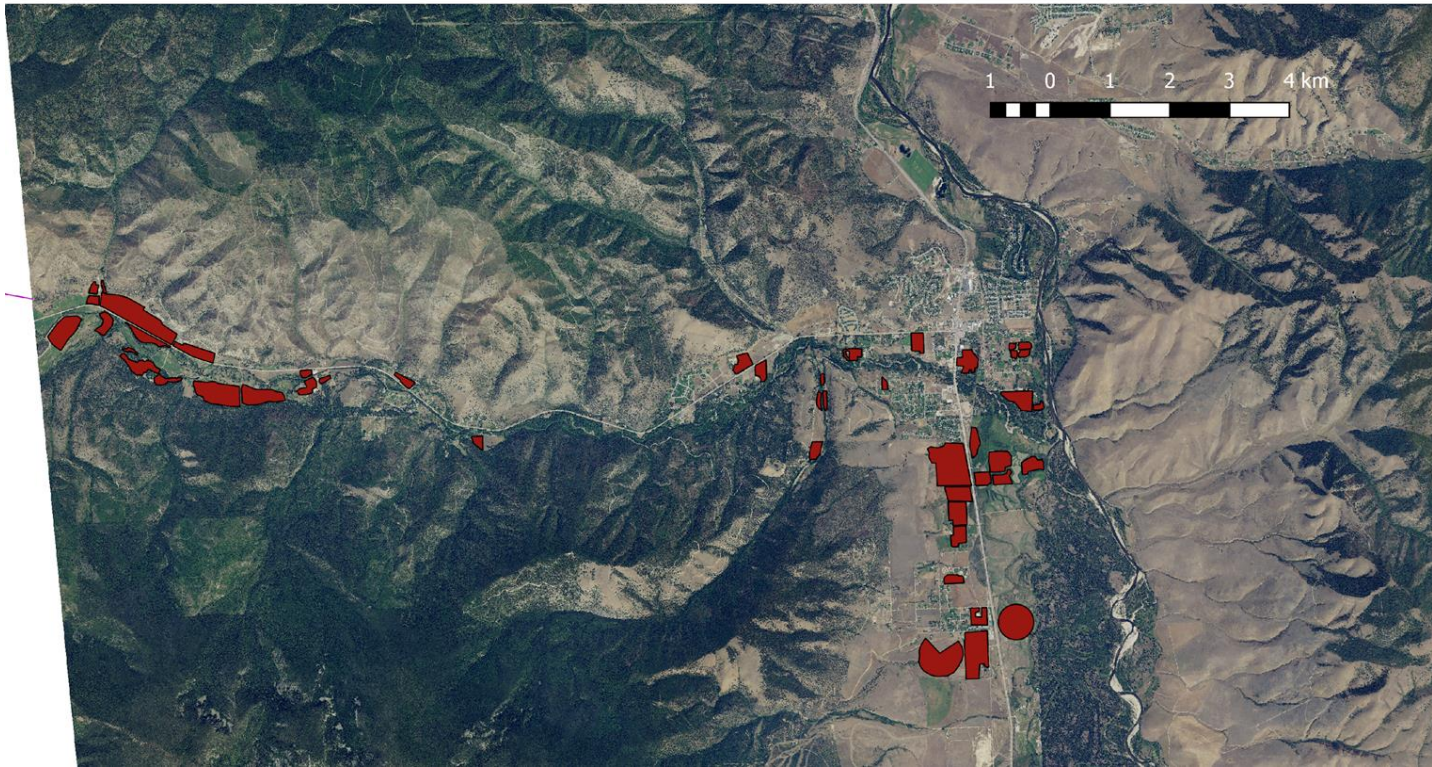
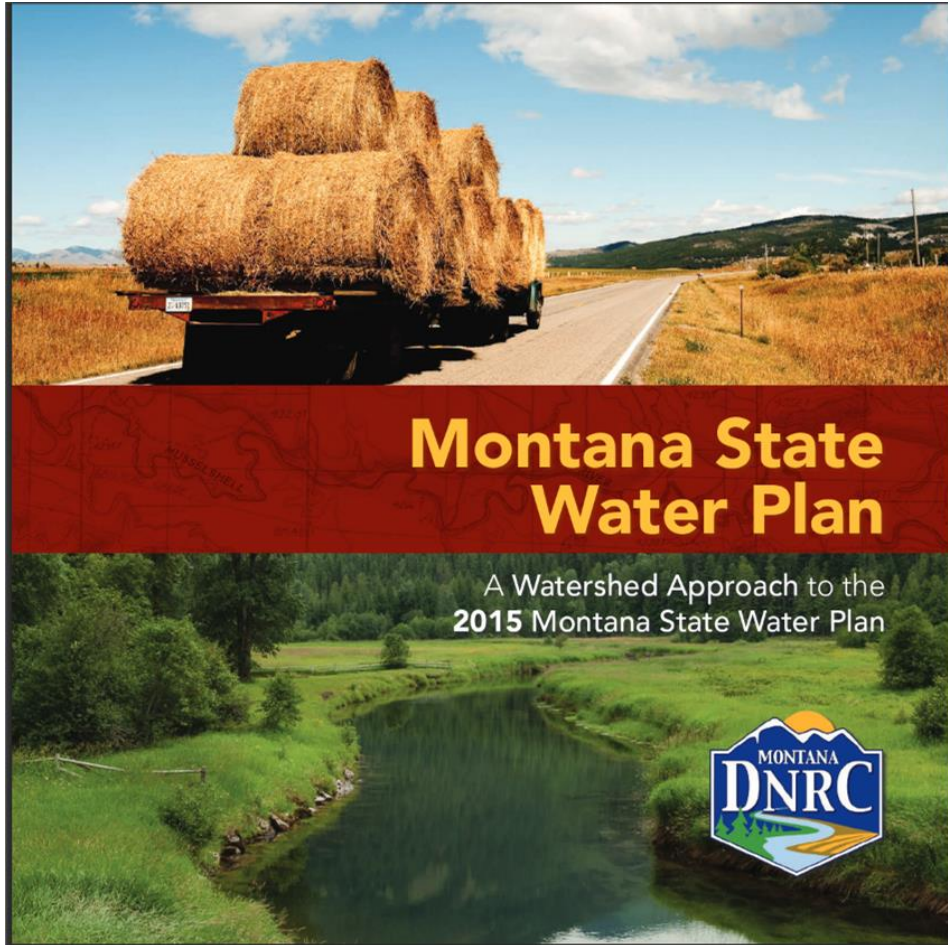


Remote Sensing Water Use in Montana at DNRC

David Ketchum
James Heffner
Paul Azevedo
September 17, 2019



MT State Water Plan (2015)



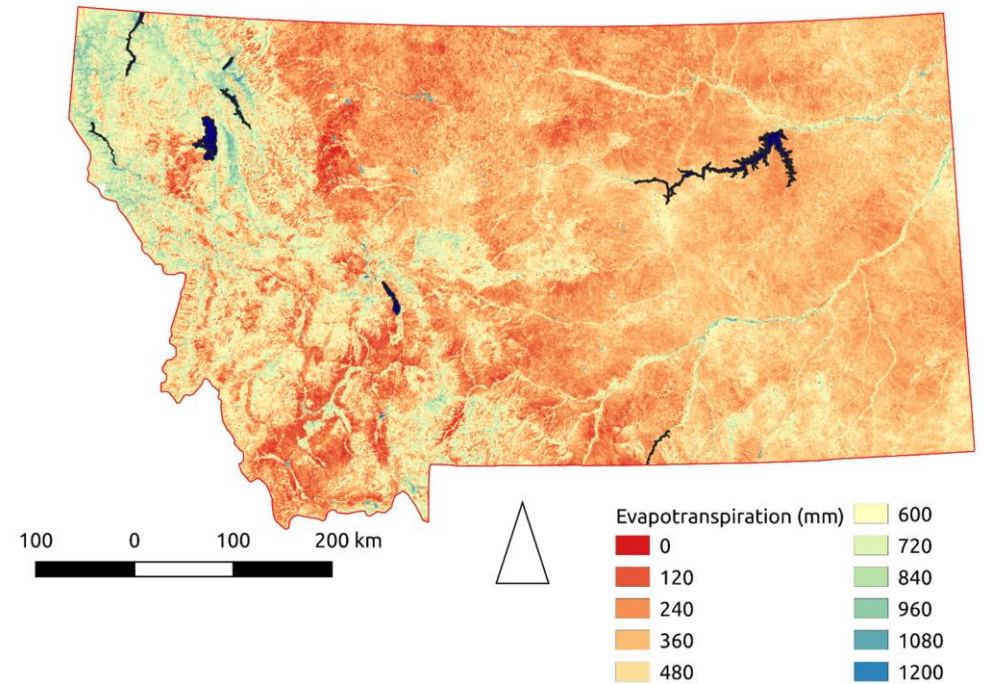
2015 Montana Water Supply Initiative
Major Water Planning Basins



Map Prepared By:
State of Montana
Dept. Natural Resources & Conservation
Water Resources Division - GIS
September 2013

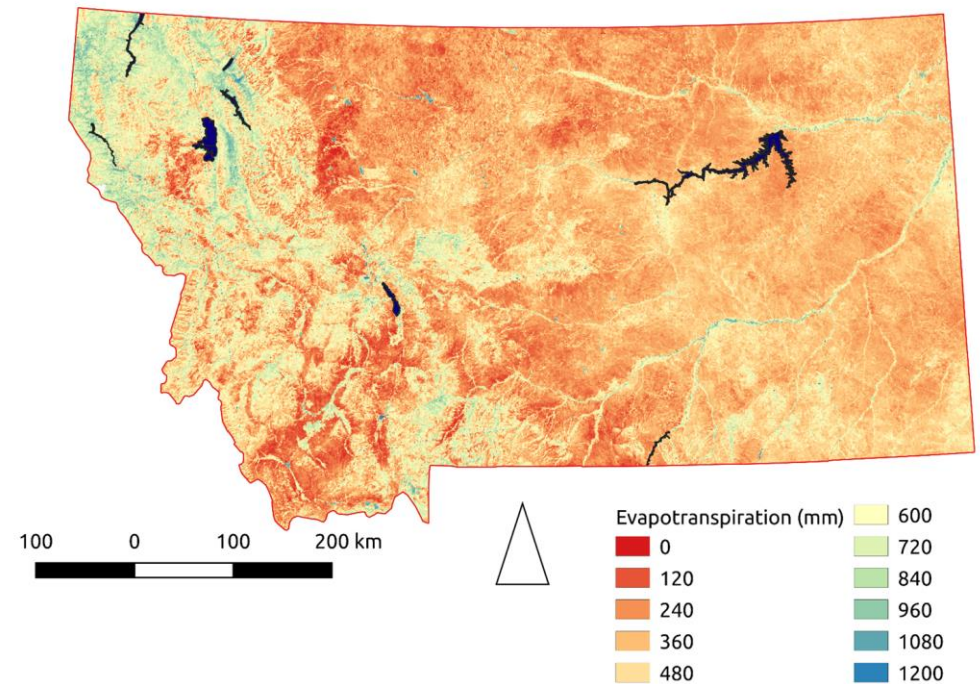
USGS Water Use Data and Research

- Objectives:
 - Document gaged surface water withdrawals.
 - Estimate crop consumption.
 - Estimate total irrigation efficiency.
 - Extrapolate withdrawals statewide.

