



The Potential Impact of Climate Change to California

Workshop on Climate Change Impacts and Integration Assessment

ENERGY MODELING FORUM

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Snowmass, CO

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Public Interest Energy Research (PIER) Program

California Energy Commission

Outline



- Background Information
- 2009 “Assessment”: general approach
- Selected Sectoral Results:
 - Water
 - Agriculture
 - Public Health
 - Timber production
 - Forest fires
 - Ecological Services
 - Energy
 - Costal impacts
- Final Remarks



Background Information

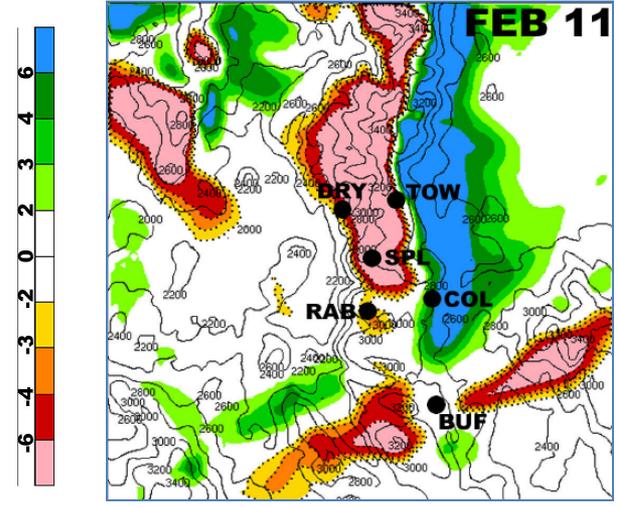
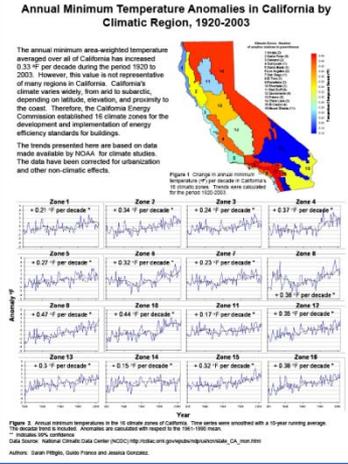
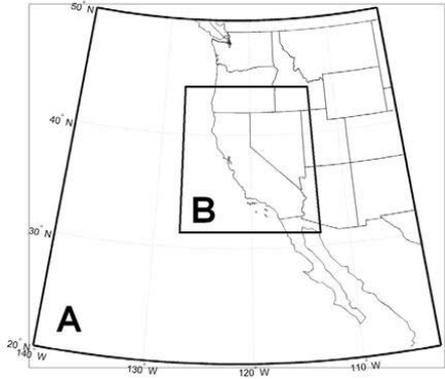


- The PIER Program has been supporting regional climate change science since 2001
- 2003 PIER climate change plan (5-yr) implemented via the CA Climate Change Center (~ 6 million/yr)
- June 1, 2005 Executive Order (EO) mandates the preparation of biennial science reports to the Governor and the Legislature. PIER leads the preparation of these reports (2006, 2009)
- Late in 2008 the Governor signed another EO mandating the preparation of adaptation plans. PIER to provide the scientific foundation
- PIER core research develops the tools and information needed for both reports (e.g. climate scenarios)

On-going studies that will inform future Biennial Assessments: examples



- Development of “probabilistic” climate scenarios for CA
- Effect of aerosols on orographic precipitation
- Black carbon and snow melting
- Development of a coastal evolution model for CA
- INFORM phase II



Source: Saleeby et al., 2009

Simulated total accumulated SWE difference (mm). Increased pollution aerosols reduced precipitation on the windward slope and increased precipitation on the leeward slope



2009 Assessment: general approach

Organization



Climate Action Team (CAT)

