



UNIVERSITY OF SASKATCHEWAN  
College of Agriculture  
and Bioresources

DEPARTMENT OF SOIL SCIENCE  
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# Digital agriculture to support sustainable soil management

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# Land Acknowledgement

*As we gather here today, we acknowledge we are on Treaty 6 Territory and the Homeland of the Métis. We pay our respect to the First Nations and Métis ancestors of this place and reaffirm our relationship with one another*



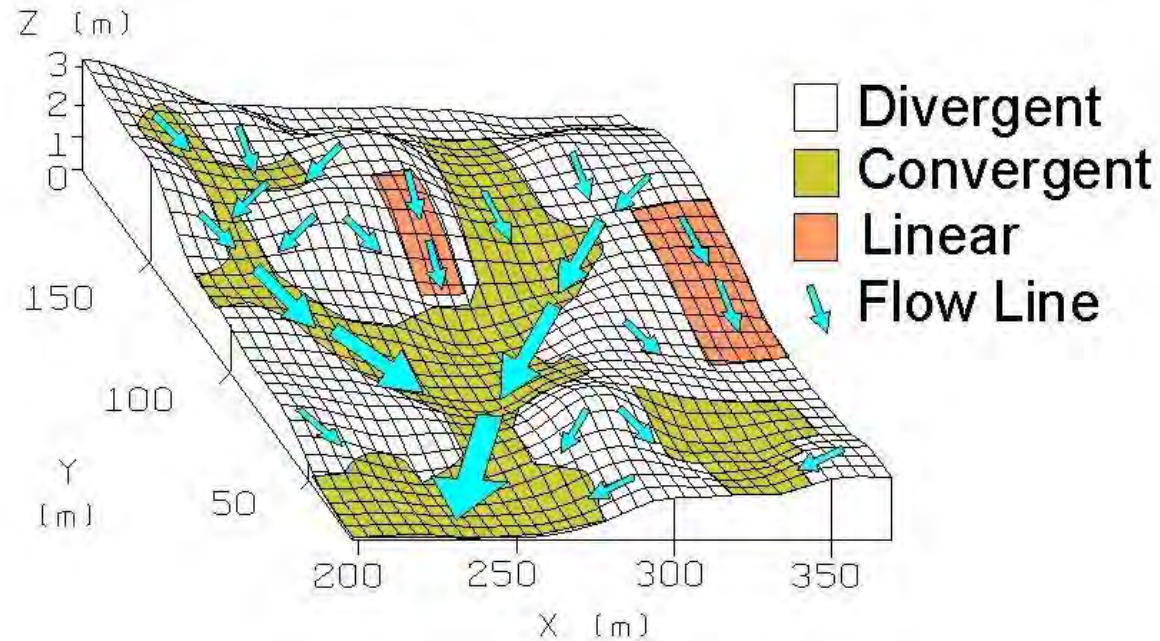
# Outline

- Scaling Soil Observations to Landscapes
- Predictive Soil Mapping (PSM)
- Sample Optimization
- Soil Property Mapping
- Soil Carbon and Crop Yield
- Soil Carbon Monitoring
- Soil Carbon Forecasting





# Soils are 3D



*Schematic diagram of water flow in a hillslope. Slope segments where water flow diverges will be drier than the hillslope average, and segments where flow concentrates will be moister than the average. © Dan Pennock, Univ. of Saskatchewan, is licensed under a [CC BY \(Attribution\)](https://creativecommons.org/licenses/by/4.0/) license.*



# Predictive Soil Mapping

- $S_c = f(s, c, o, r, p, a, n)$
- $S_a = f(s, c, o, r, p, a, n)$

$S_c$  is the soil classes

$S_a$  is the soil attribute

s – soil, other properties of the soil at a point

c – climate, climatic properties of the environment at a point

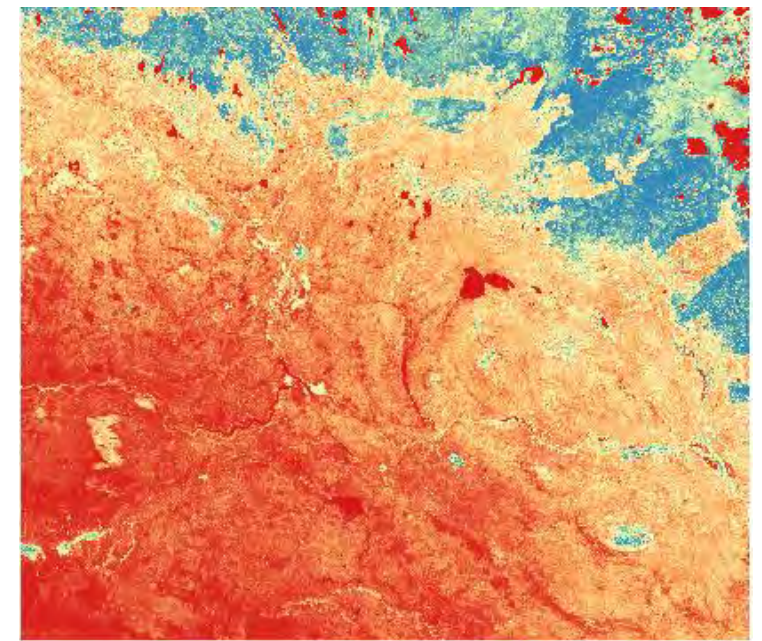
o – organisms, vegetation or fauna or human activity

r – topography, landscape attributes

p – parent material, lithology

a – age, the time factor

n – space, spatial position



McBratney, A.B., Mendonça Santos, M.L., Minasny, B., 2003. On digital soil mapping, *Geoderma*.

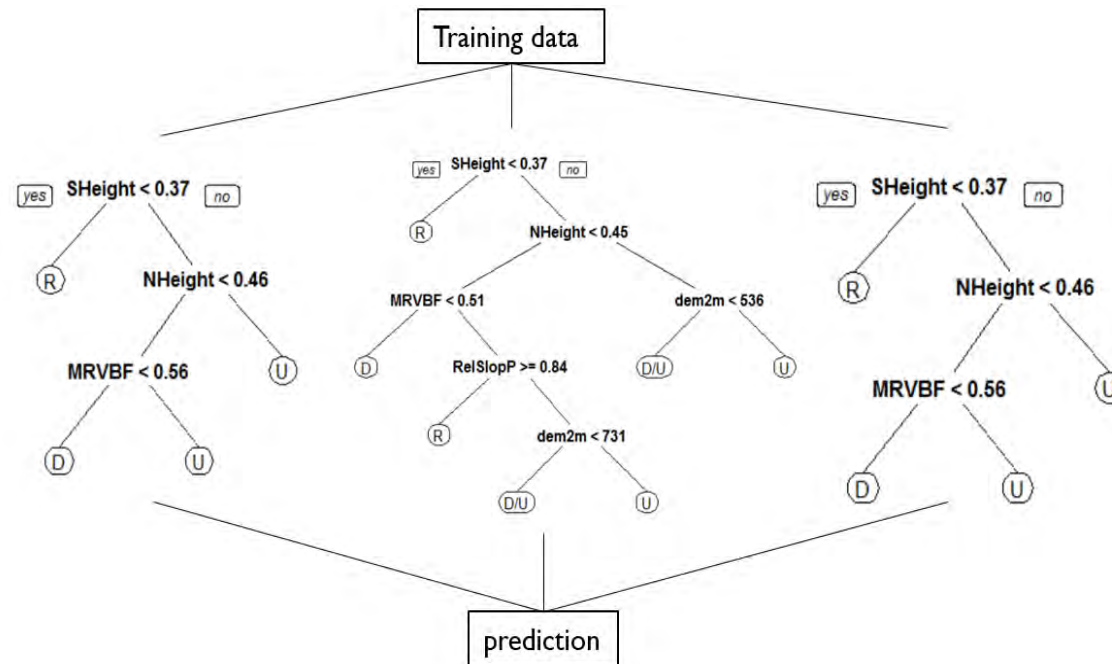
[https://doi.org/10.1016/S0016-7061\(03\)00223-4](https://doi.org/10.1016/S0016-7061(03)00223-4)



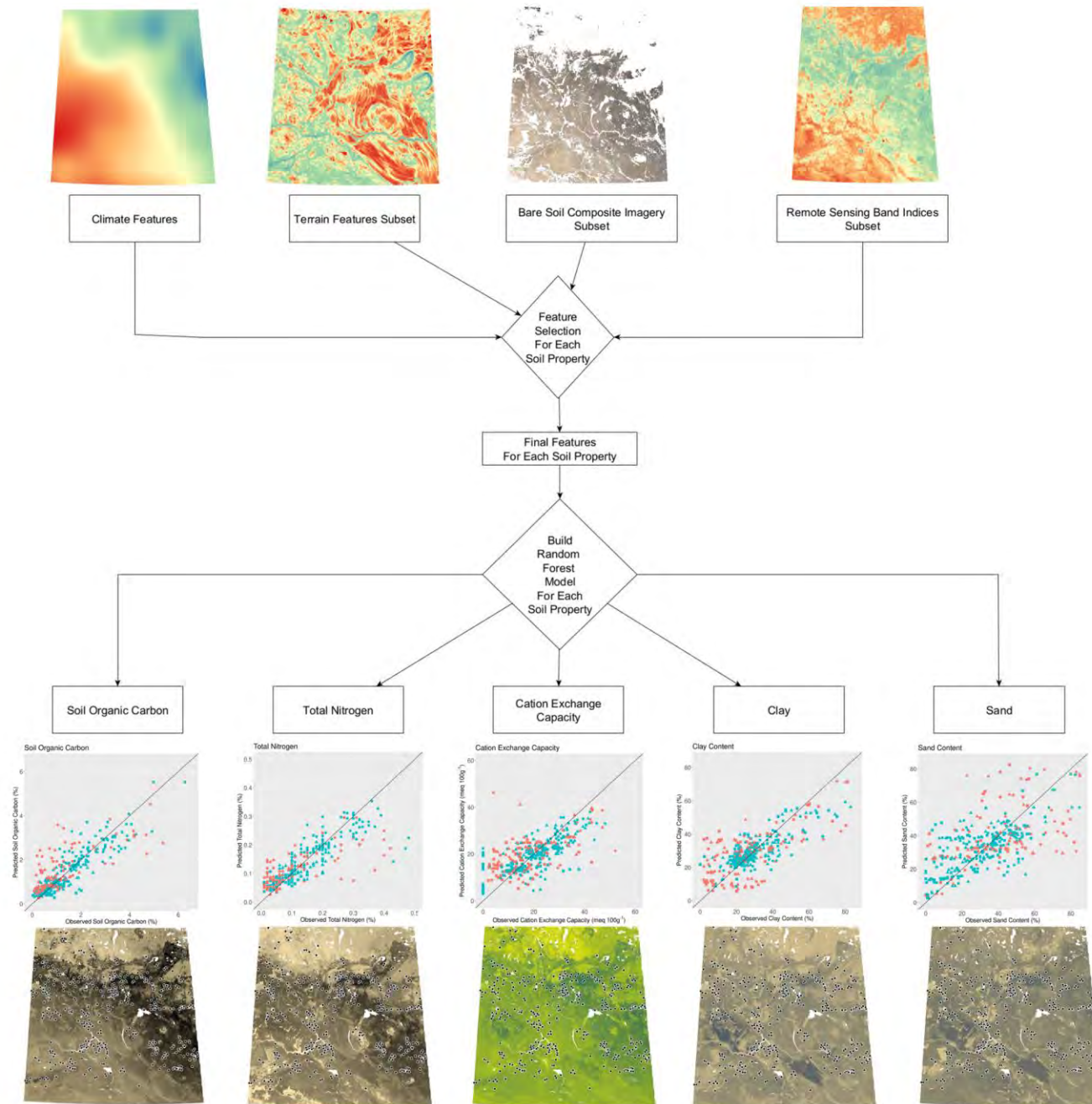
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# Predictive Soil Mapping

- Machine Learning Models have become standard
- Training data and covariate selection is critical!
- More advanced statistical models cannot solve bad data and bad covariates
- More sophisticated models can improve results with good data and good covariates