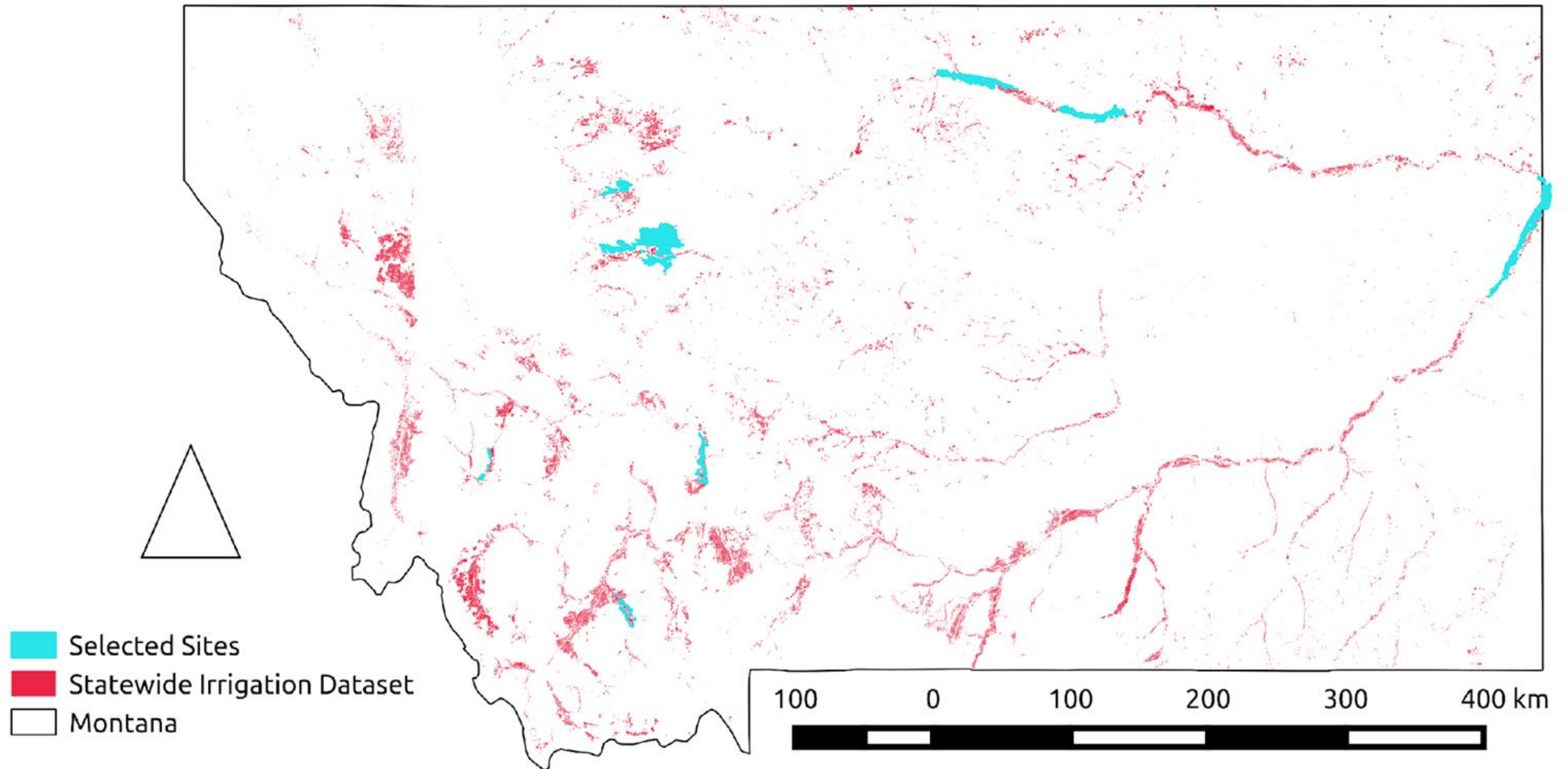


USGS Water Use Data and Research

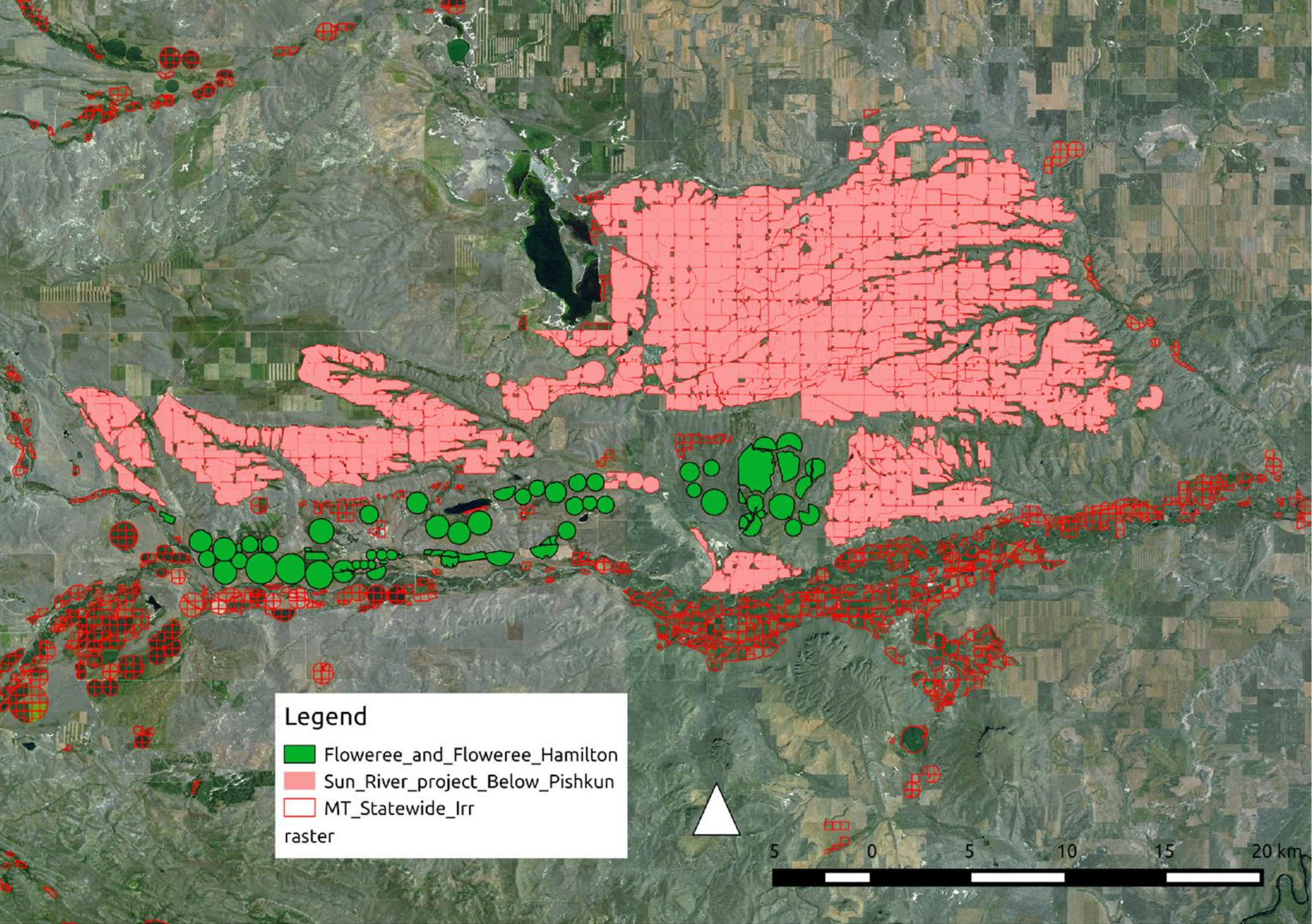
- Methods:
 - GIS for 14 surface water diversion sites
 - SSEBop Algorithm
 - Crop Consumption
 - Extrapolation



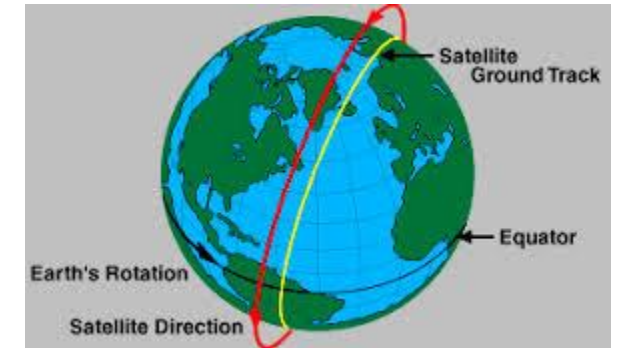
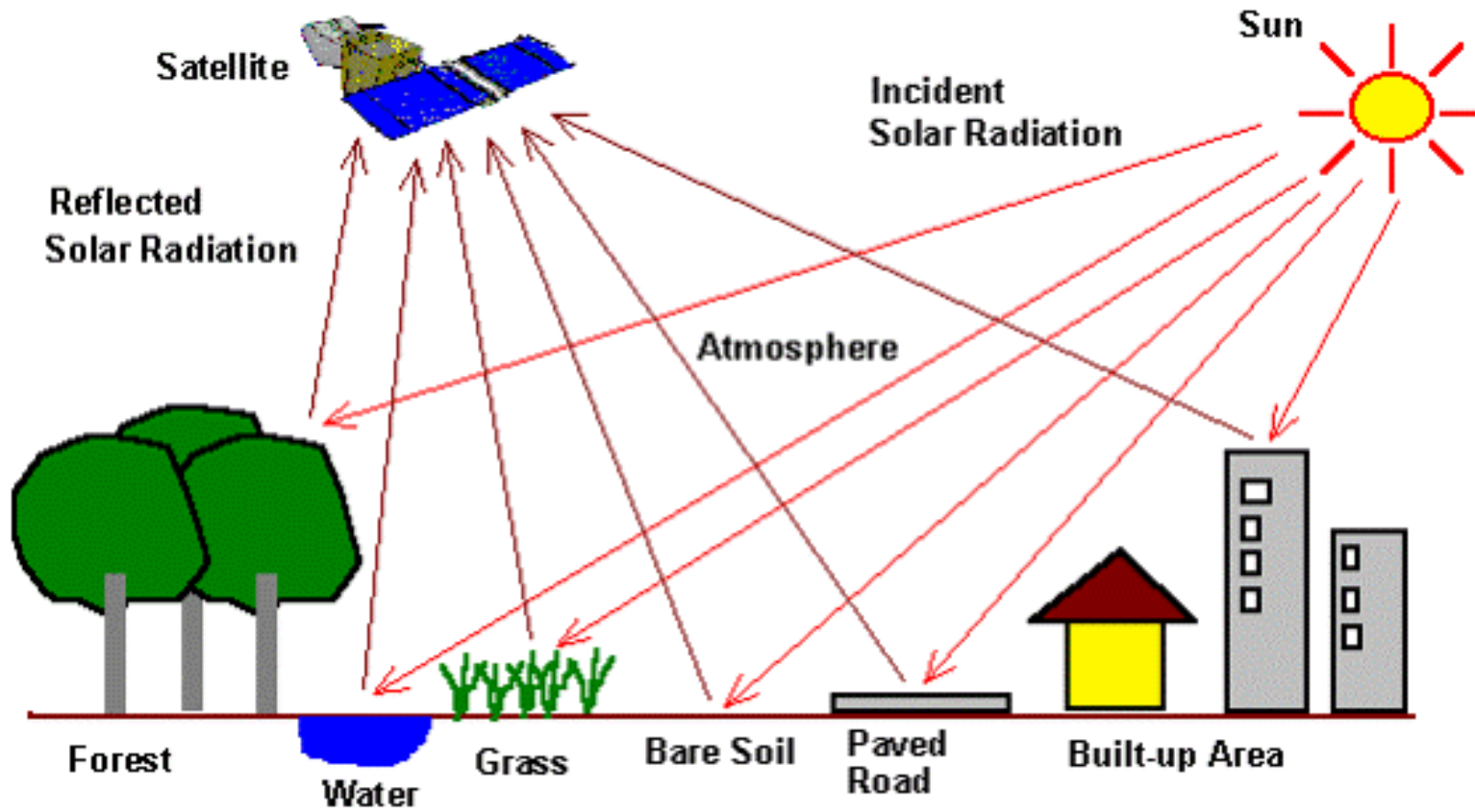
Selected Sites



