



Characterizing Sediment Source Variability

Landscape and Land Use Influences on Fingerprint Properties

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Acknowledgements

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Introduction

- Sediment fingerprinting links sources to downstream sediment
 - Using soil/sediment properties as fingerprints (tracers)
 - Provide an estimate of the relative contribution from each source
- Used to understand watershed processes and guide management practices



Research question

- Characterizing the sources of sediment is an important step
- Focus has been on:
 - Novel fingerprints
 - Fingerprint selection
- What about the sampling design?
 - Logistics
 - Cost
 - Judgement



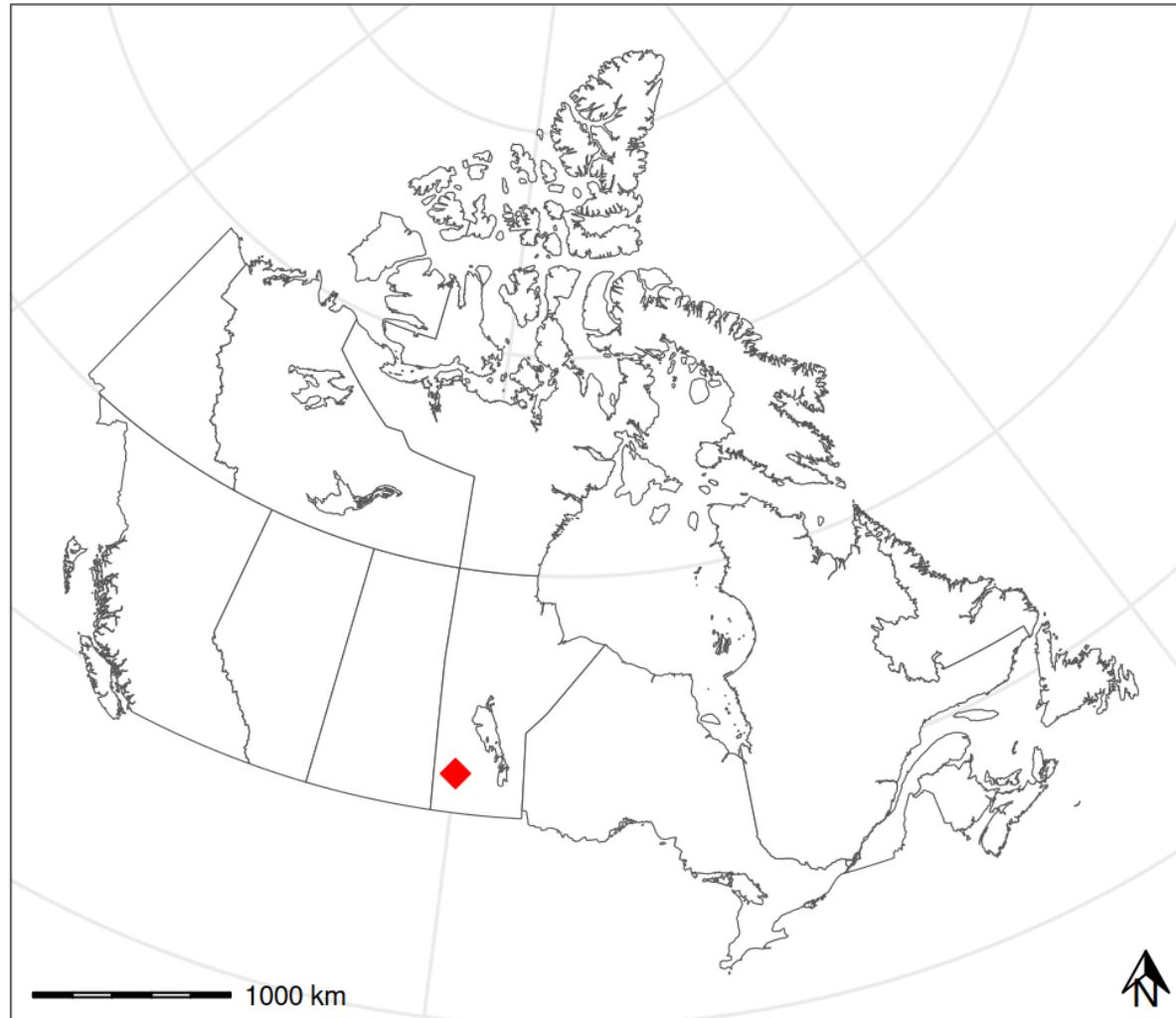
Objectives

Using a range of soil colour and geochemical properties across two contrasting land uses:

