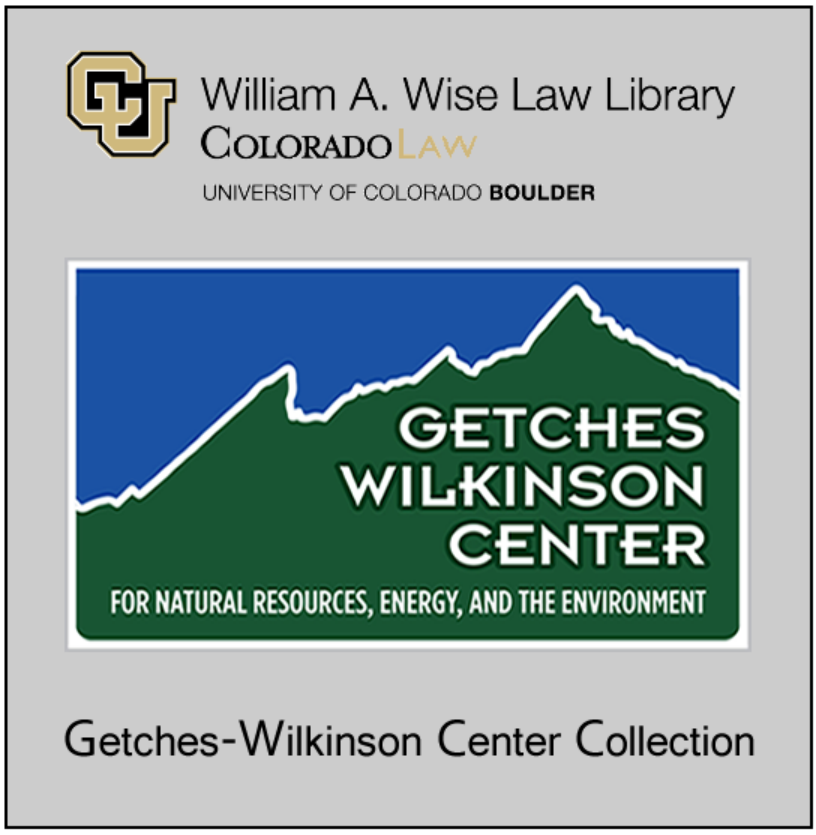
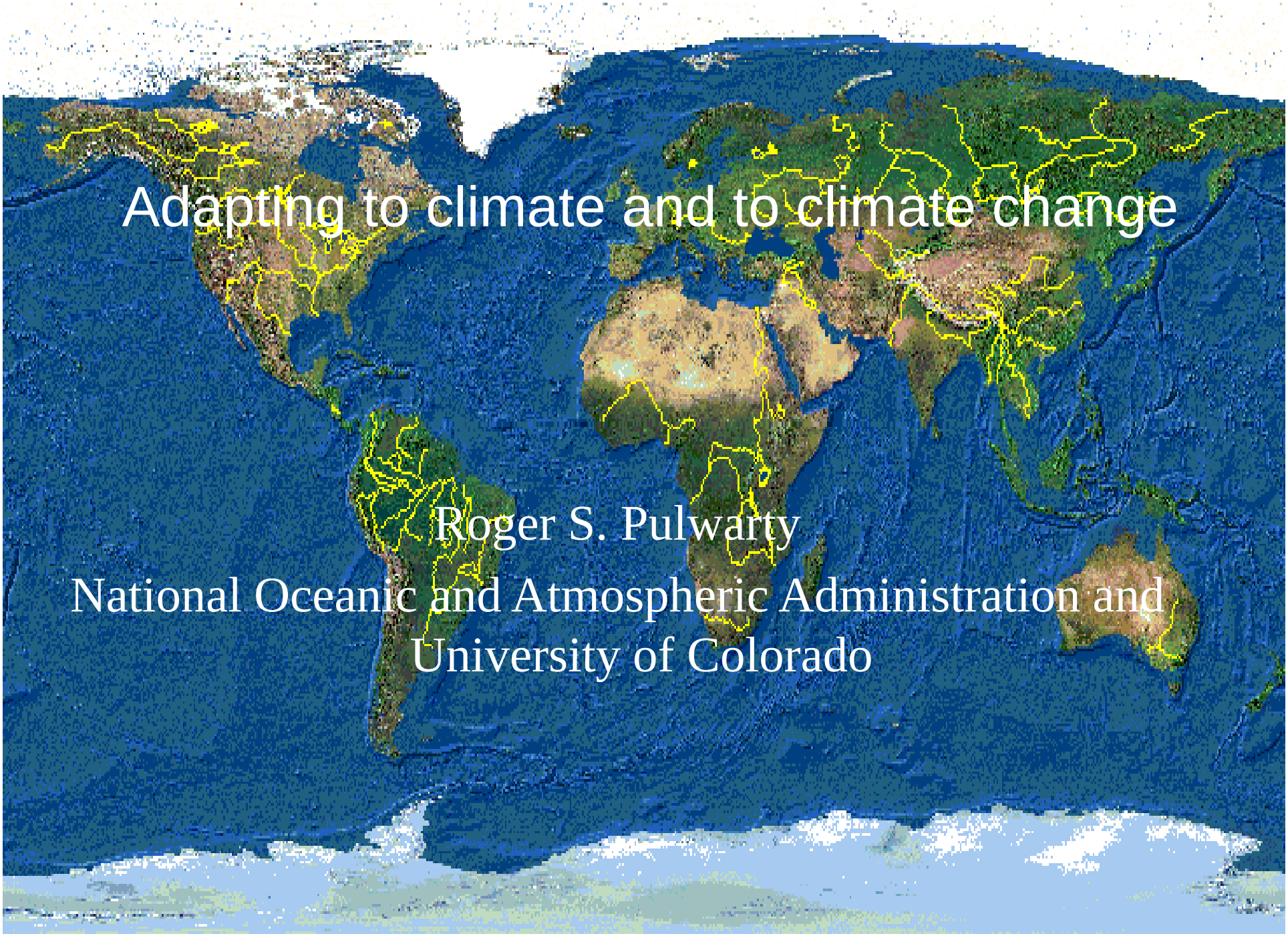
6-9-2006

SLIDES: Adapting to Climate and to Climate Change

Roger S. Pulwarty



Roger S. Pulwarty, *Adapting to Climate and to Climate Change*, *in* CLIMATE CHANGE AND THE FUTURE OF THE AMERICAN WEST: EXPLORING THE LEGAL AND POLICY DIMENSIONS (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 2006).



