NASA Science Mission Directorate
Earth Science Division
Applied Sciences Program

Operational Remote Sensing of Agricultural Water Use in Cooperation with Western State Water Resource Agencies for Improved Water Management

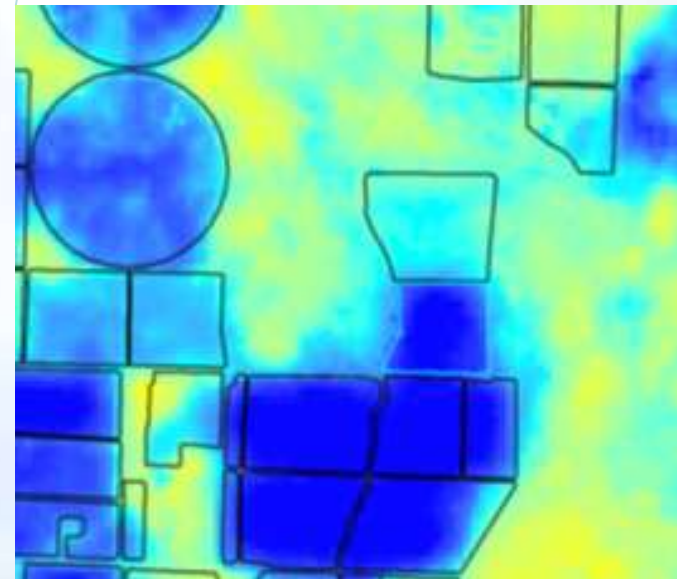Justin Huntington & Lee Johnson
DRI & NASA Ames / CSUMB

Statement of challenges / need / opportunity

- Historical and current actual ET estimates are needed for quantifying volumes of water use

  – Support inventories of surface and groundwater use and predictive studies

  – Knowing the past will help us better predict the future

- Remote sensing is the only way to estimate actual ET over large areas and long time histories
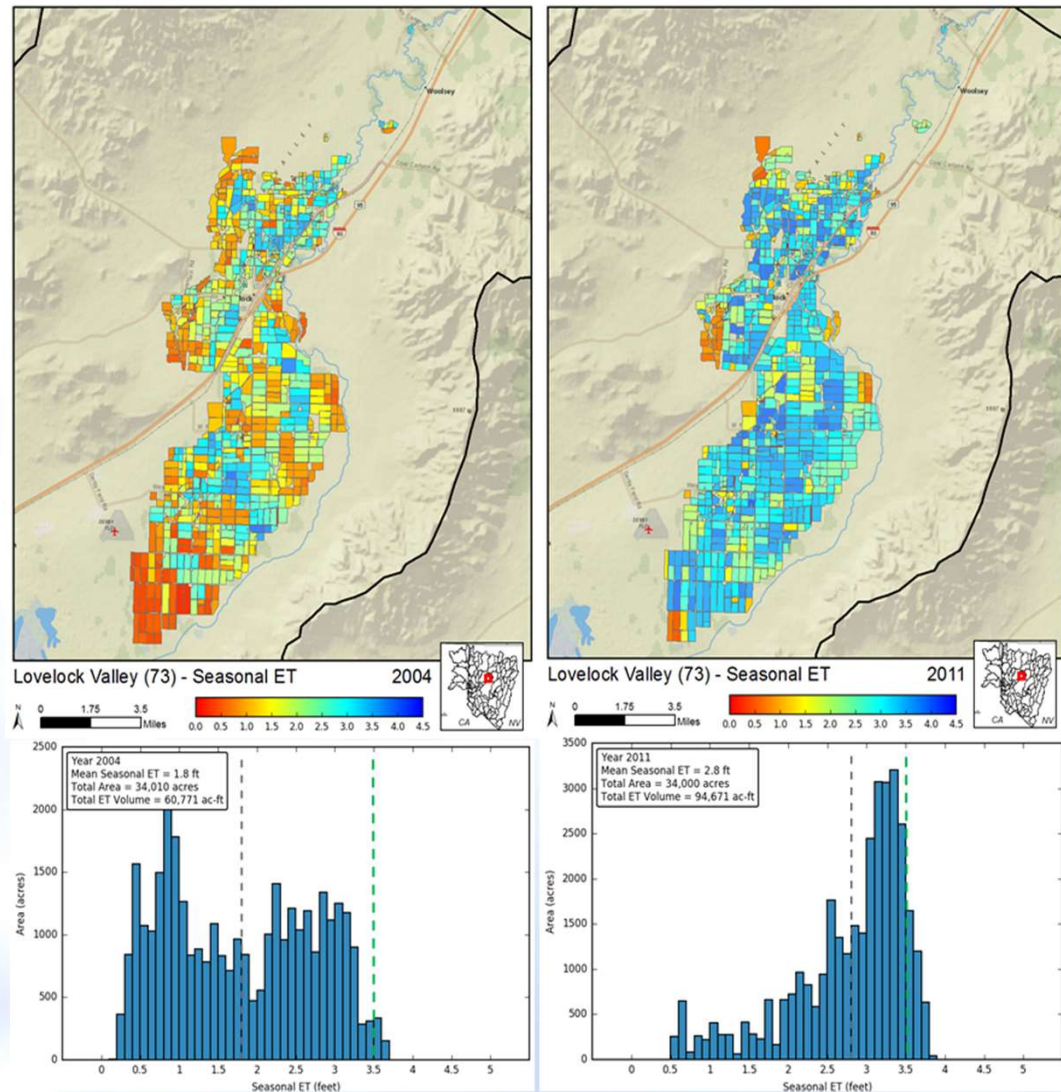
Landsat 8