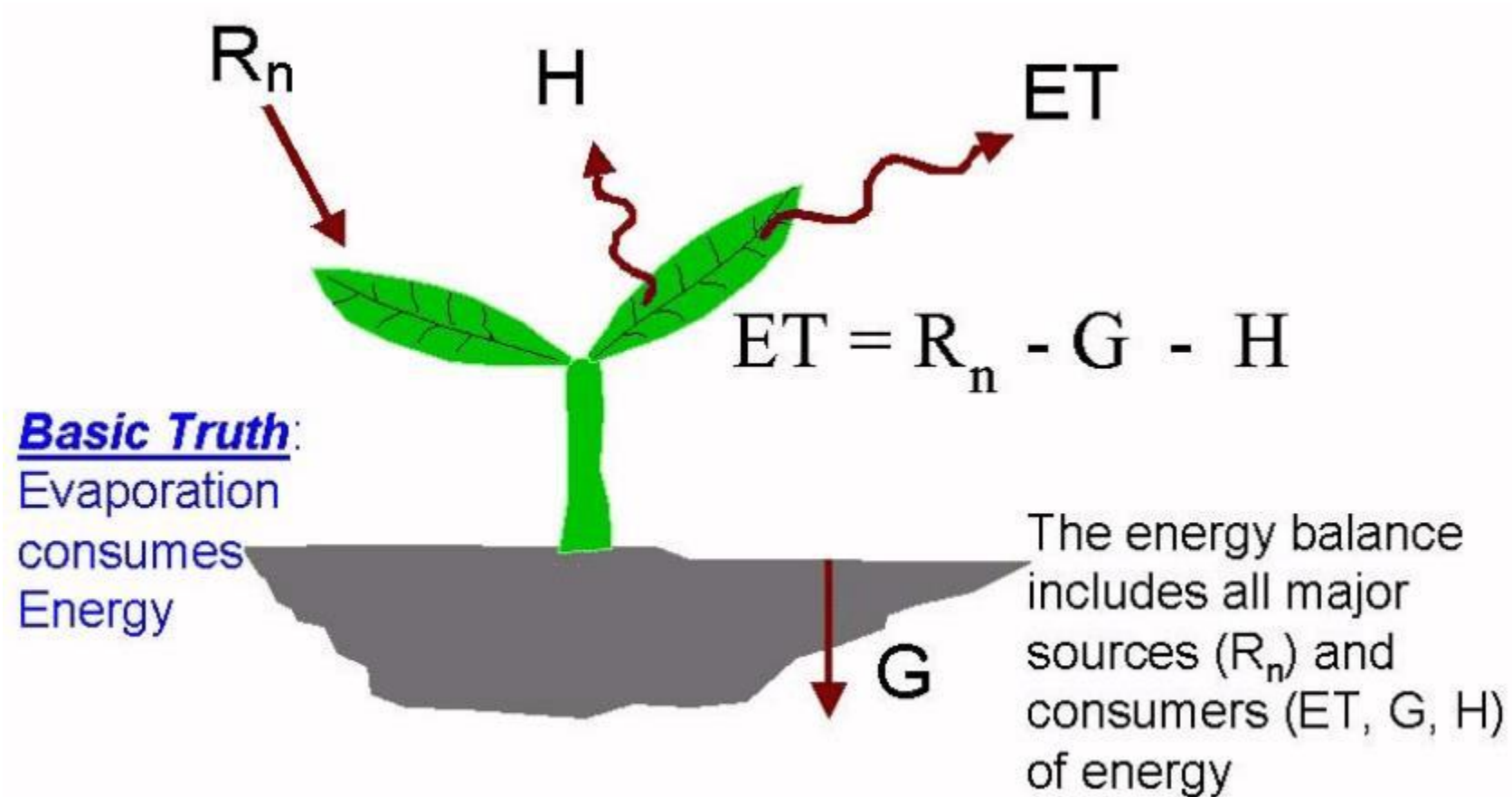
Site Detail



Satellite Data

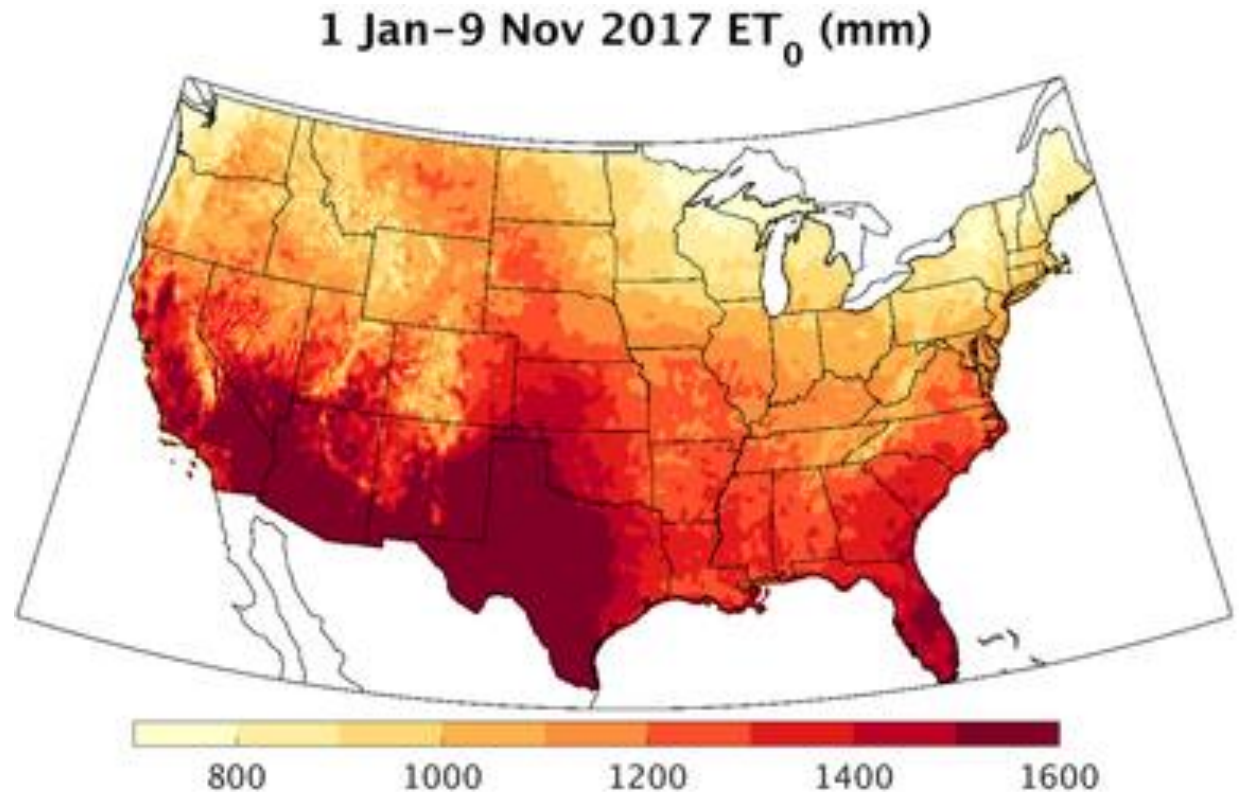


Surface Energy Balance

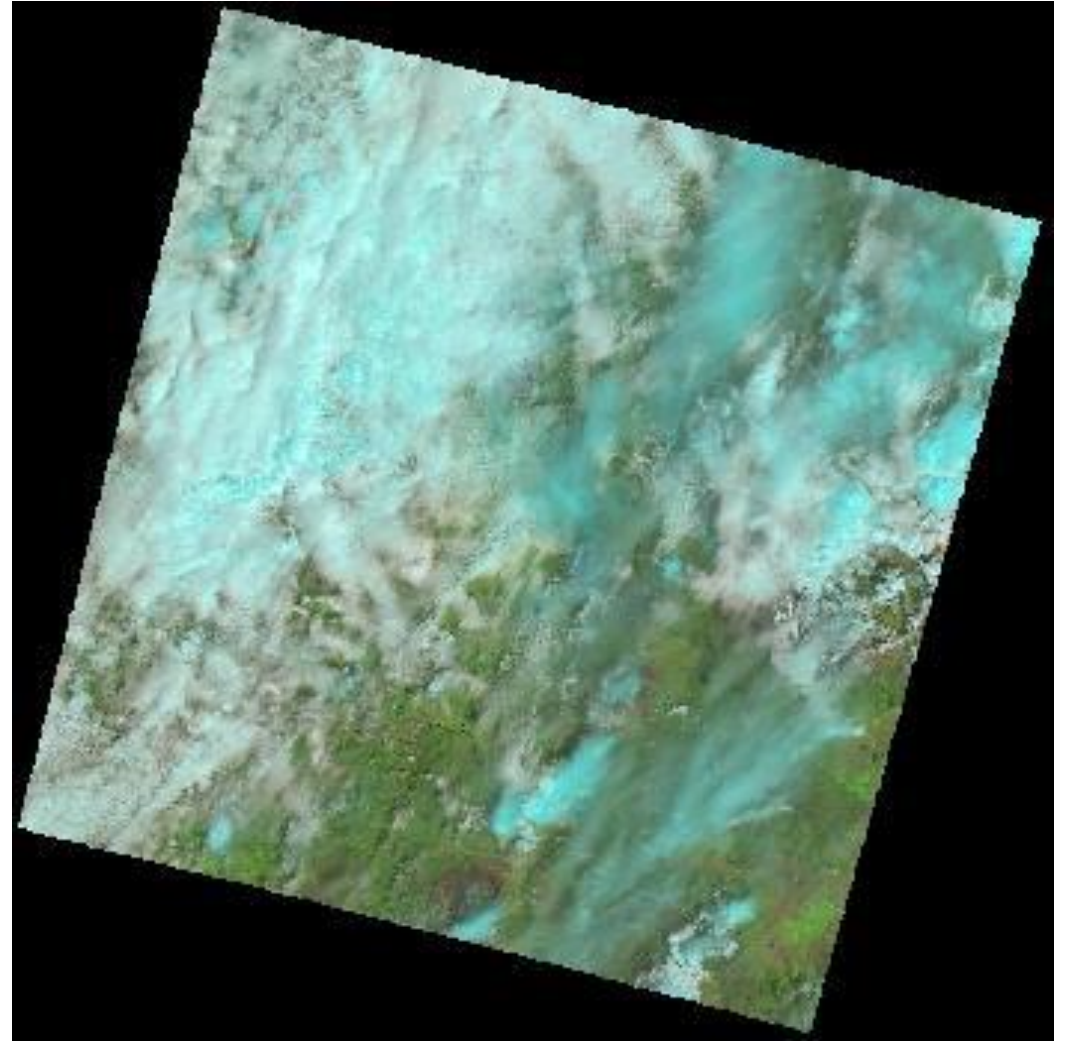
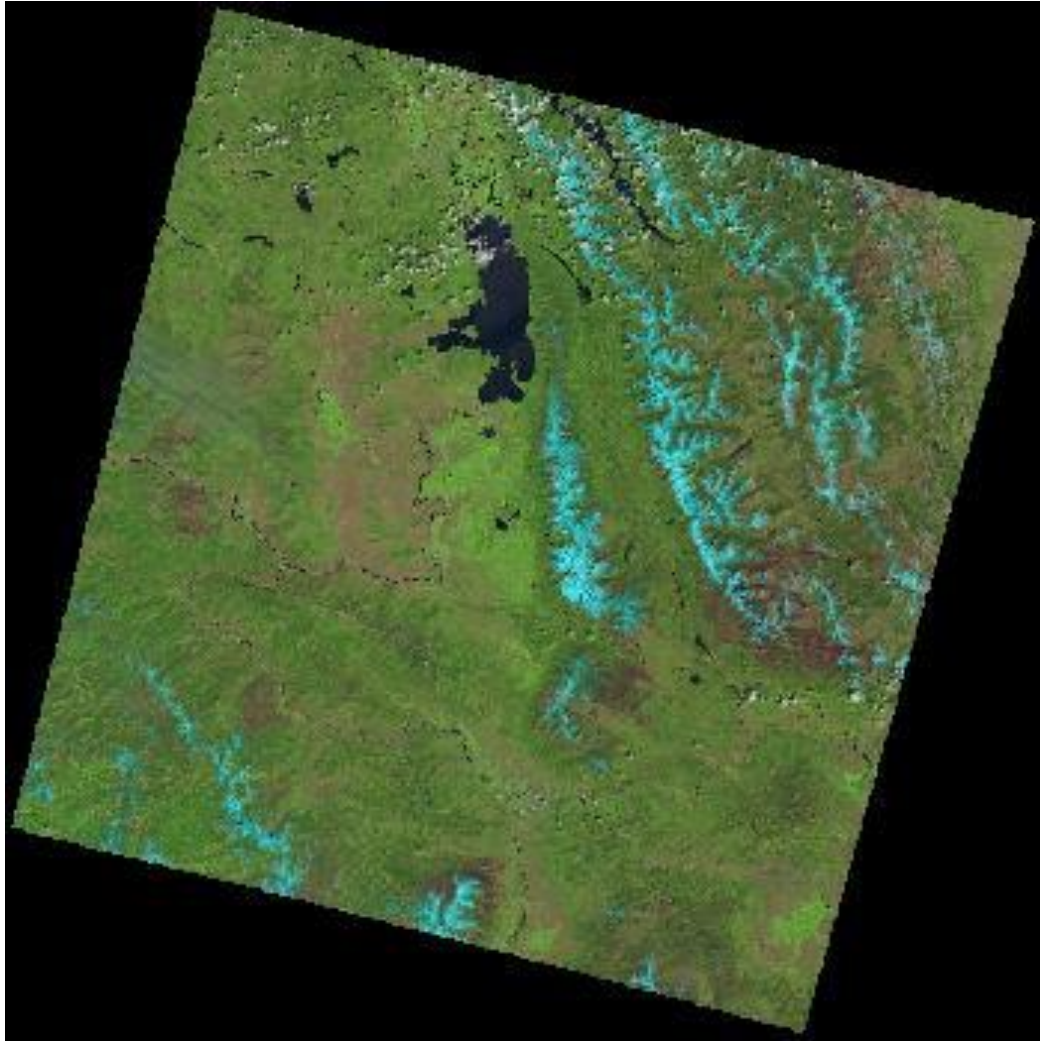


gridMET

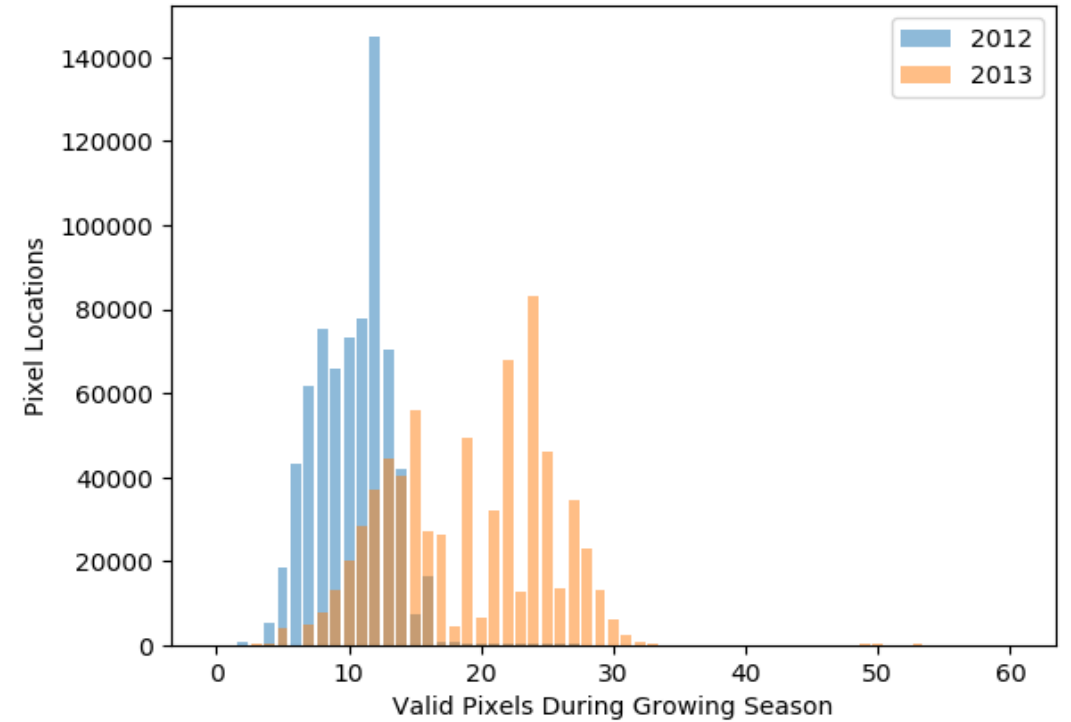
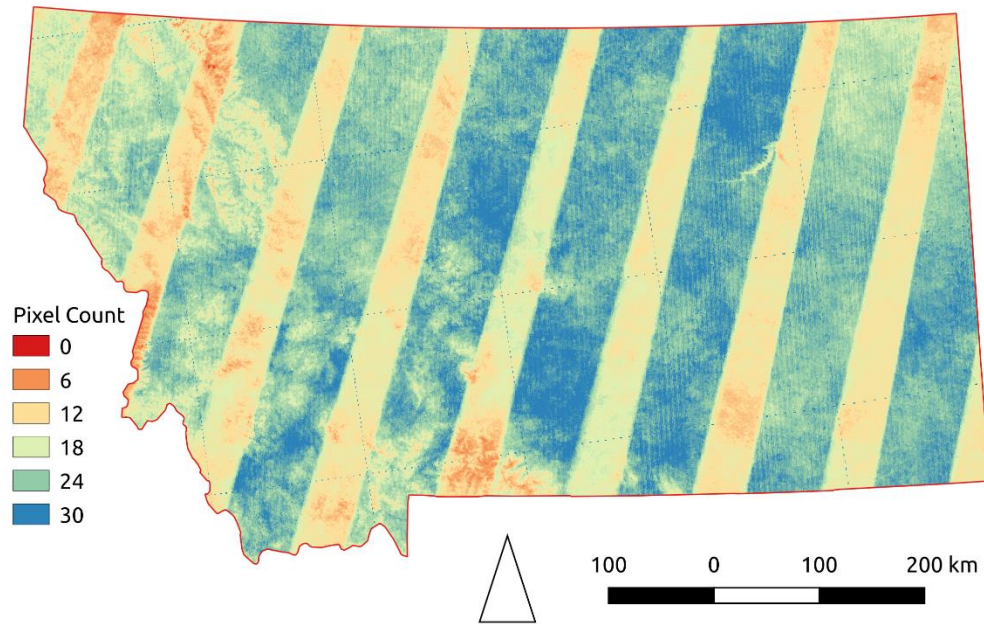
- 4 km resolution gridded meteorological data
- Includes ETr , wind speed, precipitation, temperature, etc.
- Designed to estimate conditions over natural vegetation.



