



# 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





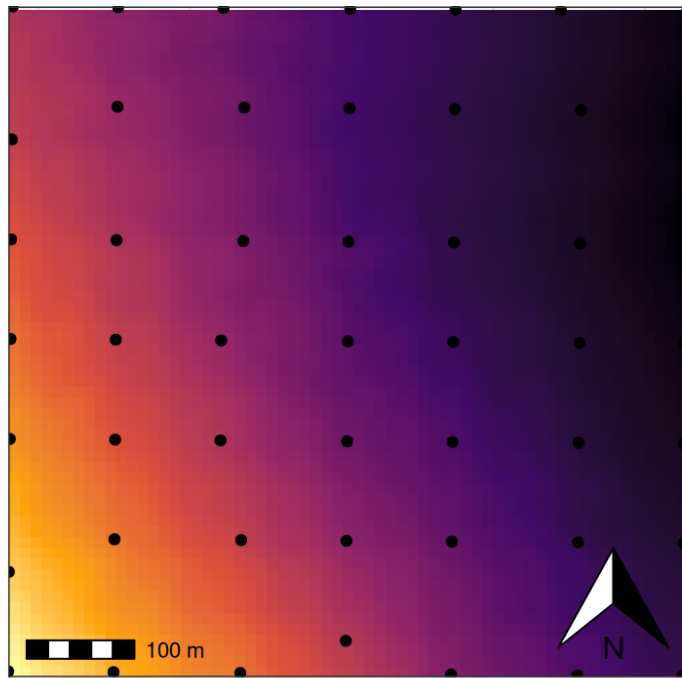
# Location



# Sampling

- Surface soil
- 49 points at 100m spacing

Agriculture

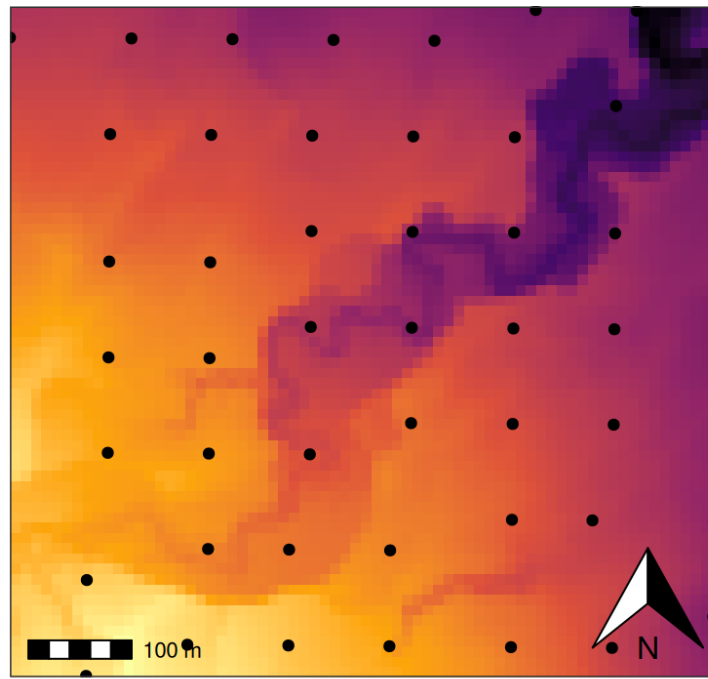


Elevation (m)




310 311

Forest



Elevation (m)



360 365 370 375

# Lab analysis

- Sieved to  $< 63 \mu\text{m}$
- Geochemistry
  - Aqua-regia
  - 51 geochemical elements
- Spectral reflectance
  - FieldSpecPro
  - 15 colour coefficients

Based on previous work (Luna Miño et al. 2024)