1. Quantify the variability
2. Characterize the spatial patterns
3. Assess the the importance of terrain attributes

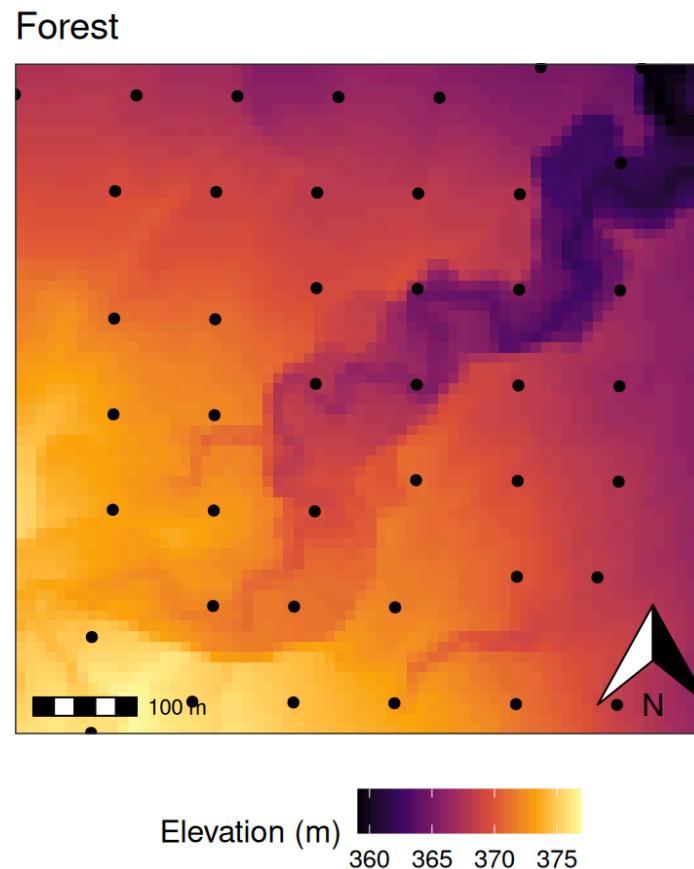
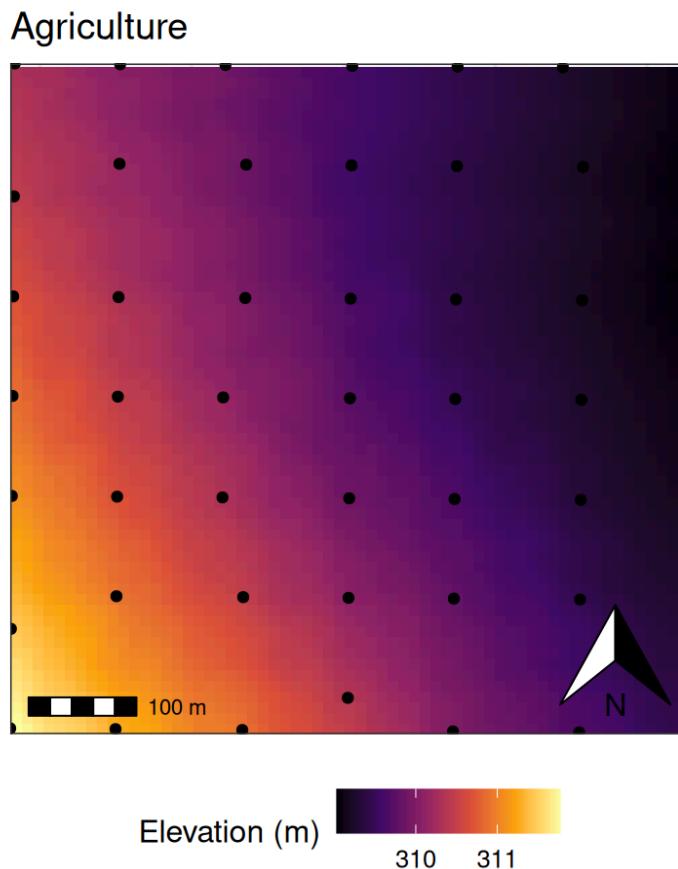


