Bridging Science and Policy

Climate change research and outreach in the Pacific Northwest

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Science in Society

• Scholars have a responsibility to provide perspective on social, technological and environmental change and the challenges and opportunities they create for society.

• Much global change research motivated by a desire to contribute to this understanding, either directly (via problem-focused research) or indirectly (via exploratory research). But…
  – Researchers often frustrated because the fruits of their labors are misused, misinterpreted, or ignored.
  – Policymakers frustrated because scientists only produce useless information.

*What goes wrong?*
Flies in the Ointment

• Science (even more and better science) isn’t always the answer
  *Consider other adaptive responses*

• Knowledge is power
  *Attend to equity issues*

• Science is better at filling decision makers’ inboxes than emptying them
  *Engage in a new type of science and communication*
Building the Bridge

• Identifying relevant scientific research requires answering the questions: Relevant to whom? For what?
  “If scientists are serious about wanting to do research that supports decision maker needs, then they could insist on a systematic and rigorous assessment of such needs as primary input to setting research priorities…” (Pielke & Sarewitz 2002, “Wanted: Scientific Leadership on Climate”)

• Application of research results requires translation
  No more “loading dock science”

What makes knowledge usable within both society & science?
Building the Bridge I: Solution-Oriented Research

- Requires attention to “real-world” issues and constraints of decision makers…
  - Define users (“clients”)
    • Types of collaboration
    • Method of distribution
    • Technological sophistication
    • Issues of concern
  - Understand context in which information will be used
    • Time and space scales
    • Institutional, economic, and cultural circumstances in which decisions are made

- What is the real value of the information?

Requires a new type of science
# The Climate Impacts Group

**Areas of study:**
- Water resources
- Salmon
- Forests
- Coasts

**Motivation:**
- Increase regional resilience to climate variability and change
- Produce science useful to the decision making community

An understanding of the patterns and consequences of past climate variability, policy responses and their impacts is essential for preparing for future changes in climate.
Climate Impacts Science

The study of how climate, natural resources, and human socio-economic systems affect each other

→ Requires integration of physical and social science research (UW+) & incorporation of stakeholders’ perspective (federal, tribal, state, local)
Building the Bridge II:
Application Requires Translation

• Focus on usability, not just availability … no “loading dock” science
  – “value added” products
  – Diffusion of innovations
  – Capacity development
  – Evolution of “proper” relationship between science and policy

• What’s the motivation for use?

Requires dialogue between scientists and stakeholders
## Working with stakeholders

<table>
<thead>
<tr>
<th><strong>Target Audience:</strong></th>
<th><strong>Key stakeholders:</strong></th>
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<tbody>
<tr>
<td>- Resource managers</td>
<td>- <strong>Federal</strong> (Bonneville Power Administration, Natural Resource Conservation Service, Army Corps of Engineers, Forest Service)</td>
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<td>- Regulatory agencies</td>
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<td>- Service and forecasting agencies</td>
<td>- <strong>Tribal</strong> (Columbia River Intertribal Fisheries Commission, Northwest Intertribal Fish Comm.)</td>
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<tr>
<td>- Policy makers</td>
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<td>- All levels of government</td>
<td>- <strong>State</strong> (WA Depts of Ecology, Natural Resources, Fish &amp; Wildlife; OR Dept of Lands (Coastal Mgmt), ID Dept of Water Resources)</td>
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<tr>
<td>- Media</td>
<td></td>
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<tr>
<td>- Public</td>
<td>- <strong>Local</strong> (Seattle Public Utilities (Water), Seattle City Light, Portland Water Bureau)</td>
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### Putting into practice:
- Interviews
- Water workshops
- High-level policy meetings
- Long-term commitment
Putting It All Together: Regional Climate Impacts Assessment

Climate Variability
- past variations and their impacts
- ability of institutions to respond to extremes

Climate Change
- regional consequences of global warming
- adaptation/vulnerability
And now for the details…

CIG’s Process of Integrated Assessment:

- Climate dynamics provides the anchor
- Components of the assessment are undertaken in parallel, rather than in series
- Close communication within the assessment team ensures that methods and assumptions are compatible
Northwest warming

- Warmest scenario
- Average
- Coolest scenario
- Observed

Degrees C

- 1900s
- 1920s
- 1940s
- 1960s
- 1980s
- 2000s
- 2020s
- 2040s
Despite the variability in climate change projections, all climate change scenarios examined result in similar impacts on PNW water resources.