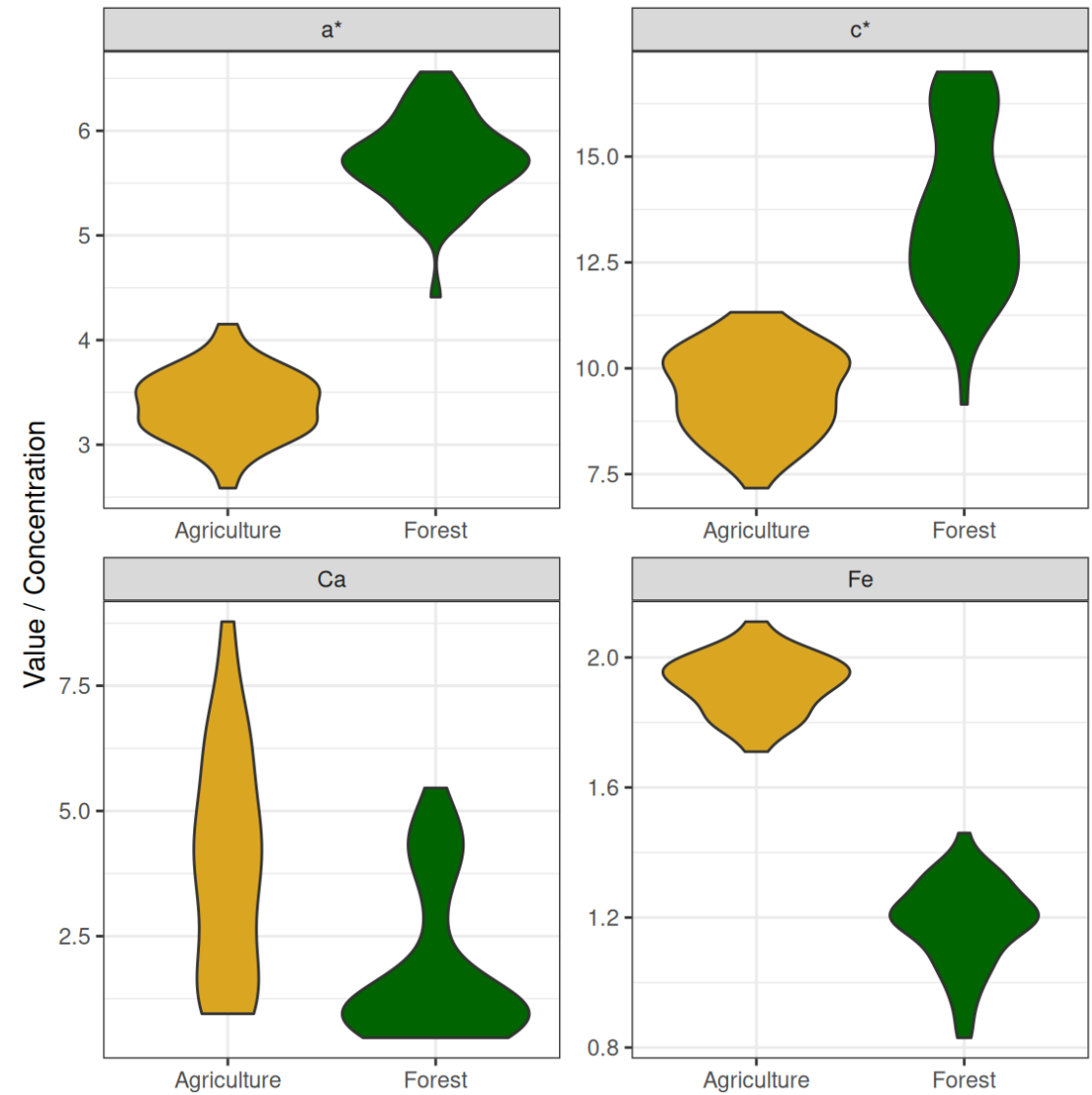
- Ca, Co, Cs, Fe, Li, La, Nb, Ni, Rb, and Sr
- $a^*$ ,  $b^*$ ,  $h^*$ , and  $x$