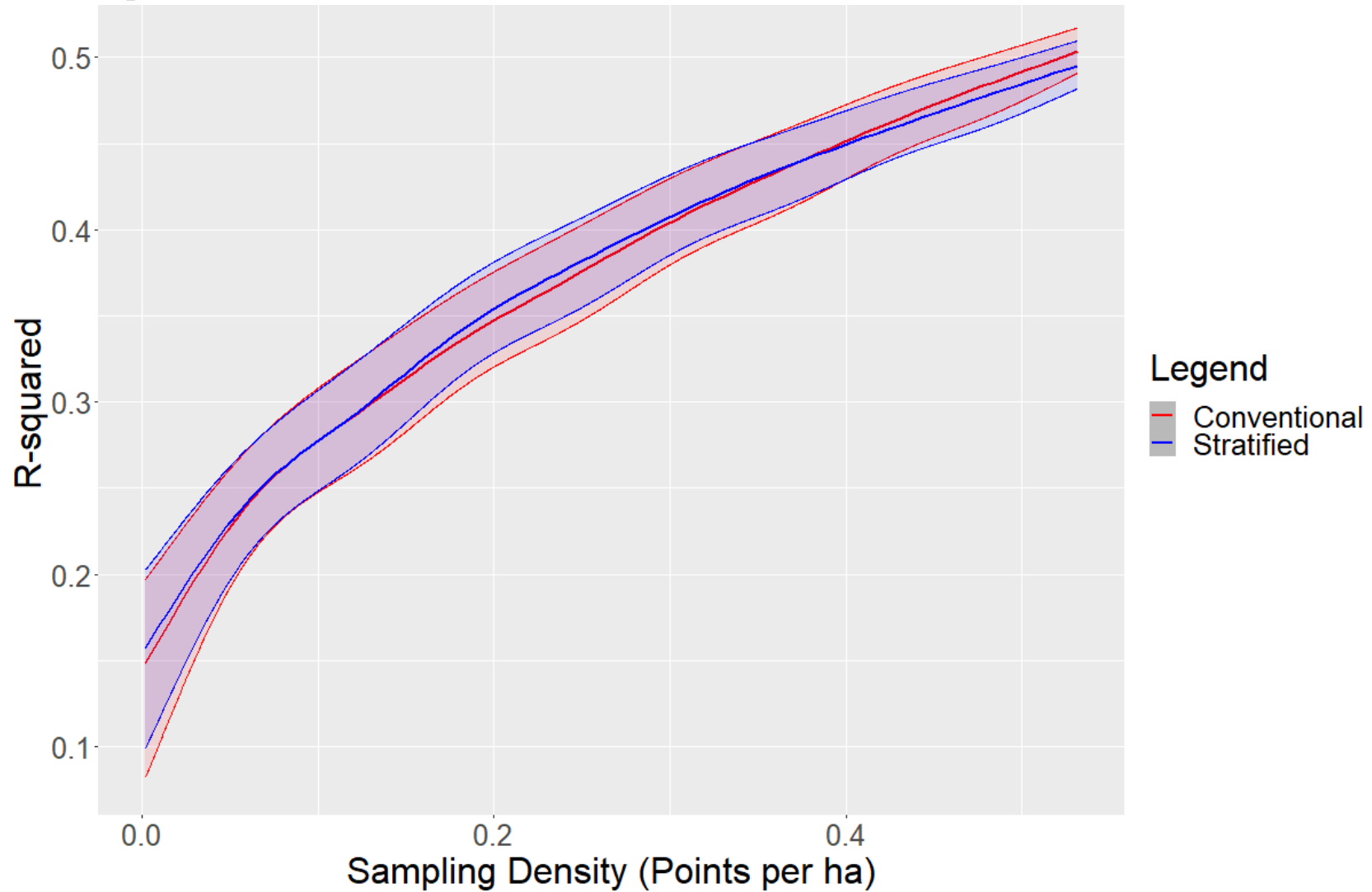


# Sample Optimization

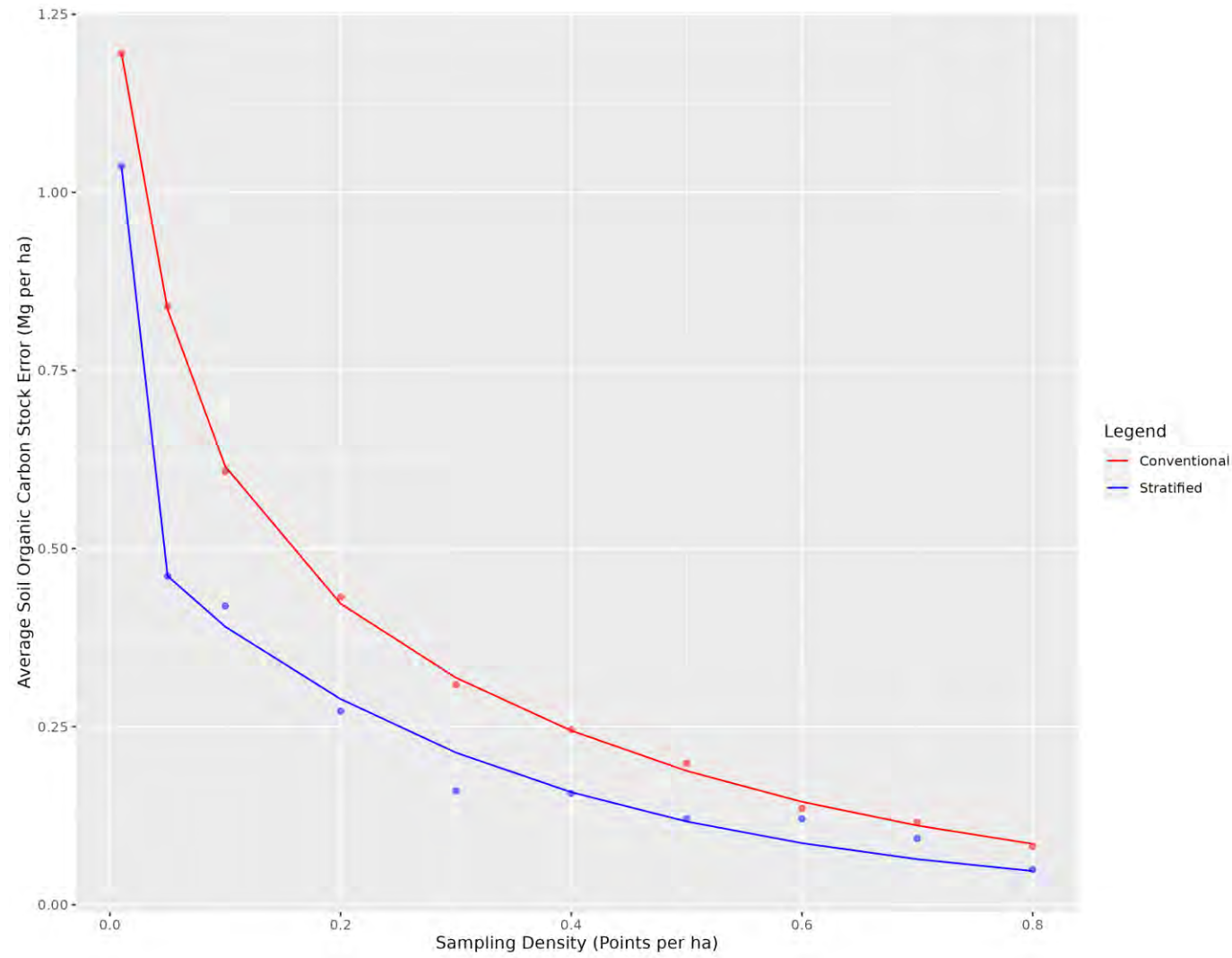




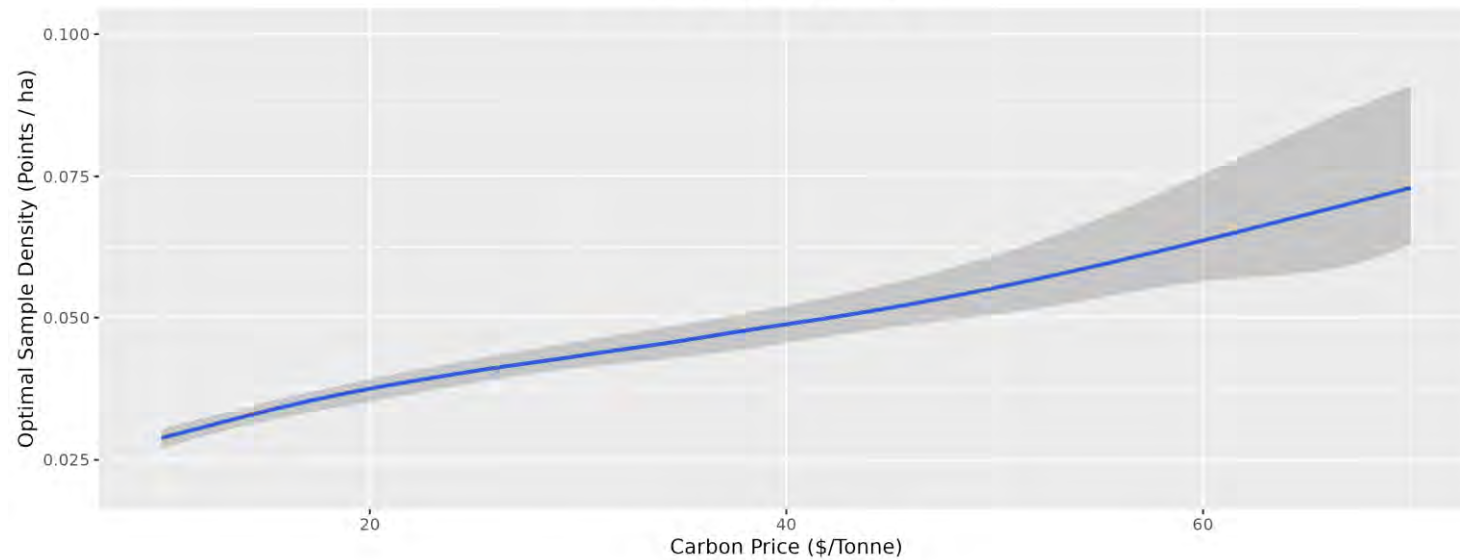
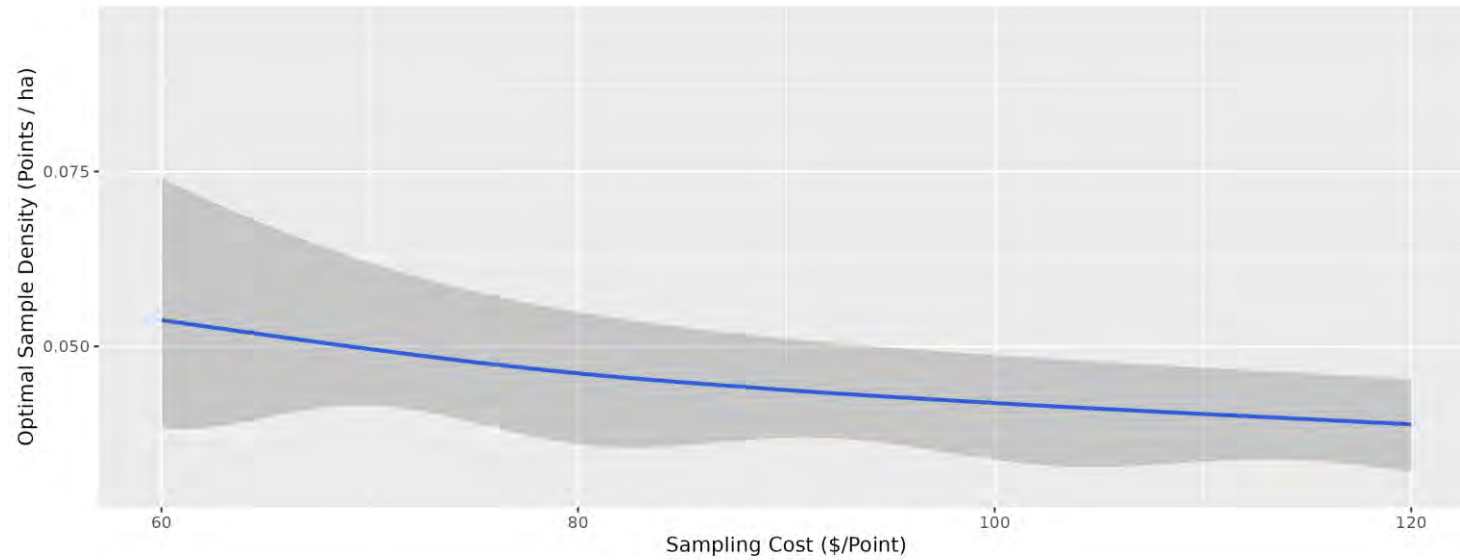
# Sample Optimization



