The California - Nevada Drought.

Update: 9 July 2015

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White House Subcommittee on Disaster Reduction
National Science and Technology Council
National Integrated Drought Information System Briefing
9 July 2015
Outline

How did we get here?

Current status

Unusual aspects of the current drought

What can we say about the upcoming winter?

The rise of El Nino ... Implications ???

Near term strategies (next several months into early winter)

Biological effects in rivers and ocean - relationship to drought

Discussion
Borrowing the phraseology of Steven Johnson,

During the last year .....
Percent of Normal Precipitation (%)  
10/1/2011 - 9/30/2012

Water Year 2011-12  
01 Oct 2011 Thru 30 Sep 2012

Generated 10/11/2012 at HPRCC using provisional data.
Water Year To Date
2014-15
01 Oct 2014 Thru 3 July 2015

Percent of Average Precipitation (%)
10/1/2014 - 7/3/2015

Generated 7/04/2015 at WRCC using provisional data.
NOAA Regional Climate Centers
Oct 1 - May 31  Water Year to Date 2014-2015  Oct 1 - May 31

Percent of Normal Precipitation (%)  
10/1/2014 – 5/31/2015

Departure from Normal Temperature (F)  
10/1/2014 – 5/31/2015

Precipitation Percent

Temperature Departure (F)
May 2015
Precipitation
Percent of Normal

01 May 2015 Thru 31 May 2015
Percent of Normal Precipitation (%)
6/1/2015 - 6/30/2015
The Missing Years:
Precipitation Deficits Over Four Winters 2011-12/14-15
Expressed in Units of Average Annual Precipitation.
Based on PRISM. Courtesy Paul Iniguez, NWS Phoenix.
California Reservoir Storage, Million Acre-Feet, 1977 and 2010-15

Note: One acre-foot is equal to 325,851 gallons, or the amount of water it takes to cover one acre to a depth of one foot.
Welcome

The Department of Water Resources (DWR) is responsible for managing and protecting California’s water. DWR works with other agencies to benefit the state’s people, and to protect, restore and enhance the natural and human environments.

Spotlight

Forum on Water Bond
Green Bridge
Lake Oroville
Feather River

2011 July 20

Enterprise Bridge
Lake Oroville
Feather River

2014 August 20
Bidwell Marina
Lake Oroville
Feather River
2011 July 20

Enterprise Bridge
Lake Oroville
Feather River
2014 August 19
Average Annual Precipitation (Inches), California
Period: 1961-1990
Population Centers Rely Heavily on Imported Water

Imported Water as a Percent of Use by Water Region
- 0-33%
- 33-66%
- Over 67%
- Net Exporters
What would a Drought Monitor map look like that incorporated this complexity???
California Water Action Plan

January 2014

[Logos of California Natural Resources Agency, CDFA (California Department of Food & Agriculture), and California Environmental Protection Agency (Cal/EPA)]

Figure 1: 2014 Highlights

January
- Governor Releases Water Action Plan
- Emergency Legislation Helps Drought-Stricken Communities
- Drought Forum Raises Awareness
- Adjusted Operations Save Water
- Integrated Projects Receive Grants

March
- Governor Orders Redoubling of Drought Efforts
- State addresses Fisheries Crisis
- State Publishes Groundwater Shortages Report

April
- Final State Budget Funds Action Plan and Drought Relief
- Delta Communities Receive Flood Emergency Response Funds

May
- Save Our Water Month
- State Coordinates Voluntary Actions in Key Watersheds
- Low Interest Loans for Water Recycling
- Emergency Funding for Drinking Water Systems

June
- Final State Budget Funds Action Plan and Drought Relief
- Delta Communities Receive Flood Emergency Response Funds
- State Prioritizes Groundwater Basins
- State Eases Path to Recycled Water Use

July
- State Consolidates Water Quality Programs
- State Adopts Emergency Conservation Regulation
- New Grant Program will Restore Wetlands and Reduce Carbon

August
- Grants Promote Water Desalination
- State Prioritizes Groundwater Basins
- State Eases Path to Recycled Water Use

September
- Water Year 2014 ends as California’s driest
- Landmark Groundwater Legislation Passes
- Families without Drinking Water Get Relief

October
- State Publishes California Water Plan Update
- Grants Award $3.6M in Greenhouse Gas Reduction Funds

November
- Voters Approve Water Bond
- Agency Coordination Promotes Efficiency on Delta Solutions
- State Publishes Report on Drought Impacts to Groundwater

