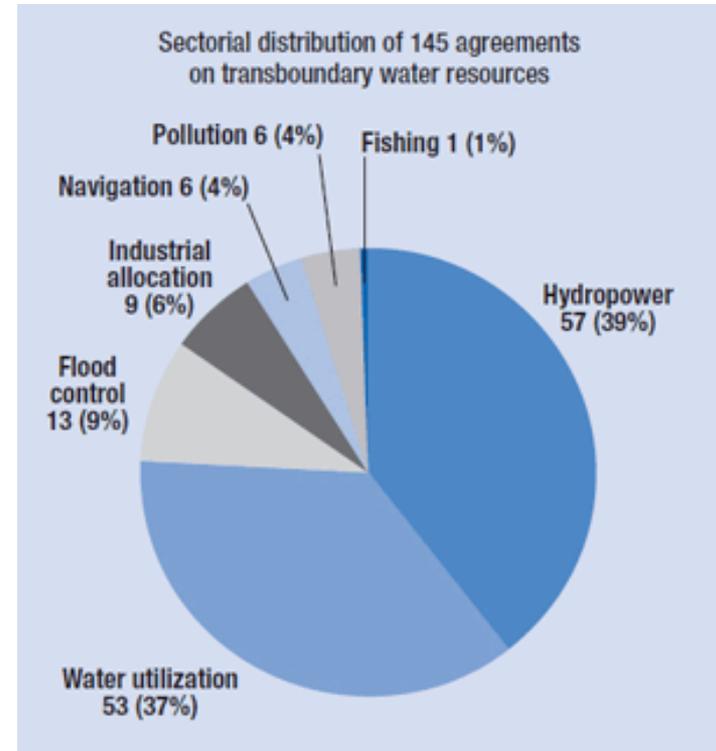
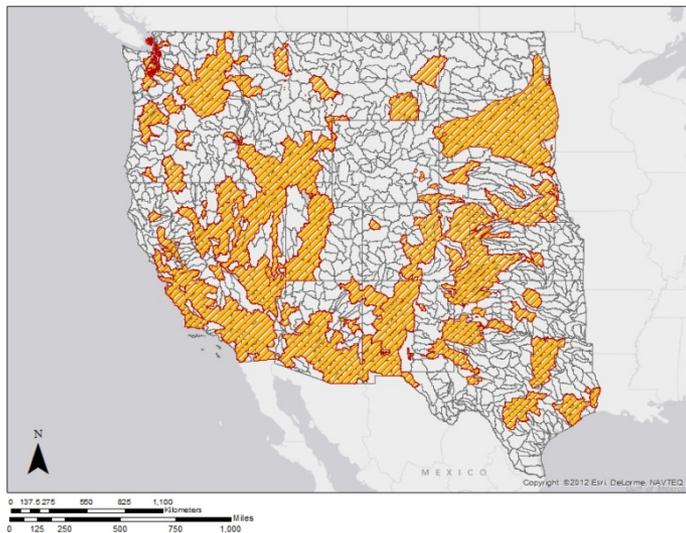


- Accounting for and promoting environmental services

Water Institutions

- The world's 263 transboundary lake and river basins cover nearly half of the Earth's land surface.
- A total of 145 nations include territory within transboundary basins