Scenario Subgroup of the CAT Team

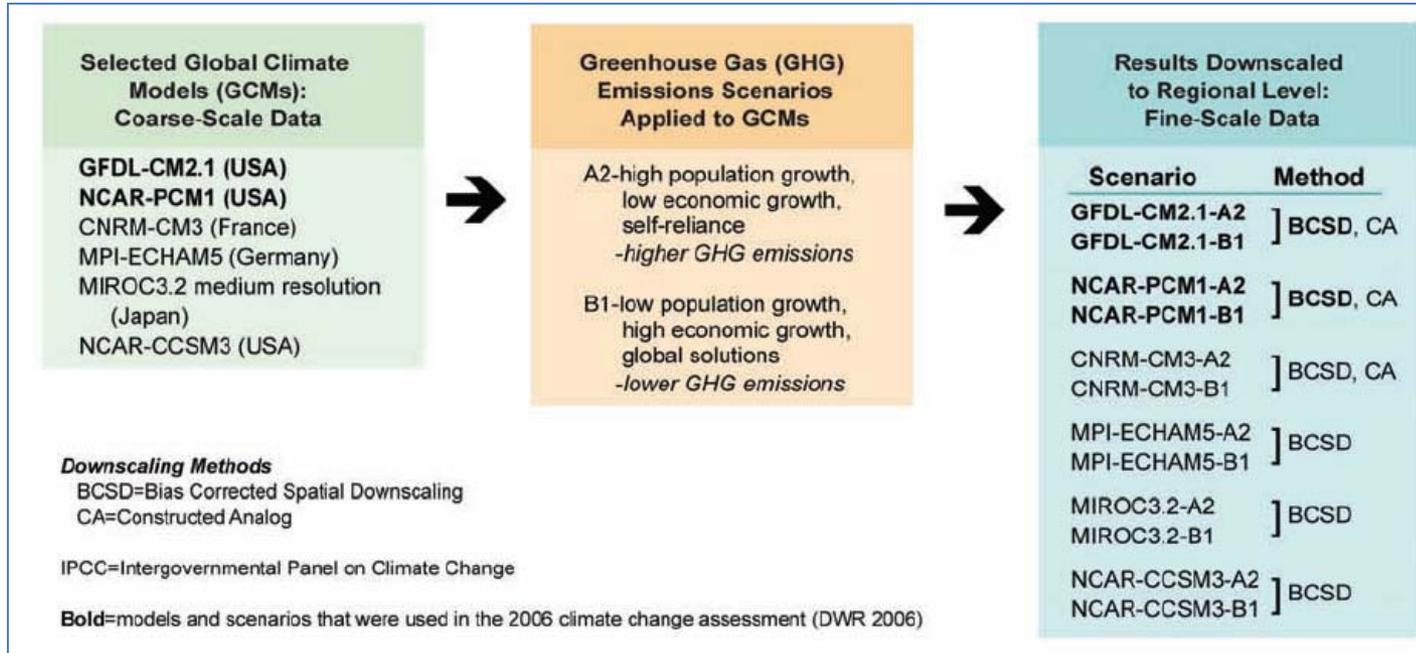
CalEPA, Resource Agency, ARB, Caltrans, DWR, OPC, Coastal Commission, BCDC, OEHHA, Dept. of Health, Cal Fire, CDFG, CDFA, CEC

Core Group

Dan Cayan (Co-Chair, Scripps), Michael Hanemann (UC Berkeley), Andrew Altevogt (CalEPA), Alan Sanstad (LBNL), Susanne Moser (Consultant/PIER), Bart Croes (ARB), D. Orrill (Resources), Guido Franco (Co-Chair - CEC)

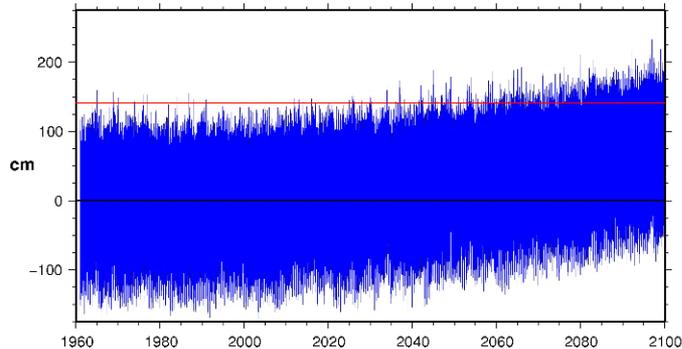
Research Team

Scripps/UC San Diego, UC Berkeley, UC Santa Barbara, Stanford, UC Merced, Santa Clara University, USGS, UC Davis, RAND, Pacific Institute, JPL/UCLA, TNC, Oregon State, UC Santa Cruz, LLNL, USFS, LBNL, OEHHA, DWR, ARB, CDF, CEC