# Univariate analysis

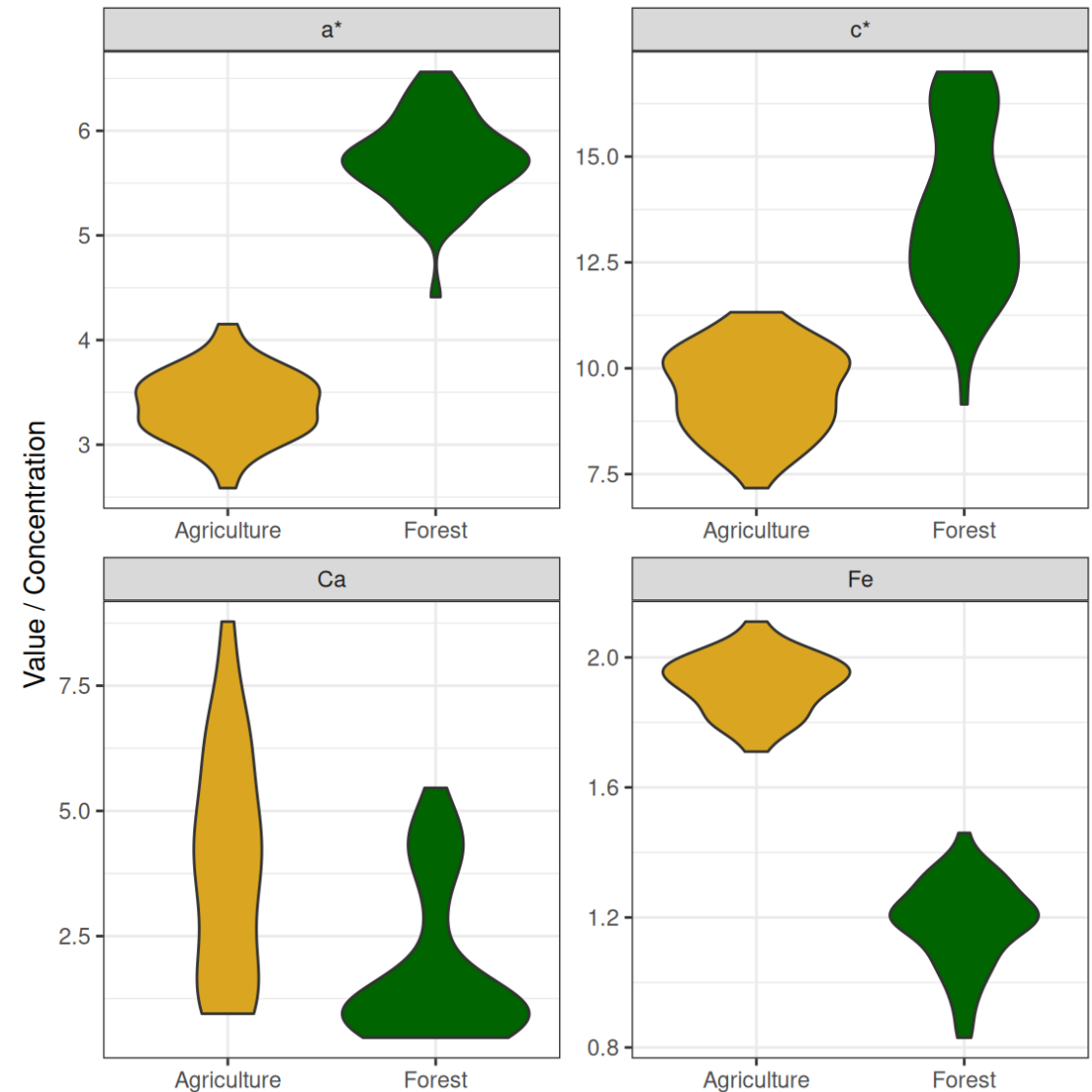
- Mean
- Standard deviation
- Skewness
- Coefficient of variation