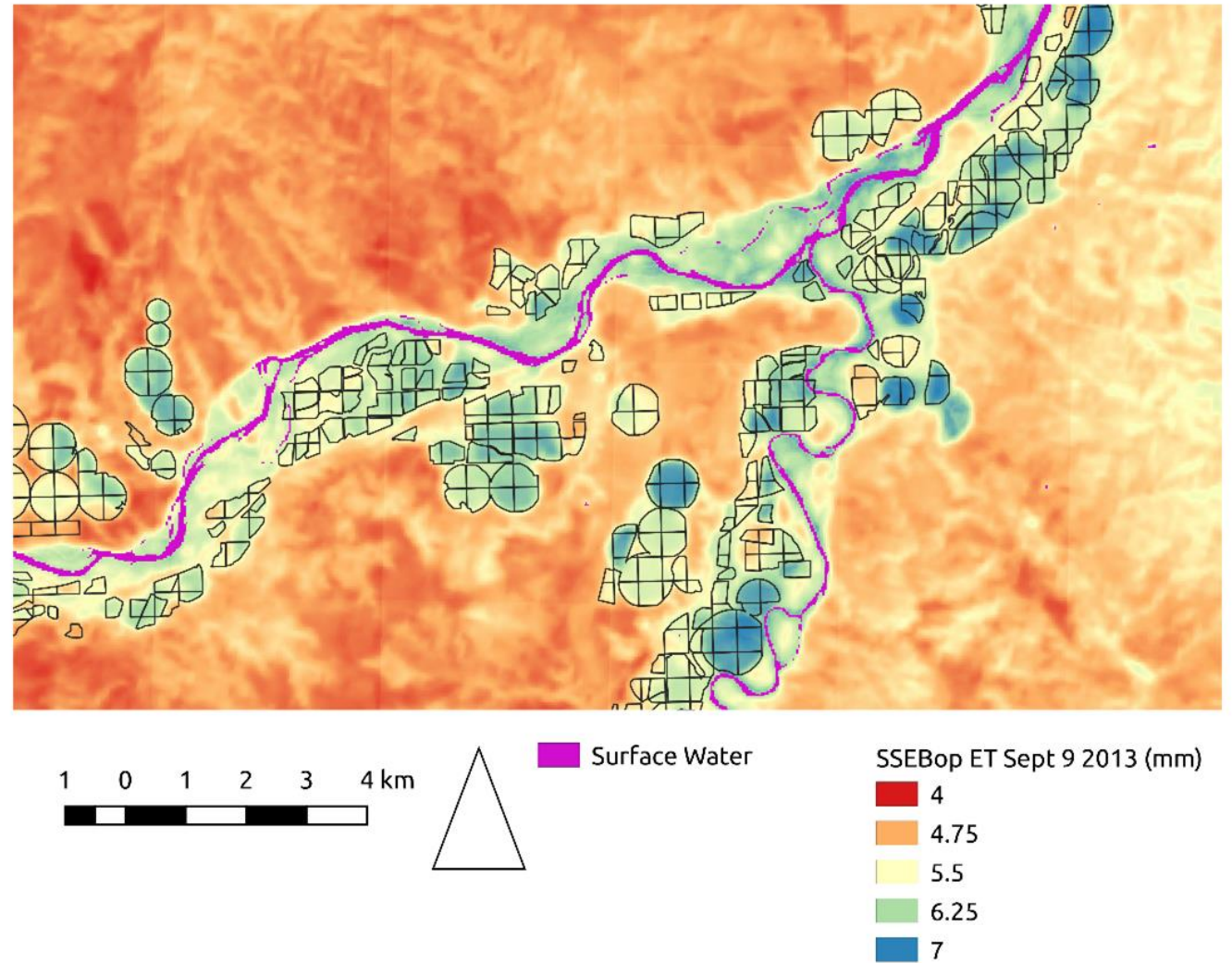
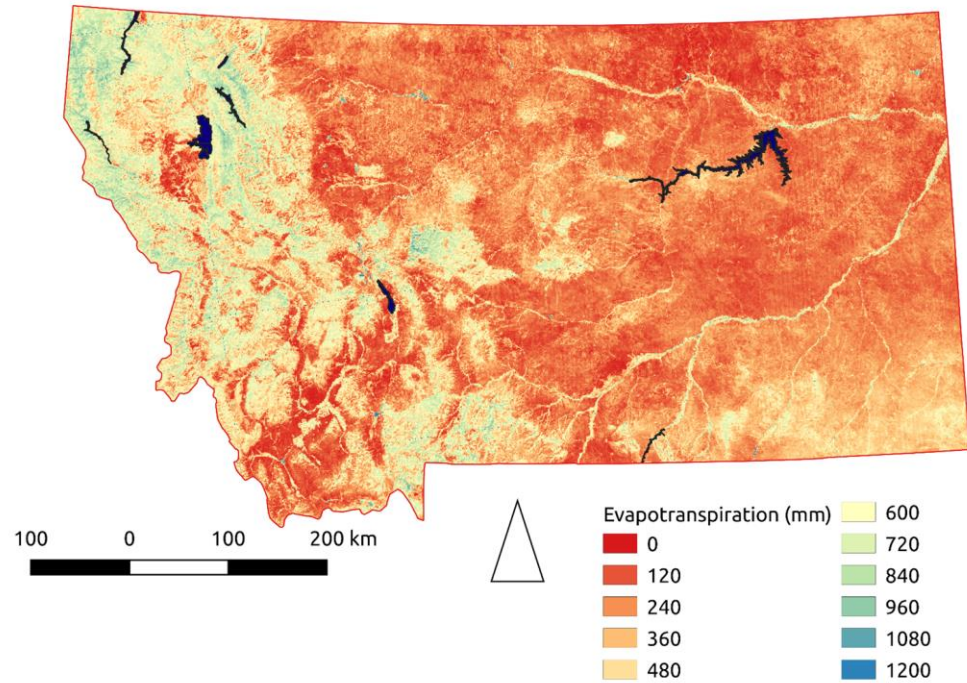
Finding Valid Images



Finding Valid Images



Results



Results - Efficiency

- We found a large variation in efficiency in flood irrigation systems.
- Linear relationships between flood/sprinkler/pivot systems and overall efficiency are generally weak ($R^2 \sim 0.02$), excepting systems with greater than 10% pivot ($R^2 \sim 0.20$).
- The limitations of the data do not allow for precise extrapolation of **overall** efficiency to 'outside' irrigation systems; we used:
 - 30% for flood and sprinkler
 - 45% for pivot



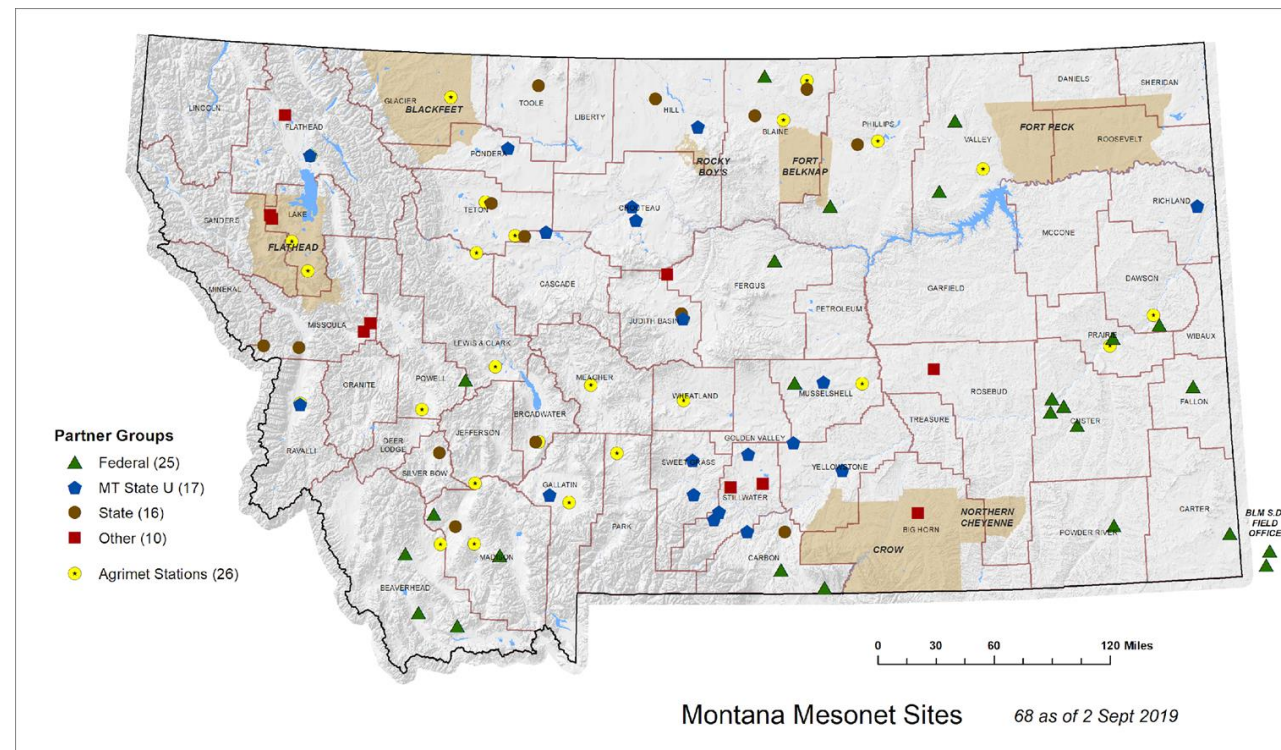
Results - Water Use

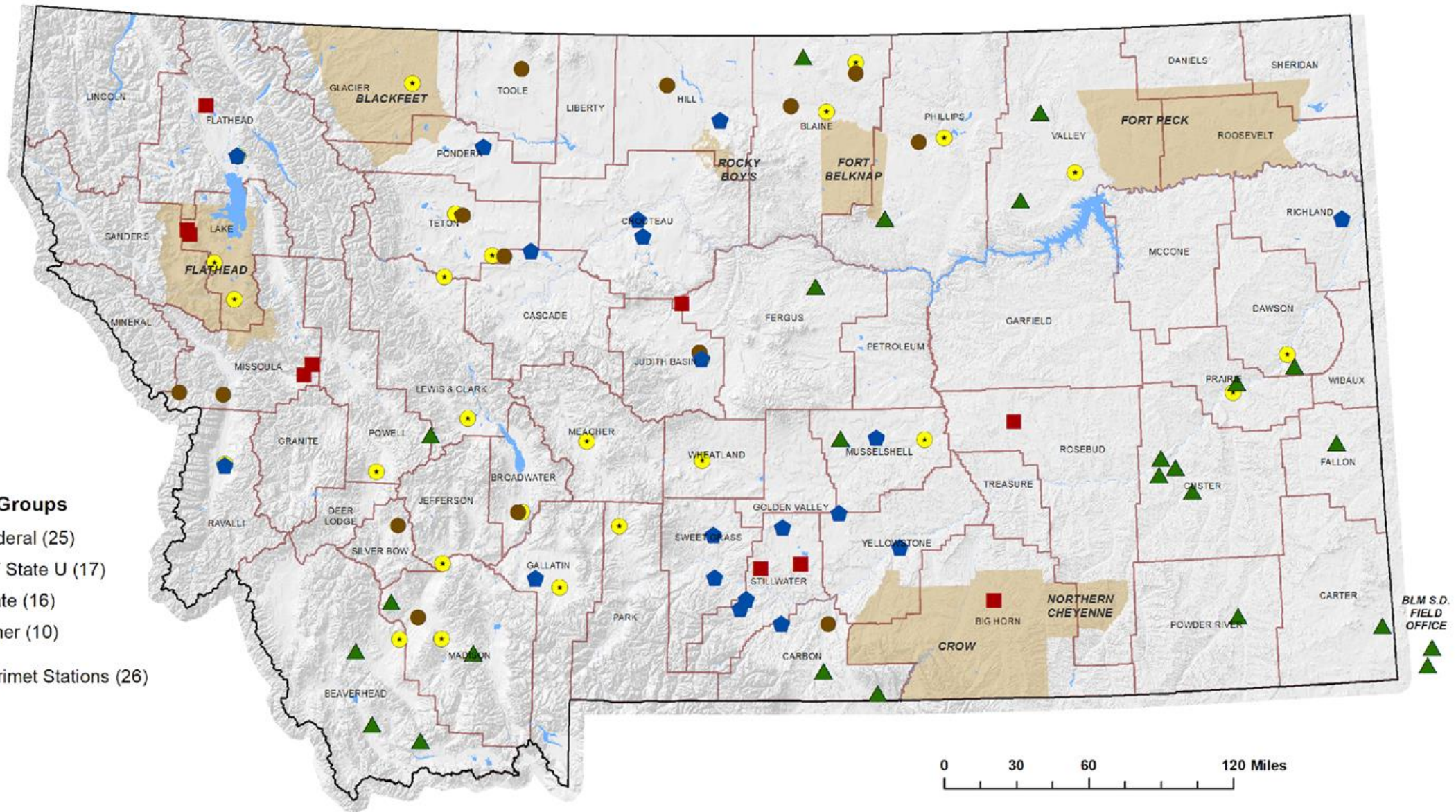
Table 2: Estimated Agricultural Evapotranspiration, Precipitation, Crop Consumption and Statewide Irrigation Withdrawals (2008-2013).