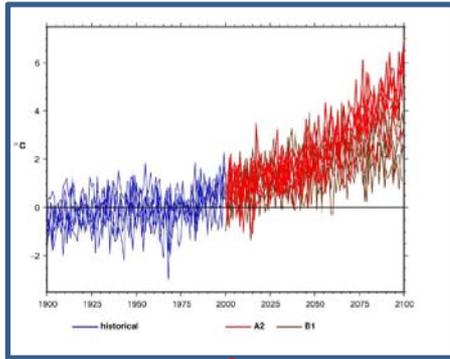
San Francisco hourly sea level
 GFDL CM2.1 20c3m and SRESA2
 effect of dams not included; uses Cheng tide

Source: DWR, 2009

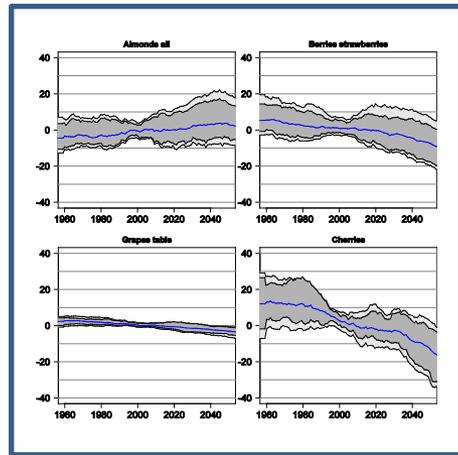


Source: Cayan et al., 2009

Climate and Sea Level Rise Scenarios

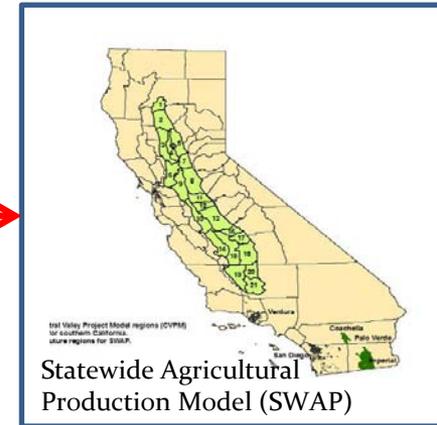


Physical Impacts



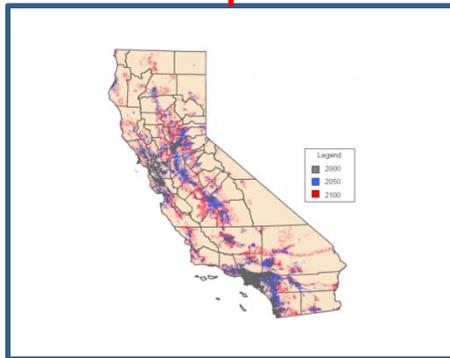
Lobell and Field (Stanford)

Economic Outcomes



Howitt et al. (UC Davis)

Sanstad et al., (LBNL, PPIC, LLN, CEC)



Demographic and Urban Projections





Selected Sectoral Studies

Water

- Three studies
 - WEAP model (SEI, UC Berkeley)
 - CALVIN model (UC Davis)
 - CalSim model (Dept. of Water Resources)
- CALVIN (“perfect” adaptation)
 - Economic costs relatively modest
 - Environmental constraints not always met
 - It does not take into account sea level rise
- CalSim (current rules to 2100)
 - The reliability of the SWP and CVP water supply systems is reduced
 - Reductions in exports of water from the Delta
 - Reductions of carryover storage would reduce the system’s flexibility during water shortages. In the Sacramento Valley, reduced surface water supplies are likely to be augmented by increased groundwater pumping.
 - Under climate change, in some years water levels in the main supply reservoirs (Shasta, Oroville, Folsom, and Trinity) could fall below the lowest release outlets making the system vulnerable to operational interruption.