# Sample Optimization

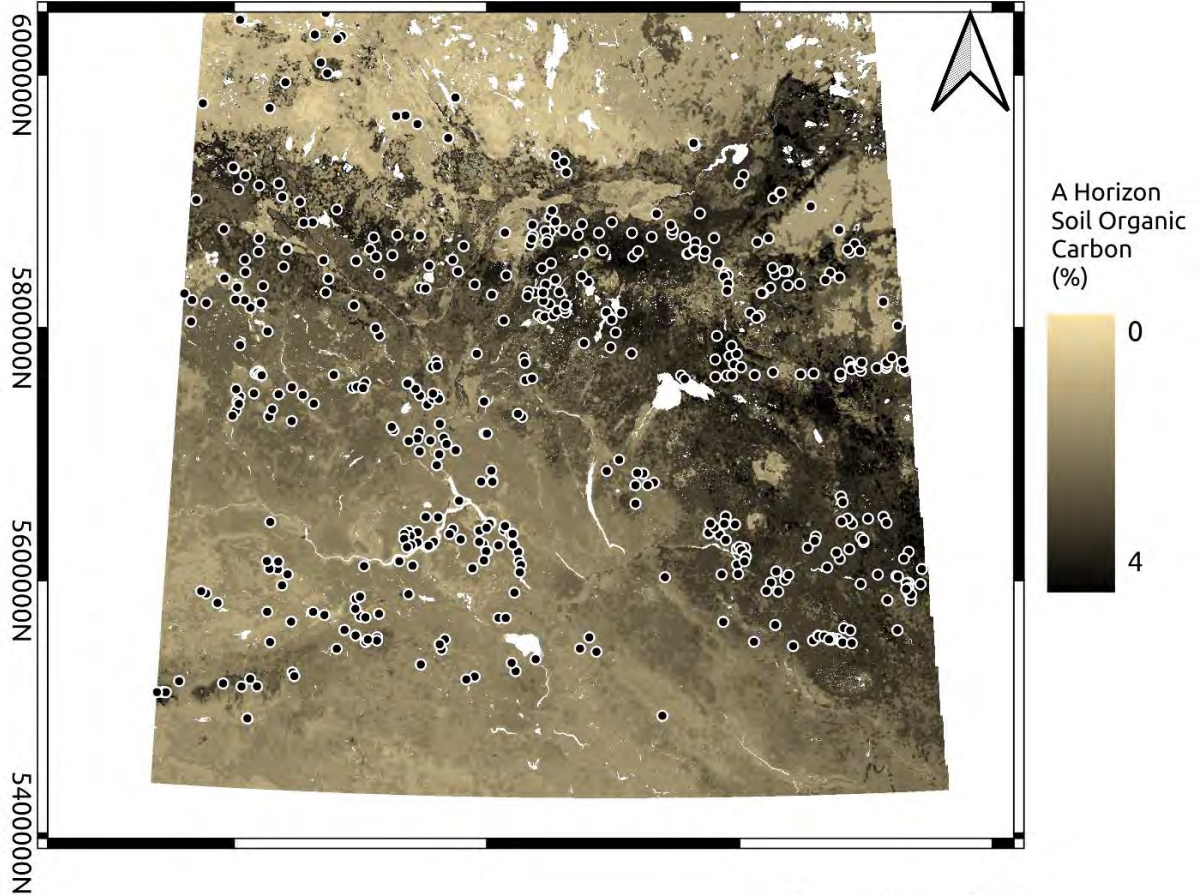
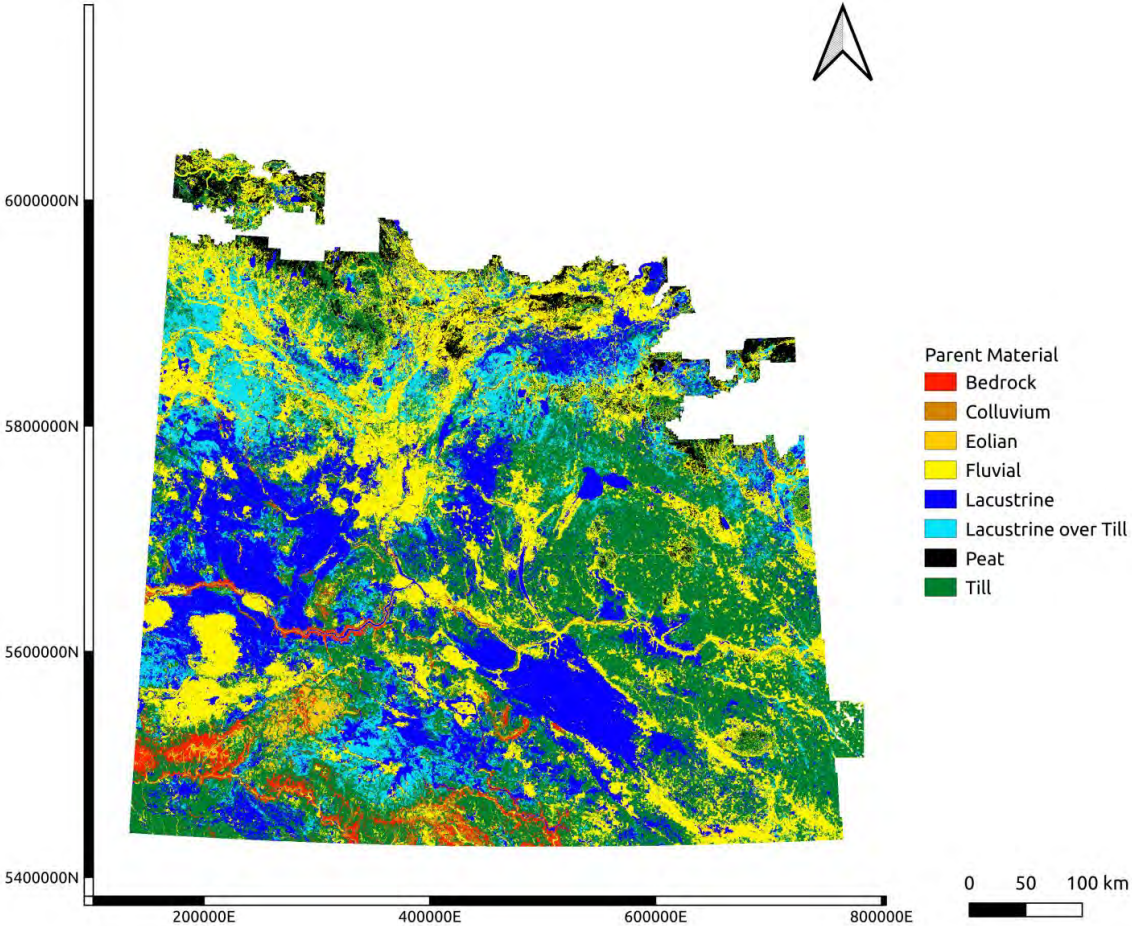


# Sample Optimization

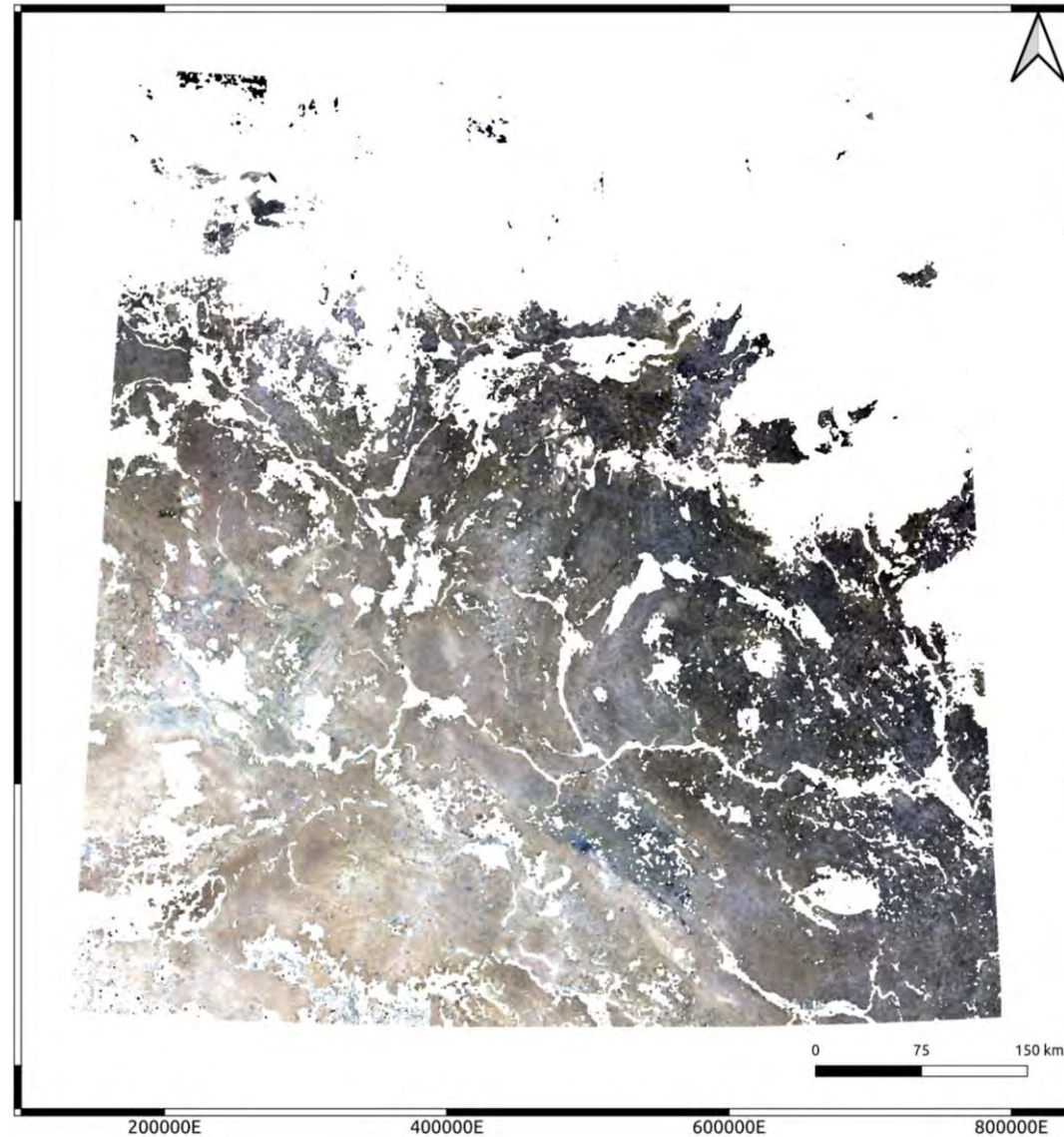




# Soil Property Mapping



# Soil Property Mapping – Bare Soil

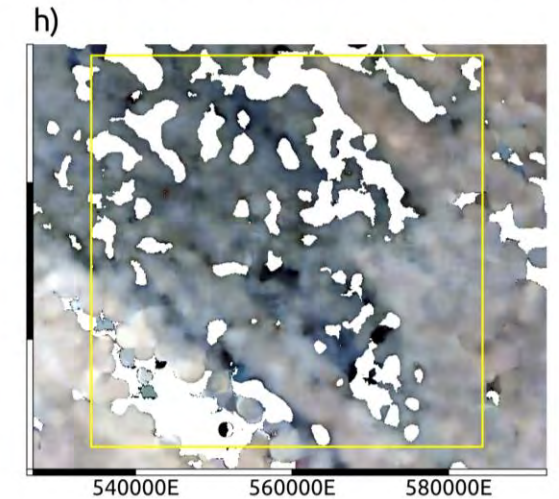
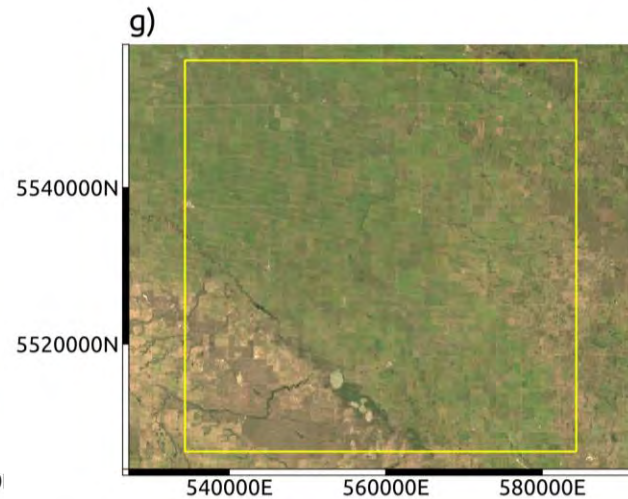
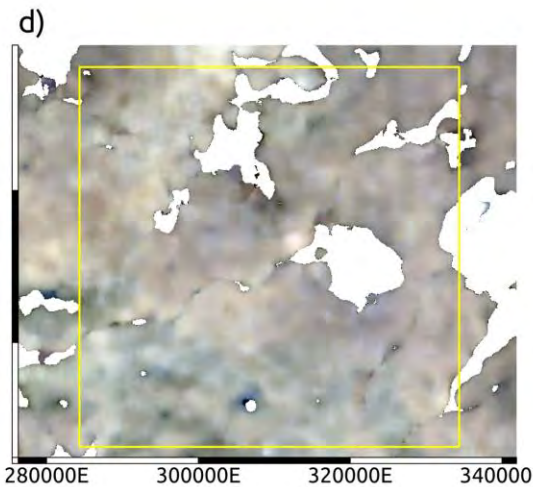
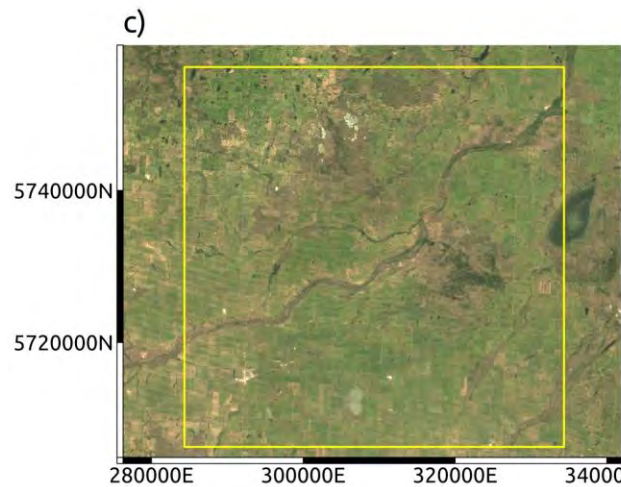
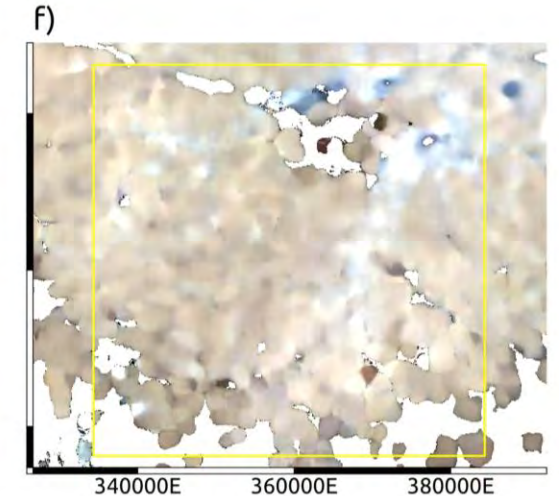
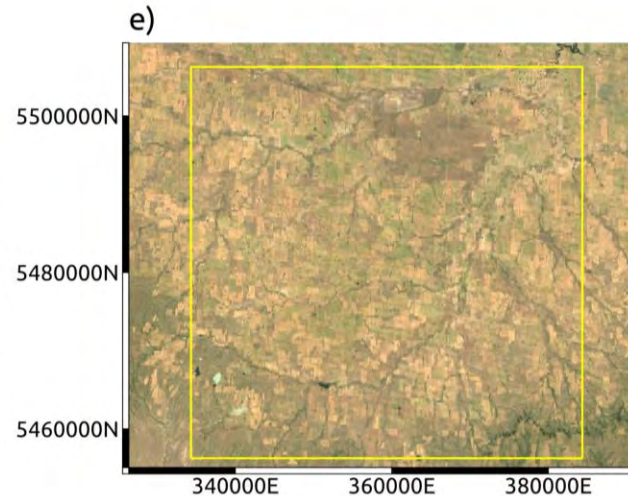
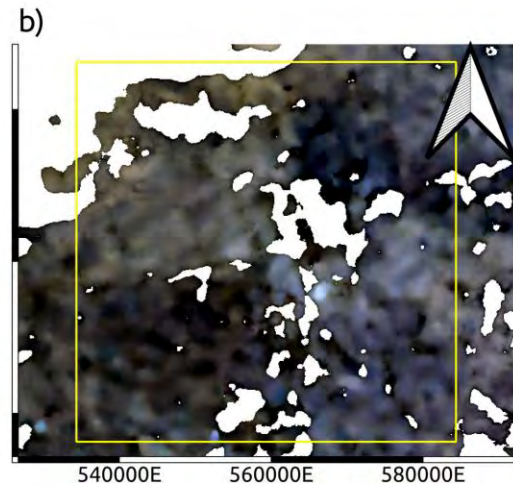
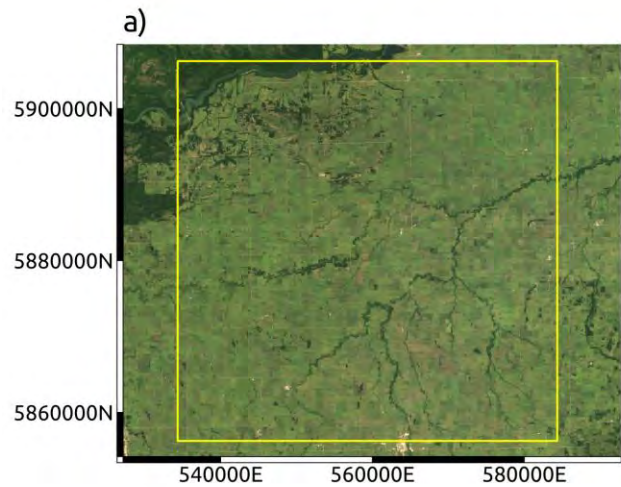


