California's Climate Change Assessment Program

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Topics

- Some personal reflections on the history of the California Assessments
- What has been distinctive about the California Assessments
- The importance of downscaling
- Local extreme events
- The issues that arise with water sector impacts

Some personal reflections

- Most economists who have worked on the economics of climate change have focused on *mitigation* – how to devise efficient policies to control greenhouse gas (GHG) emissions, and how the cost of doing this will affect the economy and economic growth.
- I came into climate change from a different angle – *impacts*.
- As an environmental and resource economist, I had focused on *non-market valuation* and also the economics of water, especially in the US West.
- I was interested, therefore, in measuring the value of the damage that would be caused by climate change.
- Moreover, a major pathway by which climate change will affect California is through the impacts on our water system.
- For me, these were the points of entry into the economics of climate change. Perhaps this is why Guido Franco recruited me in 2002.

Actually, there have been 4.5 prior climate change assessments by California before the present one.

- The very first climate change assessment was farmed out to EPRI in 2000-2001, and appeared in 2002.
- Meanwhile the California Energy Commission (CEC) had decided to bring future assessments, the first one under the new arrangement starting in 2003.
- But, a subset of the researchers involved in it, had collaborated with Chris Fields and Katharine Hayhoe in an effort sponsored by the Union of Concerned Scientists, which led to the publication of a paper on the impacts of climate change in California in PNAS in August 2004.

- The assessment that started in 2003 was supposed to complete its work and publish the results by 2007.
- However, it was overtaken by events when Governor Schwarzenegger took office. In the Spring of 2005 he decreed that the new assessment of the impacts of climate change on California be completed by December.
  - He made the judgment that the release of the assessment coincide with the release of his administration's climate mitigation strategy for California.
  - This became the First California Climate Change Assessment (2006).
- Almost immediately, work began to update and extend the assessment.
  - The set of topics and researchers was widened.
  - This became the Second California Climate Change Assessment (2009).
- Then, work began to update and extend the assessment.
  - The set of topics and researchers was widened.
  - This became the Third California Climate Change Assessment (2012).
- Then, funding for the next assessment bogged down, and I left for ASU.

What is distinctive about the California assessments

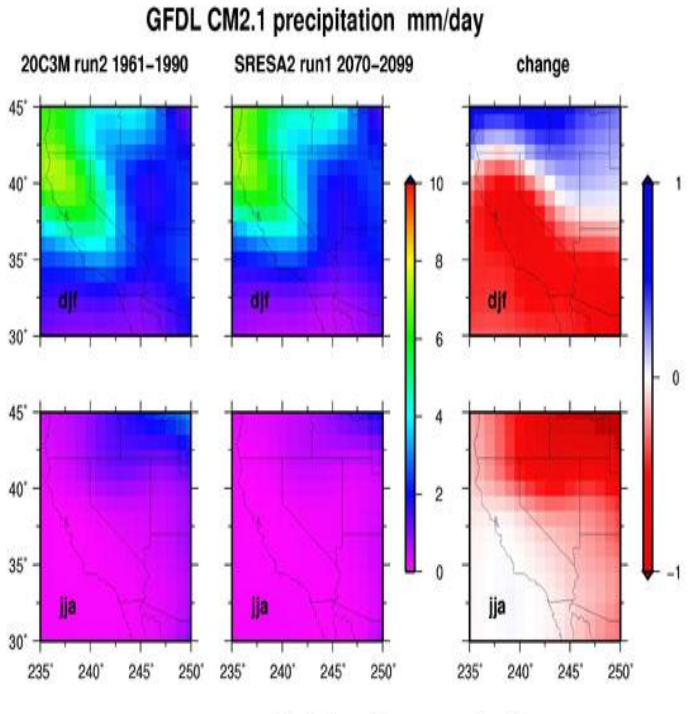
1. The establishment of a common set of climate change scenarios, derived from alternative GCMS and downscaled to relatively fine spatial scale.
2. The employment of multiple teams of researchers on a given topic, using different methodological approaches.
3. The commitment to an iterative approach: this assessment represents the best that we can say so far; but we plan to update it and expand it very shortly.
4. The commitment to a high scientific standard. For the program manager, a key metric of success was the publication of peer-reviewed journal articles based on research conducted.
5. Above all, the vision and drive of the program manager, Guido Franco, with support from CEC and CalEPA.

