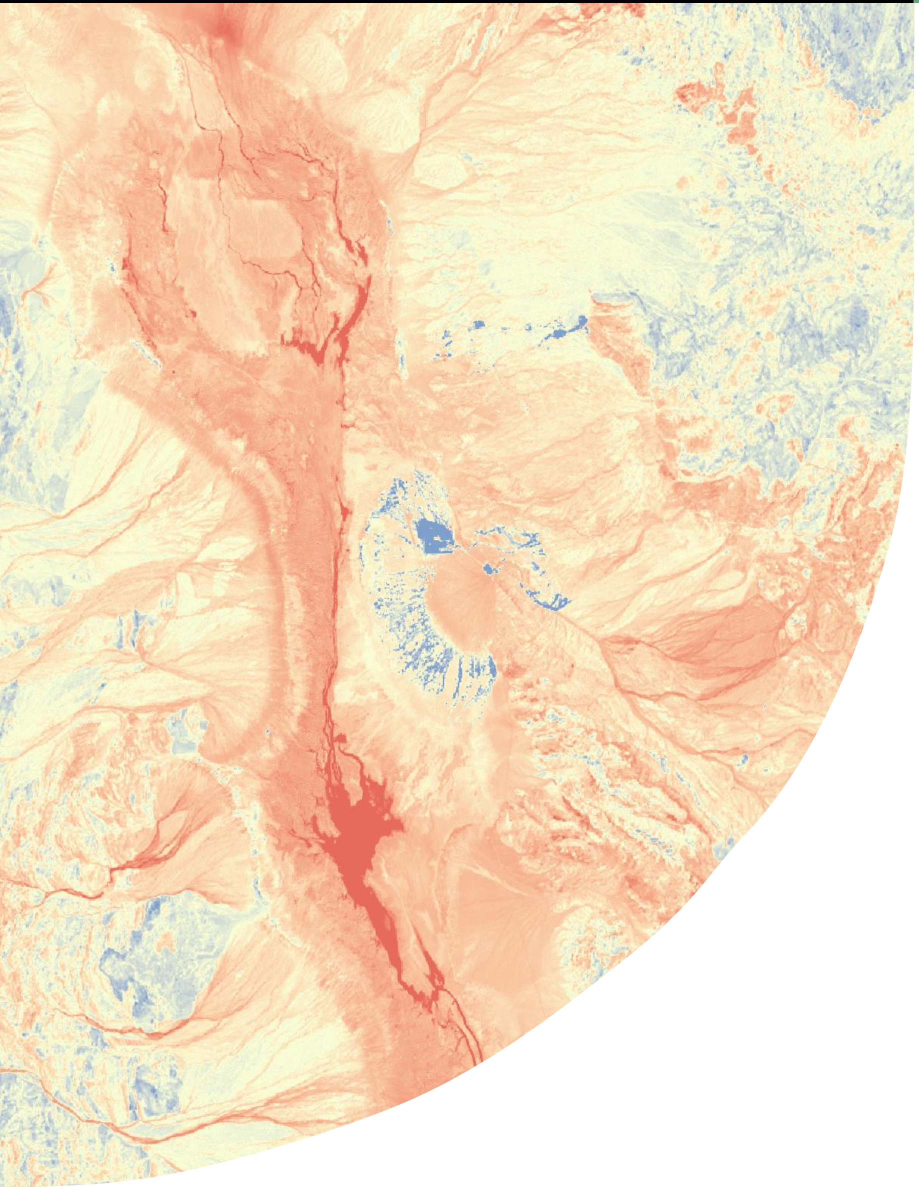
National Aeronautics and Space Administration



Amargosa Basin Ecological Conservation

Evaluating the Health of the Mesquite Bosque in the Amargosa Basin using Earth Observations

Gabrielle Shen, Alondra Gallegos, Simon Ng, Peter Blatchford (Analytical Mechanics Associates)

California – JPL | Spring 2025

DEVELOP

Western Honey Mesquite


Image Credit: Caroline Baumann

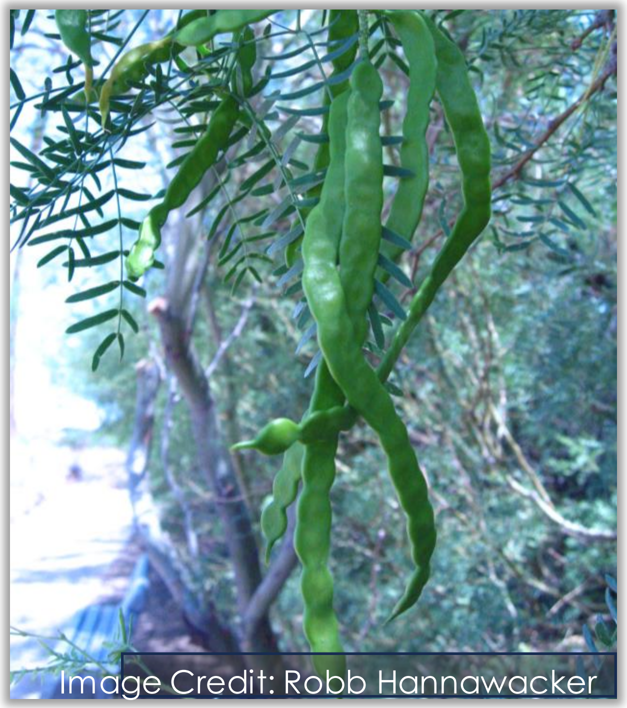


Image Credit: Robb Hannawacker

Western Honey Mesquite (*Prosopis glandulosa* var. *torreyana*) holds **cultural importance** to the **Timbisha Shoshone**

Community Concerns

Image Credit: Alondra Gallegos

Image Credit: Austin Roy

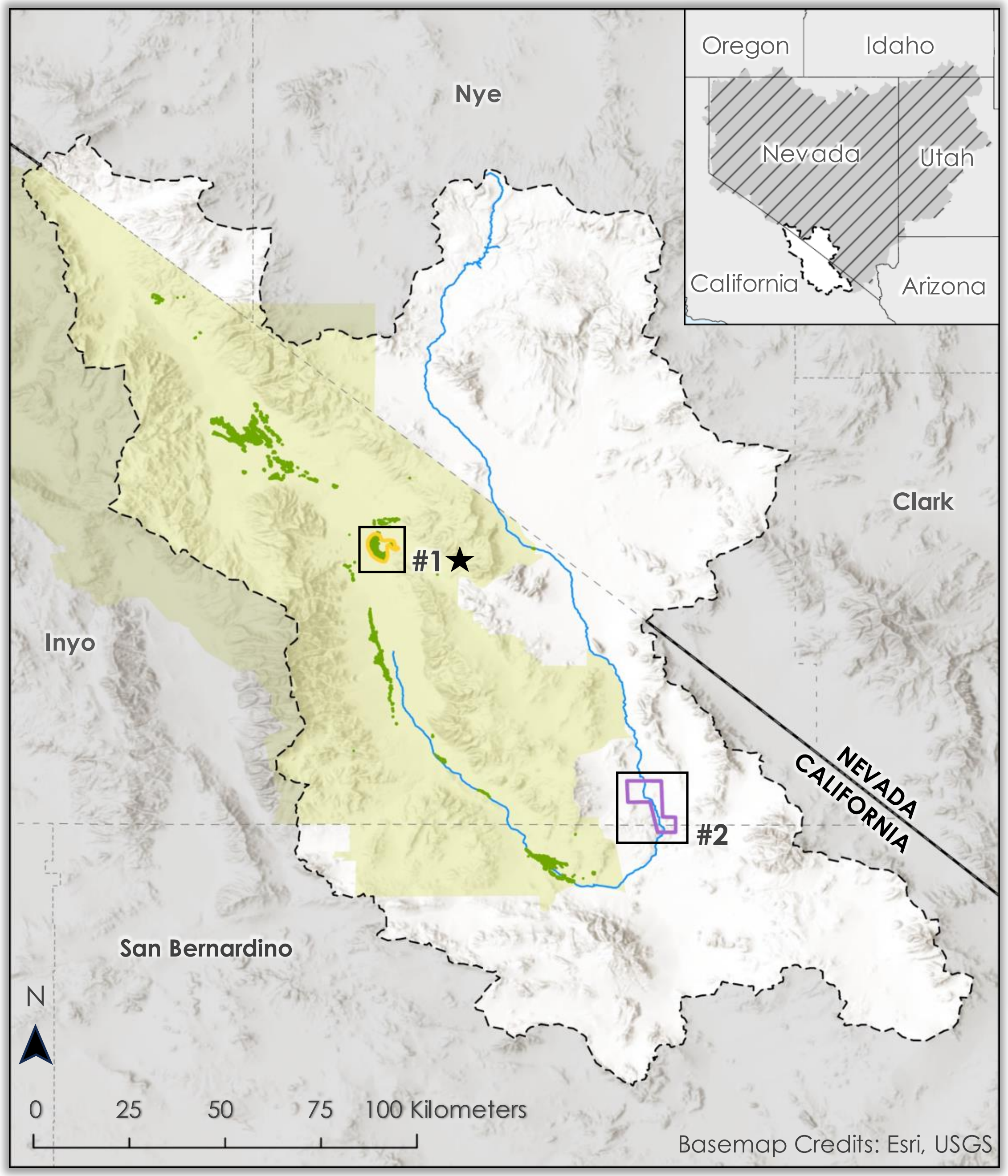
Altered hydrology from **increased development** threatens **mesquite bosque health** and the habitat of the endangered **Amargosa Vole**

Image Credit: Bob Wick

Partners

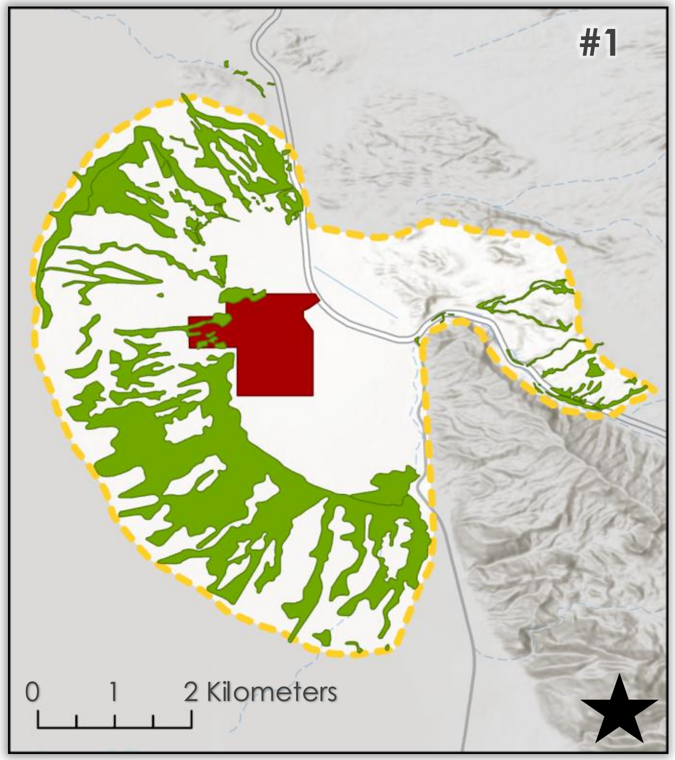
- **Timbisha Shoshone Tribe**
- **U.S. Fish & Wildlife Service**, Southern Nevada Fish and Wildlife Office, Partners for Fish and Wildlife Program
- **Friends of the Amargosa Basin**
- California Department of Fish and Wildlife
- National Park Service, Death Valley National Park

