How Geospatial Technology Addresses Water Supply Impacts of Climate Change

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1. Agency overview
2. Water in California
3. Impacts of Climate Change
4. Geospatial Technology for Adaptation
EBMUD System

EBMUD WATER SUPPLY

EBMUD SERVICE AREA
332 SQUARE MILES

EBMUD MOKELEUMNE AQUEDUCTS
3 - 85 MILE LONG WATER SUPPLY PIPELINES

FREEPORT REGIONAL WATER FACILITY
SUPPLEMENTAL WATER SUPPLY FOR DRY YEARS

CAMANCHE RESERVOIR
FLOOD CONTROL

PARDEE RESERVOIR
MUNICIPAL WATER SUPPLY

MOKELEUMNE RIVER WATERSHED

LAKE PILGRIM

SACRAMENTO — SAN JOAQUIN DELTA

EBMUD SYSTEM

YOSMITE NATIONAL PARK

SAN FRANCISCO
EBMUD’s Water System

- 1,300,000 retail customers
- 400,000 services
- 6,600 km pipe
- 31 dams
- 5 treatment plants
- 126 pumping plants
- 165 reservoirs/tanks
- 122 pressure zones
- Elevation: MSL-442 m
Water in California
Precipitation and Population Not in the Same Place

Graphic from Jay Lund, mavensnotebook.com
Mediterranean Climate
Atmospheric Rivers Concentrate Precipitation in Just a Few Storms

SSM/I Water Vapor (Schluessel algorithm) February 16, 2004

Atmospheric River generates flooding

Source: the Pacific Institute

Source: NOAA

Source: NOAA
The current dry year may be far more “typical” than the short historical record would suggest. Tree-ring studies suggest that the last 100 years have been abnormally wet.
Conceptual reservoir operational rule curve

Basic Flood Control Diagram

- Reservoirs fill with April – July Snowmelt
- Flood Control Pool

Reservoir pool elevation, TAF
- Month

- Sep-06 to Aug-07
Unsustainable Groundwater Extraction Leads to Huge Subsidence

By Dr. Joe Poland of USGS, 2013 [USGS report, SIR 2013-5142]
Impacts of Climate Change
Expected Stresses From Climate Change

Warmer weather stresses water supply by increasing demand for water and increasing losses from evapotranspiration and sublimation.

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

Source: Dan Cayan et al. 2009.

Projected Average Precipitation in California, relative to 1961-1990

Climate change will tend to reduce average precipitation in Northern California, even though other parts of the world will see an increase in average precipitation.

High spring temperatures can produce devastating loss of an already reduced precip. Winter flood and summer drought can occur in the same water year.
Beyond Average Trends, the Big Story is About Variability

The last 100 years show huge variation in supply, but paleo-climatologists believe they’ve been atypically consistent.

Climate change is expected to further amplify variability.
Geospatial Technology for Water Supply Adaptation to Climate Change
1. Facilitates analysis and visualization to inform policymakers

2. Enhances conservation efforts, e.g. satellite imagery helps establish water budgets

3. Enables adaptive operations by providing better data, better long-term weather forecasts
GRACE is Enhancing Knowledge of Climate Change Impacts

Gravity Recovery And Climate Experiment can monitor groundwater and soil moisture.
GRACE data show continued groundwater depletion

Famiglietti, J.S., 2011 Geophysical Research Letters, Satellites measure recent rates of groundwater depletion in California’s Central Valley
50-year groundwater trend

From UCCHM Water Advisory #1, 2014, after USGS Professional Paper 1766
Conservation water budgets are built using geospatial data and tools such as ortho-imagery and land cover data.
What if the rule curve could change **dynamically** based on improved weather forecast?

Space in reservoir reserved for flood.
Accurate long-term weather forecasts based on geospatial data promise to allow dynamic, real-time operations instead of static rule curves.

Images from http://www.pmel.noaa.gov/tao/elnino/nino_profiles.html
Sea topo from NASA TOPEX satellite
SST from NOAA AVHRR satellite
Subsurface temps from NOAA TAO buoys
PROBABILISTIC EL NINO FORECAST

Based on data from the National Oceanic and Atmospheric Administration and International Research Institute for Climate and Society

From http://www.adventure-journal.com/2014/03/goodbye-to-la-nada-here-comes-el-nino/
Summary

1. Public policy on climate change relies on facts and information from geospatial systems

2. Geospatial technology is a major part of climate change adaptation