Why is ET Useful?

Measurement of evapotranspiration (ET) enables us to…

- Match irrigation to plant water requirements
- Establish water budgets using best-available-science derived actual consumptive use instead of potential consumptive use
- Support conservation and innovation
- Give proper credit for reduced use
- Reduce the transaction and monitoring costs for water trading and water use reduction programs
- Document and improve on-farm efficiencies
OpenET Goals

Reliable ET data are produced and available at low cost, and easily accessible via etdata.org for any area within the western US.
OpenET Goals

There is trust in the validity of the data and information provided by the platform, and it is utilized by private and public resource managers at the local, state and federal levels.
OpenET Goals

A variety of sustainable resource management practices are enabled at a much larger scale than is currently possible.
OpenET Team

**Environmental Defense Fund:** Robyn Grimm, Dana Rollinson, Maurice Hall

**Google Earth Engine:** Tyler Erickson

**ALEXI / disALEXI Team (USDA, NASA, U. Maryland, U. Wisconsin):** Martha Anderson, Mutlu Ozdogan, Christopher Hain, Mitch Schull, Yun Yang

**SEBAL Team (UNESCO IHE):** Wim Bastiaanssen, Tim Hessels

**METRIC / EE Flux (DRI, U. Nebraska):** Justin Huntington, Rick Allen, Charles Morton, Ayse Kilic

**SSEBop Team (USGS):** Gabriel Senay, Mac Friedrichs

**Priestley-Taylor JPL Team (NASA JPL Team):** Josh Fisher, Greg Halverson

**SIMS Team (NASA, CSUMB):** Forrest Melton, Alberto Guzman, Lee Johnson

**Multimodel Development, Integration, API, UI:** Charles Morton (DRI), Britta Daudert (DRI), Alberto Guzman (NASA), Jordan Harding (HabitatSeven), Jamie Herring (HabitatSeven)

**World Bank GWSP:** Aleix Serrat-Capdevila
Some Comments from Agency Partners

- Open lines of communication with technical staff via GitHub and Slack
- Version Control System using GitHub
- Documentation and Transparency
- OpenET allows for rapid assessment and application for water management that would otherwise would take weeks to years
- Without open and free Landsat data, agencies won’t be able to accurately track water use over large areas
Project Design and Execution
# OpenET Project Timeline

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Define User Requirements</strong>&lt;br&gt;Mid 2018 – Mid 2019</td>
<td><strong>Refine and Test the Technology</strong>&lt;br&gt;Mid 2019 – Late 2020</td>
<td><strong>Apply the Technology</strong>&lt;br&gt;Late 2020 – Mid 2021</td>
<td><strong>Transition to Sustained Operations</strong>&lt;br&gt;Mid 2021 – Mid 2022</td>
</tr>
<tr>
<td><strong>Front End Development</strong></td>
<td><strong>Platform Development</strong></td>
<td><strong>Management, Coordination, and Outreach</strong></td>
<td></td>
</tr>
<tr>
<td>Finalize OpenET website design</td>
<td>Implement ET Models on Google Earth Engine, develop shared API, and release User Requirements Report</td>
<td>Build partnerships and solicit input from various end use communities</td>
<td></td>
</tr>
<tr>
<td>Develop OpenET prototype website and process for user testing and refinement</td>
<td>Refine API/Website interface, develop Model Intercomparison Study</td>
<td>Work with end users to refine the user interface and begin to develop end use case studies</td>
<td></td>
</tr>
<tr>
<td>Develop custom applications and launch OpenET website</td>
<td>Add additional functionality for custom applications; develop Best Practices Manual</td>
<td>Develop use case reports and transition plan for long-term sustainability</td>
<td></td>
</tr>
<tr>
<td>Refine OpenET website and custom applications as needed</td>
<td>Develop training materials and host final workshop</td>
<td>Transition OpenET to its long-term home and conduct trainings</td>
<td></td>
</tr>
</tbody>
</table>
Diverse Use Cases are Guiding Development
Partnering with experts to guide development

California Working Group - Organizations Represented

1. CA Farm Bureau Federation
2. CA Dept of Food and Ag
3. Sustainable Conservation
4. E&J Gallo
5. CA State Water Resources Control Board
6. UC Ag Issues Center
7. David’s Engineering
8. Governor’s Office of Planning and Research
9. CA Dept of Water Resources

Colorado River Basin Working Group - Organizations Represented

1. Audubon
2. Wyoming Office of Engineers
3. Metropolitan Water District
4. Arizona Dept of Water Resources
5. Wilson Water Group
6. Utah State Univ.
7. Nevada Division of Water Resources
8. New Mexico Office of the State Engineer
9. US Bureau of Reclamation
10. Utah Division of Water Resources
OpenET Methods

