Irrigation Impacts on Streamflow

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Montana AWRA
October 11, 2024

This work was supported in part by the National Science Foundation under Grant No. **1633831**

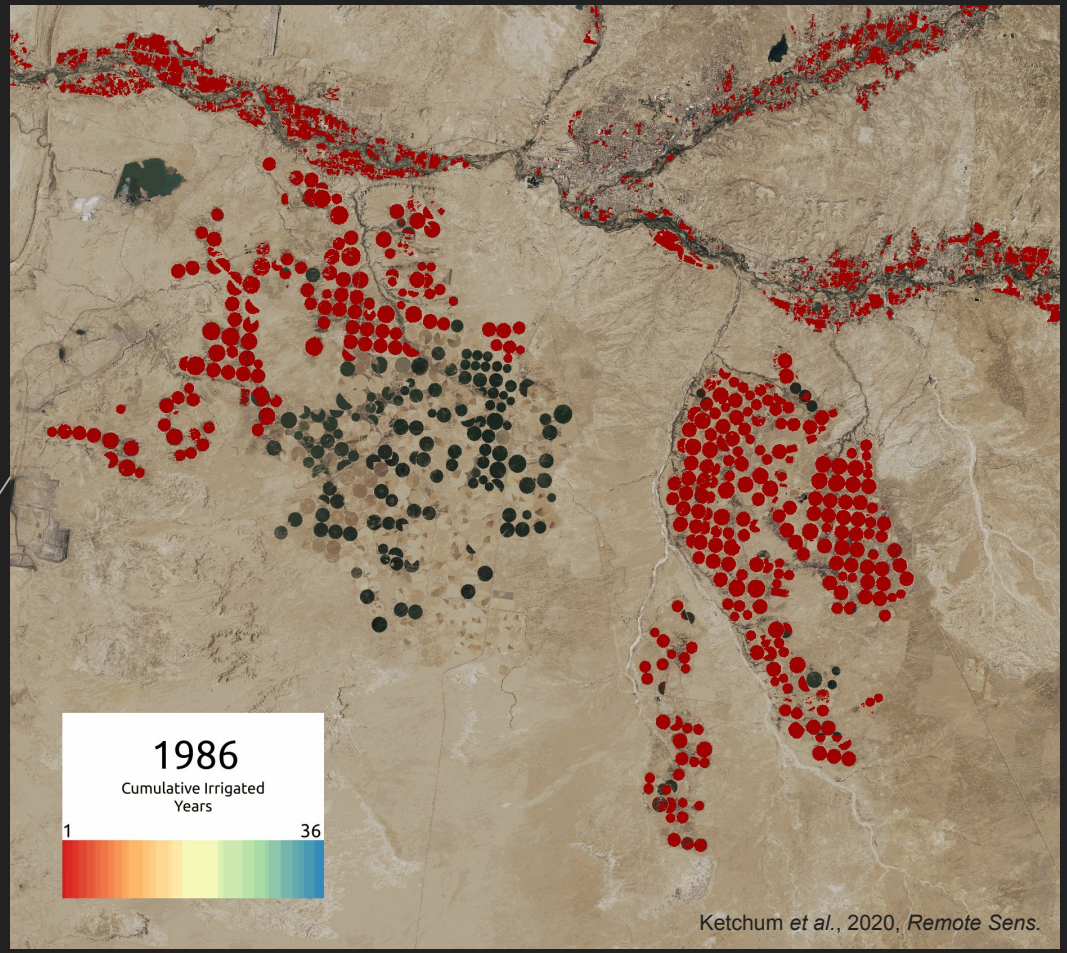
Q = P - ET

US Dept. Ag., National Agriculture Imagery Program (2019)

Overview

1. Map irrigation at high resolution (1987 - 2021) using *IrrMapper*.

- Random Forest (Supervised Machine Learning)
- Training Data: 100,000 irrigated fields and 200,000 non-irrigated features
- 30 m resolution



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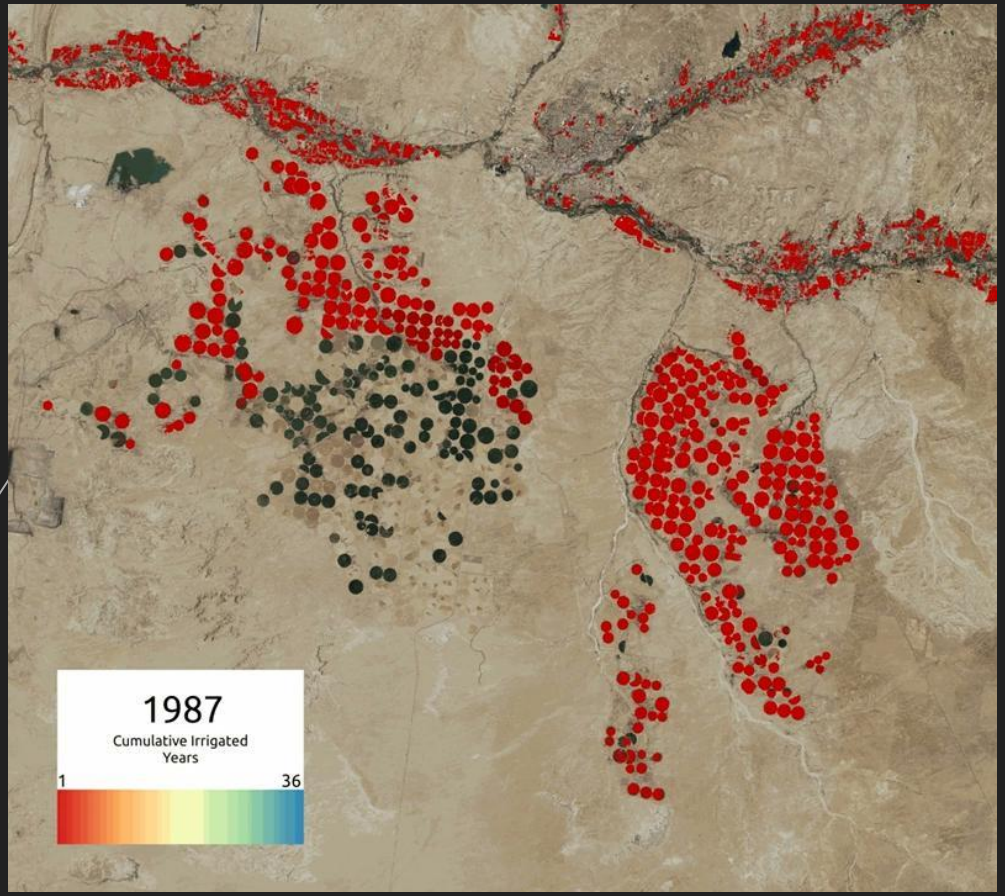
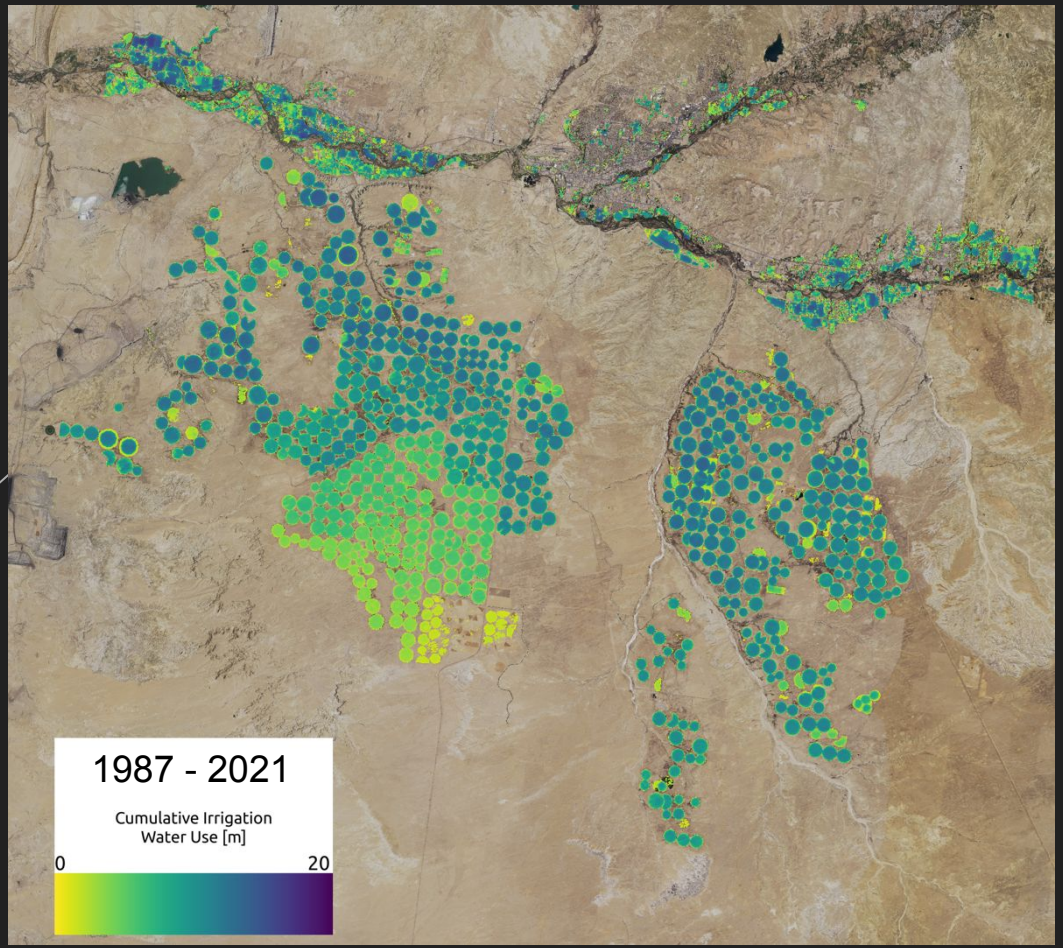
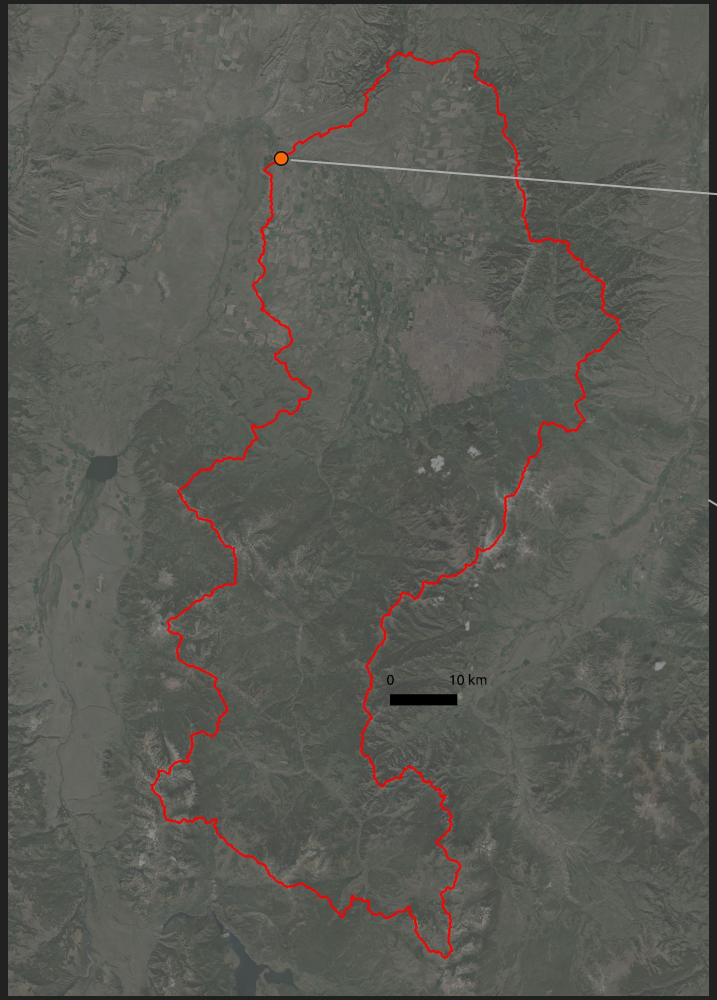


