

Landsat 4-9 & Water Resource Management

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1 Introduction

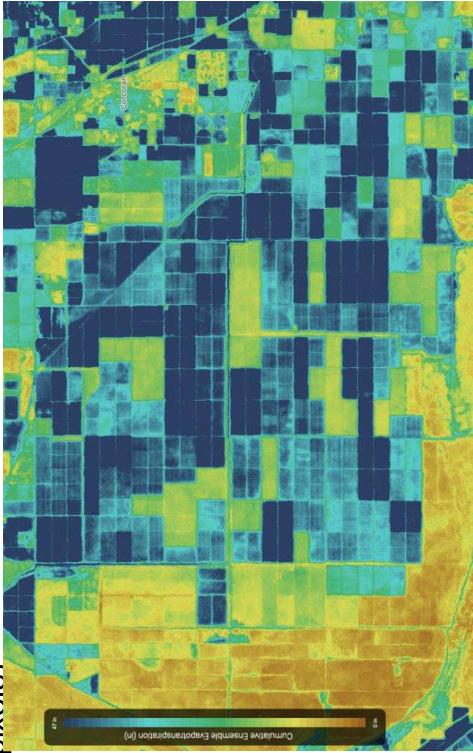
Landsat 4-9 plays a key role in monitoring and managing water resources by providing high-resolution data on **actual evapotranspiration (ETa)**. This is useful for estimating water consumption across diverse ecosystems, making it essential for agricultural water management and drought monitoring.

2 Key products and sensors

The **Landsat Provisional ETa product** estimates water loss from the Earth's surface by combining **thermal data** from the **Thermal Infrared Sensor (TIRS)** with visible and near-infrared (NIR) data from the **Operational Land Imager (OLI)**. [3]

The **ETa** product contains the following data [3]:

- Per-pixel actual evapotranspiration
- Unitless fraction of alfalfa-reference potential evapotranspiration (**ETr**)
- **ET** uncertainty
- Pixel Quality assessment (general stat for all Landsat pixels)



Figures 1: OpenET's ETa estimates for fields near Corcoran, CA. [5]

3 Why does it fit the problem?

- **High Spatial Resolution:** 30 meters is fine enough to monitor evapotranspiration at the farm field scale, enabling precise irrigation management. [3]
- **Efficiency and accuracy:** Landsat data offers greater efficiency, accuracy and cost savings compared to traditional methods. [1]
- **Cost-Effective:** Landsat data is freely available, which makes it accessible for both researchers and water resource managers.
- **Long-Term Monitoring:** Landsat 9, along with its predecessors, provides a continuous record, making it possible to track changes in water use over time.

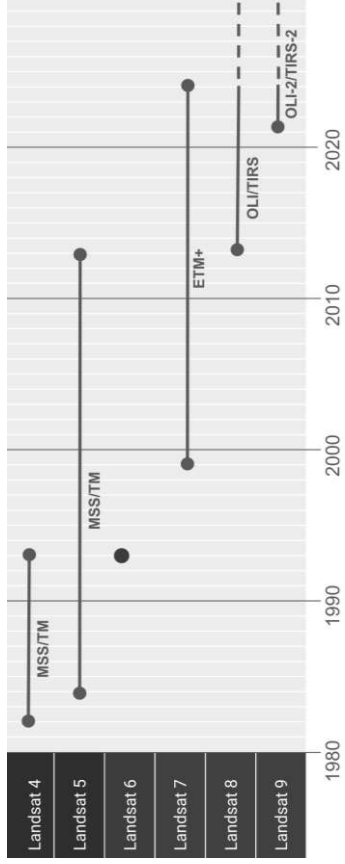


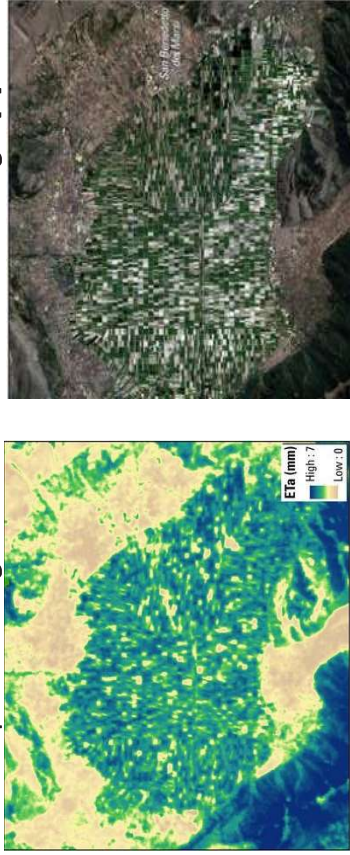
Figure 2: Overview of landsat satellites 4-9 with sensors. Dates and names of sensors sourced from [6].

4 Challenges

- The 16-day revisit time may not capture rapid changes in water use or water stress, but combining Landsat 8 and 9, along with other sources like **MODIS**, provides more frequent data coverage.
- Artifacts from the Landsat collection process such as the "blockiness" in areas with "contrasted thermal signatures." This is due to nearest-neighbor interpolation problems. [2]

5 Use Cases and Research

- The **ETa product** helps farmers match irrigation schedules to crop water demand by monitoring water use over large areas.
- In the USA, **OpenET** provides Landsat-based **ETa** to approximate water usage. The tool is used by farmers and policy makers alike. [7]
- To approximate water usage by non-agricultural vegetation, such as riparian vegetation's water consumption leading to the Colorado River's shrinkage. [4]



Figures 3 & 4: Example of evapotranspiration science product for agricultural fields on the Fucino plain near San Benedetto dei Marsi, Italy. [3]

References

1. Serbina, Larisa O., and Holly M. Miller. *Landsat and Water: Case Studies of the Uses and Benefits of Landsat Imagery in Water Resources*. Open-File Report 2014-1108, U.S. Geological Survey, 2014, <https://doi.org/10.3133/ofr20141108>.
2. "Landsat Collection 2 Known Issues." Landsat Collection 2 Known Issues | U.S. Geological Survey. Accessed September 18, 2024. <https://www.usgs.gov/landsat-missions/landsat-collection-2-known-issues>.
3. "Landsat Collection 2 Provisional Actual Evapotranspiration Science Product." Landsat Collection 2 Provisional Actual Evapotranspiration Science Product. Accessed September 18, 2024. <https://www.usgs.gov/landsat-missions/landsat-collection-2-provisional-actual-evapotranspiration-science-product>.
4. Rocchio, Laura E. "Meat of the Matter: Colorado River over-Consumed." NASA, May 1, 2024. <https://landsat.gsfc.nasa.gov/article/meat-of-the-matter-colorado-river-over-consumed/>.
5. Rocchio, Laura E. P. "Ten Years of TIRS: Data for a Thirsty World." NASA, June 2, 2023. <https://landsat.gsfc.nasa.gov/article/ten-years-of-tirs-data-for-a-thirsty-world/>.
6. "Timeline", NASA, <https://landsat.gsfc.nasa.gov/satellites/timeline/>
7. "What is Evapotranspiration?" OpenET. Accessed September 18, 2024. <https://etdata.org/what-is-evapotranspiration/>.