# Univariate analysis

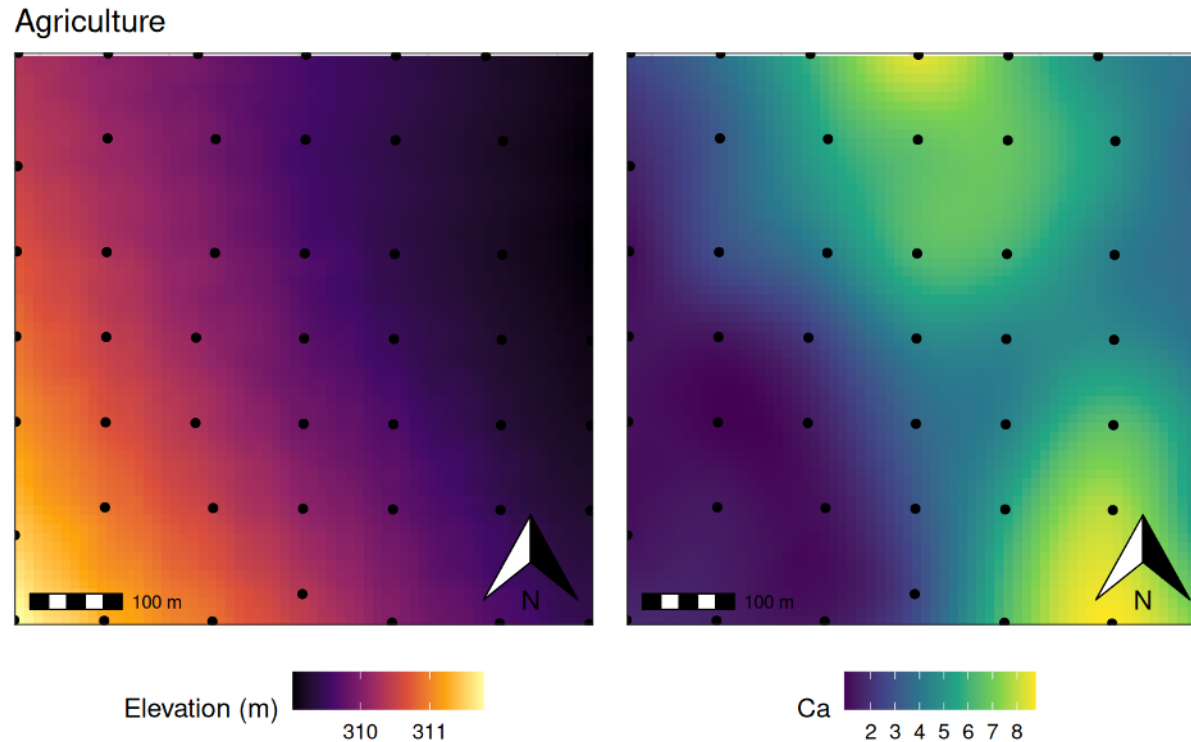
## Overall

- 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

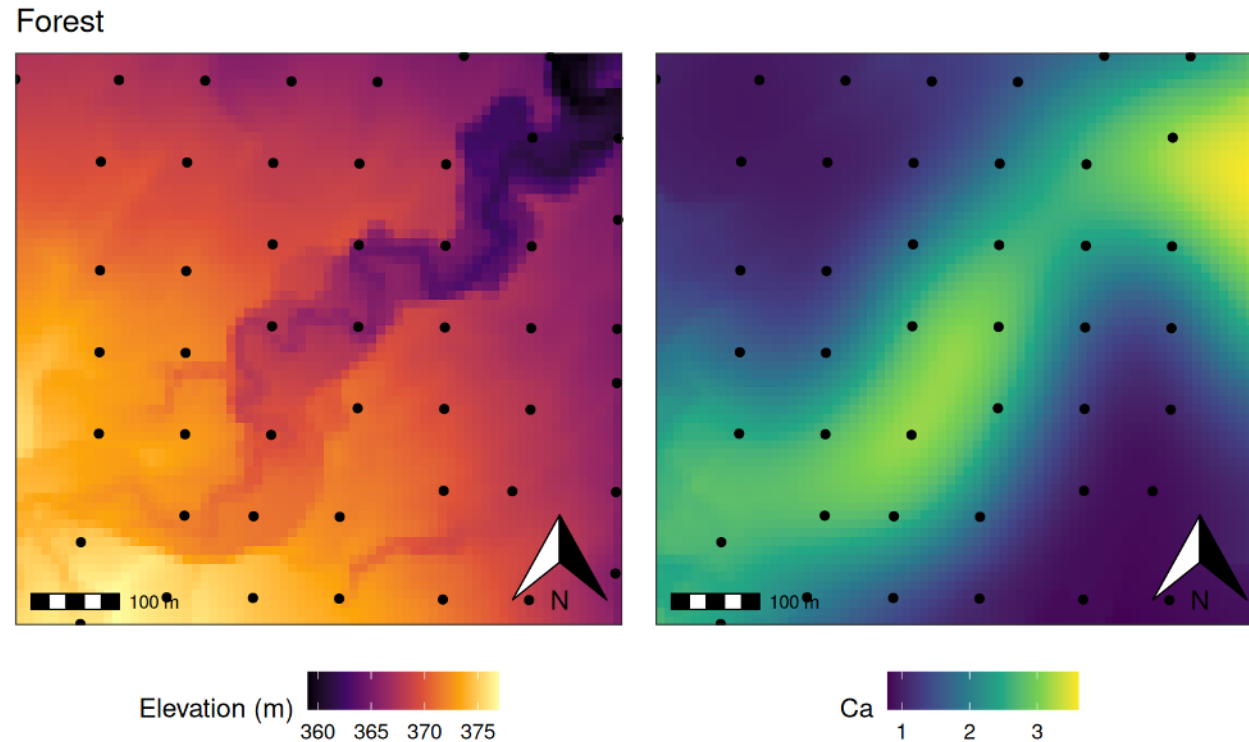
Range = 580m

Spatial Class = Strong