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# Soil Property Mapping – Bare Soil

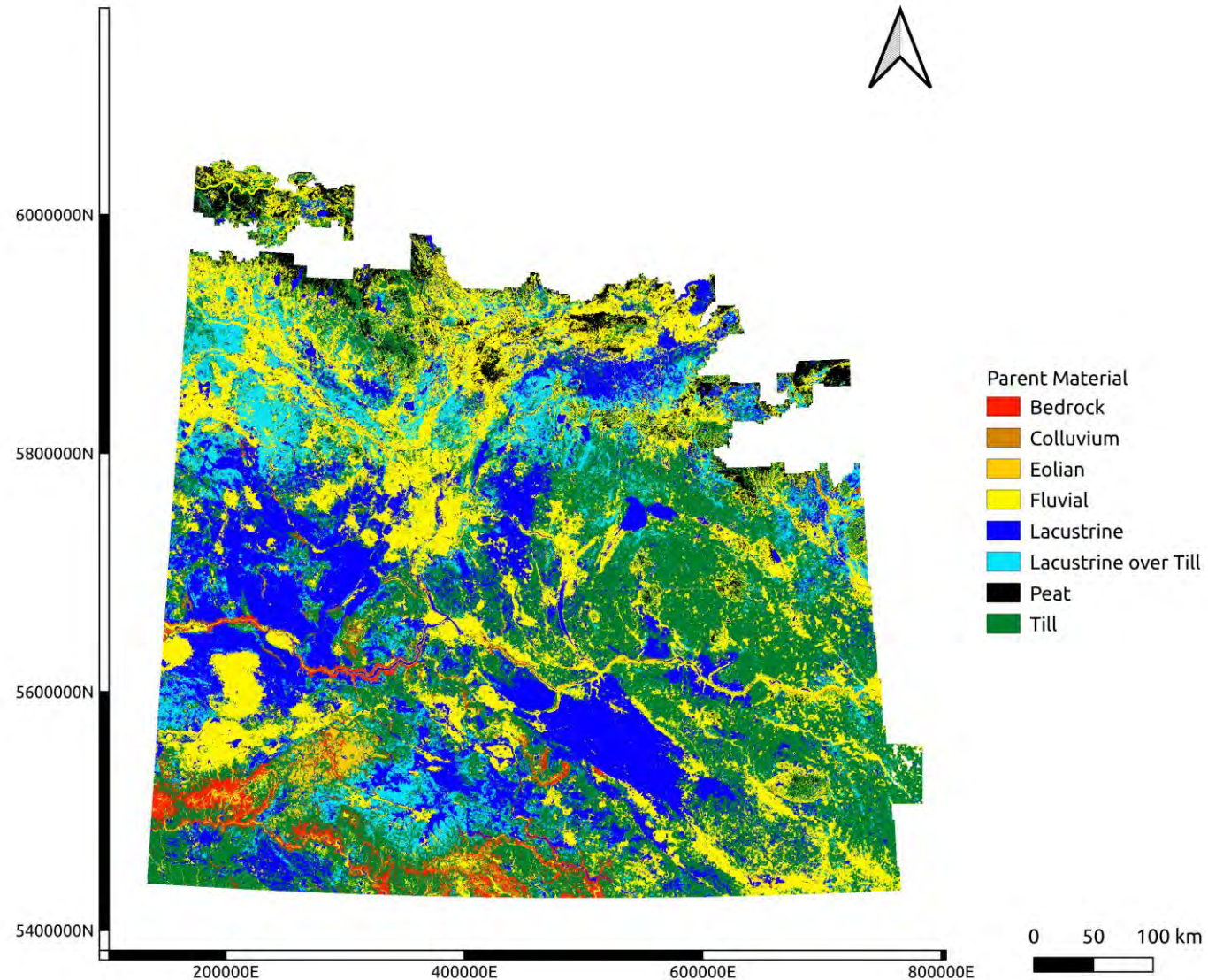


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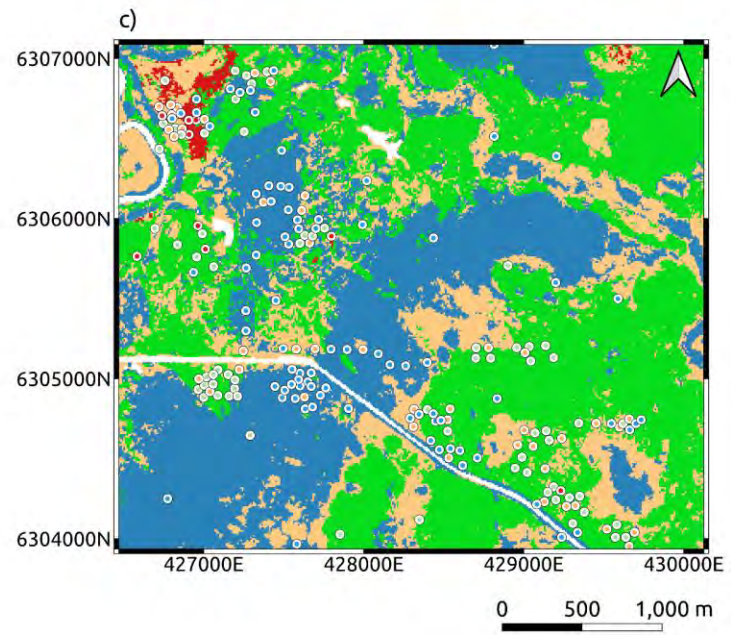
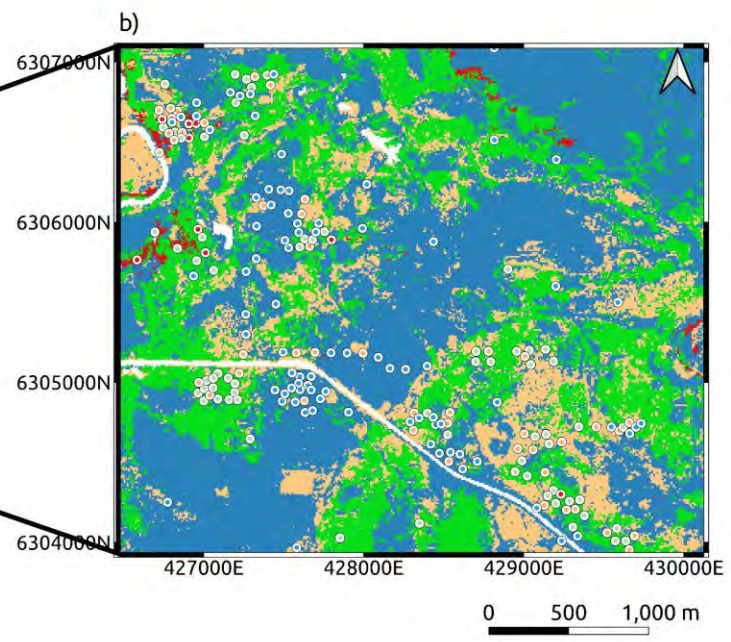
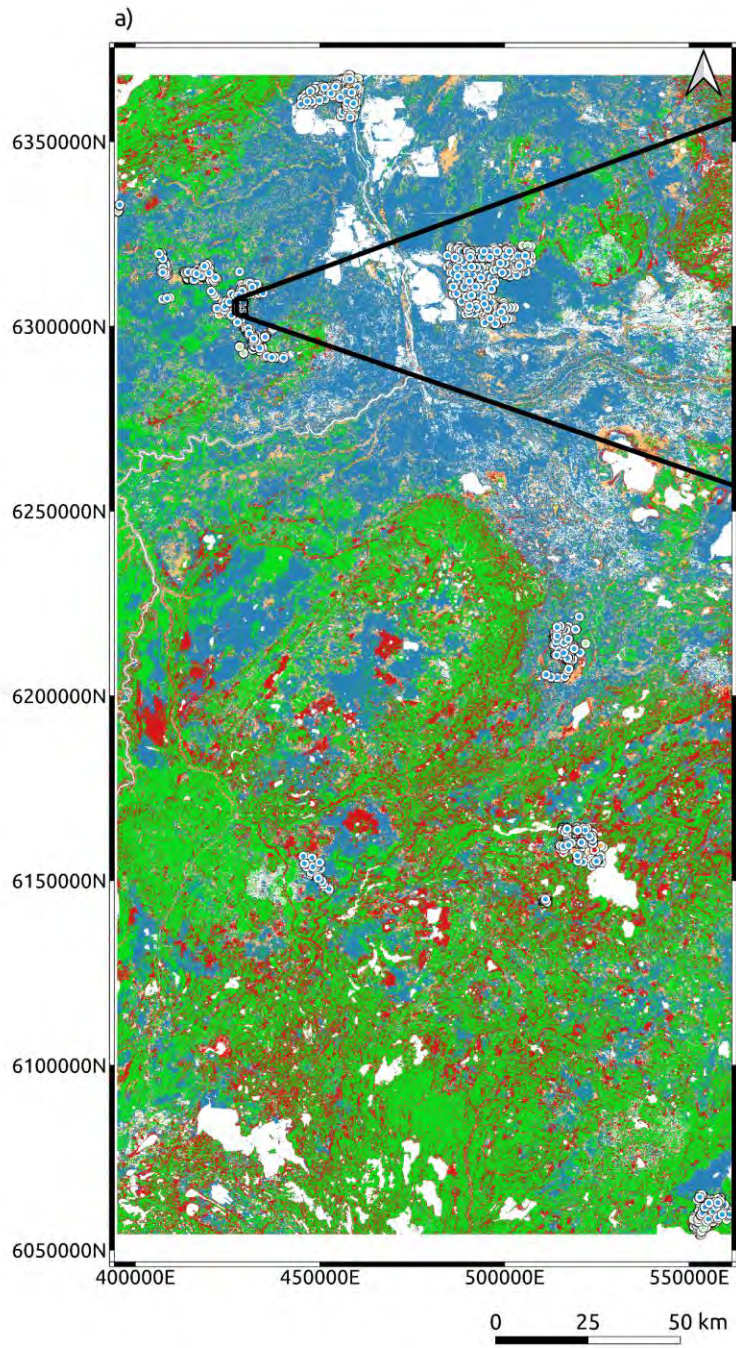
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# Soil Property Mapping - Classification