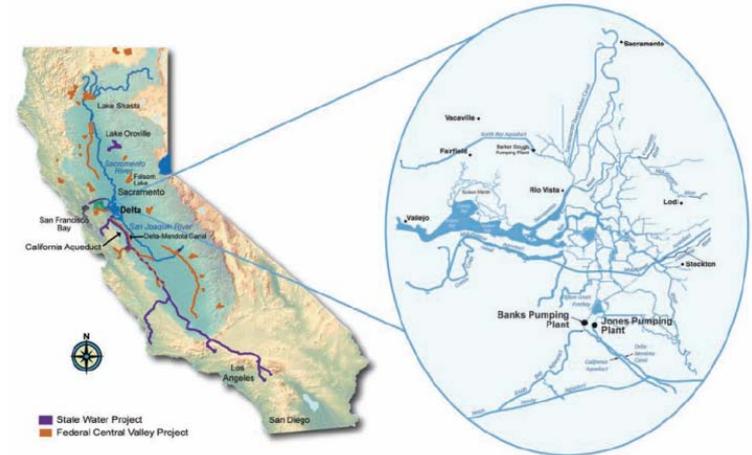
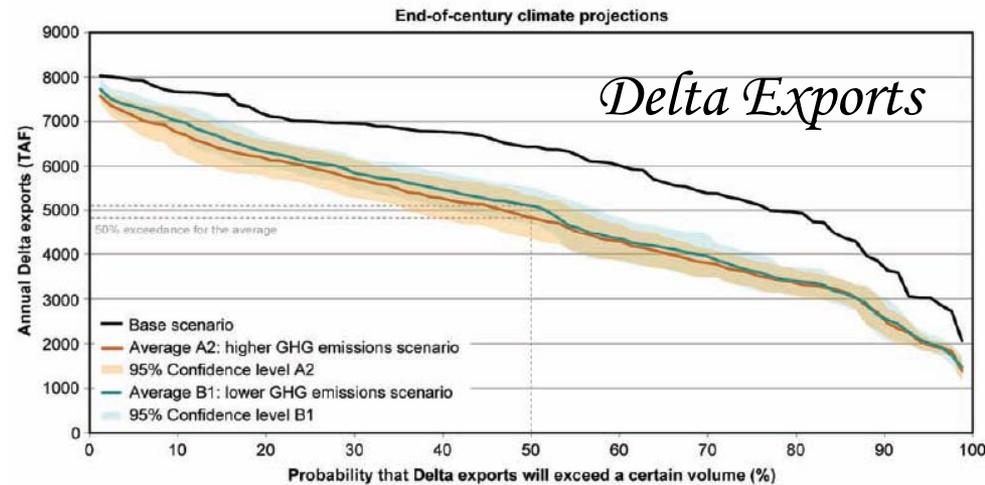


Figure 1. State Water Project and Central Valley Project in California (left). Sacramento-San Joaquin Delta (right).

