The effects of climatic and soil properties on soil water repellency

Maria Then, Soudabeh Shemehsavar, David Henry, Richard Harper

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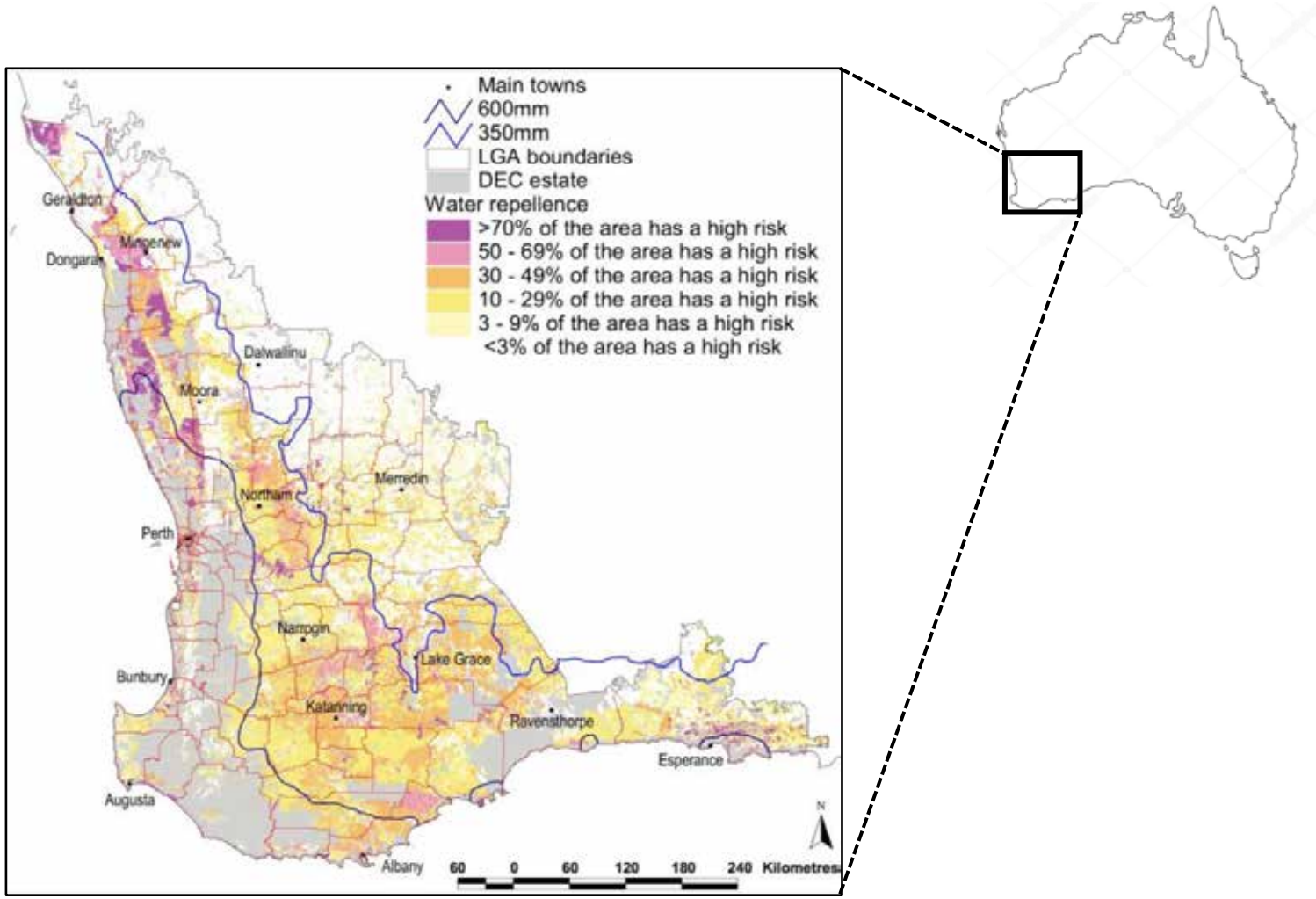
Soil water repellency (SWR): A global challenge for dryland agriculture

