Exploring novel Compound Specific Stable Isotope (CSSI) tracers with conventional fingerprinting properties for sediment source apportionment

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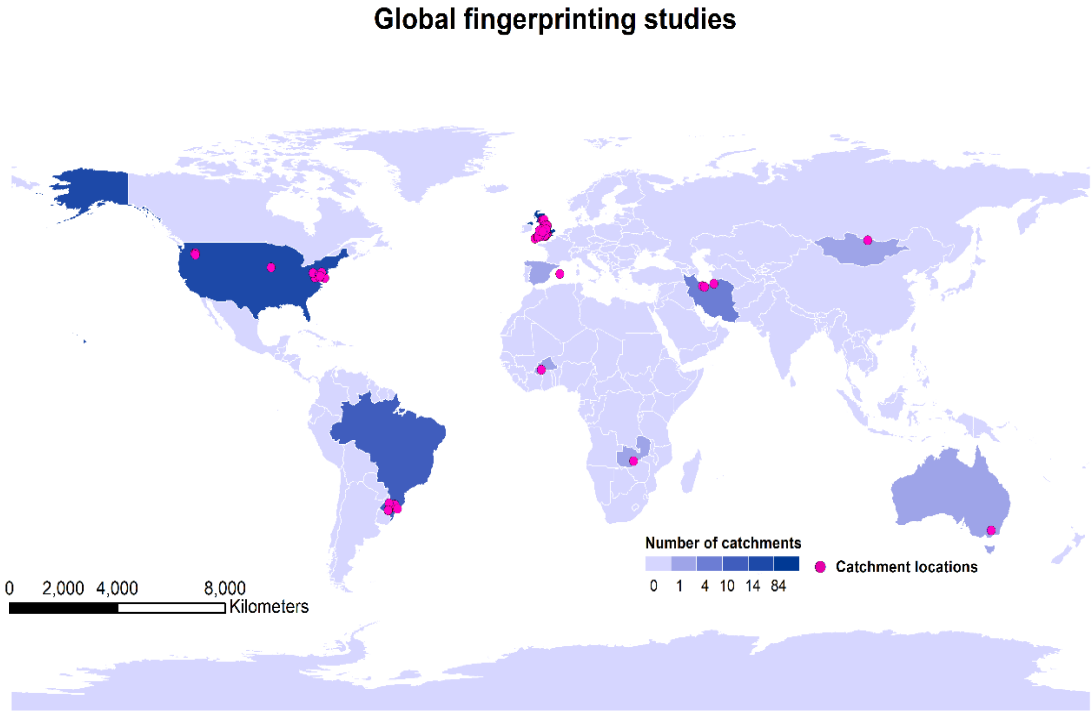
Motivation

- Ecosystems are impacted by sediment inputs
- Upland and bank erosion may change with catchment size
- Share of sediment sources often unknown
- Knowledge on sources are specifically rare in Central Europe



The fingerprinting studies with spatial distribution of the sites

Objectives

➢Disentangle crop-specific soil loss

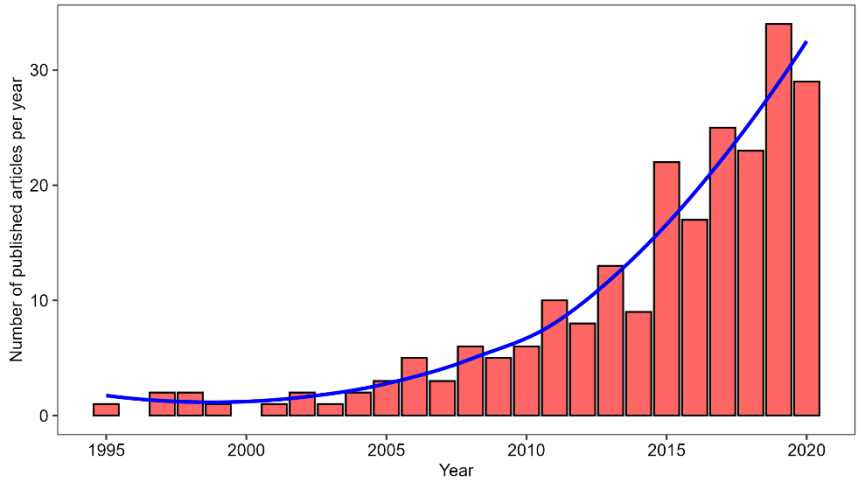
➢Investigate the suitability and consistency of compound specific stable isotopes (CSSI) technique