Groundwater Administrative Areas



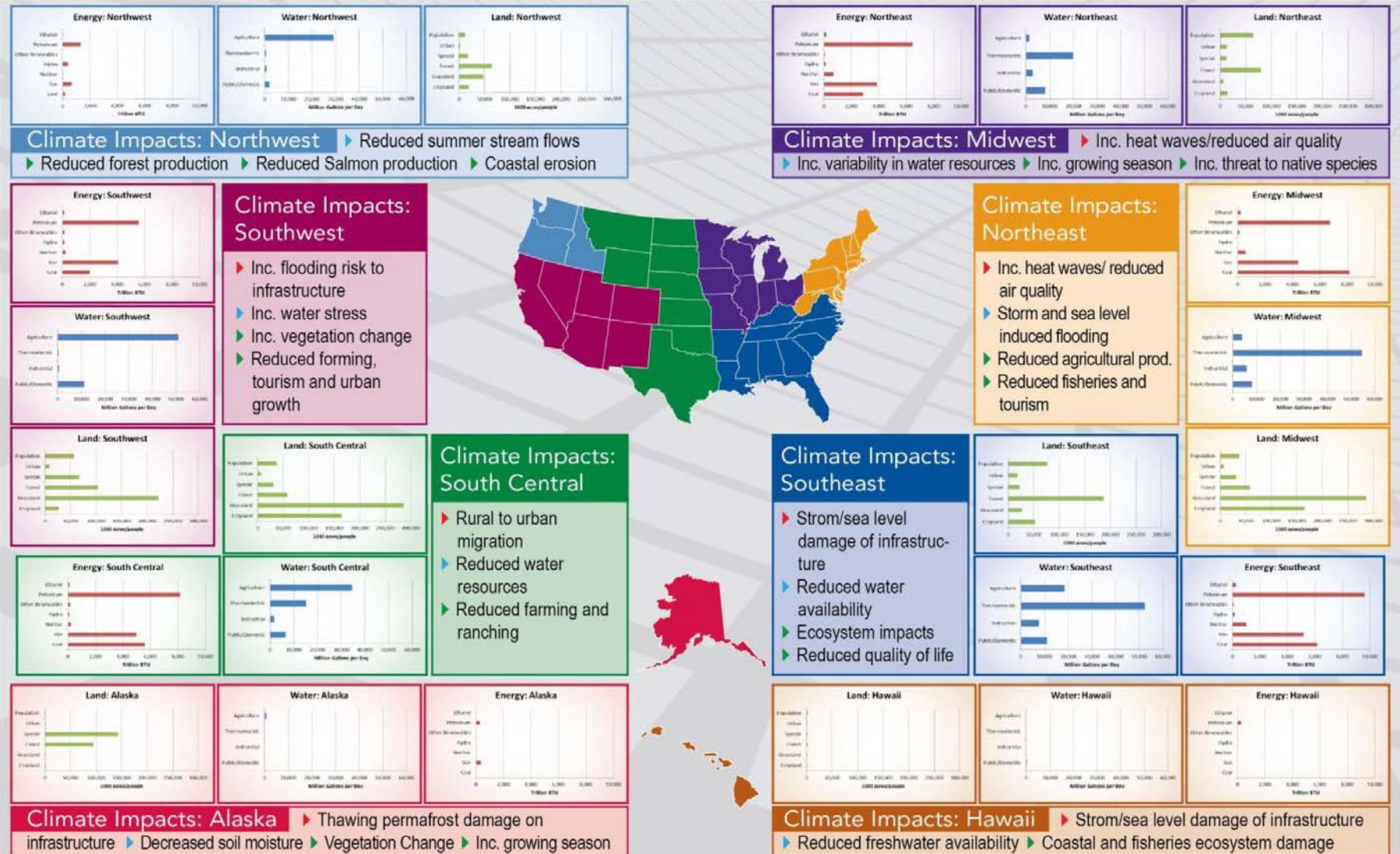
UNDP Human Development Report 2006

- Numerous water management institutions exist within nation states with varying responsibility and purpose.