- Some soils express SWR more strongly than others when they dry out.
- SOM, soil texture, soil moisture, and soil temperature influence SWR.
- Often a feature in sandy soils.
- Drying cycles and higher temperatures exacerbate SWR.
- *Then, M., Shemehsavar, S., Henry, D.J., Harper, R. J. (2025). The effects of climatic and soil properties on soil water repellency, CATENA. 258: 109218. https://doi.org/10.1016/j.catena.2025.109218*



(Van Gool et al., 2008)

Current knowledge à Rethinking SWR under climate variability

- Drying conditions will increase in dryland agricultural areas.
- Climate change will likely increase the expression of SWR…
- But other climate-driven mechanisms in soil may affect SWR risk too.
- Most SWR research has been done in controlled settings.
- As a surrogate for climate variation, we use 355 field samples across a climate gradient at the regional (50,000 km^2) scale.

Global Change Biology

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REVIEW

Soil water repellency and its implications for organic matter decomposition – is there a link to extreme climatic events?

MARC-O. GOEBEL*, JÖRG BACHMANN*, MARKUS REICHSTEIN†, IVAN A. JANSSENS‡ and GEORG GUGGENBERGER*

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The effects of climatic and soil properties on soil water repellency

Maria Then [a,c], Soudabeh Shemehsavar [b], David J. Henry [b,c], Richard J. Harper [a,c,*]

[a] Centre for Crop and Food Innovation, Murdoch University, Murdoch, WA 6150, Australia
[b] Chemistry and Physics, Murdoch University, Murdoch, WA 6150, Australia
[c] Cooperative Research Centre for High Performance Soils, Callaghan, NSW 2308, Australia

Research questions à Investigating the effects of climatic and soil properties on SWR

1. Do known relationships – e.g., less clay = more SWR, more OC = more SWR – hold in a range of WA soils?

2. Does climate variation modify these relationships?

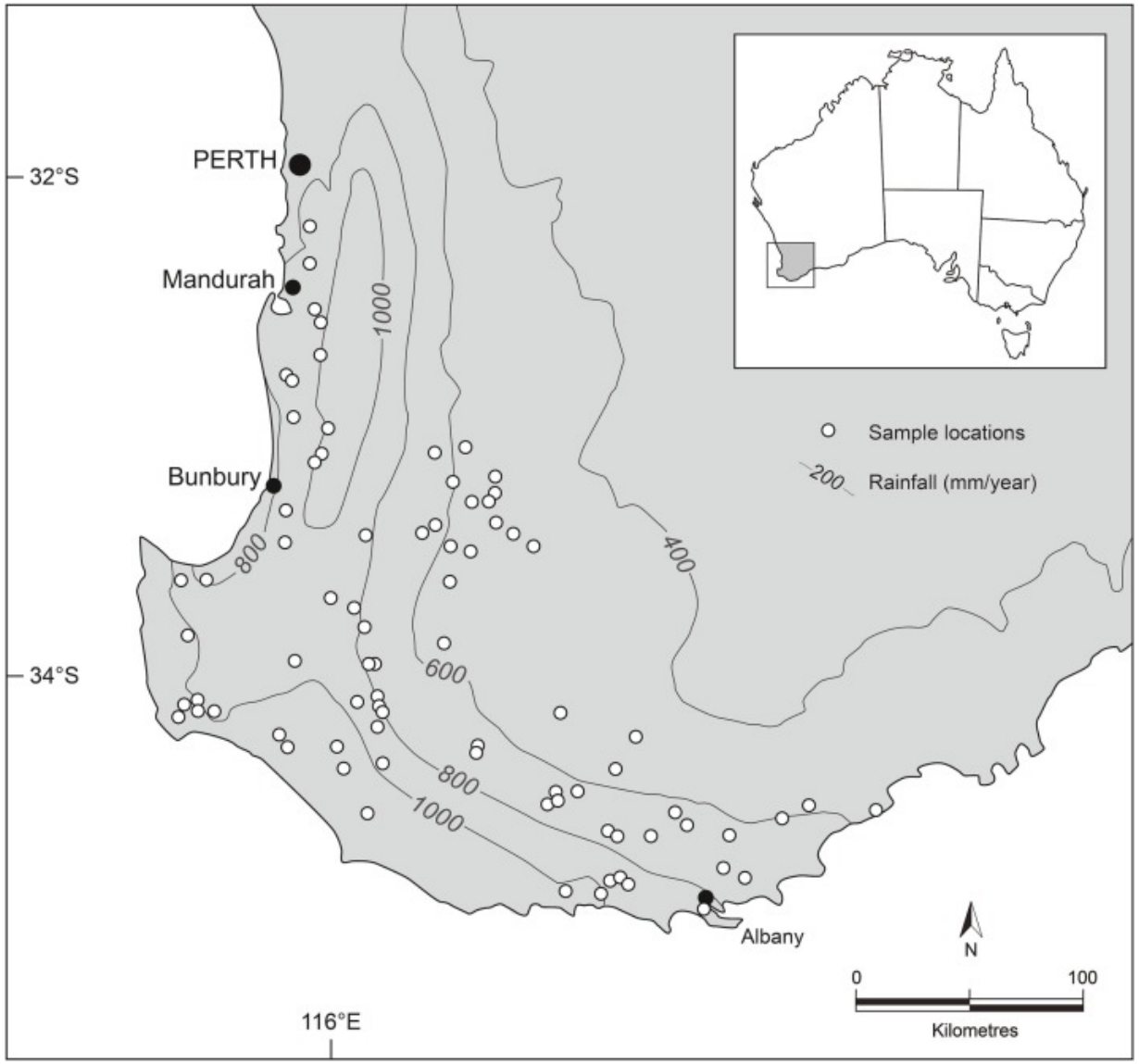
3. What are the implications for climate change mitigation projects?