# Geospatial analysis

- Spatial autocorrelation
  - Semivariograms
- Interpolation and mapping
  - Kriging



Nugget = 1.6

Sill = 2.7

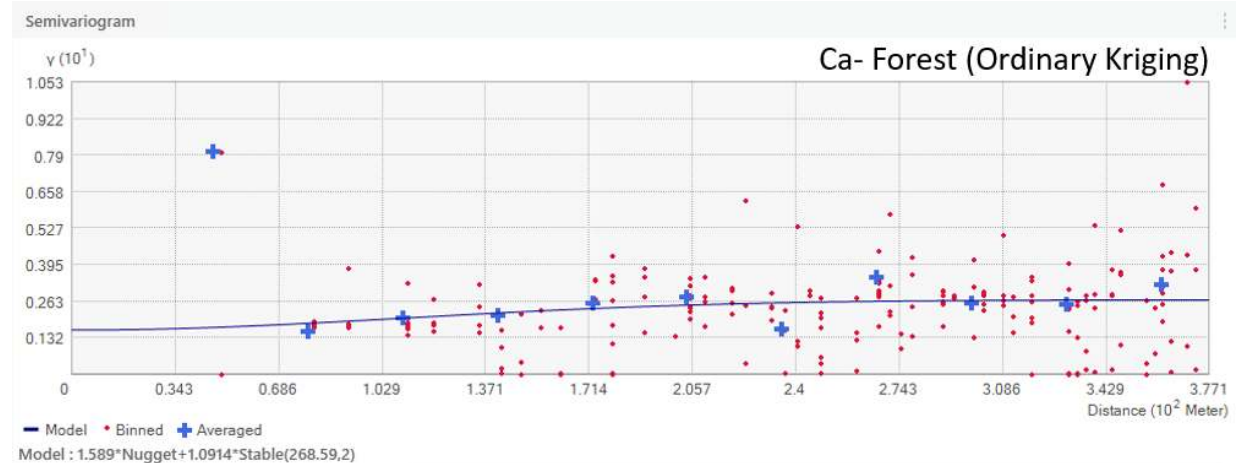
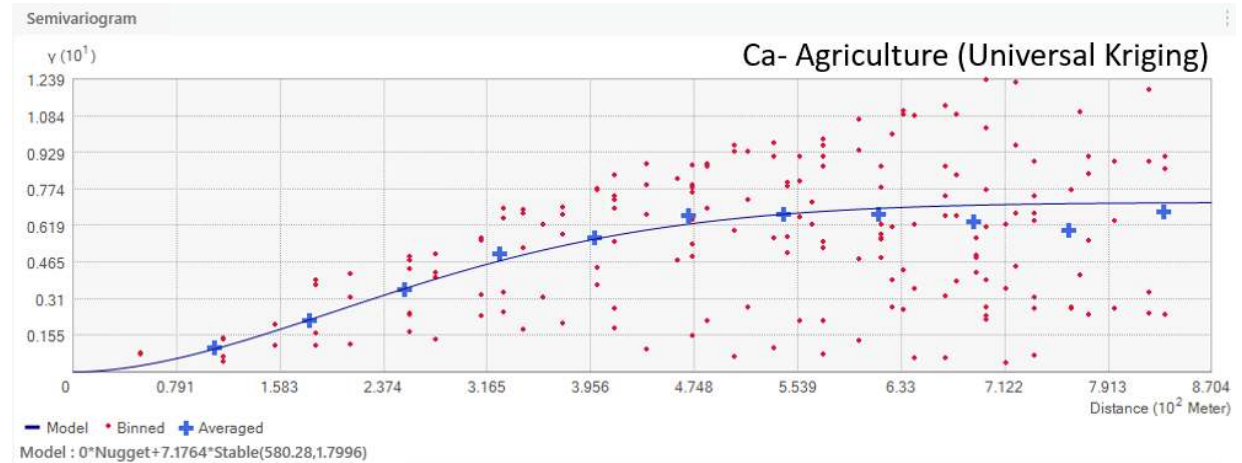
Range = 269m