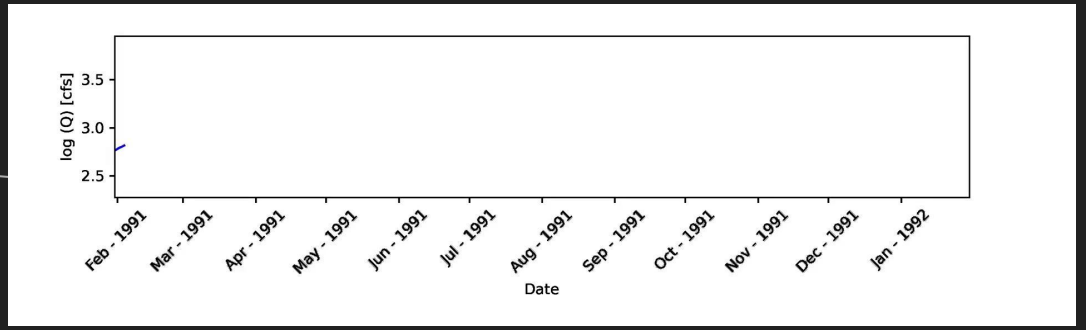
Overview

2. Map irrigation water use (IWU) in the Columbia, Colorado, and Upper Missouri river systems.

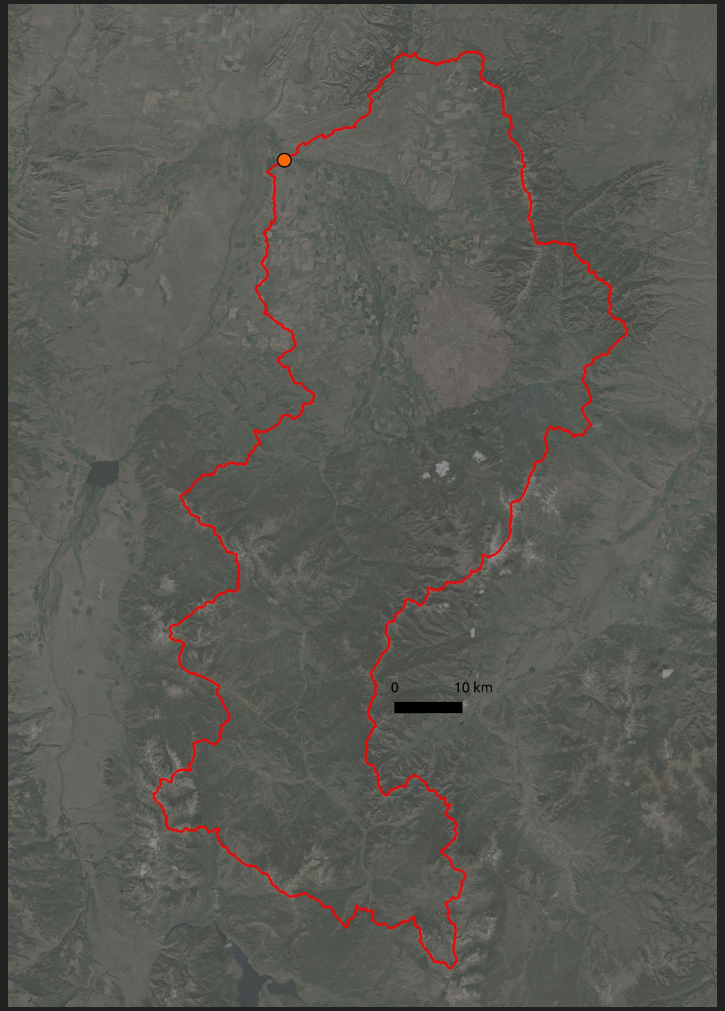


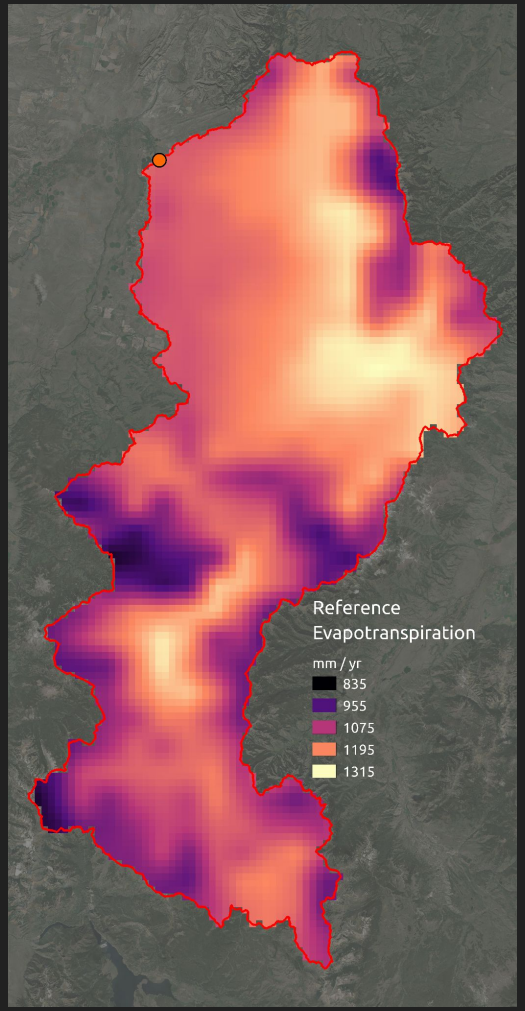
Senay *et al.*, 2022, *Remote Sens Environ.*

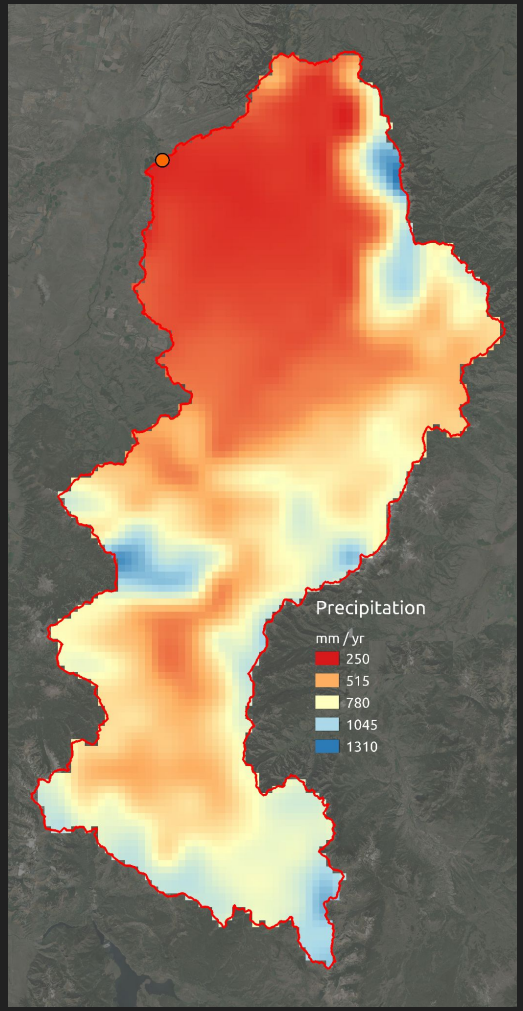




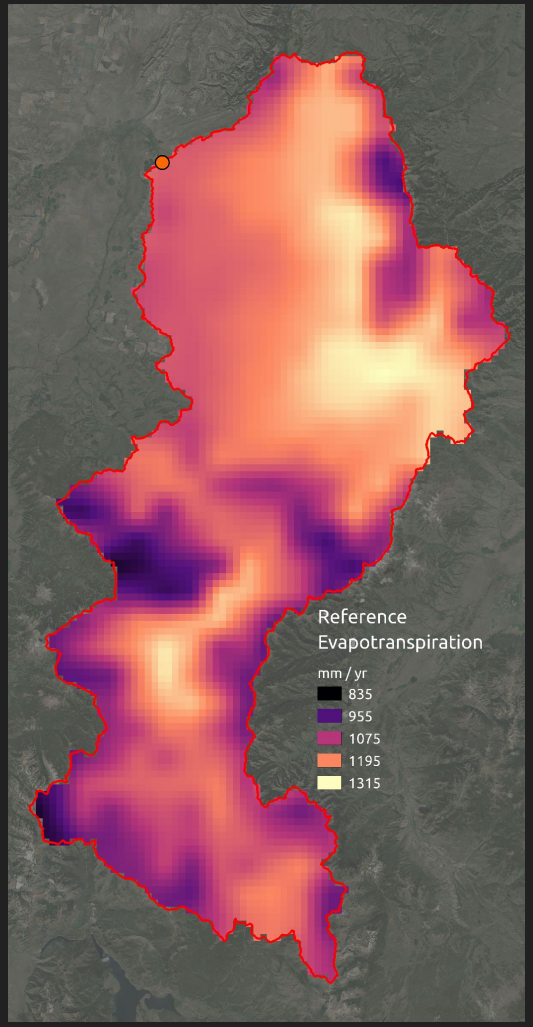
USGS, *National Water Information System*