A regional-scale study in southwest WA

- 355 samples
- 113 sites
- Across ~50,000 km²
- Temperature range: MAT 13.9 – 17.6°C
- Rainfall range: 507 – 1443 mm/year

Climate	Soil
Mean maximum temperature	SWR (M)
Mean minimum temperature	Organic carbon
Rainfall	Clay
Pan annual evaporation	Silt
	Total nitrogen
	Exchangeable cations
	pH and EC

- **Analysis:** Boosted Regression Trees (BRT)



SWR is not confined to sandy soils

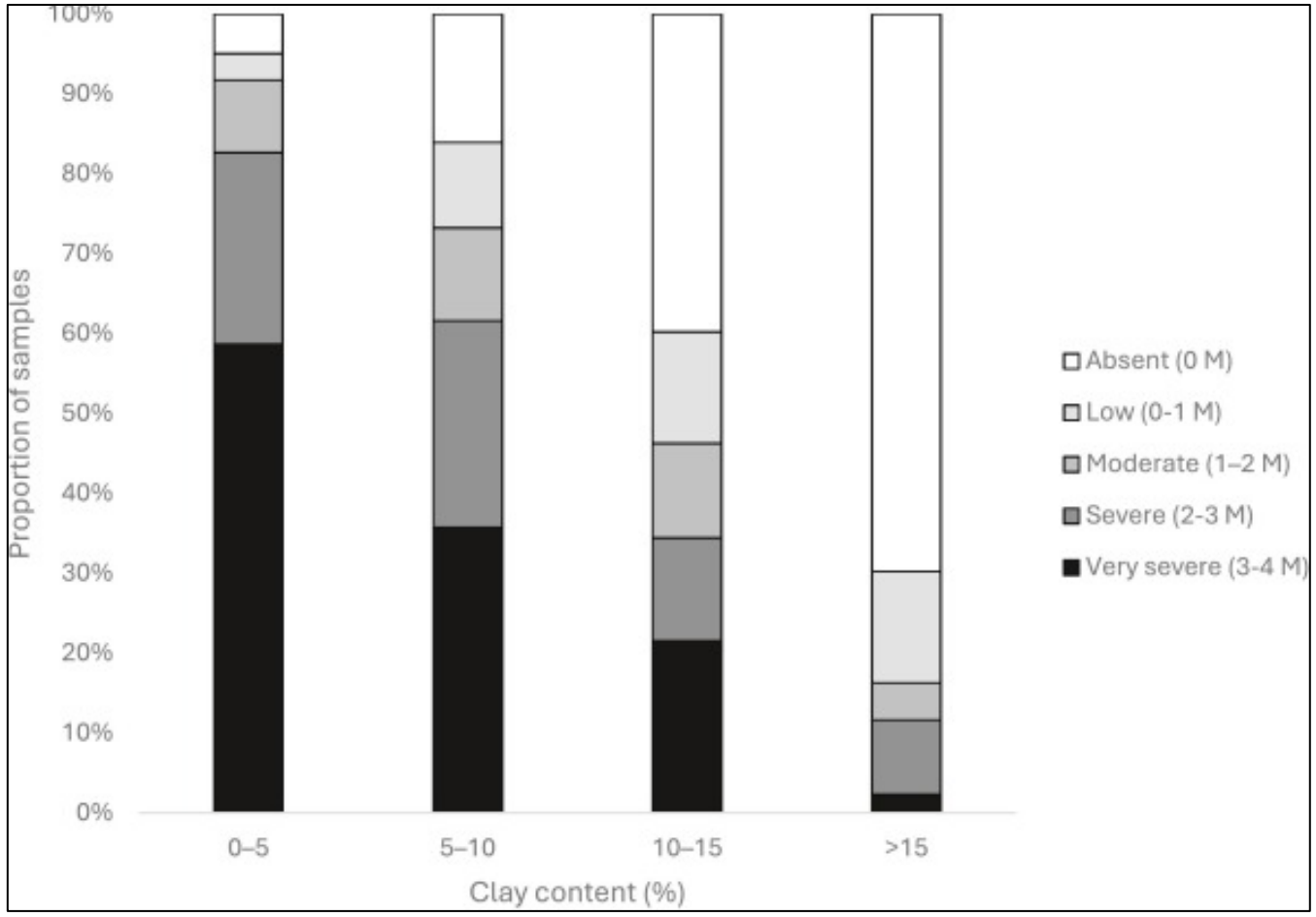
As expected,

ü Clay reduces SWR

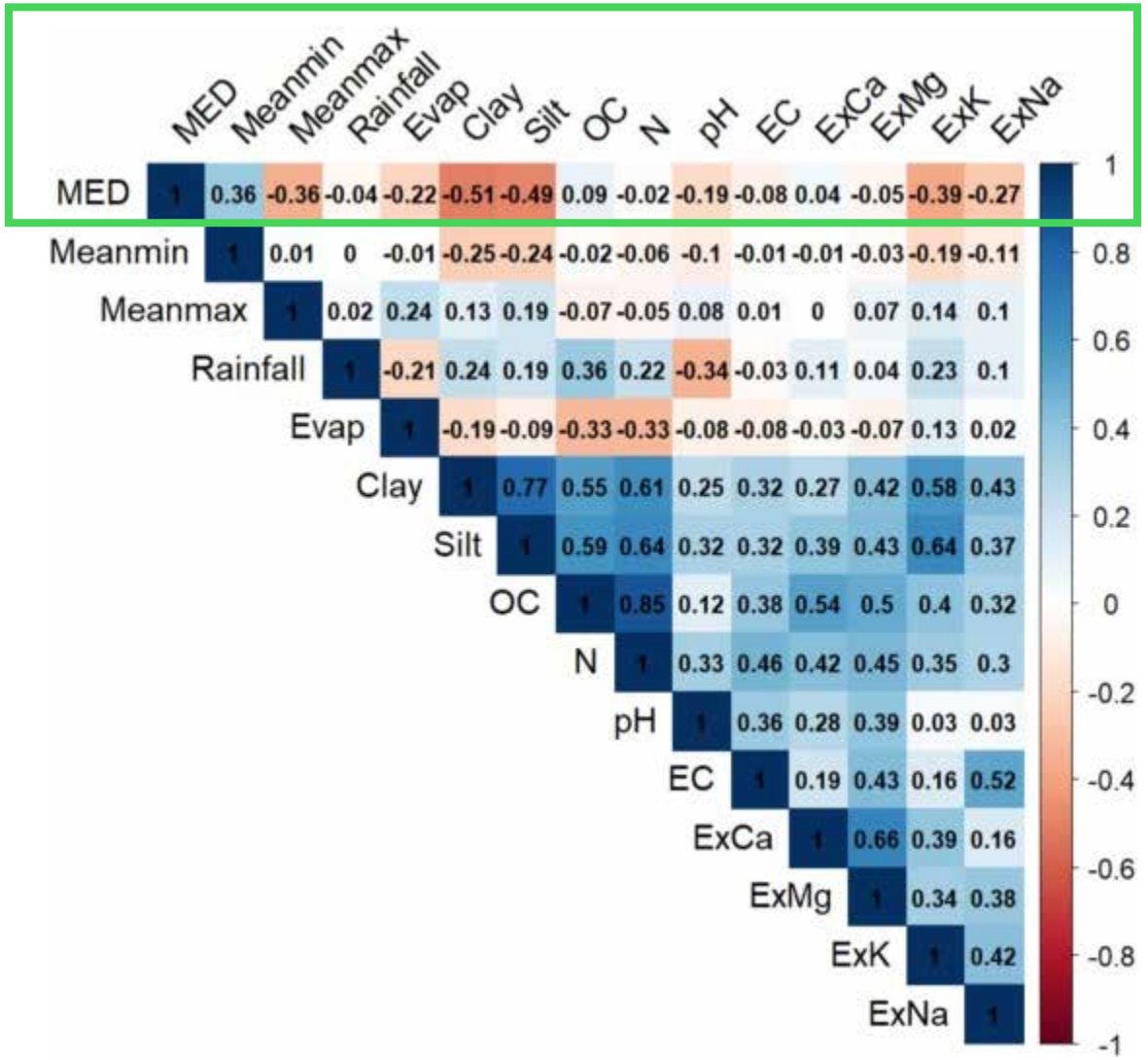
ü OC increases SWR

v BUT we observed SWR across a wide range of soil textures, not just sands.

