Improving the Decision-Relevance of Climate Science for Adaptation Planning

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Overview

• The Big Picture
• State of climate science for California
  – Lessons from the 4th Assessment
• From climate assessment to climate services
  – Critical need to evaluate fitness of climate data products
• Work on developing ”decision-relevant” climate metrics
• Promising next steps for climate services
U.S. 2017 Billion-Dollar Weather and Climate Disasters

NOAA counted 16 weather and climate disasters in 2017 that each exceeded $1 billion in losses, including the western wildfires that it combined into a single, $18 billion event.

- Montana, the Dakotas: Drought, Spring-Fall
- Midwest: Severe weather, June 27-29
- Minnesota, Upper Midwest: Hailstorm, severe weather, June 9-11
- Midwest: Tornado outbreak, March 6-8
- Midwest-Southeast: Tornado outbreak, Feb. 8-March 1
- Missouri-Arkansas: Flooding, severe weather, April 25-May 7
- Southeast: Freezing conditions, March 14-16
- South/Southern Plains: Severe weather, March 26-28
- South: Tornado outbreak, storms, Jan. 20-22
- Hurricane Harvey: August 25-31
- South: Hurricane outbreak, storms, Jan. 20-22
- Hurricane Maria: Sept. 19-21
- California, Western States: Wildfires, Summer-Fall
- California: Flooding, Feb. 8-22

SOURCE: NOAA

PAUL HORN / InsideClimate News
Global Mean Temperature Trend

Global Land and Ocean Temperature Temperature Anomalies, January-December

Average August Temperature in LA

Sun, Walton, and Hall 2015, UCLA Center for Climate Change Solutions
Climate change in California

Assessment Reports Provide a Synthesis of What is Known

Global

National

State

Regional
CA 4th Climate Assessment

- More than 50 reports total
- 9 regional reports
- Hundreds of authors and stakeholder reviewers
1. Our global success (or not) in cutting carbon pollution will make a significant difference for CA climate impacts after 2050.
2. While everyone will seriously affected by climate impacts, vulnerable populations/communities will be hit harder and will have a tougher time recovering.


## Table 1: Factors Contributing to Social Vulnerability to Natural Hazards

<table>
<thead>
<tr>
<th>Category</th>
<th>Vulnerability Factor(s)/Vulnerable Population</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Socio-economic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-income</td>
<td></td>
<td>Bolin and Bolin 1986; Fothergill and Peek, 2004; Blanchard-Boehm 1997; Collins and Bolin 2009; Hajat et al. 2003</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td>Hajat et al. 2003</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elderly</td>
<td></td>
<td>Hajat et al. 2003</td>
</tr>
<tr>
<td>Children</td>
<td></td>
<td>Hajat et al. 2003</td>
</tr>
<tr>
<td><strong>Housing conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home renters</td>
<td></td>
<td>Collins and Bolin 2009</td>
</tr>
<tr>
<td>Flammable roof, vegetation within 10 meters of home</td>
<td></td>
<td>Collins 2005 citing Foote 1994; Howard et al. 1973</td>
</tr>
<tr>
<td><strong>Isolation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language ability/linguistic isolation</td>
<td></td>
<td>Wang and Yasui 2008</td>
</tr>
<tr>
<td>Isolation from public agencies or fear of interacting with public agencies</td>
<td></td>
<td>Wang and Yasui 2008</td>
</tr>
<tr>
<td>Geographic isolation</td>
<td></td>
<td>Moser and Ekstrom 2010</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No health insurance</td>
<td></td>
<td>Bovbjerg and Hadley 2007</td>
</tr>
<tr>
<td>No vehicle</td>
<td></td>
<td>Brodie et al. 2006</td>
</tr>
<tr>
<td>Disabled (or family member disabled)</td>
<td></td>
<td>Hajat et al. 2003; Brodie et al. 2006</td>
</tr>
<tr>
<td>Institutionalized populations</td>
<td></td>
<td>Moser and Ekstrom 2010; Caruson and MacManus 2008</td>
</tr>
</tbody>
</table>

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**Figure 4: Projected 1.0 m Rise in Sea Levels and Social Vulnerability**