Techniques for soil erosion assessment

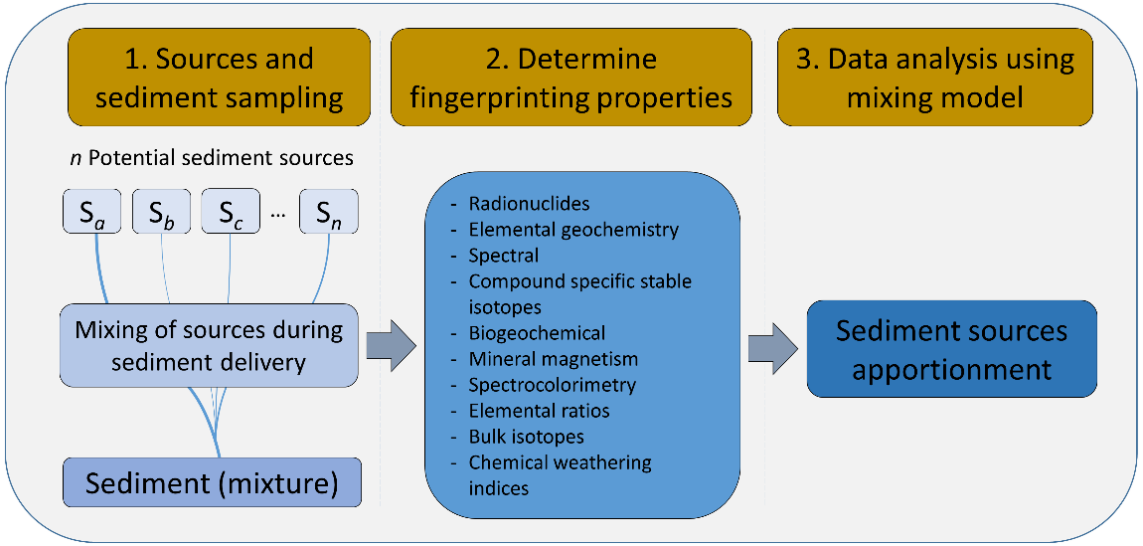
“ Things you measure tend to improve”

- Modeling (e.g. USLE)
- Erosion pins installation for soil loss rate
- Measuring soil erosion by field plots
- Indirect methods (i.e. sediment deposits)