Adapting to climate and to climate change

Roger S. Pulwarty

National Oceanic and Atmospheric Administration and

University of Colorado

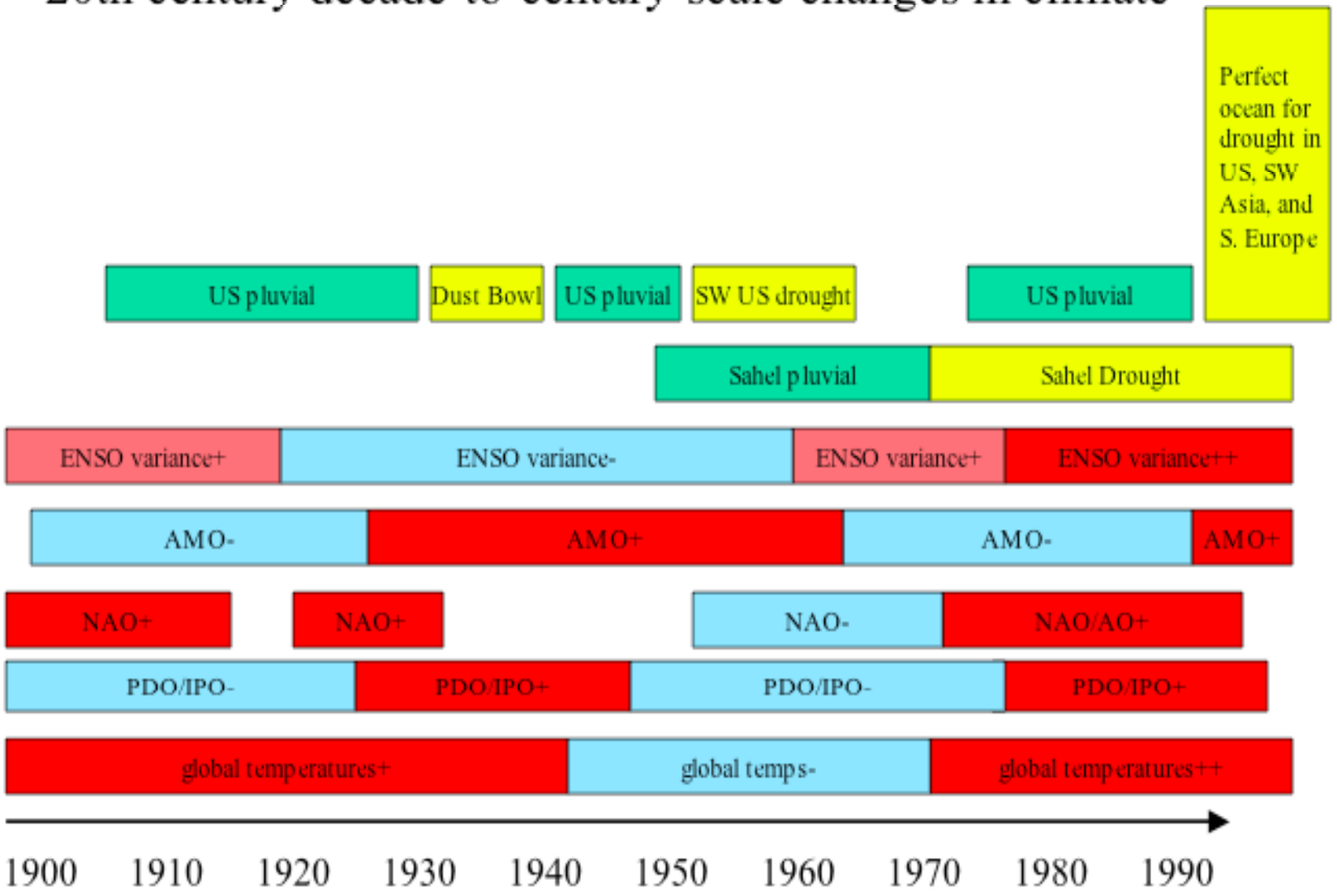
Three reasons for assessing climate change the context of adaptation to extremes and variability in the recent past:

(1) A strictly long-term focus can overshadow the role of surprise in shaping responses

(2) Adaptations in many cases are driven by crises, learning and redesign

(3) Opportunities exist to learn from organizations that cope with change andfocus on responses and social networking such as disaster relief and research

20th century decade-to-century-scale changes in climate



Conclusions, so far

- Processes involve multiple timescales:rates of change are important

- Early “winners” are unlikely to be willing to alter earlier terms of agreement even when changes in climate conditions are well documented

Physical scientists and engineers commonly foreground environmental limits and background the institutional limits

- Political boundaries, whether domestic or international;

  Often separate the location where problems are felt from the location

  where the most effective and efficient solutions can be applied

Conclusions, so far

- Degradation is often a long-term process with cumulative phases of acceleration and deceleration
- Rates of changes are important
- Processes involve multiple timescales

  (conjunction of several factors at unique points)
- Degradation must be placed within wider social and environmental dynamics (other phases of landscape transformation)

  eg size of settlements and adequacy of social mechanisms to deal with changing circumstances

Foregrounding of the environmental limits and the backgrounding of the institutional limits

Single factor causation

Irreducible complexity

Competing explanations:

Proximate and underlying driving forces

"They will never agree," said the nineteenth-century wit Reverend Sidney Smith when he saw two people shouting at each other from houses on opposite sides of an Edinburgh street

"They are arguing from different premises."

- 1900-1960

The PHYSICAL COAST
Beach
Storms
Waves

Control

Damage

COASTAL COMMUNITIES

Damage cost data

Shore protection

GOVERNMENT

PRIVATE OWNERS

post-1960s general model

The COASTAL ENVIRON.
Shoreline processes
Coastal ecology
Water quality
Aesthetics

Env. Impacts and Adjustment

Risk and Env. Perc.

COASTAL LAND USE
Spatial Development and Conservation Practice

Damage

Econ. and Env. Cost Data

Range of Choice/Options
nourishment, shore protect. incentives

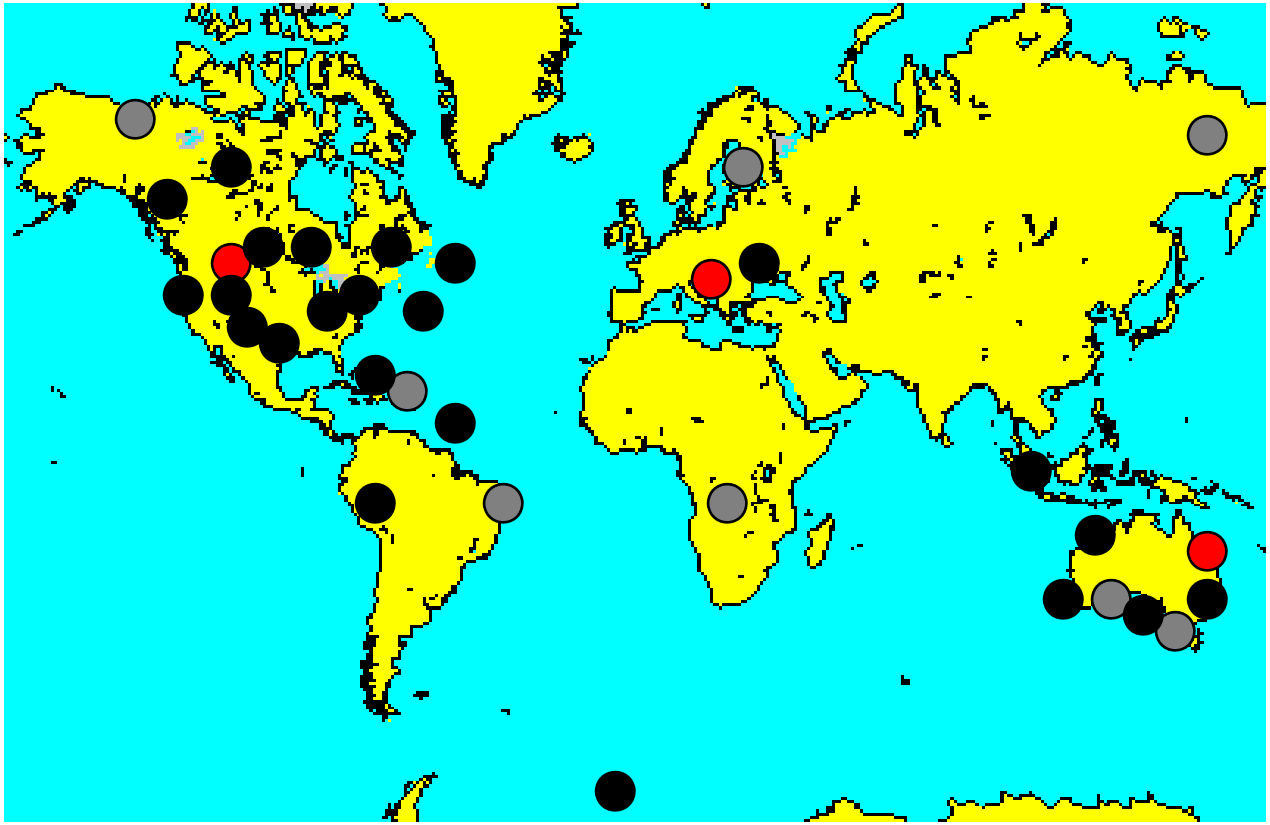
GOVERNMENT
Federal
State
Local

COURTS

PRIVATE OWNERS

Track record for exporting and implementing adaptive management:

Successful Modeling failure Implementation failure



(after Walters et al.)