Location



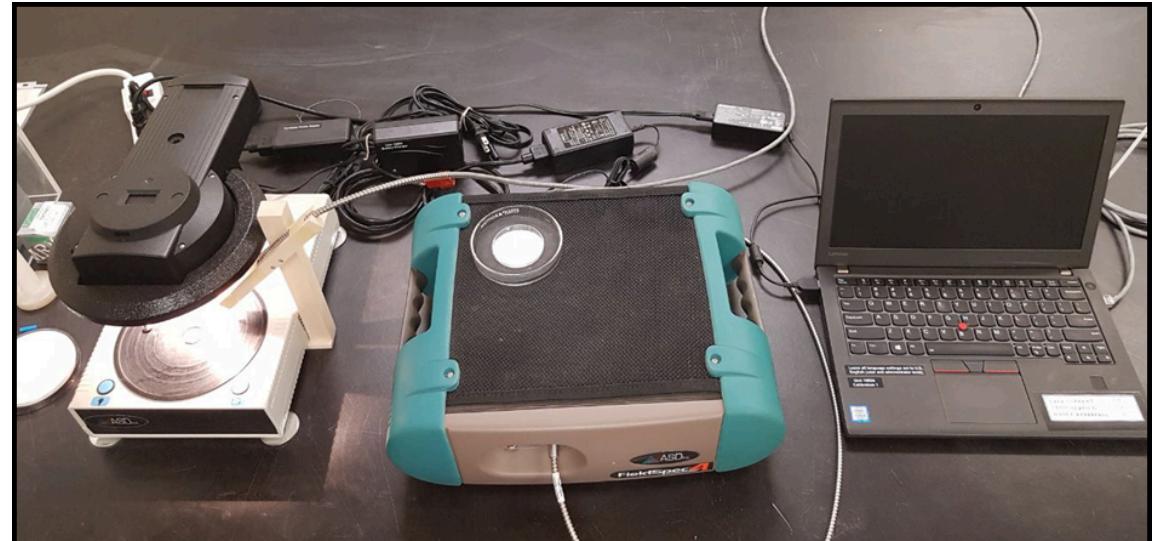
Sampling

- Surface soil
- 49 points at 100m spacing



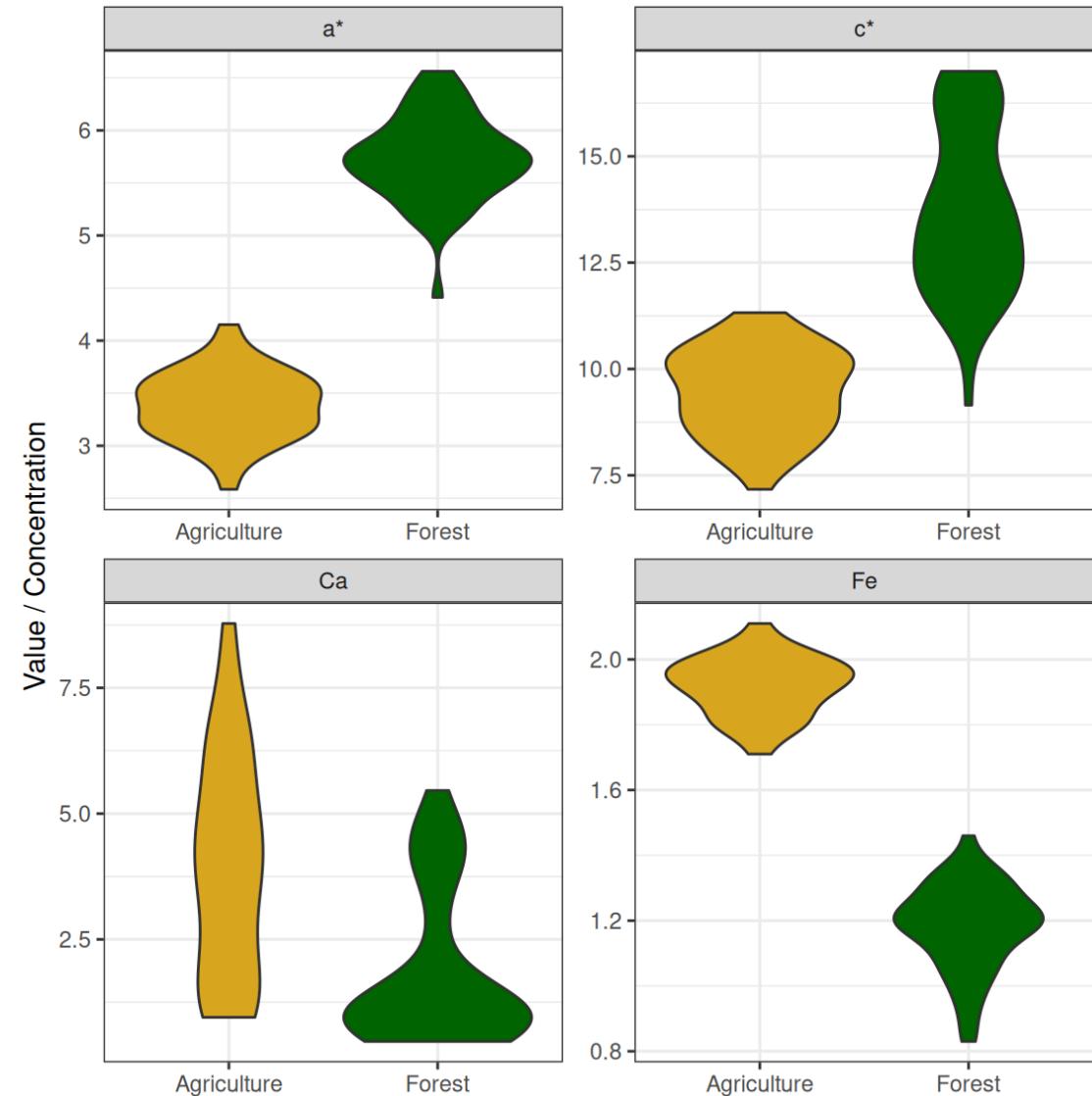
Lab analysis

- Sieved to < 63 um
 - Geochemistry
 - Aqua-regia
 - 51 geochemical elements
 - Spectral reflectance
 - FieldSpecPro
 - 15 colour coefficients
- Based on previous work (Luna Miño et al. 2024)
- Ca, Co, Cs, Fe, Li, La, Nb, Ni, Rb, and Sr
 - a^* , b^* , h^* , and x