Variation in Resource Provisioning and Demand

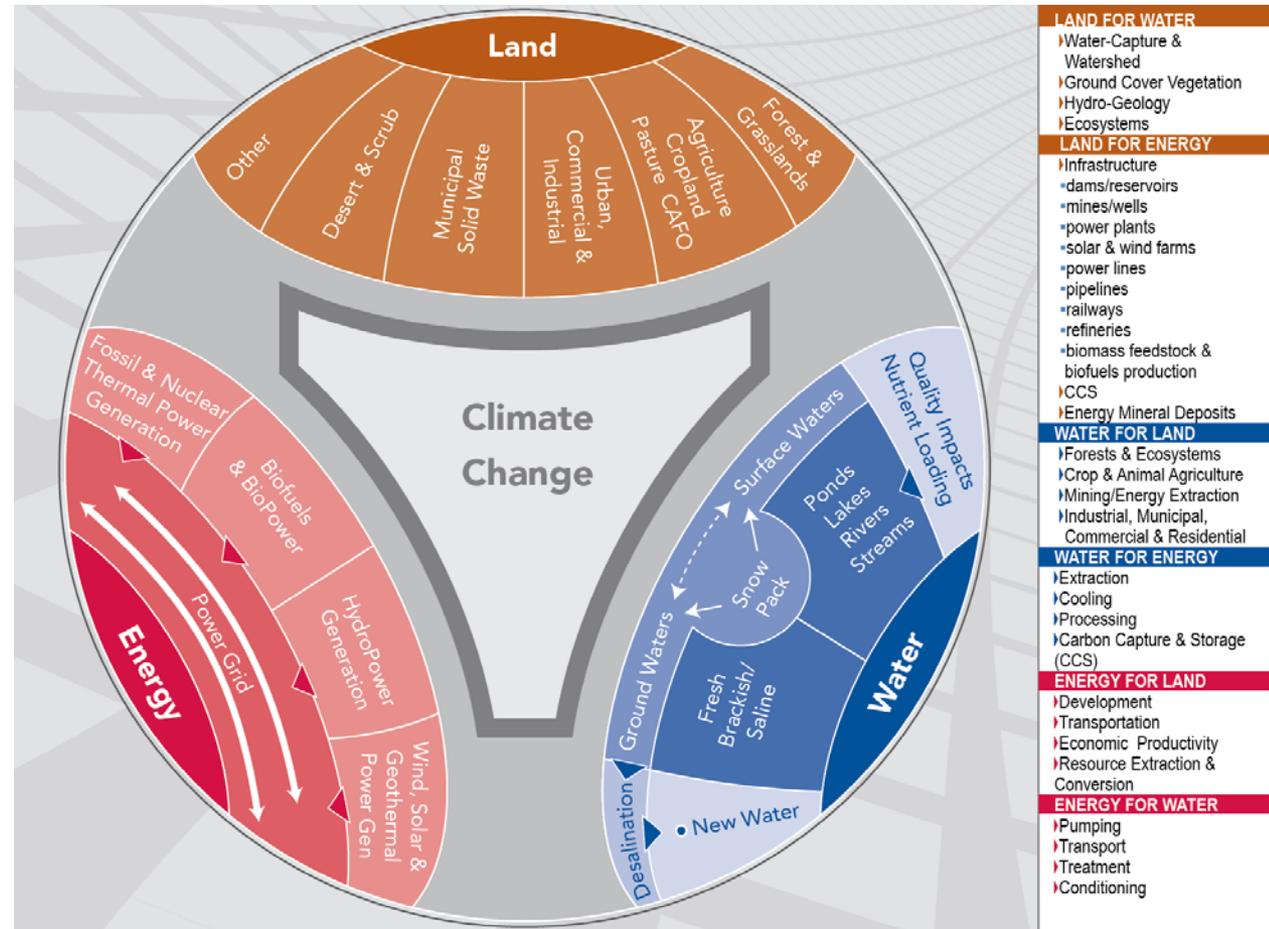
Variation in Resource Provisioning and Demand

differences give rise to different adaptive capacities and thus different adaptive pathways



Cross-Sectorial Interaction

- Changes in one sector cascade to other sectors
- Adaptation is challenged by cross-sectorial interaction