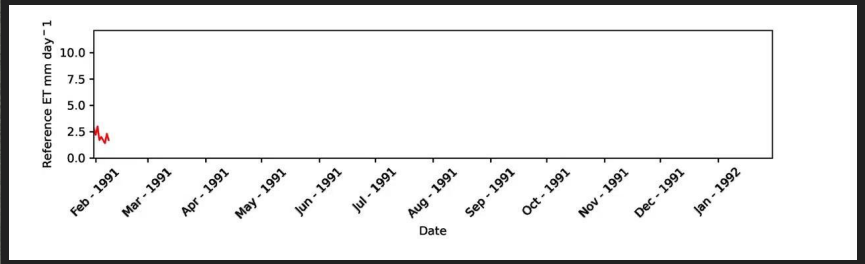


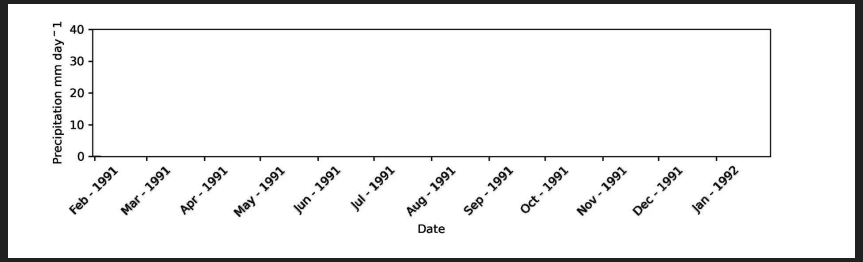


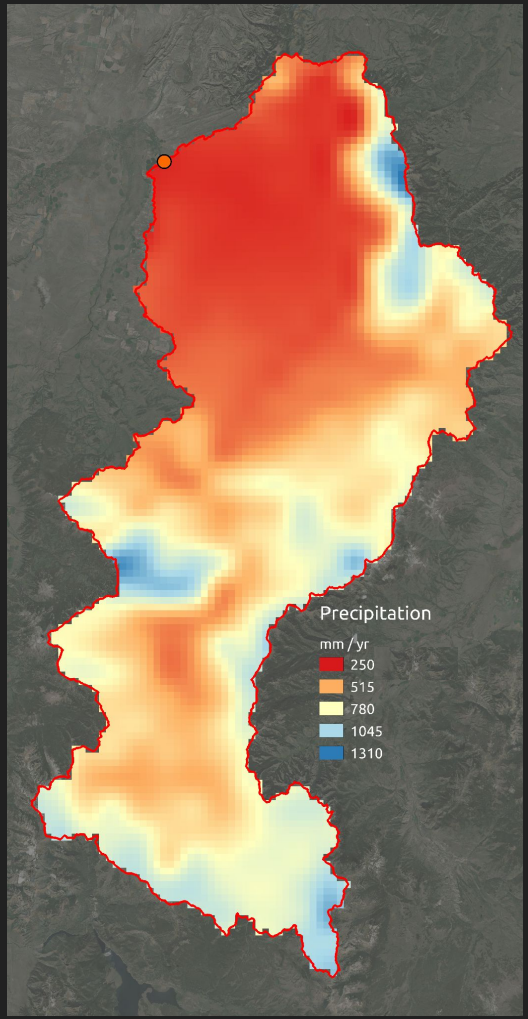


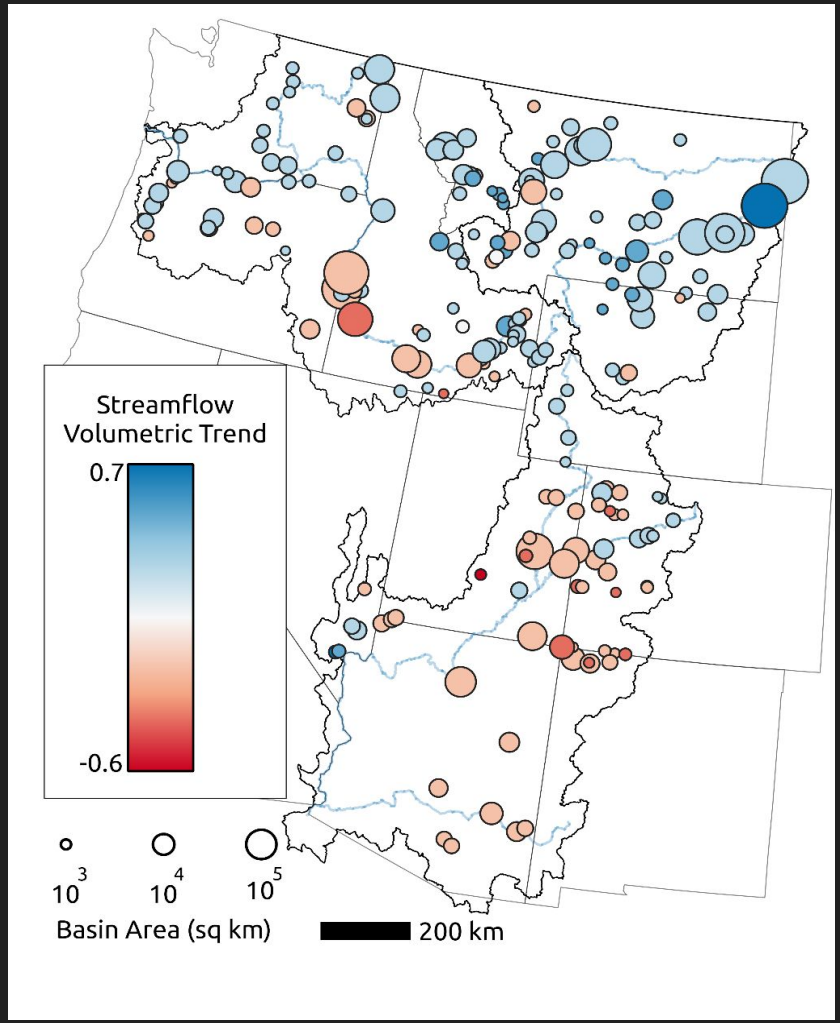
Abatzoglou *et al.*, 2013, *Int. J. Climatol.*

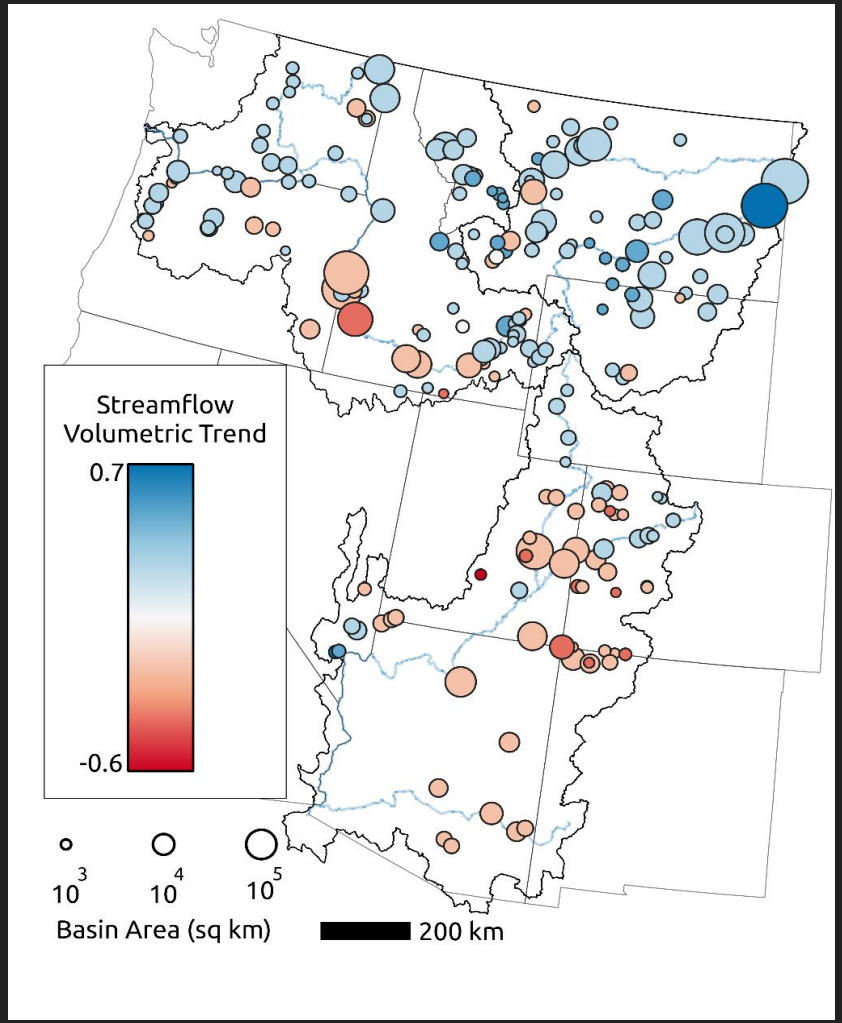

Reference
Evapotranspiration
mm / yr
835
955
1075
1195
1315

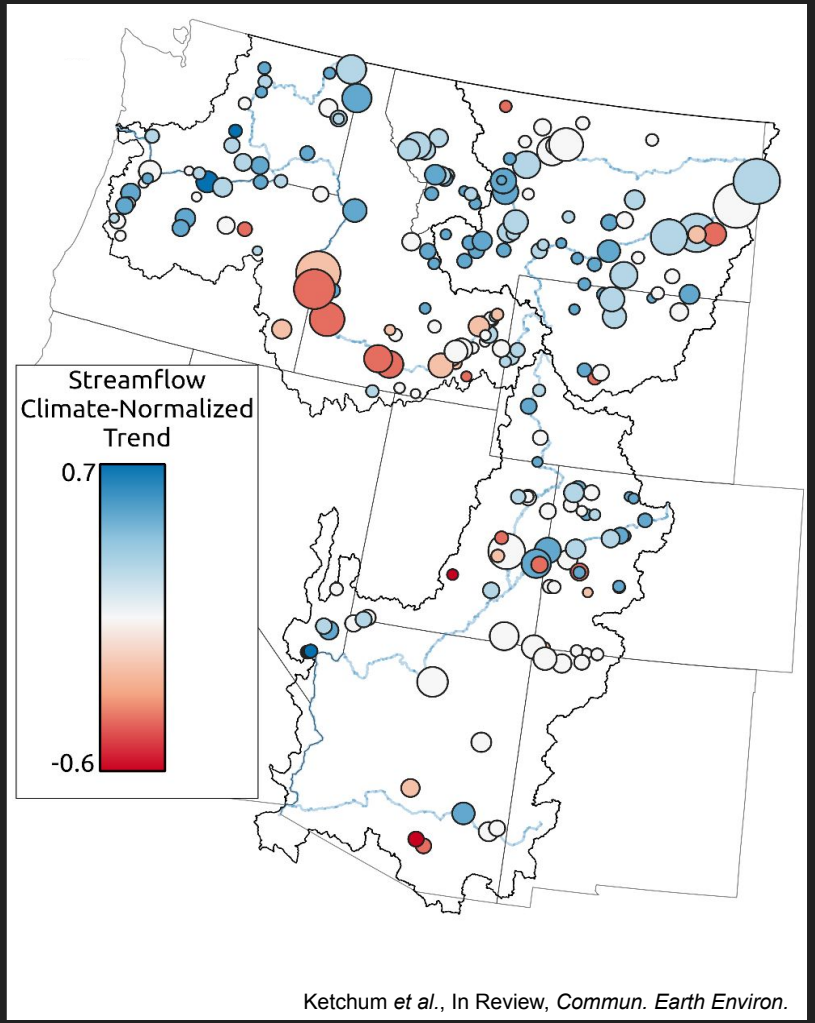

Reference ET mm day⁻1
10.0
7.5
5.0
2.5
0.0
Feb - 1991
Mar - 1991
Apr - 1991
May - 1991
Jun - 1991
Jul - 1991
Aug - 1991
Sep - 1991
Oct - 1991
Nov - 1991
Dec - 1991
Jan - 1992
Date


Precipitation mm day⁻1
40
30
20
10
0
Feb - 1991
Mar - 1991
Apr - 1991
May - 1991
Jun - 1991
Jul - 1991
Aug - 1991
Sep - 1991
Oct - 1991
Nov - 1991
Dec - 1991
Jan - 1992
Date