Univariate analysis

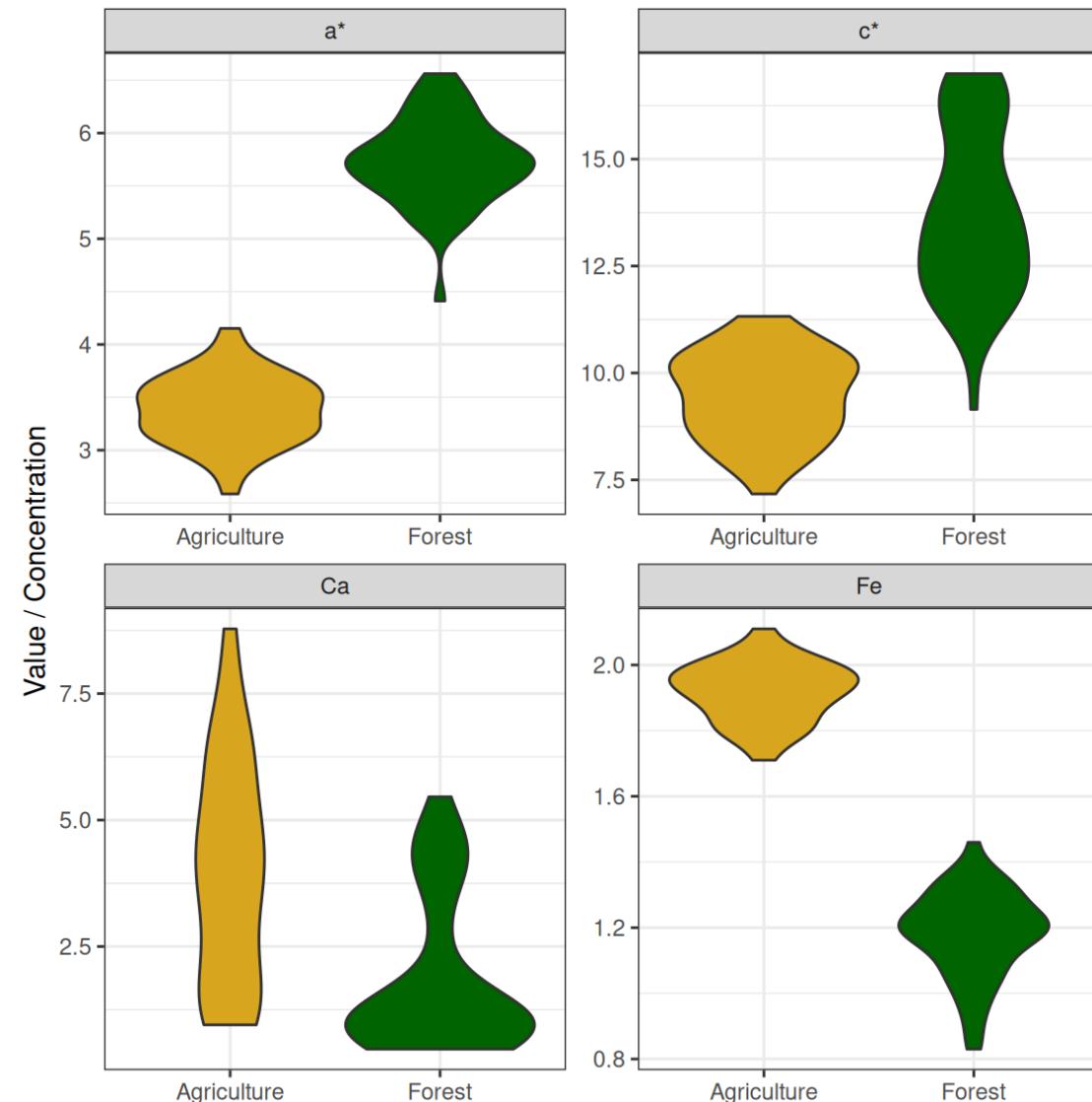
- Mean
- Standard deviation
- Skewness
- Coefficient of variation