Statement of challenges / need / opportunity

- Software tools are needed to make field scale ET raster and vector geodatabases
  - In-house use by agency staff

- ET estimates that are averaged to field boundaries are needed
  - Include attributes of numerous ET variables (ETo, PPT, EToF, NetET, basin, permit #, etc..)

- Need for rapid visualizations and summaries of ET raster & vector data for user defined time periods and areas of interest

Lovelock Valley (73) - Seasonal ET   2004

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Year 2004
Mean Seasonal ET = 1.8 ft
Total Area = 34,010 acres
Total ET Volume = 60,771 ac-ft

Lovelock Valley (73) - Seasonal ET   2011

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Year 2011
Mean Seasonal ET = 2.8 ft
Total Area = 34,000 acres
Total ET Volume = 94,671 ac-ft

Current partners and user community

- Project partners include:
  - California State Water Resource Control Board
  - Nevada Division of Water Resources
  - Utah Division of Water Resources
  - Idaho Department of Water Resources
  - Oregon Water Resources Department
  - Wyoming State Engineer's Office
  - Texas Water Development Board
  - Montana Department of Natural Resources and Conservation
  - California Department of Water Resources
  - Google Earth Engine Team

- Other user community includes federal, state, local, and private / NGOs
  - Reclamation
  - The Nature Conservancy

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Approach

- Develop an open-source open-platform ET toolset (based in Python) and operationally produce field scale ET estimates
  - pySIMS and pyMETRIC

- Hold numerous hands on trainings with state agency staff to ensure transition of developed tools and technologies

- Develop a 10 year archive of ET estimates for priority/study areas in each partner state