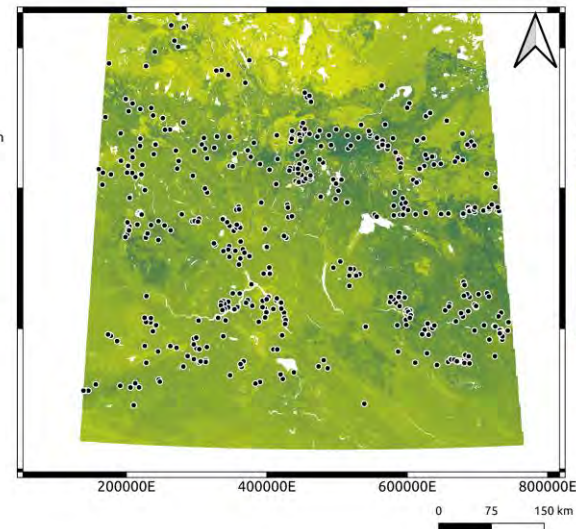
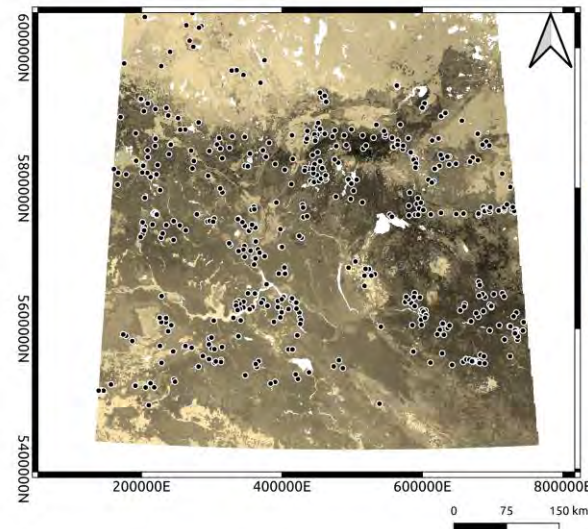
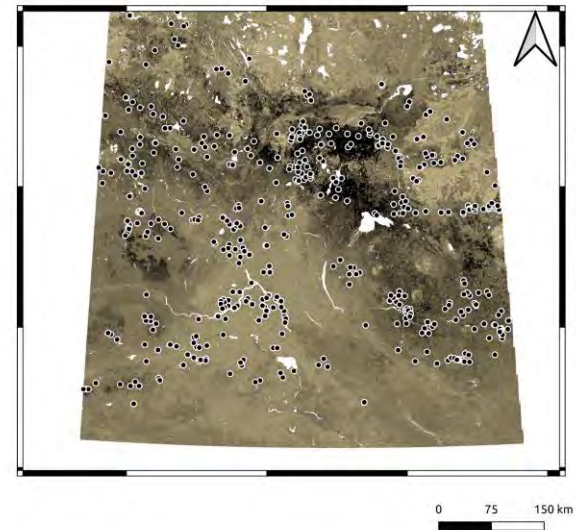
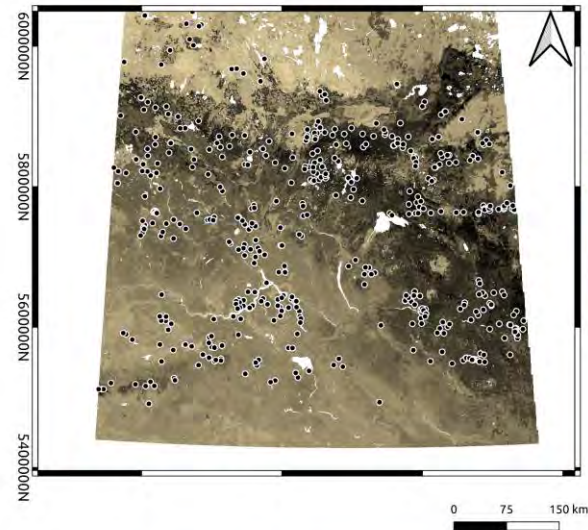




- Training Data**
- Brunisol
  - Gleysol
  - Luvisol
  - Organic
- Predicted Soil Order**
- Brunisol
  - Gleysol
  - Luvisol
  - Organic

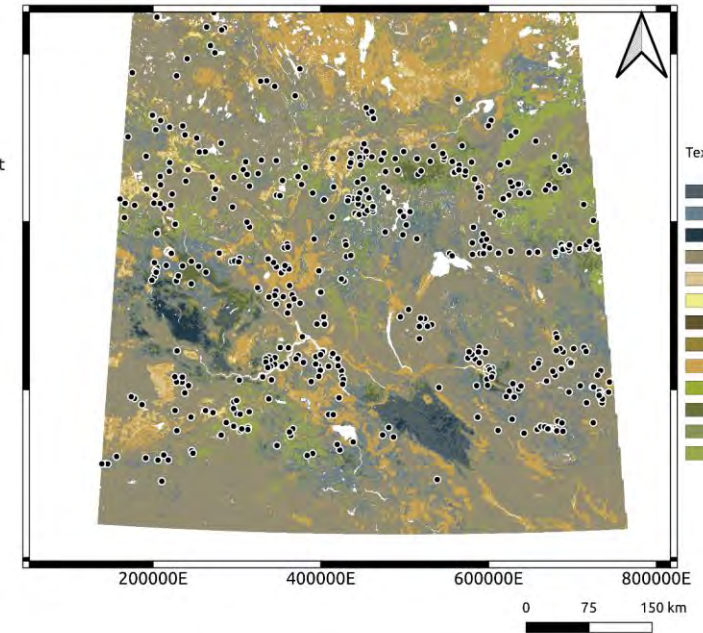
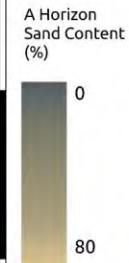
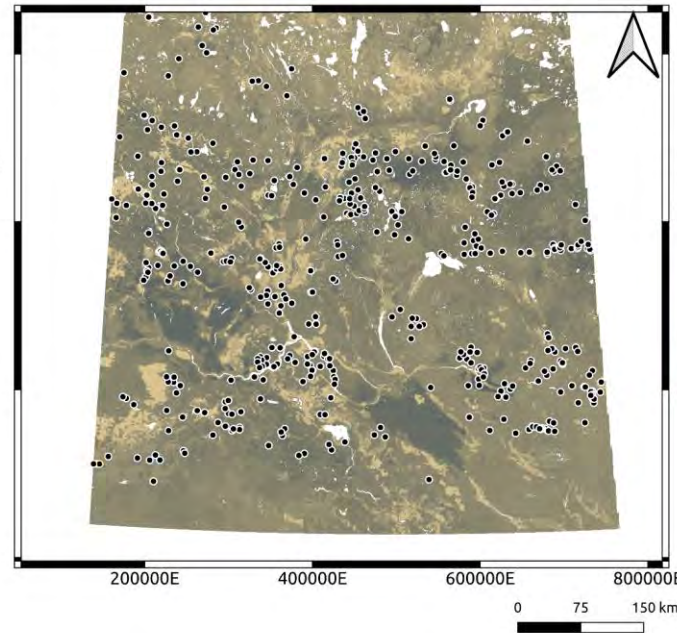
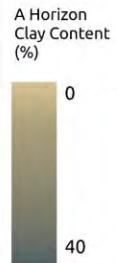
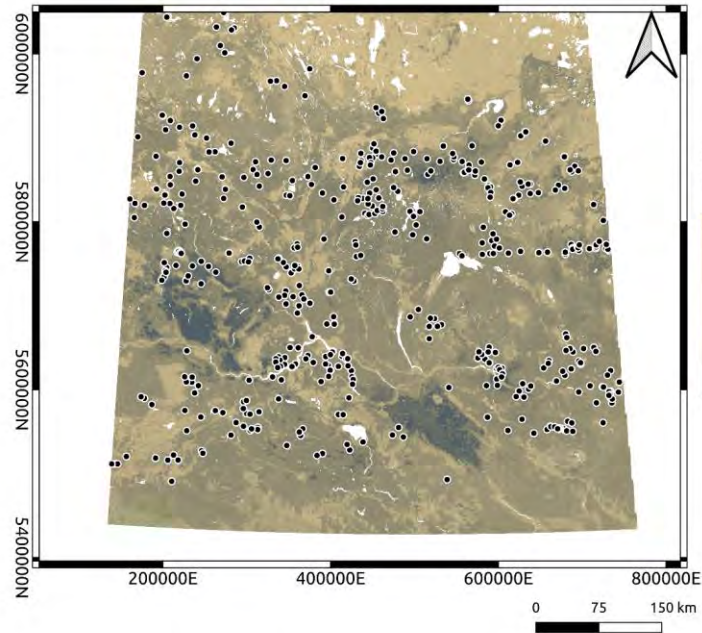


# Soil Property Mapping



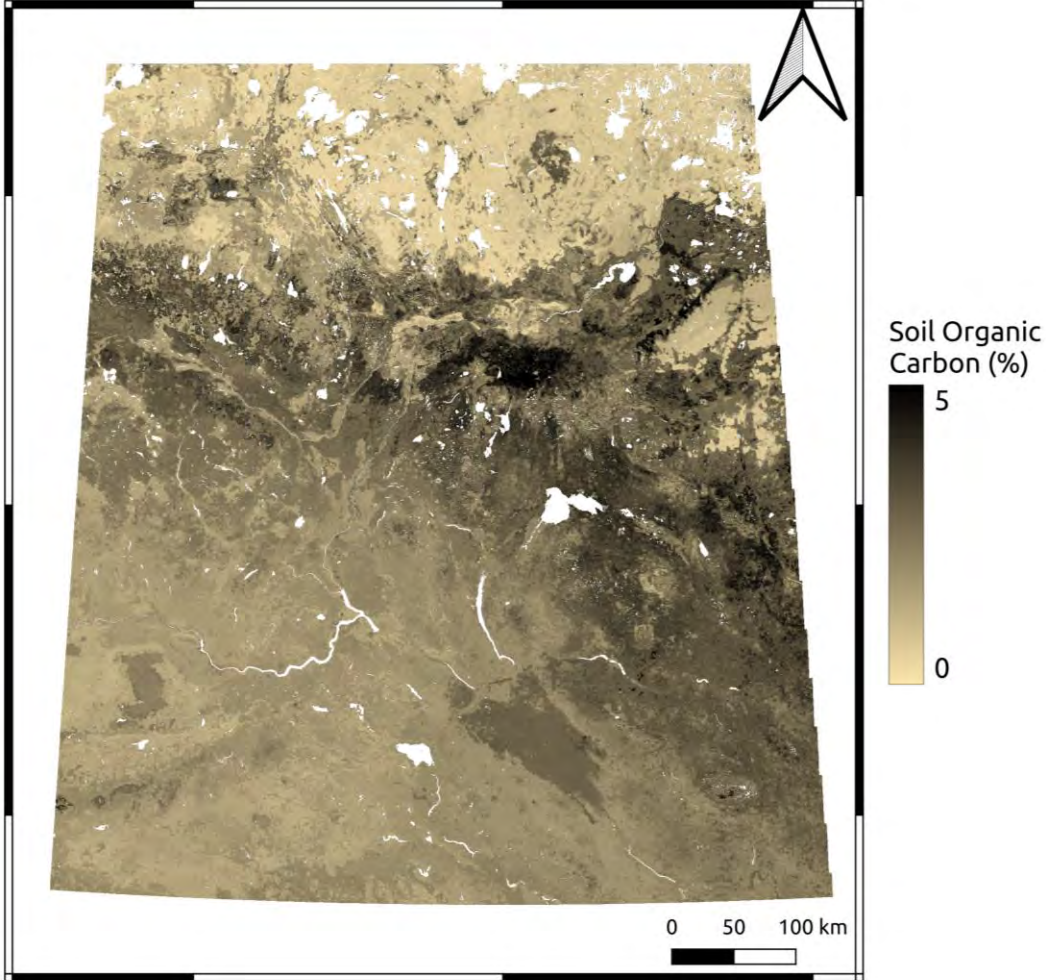
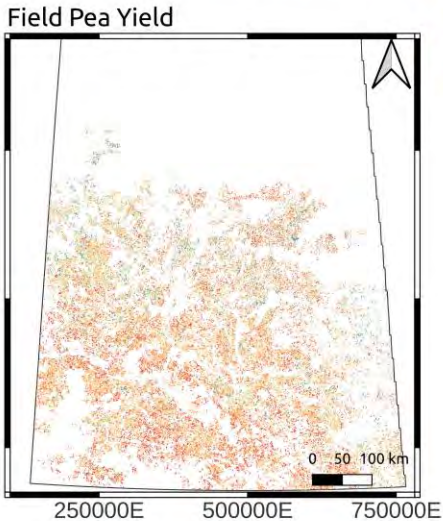
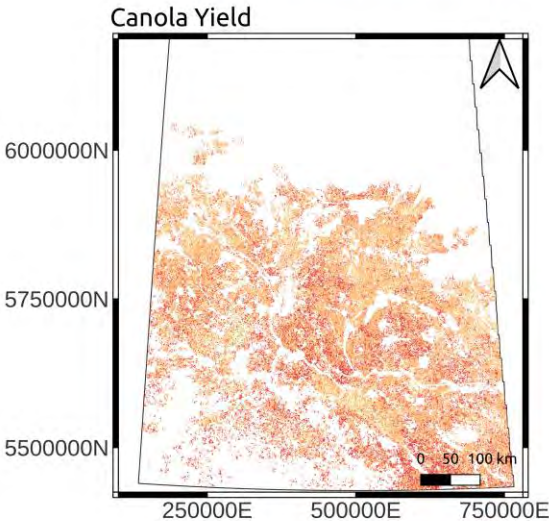
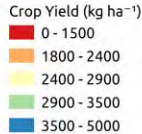
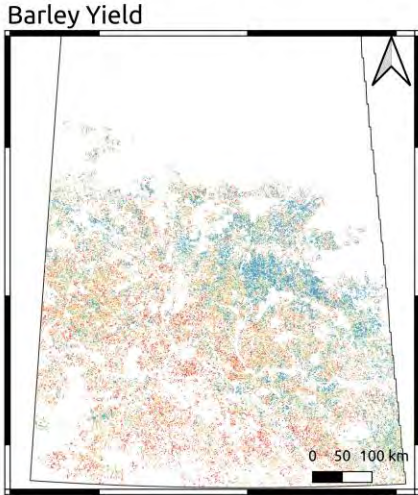
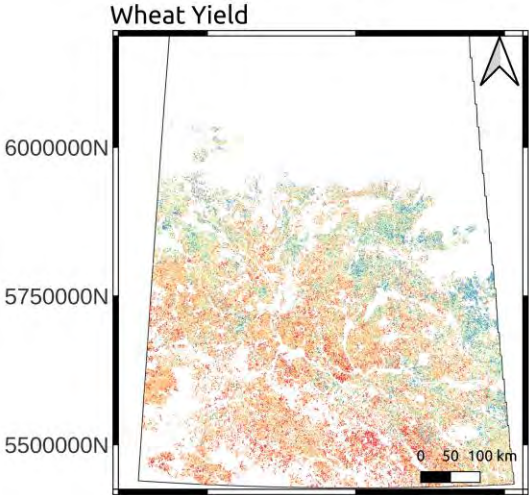