Univariate analysis

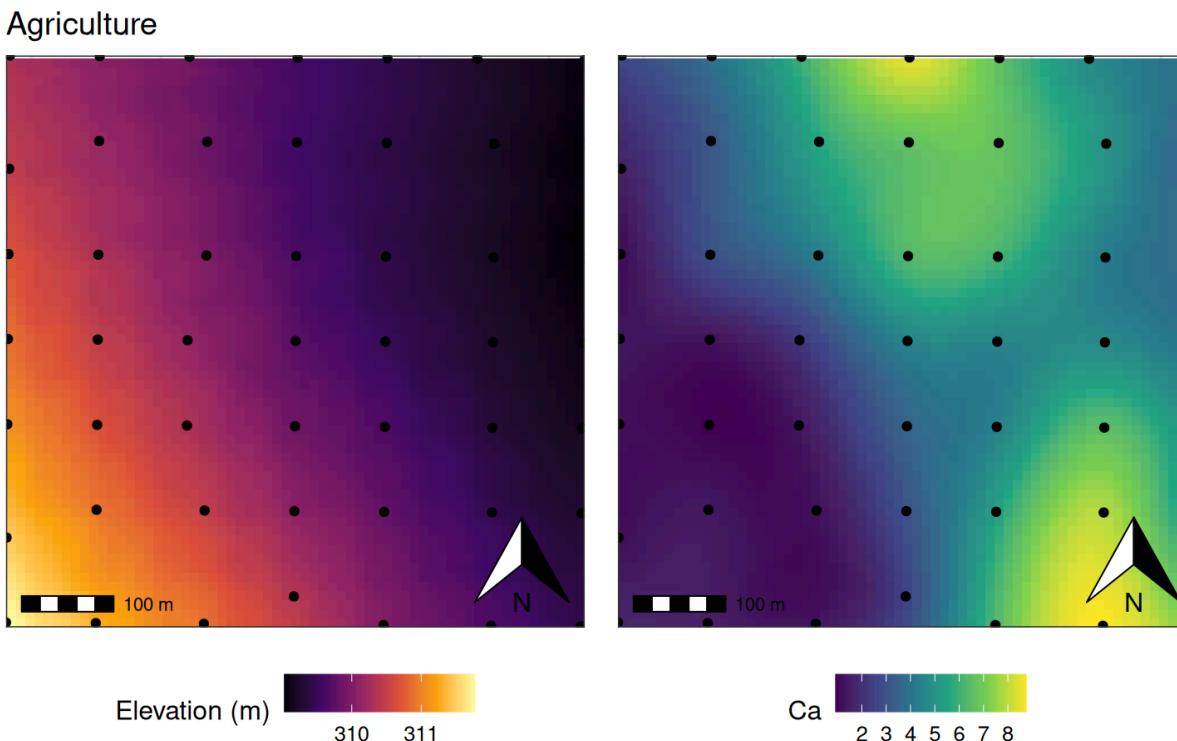
Overall

- Colour properties and the agricultural land use
 - Exhibited lower variability and more symmetrical data
- Forested site has a more complex topography and geomorphic setting (floodplain)
 - Greater variability in SOM and grain size
- Colour properties make ideal fingerprints
- Differences between sites makes direct comparisons a bit tricky
 - Transformations?



Geospatial analysis

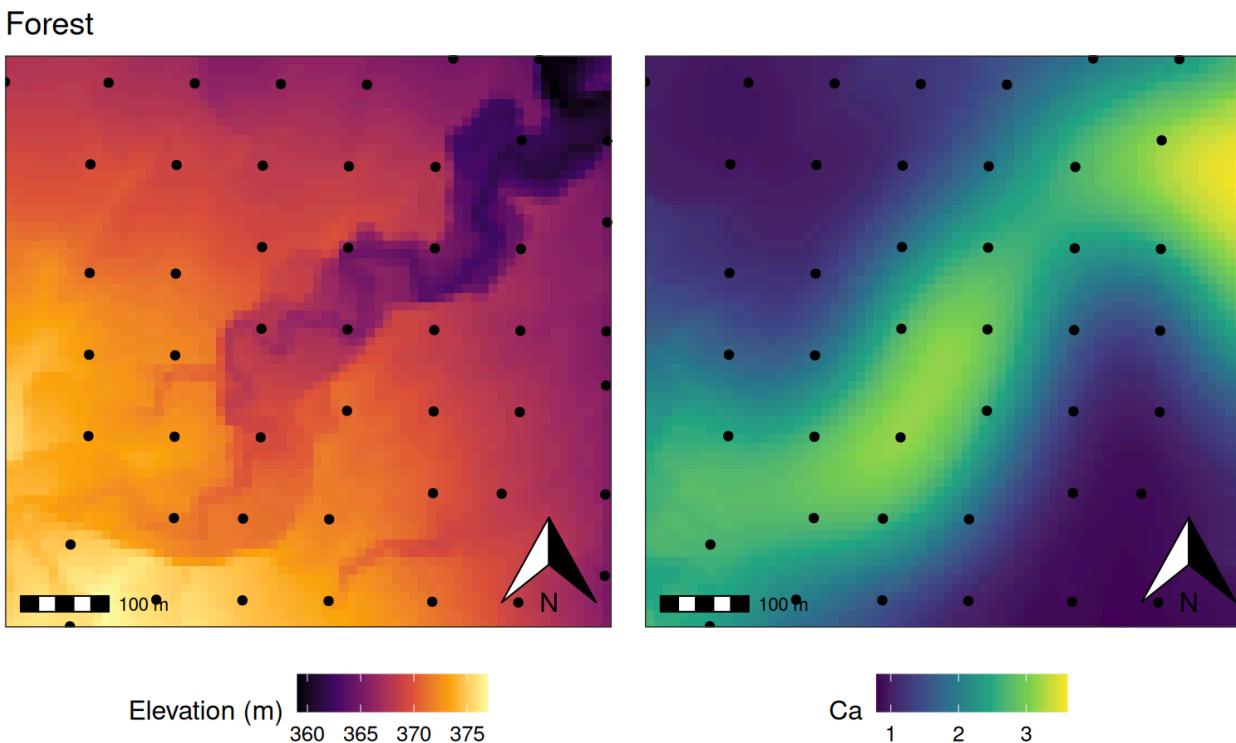
- Spatial autocorrelation
 - Semivariograms
- Interpolation and mapping
 - Kriging



Nugget = 0.0
Sill = 7.2
Range = 580m
Spatial Class = Strong

Geospatial analysis

- Spatial autocorrelation
 - Semivariograms
- Interpolation and mapping
 - Kriging