- Migrate the framework to the cloud for operational storage and compute resources, web-mapping, visualization of spatial data and summaries, and long term sustainability
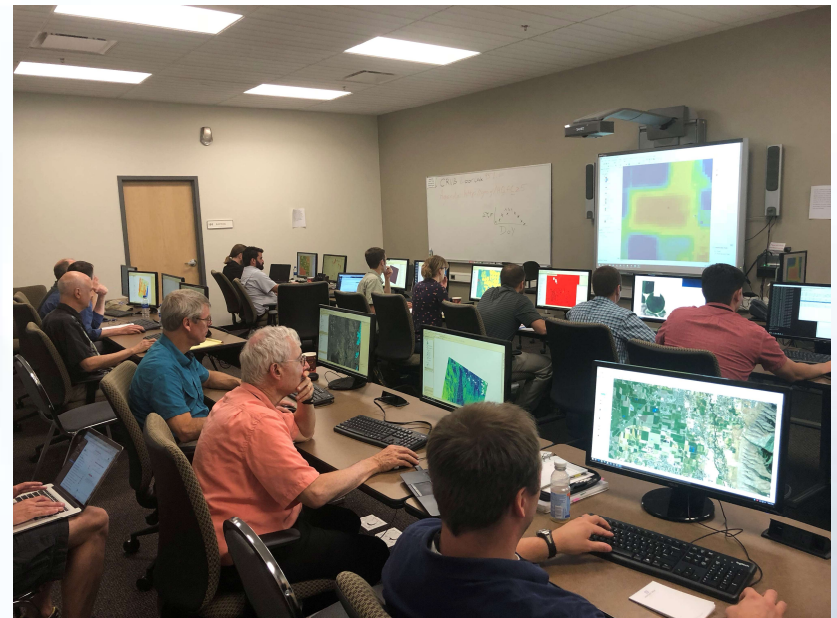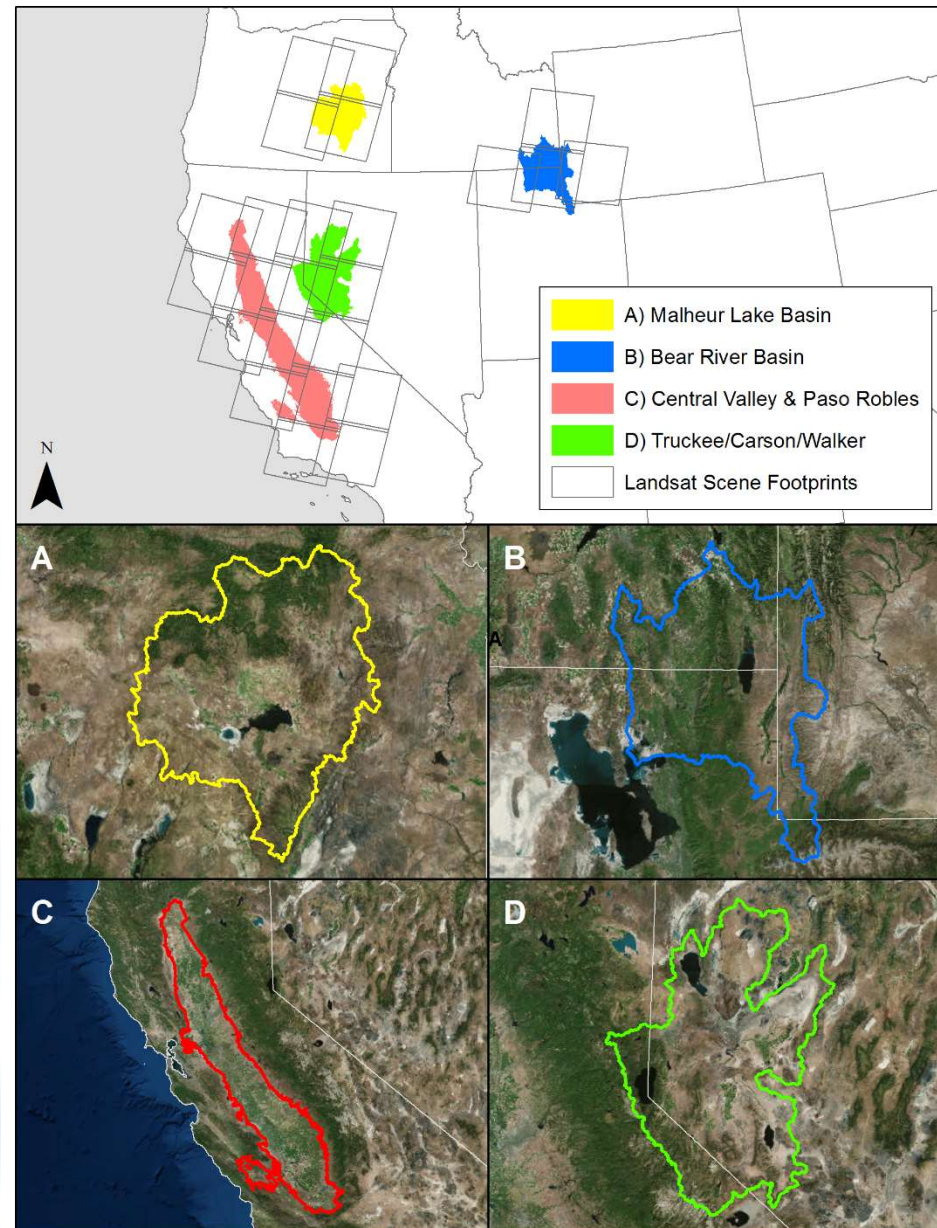