Adaptation

- Organisations adapt to climate in the context of other environmental signals: need to understand *processes* of adaptation by organisations
- No *a priori* simplifying assumptions: autonomy, efficiency, foresight…
- Traceability of impacts from interventions is not always clear

Resources for adaptation

- All organisations have a capacity to adapt – financial, technical,cognitive, cultural
- Organisations are continually adapting – climate change is a new stimulus for adaptation
- Greater adaptive capacity imposes new costs - adaptation requires resources and capabilities (some internal, others external)

- Learning processes seek to draw lessons from historical accounts of experience in distant issue areas or national contexts

- Expectations about the future tend to be better understood by people within organizations if there is a clear parallel with the past:

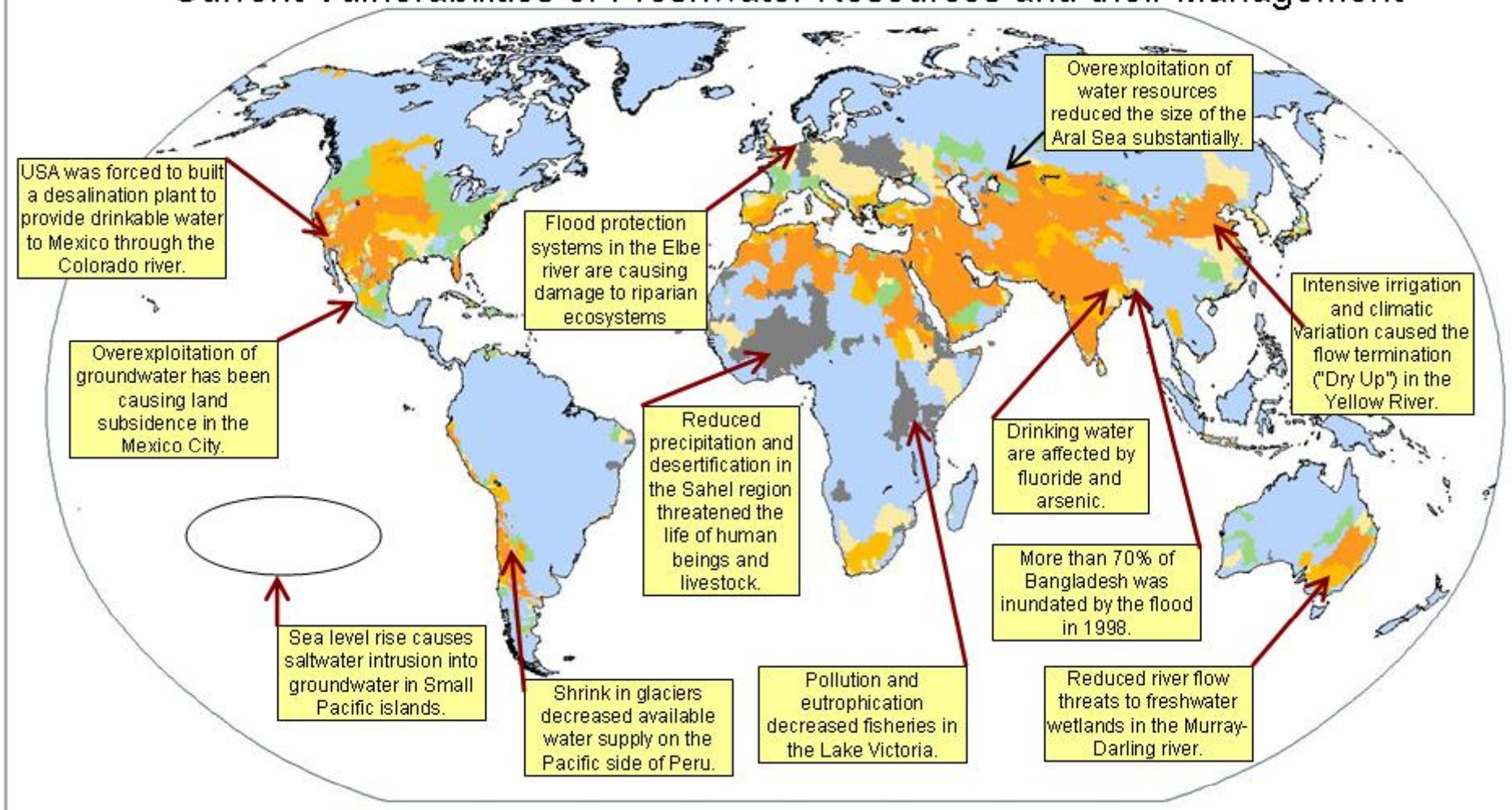
  - Usually concentrates on the incorporation of new knowledge or experience into existing models, decision processes and practices
  - The most important social learning involves higher order properties such as norms, goals, and the basic "framing" of issues in terms of the causes and effects selected for attention

Interacting with other Disciplines

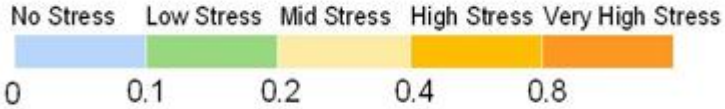
Interacting with other institutions

Interacting.....

