Water In California and WRPM

ESM-121 Water Science and Management

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Assistant Professor
Atmospheric Rivers

Mediterranean Climate
- Dry Summers
- Wet Winters

Atmospheric Rivers hitting California, Feb. 8-9
75% of California's precipitation occurs north and east of Sacramento, and 75% of its water demand lies to the south.

Natural Flow Class

- (SM) Snowmelt
- (HSR) High-volume snowmelt and rain
- (LSR) Low-volume snowmelt and rain
- (RSG) Rain and seasonal groundwater
- (WS) Winter Storms
- (GW) Groundwater
- (PGR) Perennial groundwater and rain
- (FER) Flashy, ephemeral rain
- (HLP) High elevation & low precipitation
**Water Supplies**
- Mostly in North
- Mostly in Wet Season

**Water Demands**
- Mostly central and South
- Mostly in Dry Season

**Aqueducts, reservoirs, & groundwater use**

**Water Supply in Average Year (2010)**
- Environmental use: 39 MAF
- Agricultural water use: 33 MAF (~30% from GW)
- Urban water use (residential + industrial): 8 MAF
- Recycled water use: 0.60 MAF (7.5% = 0.6/8 MAF)

**Total beneficial water use**: 80 MAF/Yr

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**California Water Budget**

- Precipitation: ~ 200 MAF
- Evapotranspiration &/or Recharge: ~ 120 MAF
- Water available as runoff: ~ 80 MAF

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*Hanak et al. (2011). “Managing California’s Water. From Conflict to Reconciliation”*

*http://watershed.ucdavis.edu/research/waterpolicy.html*
BENEFICIAL WATER USE: 80 MAF

California Water Use

- Environment: 49%
- Agriculture: 41%
- Wild & Scenic Rivers: 31%
- Urban: 10%
- Instream Flows: 9%
- Required Delta Outflow: 7%
- Managed Wetlands: 2%
- Irrigated Agriculture: 41%

California Agriculture Facts (DWR Water Plan 2010)

- > 80,000 Farms => $45 Billion Industry (< 5% GIR)
- 26 Million Acres of Agricultural Lands
  - 13 Million Acres of Pasture and Rangeland
  - 9.5 Million Acres of Irrigated Cropland
  - 6.2 Million Acres Annuals
  - 3.3 Million Acres Orchards/Vineyards
- > 350 crops

California Water Facts

- Water Supply in Average Year (2010): 200 (precip. + import)
- Environmental use: 39
- Agricultural water use: 33 (~30% from GW)
- Urban water use (residential + industrial): 8.5
- Recycled water use: 0.65 (7% = 0.65/8.5 MAF)
- Total beneficial water use: 80.5
**Water Use by California Crops**

4-Year Ave. 2006-2009

- Alfalfa: 3.7 MAF (9%)
- Almonds & Pistachios: 5.9 MAF (18%)
- Orchard deciduous: 3.7 MAF (9%)
- Vineyard: 1.1 MAF (<3.5%)
- Rice: 3.4 MAF (10%)
- Corn: 1.3 MAF (3%)
- Other Field Crops: 1.2 MAF (3%)
- Citrus & Subtropical: 2.3 MAF (6%)
- Truck Crops: 1.1 MAF (3%)
- Grains: 0.9 MAF (2%)
- Cotton: 0.2 MAF (0.5%)
- Tomato Processing: 0.1 MAF (<0.1%)
- Onion & Garlic: 0.1 MAF (<0.1%)
- Cucurbits: 0.1 MAF (<0.1%)
- Dry Beans: 0.1 MAF (<0.1%)
- Sugarbeet: 0.1 MAF (<0.1%)
- Tomato Fresh: 0.1 MAF (<0.1%)
- Safflower: 0.1 MAF (<0.1%)
- Potatoes: 0.1 MAF (<0.1%)

Source: Unpublished data DWR

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**Water Supply Management**

- Water Supply
  - Environment
  - Urban
  - Agriculture

[Map showing water availability and use in California]
Spain: 70 gpd
France: 45 gpd
Germany: 35 gpd
Mexico: 71 gpd
South Africa: 49 gpd
China: 67 gpd
“Because water is not equitably distributed in time and place, in the right quantity with the adequate quality, a discipline called water resources planning and management is used to redistribute the resource in a way that satisfies the needs of water users, including the environment, today and in the future.”

Discipline: Systematic instruction, series of techniques and method.

**WRP&M**

**APPROACHES**

- **Top-Down**
  - Policies to be implemented
  - Master Plan
  - Implemented Policies

- **Bottom-Up**
  - Recommendation of Policies to be Implemented
  - Analysis and Consensus
  - Ideas Proposed "Scenarios"
**WATER RESOURCES CHALLENGES**

- Too much
  - Floods
- Too little
  - Droughts
  - Water Supply
- Too dirty
  - Water Quality
- Too much ecosystem lost
  - Competitive Water Uses
  - Environmental Stewardship

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**TOO MUCH: FLOODS**
“LAKE SACRAMENTO”
- Can It Happen Again?

K STREET IN THE '49 FLOOD


LOS ANGELES (1955)
**Competing Demands & Anthropogenic Impact on Water Resources**

- Power
- Domestic
- Agriculture
- Wildlife
- Recreation & Navigation
- Industry


**Too Little: Water Supply**

![Graph showing water use and supply](image)

DROUGHT

HIGH PRESSURE RIDGE AKA “RRR”: RIDICULOUS RESILIENT RIDGE

Rain that usually reaches California from the Pacific is being pushed to the north by a huge ridge of high-pressure air parked in the way.