**METRIC**, 30m, 20+ state water mgmt agencies

**SEBAL**, 30-300m, World Bank, UN FAO, eLeaf

**SSEBop**, 30m-1km, USGS National Water Census

**ALEXI/DisALeXI**, 500m-5km, NOAA, USDA, NASA, U.S. Drought Monitor

**SIMS**, 30m, CA Dept. of Water Resources, UCCE, +5 western states, NASA

**JPL-PT**, 30m-1km, New Mexico State Eng. Office, NASA
OpenET Satellite Data

**Landsat 5/7/8 (TM / ETM+ / OLI)**
30m / 0.25 acres; overpass every 8-16 days

**Terra / Aqua**
1 km; Daily overpass

**Suomi NPP**
~300-375m, Daily overpass

**ESA Proba-V**

**NOAA GOES-15/16/17**
0.5-4 km; < hourly

**ESA Sentinel-2A, 2B**
20m / 0.1 acres
Overpass every 5-10 days
MVP: Beta Version of the OpenET Data Explorer

Data
- Variables: ET, ET_{ref}, E_{t_r}, NDVI
- Data from at least two models
- Monthly data
- Years: 2016, 2017, 2018, 2019
- Region: California and Nevada (minimum)

Visualizations and Functionality
- Choropleth maps produced using publicly available field boundary datasets
- Raster maps of monthly and annual data from the ensemble
- Hover over individual polygons or click on pixels to view graphs of time series data

Additional Content
- Text and content for the homepage
- Documentation for models and explanations of data
- At least one use case example
OpenET provides data at a variety of scales. You can view data summarized at field scales, view the raw data outputs or create your own custom report.
My Secure Dashboard

Add New Report

Is this report based on Polygons or Raster data?  
- Raster  
- Polygon

Is this report one-time or recurring?  
- One-Time  
- Recurring

1. Name of this Report

2. Pick a Point, Draw a Polygon or...
   - Upload Shape File
   - Use Previously Uploaded Shape File
   - Use My Earth Engine Feature Collection

Use Previously Uploaded Shape File

- Shape File Name
  Created January 10, 2019
- Shape File Name
  Created January 12, 2019
OpenET Accuracy Assessment

Images courtesy of Ray Anderson, USDA ARS
OpenET Accuracy Assessment

- Validating at AmeriFlux, FLUXNET2015, other research flux sites, and comparing to groundwater pumping
- Developed standardized QAQC and energy balance closure software to apply across all flux sites
- Intercomparison of model results at scale proving useful for understanding results and improving our models

![Graph showing the relationship between Reported May-Sept Pumpage and METRIC May-Sept Net ET Volume (Acre-Feet) with the equation y = 1.23x and R² = 0.94.](image)
## OpenET Technical Requirements

<table>
<thead>
<tr>
<th>Application</th>
<th>Baseline Accuracy</th>
<th>Ideal Accuracy</th>
<th>Time of Use</th>
<th>Ensemble of Values or One Value?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation scheduling</td>
<td>+/- 25% daily</td>
<td>+/- 10-15% daily</td>
<td>1-3x per week</td>
<td>One value</td>
</tr>
<tr>
<td>Water accounting / demand projections</td>
<td>+/- 20% monthly</td>
<td>+/- 15%</td>
<td>Monthly to annual</td>
<td>Ensemble</td>
</tr>
<tr>
<td>Drought monitoring / impact assessment</td>
<td>+/- 20% monthly</td>
<td>+/- 15%</td>
<td>Monthly or seasonal reports</td>
<td>One value</td>
</tr>
<tr>
<td>Water transfers</td>
<td>+/- 20% monthly</td>
<td>+/- 10%</td>
<td>Monthly and annual reports</td>
<td>One value</td>
</tr>
<tr>
<td>Water budgets</td>
<td>+/- 15% annual</td>
<td>+/- 10%</td>
<td>Annual reports</td>
<td>One value</td>
</tr>
<tr>
<td>Calibration of groundwater models</td>
<td>+/- 15% annual</td>
<td>+/- 15%</td>
<td>Retrospective analyses</td>
<td>Ensemble</td>
</tr>
<tr>
<td>Conservation planning</td>
<td>+/- 15% annual</td>
<td>+/- 15%</td>
<td>Retrospective analyses</td>
<td>Ensemble</td>
</tr>
<tr>
<td>Water rights admin / Regulatory compliance</td>
<td>+/- 20% monthly</td>
<td>+/- 5-10%</td>
<td>Monthly and annual reports</td>
<td>One value</td>
</tr>
</tbody>
</table>
We gratefully acknowledge support by the Windward Fund, the S.D. Bechtel, Jr. Foundation, the Gordon & Betty Moore Foundation, the Walton Family Fund, and the NASA Applied Sciences Program.
Back-up
Bringing Communities Together and Building Trust
Transparency of water use through ET maps support conservation and groundwater management - example from OWRD who are using OpenET based ET maps and meeting with farmers about their water use.

Similar work in Kansas - “The results of this analysis demonstrate that conservation programs that are irrigator-driven with regulatory oversight can provide a path toward sustainability in stressed aquifers.” - Deines et al., 2019 - [https://iopscience.iop.org/article/10.1088/1748-9326/aafe39](https://iopscience.iop.org/article/10.1088/1748-9326/aafe39)