OpenET
A Water Community Focused Open Source ET Project
Towards Filling the Biggest Gap in Water Information

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The Information Gap

The question of “how much water is being used?” in agriculture remains largely unanswered. Hard to manage what we are not measuring.

The water use information gap makes it difficult to effectively manage water and adopt new management strategies (reduction, trading, banking, etc...)

Map: PPIC, 2016; Photo: DWR, 2015
Importance of Open ET Data

Open ET data will inform sustainable water management

- Healthy Water Trading Program: Critical
- Groundwater Management (including SGMA): Critical
- Irrigation and Crop Management: Key
- Sustainable Supply Chains: Important
Proven Approach

Satellite Imagery + Ground-based Weather Data + Advanced Analytics

Evapotranspiration Data

Satellite Archives

Consumptive Use
The Vision: An OpenET Software and Data Platform

- A web-based platform (OpenET) provides automated, and widely accessible ET data available to end users across the western U.S. for user-defined areas and time frames
- Open source software on GitHub so the water community can contribute, collaboratively code, or just look under the hood
One Platform, Multiple Operational Models

OpenET: Shared Architecture for ET Mapping

- **User interface:** query, data access, data summary and reporting tools, account and permission management

**Common API for Data Queries**

**Models/Applications (implemented on Earth Engine):**
- METRIC
- DiSLEXI
- SEBAL
- SSEBop
- SIMS
- Other models/applications

**Earth Engine Data Resources:**
- Landsat, MODIS, VIIRS, GOES, Sentinel-2A/2B, Spatial CIMIS, FRET, GFS . . .
- ALEXI, JPL-PT, METRIC (manual/expert) . . .
Initial Case Study Locations

- McDonald Island, CA
- Upper Colorado River Basin
- Colusa GW Subbasin
- Diamond Valley, NV
- CA Almond Board
- Butte GW Subbasin
- Tulare County, CA
- Rosedale-Rio-Bravo W.S.D.
- Pinal County, AZ

Legend:
- Approved
- Proposed
- Water Trading
- Groundwater Management
- Irrigation and Crop Mgmt
NASA Applied Sciences Program – Water Resources: DRI/NASA ET Project

- Goal - Enable agency staff to gain a thorough understanding of models, assumptions and limitations, software operation and post-processing, and ultimately sustain in-house ET mapping over the long-term

- Focus on specific study areas for software development, testing, training, and initial implementation
Moving Past Engagement to Trainings

• The days of “loading dock science” are gone...
• Open sharing of codes and trainings on how to use the codes and web applications is a must if we want end users to actually adopt our products

NASA/DRI ET Workshop with 21 state water agency staff from 8 western states
Funded by NASA ROSES ASP Western States Remote Sensing of ET Project
Quick Success Story

- Within a few weeks of the workshop, hydrologist at OWRD created a 2016 seasonal ET map with METRIC and ET Demands for the Malheur Lake Basin (SE OR) and provided maps to farmers for feedback.
Our First Test

- Regional scale field level ET mapping on Google Earth Engine
- Example collaboration with Gabriel Senay, MacKenzie Friedrichs, and others at USGS EROS

2015 annual ET - 16,000 Landsat images processed over a weekend
Desired Breakthroughs

• For multiple ET research teams and water agencies to contribute to OpenET via the GitHub version control software
  – Goal of advancing science and providing end users with free to low cost ET data via a state-of-the-art web application

• Ensemble water use mapping to better understand model differences and co-variates in space and time
  – Climate models
  – Hydrologic models
  – Land cover land use
  – Why not ET models?... now that we can!
How can ET help Groundwater Management?

• Provide ability to assess 30+ years of water use (1984-current)
• Develop a more complete picture of baseline water consumption
• Complement groundwater pumpage inventories / metering program
• Fill in gaps in groundwater pumpage data
• Provide a backup and independent assessment of consumptive use
• Ability to assess within field variability / stressed / water short areas
• Provide readily available data to track and illustrate decreases in consumptive use as groundwater management plans are acted on
• Provide 7 day forecasts of reference ET / evaporative demand to improve irrigation scheduling
• Other ideas?
Example Interface - Climate Engine - app.climateengine.org

On-Demand Cloud Computing and Visualization of Climate and Remote Sensing Data

Median NDVI (Landsat 4/5/7/8 SR)
Target Period: 2017-06-01 to 2017-08-31

Variable: NDVI (Vegetation Index)
Computation Resolution (Scale): 30 m
Climate Engine Beta

Product
Type: Remote Sensing
Dataset: METRIC ET - Central Valley
Variable: ET (Evapotranspiration)
ET (Evapotranspiration)
ETrF (Fraction of Reference)
ETr (CIMIS Reference ET)

Values
Average Conditions
Difference From Average Conditions
Percent Difference From Average Conditions
Percent Of Average Conditions

GET MAP LAYER

Time Period
Start Date: 2015-04-01
End Date: 2015-06-30

Climate Engine is powered by Google Earth Engine and the Google Cloud.
On-demand spatial averaging in time and plotting
-Time Series for 2014 – Alfalfa Field in Central Valley, CA
Summary

- Remote sensing is the only way to estimate actual ET over large areas and long time histories
- Field scale satellite archives combined with availability of climate data and cloud computing is creating transformative opportunities
- Rapid processing and visualization tools for simple consumptive use decision support
  - Will allow for all to perform field scale consumptive use analysis
  - Free and open access to objective data where everyone is treated equally will reduce the likelihood for disputes over data or lack of data
- Outreach through hands-on training is key for adoption
- Contact Justin.Huntington@dri.edu if interested in participating or for more details
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Program Design/Execution

EE Algorithm & Platform Development

Front End Development

End Use Applications

Coordination, Project Management & Outreach

Water Community