June 27, 2018 – DRI Computer Lab

Approach

- Focus on specific study areas for software development, testing, training, and initial implementation

- Basins identified as high priority by state agencies
  - Over drafted GW
  - Conjunctive use of SW/GW
  - Multi-state water right issues (UT, WY, ID)
  - Water right buyouts and mitigating impacts to existing rights

Legend:
- A) Malheur Lake Basin
- B) Bear River Basin
- C) Central Valley & Paso Robles
- D) Truckee/Carson/Walker
- Landsat Scene Footprints

- Mapping ET in Montana Using NASA-ROSES Tools

- Pilot Project – Lolo Creek, Missoula County, MT (pyMETRIC)
    - Solve agricultural component of water balance through time.
    - Investigate causes of creek dewatering.
    - Quantify impact of land use change on water balance.
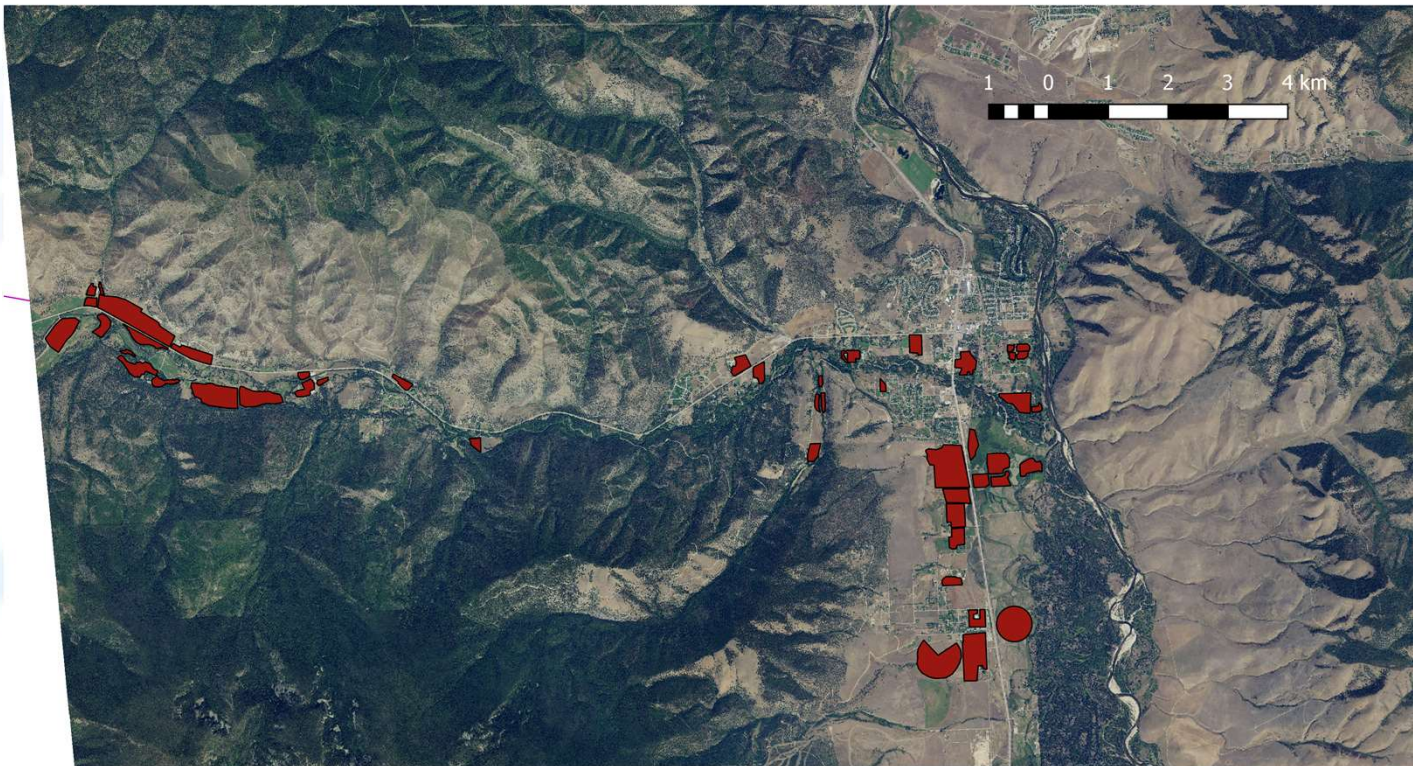
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- Mapping ET in Montana Using NASA-ROSES Tools

- Future Work:
    - Prairie watershed water balance.
    - Assessment of new appropriations and change applications (water rights admin.).
    - Assessment of irrigation efficiency and infrastructure investment planning in the Flathead.