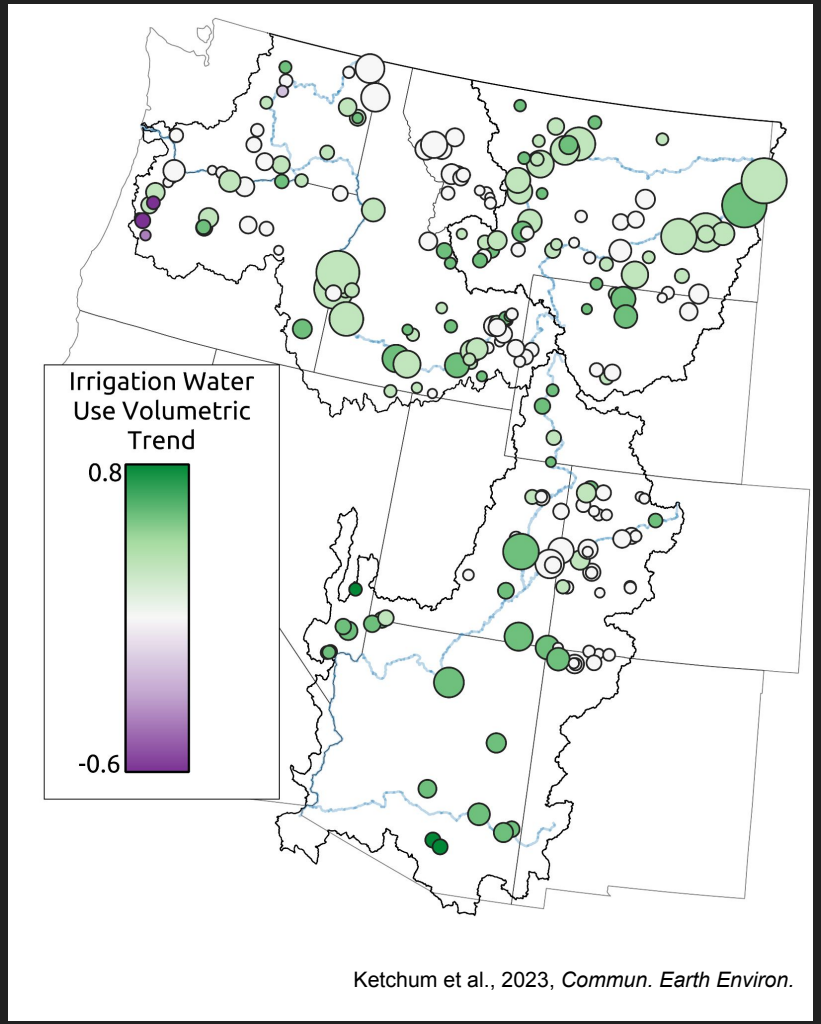

Precipitation
mm / yr
250
515
780
1045
1310


Streamflow
Volumetric Trend
0.7
-0.6
10^3
10^4
10^5
Basin Area (sq km)
200 km





Ketchum *et al.*, In Review, *Commun. Earth Environ.*



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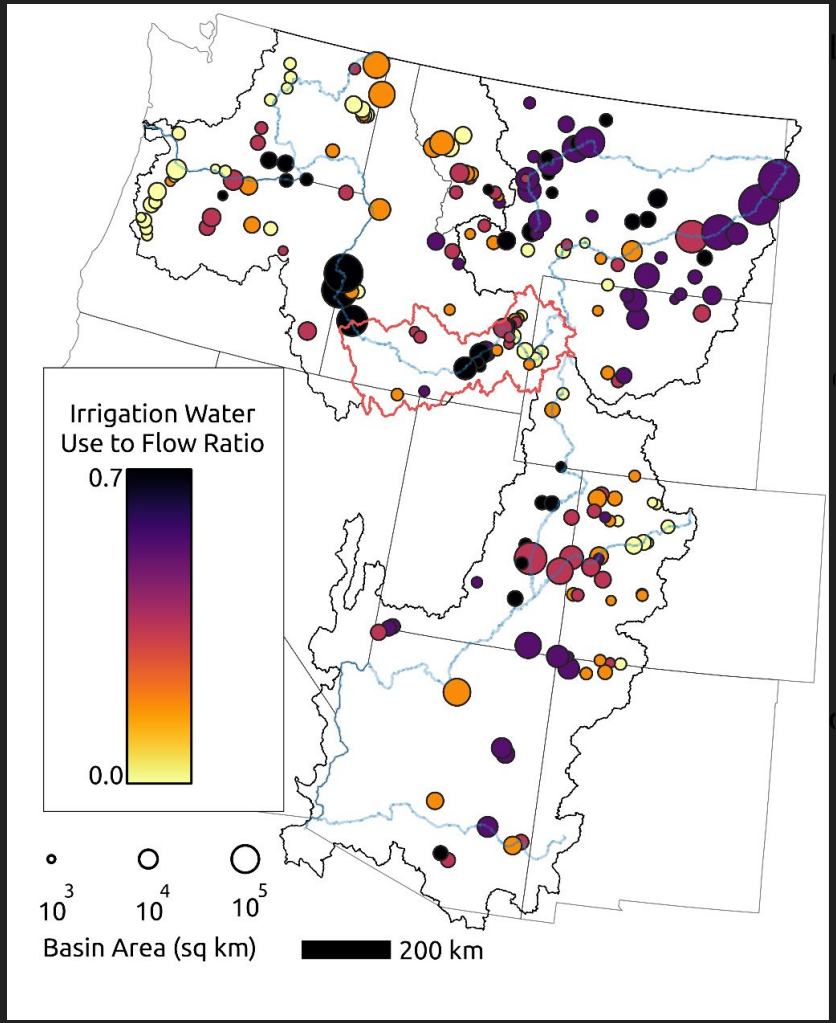

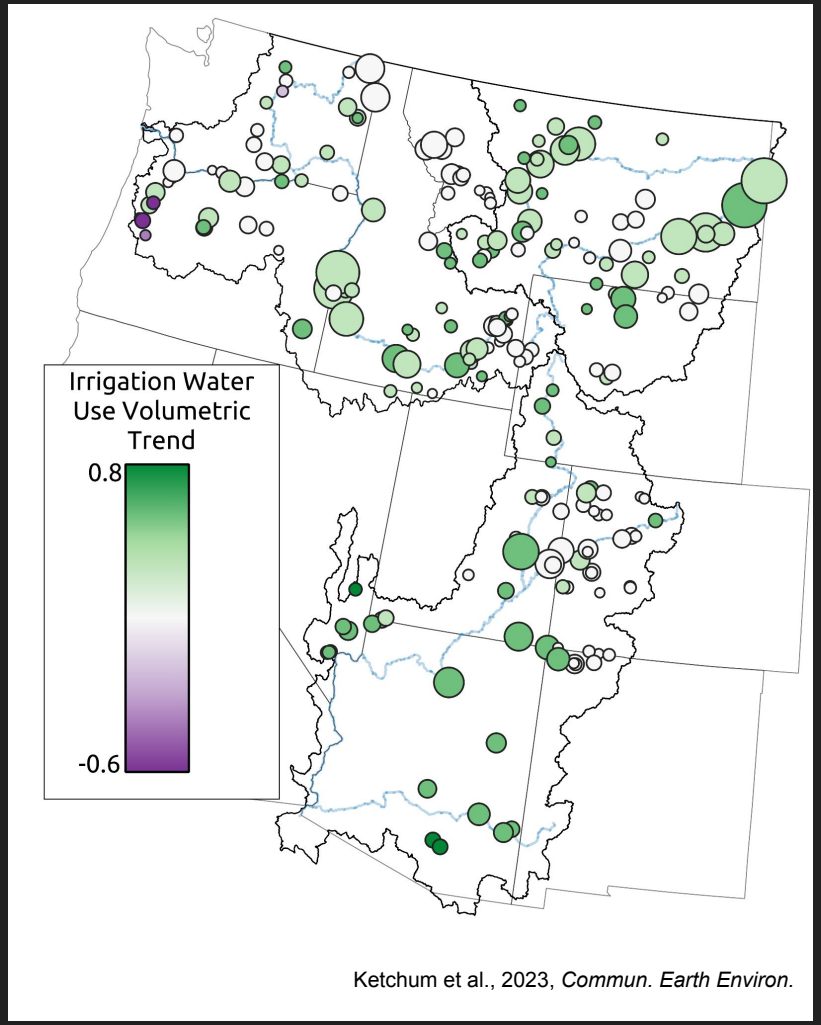

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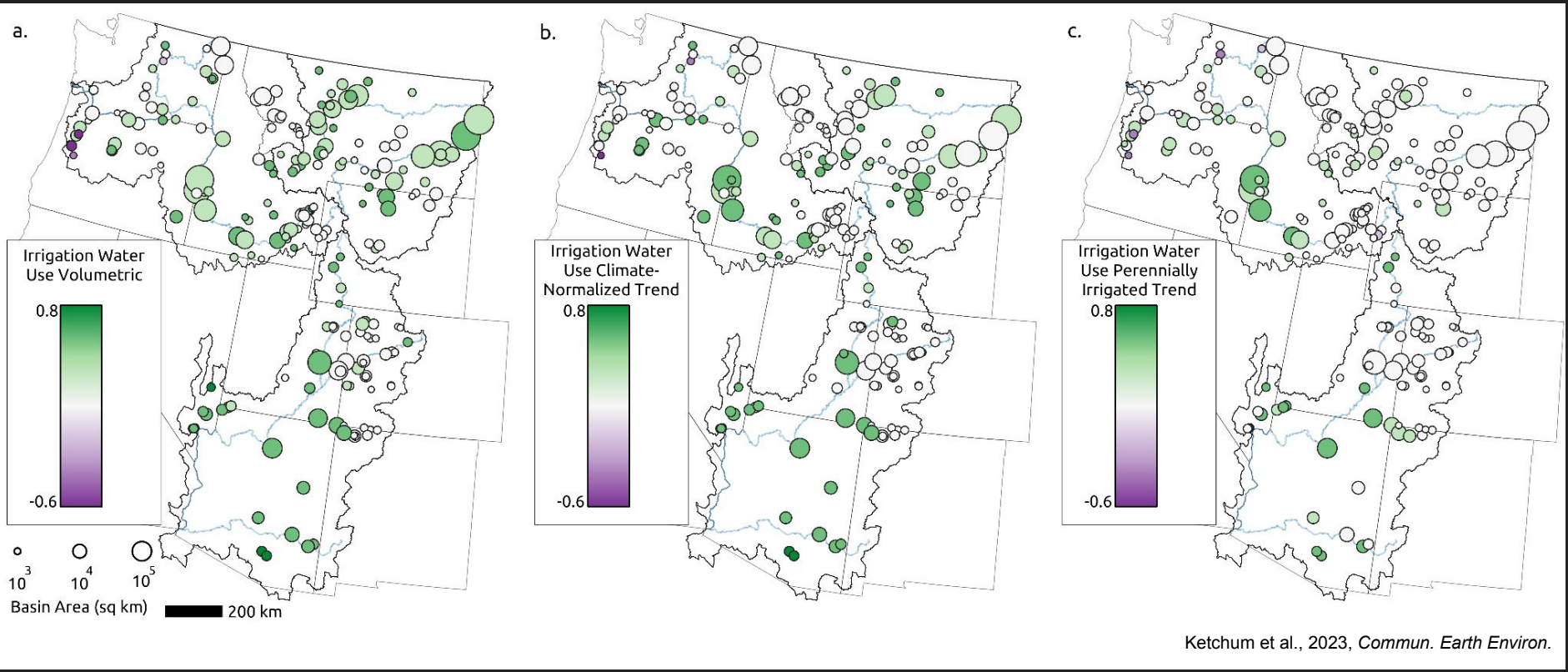

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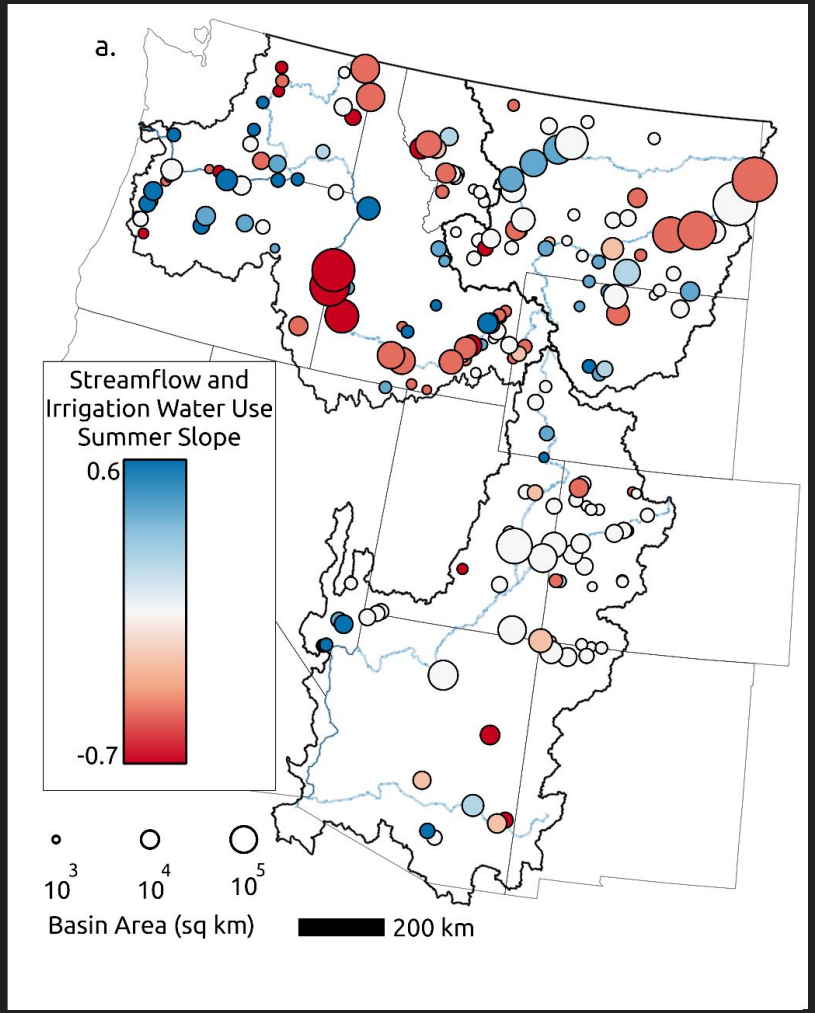