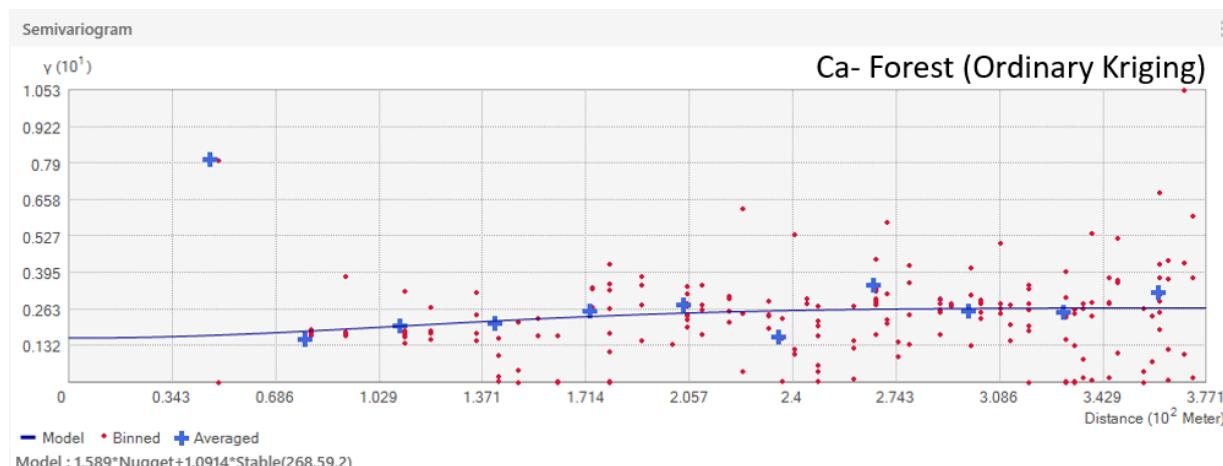
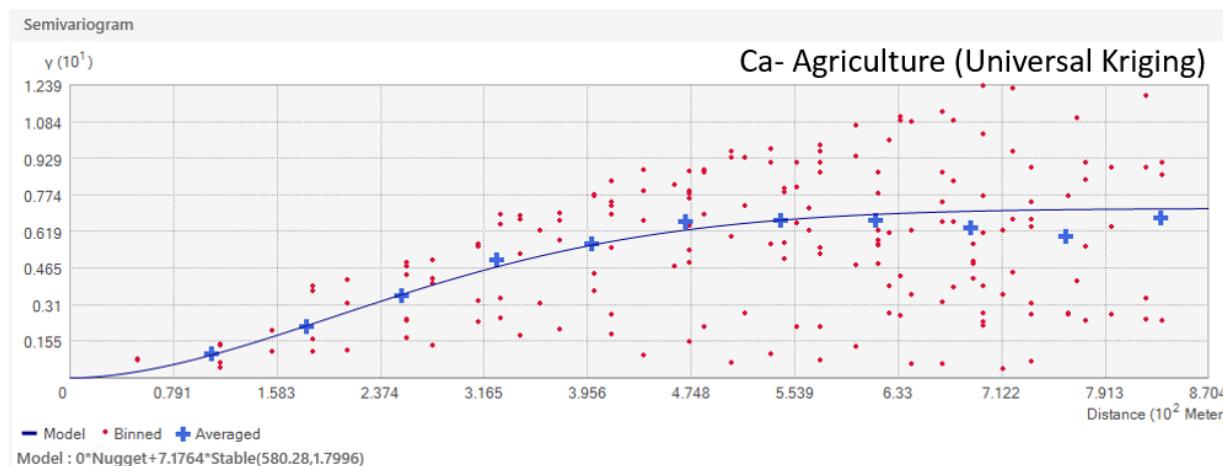


Nugget = 1.6
Sill = 2.7
Range = 269m
Spatial Class = Moderate

Geospatial analysis

Semivariogram interpretation

- Small nugget reflects low measurement or sampling error
- Small sill indicates low overall variance
- Small range indicate spatial correlation persists over short distances