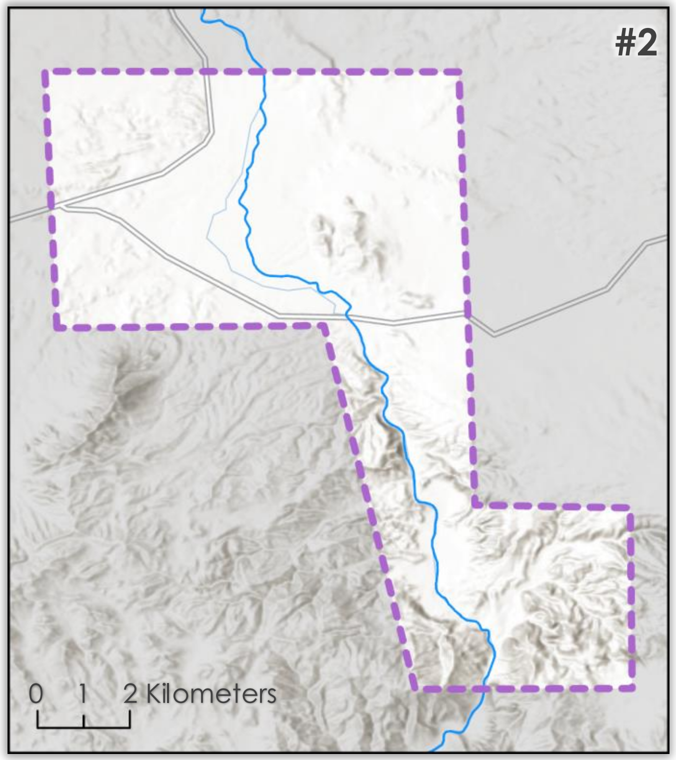
Study Area



Regional Map

- Amargosa River
- Mesquite Bosque
- Great Basin
- Amargosa Basin
- Death Valley National Park





Area of Interest #1

- Furnace Creek Province
- Timbisha Shoshone Tribal Land
- ★ Focus of this study

Area of Interest #2

- Vole Habitat

Project Objectives

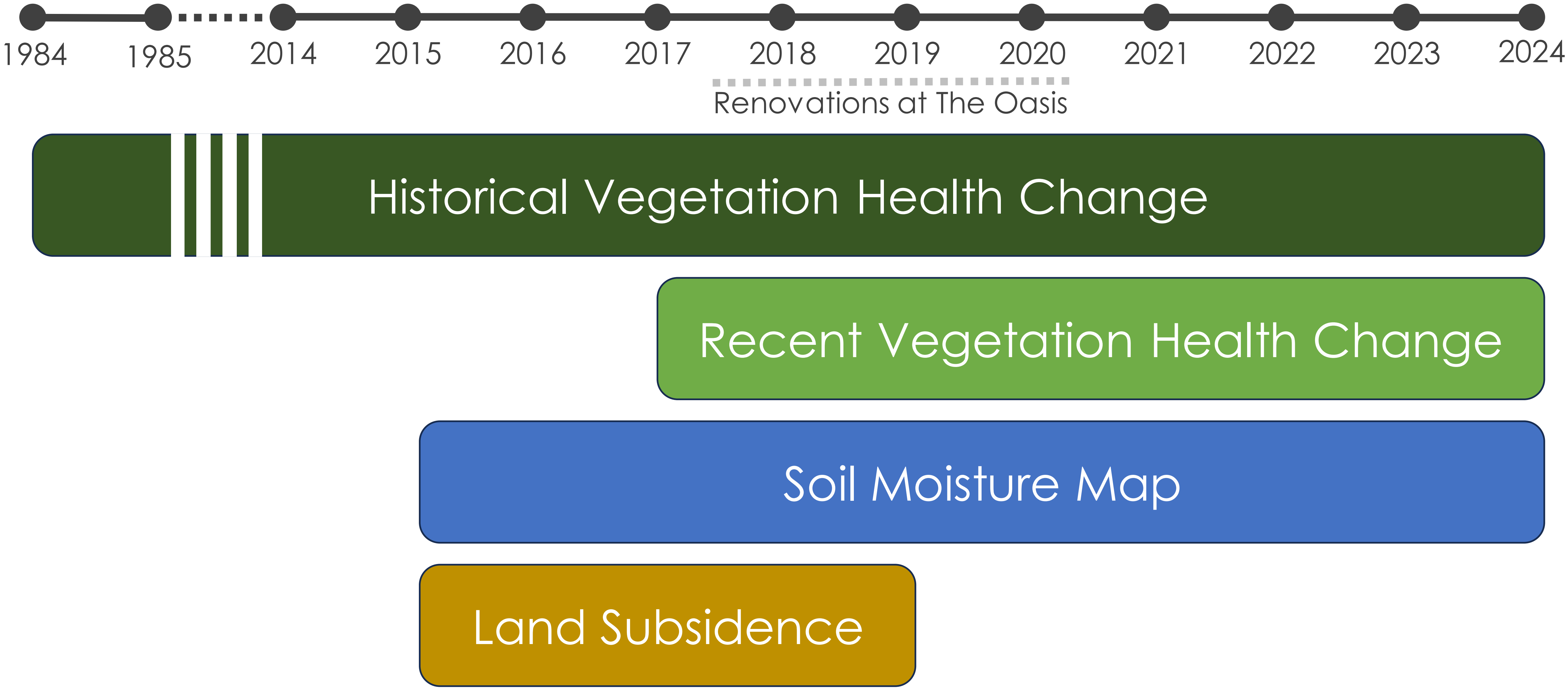
Use **NASA Earth observations** to create:

- Historic Vegetation Health Change Map
- Recent Vegetation Health Change Map
- Soil Moisture Map
- Land Subsidence Map

In order to:

- Aid effective strategies for water conservation and mesquite bosque restoration
- Investigate potential causes for changes, such as increased development

Study Period: June 1984 – December 2024



Earth Observations: Data Acquisition

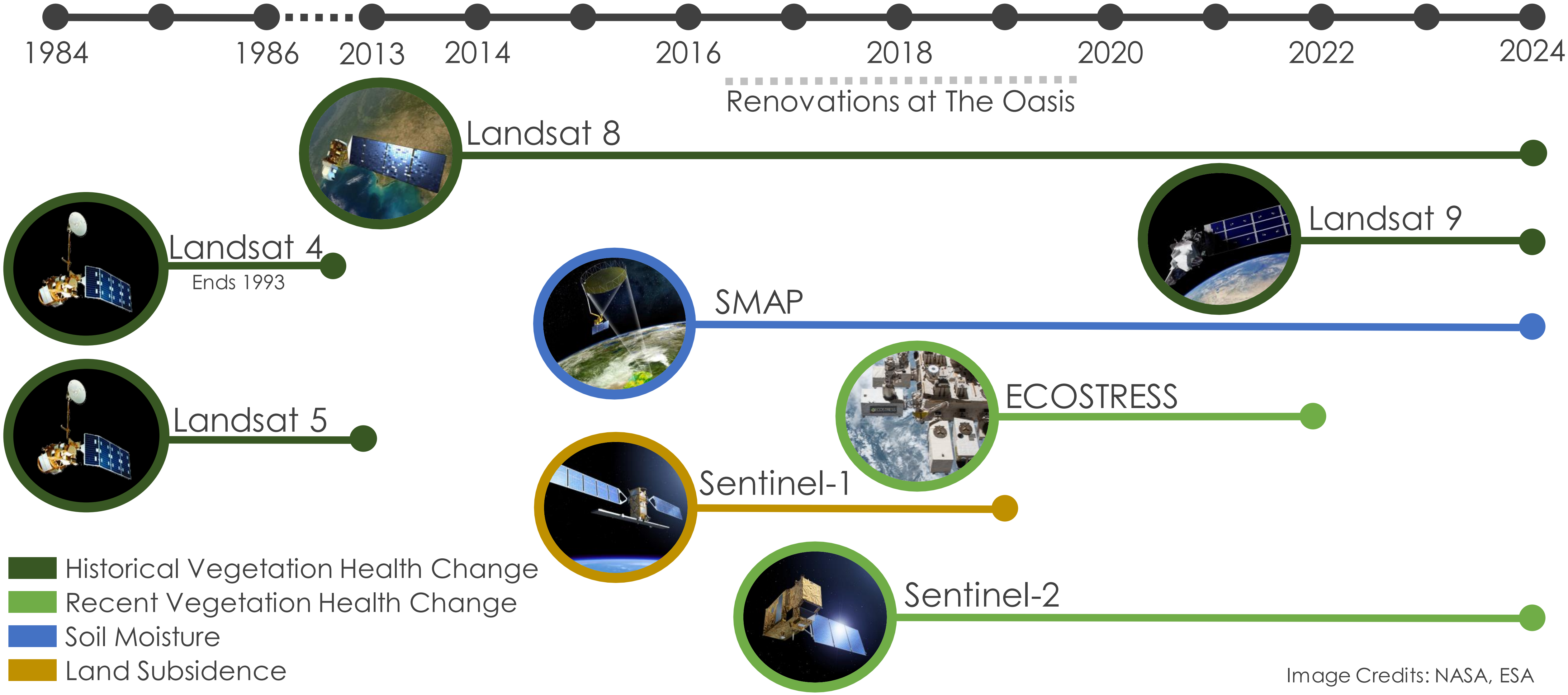
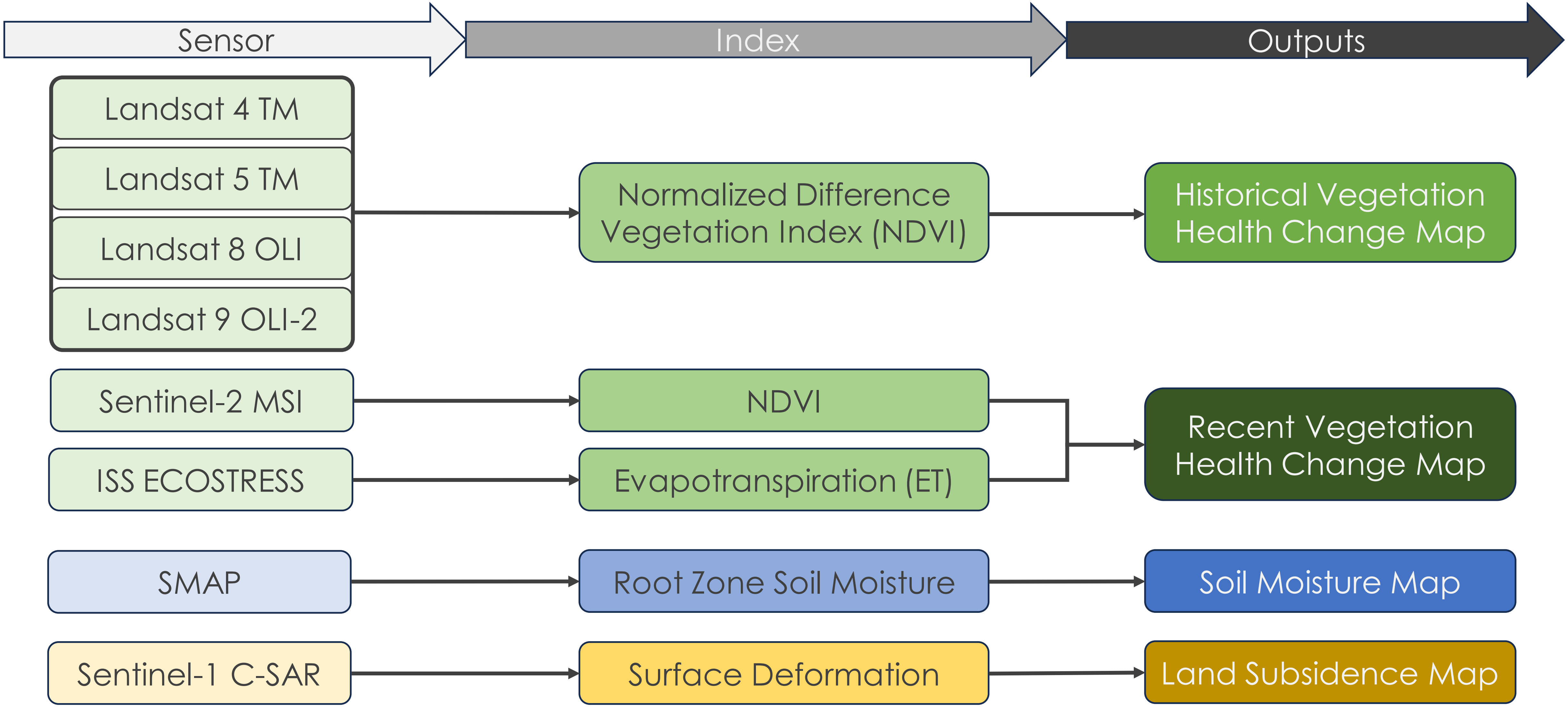