Current Vulnerabilities of Freshwater Resources and their Management



Water Stress Indicator: Withdrawal-to-Availability Ratio



no/low stress and per capita water availability < 1700 m³/year

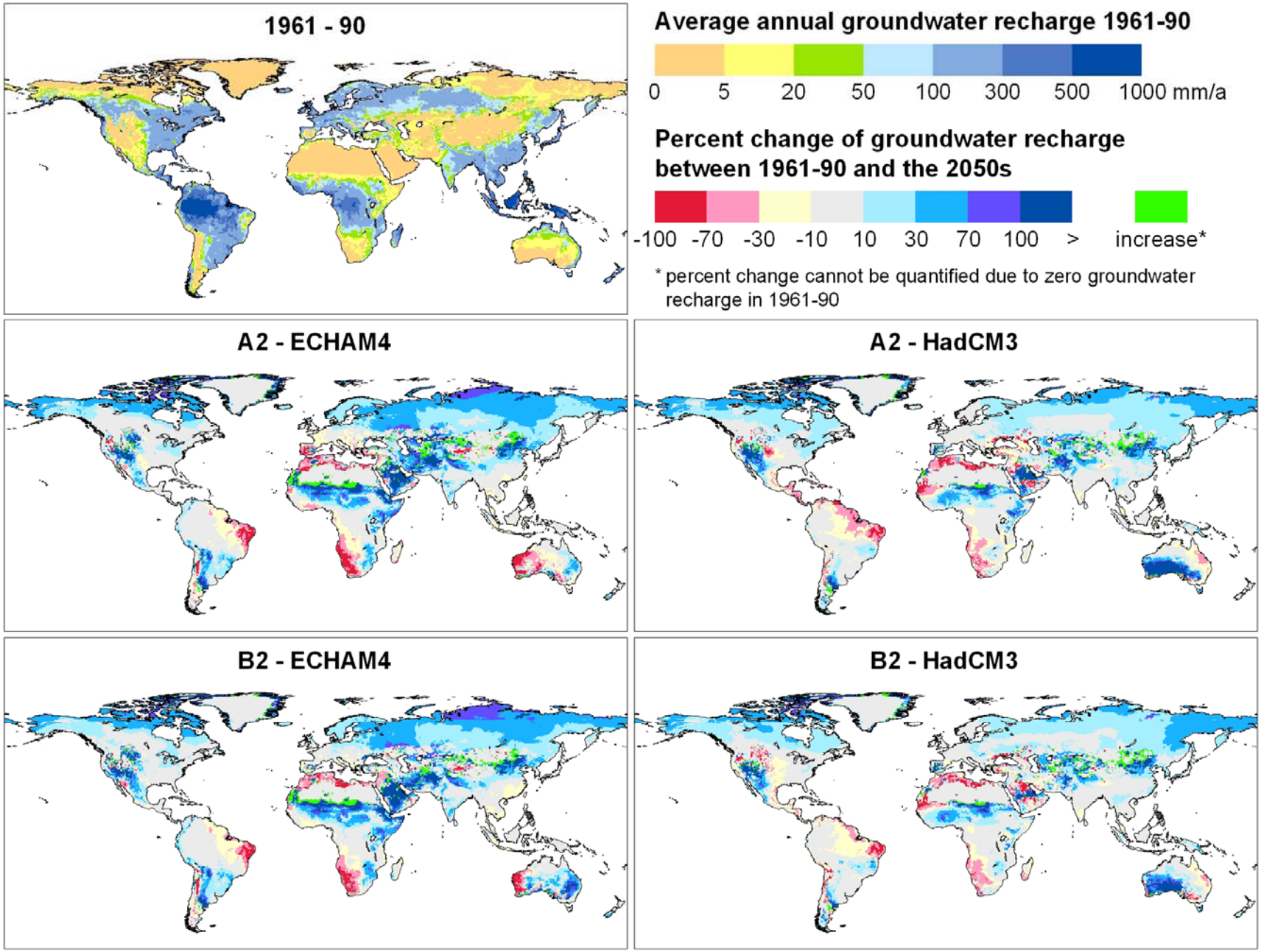
Water withdrawal: water used for irrigation, livestock, domestic and industrial purposes (2000)

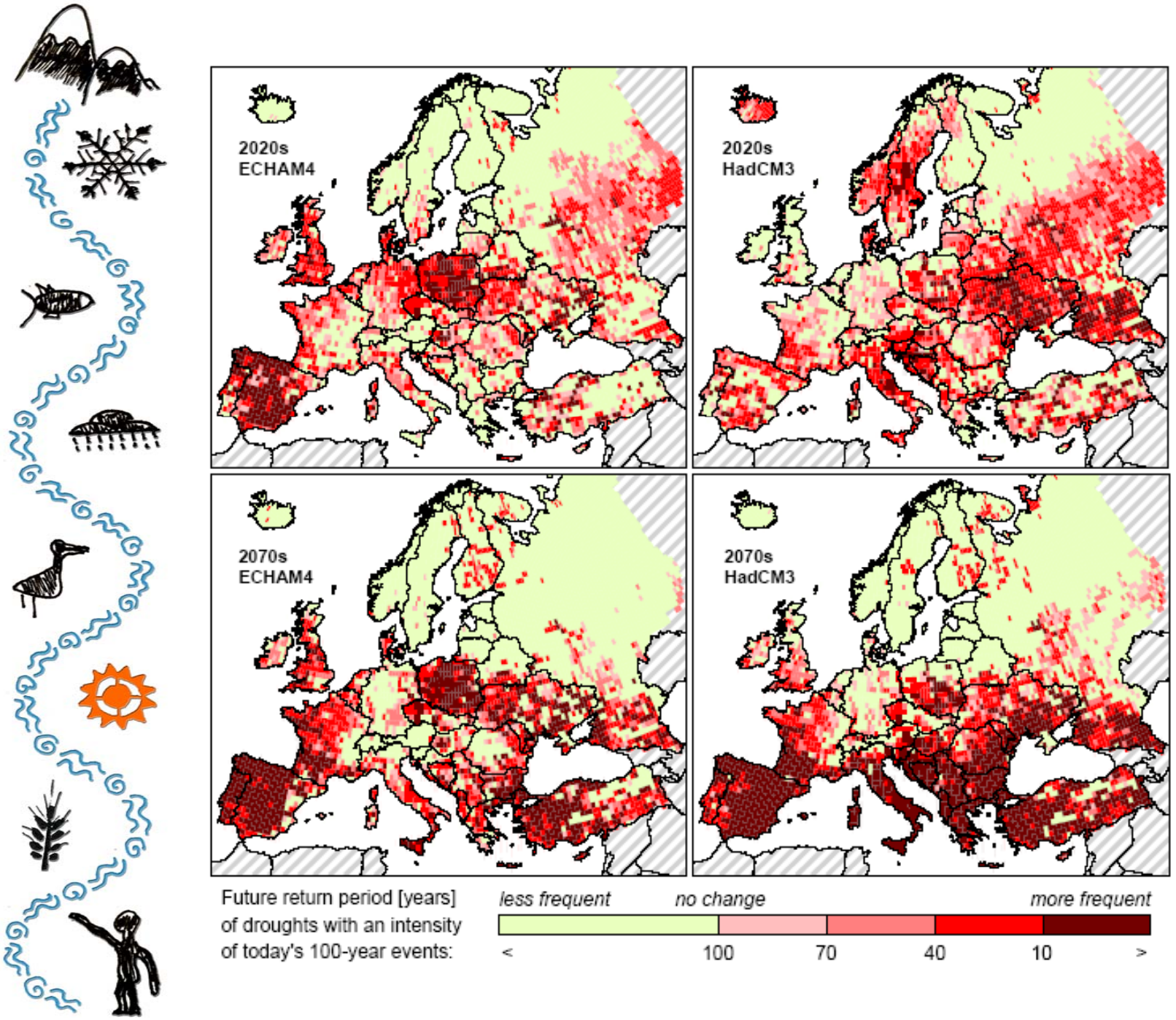
Water availability: Average annual water availability based on the 30-year period 1961-90

Country	Sensitivity *(most vulnerable)*	Climate-related Stress	Adaptation Practice	Scale/ Actors	Type of Adaptation
Austria European Environment Agency (2005) p.51	Ski resorts	Unreliable snow cover	Diversification of services (Opening spa-programs, Eco-tourism)	D,P	e
Bangladesh Schaerer (2005), Pouliotte (2005)	Livelihoods, Food, Water, Health, Gender, Income (*poor women*)	Sea level rise, salinization	Alternative crops and sources of income, marketing, low-tech water filters, water management, and mobilization	H, O, I	t, i
Germany (Bavaria) European Environment Agency (2005) p.48	Housing, Construction	Flood	Allowance made for the construction of new flood protection facilities	L,G	i,e
Botswana FAO (2004) p.121-133	Food, Livestock, Livelihood, Health, Income (*Rural poor, small subsistence farmers*)	Drought	-Drought response (Creation of employment after drought, capacity building of local authorities for disaster relief, assist livestock owners during drought) -Crop production (Assist small subsistence farmers to increase crop production)	N,G	i, t, e
Cook Islands Bettencourt *et al.* (2006) p.29	Drinking water	Droughts, saltwater intrusion	Rainwater harvesting, leakreduction, hydroponic farming, bank loan policies to facilitate purchase of rainwater storage tanks, and education.	S	i, t, e
Fiji Bettencourt *et al.* (2006) p.28	Coastal erosion	Wind, wave	Replanting of mangroves	L	t
Germany European Environment Agency (2005) p.50.	Health	Heat	Heat warning system	N,G	t
Netherlands European Environment Agency (2005) p.47	Livelihoods, food, town	Sea level rise	Periodical update of criteria for the safety features of protection infrastructure	N,G	i
Niue Bettencourt *et al.* (2006) p.28	Topsoil, vegetation, coral reefs	Cyclone, wave	Replantation of 150 different types of trees	L	t
Niue	Human life, Crop production, Buildings	Cyclone	Early warning system, promotion of a resilient cash crop (vanilla), relocation of all government buildings	N,G	i, t

"Adaptation" leaves open the questions:

- Over what time scale are harmful and beneficial consequences of action to be compared?
- Do the benefits of AM exceed the expected costs?
- Are future management changes likely to result from interventions being undertaken at present?