- **If OC is high enough, even loamy and clayey soils can become repellent.**



Spearman's rank correlation



The effect of climatic vs. soil properties on SWR

Climate alone predicts SWR reasonably well, but…

(a) Climate predicting SWR = **(R^2 = 0.55)**

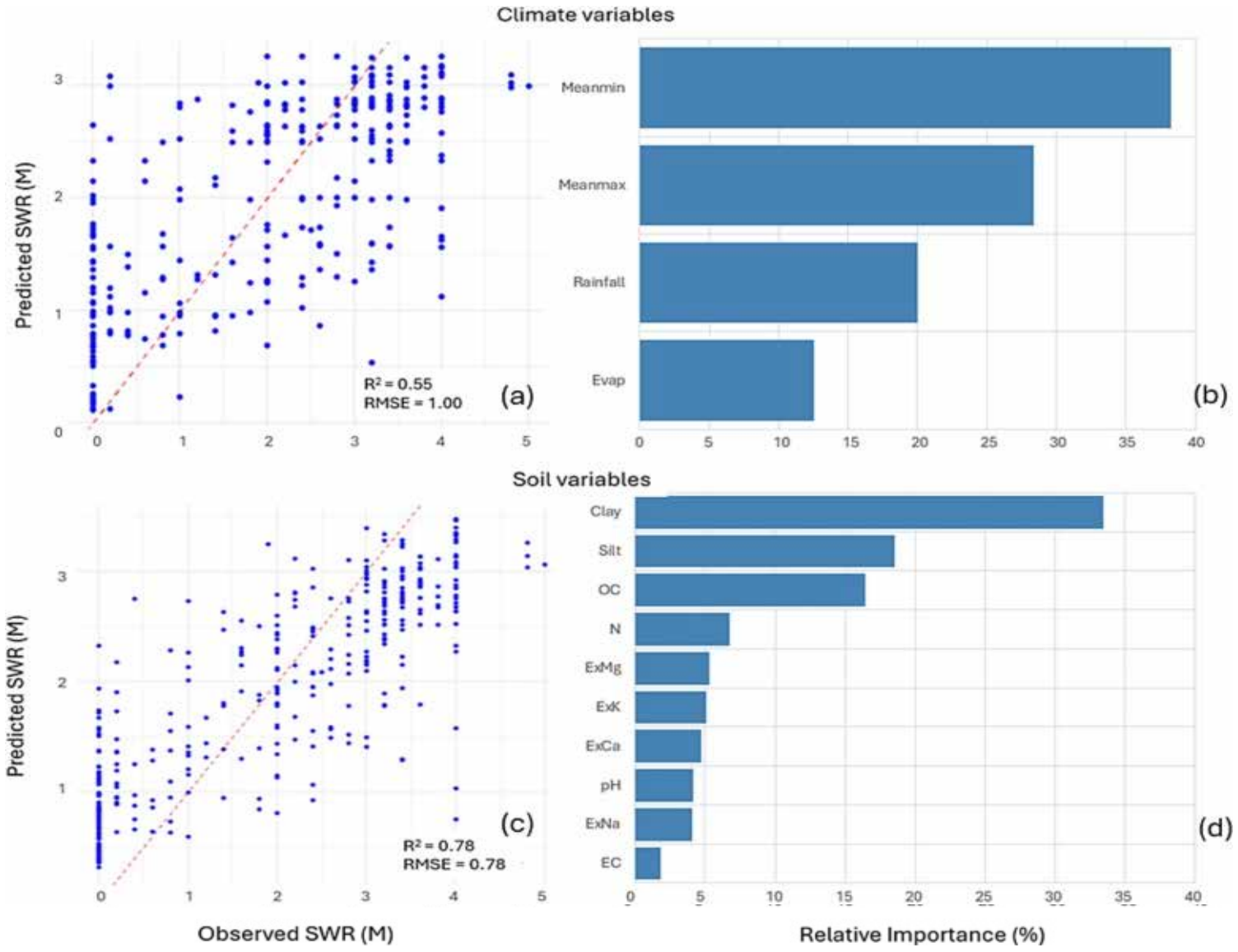
(b) Meanmin > Meanmax > rainfall > evaporation.

Soil properties explain more variation than climate alone

(c) Soil predicting SWR = **(R^2 = 0.78)**.