- Benefits of NASA-ROSES/DRI-supported tools.
    - Documentation.
    - Use of accepted remote sensing algorithms (METRIC).
    - Version Control Systems!
    - Ease of using MT DNRC tools alongside pyMETRIC and Clear-Scene tool suite.
    - Open lines of communication with technical staff using Slack.
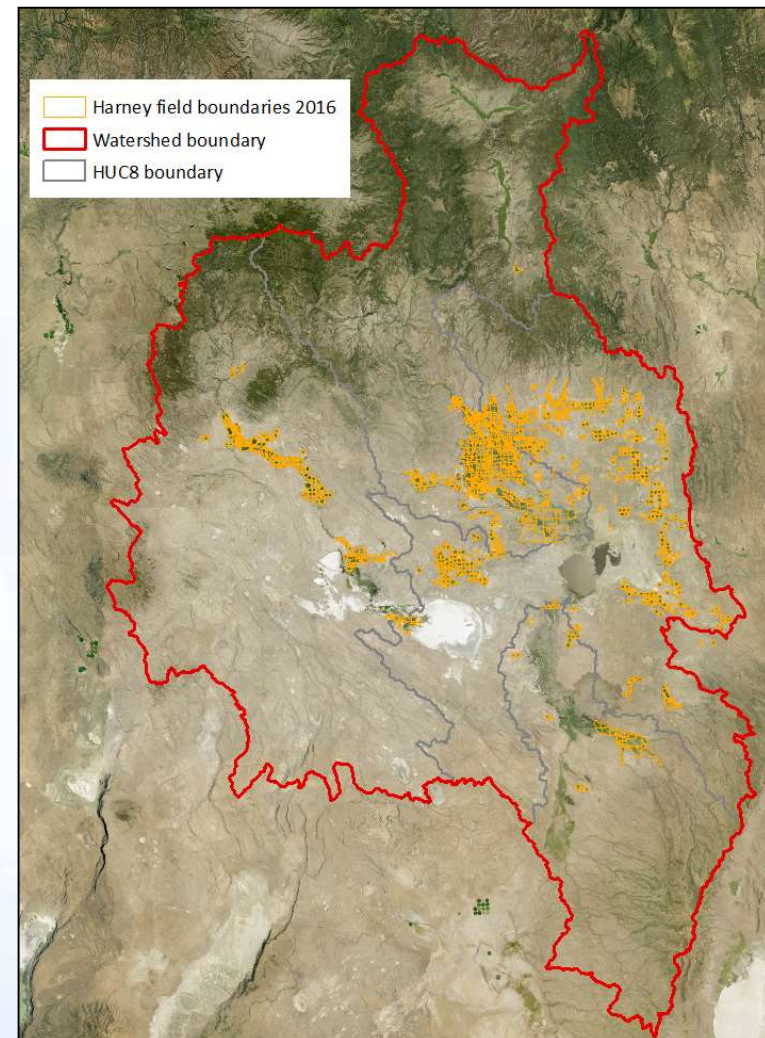
NASA-ROSES Project

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- OWRD identified the **Harney Basin** as the NASA-ROSES study area

- Information about crop water use is a major information gap for both basin (ongoing GW study and basin planning efforts)