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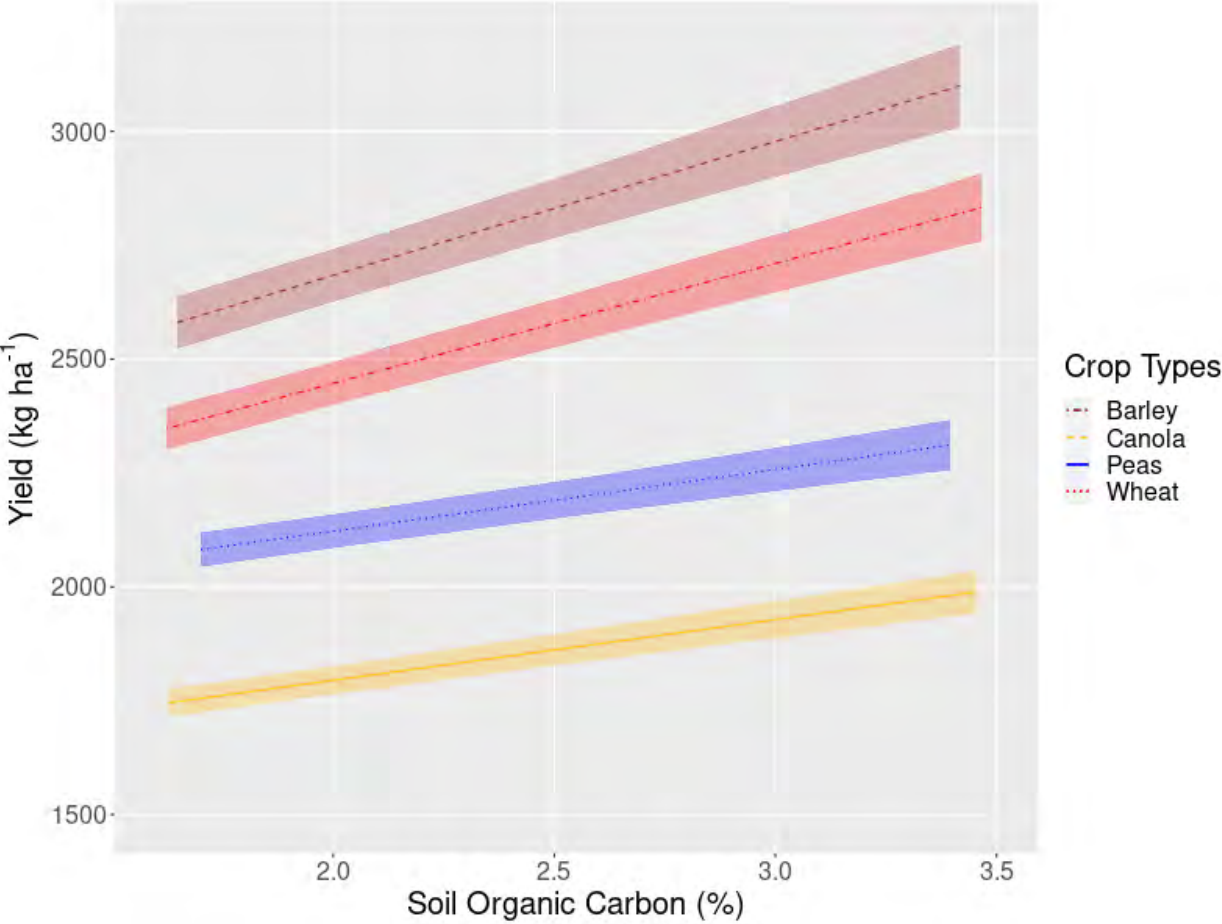
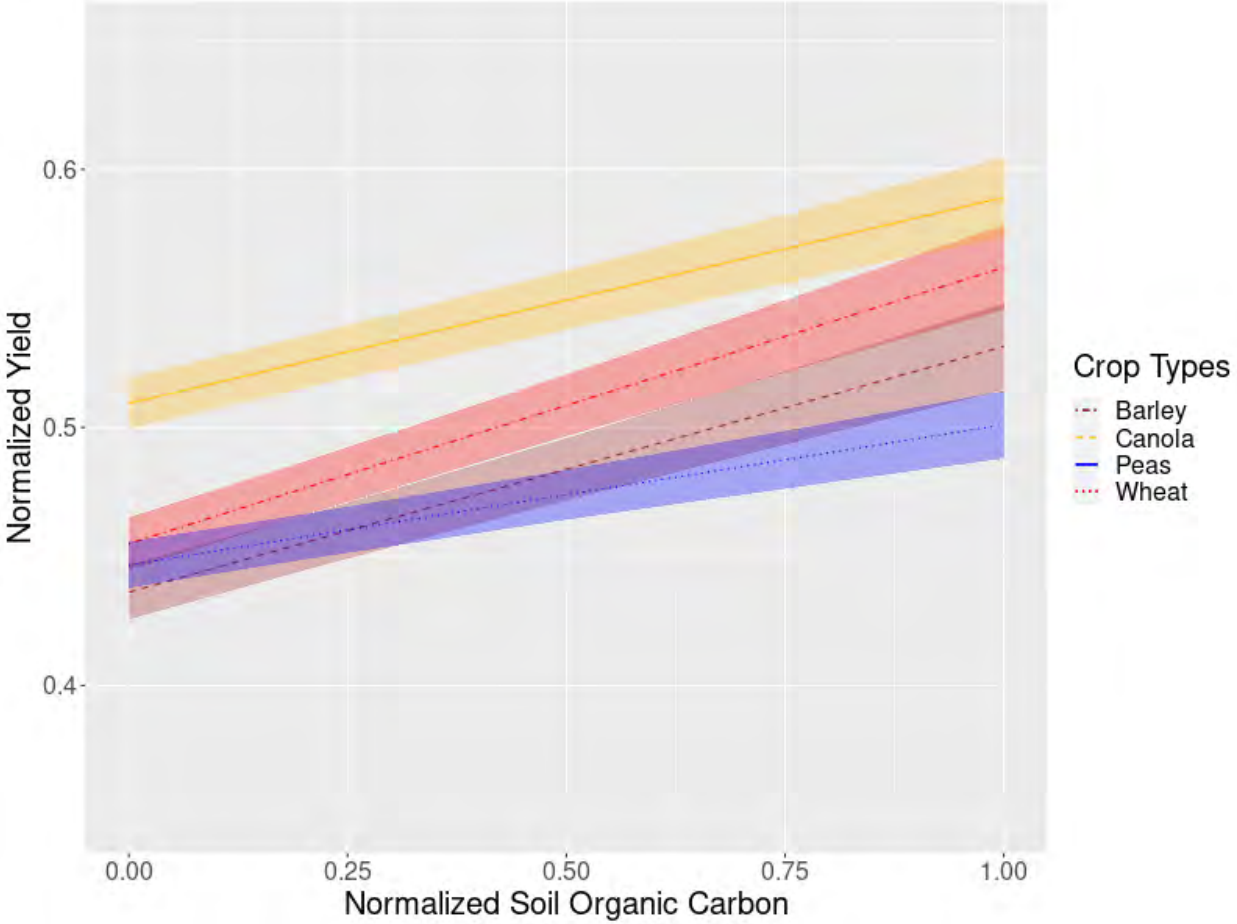