**Climate change:**

- Large warming
- Wetter winters, wetter/drier summers

**Changes in the water cycle:**

- ≠ winter runoff & streamflow
- Ø snowpack accumulation, spring (peak), summer, fall streamflows – even with winter precipitation
- earlier peak flows, longer time between snowmelt & fall rains
The Main Impact: Less Snow

Snoqualmie Pass 3022 ft

- 3000 ft (Present)
- 4100 ft (Future)
### April 1 Snowpack Projections

<table>
<thead>
<tr>
<th>Historic (1950-99)</th>
<th>2050s</th>
<th>2090s</th>
</tr>
</thead>
</table>

![Map showing snowpack projections for different time periods](image_url)

Provided by Andy Wood and Dennis Lettenmaier, UW Civil Engineering

*Accelerated Climate Prediction Initiative*, a UW-SIO-PNNL collaboration
Changes in the Water Cycle

Naturalized Columbia River flow - the Dalles, OR.

**Less snow, earlier melt:** less water in summer
- irrigation
- urban uses
- fisheries protection
- energy production

**Warmer temperatures:** more water in winter
- more hydropower production
- flooding
Varying sensitivities:

- snow-melt basins, $T_{winter} \gg 0^\circ C$
- snow-melt basins, $T_{winter} > 0^\circ C$
- transient snow basins, $T_{winter} \leq 0^\circ C$

PNW water systems:

- relatively little reservoir storage
- strong reliance on mountain snowpack
- sensitive to changes in seasonal streamflow patterns

Implications for PNW water resources:

- $\neq$ frequency of summer low-flow events
- $\neq$ competition among water users
Climate Change Impacts on Portland, Oregon
Palmer & Hahn, in prep.

- More winter streamflow
- Less spring/summer streamflow
- Increased demands

2040s WATER NEEDS IN PORTLAND (OR):
Regional growth: +40 mgd
Climate change: +20 mgd
Climate change impacts = 50% of growth impacts!!

Average Monthly Bull Run Inflows 1950-1999

- Current Climate
- PCM3 2040
- ECHAM4 2040
- HadCM2 2040
- HadCM3 2040

2040s WATER NEEDS IN PORTLAND (OR):
Regional growth: +40 mgd
Climate change: +20 mgd
Climate change impacts = 50% of growth impacts!!
Timing of significant changes:

~20 years: hydrologic changes in transient watersheds
[Cascade mountains and southern interior of the Columbia River basin (e.g., Snake River)]

40-50 years: hydrologic changes in snow-melt dominated systems
[northern headwaters of the Columbia River]

30-50 years: to change water resources systems

⇒ PNW policy makers and water management agencies should start planning for potential climate change now
Building Bridges Between Scientific Research Results and Policy Decisions

- **Models** $\rightarrow$ increasing understanding of coupling between natural and social systems aids in managing complexity
- **Scenarios** $\rightarrow$ perception of alternative pathways
- **Risk assessments** $\rightarrow$ formulating bottom lines
- **Options** $\rightarrow$ expand via identification and evaluation
- **Decision support tools** $\rightarrow$ better management
Recognizing the Mis-match: Different Tools, Different Objectives

- Climate Impact Assessments
- Coupled Models (climate + hydrologic + water mgmt)
- Innovation

- Formal Planning Exercises
- Limited Resources (financial & technical)
- Institutional Resistance to Change, Risk Aversion
Climate change information must be appropriately tailored to the existing framework for planning & decision making.
Characterizing existing planning frameworks

Decision calendars:

• When/how are decisions made?
  – Specific (in-house) water resources models/tools
  – Historical streamflow record
  – Specific locations for specific time periods
• Where is climate information relevant to decisions?