1961 - 90
Average annual groundwater recharge 1961-90
0 5 20 50 100 300 500 1000 mm/a
Percent change of groundwater recharge between 1961-90 and the 2050s
-100 -70 -30 -10 10 30 70 100 > increase*
* percent change cannot be quantified due to zero groundwater recharge in 1961-90
A2 - ECHAM4
A2 - HadCM3
B2 - ECHAM4
B2 - HadCM3


2020s
ECHAM4
2020s
HadCM3
2070s
ECHAM4
2070s
HadCM3
Future return period [years]
of droughts with an intensity
of today's 100-year events:
less frequent
no change
more frequent
<
100
70
40
10
>

Adaptation Costs and Benefits in Water Management Sector

South Africa: Berg River basin

- Adaptation measures: institution of an efficient water market and an increase in water storage capacity through the construction of a dam

- Costs and benefits estimates for storage and water market adaptation strategies. Adaptation net benefits were estimated to range between 34 and 1143 billion 2000 Rand when both options where implemented
- Reducing potential climate change damages by up to 17.41%
- Rising cost for urban water use could impact urban poor representing a significant social cost

Adaptation option	Application	Relative unit cost	Water saved or supplied in % of the current supply
Irrigation scheduling	Large holdings to small holdings	1.0 Š 1.7	10%
Public education	Large & medium communities	1.7	10%
Storage	Low to high cost	2 Š 3.0	Limited (most sites already developed)
Lake pumping	Low (no balancing) to high cost (with balancing)	1.3 Š 5.4	0 Š 100%
Trickle irrigation	High to medium demand areas	3.0 Š 3.3	30%
Leak detection	Average cost	3.1	10 Š 15%
Metering	Low to high cost	3.8 Š 5.4	20 Š 30%

There is strong evidence that not all climate Risks are being incorporated in decision making, Even with regard to weather extremes

History is filled with examples of groups and researchers that have proposed models of societal progress that turn out in practice to benefit a Fraction of the population (Orlove, 2005)

Benefits of controlling seasonality/hydrology

- Conveyance of flood waters
- Storage for irrigation (and power)
- Predictable navigation opportunity
- Enhanced recreational uses

Adaptation requirements

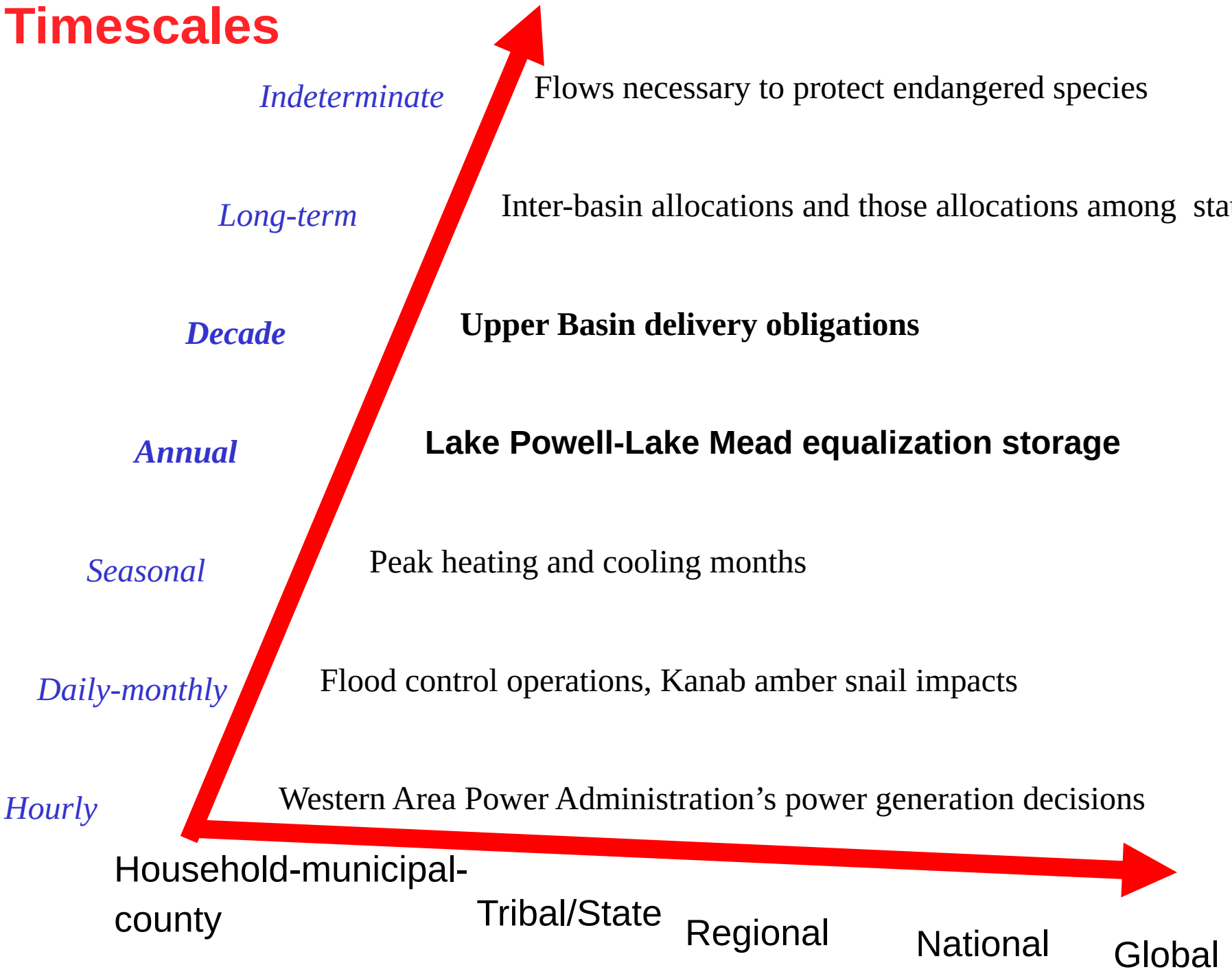
- Sufficient water resources for experimentation
- Resilience identified/understood in key ecosystem components
- Flexibility among stakeholders
- Room for political negotiations

de Loe et al (2001) propose eight criteria for screening the broad range of available options in the "the near term" in the Grand River basin (i.e. over the next decade):

- No regrets
- Reversibility
- Minimize environmental impacts
- Cost effectiveness
- Equity (dist/proc)
- Reduce vulnerability
  (at least do not increase)
- Ease of implementation
- effectiveness

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Timescales


Indeterminate
Flows necessary to protect endangered species
Long-term
Inter-basin allocations and those allocations among states
Decade
Upper Basin delivery obligations
Annual
Lake Powell-Lake Mead equalization storage
Seasonal
Peak heating and cooling months
Daily-monthly
Flood control operations, Kanab amber snail impacts
Hourly
Western Area Power Administration's power generation decisions
Household-municipal-county
Tribal/State
Regional
National
Global