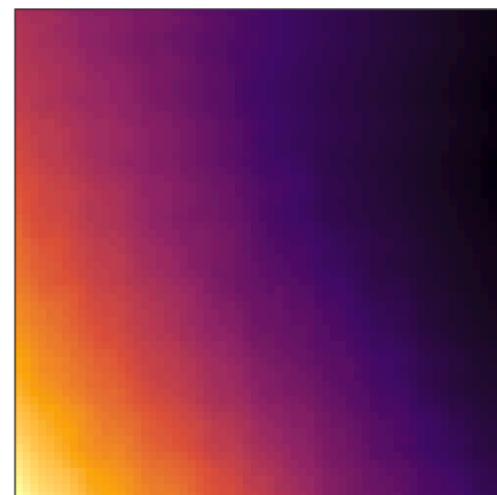


Geospatial analysis

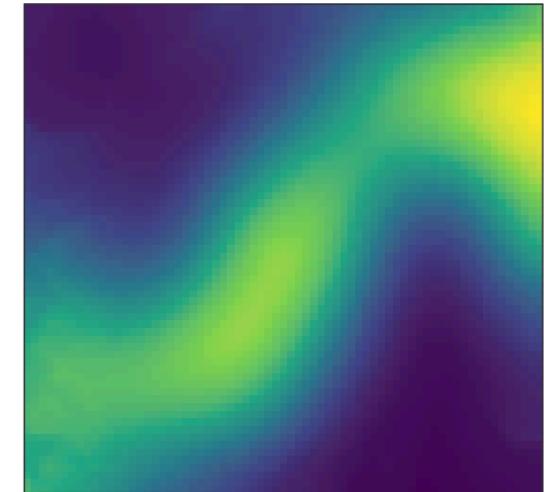
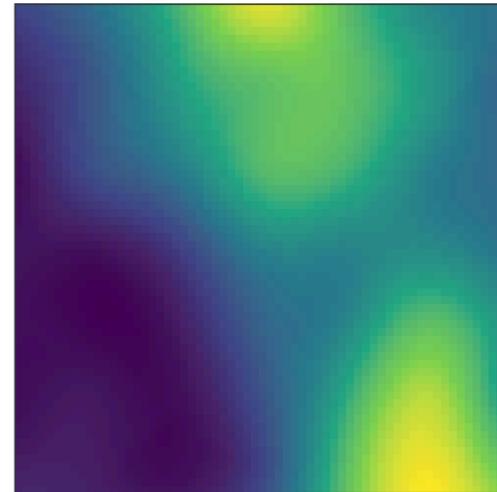
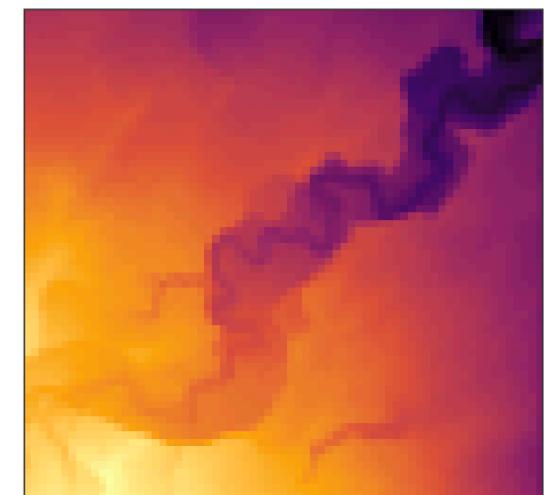
Spatial autocorrelation

- Soil properties at the **agricultural site** exhibited **stronger** spatial autocorrelation
 - 6 soil properties at the forested site exhibited **no** spatial autocorrelation
- Soil properties presented patterns that roughly matches the topography