Pacific Institute
3. Land use decisions will be critical to increasing (or decreasing) our ability to adapt to climate change and to build more resilient communities.
Sea Level Rise

Heat Islands

Agriculture and Working Lands

Wildfire Risk
Global Emissions of Greenhouse Gases are Rising

Total Annual Anthropogenic GHG Emissions by Groups of Gases 1970–2010

IPCC AR5 WG3 SPM
Carbon Dioxide is Main GHG Emitted by California Too

Emissions by GHG

- CO₂: 84%
- CH₄: 9%
- N₂O: 3%
- HGWP: 4%

2013 Total CA Emissions: 459.3 MMTCO₂e

Emissions by Sector

- Transportation: 37%
- Industrial: 23%
- Residential: 7%
- Commercial: 5%
- Agriculture: 8%
- Electricity Generation (Imports): 9%
- Electricity Generation (In State): 11%
- Not Specified: <1%

2013 Total CA Emissions: 459.3 MMTCO₂e

- California contributes 1% of total global emissions.
- Global emissions are growing at >2% per year.
- Globally, CO₂ accounts for 75% of GHG emissions.

CARB, 2015
Our Adaptation Challenge

Rest of World = Adding 2 California’s Per Year
From climate assessment to climate services
Models increasingly able to capture decision-relevant scales and phenomena
Implications of Exascale Computing

- terascale (2000s)
- petascale (today)
- exascale (2021)

- 2012 ~25km
- 2022 ~1km
US Department of Energy’s Launch of Exascale Era

Berkeley: 150-300 PetaFLOP/sec. (2020)

Argonne: 1+ ExaFLOP/sec. (2020)

Oak Ridge: 1+ ExaFLOP/sec. (2020)
Range of Uncertainties is Consequential

Agreement on sign of temperature-driven changes

Loss of Snowpack

Major uncertainties in precipitation magnitude, timing, and location
Information is Evolving Rapidly

Range of California Sea Level Rise Projections over Time

Ocean Protection Council, Rising Seas Report
Practitioner’s Dilemma

Which data to use?

Global Downscaled Data

Downscaled global CMIP3 GCM output are served [here]. This covers global land areas at a 1/2-degree (about 50 km) spatial resolution. A similar downscaled product using CMIP5 GCM runs is available [here].

Both the global and US-wide datasets are included in the Climate Wizard: [http://www.climatewizard.org]. Both CMIP3 and CMIP5 globally downscaled data and analysis can be obtained at the Climate Wizard Custom website: [http://climatewizardcustom.org].

Library of Downscaled Climate Projections

A data set of 112 downscaled climate projections, based on output from 16 GCMs and 3 different SRES emissions scenarios (A2, A1B, B1) has been made available for public downloading. The spatial domain is shown in the figure, covering the contiguous US plus portions of Canada and Mexico. The resolution is 1/8 degree (~140 km² per grid cell). Raw monthly data for any region as well as summary statistics may be specified. The data set is formally introduced in [AGU’s Eos 88(47), En Data Oasis. Streamflow was here, with documentation here]. Along with many other...

Precipitation: Decadal Averages Map

The following map displays the projected annual precipitation totals across the state at decadal averages. The projections show little change in total annual precipitation in California. Furthermore, among several models, precipitation projections do not show a consistent trend during the next century.

The Mediterranean seasonal precipitation pattern is expected to continue, with most precipitation falling during winter from North Pacific storms. One of the four climate models projects slightly wetter winters, and another projects slightly drier winters with a 10-20% decrease in total annual precipitation. However, even modest changes would have a significant impact because California ecosystems are conditioned to historical precipitation levels and water resources are nearly fully utilized.
We Need to Partition Uncertainty

Now

Future

Reducible

Irreducible

Reducible

Irreducible
Chain of Uncertainties

An Evolving Role for Assessment

- Questions
- Models
- Methodologies
  - Experiments
  - Observations

Fundamental Climate Research

- Flood Management
- Public Health
- Fire Risk Mitigation
- Infrastructure Planning
- Agriculture

