Drought kills 27 million more trees in California

Another 27 million trees died in California last year due to the lingering effects of drought, according to new aerial total number of trees killed statewide to a staggering 129 million since 2010.
NASA Earth Science Assets
Missions: Present through 2023

ISS Instruments
LIS (2020), SAGE III (2020)
CLARREO-PF (2020)

JPSS-2 Instruments
OMPS-Limb (2019)

(In)Formulation
Implementation
Primary Ops
Extended Ops

ISS Instruments

ISS

JPSS-2 Instruments

InVEST/CubeSats

RAVAN (2016)
IceCube (2017)
MiRaTA (2017)
HARP (2018)
TEMPEST-D (2018)
RainCube (2018)
CubeRRT (2018)
CIRIS (2018*)
CSIM (2018)

* Target date, not yet manifested

01.29.18
Adapting global-scale missions to regional to local scale applications
Examples of water resources management applications in California
Examples of water resources management applications in California

Water quality
Infrastructure
Water supply
Retrospective analysis of stormwater plumes in Santa Monica Bay, evaluating enterococci samples collected coincident with plume detection (synthetic aperture radar)
Evaluating diversions impacts from HTP using sea surface temperature and chlorophyll response

Credit: Trinh et al 2017
Maximizing Utility of Remote Sensing in CA Water Resources Management
California’s water is required for a variety of beneficial uses and transported long distances.

California’s water is required for a variety of beneficial uses and transported long distances.

And faces diverse water quality challenges depending on source, land use and development and other issues.
Goals of Effort

- Enhance water quality and resources management
- Improve access to remote sensing-derived water quality data
- Operationalize production through Bay Delta Live portal
Hypomesus transpacificus – the “Delta Smelt”

2007 federal judge court ruling

Delta Smelt BiOps: turbidity to trigger pumping restrictions

Delta Smelt Working Group

Identify reasonable alternate actions
It is thought that the turbidity pulse from the winter storms triggers smelt to migrate into the delta to spawn.

**Decision process**

- 2007 federal judge court ruling
  - Delta Smelt BiOps: turbidity to trigger pumping restrictions
    - Delta Smelt Working Group
      - Identify reasonable alternate actions
More delta smelt were found entrained in pumps during periods of increased turbidity.

- **Decision process**
  - 2007 federal judge court ruling
  - Delta Smelt BiOps: turbidity to trigger pumping restrictions
  - Delta Smelt Working Group
  - Identify reasonable alternate actions

*Hutson, Fullerton et al., Metropolitan Water District*
Turbidity

\[ T = \frac{A_T^\lambda \rho_w(\lambda)}{(1 - \rho_w(\lambda)/C^\lambda)} \] [FNU]

\( A_T^\lambda \) and \( C^\lambda \) represent absorption and backscatter terms in turbid systems and can be determined using in-field measurements. \( \rho_w \) is calculated using \( \text{Rrs} \) term, adjusted for water refractive properties.  

Nechad et al 2009
Turbidity

\[ T = \frac{A_T^\lambda \rho_w^\lambda}{(1 - \rho_w^\lambda/\rho_C^\lambda)} \quad \text{[FNU]} \]

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<table>
<thead>
<tr>
<th>Summary of Data Sources</th>
<th>Temporal Resolution</th>
<th>Spatial Resolution</th>
<th>Spatial Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quality Stations</td>
<td>15 minutes intervals</td>
<td>point data</td>
<td>63 (^1) stations over 5600 square miles</td>
</tr>
<tr>
<td>Sentinel-2A/B</td>
<td>4-5 days 55 clear sky acquisitions 2016-2018</td>
<td>20-m x 20-m pixels (average value over 20-m x 20-m)</td>
<td>36M+ pixels over 5600 square miles</td>
</tr>
</tbody>
</table>

Table 1. Overview of differences in data sources.
Comparing turbidity derived from satellite data and USGS and other station data

- Process Sentinel-2 (S2) satellite data to turbidity
- Extract pixels over stations lat/lon
- Extract turbidity values from stations
- Match up comparison
- Calibrate / adjust other turbidity pixels
Comparing turbidity derived from satellite data and USGS and other station data.

