



Are catchment-scale nitrogen and phosphorous use efficiencies controlled by climate?

Bolin Centre for
Climate Research



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- Soil moisture mediates nutrient uptake by plants and leaching
- Hypothesis: ET/P drives the efficiencies (through time)
- **Hydrological controls explain variations in nutrient use efficiency**

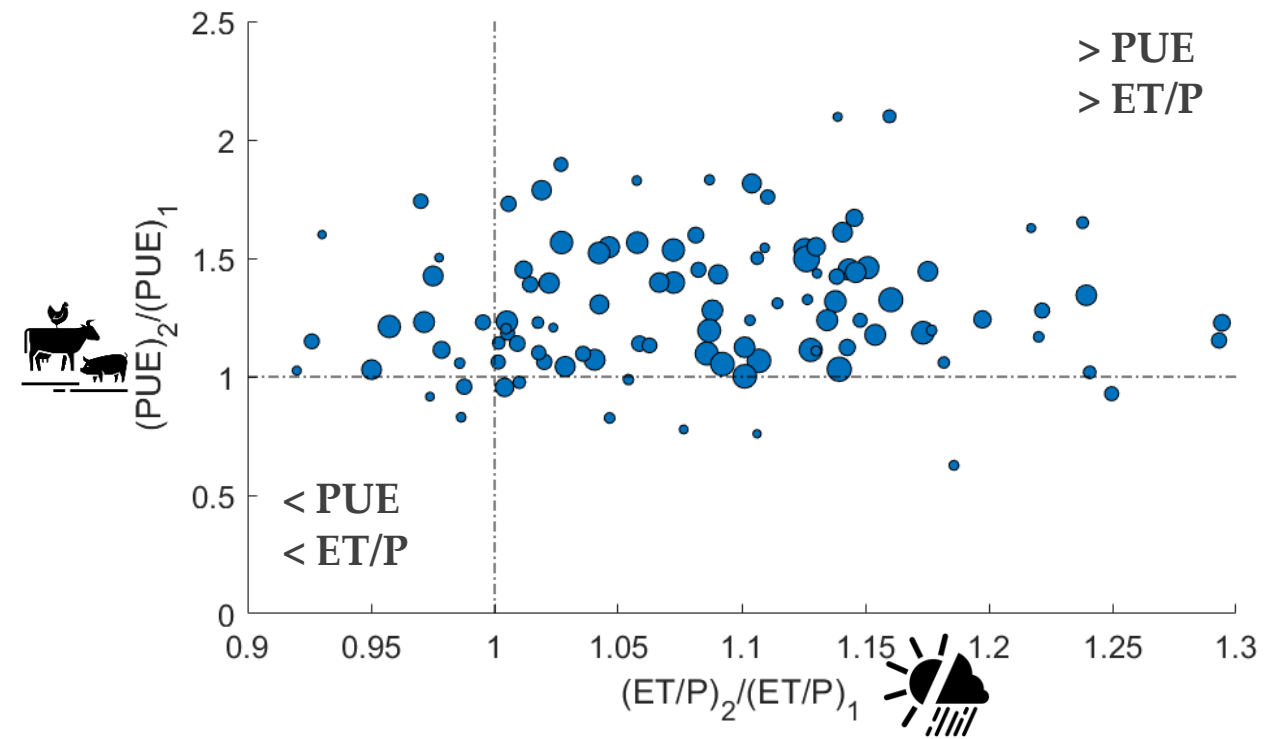
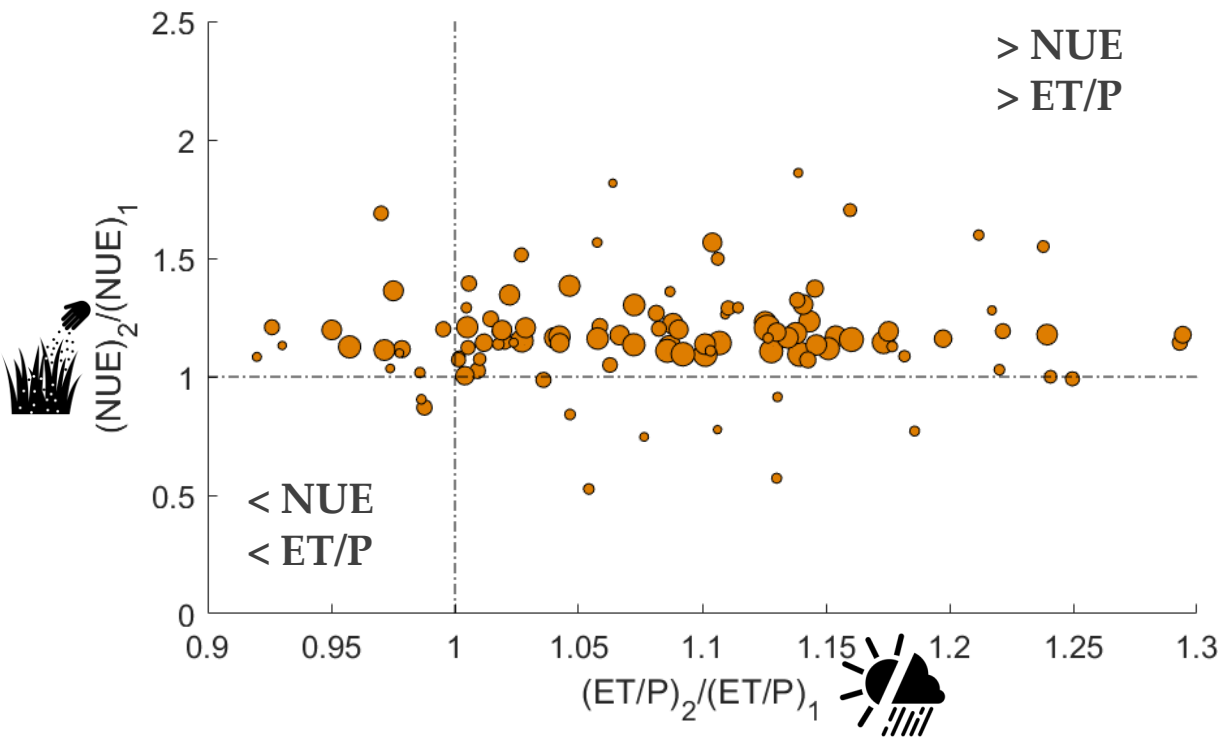