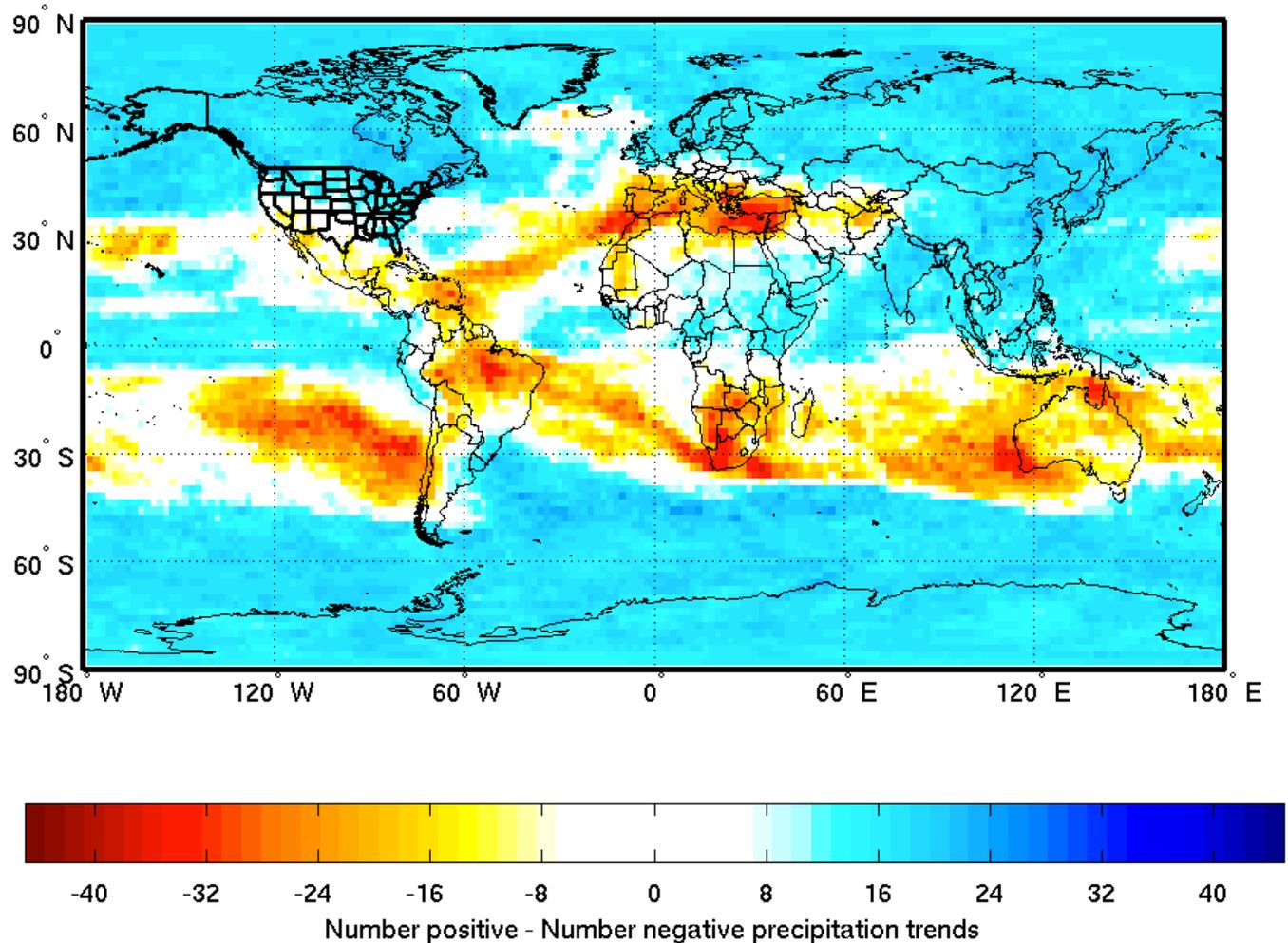
Skaggs et al. 2012

Projected CMIP5 rcp26, rcp45, & rcp85 Precipitation Trends, 2006-: Consistency among 45 projections

*Decision makers
want to know:*

*what is
the fate
of today's
regional
precipitation
patterns
under
projected
climate
change?*