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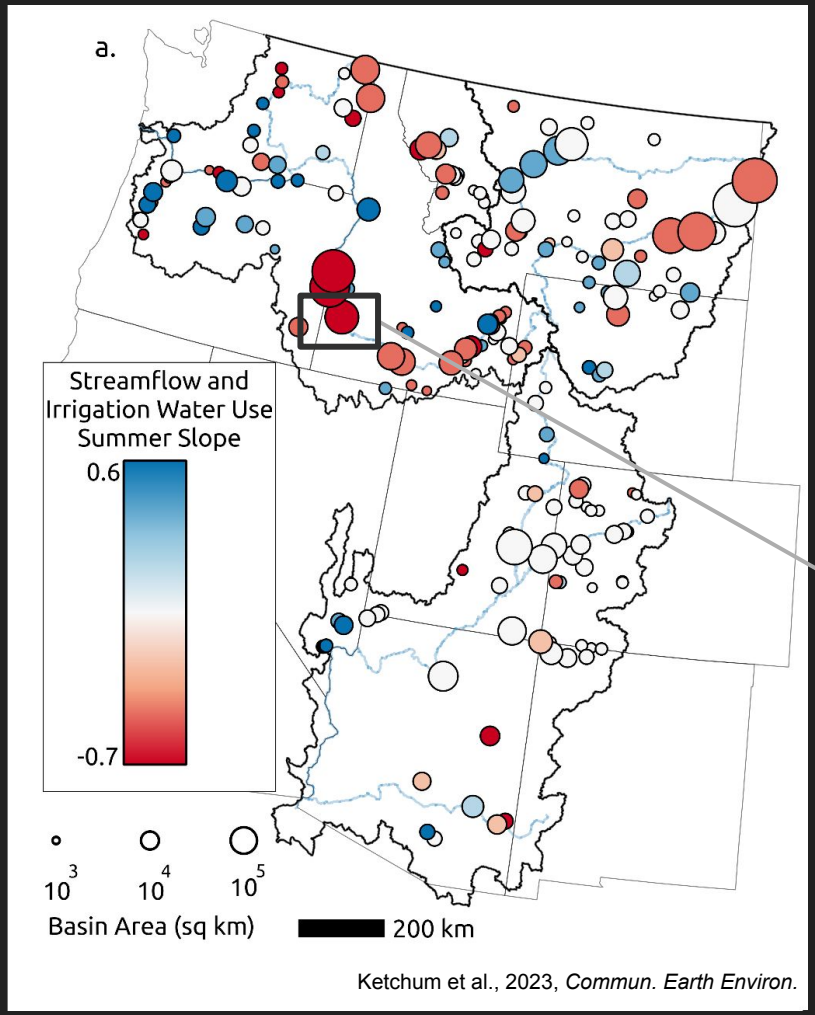

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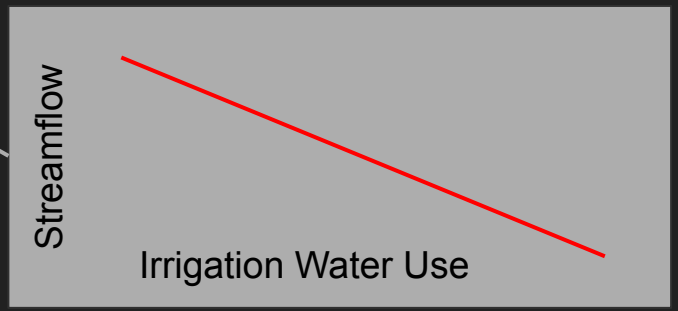
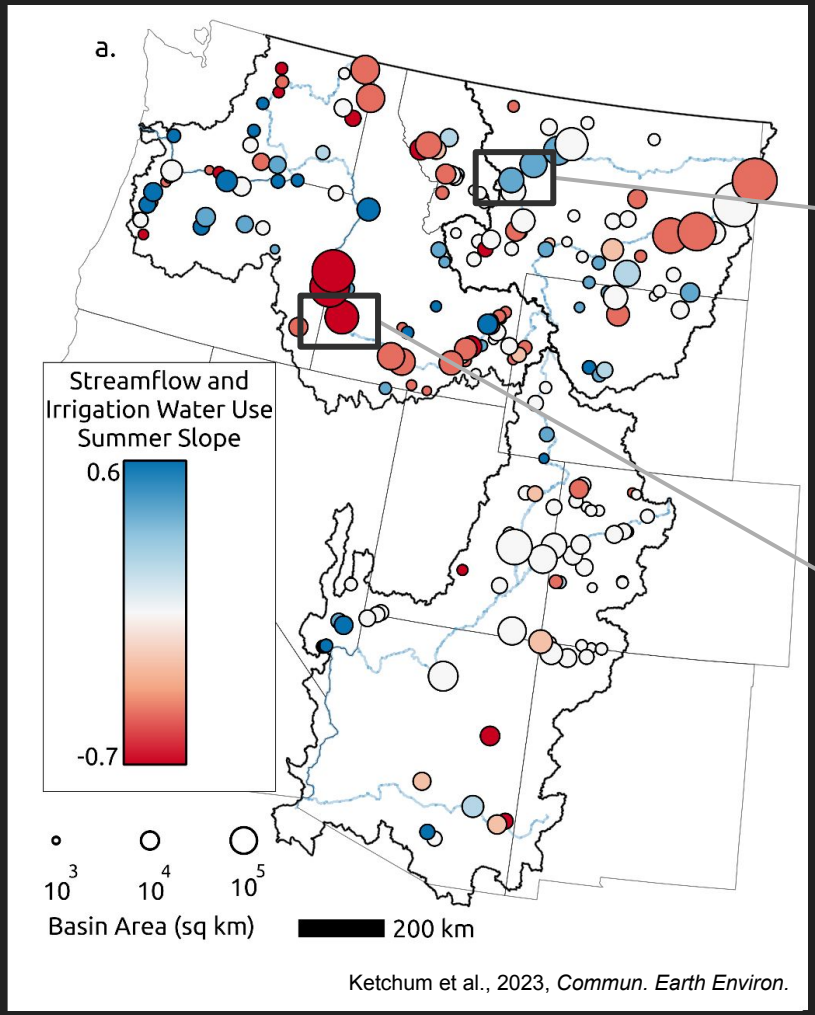
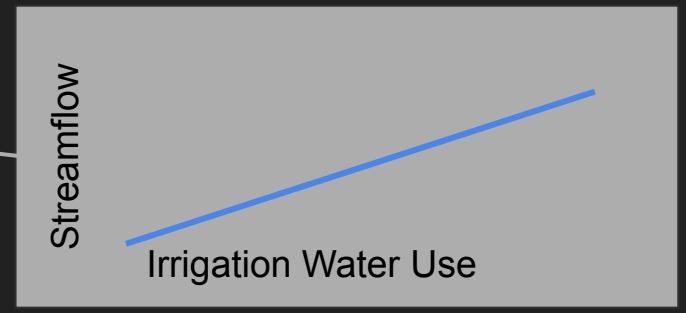
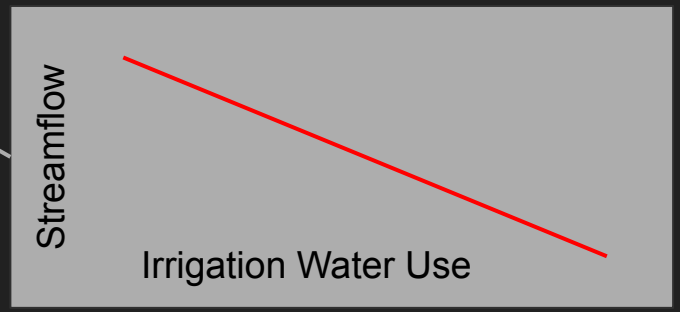
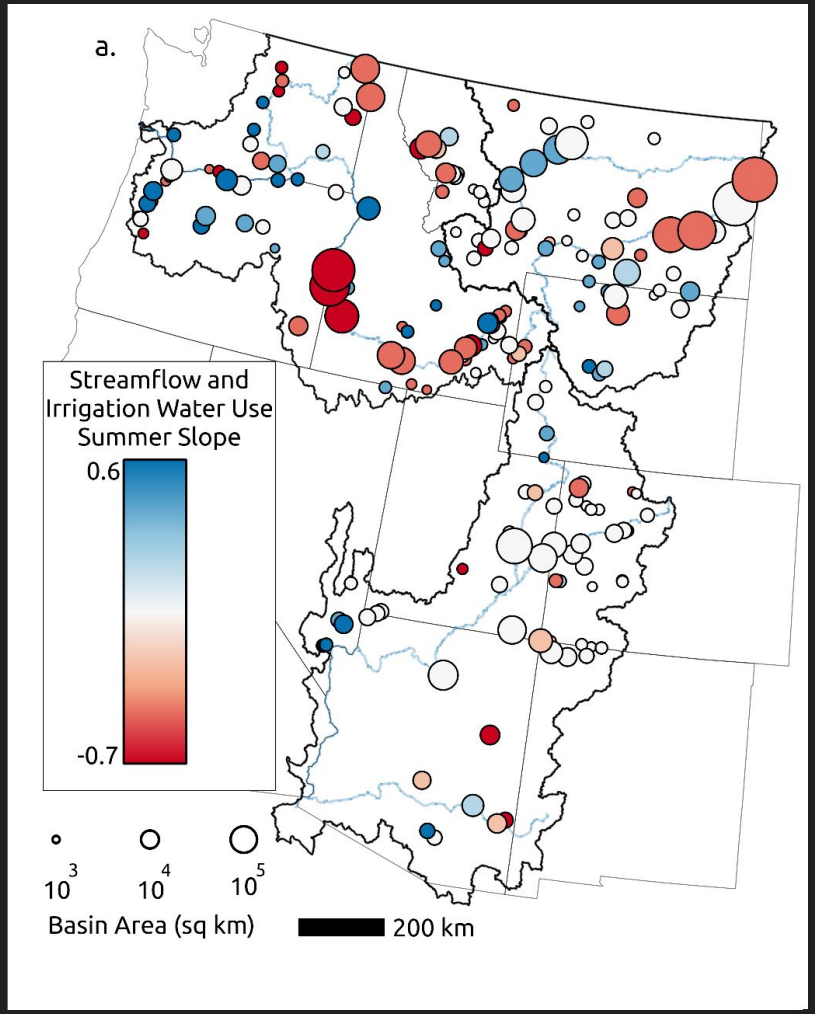


