ETAAC Advisory Committee
Local Implications of Climate Change

Susan Hackwood
California Council on Science and Technology

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About CCST

• Nonpartisan, not-for-profit corporation established in 1988 by state legislation

• Offers independent expert advice to state government and recommends solutions to S&T related policy issues -- teamed with the National Academies, modeled after NRC

• **Sustaining institutions:** University of California, California State University, California Community Colleges, Stanford University, University of Southern California, California Institute of Technology

• **Affiliate members:** Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory/California, Stanford Linear Accelerator Center, NASA Ames, Jet Propulsion Laboratory

• Work funded by state agencies, foundations, industry

• 14 Board members, 30 Council members, 122 Fellows, 12 Cal TAC

6 Nobel Laureates, 81 National Academies members, 12 National Medals of Science or Technology, 12 science and math teachers
CCST’s Energy Agenda

- Deliberation on CA’s energy future, joint meetings with NAE and NAS

- **Goals:**
  - Future of sustainable energy options at national & state level
  - Challenges and opportunities in production, distribution, and use of clean, reliable energy sources, including nuclear energy
  - Connect to federal initiatives
  - Create mechanism to inform state policymakers on new and emerging options

Opportune moment: widespread mandate for climate change has government looking for information on options
Social Science and Climate Change Strategies

1. We will need to prepare for the challenges of climate change – but what do we need to do and how prepared are we to change?

2. What are the costs of effective behavioral change campaigns using knowledge of successful efforts, e.g., changing behaviors related to smoking, seat belts, and recycling?

3. Once the public is convinced and prepared to change behavior, do we have the ability (technologically and structurally) to offer solutions?
Microclimate Change

Using the Immense Resources in CA
Asses the Impacts of Climate Change

100Km >10K
100 years >10 years

“Investment Timeframes”
Think globally,
Assess regionally,
Act locally

Assessing the impacts of climate change in California
California Climate Assessment

*Think globally, assess regionally, act locally*

- How Assessments have been influential
- The 2007 IPCC Global Climate Assessment
- Why California needs to do its own
- California’s first assessment: “Our Changing Climate”
- What improvements are needed?
- Who cares?
- Assess, then assist
- Ways to improve California’s assessments
- California has the technical and institutional resources
- Next steps
Policy Assessments

Expert reviews of the state of knowledge
California’s Climate Action Team

Climate change now a broad governmental concern

- Waste Management Board
- Air Resources Board
- Transportation & Housing

- Public Utilities Commission
- Energy Commission
- Resources Agency
- Department of Food & Agriculture
Even if concentrations of greenhouse gases and aerosols were held constant at 2000 levels, warming would continue for a millennium.
Human caused climate warming found on every continent. Drying of North American West a robust forecast (IPCC 2007).
Our Changing Climate
California Climate Change Center

Summary of Projected Global Warming Impact, 2070–2099
(as compared with 1961–1990)

- 90% loss in Sierra snowpack
- 22–30 inches of sea level rise
- 3–4 times as many heat wave days in major urban centers
- 4–6 times as many heat-related deaths in major urban centers
- 2.5 times more critically dry years
- 20% increase in energy demand

- 70–80% loss in Sierra snowpack
- 14–22 inches of sea level rise
- 2.5–4 times as many heat wave days in major urban centers
- 2–6 times as many heat-related deaths in major urban centers
- 75–85% increase in days conducive to ozone formation*
- 2–2.5 times more critically dry years
- 10% increase in electricity demand
- 30% decrease in forest yields (pine)
- 55% increase in the expected risk of large wildfires

* For high ozone locations in Los Angeles (Riverside) and the San Joaquin Valley (Visalia)
Sierra Nevada Snow-pack
Stores more water than the California water project
Diminished mountain snow pack will reduce water supplies.

Impacts residential, commercial, agriculture, and energy production.
Up to 2.5 times as many critically dry years

Whether, where, when to allocate, invest?

IPCC 2007
Up to 2.5 times as many critically dry years

Whether, where, when to allocate, invest?
Heat Waves
Up to four times as many heat wave days

Electricity Consumption
Excess Mortality
SMOG
California Wildfires
55% increase in risk, 2070-2099?

October 27, 2003
Rising Sea Level

6-30 inches, 2070-2099  *How much, how fast?*
One meter of sea level rise

Courtesy of San Francisco Bay Conservation and Development Commission
Infrastructure

When to invest?

Engineering lifetime?

Flood insurance rates?

Land use policies?