Process Sentinel-2 satellite data
turbidity

Extract turbidity values from stations

Match up comparison

Extract pixels over stations

Calibrate / adjust other turbidity pixels
For Sentinel-2, we looked at 2016-2018, which amounted to approximately 55 dates with station matchups, and N=1540 in total, here separated out by date.
Same dataset but organized by station.
Water temperature is another critical water quality issue in the Bay Delta.

PROJECTED CHANGES IN ANNUAL MEAN TEMPERATURES IN THE BAY DELTA (CLOERN ET AL 2011)

DEPICTS THE PROJECTED # DAYS WHERE HIGH TEMPERATURES ARE DETRIMENTAL TO DELTA SMELT. (WAGNER ET AL 2011)
The First of a New Series of Missions to the International Space Station

Simon J. Hook (PI) and the ECOSTRESS Team

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

First Look at Bay Delta ECOSTRESS for 34N

2018-08-11
20:04 UTC
UTM 10N 70m

Water Surface Temperature
First Look at Bay Delta ECOSTRESS for 34N

2018-08-11
20:04 UTC

UTM 10N 70m

30° C

Water Surface Temperature

7° C
CHANGES IN SPATIAL DISTRIBUTION OF ECOSTRESS SURFACE TEMPERATURE IN GRIZZLY BAY USING TWO ACQUISITIONS (WITHIN 24 HOURS). THE LEFT PANEL WAS ACQUIRED ON 8/10/2018 AT 630PM PT AND THE RIGHT PANEL WAS ACQUIRED ON 8/11/2018 AT 1200PM PT.
Work Plan for Monitoring and Assessment of Proposed Suisun Marsh Salinity Control Gates Action, 2019

By Department of Water Resources Division of Environmental Services

June 3, 2019
San Luis Reservoir (also part of the California State Water Project) with multiple uses, including water supply holding grounds, recreation, habitat.
JPL proposal to partner with MWD SD to improve mapping of harmful algal blooms, collaboration with UCLA/Ozcan and Batalin

![MWDSC service area and reservoirs and uses.](image)

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Owner</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Skinner</td>
<td>MWDSC</td>
<td>Drinking Water Supply, Recreation</td>
</tr>
<tr>
<td>Lake Mathews</td>
<td>MWDSC</td>
<td>Drinking Water Supply</td>
</tr>
<tr>
<td>Lake Perris</td>
<td>CA DWR</td>
<td>Drinking Water Supply, Recreation</td>
</tr>
<tr>
<td>Diamond Valley Lake</td>
<td>MWDSC</td>
<td>Drinking Water Supply, Recreation</td>
</tr>
<tr>
<td>Silverwood Lake</td>
<td>CA DWR</td>
<td>Drinking Water Supply, Recreation</td>
</tr>
<tr>
<td>Castaic Lake</td>
<td>CA DWR</td>
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</tr>
<tr>
<td>Pyramid Lake</td>
<td>CA DWR</td>
<td>Drinking Water Supply, Recreation</td>
</tr>
</tbody>
</table>

![Cyanobacterial Index values in Diamond Valley Lake using Sentinel-3 data. Source: cchab.sfei.org](image)

A taste-and-odor producing detrimental cyanobloom in Diamond Valley Lake in 2014.

![Setup for the in-situ automated high-throughput imaging flow cytometry platform based on lensfree computational microscopy principles.](image)
The COAST Instrument

Innovating Coastal Observations

- VSWIR 380 -2510 nm hyperspectral imager in a 1-day/ 16 orbit repeat cycle
- High SNR for aquatic products
- Frequent lunar and Earth calibration views
- Sun-glint avoidance
- Easy to accommodate – heritage LEOStar-2 and Pegasus launch demonstrated as feasible, other options available
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