Agriculture

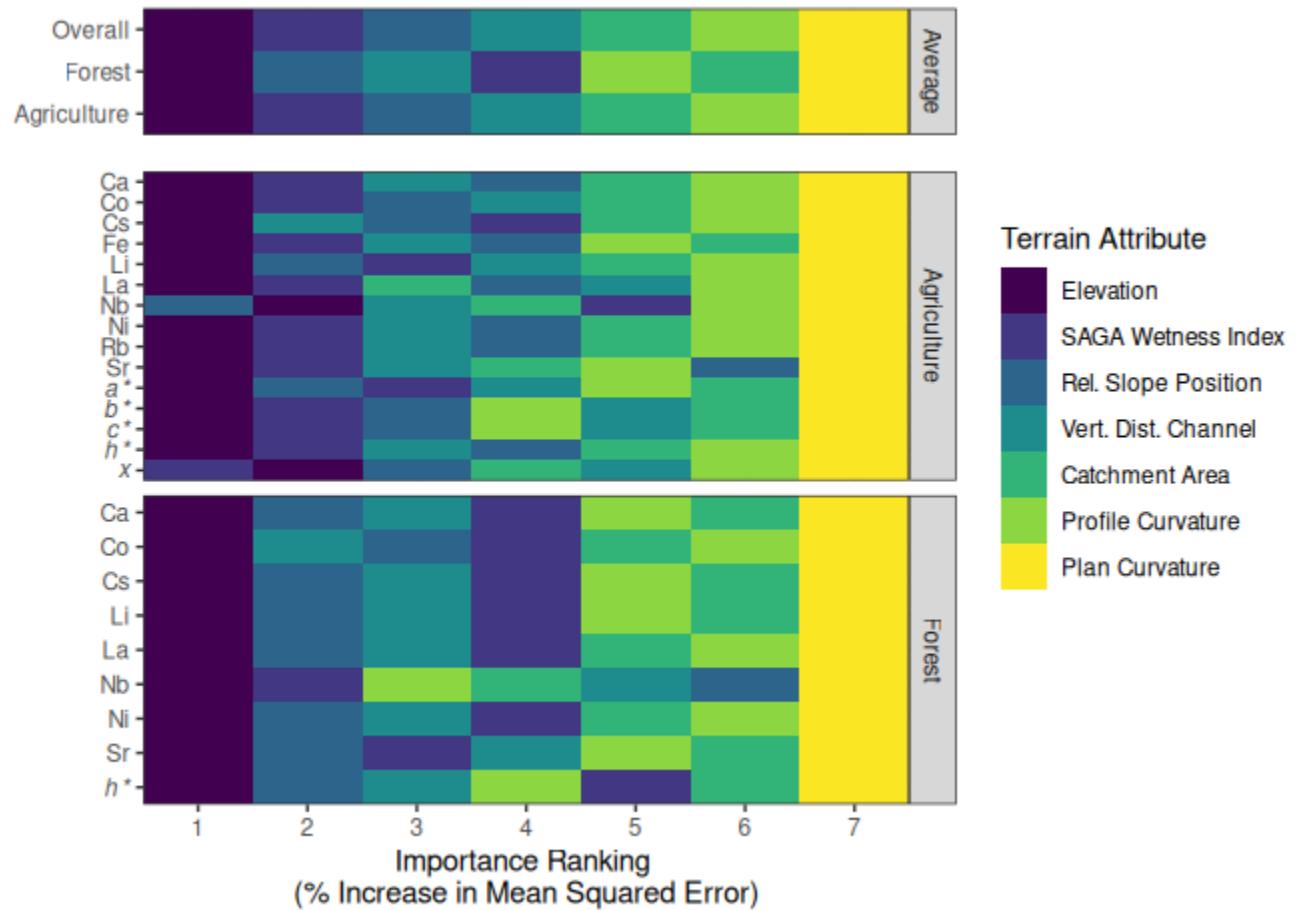


Forest



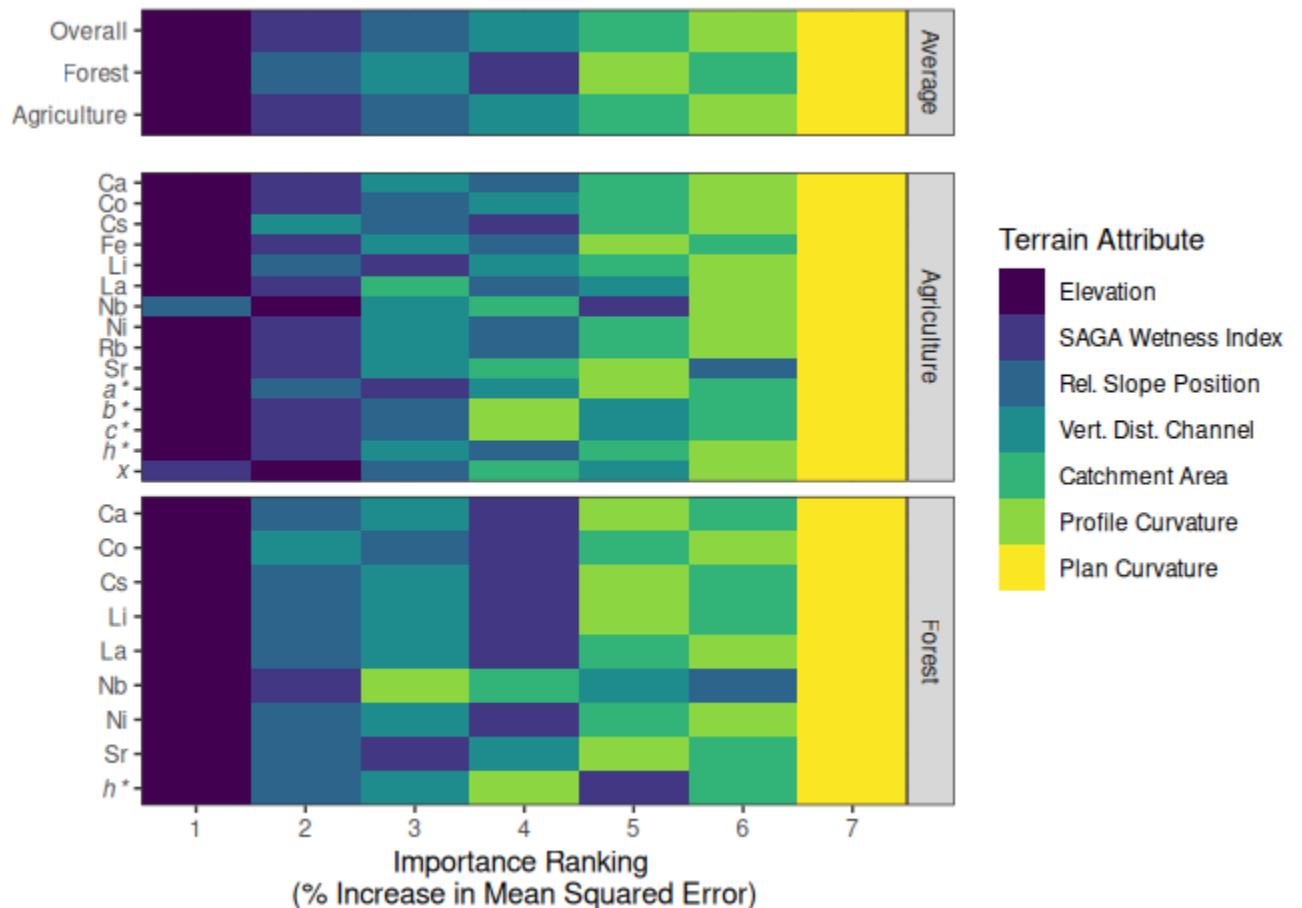
Terrain analysis

- Terrain attributes
 - System for Automated Geoscientific Analyses (SAGA)
 - Random Forest Regression
1. Plan curvature
 2. Profile curvature
 3. SAGA wetness index
 4. Catchment area
 5. Relative slope position
 6. Vertical channel network distance



Terrain analysis

- Elevation was ranked as the most important predictor
 - SAGA Wetness Index
 - Relative Slope Position
- Patterns linked to hydrologic properties and processes
- Terrain attributes can be used to guide sampling and interpret data



Conclusions

- Agricultural site:
 - Gently sloping terrain
 - Lower variability
 - Approximately normal data distributions
 - Moderate to strong spatial autocorrelation
- Forested site:
 - Complex terrain
 - Higher variability
 - Data often non-normal
 - Fewer properties with spatial autocorrelation



Conclusions

- Topographic effects evident in many soil property patterns
- Top terrain predictors: elevation, SAGA Wetness Index, and relative slope position
 - Terrain–soil relationships were inconsistent in strength and direction
- Terrain-driven spatial patterns can inform more targeted soil sampling



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