December
- Grant Program Encourages Water-Energy Efficiency
- State Continues Collaboration with Tribes

Sierra Nevada Precipitation

Snow Season

Oct-Mar

1895-96 thru 2014-15

California Climate Tracker
Sierra Nevada Temperature
Water Year
Oct-Sep
1895-96 thru 2013-14
California Climate Tracker
Sierra Nevada Temperature

Oct-May

1895-96 thru 2014-15

California Climate Tracker
San Joaquin Precipitation: 5-Station Index, June 1, 2015

- CVT - Calaveras Big Trees
- HTH - Hetch Hetchy
- YSV - Yosemite HQ
- NFR - North Fork RS
- HNT - Huntington Lake

5-Station Index Precipitation

Wettest (1982-83)

2010-11

2012-13
2011-12
2013-14
2014-15

Two driest years, (1976-77, 1923-24)

CA - DWR
Winter Season
Snow Water Content

1982-83 wettest

Average

2013-14

2014-15

1976-77 driest

Thru 01 Jun 2015
Cal DWR
15-Year Mean Sierra Snow Water Equivalent 2015 March 29

Snow Water Equivalent (SWE)
15 Year Model Mean
Sierra Nevada Mtns, CA
March 29

Noah Molotch - NASA/JPL
The Great Snow Drought of 2014-15

Precipitation

Westwide SNOTEL Water Year (Oct 1) to Date Precipitation % of Normal

Snowpack

Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Provisional data subject to revision

Prepared by USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.uswa.nrcc.usda.gov
Oct-Mar Freezing Level Over Lake Tahoe.
1948-49 thru 2014-15

0°C Level at 39.06°N, 120.02°W - 6 Months Ending in March

Elevation (ft)

Ending Year (1948 - 2015)

9 year average

Last data: 2015-04-09
Means from 1981-2010
Western Regional Climate Center
What would a Drought Monitor map look like that incorporated this complexity???
Lake Powell Storage Through May 31, 2015

Currently 48 % full  (capacity 24.17 MAF)
Minimum: 33 % full on April 8, 2005
Water level on April 10, 2015 was 3597.27 ft, -103 ft below full. Minimum level on April 8, 2005 was 3555 ft, -145 ft below full. Source: www.usbr.gov/uc/water/index.htm
Lessons from History.


Red: Gauged record.
Blue: Reconstructed record.
20-Year moving averages.

CMIP5 Drought Projections (RCP 8.5, 2050-2099 CE)

Palmer drought severity index

Soil moisture (SM-30cm)

Soil moisture (SM-2m)

Central Plains

Southwest

Moisture balance

1000 1500 2000 2100

PDSI
SM-2m
SM-30cm
NADA

Is the current Southwest drought a once-or-twice-a-century drought like those of the past 500 years ...

... or ...

... a harbinger of things to come, a different type of drought that we have not observed before?
Through May 2015

“El Nino”

“La Nina”

NOAA ESRL ("CDC"), Wolter and Timlin
Ocean Departures from Average Temperature (°C) 21 - 27 Jun 2015
Recent Evolution of Equatorial Pacific SST Departures

Updated  through 2015  21-27 Jun

Climate Prediction Center
Split Samples:

Washington statewide October thru March Precip (versus Southern Oscillation Index for prior June - November)

- Years used: 1982/83 thru 1996/97
- Correlation: -0.43
- 91.26 cm / 32.00 in*
- 71.12 cm / 27.99 in (all)
- 63.26 cm / 24.91 in*

Arizona statewide October thru March Precipitation (versus Southern Oscillation Index for prior June - November)

- Years used: 1933/34 - 1996/97
- Correlation: -0.54
- 20.23 cm / 7.97 in*
- 16.28 cm / 6.41 in (all)
- 11.22 cm / 4.42 in*


ENSO

CA Division 1 October-March Precipitation
(versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
$r^2 = 0.01$
Correlation = -0.11

Mean = 44.9 in
Mean = 41.53 in
Mean all = 41.51 in
Mean = 40.15 in

El Niño  Neither  La Niña

Western Regional Climate Center
CA Division 2 October-March Precipitation
(versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
\( r^2 = 0.05 \)
Correlation = -0.22
Mean = 32.83 in
Mean all = 29.44 in
Mean = 28.8 in
Mean = 28.0 in