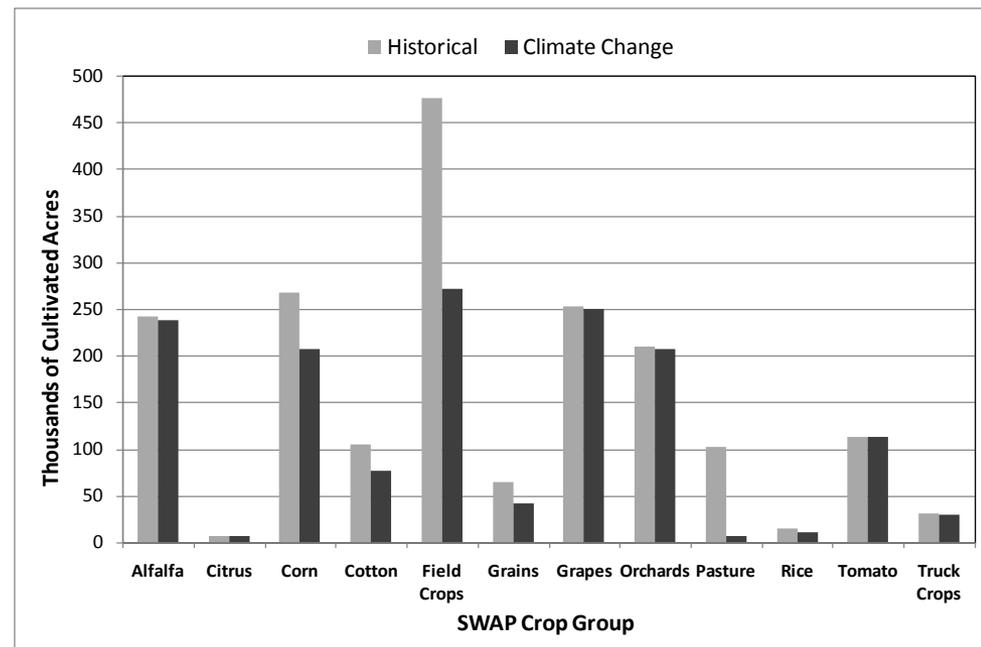


Agriculture



- Three approaches
 - SWAP model (U.C. Davis)
 - Econometric model (U.C. Santa Barbara)
 - Econometric model linked to a water model (U.C. Berkeley)
- SWAP
 - 26 agricultural regions
 - Adaptation and technical progress considered
 - Transfer of water to urban areas resulting in losses of acreage that range regionally from 28% percent to 17%
 - Farm revenue losses between 10.5% to 16.3% due to partial offsets from price and crop changes. Consumers pay more for food
 - Statewide losses of about \$3 billion/yr in ~ 2050 (dry scenario)

Total cultivated land per crop under climate scenarios in the San Joaquin Basin

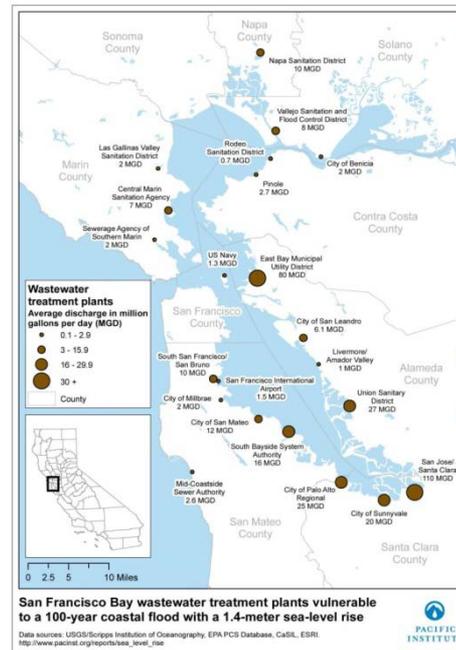
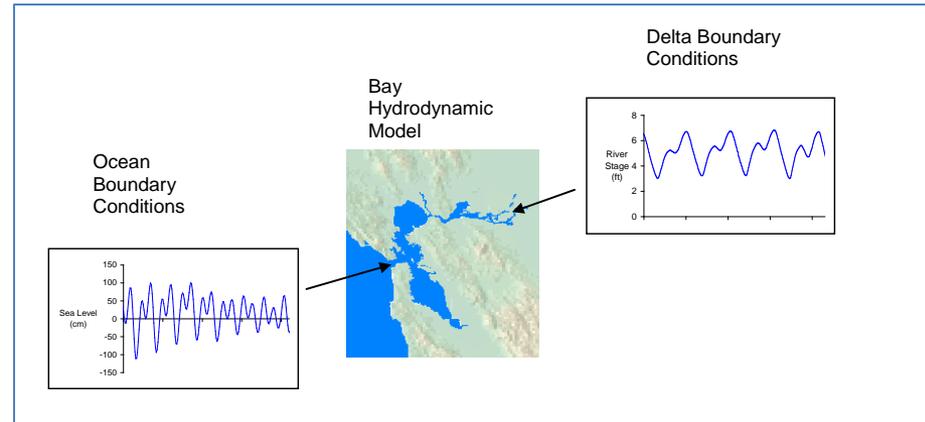