- Without **NASA-ROSES** and **access to imagery and tools**, OWRD unable to apply this technology for water management
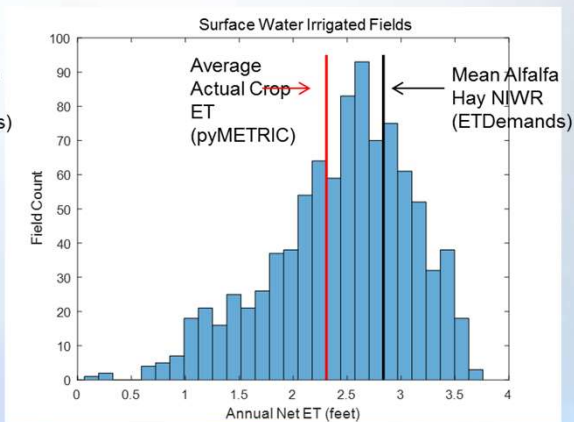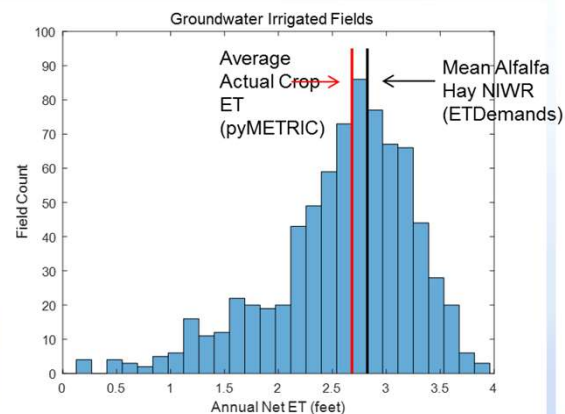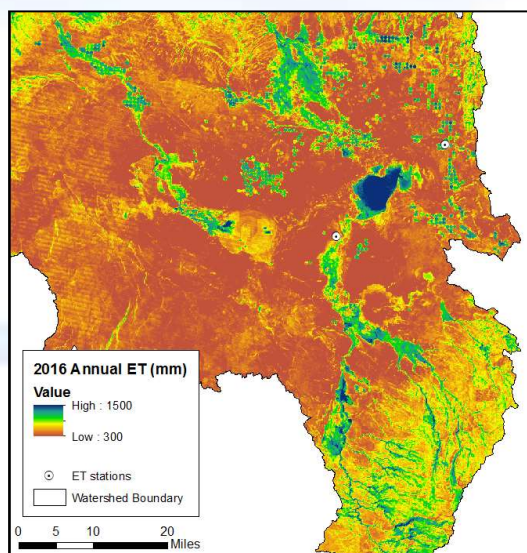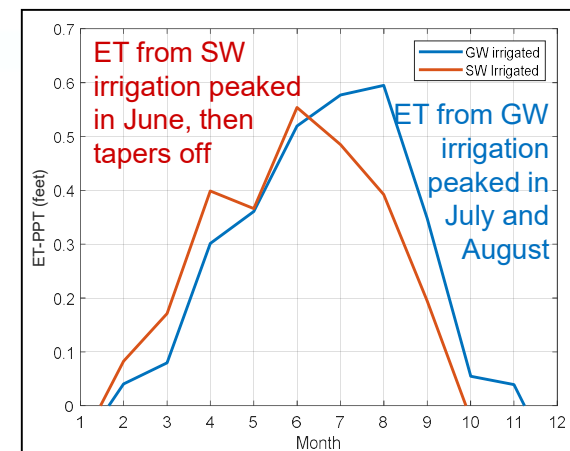

Harney field boundaries 2016
Watershed boundary
HUC8 boundary

Initial Work and Results

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- Test and apply **pyMETRIC**, **ET-Demands**, and **clear scene tools** to Harney Basin

- Use **Slack** and **GitHub** to troubleshoot and communicate

- Presented work at **AWRA** and **Basin Study** meetings

Annual Net ET - GW Irrigated
- < 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- > 3.5

ET from SW irrigation peaked in June, then tapers off

ET from GW irrigation peaked in July and August

2016 Annual ET (mm)
Value
High : 1500
Low : 300
⊙ ET stations
☐ Watershed Boundary

Groundwater Irrigated Fields

Average Actual Crop ET (pyMETRIC)

Mean Alfalfa Hay NIWR (ETDemands)

Surface Water Irrigated Fields

Average Actual Crop ET (pyMETRIC)

Mean Alfalfa Hay NIWR (ETDemands)

- KEEP LANDSAT DATA FREE !!!!

Your inputs may be provided to the Landsat Advisory Group and USGS at landsatdatapolicy@usgs.gov