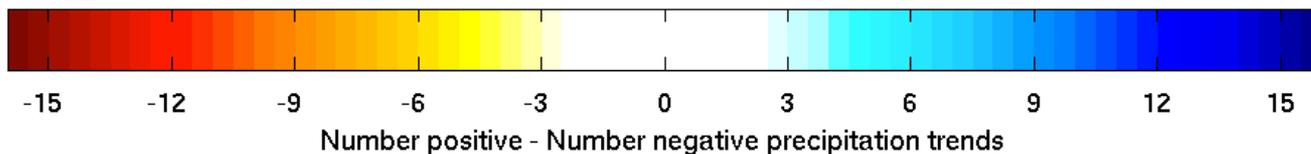
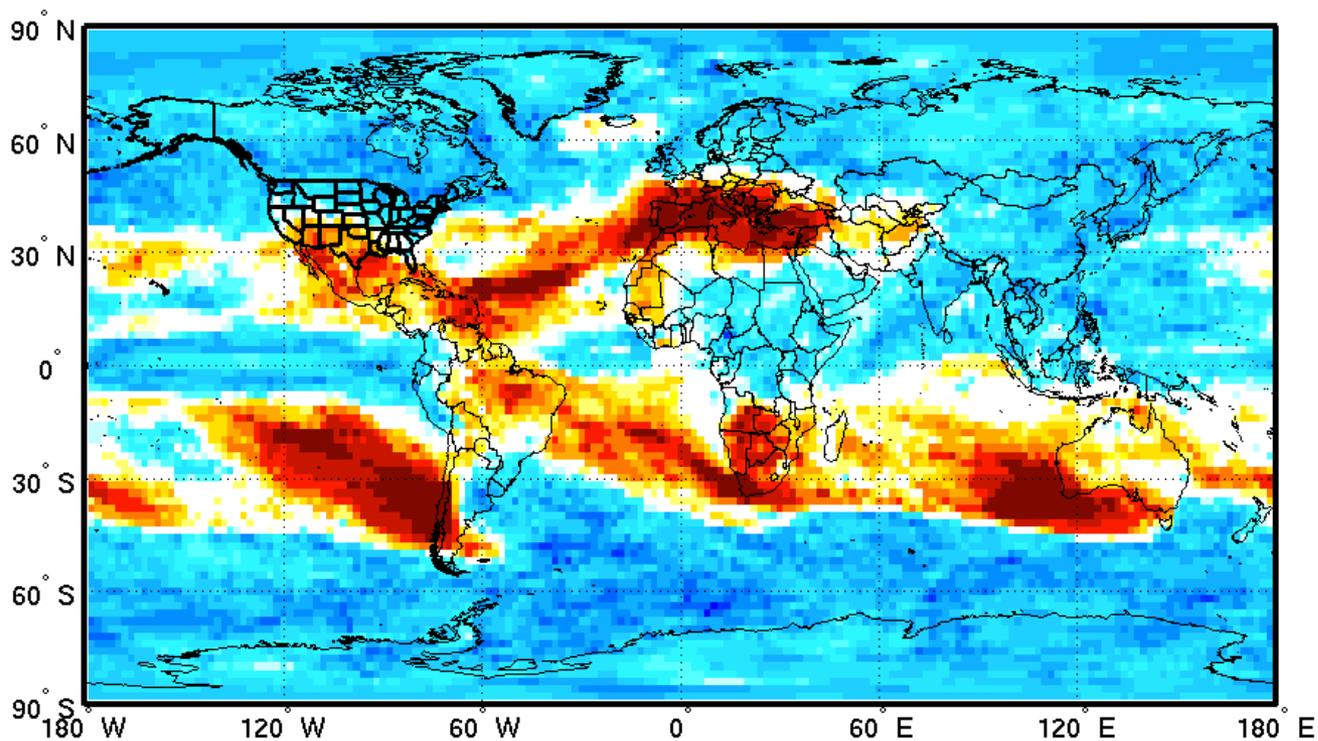
Three Emission Scenarios Combined