Year	Growing Season Evapotranspiration [Acre ft.]	Growing Season Precipitation [Acre ft.]	Crop Consumption [Acre ft.]	Statewide Irrigation Withdrawal; Combined Surface and Groundwater [Acre ft.]
2008	3,840,000	2,051,000	2,223,000	6,985,000
2009	3,891,000	1,698,000	2,495,000	7,856,000
2010	4,180,000	2,403,000	2,301,000	7,221,000
2011	4,445,000	2,487,000	2,602,000	8,175,000
2012	4,035,000	1,329,000	2,970,000	9,331,000
2013	3,993,000	2,293,000	2,194,000	6,877,000
Mean	4,064,000	2,043,500	2,464,200	7,740,800

Limitations / Opportunities for Future Work

- Irrigation Geospatial Data
- Crop Consumption
- Meteorology





Partner Groups

- ▲ Federal (25)
- ⬠ MT State U (17)
- State (16)
- Other (10)
- Agrimet Stations (26)

BLM S.D. FIELD OFFICE

Montana Mesonet Sites 68 as of 2 Sept 2019

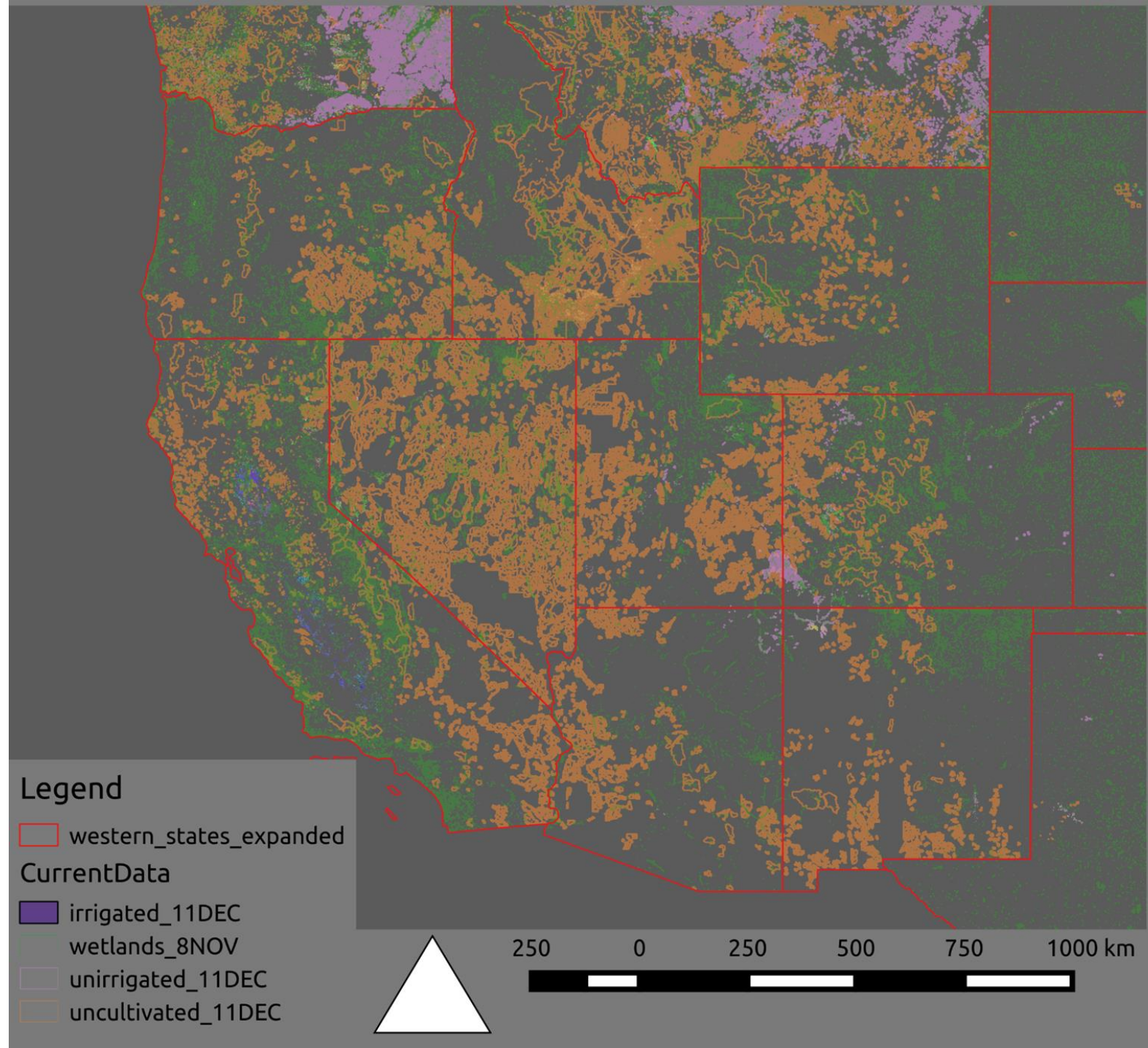
Mapping Irrigation with Machine Learning

Objectives:

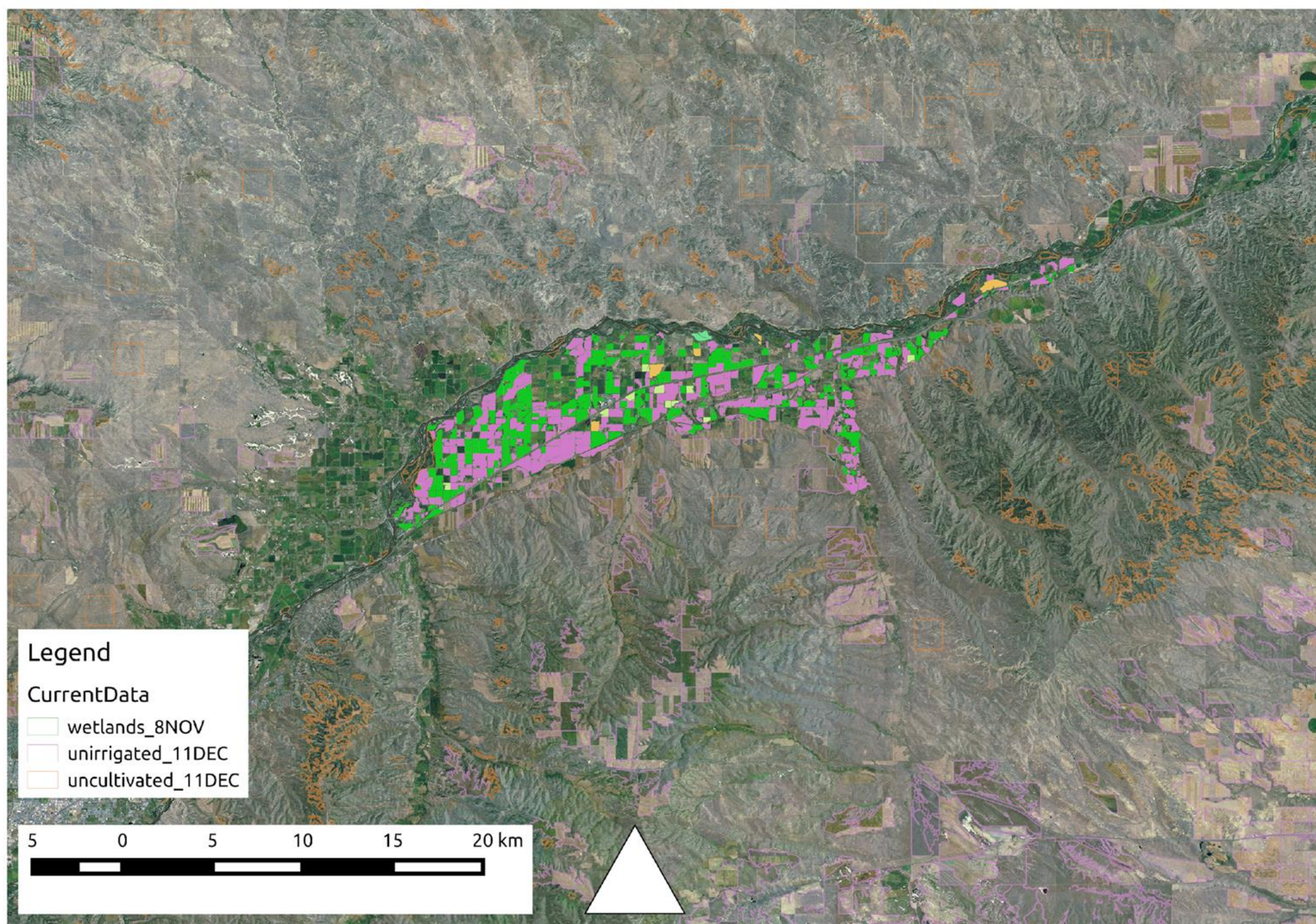
- Map irrigation activity at high resolution.