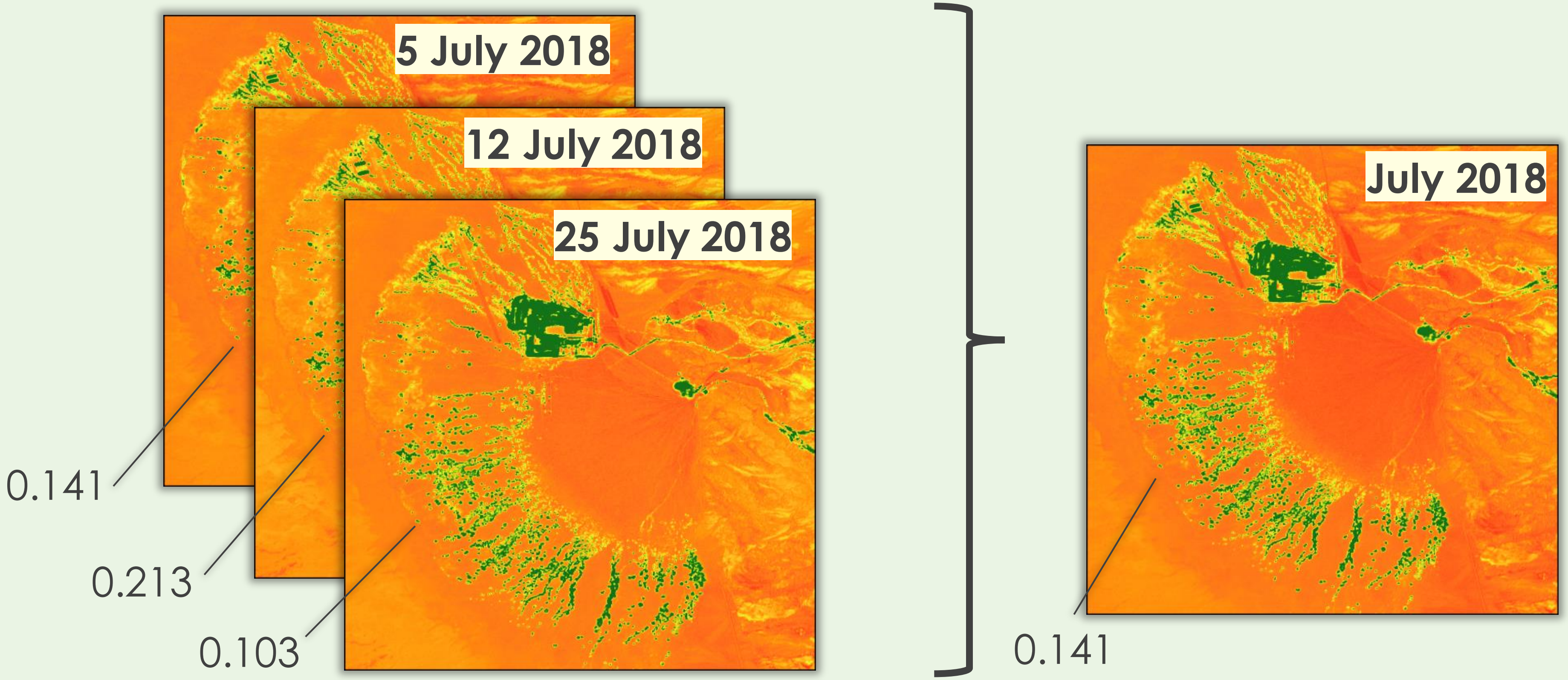
Image Credits: NASA, ESA

Methodology Overview



Methods: Data Processing

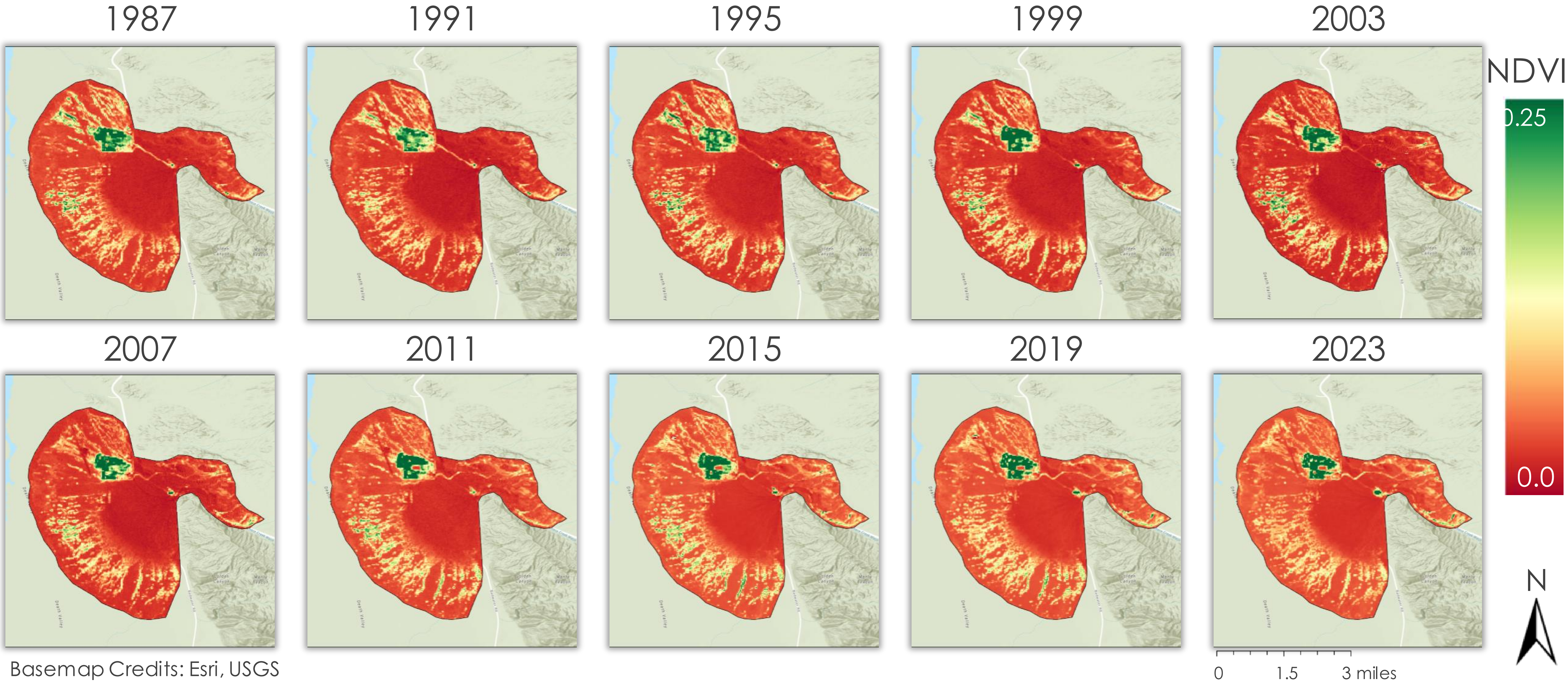
Example Sentinel-2 data



Get images throughout month → **Get each pixel value** → **Take median pixel by pixel** → **Median composite image**

