Soil texture and groundwater availability as drivers of subfield-scale yield variability, Yahara Watershed, WI

> Sam Zipper Mehmet Evren Soylu Steve Loheide





Soil texture and groundwater availability as drivers of subfield-scale yield variability, Yahara Watershed, WI

Question: How do soil texture and shallow groundwater interact to influence yield within a commercially managed cornfield?

Sam Zipper Mehmet Evren Soylu Steve Loheide







• Water stress a driver of global yield gaps (Licker et al., 2010; Lobell et al., 2009)



Soil Texture Shifts Boundaries!









GROUNDWATER INFLUENCE

SOIL INFLUENCE

MODELING & FUTURE DIRECTIONS



Worse in dry year than wet



Sensitivity Class

- Consistently Strong
- Drought Sensitive
- Consistently Medium
- Wet Sensitive
- Consistently Poor

Worse in wet year than dry



Goal: Determine influence of GW on yield.

- Shallow GW \rightarrow sensitive to wet growing season \rightarrow *groundwater penalty*
- Intermediate GW \rightarrow resilient to wet & dry growing season \rightarrow *groundwater subsidy*
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	INFLUENCE	INFLUENCE	FUTURE DIRECTIONS



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• GW-sensitivity class relationships **appear consistent** across soil types, though **small sample sizes** are present in most soil textural classes.

Limitations:

- SSURGO data not developed to be used at subfield-scale
- Coarsest soils never occur in same parts of field as shallowest GW

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- **Goal:** "Fill in the blanks" in field data using a process-based agroecosystem model, AgroIBIS-VSF.



SOIL

INFLUFNCF

MODELING &

FUTURE DIRECTIONS

User can control:

BACKGROUND

- Soil profile (multiple retention functions)
- Groundwater level (pressure head bottom boundary condition)

GROUNDWATER

INFLUENCE







AgroIBIS-VSF: Preliminary Results (Calibration in progress)





Positive value → Presence of shallow GW caused increased yield, relative to free drainage



Question: How do soil texture and shallow groundwater interact to influence yield within a commercially managed cornfield?

Conclusions:

- Shallow GW → sensitive to wet conditions
- Intermediate GW → resilient in wet & dry years
- **Deep GW** → sensitive to **dry conditions**.





• Consistent relationship across soil textures, but soil data is sparse & unreliable.

- Using AgroIBIS-VSF:
 - Actual groundwater subsidy
 - Potential groundwater subsidy
 - Optimum DTWL

for a given soil profile. (Modeling work ongoing!!)



Questions?

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BACKGROUND

GROUNDWATER INFLUENCE

SOIL INFLUENCE MODELING & FUTURE DIRECTIONS



-GW elevation

-Soil moisture profile -Soil temp. profile -Soil water potential

Point- Periodic -Stomatal conductance -Leaf area index -Plant height, leaf length, cob diameter

Point- Year-End -Grain yield -Total biomass -Moisture content -Crop characteristics (kernel count, etc.)

Distributed- Periodic -Thermal imagery -Spectral imagery

Distributed- Year-End -Grain/silage yield

Study Site:









How to separate soil texture vs. groundwater influence?

6 7 2012 (Dry Year)











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