Example: Columbia basin operating periods

1. Fixed period (Aug-Dec)
   Assume the worst about spring inflow

2. Variable period (Jan-Jul)
   Use snowpack measurements to estimate spring inflow
Planning for climate change: Scenarios of future streamflow

Remove hydrologic model bias to produce climate change streamflow scenarios that can be substituted for the historical streamflow time series used in water resources planning.

Web-based scenario tool provides free access to data

Partners:
Northwest Power Planning Council
Idaho Dept of Water Resources

www.ce.washington.edu/~hamleaf/climate_change_streamflows/CR_cc.htm
Effectively bridging the gap between science and policy requires:

- Making the science *useful* to and *useable* by decision makers
- Sustained interaction between scientists and stakeholders
- Providing tools to help empty those inboxes

**Summary**

Climate change information for water resources planning:

- Outreach experiences highlighted the need to inject climate change information into *existing* planning activities
- Climate change streamflow scenarios (produced by perturbing the observed historic streamflow record) can be directly used in existing critical period planning processes
- These scenarios provide a simple, low cost method for regional agencies to assess vulnerability to climate change
“In areas like climate change, scientific exploration and practical application must occur simultaneously. They tend to influence and become entangled with each other.”

Kates et al. 2001
Resources

• Climate Impacts Group, University of Washington: www.cses.washington.edu
• Other RISA projects: www.ogp.noaa.gov/risa
• Jacobs, K. ND. Connecting Science, Policy, and Decision-making: A handbook for researchers and science agencies. A report of the University Corporation for Atmospheric Research (NCAR) produced by the NOAA Office of Global Programs.
How different might future PNW climate be?

20th century climate
Climate change in the PNW: 2040s

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<thead>
<tr>
<th></th>
<th>Temperature</th>
<th>Precipitation</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>summer</td>
<td>winter</td>
</tr>
<tr>
<td>low</td>
<td>+1.5°C</td>
<td>+0.9°C</td>
</tr>
<tr>
<td>mean</td>
<td>+2.1°C</td>
<td>+2.0°C</td>
</tr>
<tr>
<td>high</td>
<td>+2.8°C</td>
<td>+3.0°C</td>
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**Warmer, wetter winters.**

**Warmer summers.**

Estimated climate change from 20th century to the 2040s using 8 climate model scenarios ("summer"=April-September, "winter" = October-March).
Changes in Mean Temperature & Precipitation from GCMs

Hydrology Models

Reservoir / Operations Models

Institutional Analysis
Understanding the Institutional Context of Decisions

Mapping institutional frameworks

- Identify players
- Characterize laws, treaties, rules and constraints
- Determine interactions
- Analyze individual institutions

Methods: interviews, institutional analysis

Pulwarty & Redmond 1997
Research Approach

- **Retrospective** - establish past impacts of climate and societal responses
- **Interdisciplinary & integrated** - whole greater than the sum of parts
- **Contextual** - climate one of many factors influencing natural resources
1. A well-coordinated outreach effort is required, to:

- introduce stakeholders to the potential role of climate change information in water resources management
- facilitate information transfer from the research context to practical water management applications
- understand current approaches to planning
**Planning for climate change**

**1995:**
Few managers
- Saw a role for climate information in planning & decision making
- Recognized predictability of climate (variability or change)
- Possessed a contextual framework for applying climate change information

**1997:**
- First regional-scale examination of climate change impacts on PNW
- Most stakeholders unfamiliar with potential impacts of climate change & unprepared to use this type of information
- Spatial scale of interest << scale of analysis

**1997-2001:**
- Increasingly focused climate change research
- Intensive region-wide outreach
- Shift in attitudes: widespread official recognition of regional water resources systems’ lack of capacity to meet present & anticipated future demands even without climate change!
- Out in front: Portland & Seattle
Stakeholders requested:
- Climate change information for use in existing planning models
- Case studies of incorporating climate change projections into basin planning

Requirements of climate change information:
- more detailed, small scale information (catchment, watershed)
- must be “easy to apply to the problem at hand”