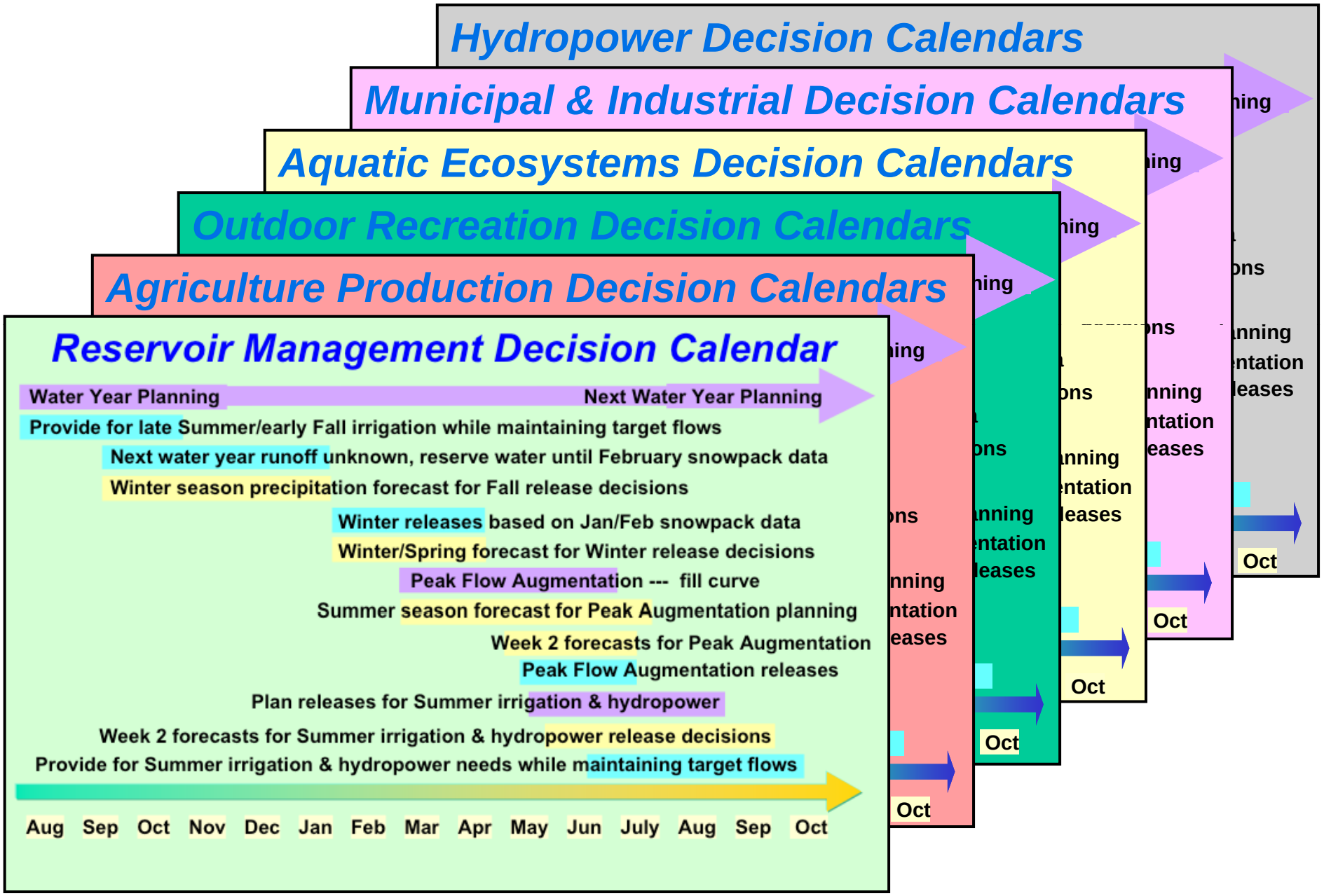
Regional Water Issues Activities - 1

What We Do	***Understand, Explain, Predict, Assess, Communicate, Evaluate***	**Climate Processes**	**Who We Work With**
Short Term Extreme Events	Develop experimental forecasts, monitoring, and application products. Experimental attribution assessments of regional extremes.	Subseasonal variability, Arctic Outbreaks, Monsoon, floods, heat waves, tornados, hurricanes	Reclamation, Fish and Wildlife Service CBRFC, Office of Hydrology, CPC, HPC, Regional Councils, Wildfire Managers
Drought seasonal to multi-year	Develop drought forecasts, monitoring, paleoclimate reconstructions and application products. Assess social, environmental, and economic impacts.	Flash droughts, snowpack evolution, soil moisture evolution, El Niño and La Niña, multidecadal ocean variability	Western Governors Association (WGA), NIDIS, NWS, RFCs, NCDC, RCCs, NDMC, USDA, NRCS, USGS, NASA, Regional Councils, State and Municipal Agencies