Methods:

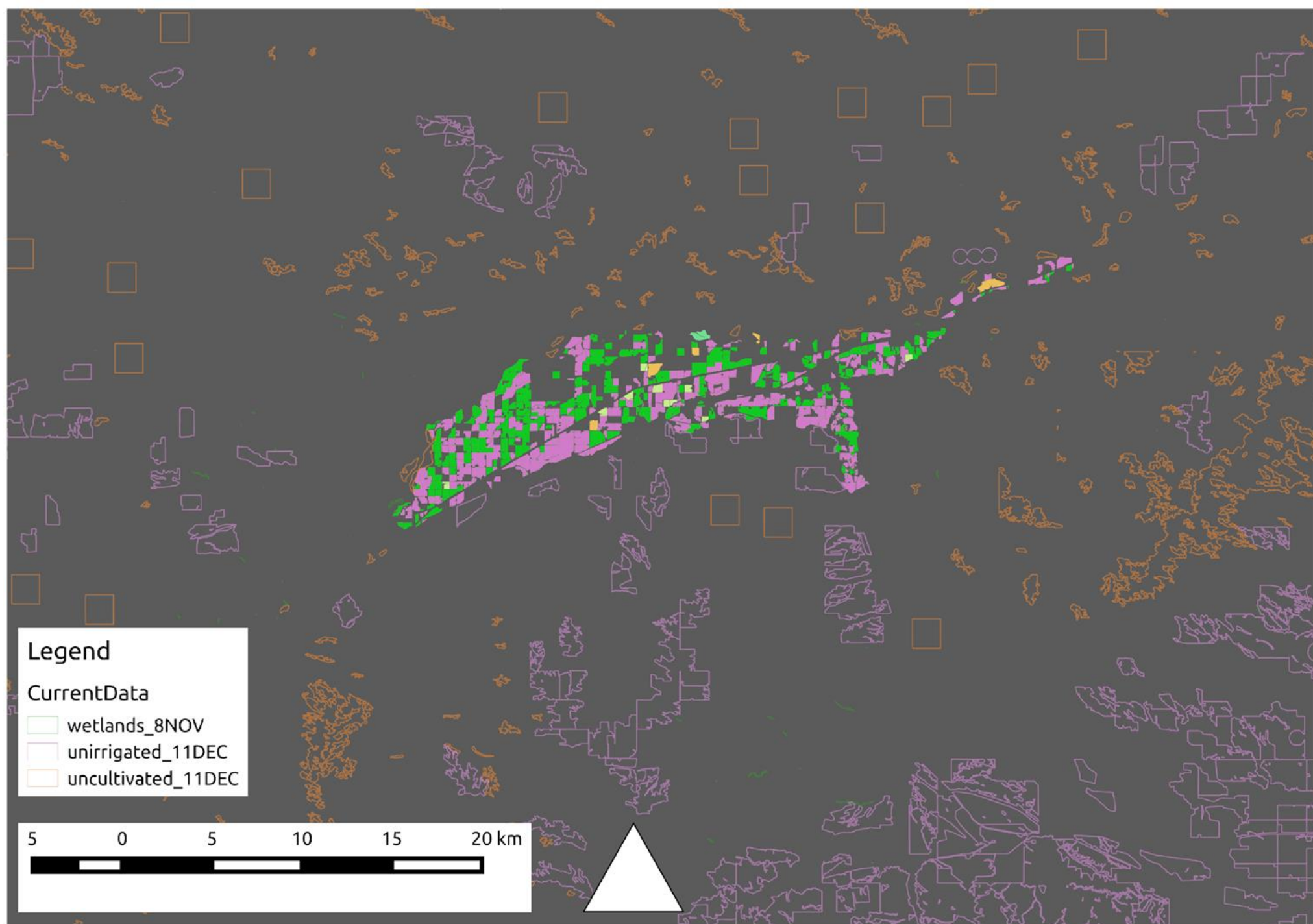
- Use known points as 'training' data to teach a statistical algorithm to discern between land use classes.
- Classes: Irrigated agriculture, fallowed/rainfed agriculture, wetlands, uncultivated lands.
- Infer land classes where data does not exist.