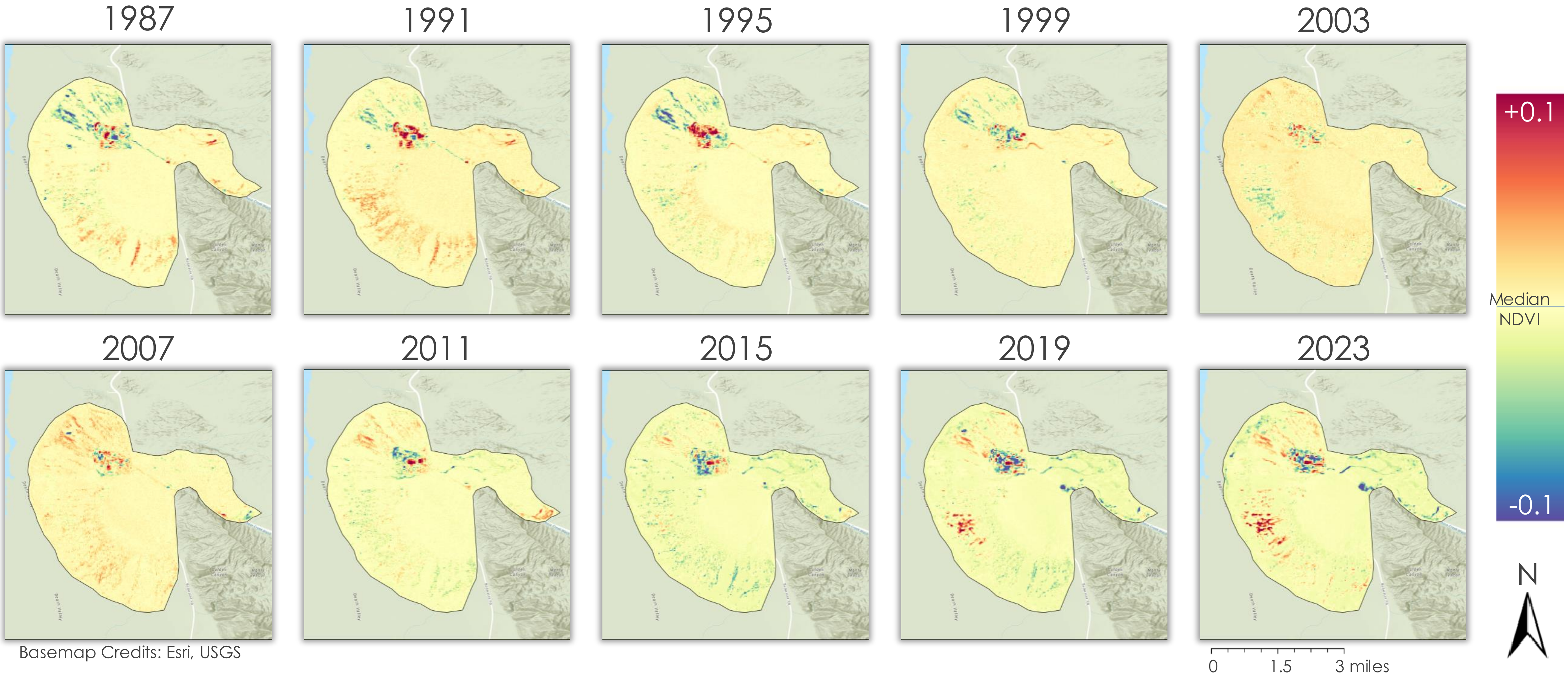
Repeat for additional years

Results: Landsat Historical NDVI, 1984–2024



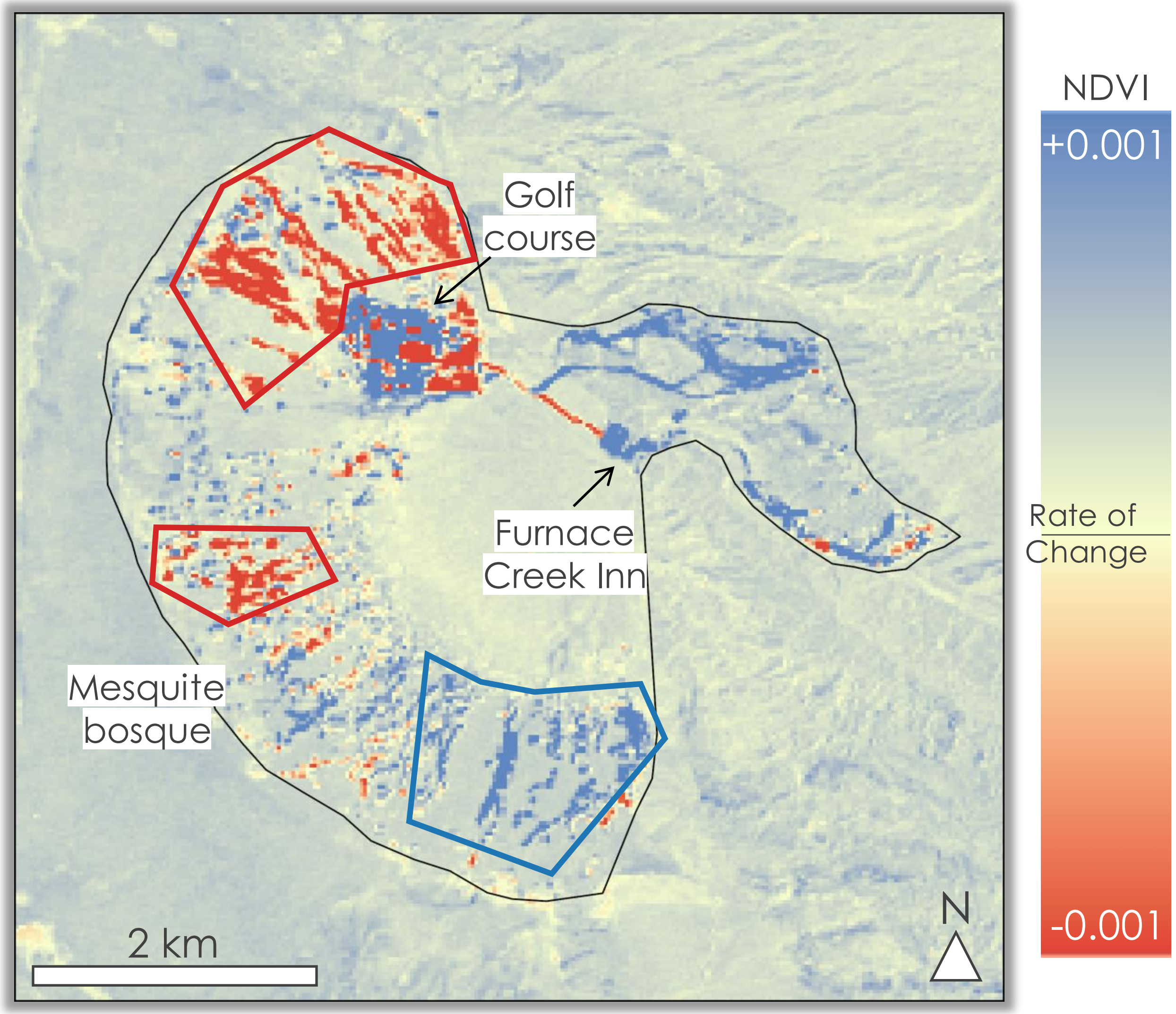
Basemap Credits: Esri, USGS

Results: Difference from Median NDVI, 1984–2024



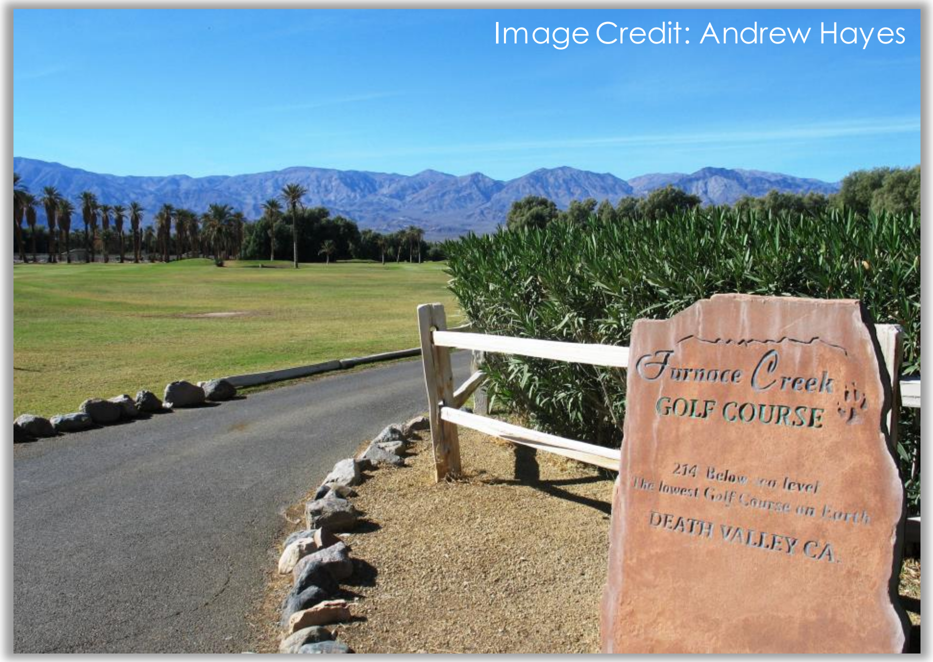
Basemap Credits: Esri, USGS

Results: Landsat Historical NDVI, 1984–2024

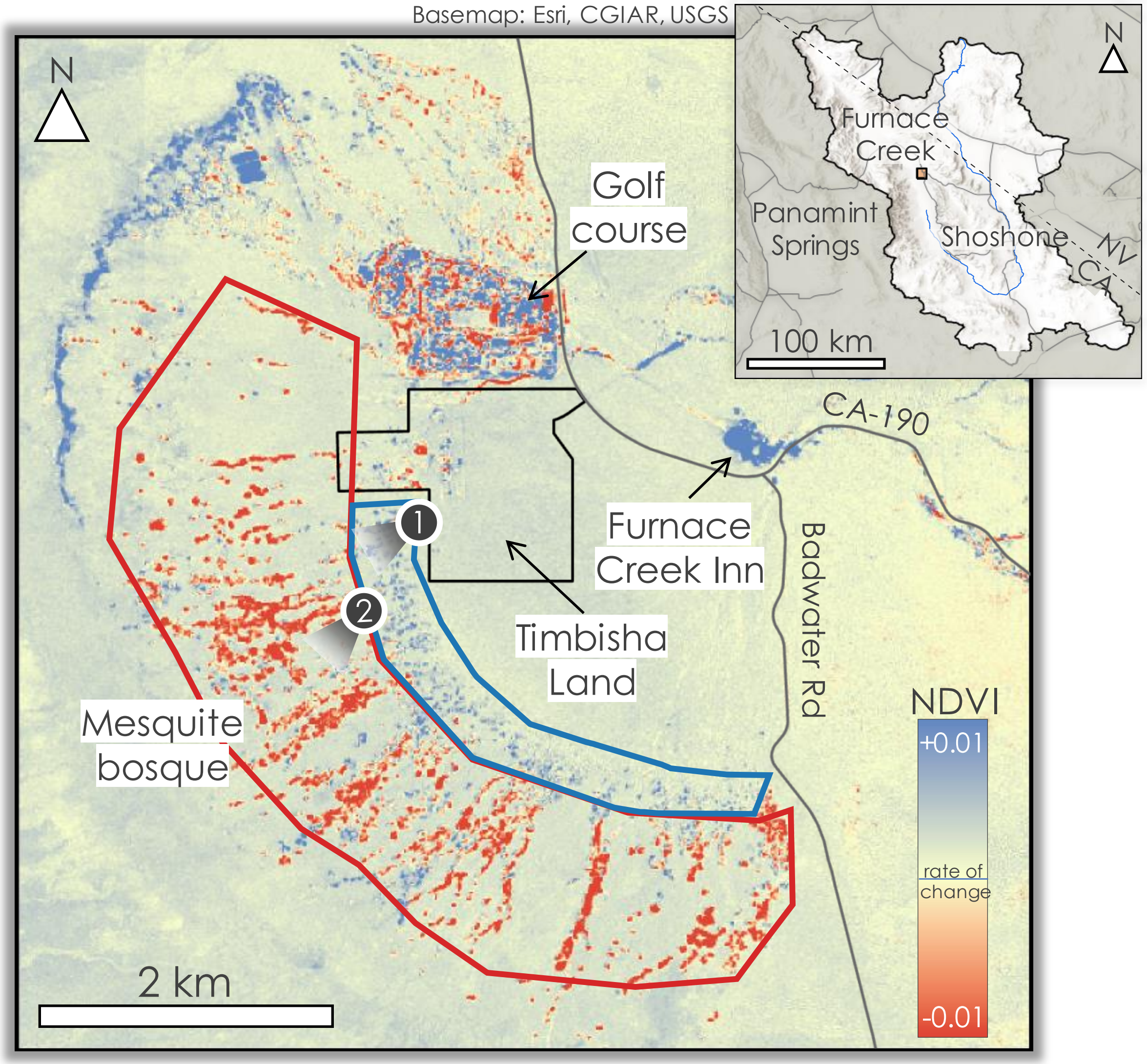


NDVI Rate of Change by Pixels

- Over 40 years, near the golf course and a central pocket decline
- A southern pocket shows increasing health



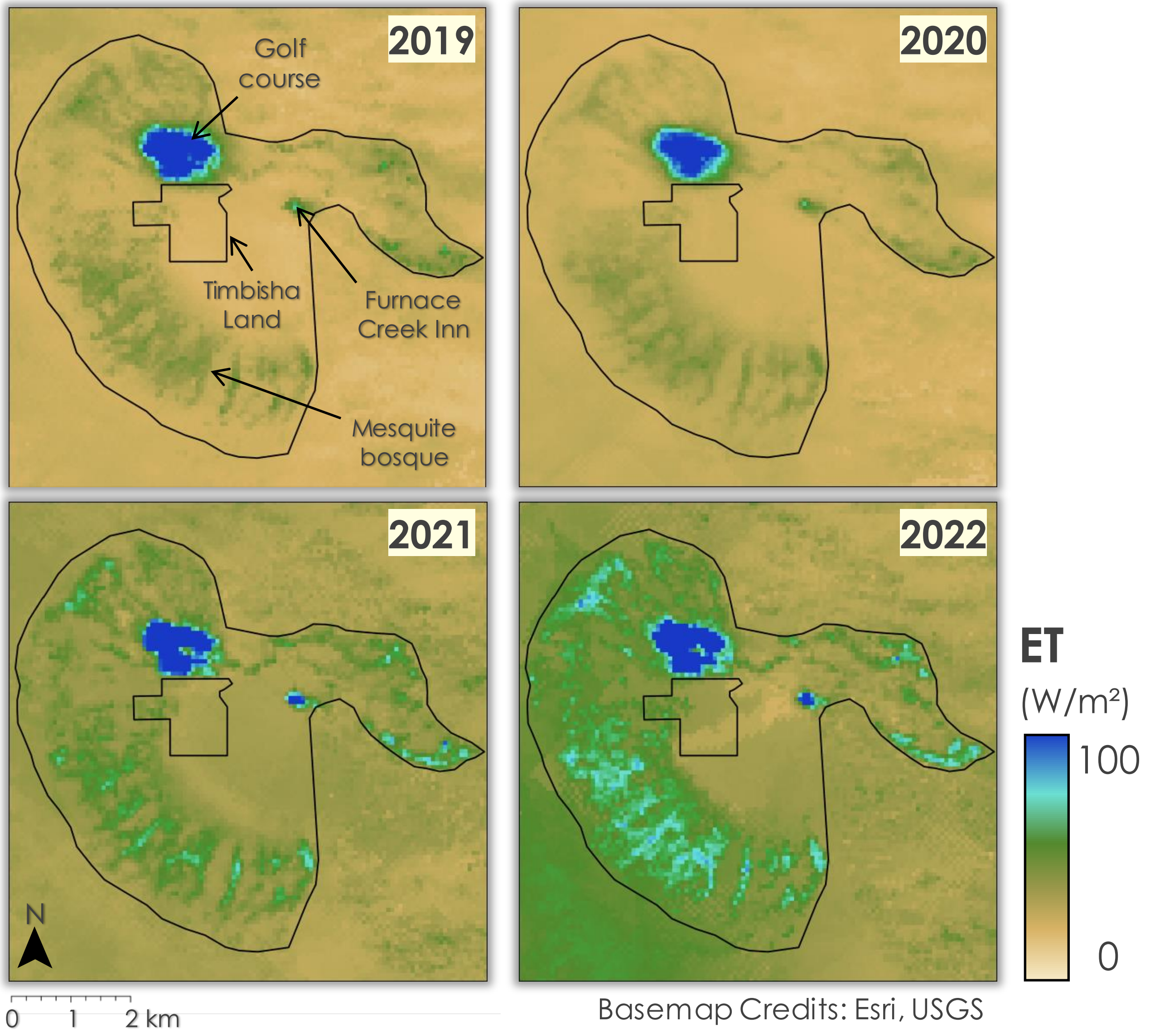
Results: Change in Vegetation Health, 2017–2024