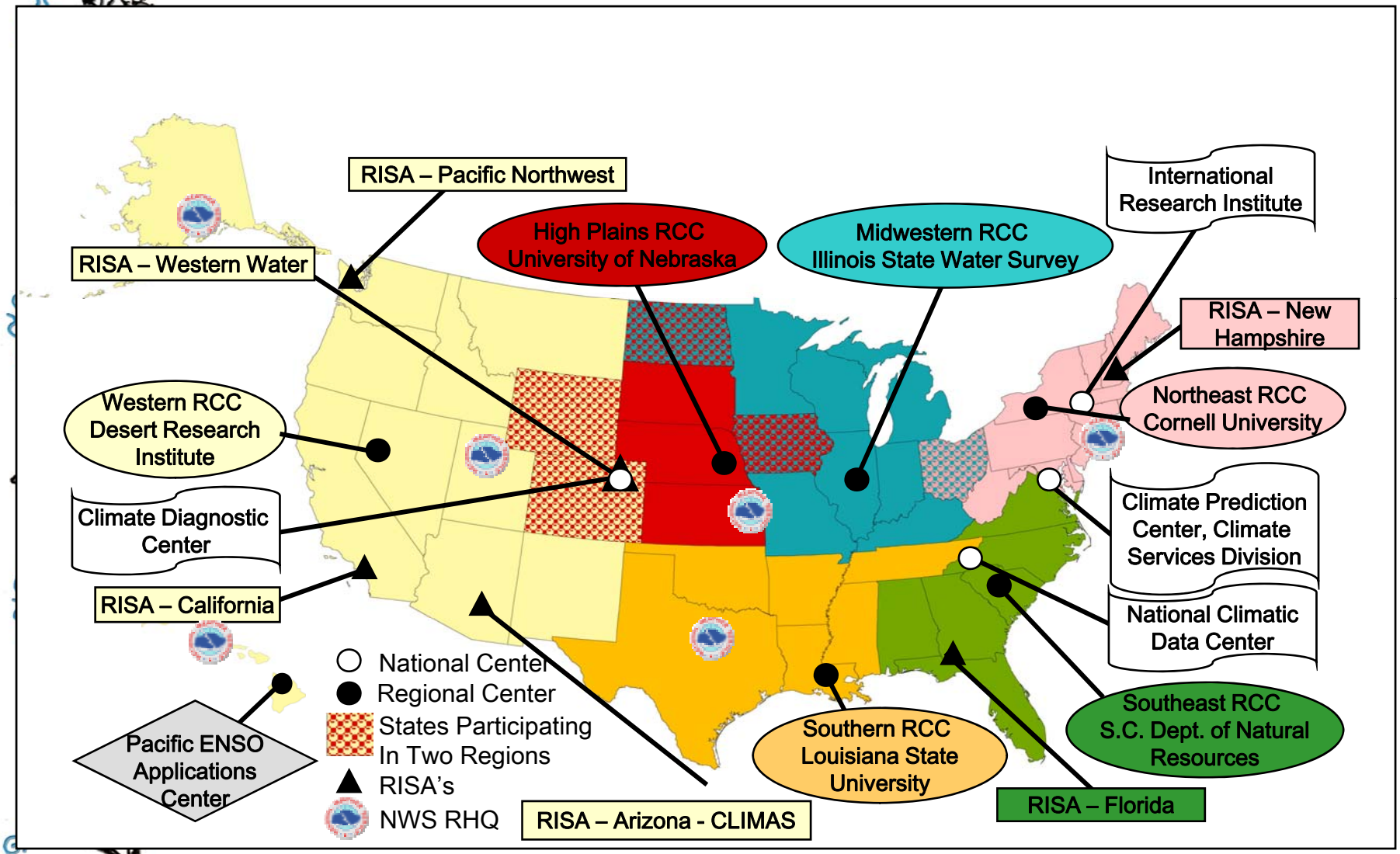
Regional Water Issues Activities - 2

What We Do	***Understand, Explain, Predict, Assess, Communicate, Evaluate***	**Climate Processes**	**Who We Work With**
Decadal Climate Variability	Develop experimental monitoring, attribution, and application products. Assessments of regional trends and risks to inform adaptation strategies.	Pacific Decadal Variability, Atlantic Multidecadal Variability, Short term influences, Regional Trends	Regional Councils, Wildfire Managers, NCAR, Regional Watershed Councils, Municipal Agencies (e.g., Denver)
Climate Change	Develop experimental attribution assessments of hemispheric to regional trends. Assess social, environmental, and economic risks (e.g., Colorado Compact).	Observed, current and evolving trends, Enhanced hydrologic cycle, High elevation change	CCSP, Reclamation, EPA, USGS, IPCC, NCAR, NASA, Regional Watershed Councils, Municipal Agencies

Water Resource Management: optimizing risk reduction



Existing NOAA architecture: NOAA-Supported Centers



Where do science and policy speak to each other?

- In learning to adapt to climate change “typically facts are uncertain, values in dispute, stakes high, and decisions urgent

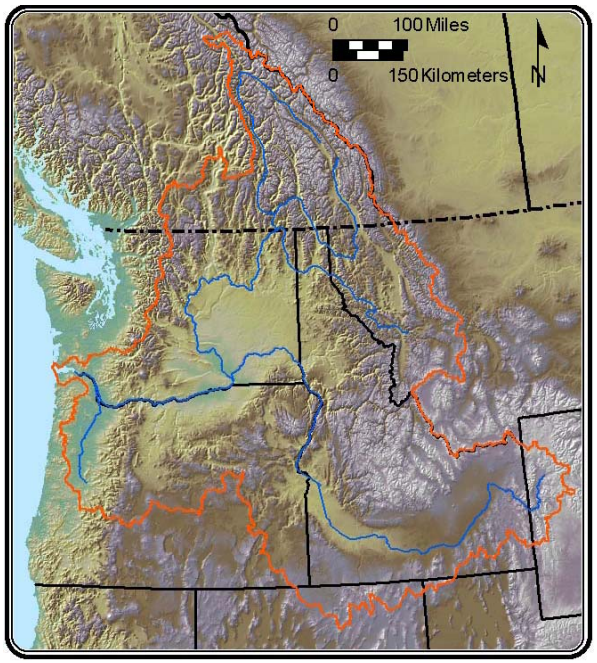
- Emphasis on 'authority' and 'expertise' alone can reduce contending perspectives and lead to unanticipated consequences.

Outreach

- Promotes regional understanding of climate impacts in PNW resource management. Activities include:
  - Workshops and meetings (4-5/year)
  - Presentations and briefings (75+/year)
  - One-on-one technical assistance (ex: watersheds)
  - Work with the local media
  - Web site development and maintenance
  - Graduate-level courses on climate impacts at UW

The Climate Impacts Group

First of 8 U.S. regional integrated assessment teams (RISAs).



Areas of study:

- Water resources
- Salmon
- Forests
- Coasts
- *[Agriculture, Human Health]*

Objectives

- Increase regional resilience to climate variability and change
- Produce science useful to (and used by!) the decision making community; requires close and sustained stakeholder interactions

A Sea Change in Perceptions

Dramatic change in stakeholder perceptions of value and relevance of information about climate variability and change…

1995:
Few managers saw role for climate info, recognized predictability of climate, or possessed a conceptual framework for applying climate info

1997-98:
El Niño and concomittant media attention stimulated widespread interest in information about climate variability and in CIG

Most stakeholders unfamiliar with potential impacts of climate change and unprepared to use such information

2001:
Senior-level water resources managers recognize climate change as a potentially significant threat to regional water resources; acknowledge climate change information as critical to future planning

2001/2:
50-year drought brings intense media attention to issue and CIG's work public & private pressure on State agencies to include CC impacts in long-term planning significant involvement of CIG in multiple efforts

2003 to present day:
Continued significant breakthroughs with stakeholder groups

As the RISAs and others have shown, the generation of coordination mechanisms takes almost as long and is possibly more involved than the accumulation of knowledge for the purpose of application

Diversity is more than insurance on responding to uncertainty.

- It is widely acknowledged that knowledge, practices and social mechanisms that recognize disturbance and surprises is needed.

- Much less is known about how to achieve and sustain these characteristics e.g. through monitoring functioning and sanctioning of reserves and protected areas, in practice

- The “push” supply of new information by would-be providers of information/technology , and the “pull” demand for new information from would-be learners.

- More difficult is socialization of lessons learned by particular individuals and organizations through their own, direct trial and error experience.:
- very few longitudinal evaluation studies can be carried out

Managing through changes:

- Key drivers, such as climate and technological change, are unpredictable with great accuracy on scales that matter for regional and local decisions. Many change non-linearly

- Human action in response to forecasts is reflexive. If important ecological or economic predictions (statements about the possible futures) are taken seriously, people will react in ways that will change the future, and perhaps cause the predictions to be incorrect

- The system may change faster than the models can be recalibrated, particularly during turbulent periods of transition, so projections may be most unreliable in precisely the situations where they are most desired

Constraints/Limits on adaptation

Related to the concept of adaptation is the notion of maladaptation, generally absent from reports that seek to offer a solely optimistic view of humanity's capacity to respond to problems

- A complementary approach to methods based on projections is to focus on maintaining the capacity of the climate-environment-society system to cope with whatever the future brings, without the system changing in undesirable ways

  (or for acceptable risks)

- One effective way of addressing risks posed by climate change and disasters is to lessen the underlying factors causing vulnerability to these phenomena

- Mismatch between what we know and what we do

Agreements in the West

- ☐Strong focusing events
- Significant public interest (making climate “hot”?
- Personal attention of key leaders
- Close Federal/State/local partnerships
- Strong funding for research basis and collaboration between research and management
- Meaningful Stakeholder involvement

Paradoxes

Decentralization….. better coordination

- Cumulative reduction of smaller scale risks…… may increase vulnerability to large events

