Use of soil organic biomarkers for tracing the origin of eroded sediment: case study in Petzenkirchen (Austria)

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Reducing soil erosion and sedimentation-related problems represents a key requirement for mitigating the impact of climate change in the agricultural areas of the European Union where water erosion risk is expected to increase by about 80% by the year 2050.

The compound-specific stable isotopes (CSSI) technique based on the measurement of $\delta^{13}C$ signatures of fatty acids (FAs) allows to identify sediment origin. The SWMCNL developed a novel application of this CSSI approach to investigate on-site sediment origins across small-scale cultivated fields (Mabit et al., 2018).

Based on the lesson learned from this study, research and development activities in using this technique have been initiated in collaboration with the Austrian Institute for Land and Water Management Research.

For this new investigation at the basin scale, the experimental and instrumented site of Petzenkirchen (Austria) was selected.

The aims of this new study were to:

o Use the CSSI technique based on most effective $\delta^{13}C$-FAs signatures to identify the various sediment sources;

o Evaluate the respective contribution of the connected sources to the sediment produced at the exit of the selected watershed.
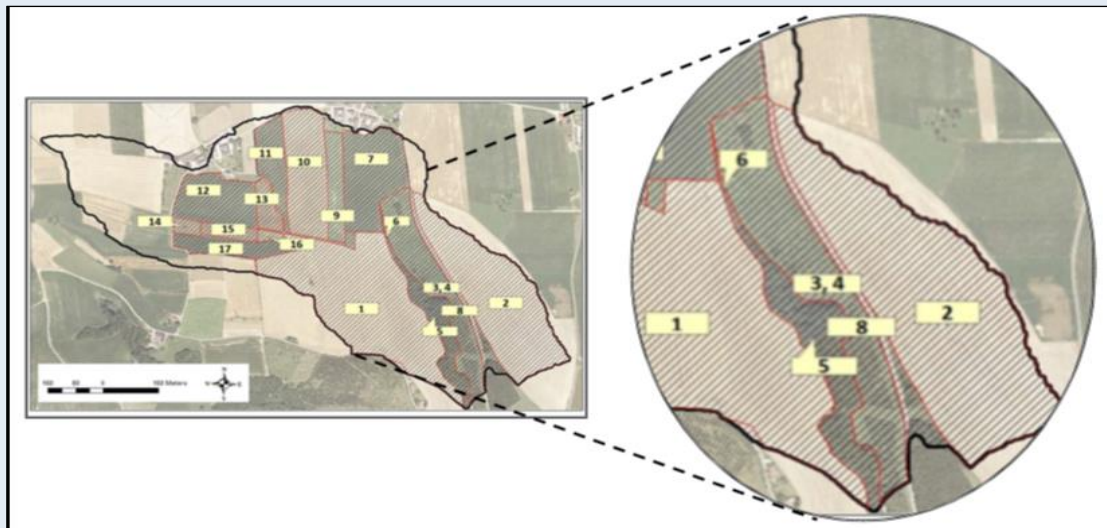
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- The Austrian watershed of Petzenkirchen (66 ha), located 100 km west from Vienna, was selected to establish the origin of the sediment produced at its outlet using δ^{13}C-FAs analysis.

- This watershed was and is still being studied for several agro-environmental purposes by different Austrian research institutions (Blöschl et al., 2016).

- The climatic conditions of the area are temperate with continental influences with a mean temperature of 9.5° C and yearly precipitation of 823 mm. The dominant soil types are Cambisols and Planosols.

- Based on existing land-use records, most of the agricultural fields are dominated by a rotation of winter wheat followed by maize cultivation.
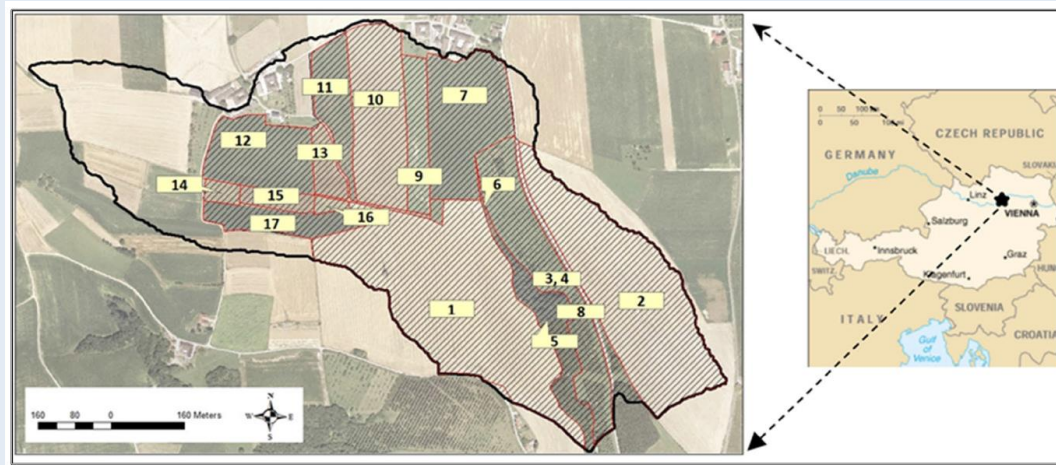
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- Considering the connectivity of the catchment the contributing area was set at around 50 ha.