- Sandy soil
- Mesquite accumulating sand mounds

- Crusty, powdery, clayey
- Possibly more saline
- Older mesquite

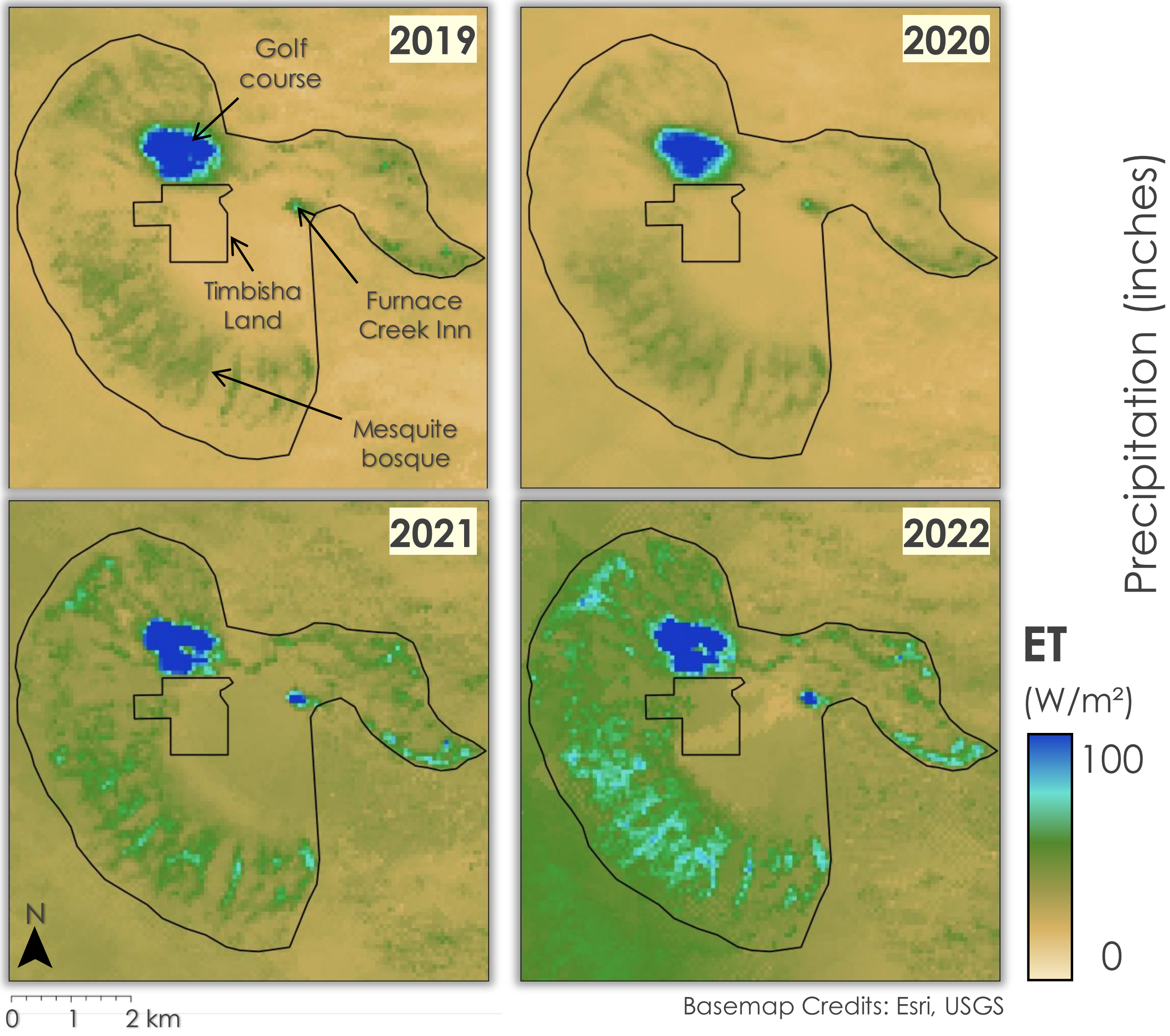
Results: Evapotranspiration (ET)



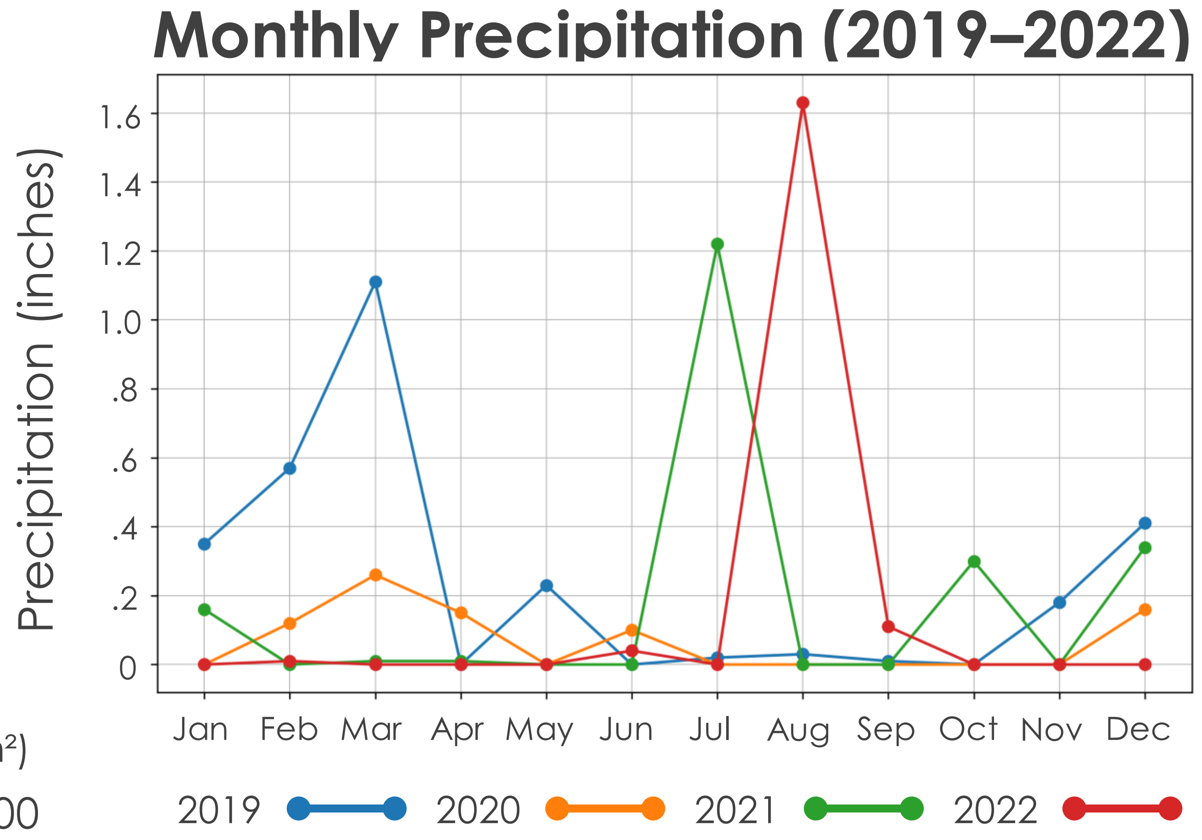
Basemap Credits: Esri, USGS

- **Evapotranspiration (ET)** is the total release of water from the land surface to the atmosphere
- Estimates total **transpiration** & **evaporation** from surface temperature data
- **Higher ET** indicates active vegetation using available water
- **Lower ET** can signal plant stress or reduced water availability

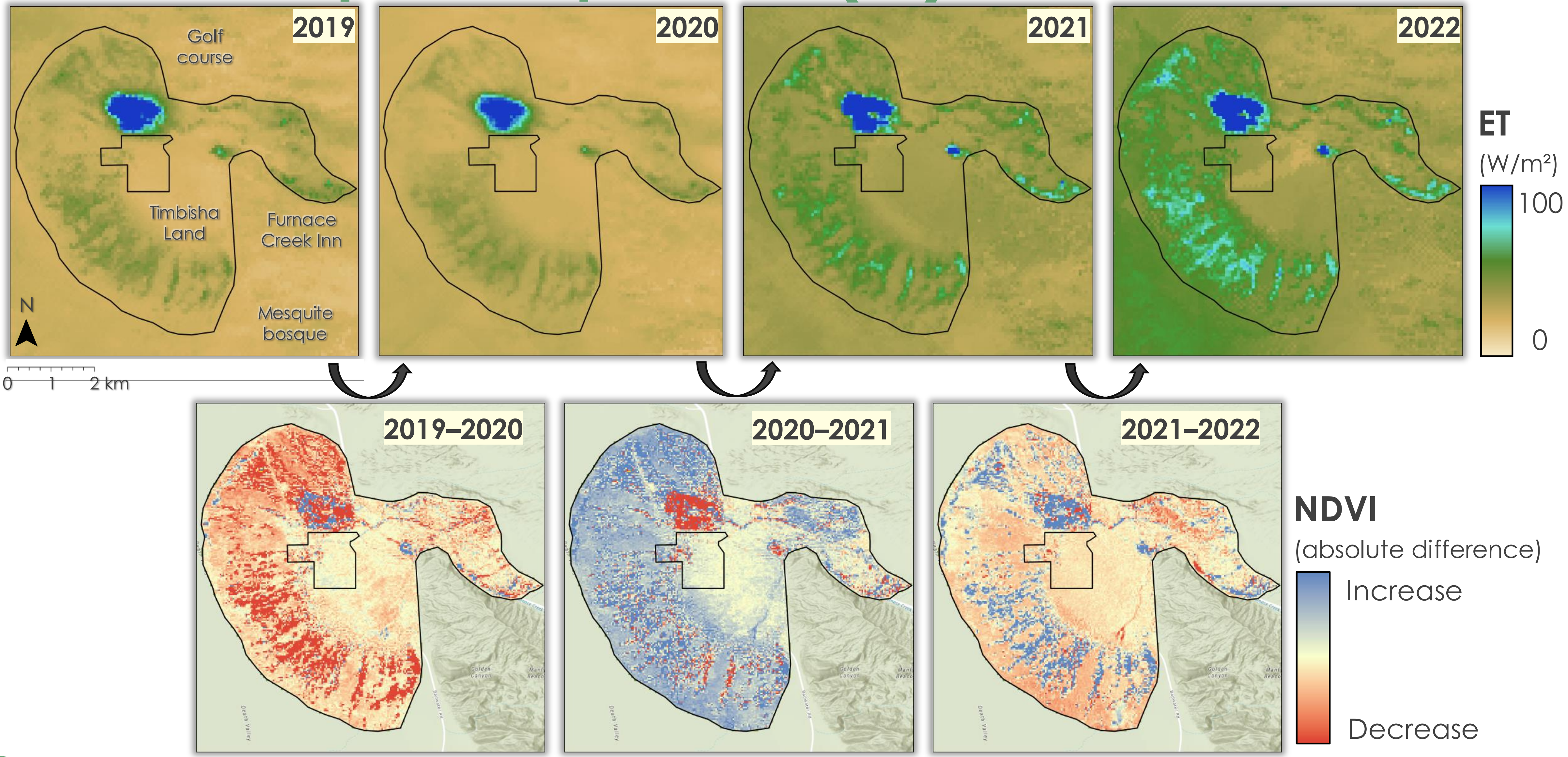
Results: Evapotranspiration (ET)