Sacramento Delta

MODIS-Aqua
Economic Impact Assessments

- Effective when forecast and investment timescales are similar
- Require high spatial specificity

Wells Fargo

San Francisco

Venture Capital & Angel Financing

Chicago Board of Trade

Wall Street
Decision Support
Agriculture and fisheries stakeholder outreach

California Agricultural Extension
Climate change, fresh water, food-biofuel competition

California Cooperative Fisheries Investigation
Warming Waters Identified as Cause of Marine Life Depletions off California
Local Environmental Decision Support

Complex information enabling adaptive management
Needs local specialization and interactive communication

Urban and natural environment and ecology
Ensure needed space observations

High-level political action in Washington

ERBS  Terra  Aqua  GRACE  QuikScat  Landsat 7  SAGE III  Jason

SeaWinds  ICESat  SeaWiFS  UARS  TOPEX/Poseidon  TSM-EP  EO-1  TRMM  ACRIMSAT  Landsat 7  Landsat 7
Deploy Regional Sensor-nets

Increase precision, enable adaptive management

Water and Climate Instruments in the Santa Margarita Ecological Reserve
Source, Dan Cayan, UCSD SIO
Enhance environmental informatics capacity
Connect research institutions, integrate research and civil sensor nets
Communicate with stakeholders
Climate Change Modeling

Link global models to local models and data

California, Federal agencies support cooperative programs

San Diego - 15 Tflops

NSF Next Machine - PetaFlops

Columbia - 60 Tflops

LLNL - >100 Tflops
California Climate Regions

- **California-specific climate drivers,**
  - natural and human
- **Regions not resolved by today’s global models**
- **Californians understand their own concerns**
High resolution climate modeling allows climate impacts to be predicted.
High resolution climate modeling allows climate impacts to be predicted.
Relationships between global and regional assessments

Global Level

Global Observations

National Level (State)

Regional Observ.

Regional Research

USER

Regional Modeling

Global Modeling

Global Research

Self-reinforcing climate/water/energy cycle

- **Energy Use**
  - More energy production -> More climate change
  - Increase temperatures
  - More water demand
  - Less water supply
  - Higher temperatures
  - Increase energy demand
  - Need more energy to get clean water

- **Water Stress**
  - Increased energy Production Requires more water

- **Climate Change**
  - More energy production -> More climate change
  - Increase temperatures
  - More water demand
  - Less water supply
Integrate climate and economic assessments

*The next frontier*

- Specific, quantitative collaborations
- Involve decision-makers, stakeholders,
- Engineer decisions, not systems
- Work with communicators
The (Messy) Causal Chain

Need info on all these links

Physical Climate Change (eg, temp) → Expanded Physical Consequences (eg, runoff)

Man-made ecoysystems (eg, forests, agriculture)

Policy Changes (eg, water allocation)

Other Human Activities

Biological Changes

Natural Ecosystems

Adaptation Investments

OVERAL IMPACTS
Potential Climate Change Impacts

Climate Changes (means, variances, extremes)

- **Temperature**
- **Precipitation**
- **Sea Level Rise**

**Individual well-being**

**Health**
- Weather-related mortality
- Infectious diseases
- Air-quality respiratory illnesses

**Agriculture**
- Crop yields
- Irrigation demands
- Pest outbreaks

**Forests**
- Change in forest composition
- Shift geographic range of forests
- Forest health and productivity
- Pest outbreaks

**Water Resources**
- Changes in water supply
- Water quality
- Increased competition for water

**Coastal Areas**
- Erosion of beaches
- Inundation of coastal lands
- Costs to protect coastal communities

**Species & Natural Areas**
- Shift in ecological zones
- Loss of habitat and species

Adapted from EPA
Different paths to sectoral impacts

Health
- Weather-related mortality
- Infectious diseases
- Air-quality respiratory illnesses

Need information on diseases, vectors, Weather extremes and susceptibilities.
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Forests
- Change in forest composition
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Need knowledge of productivity changes, Disease and harvesting changes.
Different paths to sectoral impacts

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**Water Resources**
Changes in water supply
Water quality
Increased competition for water

How will water supply change? Allocation Policies (eg ag vs. urban)? Demand and Increased prices?
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A somewhat non-Californian example
Some random acre in the Central Valley

Prior to climate change
A somewhat non-Californian example
Some random acre in the Central Valley

Simple results of productivity analysis
A somewhat non-Californian example
Some random acre in the Central Valley

Loss from productivity analysis

Simple results of productivity analysis
A somewhat non-Californian example

Some random acre in the Central Valley

Result with crop change
A somewhat non-Californian example
Some random acre in the Central Valley

Loss with crop change
For example….

Offsetting
- crops move to different parts of CA
- crops move to different micro-climates (grapes)
- Varieties change
- Crops change
- UCDavis fixes problem
- Prices increase

Reinforcing
- Water moved to urban users
- Pests increase
- Risk increases
- Change unobserved
Assess, then assist

Earth observations, predictive models, and impact assessments are foundations of decision support systems and services.
“What will happen to me?”
*The most important question in environmental science*
No other state has California’s capability
• Commit to ongoing Climate Change Impact Assessments
  – Independent governance and funding, defined schedule
  – Build on present success

• Act to strengthen California’s technical capacity
  – Start strategic planning now
    • Information systems, sensor-nets, space observations, computations, economics
    • Strategy to connect existing programs and assets
  – Integrate institutional contributions
    • Draw upon universities, laboratories, NGO’s, and industry
  – Work with federal government
    • Advocacy with Congress and administration
    • Programmatic collaborations with federal agencies

• Define management responsibility and funding authority
  – Within State government
  – Governance of institutional network(s)