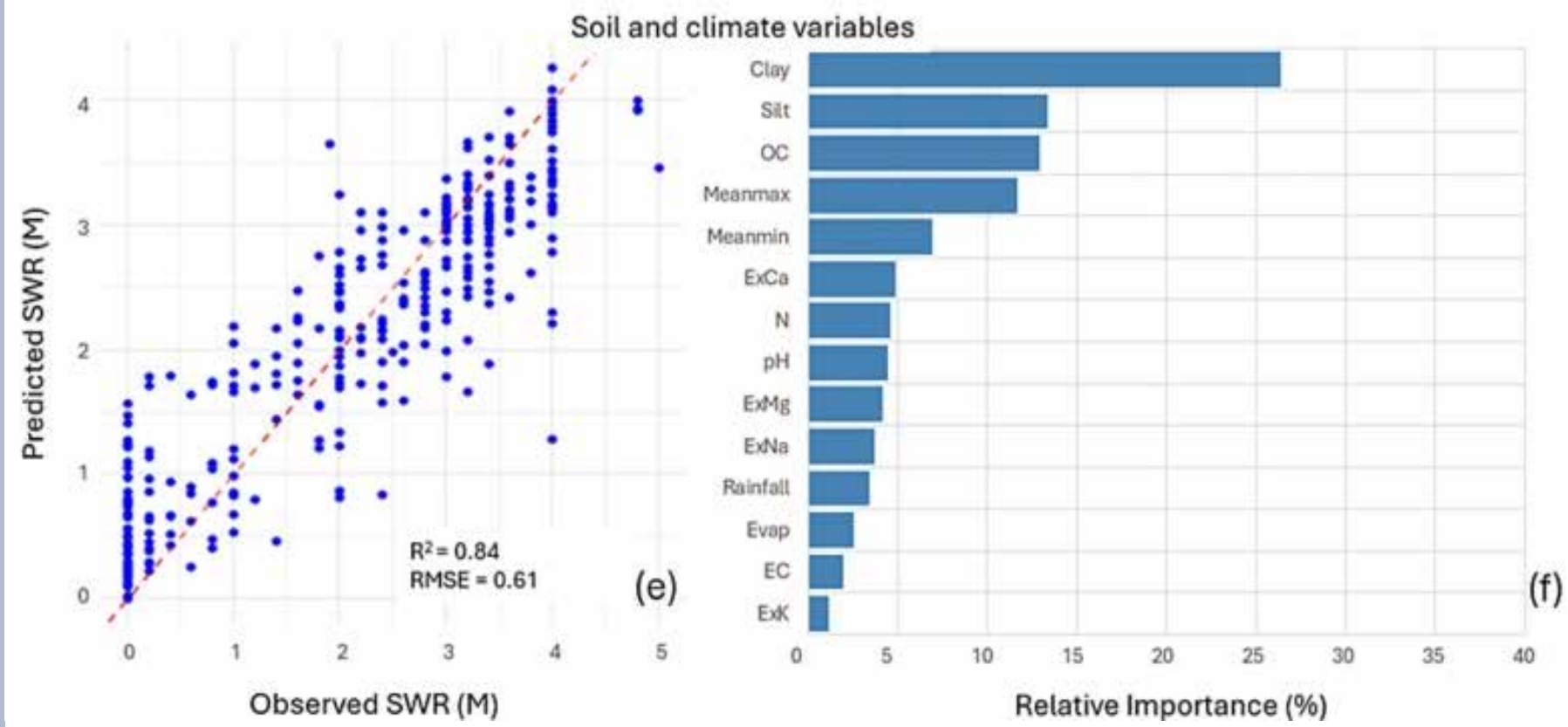
(d) Clay > Silt > OC.

- Confirmed what we already know (previous studies)



Mean maximum temperature reduces SWR and modifies OC effects

- Climate, especially **Meanmax**, modifies how soil properties affect SWR.
- SWR had an inverse relationship with **Meanmax.**
- Higher temperatures reduce the impact of OC on SWR.
- BRT model suggests: this effect occurs independently of how much OC is in the soil.

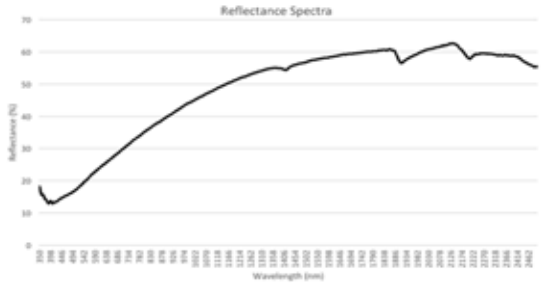


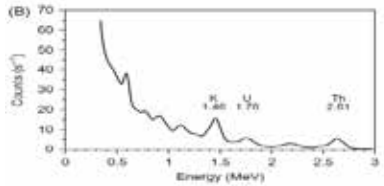
Conclusion and implications for climate mitigation and soil management

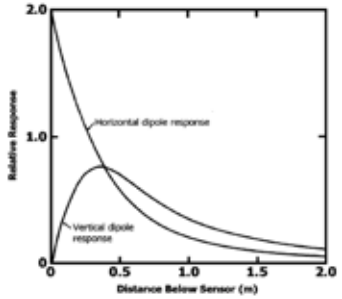
- Soil is the main driver of SWR, but climate, especially mean maximum temperature, changes how SWR behaves.
- Hotter conditions reduce SWR and weaken the effect of organic carbon.
- SWR models and risk maps must include climate, not just soil.
- Storing more carbon in soil may increase SWR risk.
- Carbon sequestration efforts often overlook this trade-off.

Broader thesis and next steps

- Part of a broader study on spatial prediction of SWR
- Used vis-NIR, gamma radiometrics, and electromagnetic induction
- Captured high-resolution spatial data on SWR and key soil properties (e.g., clay, OC)
- Provided better spatial representation than traditional point sampling







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