Basemap Credits: Esri, USGS



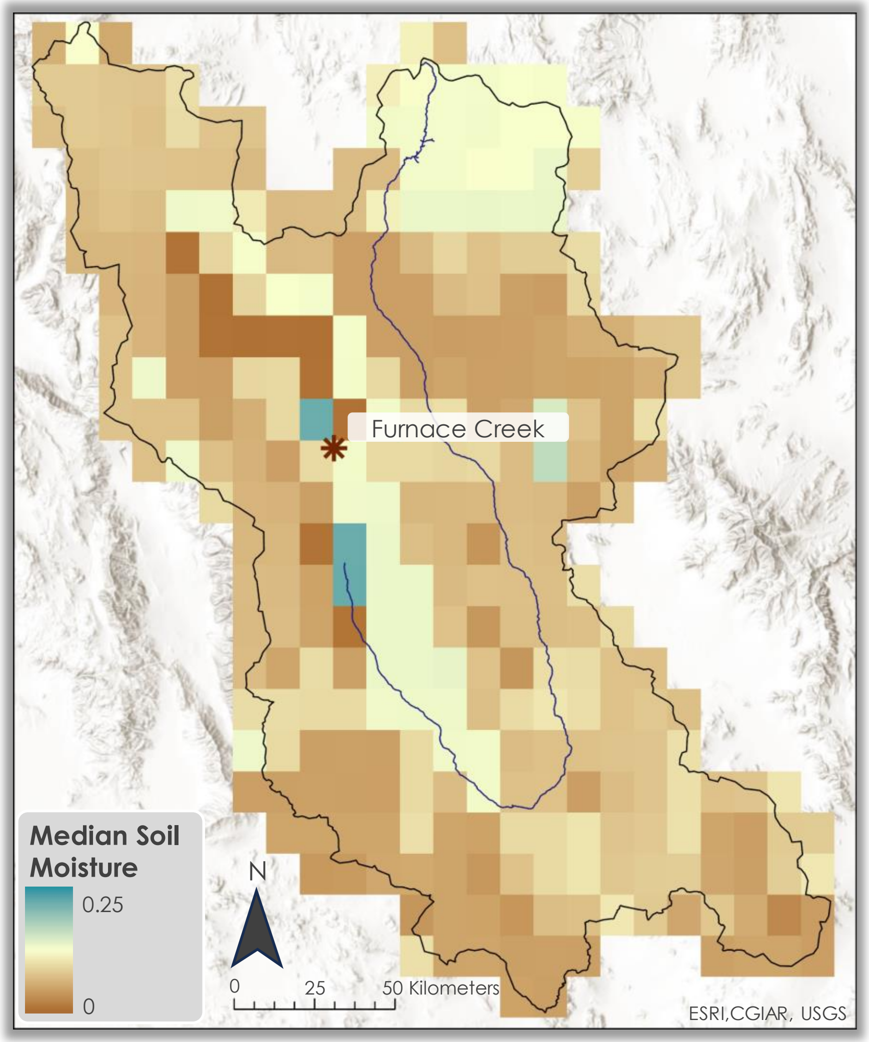
Results: Evapotranspiration (ET)



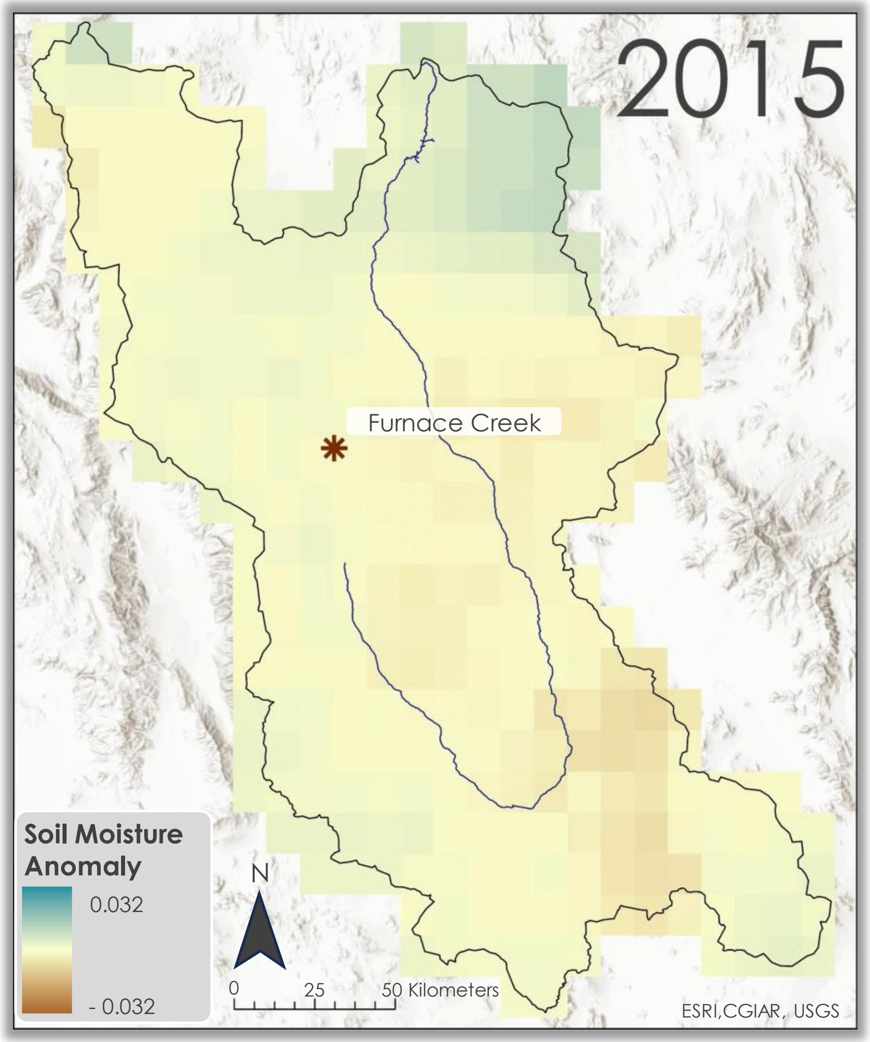
Basemap Credits: Esri, USGS

Results: Soil Moisture

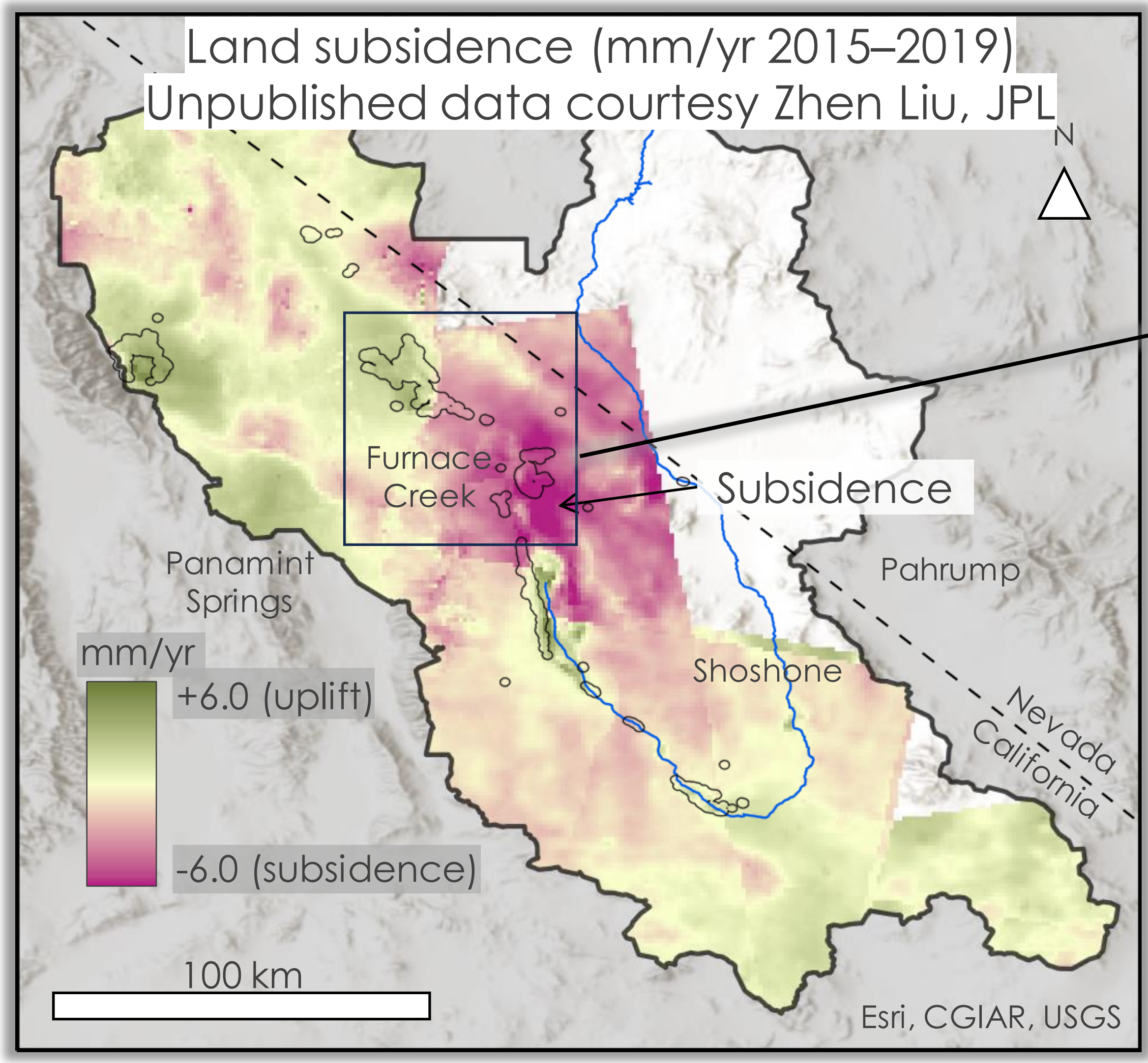
July Median Soil Moisture (2015–2024)

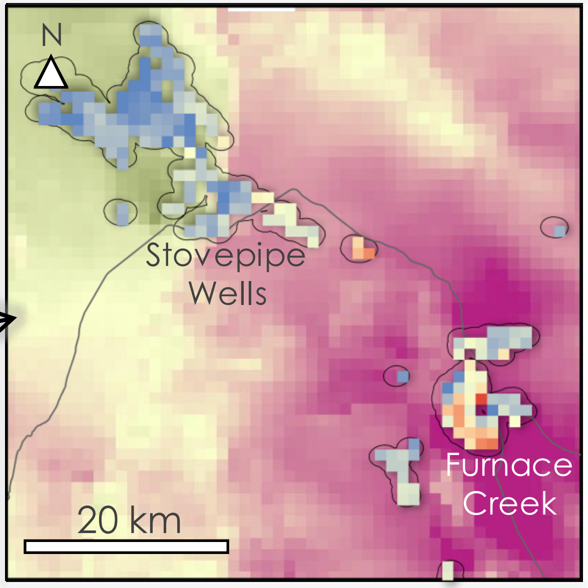


Soil Moisture Yearly July Anomaly

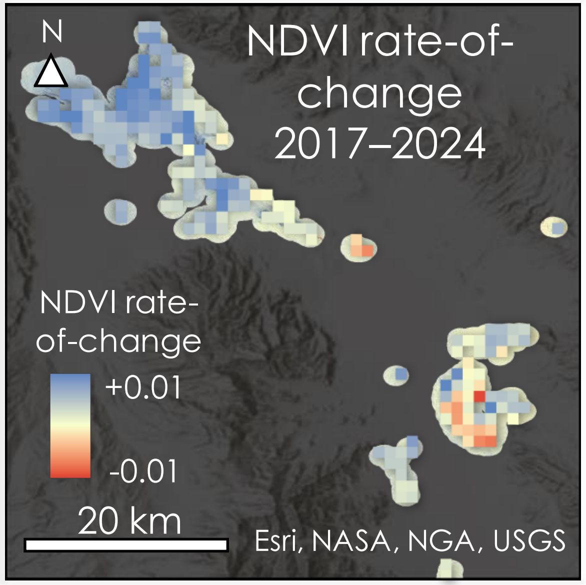


Results: Sentinel-1 Land Subsidence





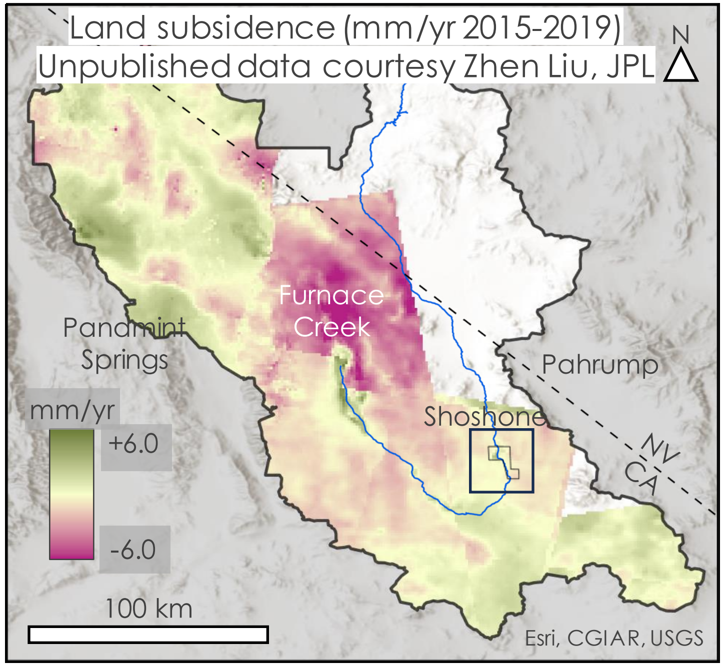
v.s.