# SOC and Yield

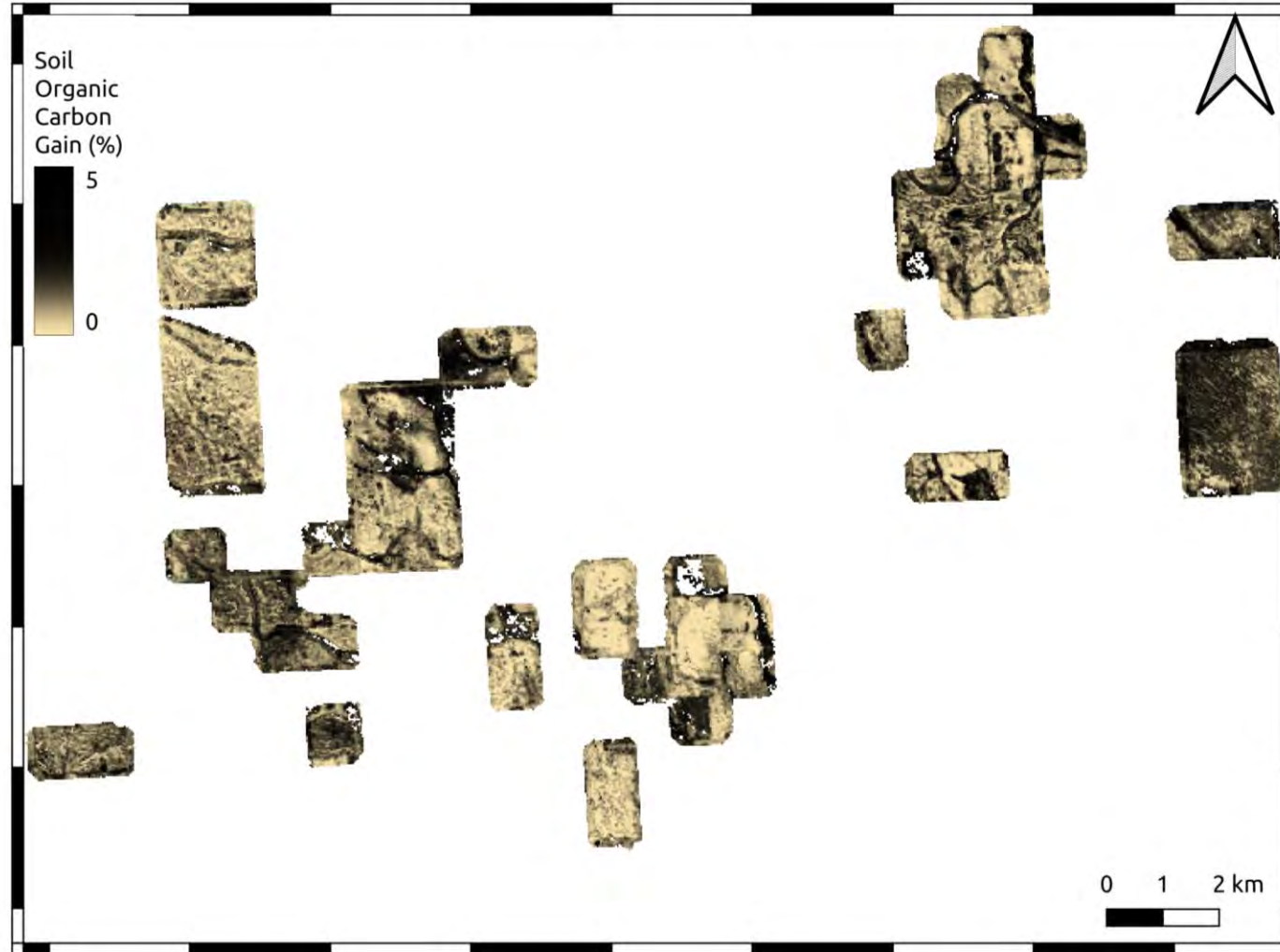


# SOC and Yield





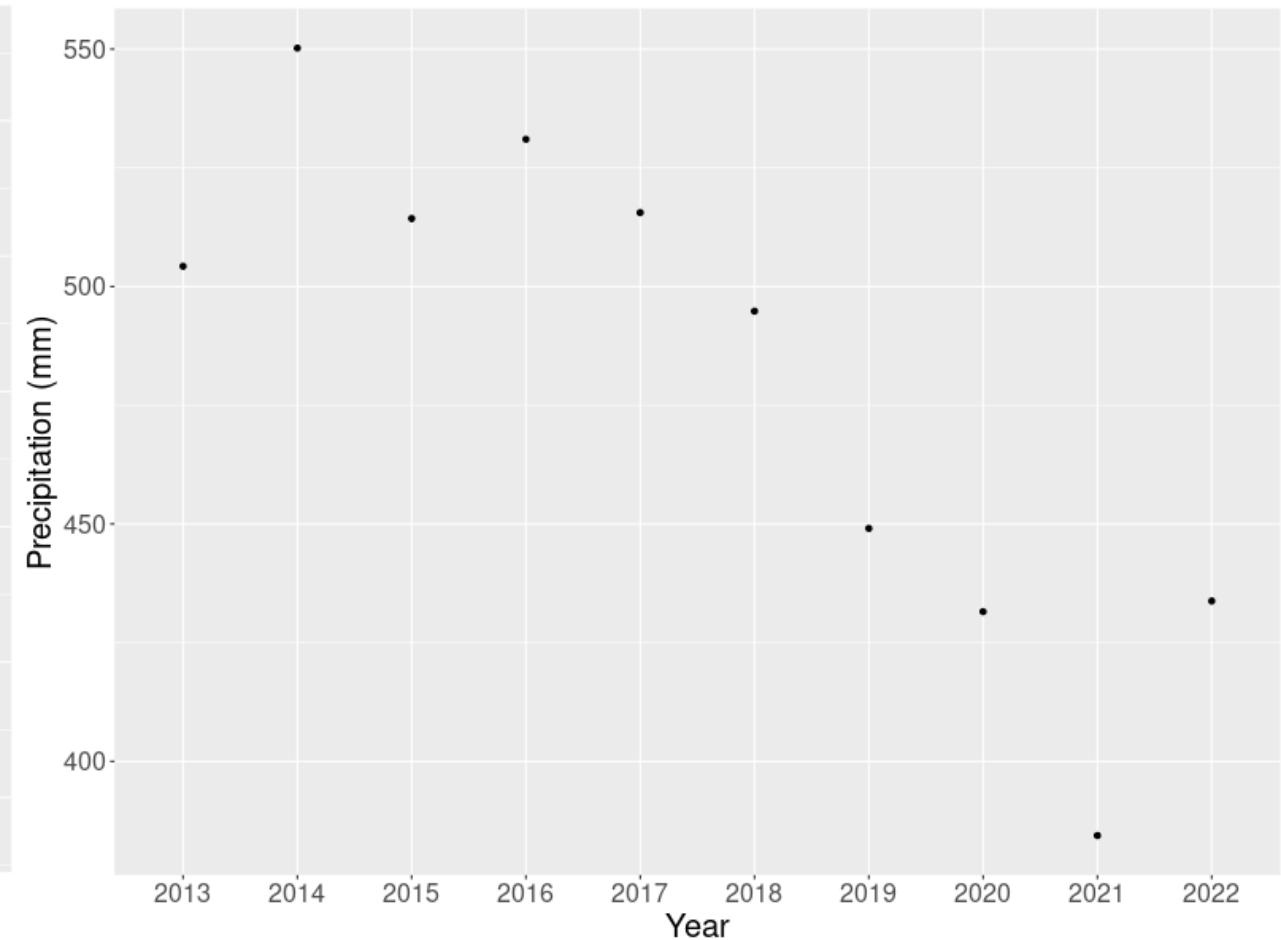
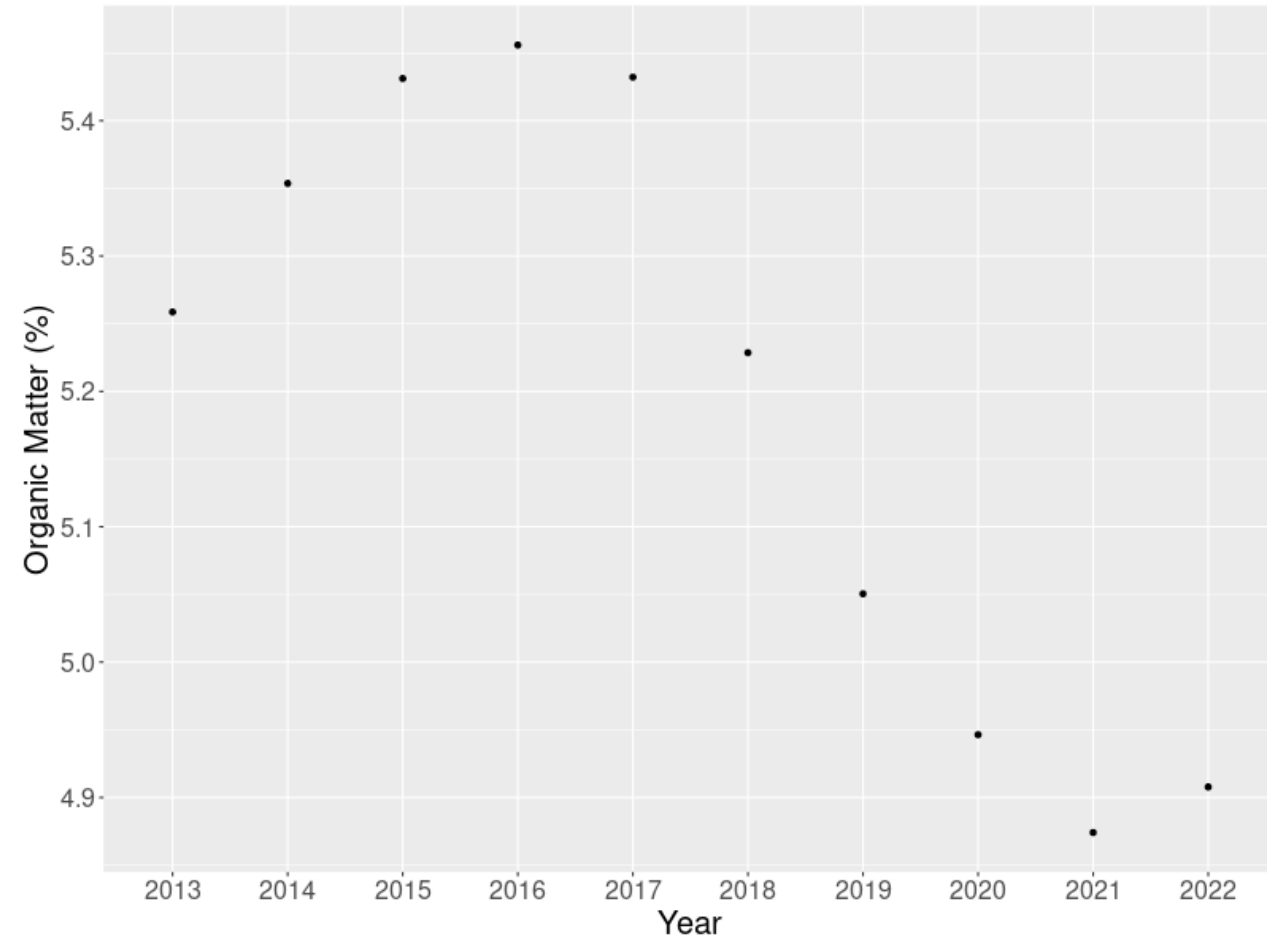
# SOC Monitoring



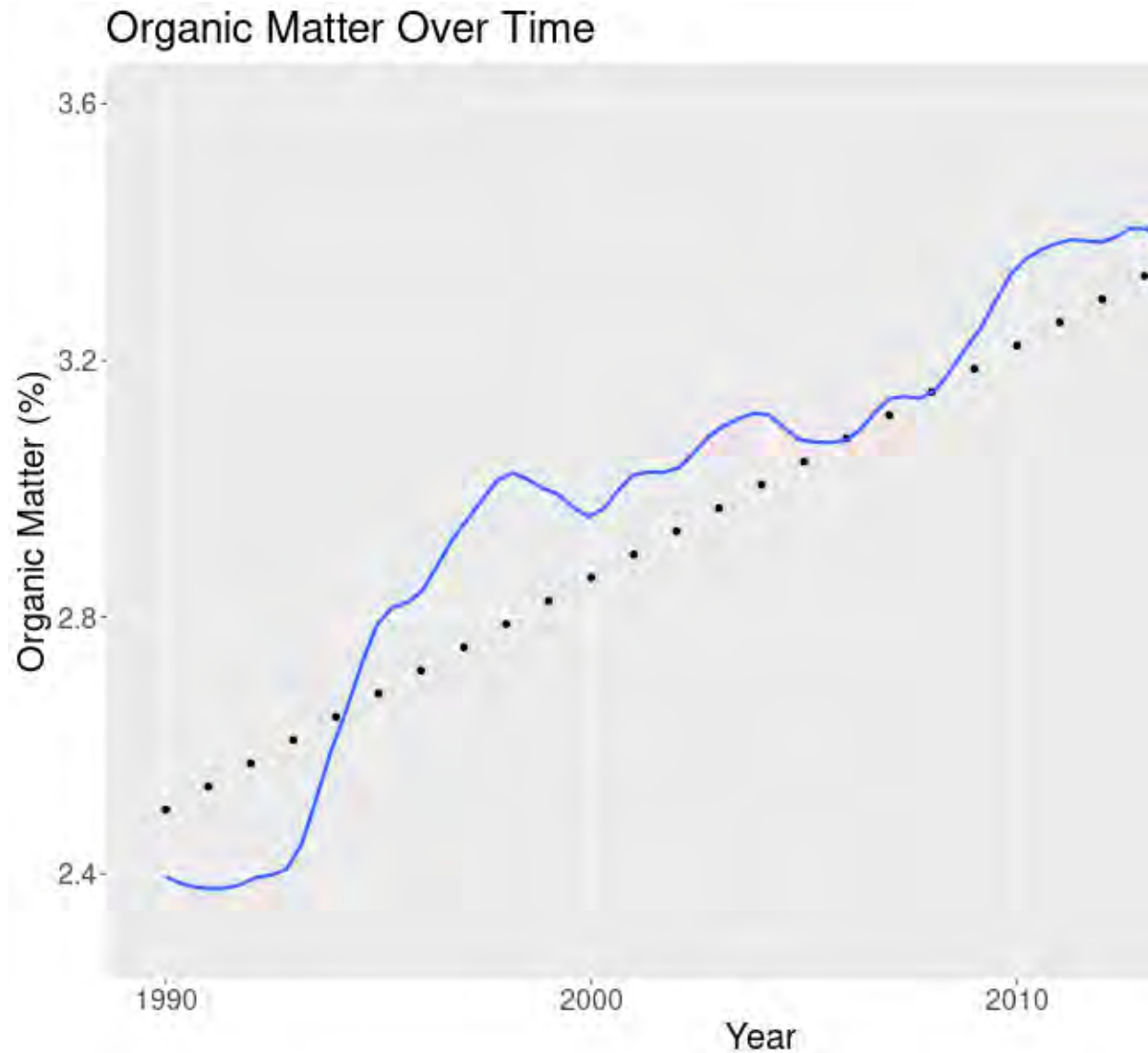
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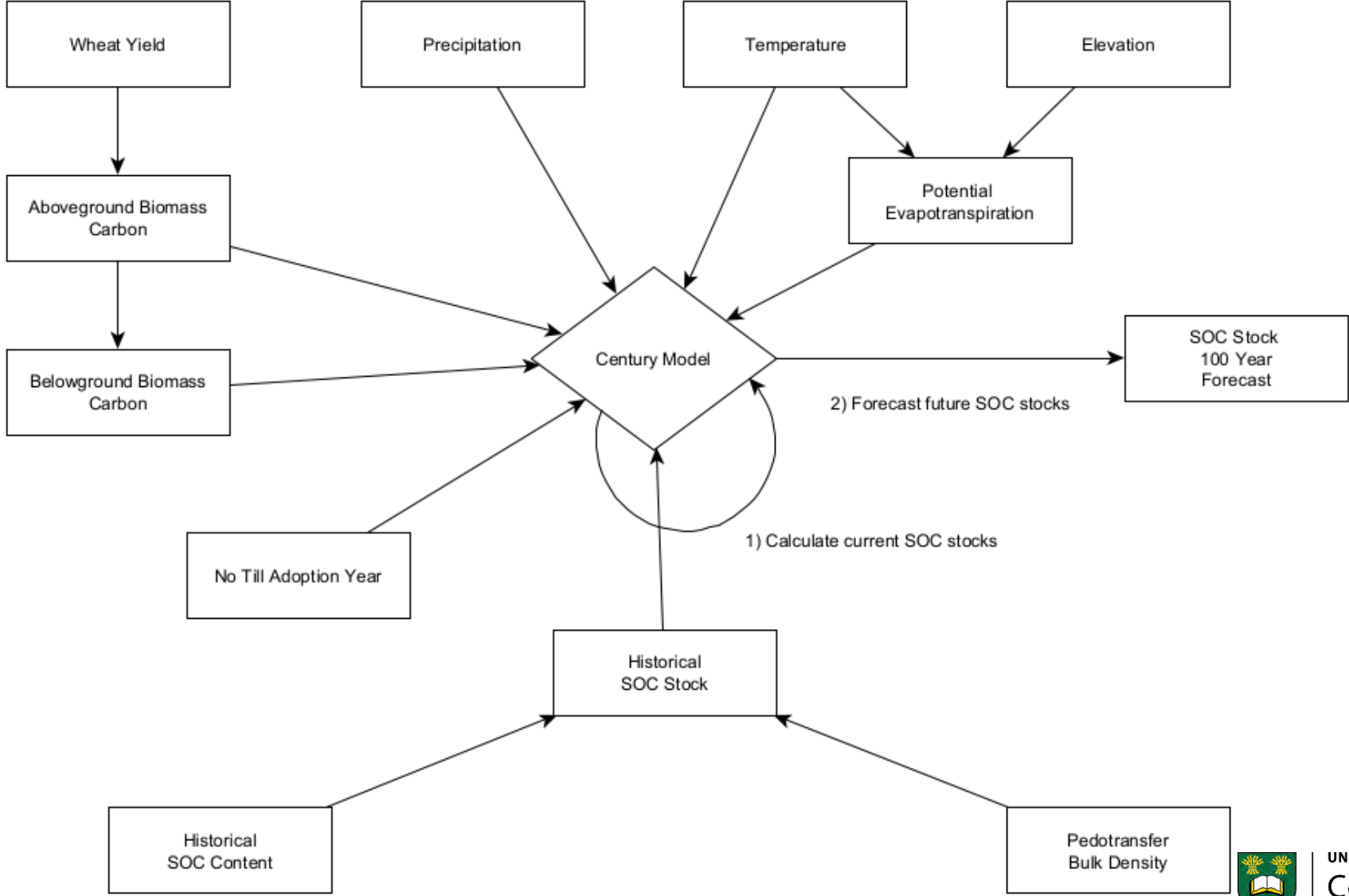