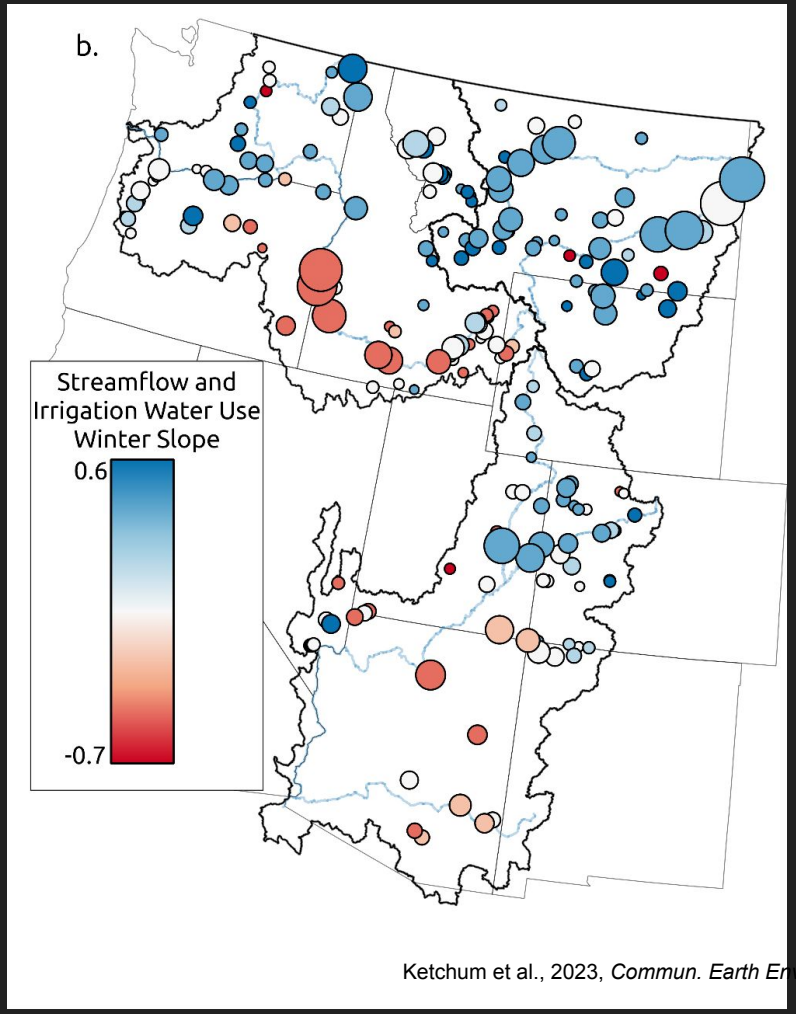


Ketchum et al., 2023, *Commun. Earth Environ.*









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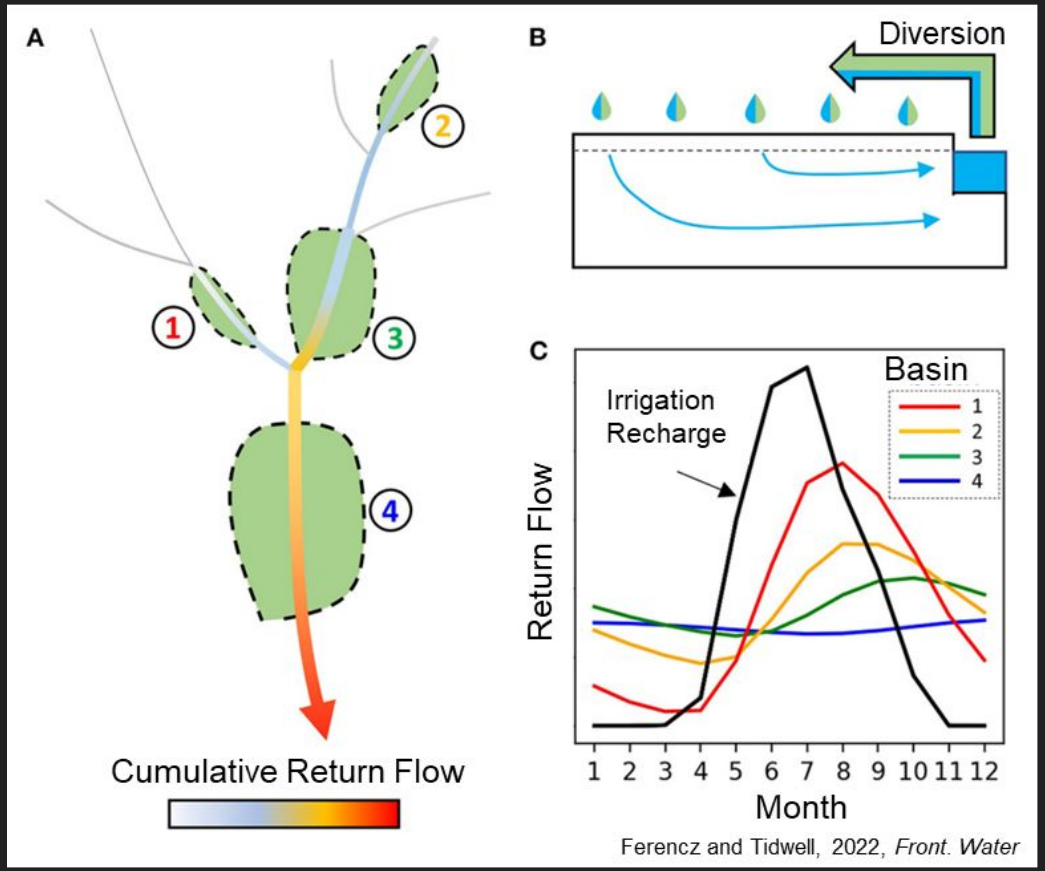
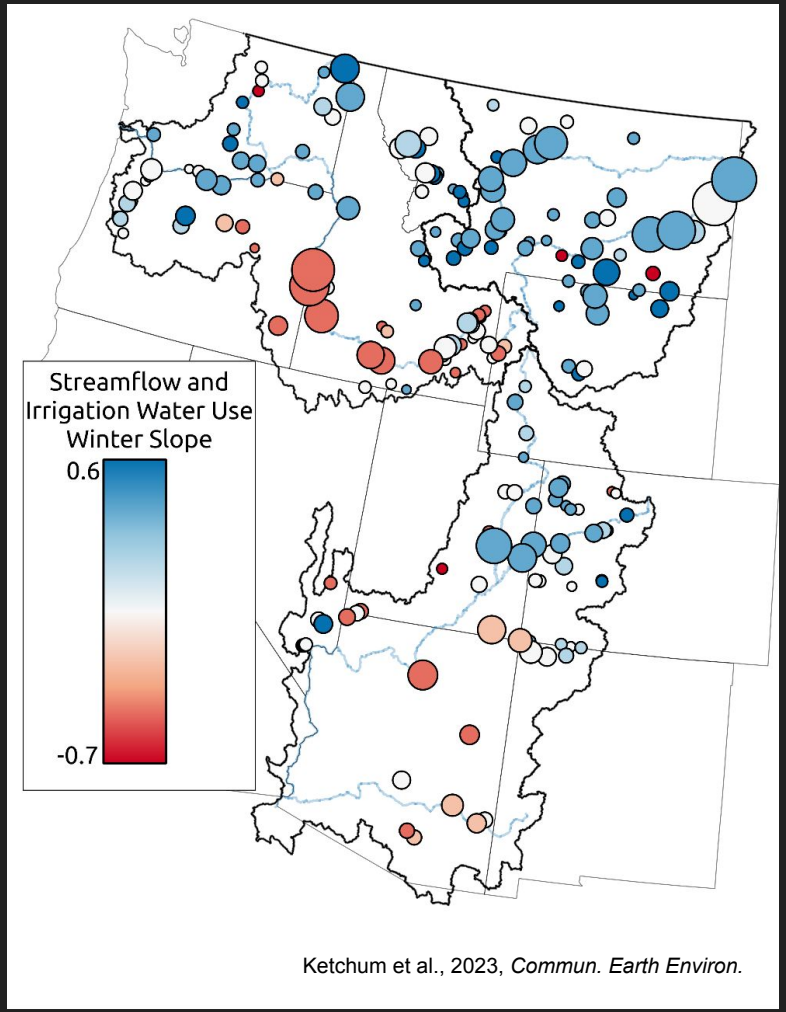
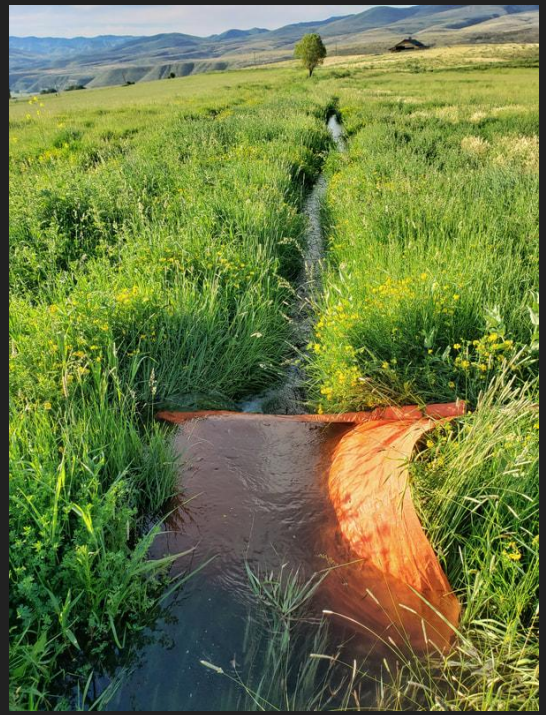


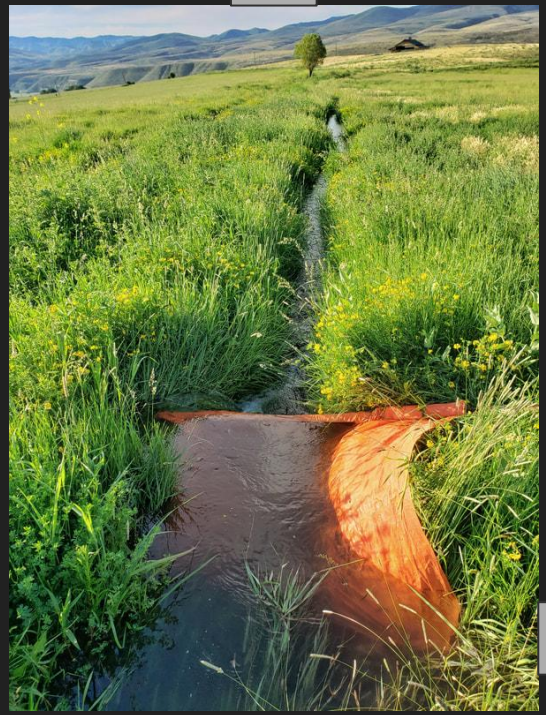


Ketchum et al., 2023, *Commun. Earth Environ.*

Up to 70% of late summer streamflow may be derived from irrigation return flows!
(Essaid and Caldwell, 2017, *Sci. Total Environ.*; Crossa *et al.*, 2006, *Water Res.*)



50%

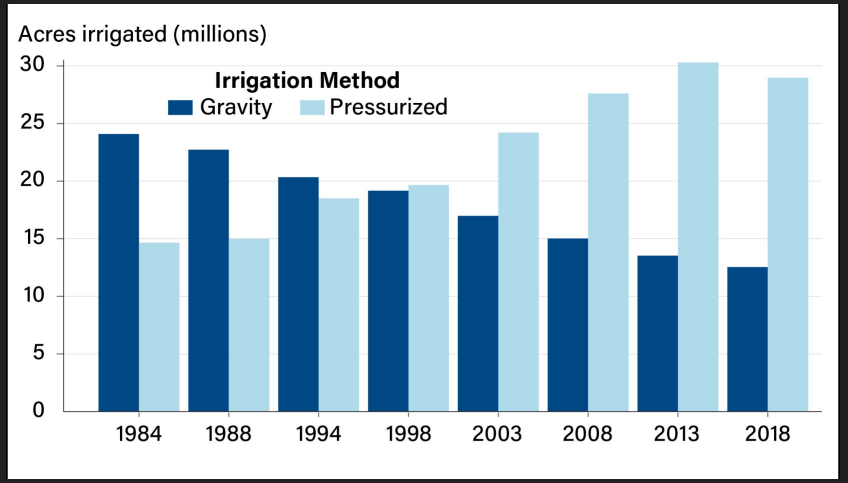


50%

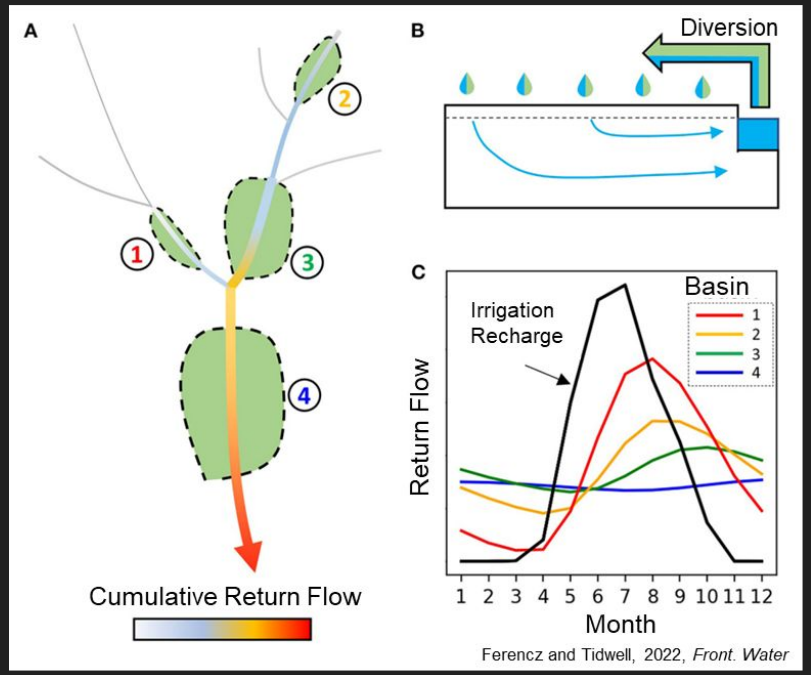
U.N Food and Agriculture Organization, *Irrigation Scheduling* (1989) 4, A-1.