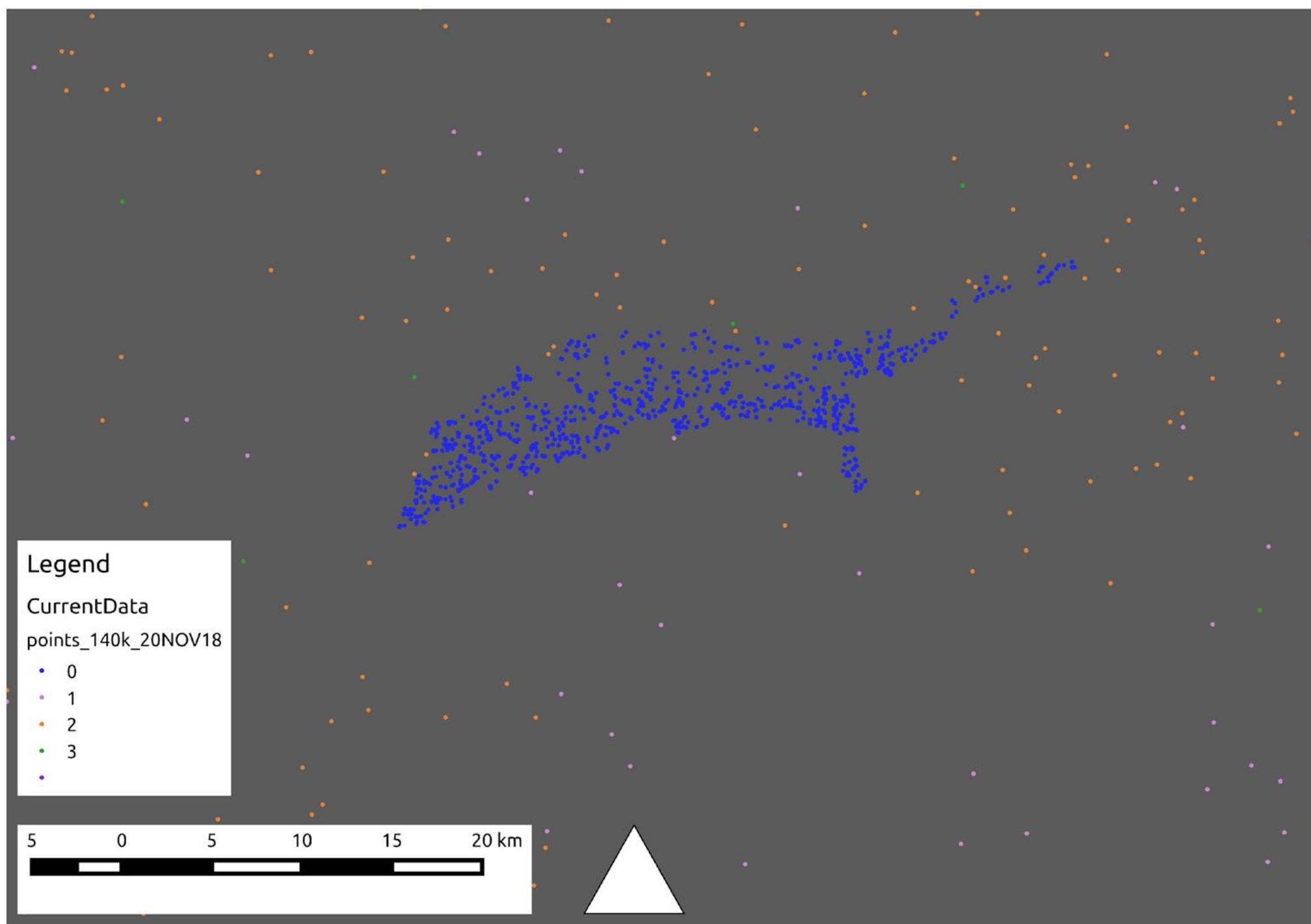
Our Training Data



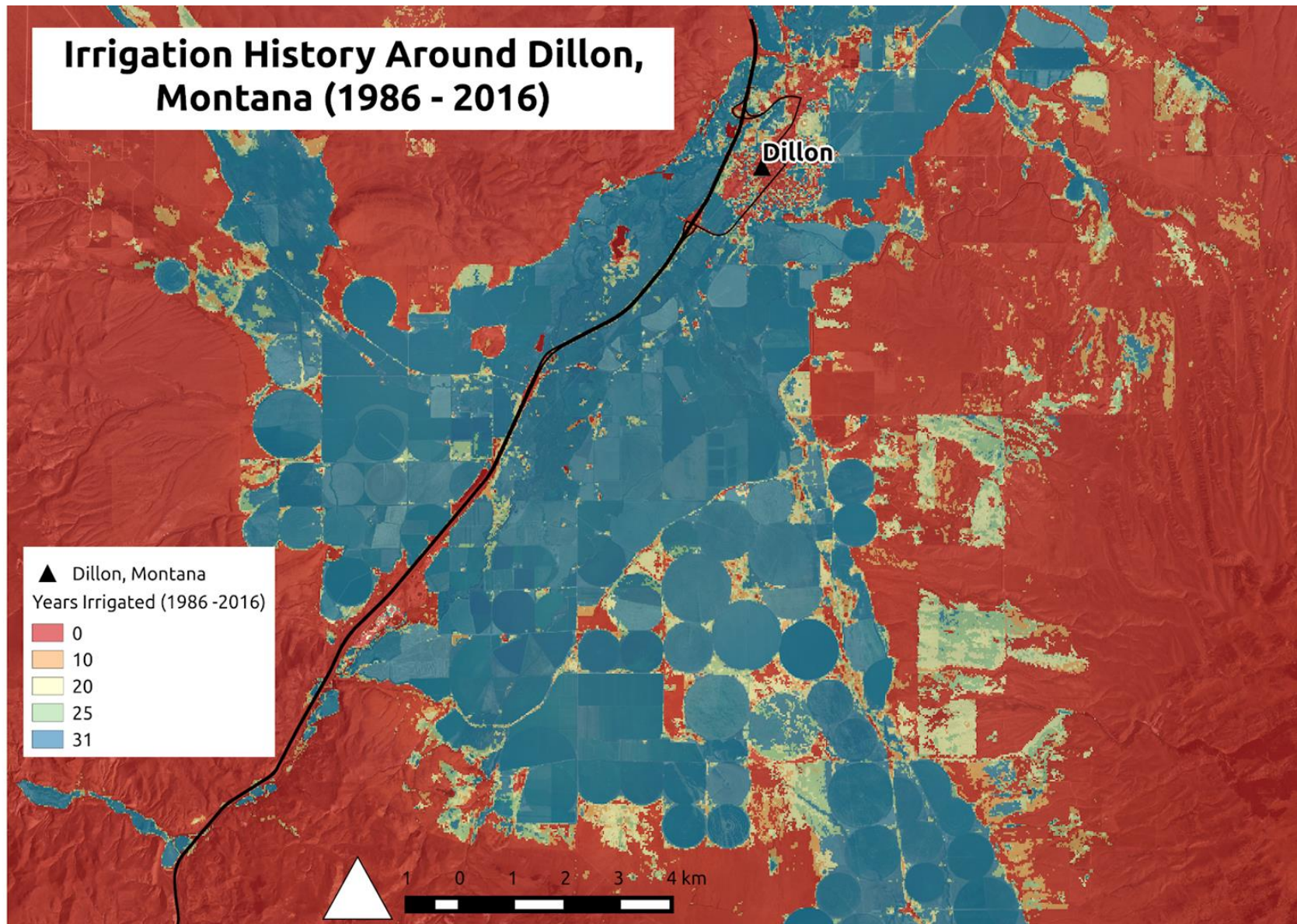
Our Training Data



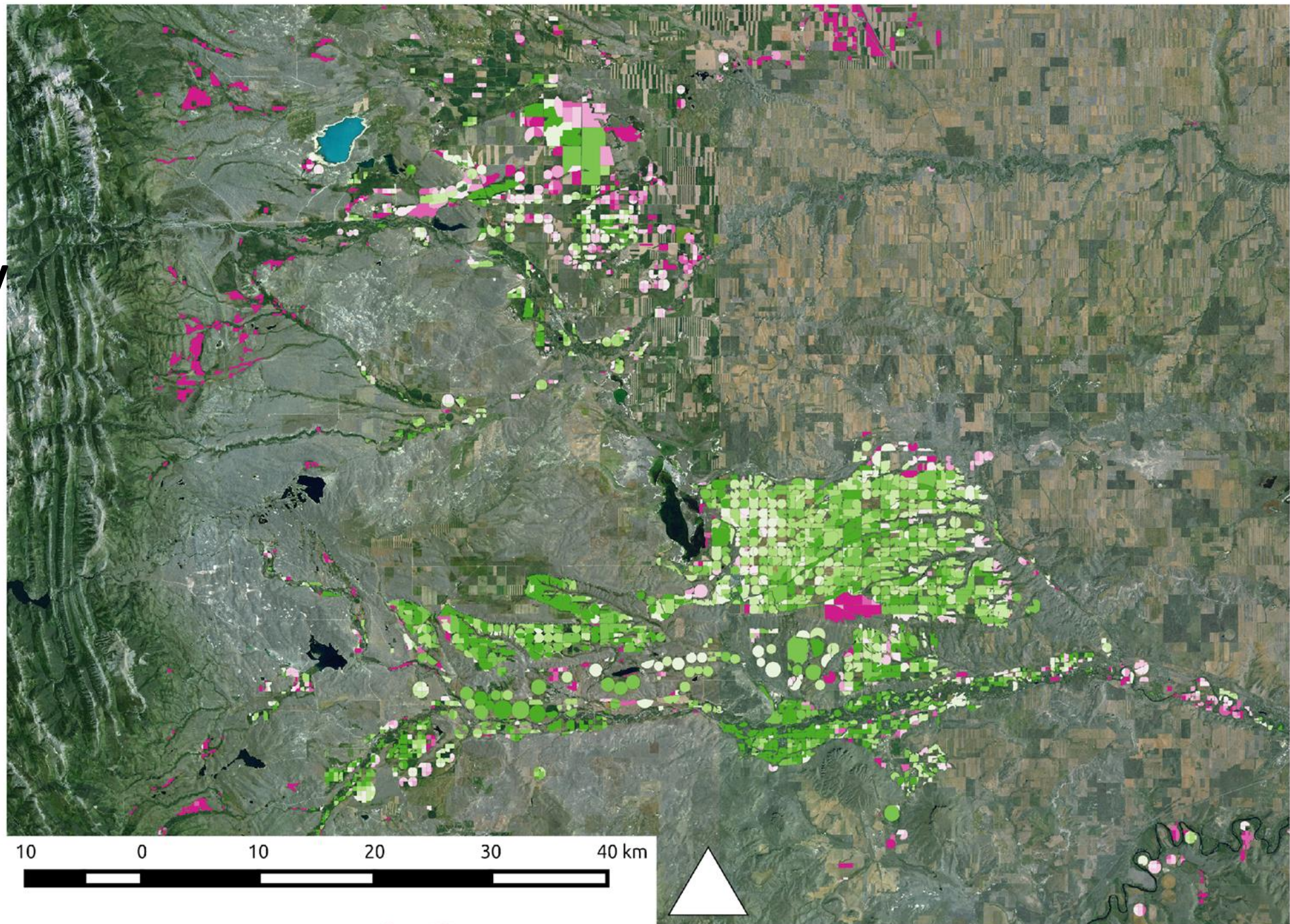
Our Training Data