Sediment source fingerprinting

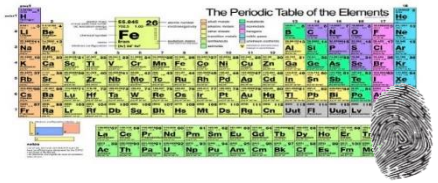


Fingerprinting studies

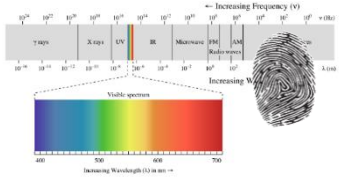


Schematic diagram of sediment source fingerprinting method

Fingerprinting properties selected

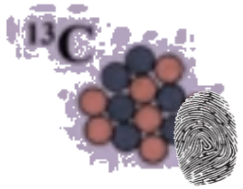


Elemental geochemistry



Spectral

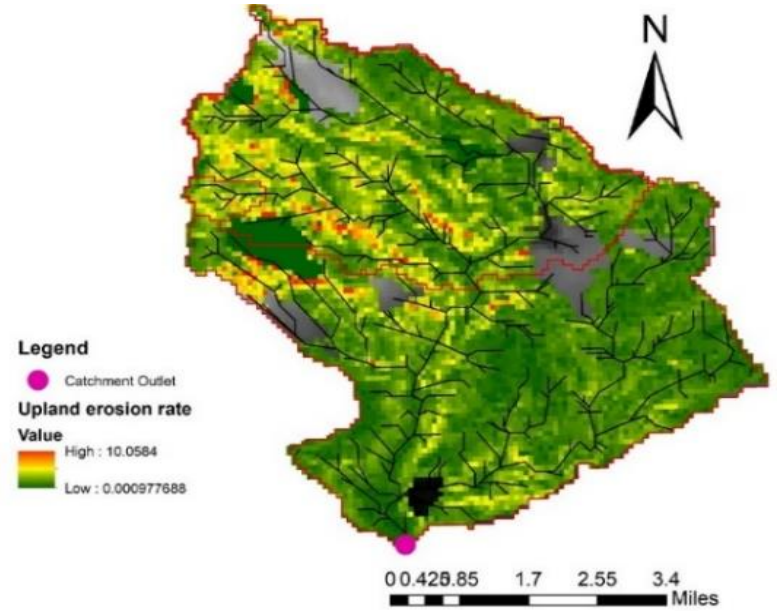
Radionuclides



Stable isotopes

CSSI sediment fingerprinting method

- The CSSI method, a forensic tool, identifies the "Sources" of sediments
- The C3 and C4 vegetation produces a range of organic compounds becoming "labels" for that land use.
- The CSSI technique uses the straight-chain fatty acids as biomarkers.
- The plants produce these fatty acids in slightly different ways.



Spatial distribution of upland erosion rate

➢ The literature review shows that the use of CSSIs is increasing with decreasing use of fallout radionuclides (Collins et al., 2020)

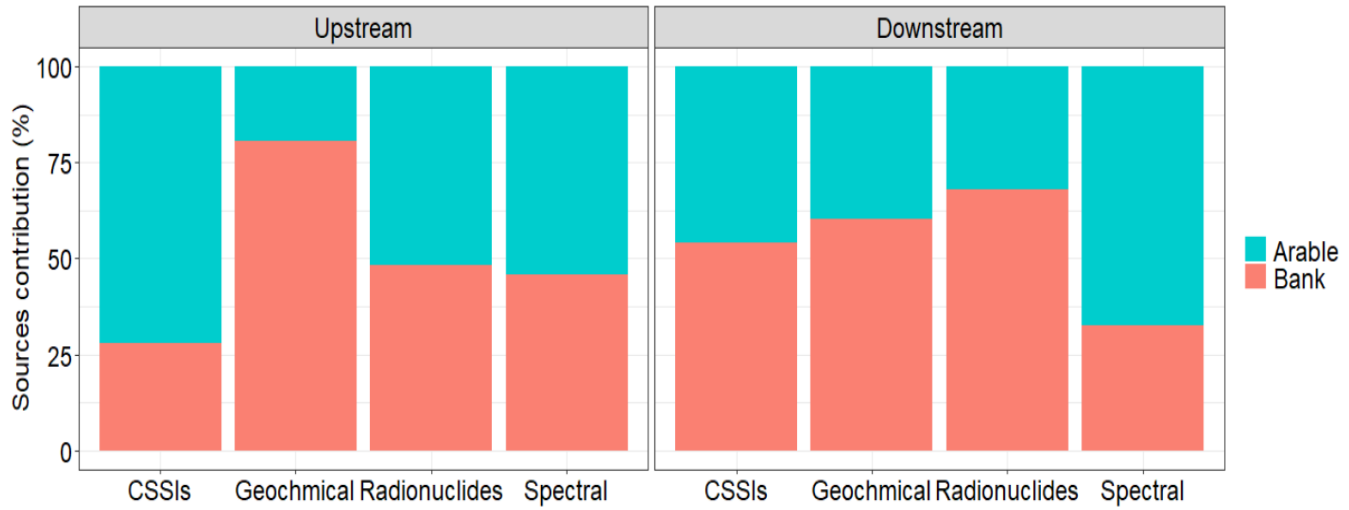
Characteristics	Geesgraben at Peseckendorf	Geesgraben midstream	Upstream
Area (km^2)	75	32	1
Major land use	Arable (86%)	Arable (82%)	Arable (100%)
Upland Erosion Rate ($t\ ha^{-1}\ yr^{-1}$)	0.001-10.1	0.002-8.5	0.29-3.1