Where? 110
catchments
in the US

$$\text{NUE} = \frac{N \text{ in yield}}{N \text{ inputs}}$$

$$\text{PUE} = \frac{P \text{ in yield}}{P \text{ inputs}}$$

$$\frac{ET}{P} = \frac{\text{Evapotranspiration}}{\text{Precipitation}}$$





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Approach

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The “actors”



$$\frac{ET}{P} = \frac{\text{Evapotranspiration}}{\text{Precipitation}}$$



$$NUE = \frac{N \text{ in yield}}{N \text{ inputs}}$$



$$PUE = \frac{P \text{ in yield}}{P \text{ inputs}}$$

- Precipitation and runoff data to estimate long-term catchment-scale $ET = \text{precipitation} - \text{runoff}$
- Agriculture data (selected catchments with >10% ag. area)
- N inputs: N fertilizer, N fixation, N deposition, manure N
- P inputs: P fertilizer, manure P
- 110 catchments in the United States
- Two averaging periods: 1988-1997 vs. 1998-2007

Crops using water efficiently also use nutrients efficiently, reducing both water (runoff) and nutrient (leaching) losses

Theoretical expectation: efficiencies $\sim \frac{ET}{P}$

(Manzoni et al. 2011)

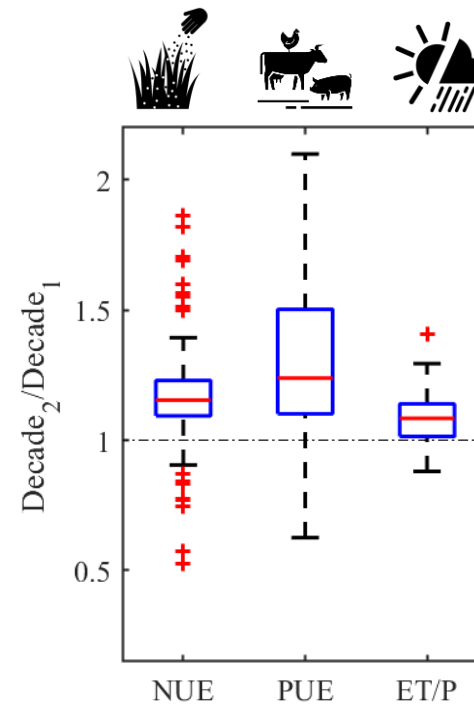
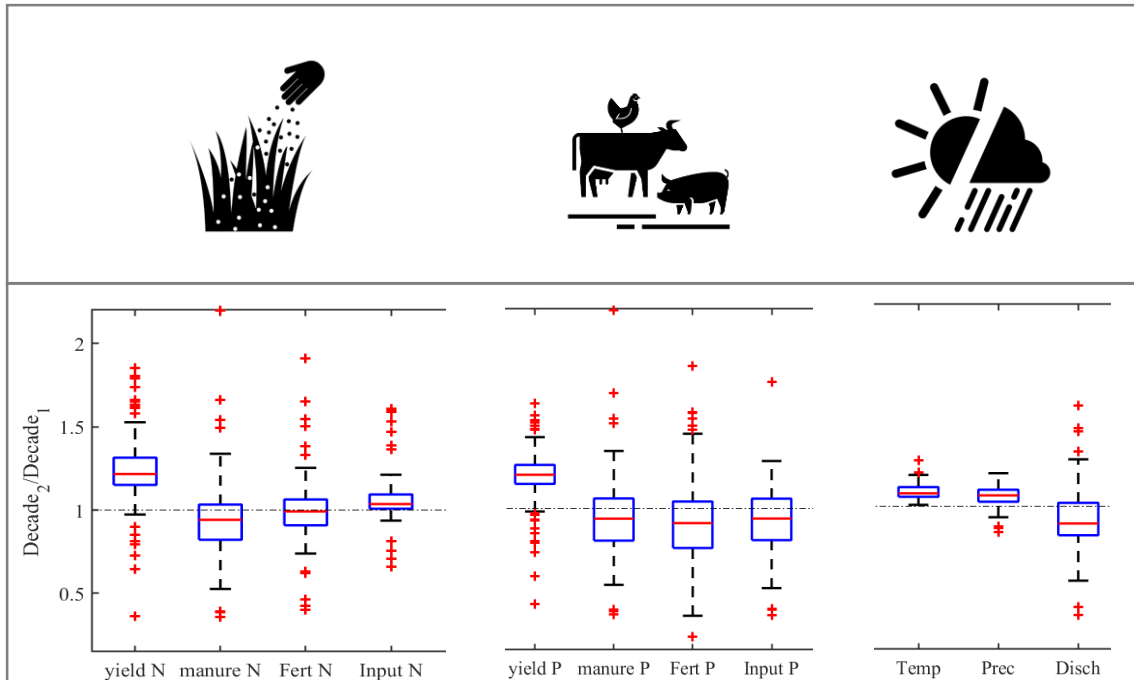


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ET/P is a significant driver of change in both NUE and PUE

Scaini et al., 2020. Hydro-climatic controls explain variations in catchment-scale nitrogen use efficiency. ERL

- NUE increases with ET/P and both increase through time
- NUE also increases with fraction of agricultural area (symbol size)
- Only climatic changes increasing ET/P without negatively affecting yields will improve NUE (increase water and N retention)



Linear mixed effect model to test the potential causal relation between hydrological and the nutrient efficiencies

ET/P is one of the significant drivers of change in both NUE and PUE.

Scaini et al., In preparation

References

Scaini et al., 2020. ERL

Manzoni et al. 2011 Proc. Royal Soc. A

Swaney et al., 2019. STE

Lasalletta et al., 2014. ERL

[Watering by Manthana Chaiwong, farm animal by Laymik, fertilizer by Ayumi Aya - the Noun Project]