Adaptation Decision Contexts
An Evolving Role for Assessment

- Questions
- Models
- Methodologies

Experiments
Observations

Assessment

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Fundamental Climate Research

Adaptation Decision Contexts
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Climate Services
- Distillation
- Tailoring
- Ongoing Guidance

Adaptation Decision Contexts
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An Evolving Role for Assessment

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- Experiments
- Observations

- Use-Informed Credibility Evaluation
- Climate Services

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Fundamental Climate Research

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Fundamental Climate Research

Climate Science Applications

Adaptation Decision Contexts
Summary

We are committed to significant warming, but mitigation needed to avoid most severe outcomes.

Changing environmental conditions pose new risks for cities, infrastructure, and working lands.

There is a growing need for climate services to inform adaptation efforts. Stakeholder feedback can play a critical role in guiding both fundamental science and design of services.
Climate Change
Adaptation and Resilience in California

Kate Gordon
Director of the Governor’s Office of Planning and Research and Senior Advisor to the Governor on Climate
OPR Mission & Functions

Mission: We serve the Governor and the Cabinet as staff for long-range planning and research, and constitute the comprehensive state planning agency.
Overview

1. What is the current state of climate adaptation and resilience in California?
2. What are some examples of adaptation and resilience in other states?
3. How does climate change relate to other state priorities?
Current State of Climate Adaptation and Resilience in California
California’s Extreme Impacts
California’s Fourth Climate Change Assessment

<table>
<thead>
<tr>
<th>CLIMATE IMPACT</th>
<th>DIRECTION</th>
<th>SCIENTIFIC CONFIDENCE FOR FUTURE CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMPERATURE</td>
<td>WARMING</td>
<td>Very High</td>
</tr>
<tr>
<td>SEA LEVELS</td>
<td>RISING</td>
<td>Very High</td>
</tr>
<tr>
<td>SNOWPACK</td>
<td>DECLINING</td>
<td>Very High</td>
</tr>
<tr>
<td>HEAVY PRECIPITATION EVENTS</td>
<td>INCREASING</td>
<td>Medium-High</td>
</tr>
<tr>
<td>DROUGHT</td>
<td>INCREASING</td>
<td>Medium-High</td>
</tr>
<tr>
<td>AREA BURNED BY WILDFIRE</td>
<td>INCREASING</td>
<td>Medium High</td>
</tr>
</tbody>
</table>
Statewide Climate Impacts

By 2100, the average annual maximum daily temperature is projected to increase by 5.6°–8.8°. Depending on greenhouse gas emissions reductions, the greatest increase is seen with business-as-usual emissions levels.

77% average area burned increase by 2100 if emissions continue to rise.

18% insurance costs increase by 2055 in highest risk areas.

By 2100, water supply from snowpack is projected to decline by two-thirds.

By 2050, heat waves in cities could cause 2-3 times more heat-related deaths. Vulnerable populations will experience the worst of these effects.
Adaptation Vision in California

• **All people and communities** respond to changing conditions in a manner that minimizes risks to public health, safety, economic disruption, and maximizes equity and protection of the most vulnerable

• **Natural systems** adjust and maintain functioning ecosystems

• **Infrastructure and built systems** withstand changing conditions, while continuing to provide essential services
Adaptation and Resilience in Other States
State Examples

- **Florida** – flood insurance market for hurricanes and regional climate collaboratives
- **Washington** – predictive models of ocean acidification’s impact on the shellfish economy
- **New Jersey and New York** – sea level rise and storm surge planning and preparedness
Related State Priorities
Climate and Planning

• General Plan Guidelines (GPG)
  • Develops long-term vision for future growth
  • Requires local governments to consider climate change in their safety element

• Land use and community planning are central to climate adaptation and resilience
Climate and Finance

- Commission on Catastrophic Wildfire Cost and Recovery
  - Examines wildfire liability, insurance, financing mechanisms, and community impacts
- Climate change is threatening the financial health of our markets
Climate and Transportation

- Transportation emissions are rising
- Reducing vehicle miles traveled (VMT) will be crucial to achieving our greenhouse gas reduction targets
Key Takeaways