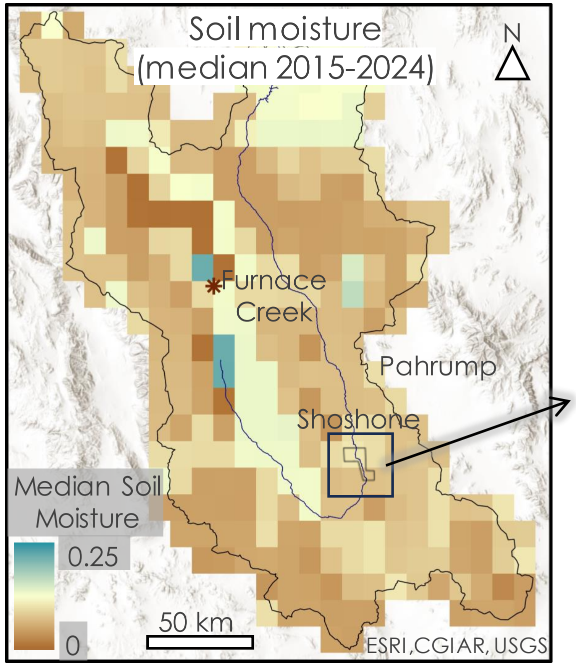


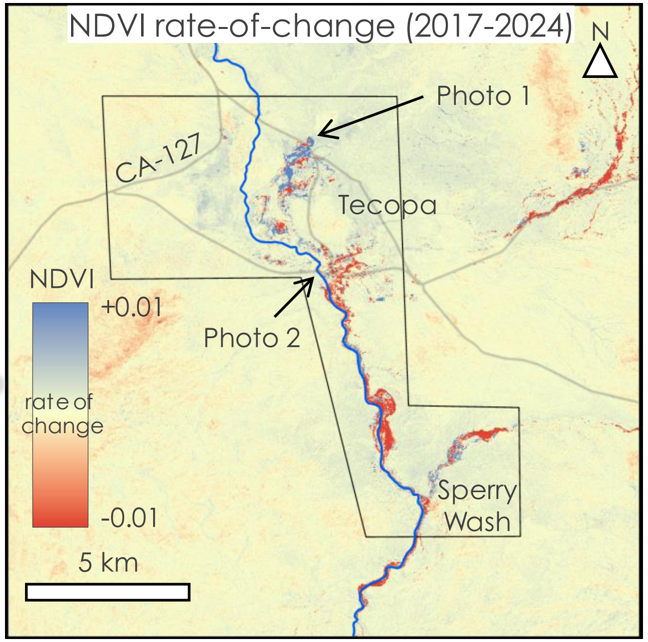
Correlation Coefficient = 0.31 (out of 1)

Land subsidence has a weak-moderate correlation with change in mesquite health, but doesn't completely explain decreasing mesquite health.

Results: Amargosa Vole Habitat







Evapotranspiration (2022)

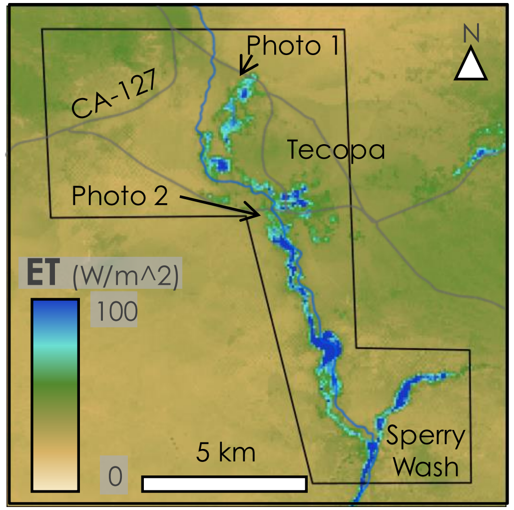


Image Credit: Austin Roy

Image Credit: Simon Ng

Image Credit: Vicky Espinoza

Errors & Uncertainties

Temporal Variability

Spatial Resolution

Groundwater Hydrology

Conclusions

Partner Implementation:

- ✓ **Identify** areas of healthy and troubled mesquite to inform conservation efforts
- ✓ **Access** a historical record of mesquite health change
- ✓ **Utilize** land subsidence as a tool to understand groundwater change
- ✓ **Visualize** temporal changes in soil moisture throughout the watershed

Feasibility:

- ✓ **Detect** and **monitor** changes in mesquite bosque health
- ✗ **Assess** how changes in groundwater availability drive mesquite health change

Acknowledgements

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Timbisha Shoshone Tribe

Austin Roy (California Department of Fish and Wildlife

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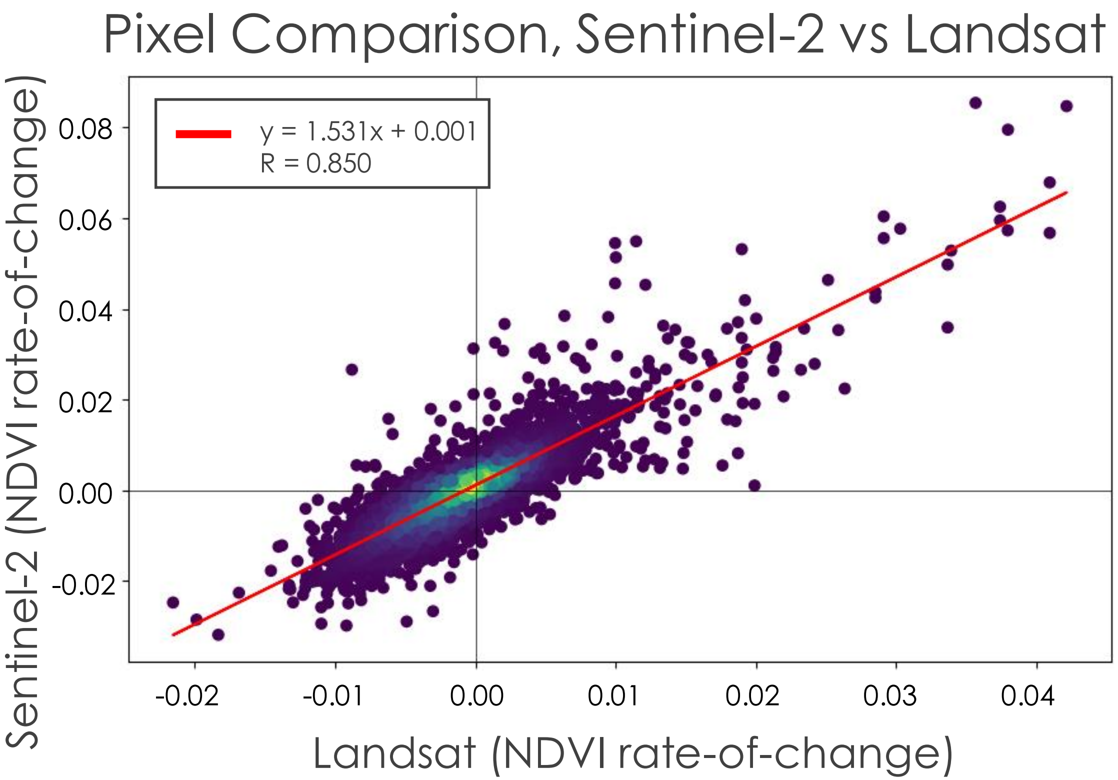
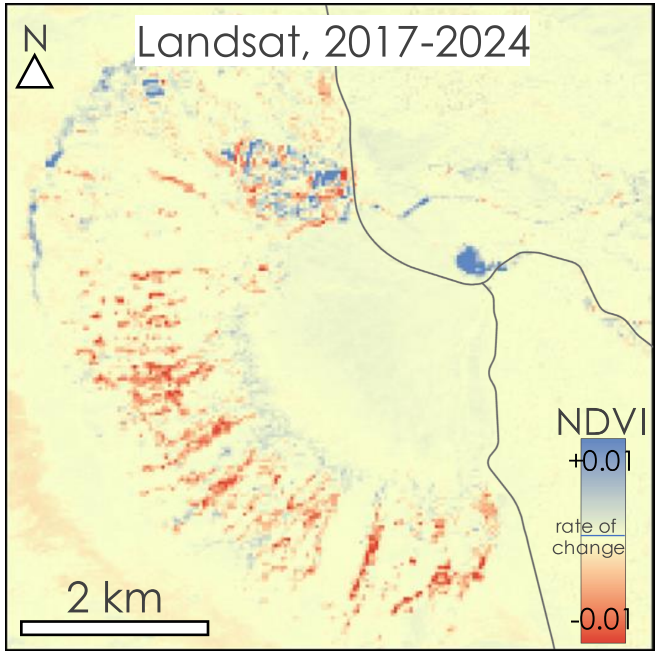
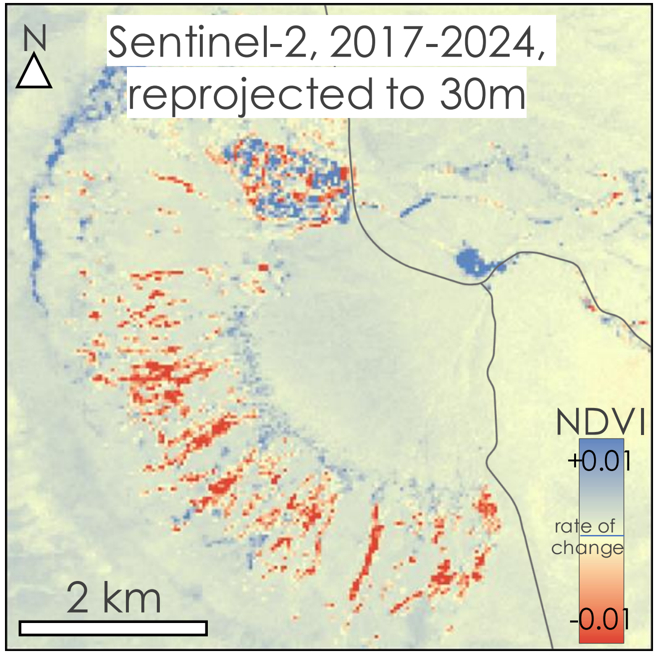
Appendix: Landsat vs Sentinel-2 time series



