Groundwater and Climate Change

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Climate Change Impacts Affecting Water:

- Higher temperatures
- Diminished snowpack
- Changes in extremes
- Changes in surface run off
- Rising sea levels

Figure 1. California Historical & Projected July Temperature Increase 1961-2099

Source: Dan Cayan et al. 2009.
Groundwater pumping will likely increase to compensate for reduced surface supplies.

Legislative Analysts Office (2010)
Climate change will exacerbate ongoing problems with groundwater including:

- **Overdraft**
- **Water quality degradation**
- **Surface streams going dry**

How can we manage our groundwater more sustainably?
Legal – Institutional Context for Groundwater Management

No State Permit System for Percolating Groundwater

Overlying Landowners

Correlative Rights Doctrine

Local Agencies are Primary Managers of Groundwater
Local Management

Agencies - Districts:
Fix & collect fees, regulate & monitor extraction & overdraft, establish recharge programs

City and County Ordinances:

* Baldwin v County of Tehama, (Ct. App 1994) *
May adopt ordinances to manage groundwater

Adjudicated Basins
Mandates to reduce overdraft
Federal
Endangered Species Act

State
1992 “AB 3030” GMPs (voluntary)
2009 (SBX7 6) Groundwater Monitoring
Reasonable Use Doctrine
Public Trust Doctrine
CA Water Code
Unsettled Groundwater Legal Issues

DEFINITION OF GROUNDWATER
Permit required - Surface waters & underground streams “flowing through known and definite channels”
No permit required - Percolating groundwater

What is the definition of a “known & definite channel”?

PUBLIC TRUST DOCTRINE
State has continuing duty to protect PT values where feasible
If applicable to streams that feed Mono Lake,

is PTD also applicable to groundwater that “feeds” a surface waterbody?
Climate Change, Groundwater and Drought
Climate Change and Water Supply Security:
Managing Groundwater to Increase Drought Resilience

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To reduce drought vulnerability, the primary strategy is to curtail water use after a drought occurs.
And Generate More Supply

Recycled water

Desalination

Caution!
Increase Water Supply During Dry Years

In Wet Years, Extra Water Can Lead to More Development

No Reserve and Hardening of Demand Strategies

Increased Vulnerability in Future Droughts
Continued loss of stored groundwater in the southern part of the CV. Since ~1960, groundwater has been depleted by almost 60 million acre-feet.

How can California communities *proactively* adapt to extreme droughts under climate change?

“..it never failed that during the dry years the people forgot about the rich years, and during the wet years they lost all memory of the dry years. *It was always that way.*”  
John Steinbeck

**Local Groundwater Drought Reserves**

*Serve as a buffer during an extreme drought*

*Less energy intensive*

*Reduce overdraft impacts*

*Support groundwater dependent ecosystems*
How does our approach differ from current groundwater banking?

Local sources of water - Stored locally
Used for local communities

Focus is on recovering groundwater levels to avoid further declines during a drought

Central Valley-Groundwater Storage Trends
10/04 - 10/09
J. S. Famiglietti et. al. (2010)
Our Approach

Case Studies

General and site-specific factors that affect drought resilience

Factors that motivate regions with long-term overdraft and conflicts over water to proactively address drought

Impacts and financial costs of a groundwater drought reserve versus a no-reserve option

Tools to assist regions in determining thresholds and other parameters for a local groundwater drought reserve
Physical Context
Sources of water
Condition of groundwater basin

Legal-Institutional Context
Water Rights, Governance

Socio-Political Context
Stakeholder conflicts
Agency/Board leadership
1996 Central California Coastal ESU of Coho Salmon
1997 Southern Oregon/Northern California Coast ESU of Coho Salmon
1999 California Coastal ESU of Chinook Salmon
2000 Northern California Steelhead ESU
2006: Convened Stakeholder Group
2007: Groundwater Management Plan

Adopted by:

Sonoma County Water Agency
City of Sonoma
Valley of the Moon Water District

Non-Regulatory and Collaborative Process

Sonoma Valley Groundwater Management Program
Central Coast Study Areas

- Soquel Creek Water District
- Santa Cruz Water Department
- Scotts Valley Water District
- Pajaro Valley Water Management Agency
Scotts Valley Water District

Groundwater from The Santa Margarita Groundwater Basin Is sole source of potable water for SVWD

Strategies to Reduce GW Production
Water Conservation
Recycled Water
Gray Water
Rebates

1975-2010 : Change in GW Production & Storage
The Purisima and Aromas Red Sands Aquifers provide all of SqCWDs water and are at risk for seawater intrusion.
Santa Cruz Water Department

Water Sources
Rivers, streams and reservoirs 66%
Groundwater 4%

Endangered Species Act
Need to reduce existing surface water diversions for endangered salmon and steelhead

Multiple Dry Water Years
Drought Reserve Project

Collaboration Between
Santa Cruz Water Department
and Soquel Creek Water District
Seawater Intrusion

~ 1,900 afa in Upper & Lower Aromas aquifers

1998-2011 - 12% increase
Total intruded area has increased
~ sevenfold fold since 1951
Largest increases correspond with periods of drought
Pajaro Valley Water Management Agency

Present Strategies to Reduce Overdraft

Recycled Water And Recharge Facilities

Stakeholder Conflicts Litigation

Coastal Distribution System
Calculating a Drought Reserve for Soquel Creek

Water Balance Model Soquel Creek
Source: Daniels (2011)
Figures from: SqCWD. 2004 & 2009

Soquel Creek Water Dist - Protective and Reserve vs Current Levels

Source: Data from Soquel Creek Water District. 2009.
Groundwater level metrics can be converted into acre-feet
Groundwater and Energy Use in California

Groundwater pumping accounts for more electricity use during summer months than pumping for the state’s three largest water conveyance systems – SWP, CVP and CRA - combined.
“…the people of the State have a primary interest in the correction and prevention of irreparable damage to, or impaired use of, the ground water basins of this State caused by critical conditions of overdraft, depletion, sea water intrusion or degraded water quality.”
California Constitution: Article X, Section 2

....the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented......

The right to water or to the use or flow of water .... shall be limited to such water as shall be reasonably required for the beneficial use to be served.....

Water Code- Section 275

The department and board shall take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water in this state.
Groundwater monitoring
Knowledge generation & dissemination
Regulatory interventions
Public participation
Institutional responsibility

A framework for measuring groundwater sustainability
Pandeya, et. al. 2011
Sustainable Groundwater Management

Sustainable thresholds for water level drawdown & water quality

Water quality and water level monitoring and assessment capable of determining if thresholds are being met

Governance structures with management mechanisms to prevent impacts before they occur & ensure that groundwater level and quality thresholds are met over the long term

Funding to support monitoring & governance/management

Oversight and enforcement in basins where ongoing management efforts are not protecting groundwater
http://droughtreserves.ucsc.edu/