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

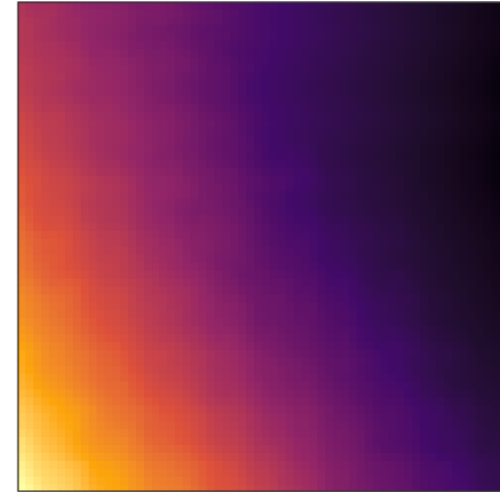


# Geospatial analysis

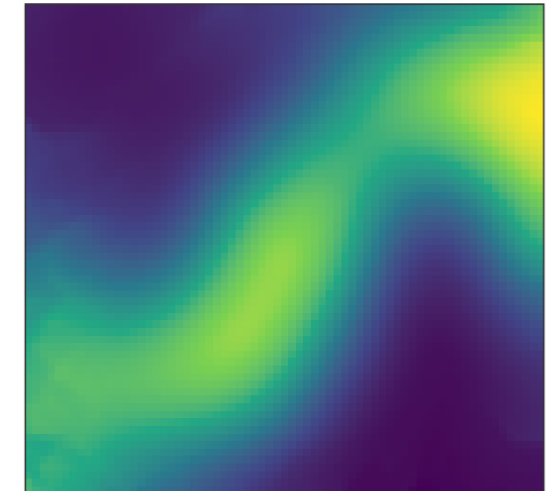
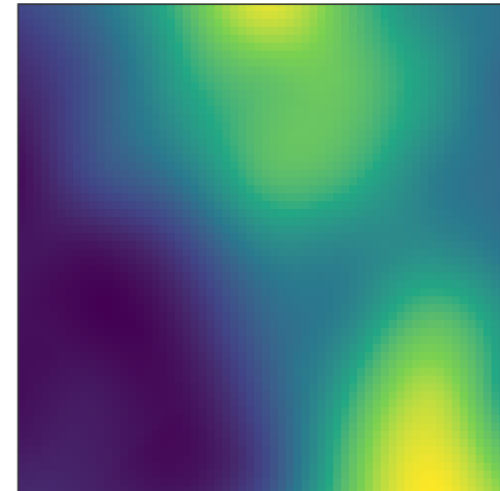
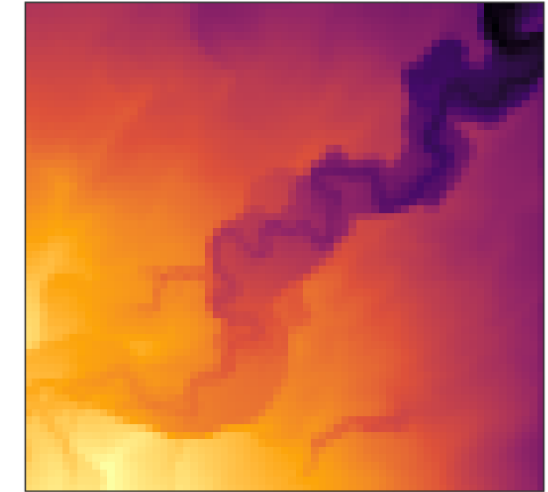
## Spatial autocorrelation