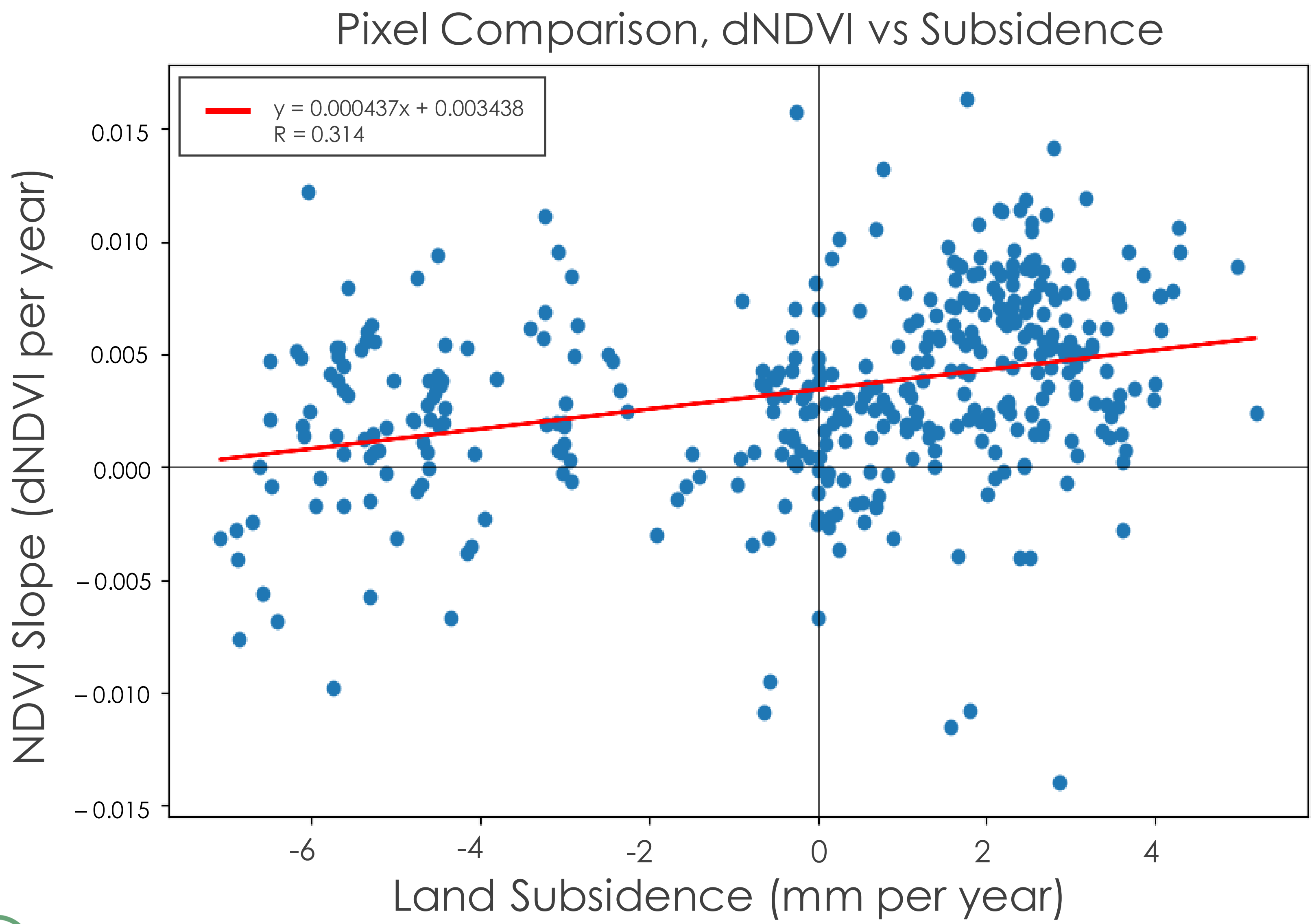




Sentinel-2 and Landsat NDVI rate-of-change 2017–2024 comparison shows strong correlation between Landsat and Sentinel-2

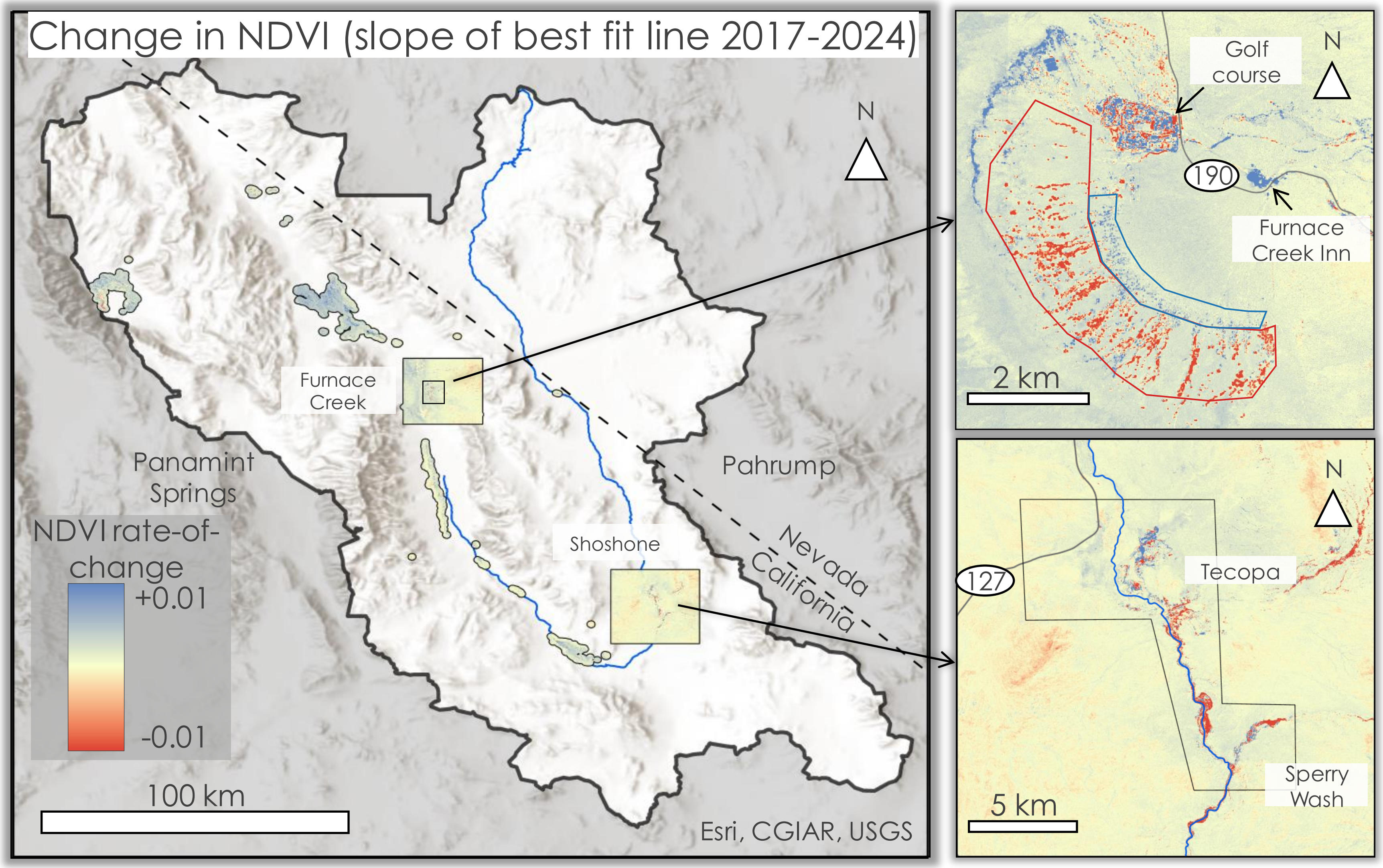
But Landsat image is ~1.5x lower value than Sentinel-2

Appendix: dNDVI vs. Land Subsidence



Coefficient of Correlation (R) indicates a **weak-moderate positive correlation** between land subsidence and NDVI slope

Appendix: Sentinel-2 NDVI, 2017-2024



- Generally decreasing NDVI in central red area
- Band of increasing NDVI in blue polygon
- Largely decreasing NDVI along streambeds

Earth Observations

Sentinel-1 InSAR

Interferometric Synthetic Aperture Radar

- Surface deformation
- Land subsidence
- Copernicus, 20 m resolution

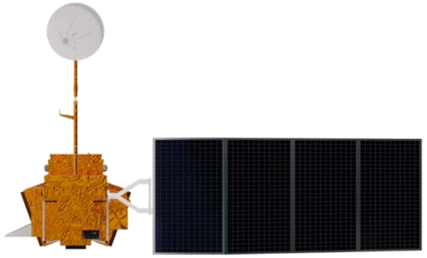
Sentinel-2 MSI

Multi-Spectral Instrument

- Normalized Difference Vegetation Index (NDVI)
- Copernicus, 10 m resolution

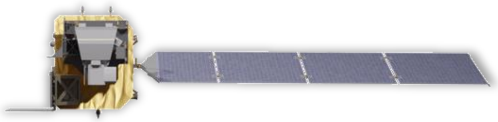
Image Credits: Copernicus ESA

Earth Observations



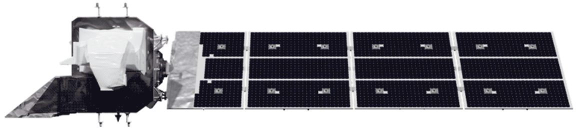
Landsat 4-5

Thematic Mapper (TM)
- NDVI/Land Cover Change
- USGS EarthExplorer
- 30 m resolution
- 1984 - 2013



Landsat 8

Operational Land Imager (OLI)
- NDVI/Land Cover Change
- USGS EarthExplorer
- 30 m resolution
- 2014 - 2024



Landsat 9

Operational Land Imager (OLI)-2
- NDVI/Land Cover Change
- USGS EarthExplorer
- 30 m resolution
- 2021 - 2024

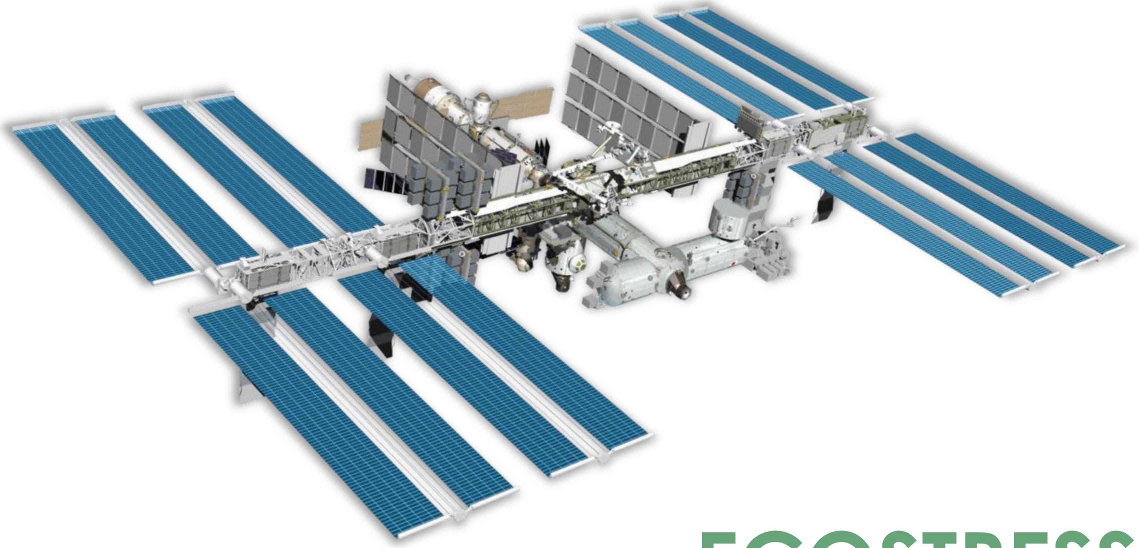
Image Credits: NASA

Earth Observations

SMAP

- **Soil Moisture Active Passive**
- Root Zone Soil Moisture: 0–100 cm depth
- National Snow & Ice Data Center
- 9 km resolution

Image Credits: NASA



ECOSTRESS

- **Ecosystem Spaceborne Thermal Radiometer Experiment on** [the International] **Space Station**
  - Evapotranspiration
  - AppEEARS
  - 70 m resolution