Collins, A. L., Blackwell, M., Boeckx, P., Chivers, C. A., Emelko, M., Evrard, O., … Zhang, Y. (2020). Sediment source fingerprinting: benchmarking recent outputs, remaining challenges and emerging themes. *Journal of Soils and Sediments*, *20*(12), 4160–4193.

Surface and subsurface sources discrimination

Selection of tracers and mixing model

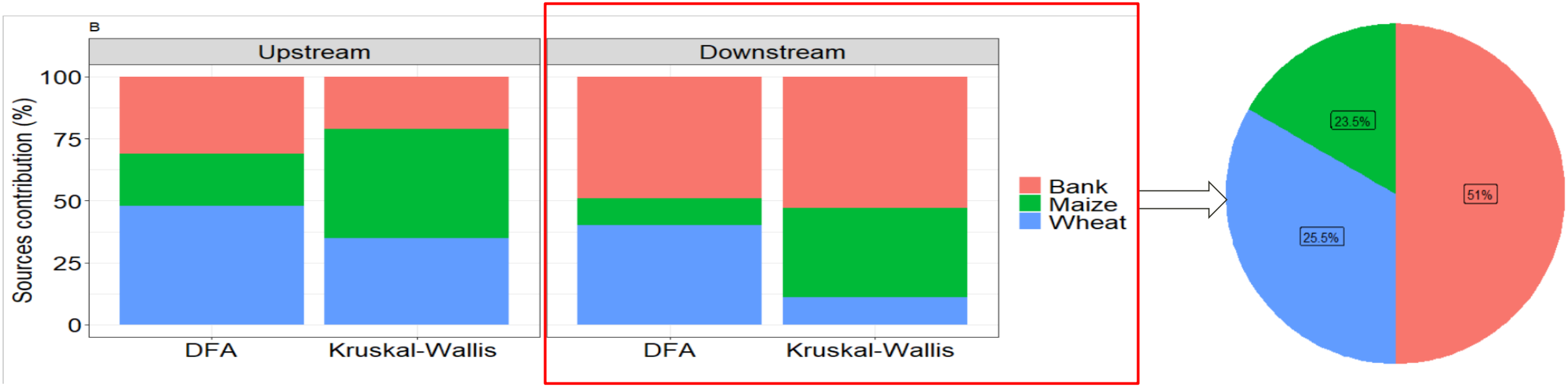
- ❑ Statistical analysis for tracers selection
- ❑ Selection of final set of fingerprinting properties
- ❑ Statistically un-mix relative contributions from sediment sources
- ❑ The applicability of CSSI δ^{13}C-fatty acids for specific land use types
- ❑ Linear multivariate mixing model



Sources contribution from surface and river banks

- The mean sediment contribution of bank erosion increase with increasing catchment size
- The sediment contribution using CSSIs are consistent and similar to other fingerprinting methods

Crop-specific soil loss from C3 and C4 vegetation



Sources contribution from C3 and C4 vegetation.

- Disentangle crop-specific soil loss such as C3 (wheat) and C4 (maize) vegetation
- The sediment contribution from C3 vegetation was relatively high at headwater catchment.
- The share of bank erosion source increases with increasing cacthment size

Conclusion

- CSSI is suitable for sediment fingerprinting at catchment scale.
- We showed that CSSI method allows to discriminate soil loss from C3 and C4 plants.
- CSSI tracers outcomes were consistent and similar to those of other fingerprinting properties.
- Share of stream bank contribution increases with increasing catchment size.
- Bank erosion may offer site-specific evidence that can be used to target bank restoration.