90%

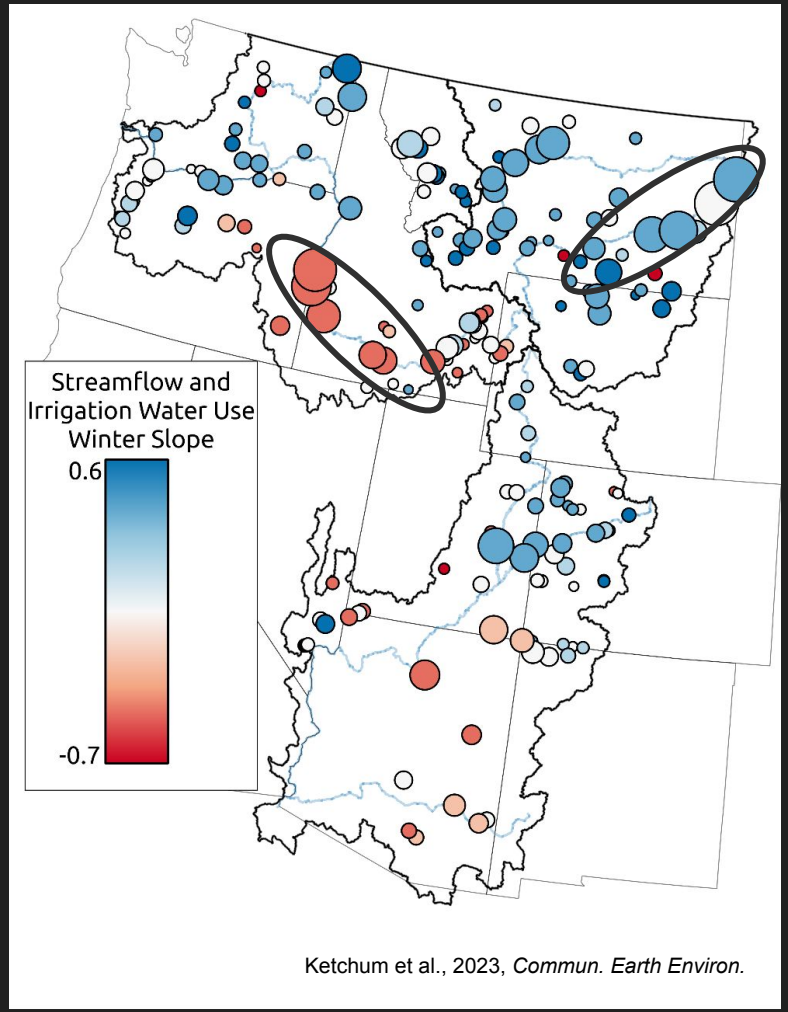
10%



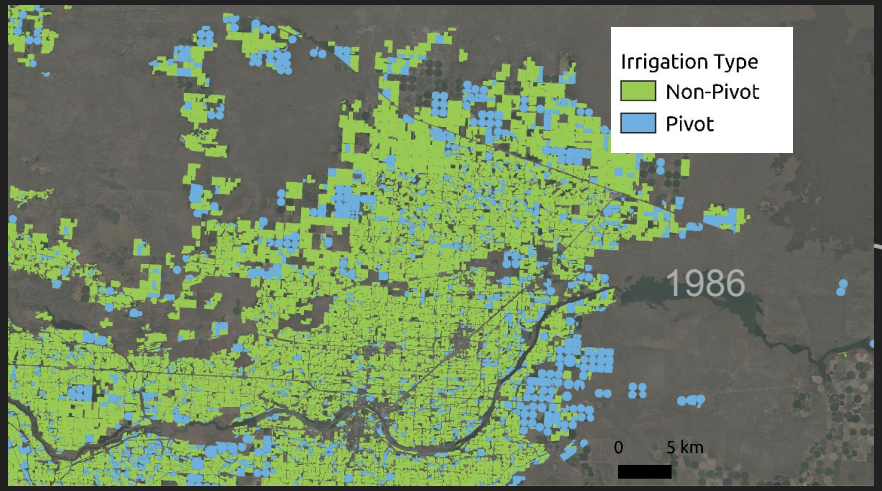
Hrozencik and Aillery, 2022; US Dept. Ag., National Agricultural Statistics Service

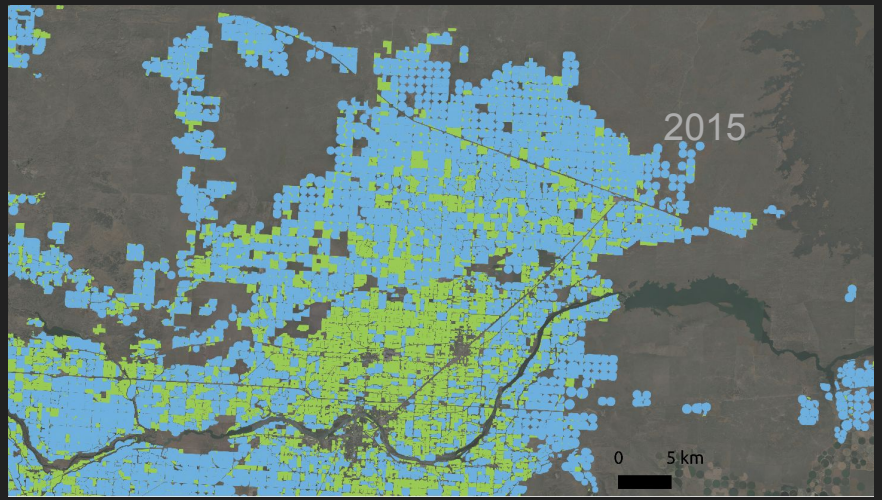


Ferencz and Tidwell, 2022, *Front. Water*

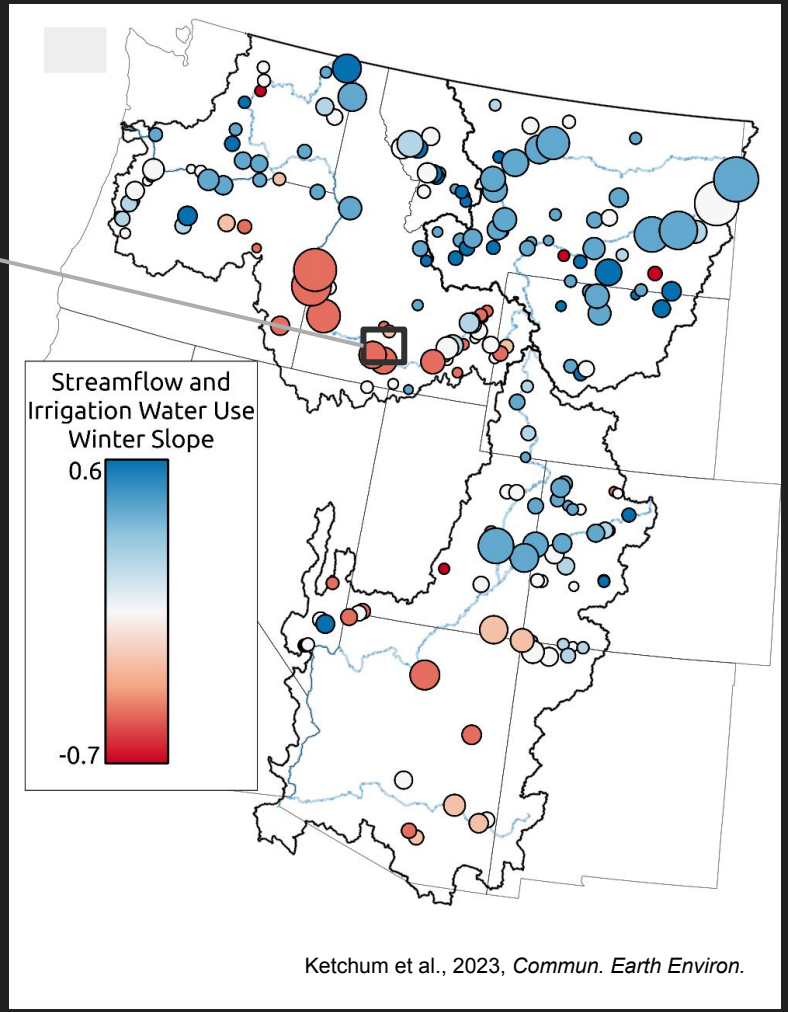


Ketchum et al., 2023, *Commun. Earth Environ.*





Idaho Dept. Water Res.



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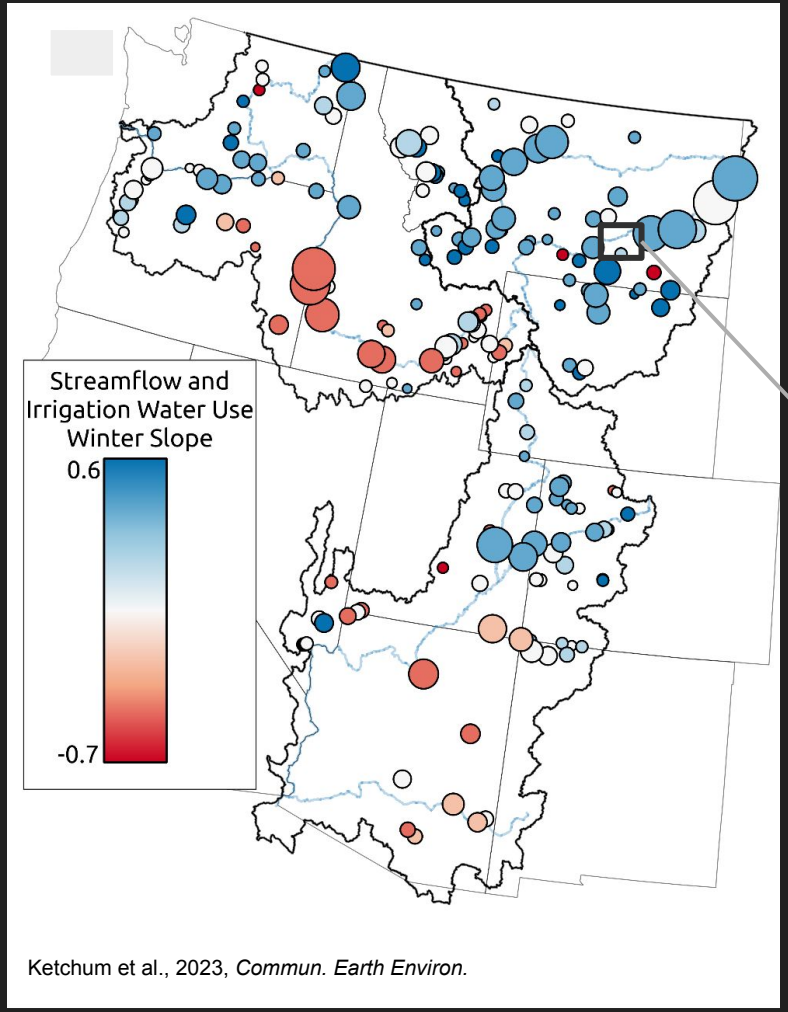
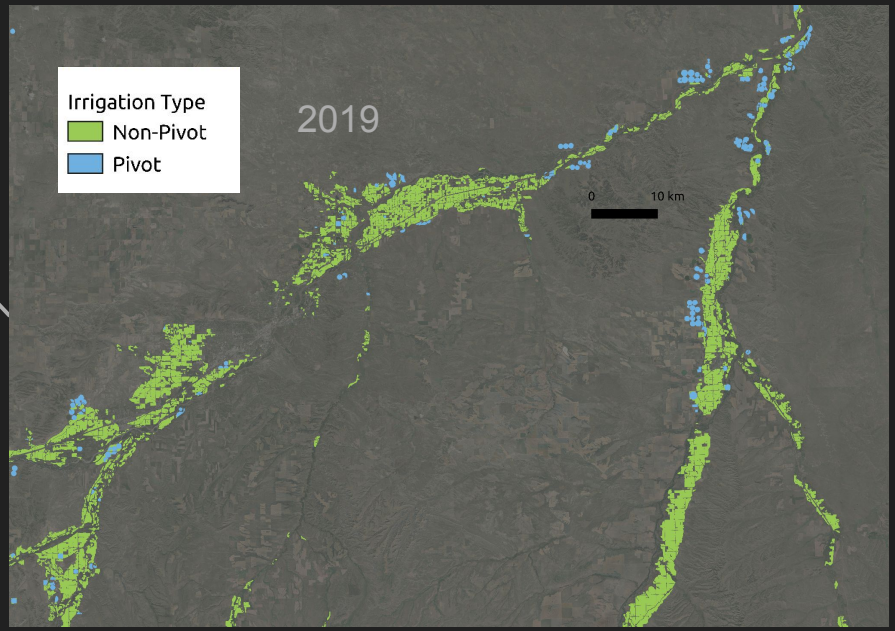
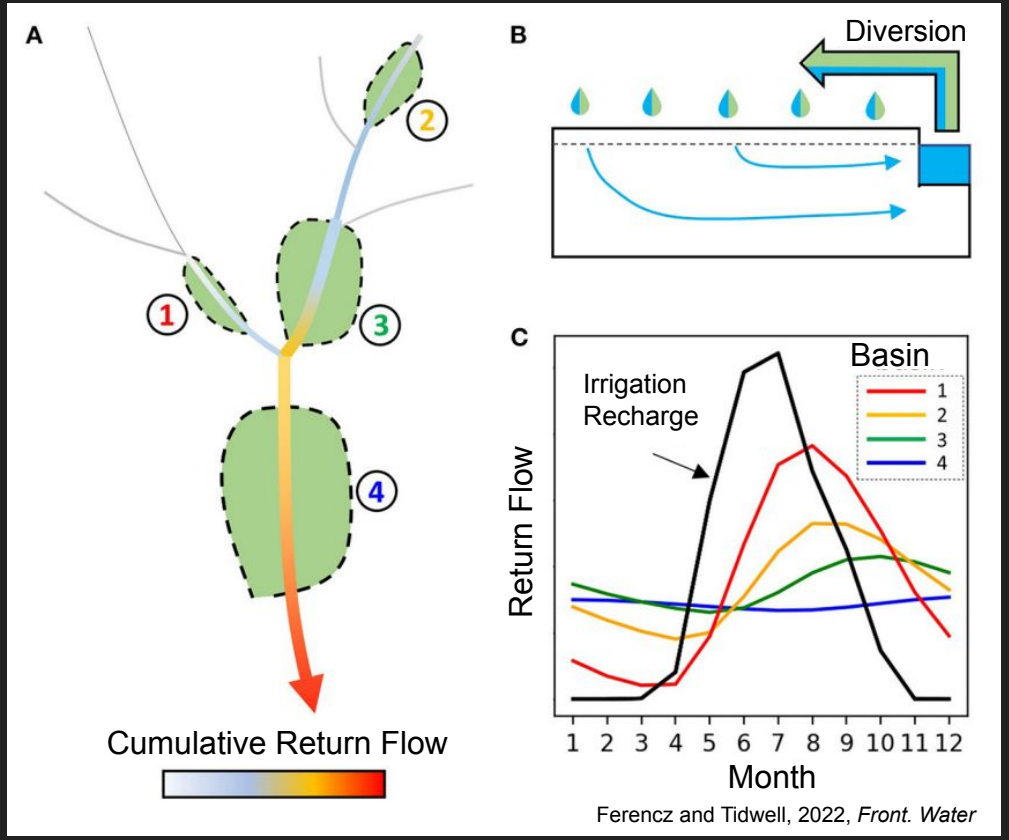