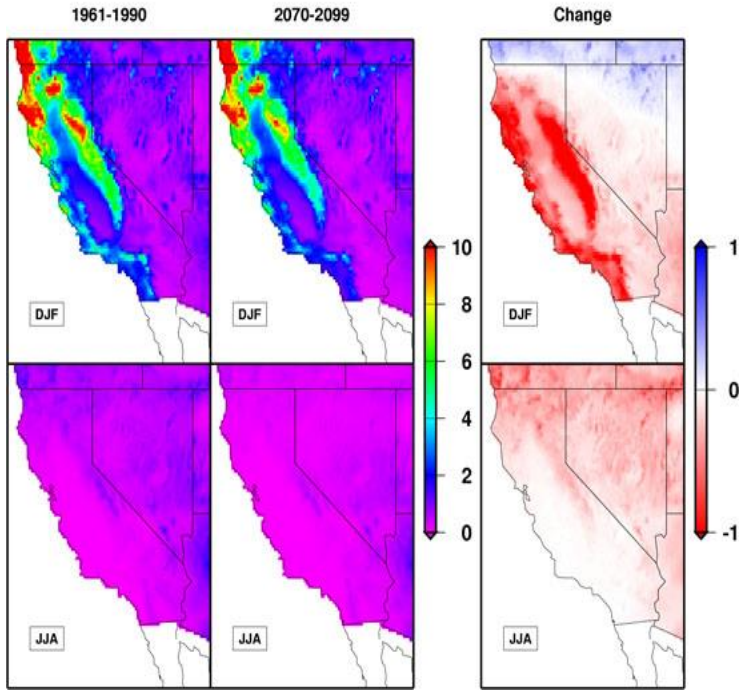
Turning points

- One turning point, already noted, occurred in 2005 with Governor Schwarzenegger: California committed to its own, state Climate Mitigation Policy (AB 32), the justification for which was the climate impacts we potentially face: impacts and mitigation are both on the table.
- In 2009, California adopts a Climate Adaptation Policy.
- Starting around 2010, county and local governments come on board; they solicit sub-regional reports for their county or their region (San Diego County, the Bay Area Counties, Los Angeles Region).
  - Some fret when a particular climate change scenario adopted by the California assessment diverges from the scenario their local government has adopted e.g., for planning future land use.

Downscaling

- Downscaling is undoubtedly difficult and not without controversy.
  - Different approaches can give very different results.
- It introduces additional elements of uncertainty and error into the projections.
- Yet it is essential for policymakers.
  - If mayors, water managers, fire chiefs etc.. cannot see their district/their territory in the projection of climate impacts, it becomes almost meaningless to them.





Global Climate Models compute Climate on a coarse grid

So, a "downscaling" procedure was used to provide temperature and precipitation over a finer mesh that is more commensurate with the California landscape

A hydrologic model is used to simulate stream flow, soil moisture and other hydrologic properties