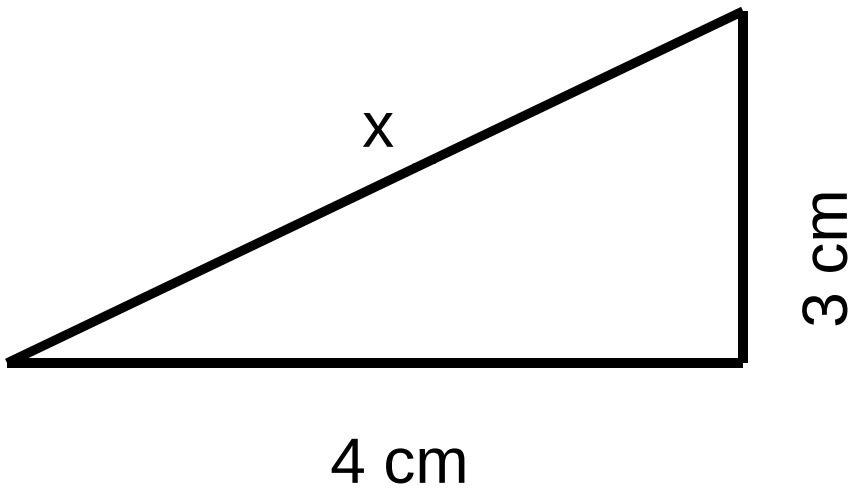
Planning…….“action” only after crisis or focusing event

- Lessons available on adjustments particular events but not to gradual changes (or abrupt regime shifts)

- Integrated River Basin management….National vs. borderlands priorities

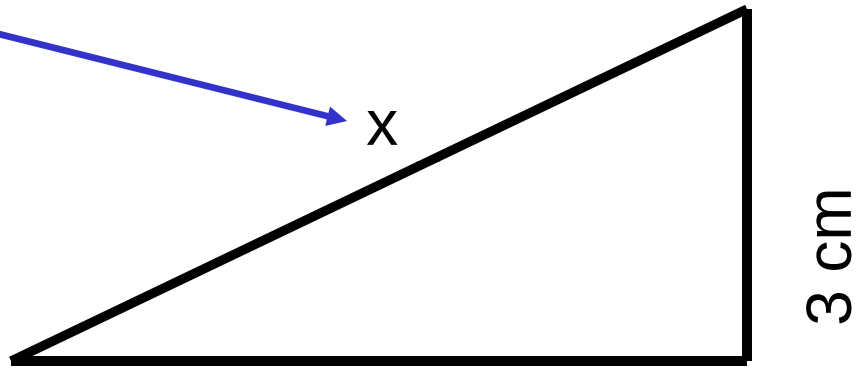
- Develop procedural/participatory mechanisms: Coalitions of local stakeholders need to be inclusive and transparent……. but this can lead to power struggles/robustness under stress

Q 3. Find x



Q 3. Find x

Here it is !



From Internationalism to Regionalism

1950s-1980s: Major shift in the post-war era

Western water policy documents ceased to refer to international experience

(focus on constitutional foundations of water management (i.e., federal and state responsibilities and relations)

Lessening hypothesis
(Kates, White and tons of others.)

- Cumulative reduction of smaller scale risks may increase vulnerability to large events
- Examples….

- Early warning cues: It is absolutely essential to treat interventions as dynamic and “to monitor and revise them continually”

Adaptive governance

•Integrates various types of knowledge and organizations

-relies on open decision-making processes recognizing multiple interests, community-based initiatives, and integrative science in addition to traditional science

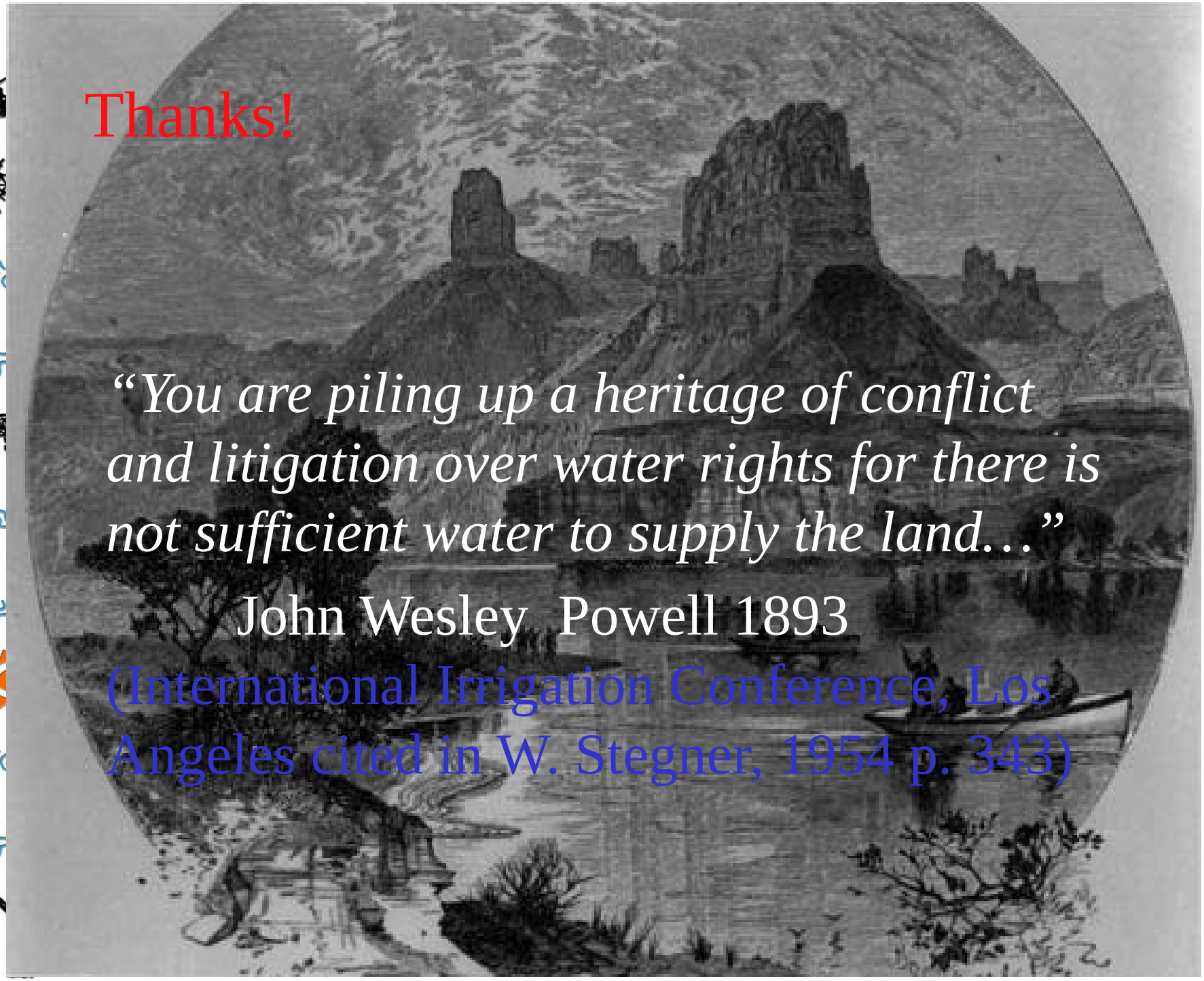
Coupled human-environment system

- Social and biophysical capital: resources, processes and access
- External forces in reshaping the system
- Differential capacities
- Perception of risk (and uncertainty: known, unknown, presumed, unknowable)
- Surprises and scale

If environment changes: Research Program

If environment changes,
Government/community:

REMAINS THE SAME GOAL	KEEPS GOAL SAME	CHANGES
	Deterioration	Symbolic gesture, Passive acceptance
CHANGES	Adjustment	Adaptation Innovation



Thanks!

"You are piling up a heritage of conflict and litigation over water rights for there is not sufficient water to supply the land…"

John Wesley Powell 1893

(International Irrigation Conference, Los Angeles cited in W. Stegner, 1954 p. 343)