Projected CMIP5 rcp85 Precipitation Trends, 2006-2100

Consistency among 16 projections

RCP8.5 Emission Scenario

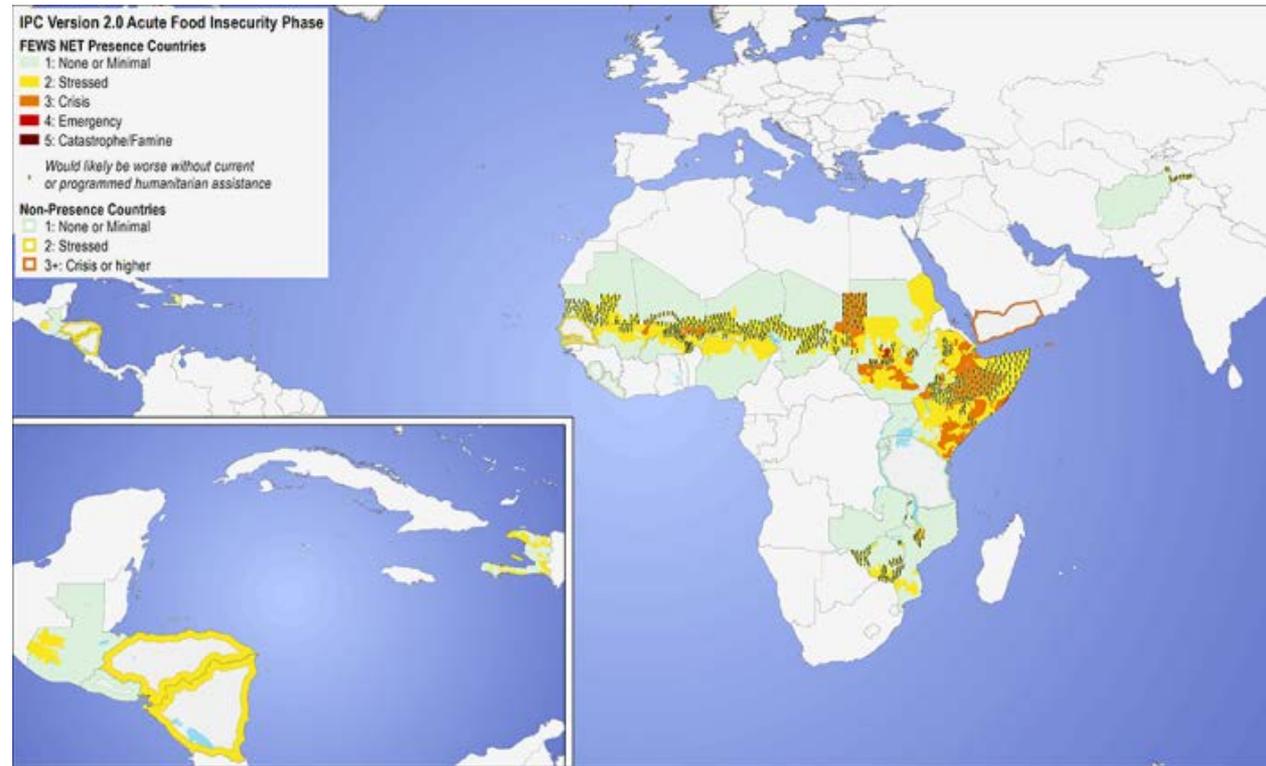


Decision makers
want to know:

*what is
the fate
of today's
regional
precipitation
patterns
under
projected
climate
change?*

Immigration

- Centers of demand will shift environmental stress and associated mobility of population