Aggregation distorts conception of temperature change Hayhoe et al PNAS 2004

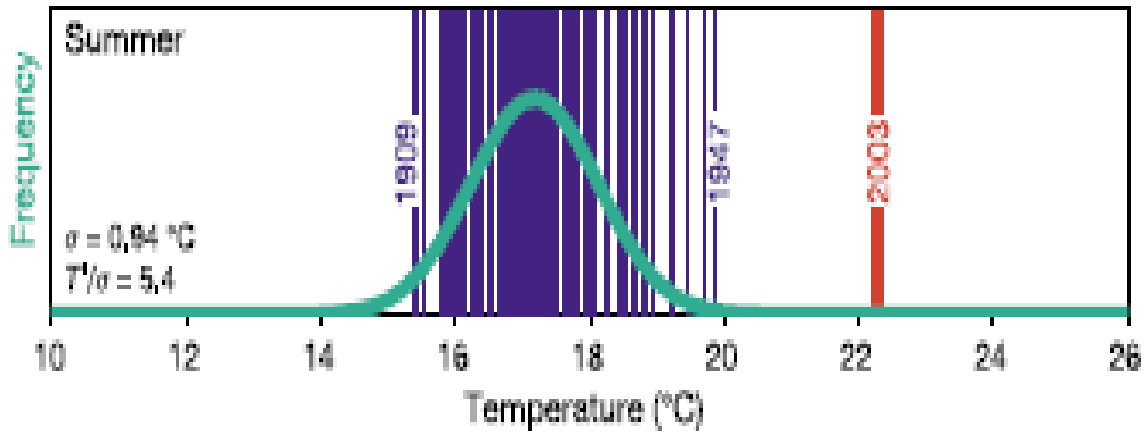
HOW TO CHARACTERIZE THE CHANGE IN TEMPERATURE, 2070-2099, USING HADCM3			
		EMISSION SCENARIO**	
		A1fi	B1
Change in global average annual temperature		4.1	2
Change in statewide average annual temperature in California*		5.8	3.3
Change in statewide average winter temperature in California*		4	2.3
Change in statewide average summer temperature in California*		8.3	4.6
Change in LA/Sacramento average summer temperature		~10	~5
*Change relative to 1990-1999. Units are ˚C			

Local extreme events

Note: I am considering local extreme events, *not* catastrophic climate events with continental-scale impacts (Lenton et al., 2008 tipping points).

Extreme heat/precipitation

Heat waves



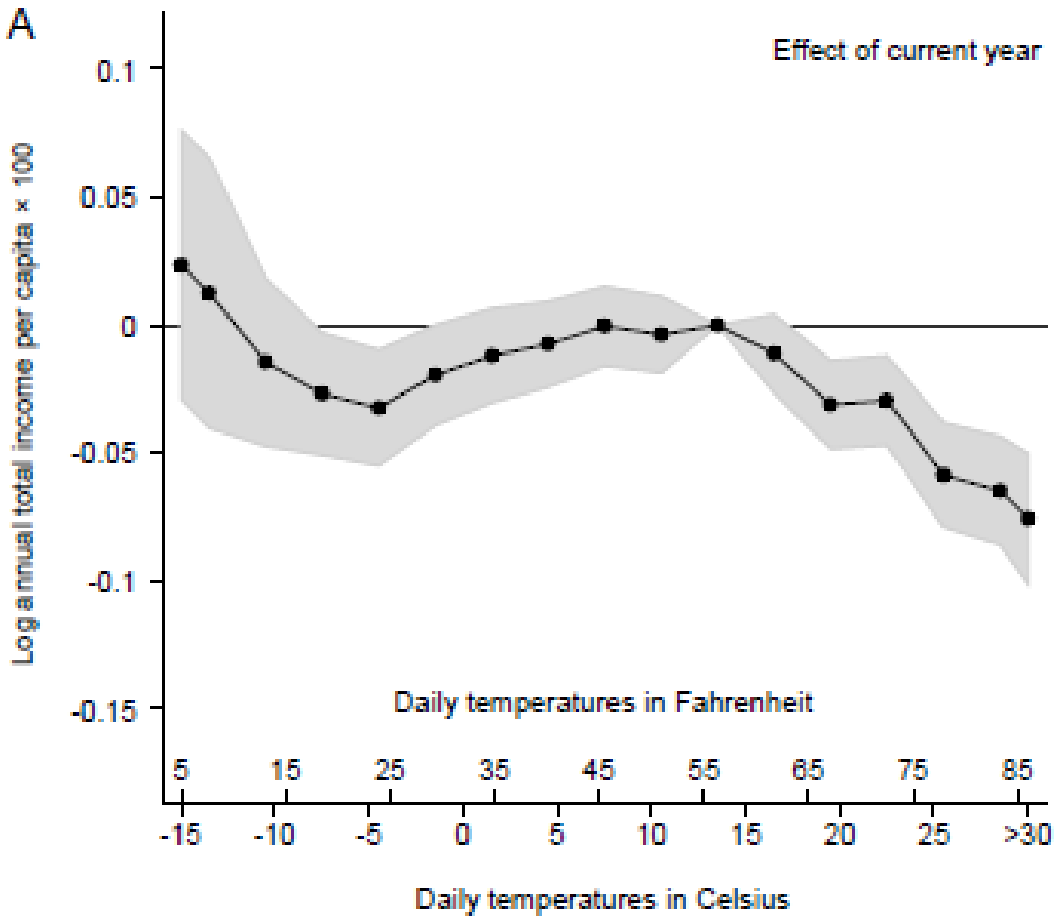
Importance of extreme temperature, especially near-term (Schlenker et al., 2006)