# SOC Monitoring

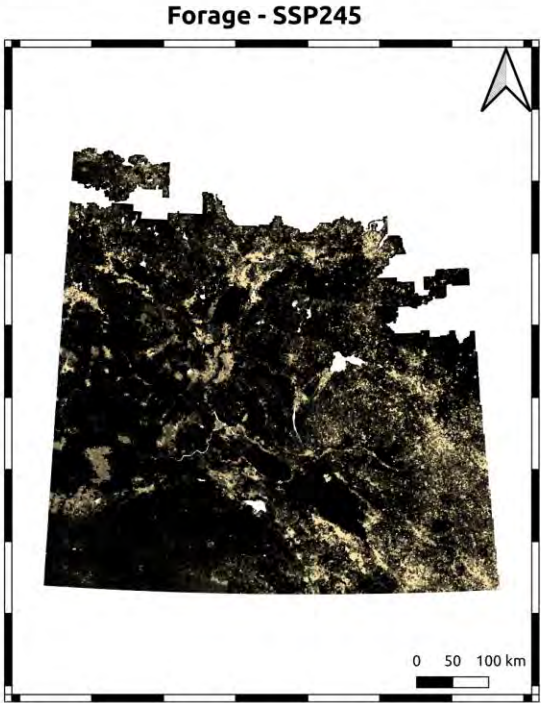
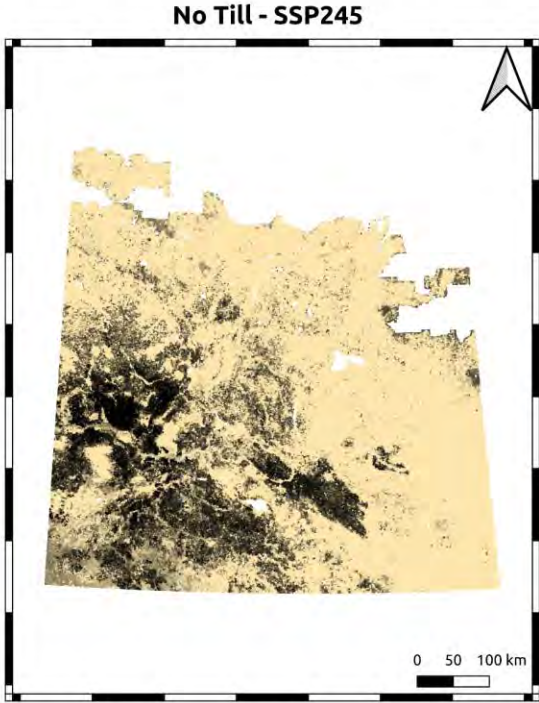
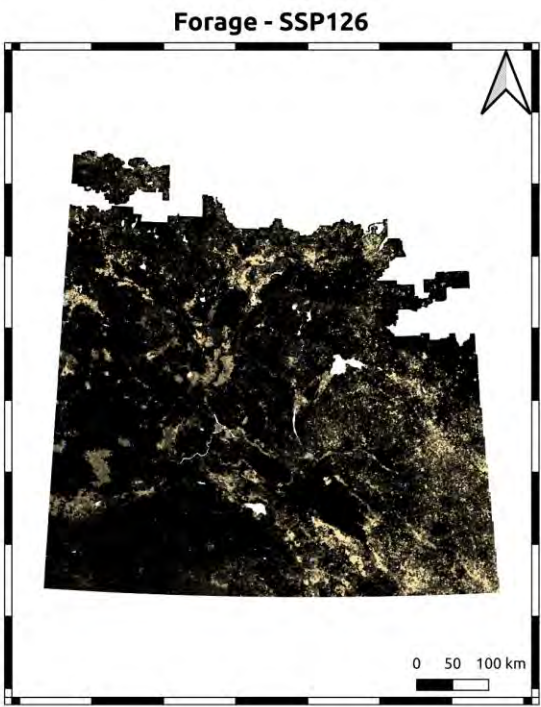
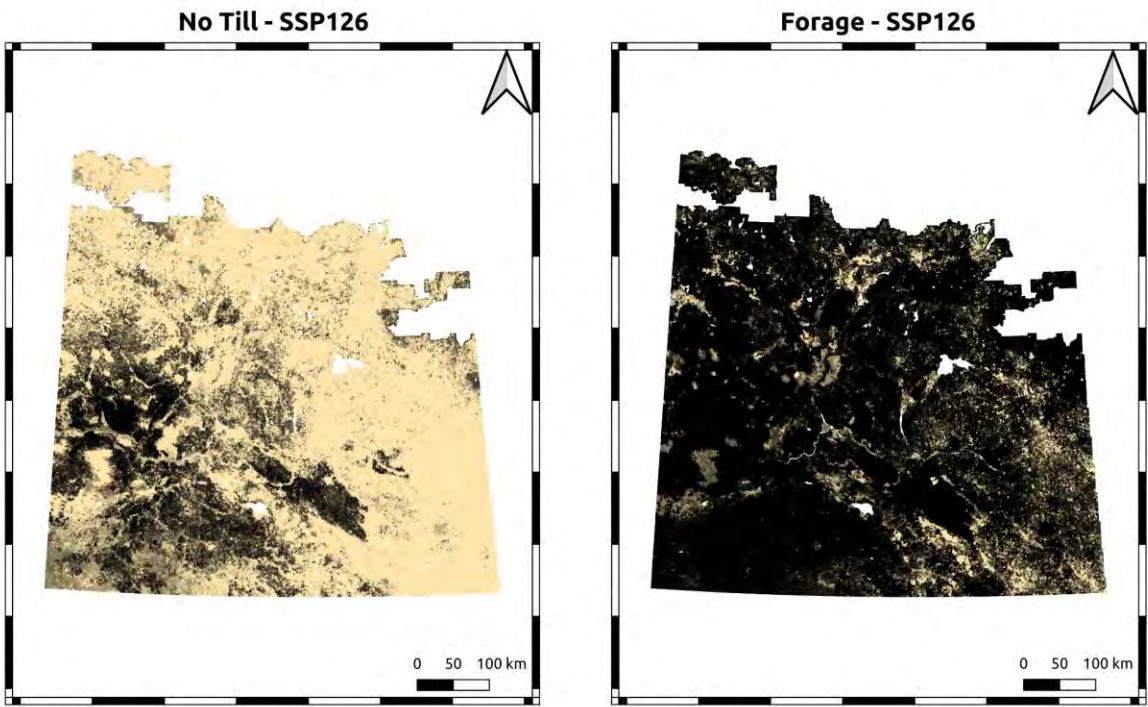




# SOC Forecasting

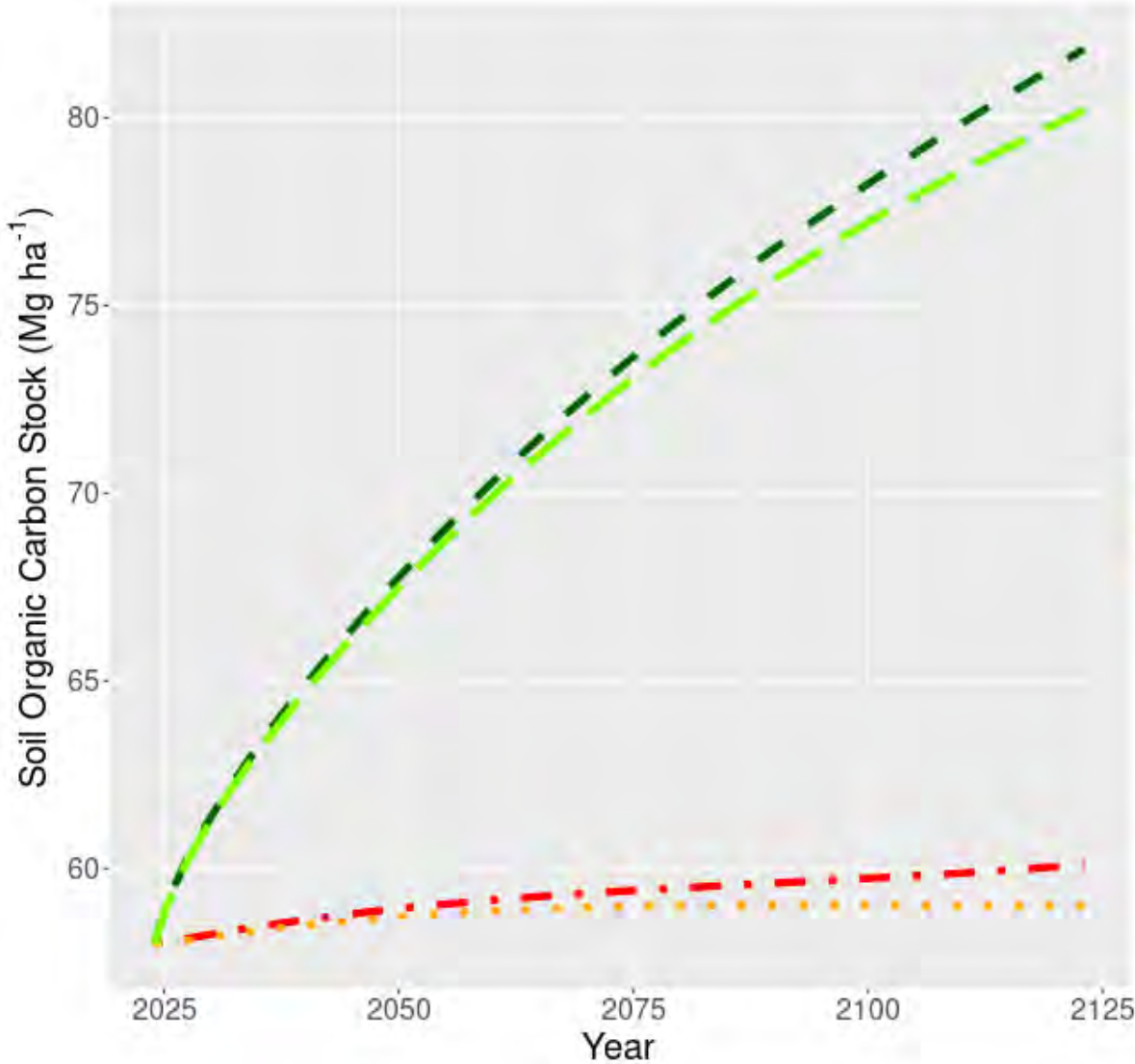


# SOC Forecasting





# SOC Forecasting



Past Gains (Model): 2.19 t/ha  
 Past Gains (PCSB 0 – 30cm): 2.21 t/ha

SSP126  
 No Till – 2.11 t/ha  
 Forage – 23.84 t/ha

SSP245  
 No Till – 1.00 t/ha  
 Forage – 22.20 t/ha



# What Next?





# Acknowledgements



Agriculture and  
Agri-Food Canada



Digital Research  
Alliance of Canada

Alliance de recherche  
numérique du Canada



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