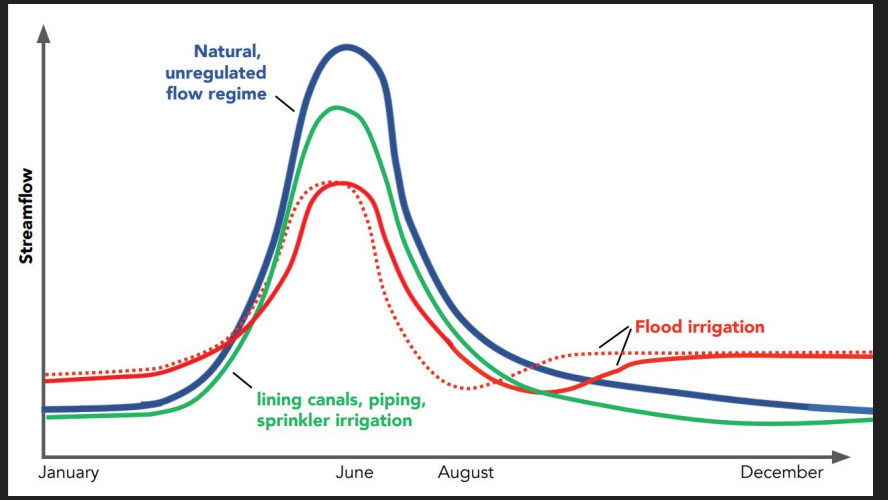
Ketchum et al., 2023, *Commun. Earth Environ.*

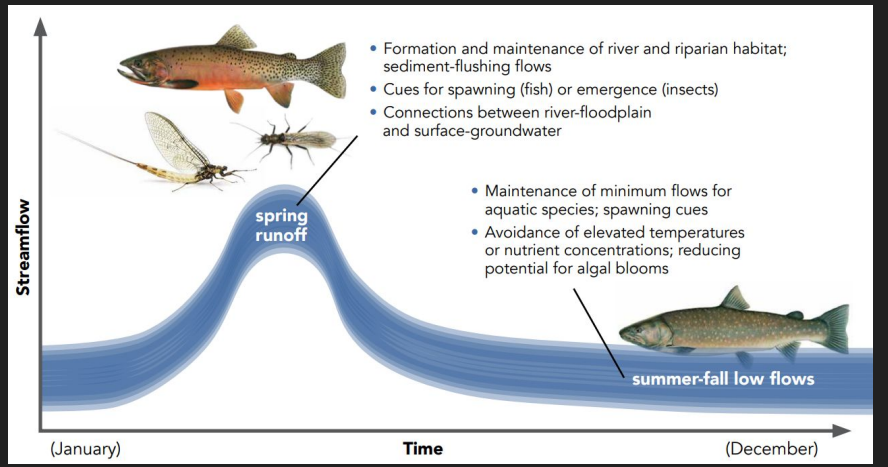


Lower efficiency, more connected aquifers -> higher return flows

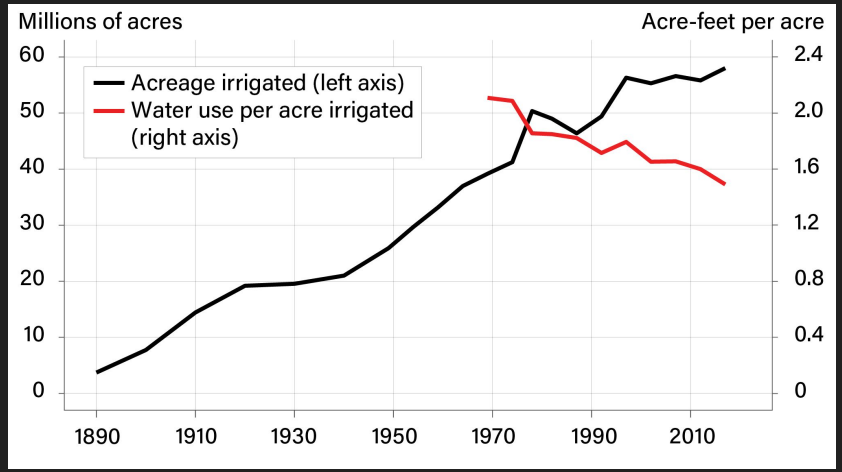


Ferencz and Tidwell, 2022, *Front. Water*



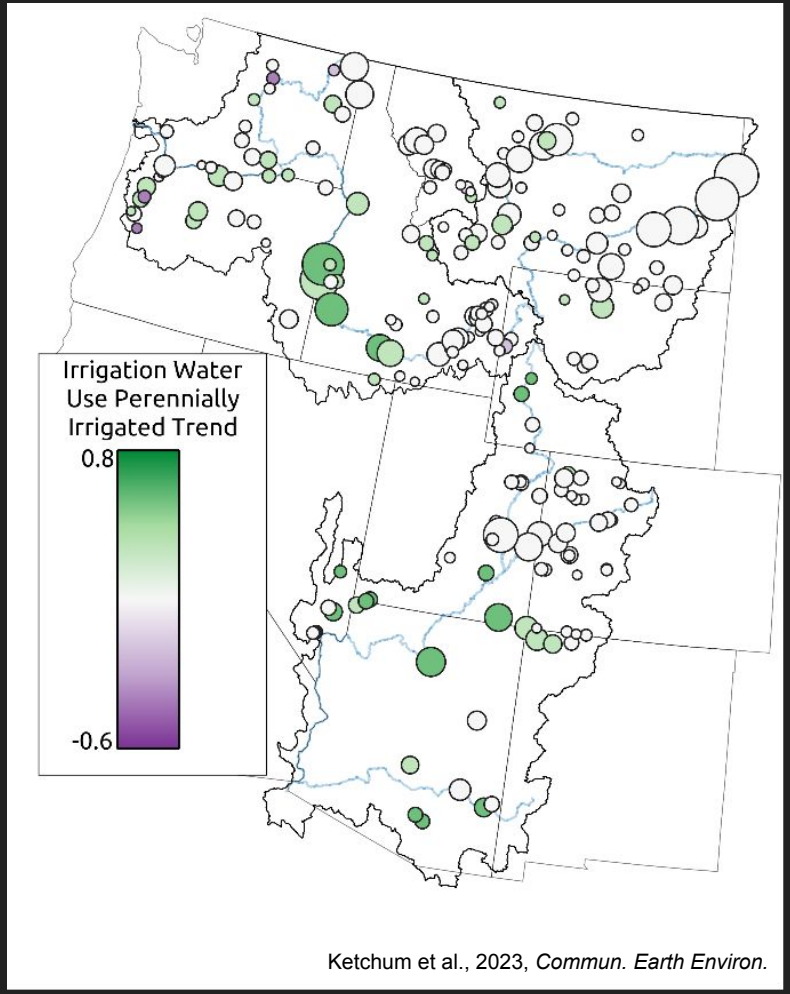


Lonsdale *et al.*, 2020, Montana Water Center



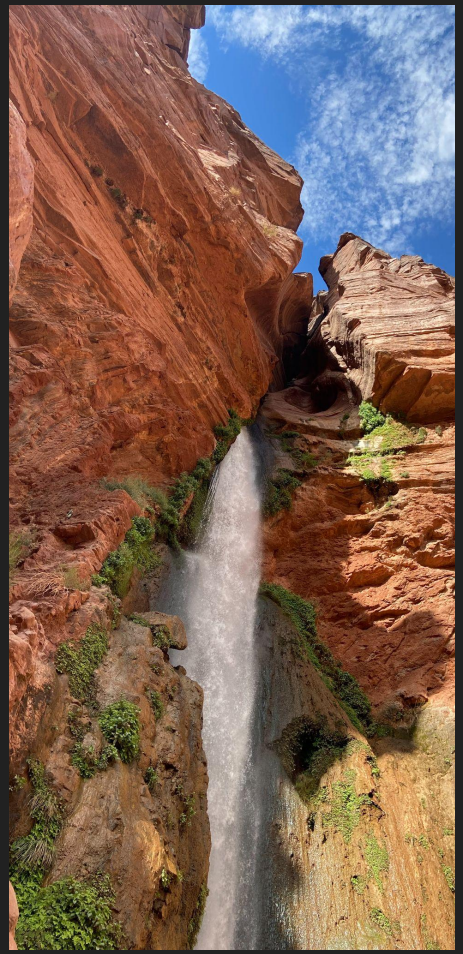
Hrozencik and Aillery, 2022; US Dept. Ag., National Agricultural Statistics Service

USDA approach to surveying irrigation does not estimate IWU, causing the implications of the ‘paradox’ of irrigation efficiency to go **unobserved** at scale.



Ketchum et al., 2023, *Commun. Earth Environ.*

Thank You!



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(available upon request; david.ketchum@mso.umt.edu):

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