Western Regional Climate Center
CA Division 2 October-March Precipitation
(versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
$r^2 = 0.05$
Correlation = -0.22
Mean = 32.83 in
Mean all = 29.44 in
Mean = 28.8 in
Mean = 28.0 in

Western Regional Climate Center
CA Division 5 October-March Precipitation
(versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
$r^2 = 0.09$
Correlation = -0.3

Mean = 19.21 in
Mean all = 16.83 in

Mean = 16.83 in
Mean = 14.91 in

Western Regional Climate Center
CA Division 6 October-March Precipitation
(versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
$r^2 = 0.22$
Correlation = -0.47

- Mean = 19.89 in
- Mean = 15.45 in
- Mean all = 15.30 in
- Mean = 11.27 in

Western Regional Climate Center
CA 8-Station Index October-March Precipitation (versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
\[ r^2 = 0.02 \]
Correlation = -0.13
Mean = 47.4 in
Mean = 43.11 in
Mean all = 43.09 in
Mean = 41.38 in

Data Source: CA DWR
Western Regional Climate Center
CA 5-Station Index October-March Precipitation
(versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
$r^2 = 0.03$
Correlation = -0.17
Mean = 35.77 in
Mean all = 33.02 in
Mean = 32.74 in
Mean = 31.36 in

El Niño
Neither
La Niña

Data Source: CA DWR
Western Regional Climate Center
Arizona Statewide October-March Precipitation
(versus Southern Oscillation Index for prior June-November)

Years 1933/1934-2013/2014
$r^2 = 0.27$
Correlation = -0.52

Mean = 7.84 in
Mean = 6.23 in
Mean all = 6.11 in
Mean = 4.46 in

Western Regional Climate Center
Mid-Jun IRI/CPC Plume-Based Probabilistic ENSO Forecast

ENSO state based on NINO3.4 SST Anomaly

Neutral ENSO: -0.5°C to 0.5°C

Probability (%)

El Nino
Neutral
La Nina

Climatological Probability:
El Nino
Neutral
La Nina

Time Period

JJA 2015
JAS
ASO
SON
OND
NDJ
DJF
JFM
FMA 2016
Temperature & Precipitation
Official Outlooks

Three Month Summer 2015

Jul-Aug-Sep T

Orange / Red - Higher likelihood of drier than usual

Green - Higher likelihood of wetter than usual

NOAA Climate Prediction Center
Seven experiments in near-term climate forecasting Nov-Jan 2015-6. Precipitation.

NMME (National Multi-Model Ensemble).
IMME (International Multi-Model Ensemble).

Dynamical Models

CFSv2: US Climate Forecasting System version 2
CMC1: Canadian Meteorological Center version 1
CMC2: Canadian Meteorological Center version 2
GFDL: US Geophysical Fluid Dynamics Laboratory
NCAR: US National Center for Atmospheric Research
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2015 Jul 3
Seven experiments in near-term climate forecasting Jul-Sep 2015. Temperature.

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2015 Jul 3
The First Three Winters of Drought

2014-2015 Update in the Works

Each winter played out differently

Background and thus causes somewhat different each winter

2014-15 cause also likely not identical to previous three winters

Explanations reach to western Pacific and eastern Indian Oceans

Not much sign of climate change as a contributor

But, possible harbinger of future droughts:

Not just dry, but extremely warm
The California - Sierra - Nevada Drought - Where from here?

NIDIS as a Drought Early Warning System
Managers and decision-makers worst fear: Being taken by surprise

How to portray current status more optimally and completely - drought in managed systems
Concerted push on prediction communities
What were we saying last year at this time?

Huge interest in the coming winter
What has stayed the same (in the climate system) over the past 4 years ??
Not great prospects for rapid seasonal / interannual forecast improvement
Thus, also need a focus on coping mechanisms

Is this drought “natural” or “climate change enhanced” or what combination?
Enlarging the climate knowledge sand pile: what is the angle of repose?
The Colorado River drought (12 of last 15 years) ... is this a megadrought??

Snow drought (snow deficiencies worse than precipitation deficiencies)
A harbinger for the future?
Why has the recent past, and particularly this winter, been so warm?
Exploring and understanding the effects of temperature, other demand variables

EL Nino : Unreliably wet winters in southern California. May / can help, but not guaranteed.
Near-term focus: Why some El Nino winters wet, others dry, in Southern California?
Connection between climate and weather seems crucial
Extreme events (large storms) often make or break a winter

Other biological phenomena: fish, marine mammals, harmful algal bloom, “the Blob”
Never waste a crisis