Source: Howitt et al., 2009

Costal Impacts



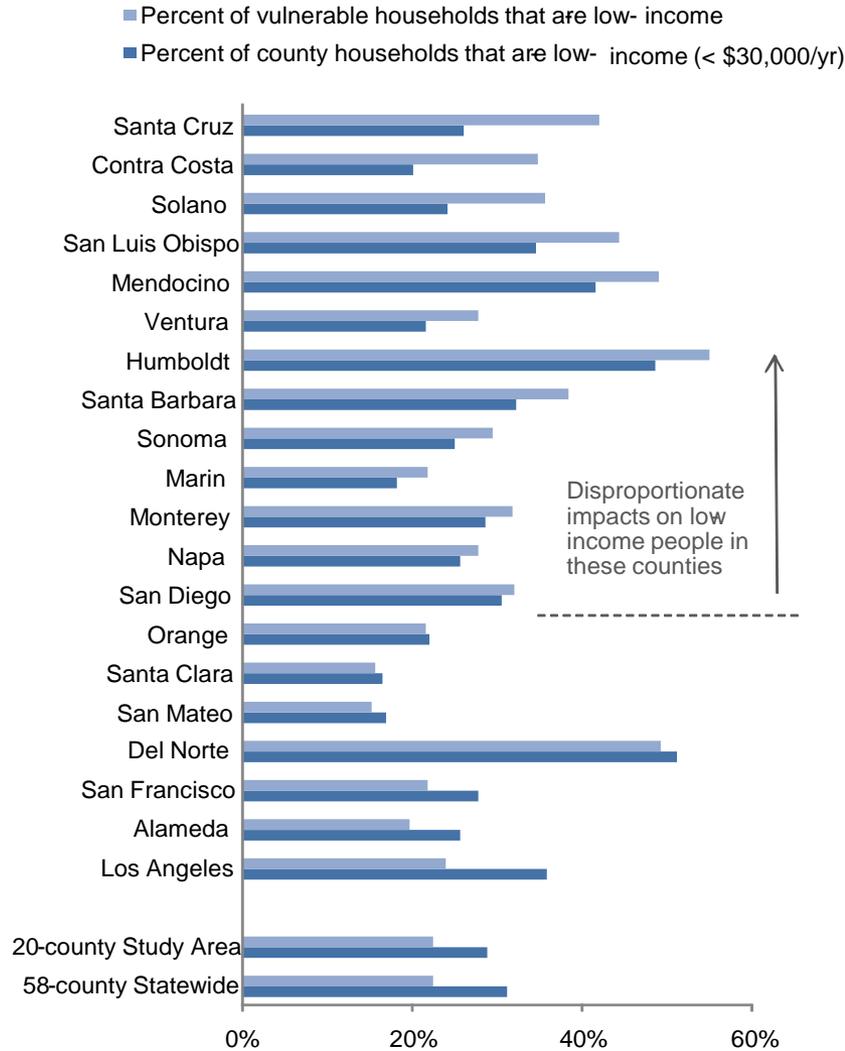
- Flooding maps and detailed GIS information about facilities (schools, power plants, hospitals, sewer systems, etc.) and people
- Cost of affected property about \$40 billion. Cost of armoring about \$13 billion and \$1.3 annual maintenance costs
- Armoring may not be practical in all situations



Coastal Impacts (cont.)



Percentages of low-income households among the population vulnerable to a 100-year flood with a 1.4 m sea-level rise compared with the county total



Final Remarks



- The 2009 Assessment included an analysis of potential impacts to the San Diego Region by 2050 conducted by local researchers but coordinated with the state-wide effort (e.g., same climate scenarios)
- The state-wide impacts studies can provide very useful information to local/regional assessments (e.g., Lake Tahoe area)
- The San Diego study is influencing other areas (e.g. SF area) to conduct their own impacts and adaptation studies. This is a great opportunity for PIER. We plan to work very closely or even partner with these groups (e.g., barriers to adaptation in urban areas)