High-pressure ridge
This vast zone of high pressure off the West Coast, nearly 4 miles high and 2,000 miles long, has not moved for the past 13 months.

Source: Weather.com
Pressure level: High

Rain
San Francisco
Vancouver

Driest Years (23-24, 76-77)

Current 1-year ago

http://www.water.ca.gov/waterconditions/droughtinfo.cfm

Wettest Year (82-83)

4-years ago

Normal

3-years ago

1-year ago

Driest Years (23-24, 76-77)
LAKE OROVILLE

LAKE OROVILLE
https://www.youtube.com/watch?v=3R6p-Y8-Imw

https://www.youtube.com/watch?v=IzgHjuHohXc
### State-Wide Agricultural Production Model, SWAP

*Howitt et al. 2014*

<table>
<thead>
<tr>
<th>Drought Impact</th>
<th>Loss Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Supply</strong></td>
<td></td>
</tr>
<tr>
<td>Surface water reduction</td>
<td>6.6 million ac-ft (~30%)</td>
</tr>
<tr>
<td>Groundwater pumping increase</td>
<td>5 million ac-ft</td>
</tr>
<tr>
<td><strong>Net water shortage</strong></td>
<td>1.6 million ac-ft</td>
</tr>
<tr>
<td><strong>Cropped lands</strong></td>
<td></td>
</tr>
<tr>
<td>Irrigated cropland fallowed (mostly S.J.V.)</td>
<td>430,000 ac (5% of total)</td>
</tr>
<tr>
<td><strong>Jobs</strong></td>
<td></td>
</tr>
<tr>
<td>Total job losses (seasonal &amp; part-time)</td>
<td>17,100</td>
</tr>
<tr>
<td><strong>State-wide costs</strong></td>
<td></td>
</tr>
<tr>
<td>Crop revenue loss</td>
<td>$810 million</td>
</tr>
<tr>
<td>Livestock and dairy revenue loss</td>
<td>$203 million</td>
</tr>
<tr>
<td>Additional pumping costs</td>
<td>$454 million</td>
</tr>
<tr>
<td><strong>Total direct losses</strong></td>
<td>$1.5 billion</td>
</tr>
<tr>
<td><strong>Total Economic Cost</strong></td>
<td>$2.2 billion</td>
</tr>
</tbody>
</table>


**Groundwater Challenges**

- State GW source
- Problems
  - Depletion
  - Seawater intrusion
  - Subsidence
- Management strategies?

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**Groundwater Depletion**

Color Ramp:
- 0 feet (ground surface)
- 400 feet below ground surface

http://gis.water.ca.gov/app/groundwater

**Seawater Intrusion**

- Illustration of seawater intrusion into groundwater levels
- Map showing historical trend of seawater intrusion in California

- Illustration of seawater intrusion due to excessive pumping
- Map showing extent of seawater intrusion

http://gis.water.ca.gov/app/groundwater
What’s going on here?
A dropping of the land surface as a result of ground water being pumped.
Cracks and fissures can appear in the land. Subsidence can be an irreversible process.

“Use the water that you need, but not a drop more”
“Usa el agua que necesites, pero ni una gota mas”

THANKS
samsandoval@ucdavis.edu
http://watermanagement.ucdavis.edu/cooperative-extension/
## Conversion Factors for Water

<table>
<thead>
<tr>
<th>Conversion Factor</th>
<th>Equivalent Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cubic foot</td>
<td>7.48 gallons</td>
</tr>
<tr>
<td>1 cubic foot per second (cfs)</td>
<td>450 gallons per minute (gpm)</td>
</tr>
<tr>
<td>1 cubic foot per second (cfs)</td>
<td>646,400 gallons per day</td>
</tr>
<tr>
<td>1 acre-foot</td>
<td>325,851 gallons</td>
</tr>
<tr>
<td>1 acre-foot per second (cfs)</td>
<td>1.98 acre-feet per day</td>
</tr>
<tr>
<td>1 cubic meter</td>
<td>811 acre-feet</td>
</tr>
<tr>
<td>1 cubic meter per second (cfs)</td>
<td>35.32 cfs</td>
</tr>
<tr>
<td>1 hectare/meter</td>
<td>8.1 AF (acre feet)</td>
</tr>
<tr>
<td>1 hectare</td>
<td>1,233 cubic meters</td>
</tr>
<tr>
<td>1 acre-foot covers an acre of land to a depth of one foot.</td>
<td></td>
</tr>
<tr>
<td>1 million cubic meters</td>
<td>811 acre-feet</td>
</tr>
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<tr>
<td>1 million gallons</td>
<td>1,120 acre-feet per year</td>
</tr>
<tr>
<td>1 million gallons per day (mgd)</td>
<td>$32.59 per acre-foot</td>
</tr>
<tr>
<td>10 cents per 1,000 gallons</td>
<td>$32.59 per acre-foot</td>
</tr>
</tbody>
</table>

* The average annual rainfall is calculated on a 30-year average.
  2005 was defined as an above normal water year.

** Environmental water includes designated wild and scenic flows, instream flows, Sacramento-San Joaquin Delta required outflow, managed wildlife refuge water, and the Environmental Water Account. Theoretically, the number would also include water for riparian habitats; however, it is not quantified at this time.