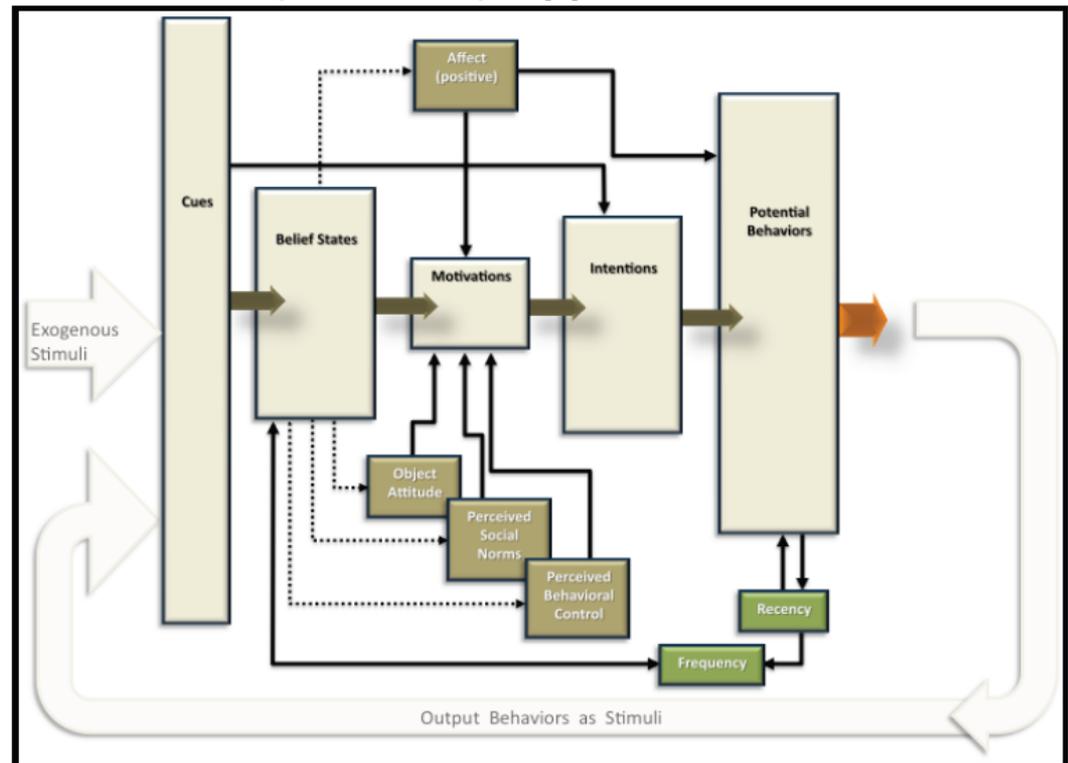
FEWS NET 2012

- Consider that 82% of US population growth from 2000-2010 fueled by immigration

Human Behavior

- Human reaction to an event or opportunity is motivated by many factors beyond economics

Political, Military, Economic, Social, Infrastructure and Information (PMESII)-type model



boundary organizations bridge gap between research and applications

Examples:

- NOAA's Regional Integrated Sciences and Assessments (RISA) program, which dates to 1995 and currently funds 11 regional centers, cover most of US
- Department of Interior's 8 Climate Science Centers, cover all of US and focus on landscape, fish, wildlife, and habitat management
- Bureau of Reclamation's WaterSmart program
- State Climatologists, some of which are working deeply in water issues in their respective states;
- NOAA Regional Climate Centers (RCC's) -- supply data, products, advice to users
- The Water Utility Climate Alliance, a partnership of 10 large urban water utilities.

Initial set of priorities:

□ Structure research calls that increasingly encourage *formation of interdisciplinary teams* to promote improved integration of the physical, biological, social and engineering sciences.

□ *Sustained observations of the 3-d atmosphere* and the hydrosphere are essential to improve understanding and develop models required for prediction, attribution and detection and improved input to linked systems. Paleoclimate indicators are needed to better understand and quantify extreme events and recurrence intervals. Also needed is a continued emphasis to evaluate and improve predictions-from short term (e.g. storms and hazards) and long term (e.g. shifts from present day climatology, drought) phenomena.

□ create of a *regional scale modeling platform that links climate to human effects*; with purpose of supporting analysis of issues of most pressing concern to resource managers.

□ Production and *evaluation of ensemble model simulations* of multiple aspects of hydrologic change associated with climate change are needed by a myriad of water agencies and other decision makers.

□ *Couch results in a probabilistic risk assessment framework* that helps make sense of the significant uncertainties both in the physical system and in the response of humans to a changing and uncertain future.

□ Develop *decision analytics that improve communication* of relevant climate information to decision makers and the lay public.