	Proportion of net economic loss to US agriculture due to change in:	
	Precipitation & degree days 8-32C	Degree days over 34C
2020-2049 both emission scenarios 2070-2099 B1 scenario	10-20%	80-90%
2070-2099 A1Fi scenario	40%	60%

DOES THE ENVIRONMENT STILL MATTER? DAILY TEMPERATURE AND INCOME IN THE UNITED STATES

Tatyana Deryugina
Solomon M. Hsiang

Working Paper 20750
http://www.nber.org/papers/w20750



- It seems likely that, for the next three or four decades at least, most of the economic effects of climate change will be associated with such local extreme events.
  - If they occur infrequently, the economic effects will be small.
  - If they occur frequently, those effects will be large.
- To model the incidence of local extreme events, one needs a fine spatial scale – with spatial down scaling – and one needs a finer temporal scale than the GCM outputs that have typically been used so far.
  - Daily rather than monthly.
  - In some cases (e.g., floods, energy demand and supply) hourly.

Water sector impacts – some distinctive features

- Institutionally, water is highly fragmented.
  - 5 retail electric utilities serve 80% of the California population.
  - ~175 retail water utilities serve 80% of the California population; also there are ~400 irrigation districts in California.
- Water supply is mediated through extensive (but highly fragmented) water supply infrastructure.
  - It is not enough to track rainfall, surface runoff, and streamflow; have to consider operating rules, local water storage, local distribution networks, etc..
- Timing is of the essence – water has to be in the right place at the right time (and of the right quality) in order to be useful.
- All of this is uncertain – and water managers are highly risk averse – in fact they are *downside* risk averse (Hanemann et al., 2016).

The key to adaptation for water

- It’s risk management, stupid!

- Above all, adaptation is about risk
  - Risk measurement
  - Risk assessment and prediction
  - Risk management
  - Risk pricing

- As it happens, water management agencies in California do a pretty poor job of risk management.
  - We don’t measure or model risk in a p*robabilistic* manner.
    - We use a historical hydrologic sequence even though this is a highly imperfect measure of risk, which almost certainly would understate the risk we face, even if there were no climate change.
  - We don’t explicitly or transparently allow for risk aversion.
  - We don’t manage for risk. We don’t frame allocation in terms of risk sharing. We still try to manage for certainty.
  - We don’t price risk.

Adaptation Prerequisites

- Monitoring and measurement
  - To establish a baseline of resource use etc.
  - To measure pace of change
- Adequate ability of property rights and other institutions to accommodate consequences of climate change
- Effective governance mechanism for collective action
  - To undertake public (as opposed to private) adaptations

- In all of these, California is lacking.