- 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



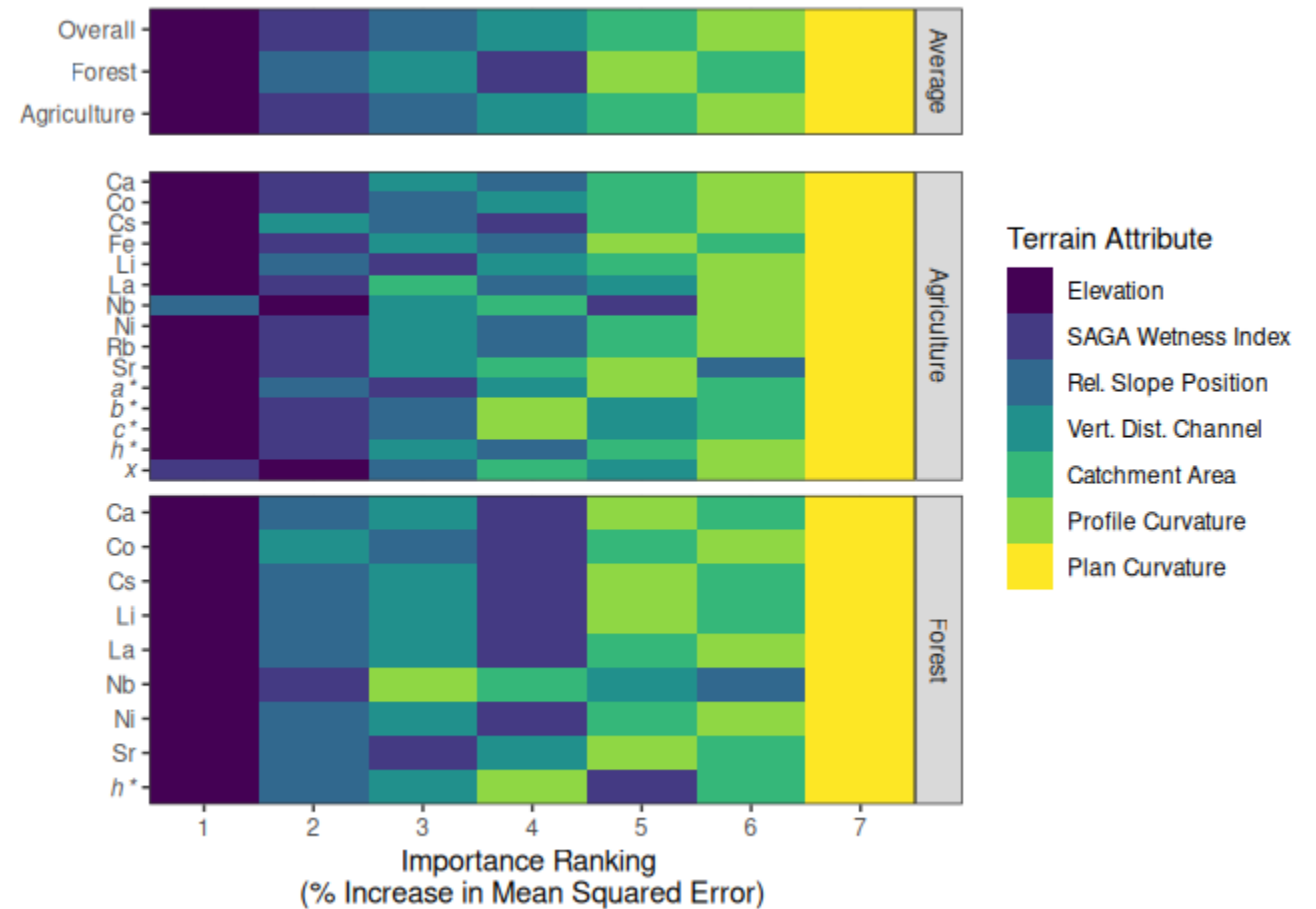
Forest





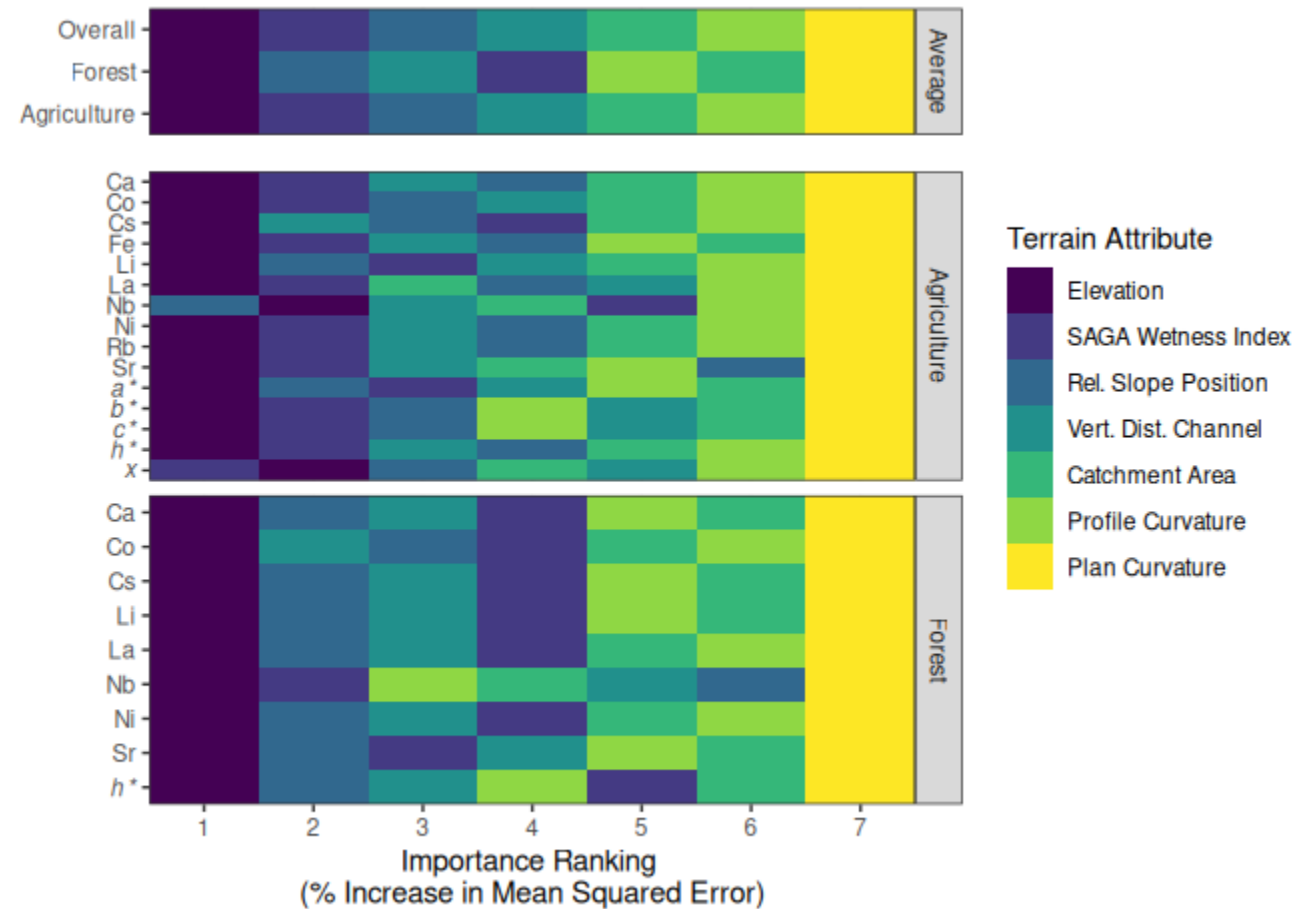
# Terrain analysis

- 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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