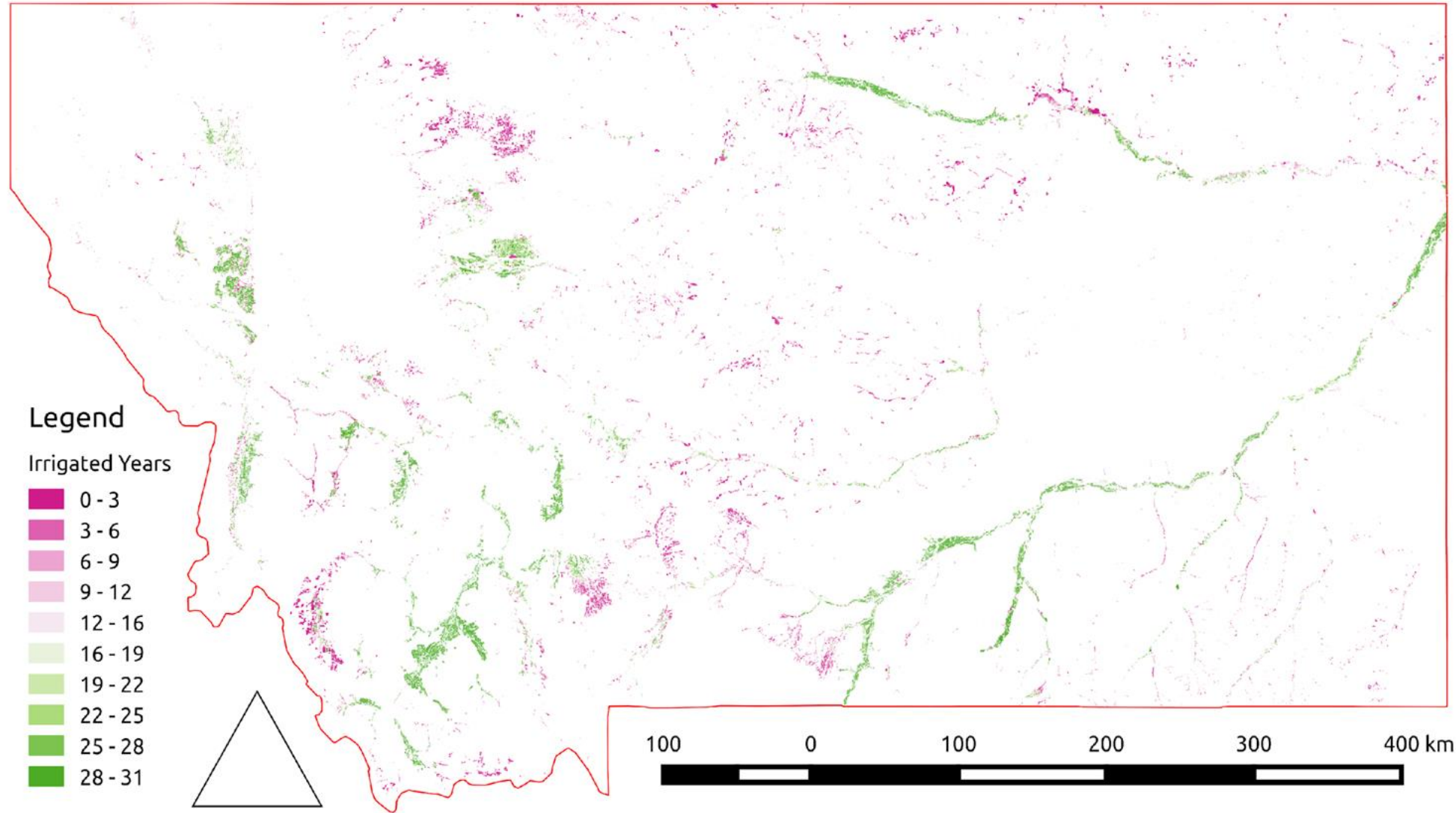
Automated Mapping of Irrigation in MT



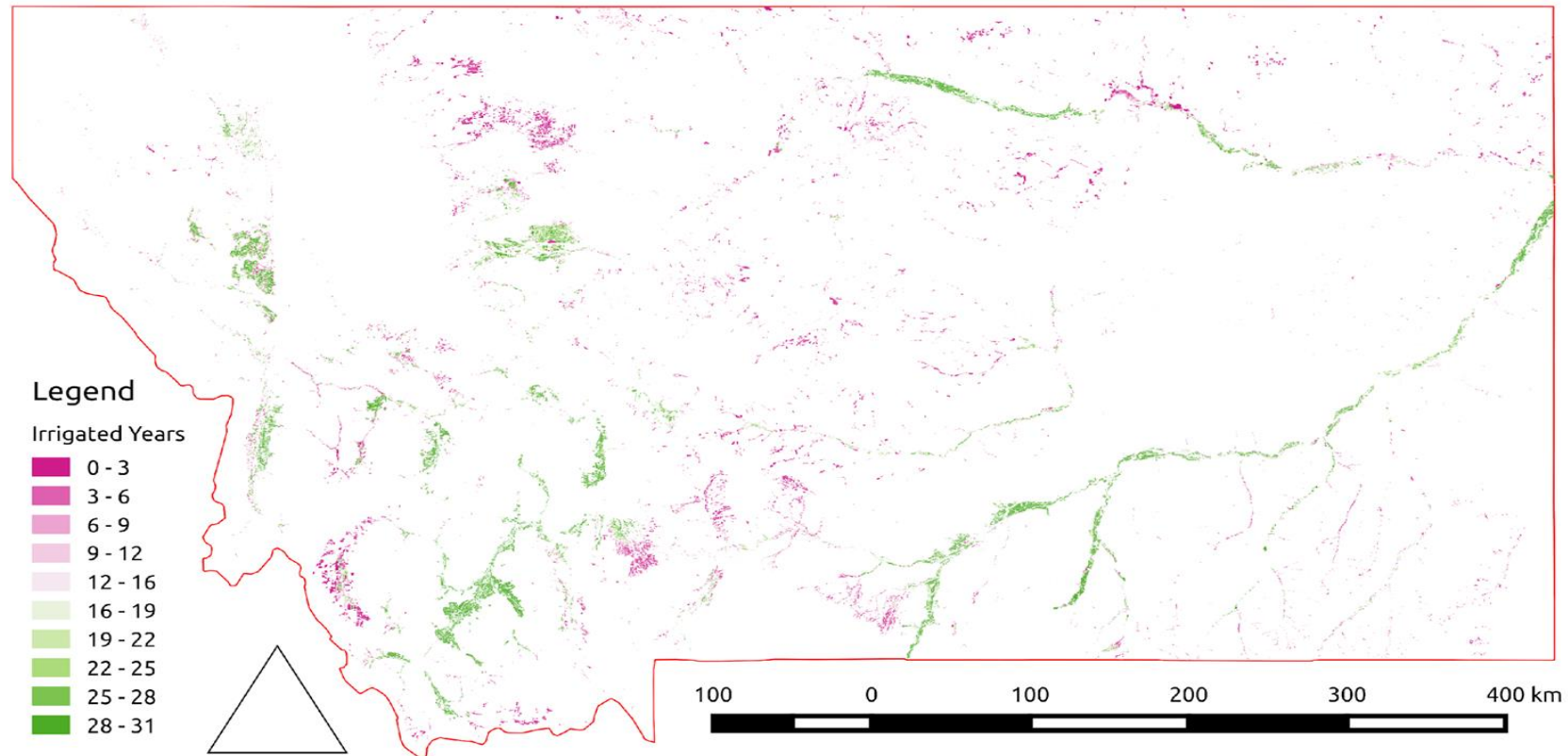
Results - Preliminary



Results – Preliminary



Thank You!



David Ketchum – david.ketchum@mt.gov