- Following Mabit et al. (2018) the sampling strategy consisted of the collection of composite samples for each sediment source i.e. 17 *"agricultural sources"* (Falcao et al., 2018).

- Based on field history/drainage system, for data processing 10 sources grouped in one source S6.

- **Final system investigated with 7 Sources** [i.e. S6, 2 agricultural fields (S1 & S2), 2 forested areas (S3 & S8), pasture (S4), streambank (S5)].

- After pre-treatment at the SWMCNL, all collected samples were sent to NIWA in New Zealand for determination of δ^{13}C-FAs signatures.

Sampling of potential sediment sources within the Petzenkirchen watershed (on the left agricultural field sampling; on the right streambank sampling)

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- Using bi-plots, the $\delta^{13}C$ signature of saturated long chain FAs (i.e. C24:0 and C26:0) allowed the best discrimination for establishing the contribution of sources to the sediment collected at the exit of the Petzenkirchen watershed (i.e. the mixture).
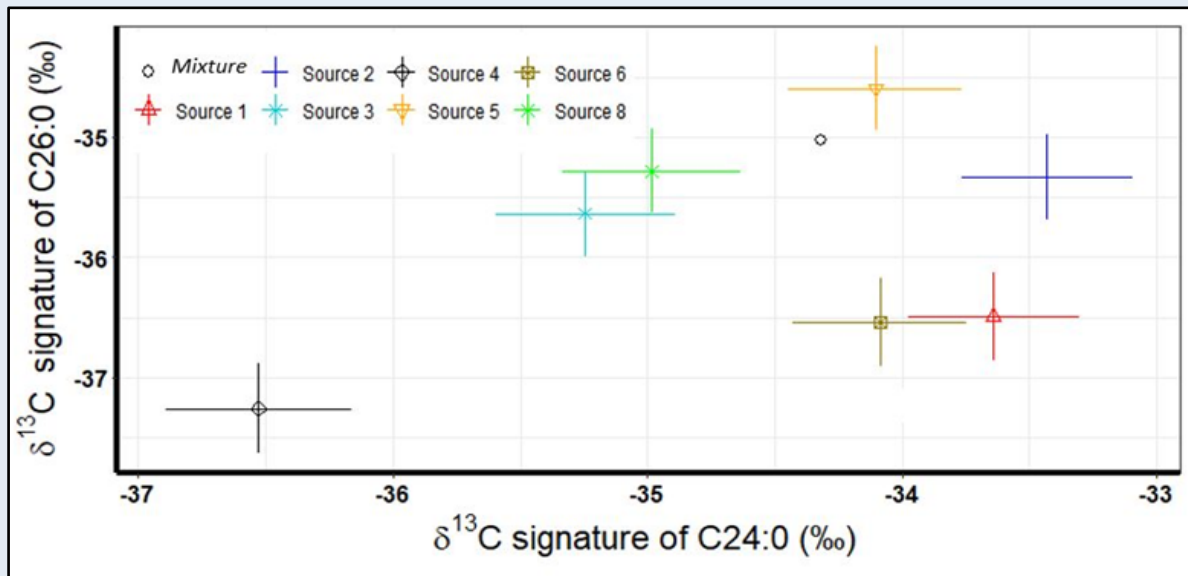

Bi-plots approach to select the best Fas
(From Mbaye et al., 2020)

- The relative contribution to the soil mixture of the different source soils identified has been determined using the Stable Isotope Mixing Models in R (SIMMR) and the organic carbon content of each source.

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	%C_{org} content	Mixing Model output (isotopic proportion)	% of the soil sources within the mixture (corrected values)
Source 1	1.89	5.1	6
Source 2	0.90	8.4	21
Source 3	2.51	6.6	6
Source 4	3.10	4.1	3
Source 5	2.15	51.7	55
Source 6	6.01	5.0	2
Source 8	2.80	8.4	7

Table 1. Contribution of the soil sources to the sediment mixture collected at the watershed outlet

Density distribution of source contribution to the mixture (corrected with %Corg)
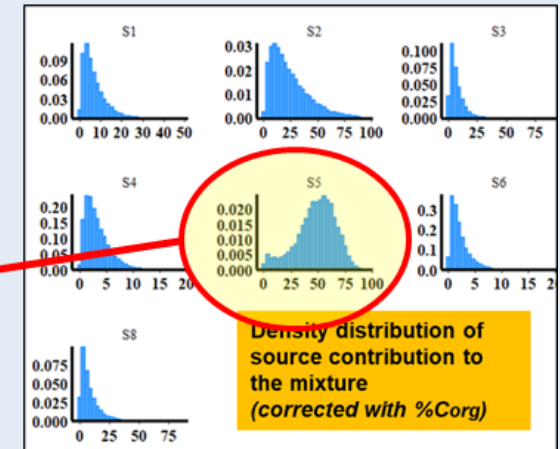
- The simulated results derived with SIMMR highlights that 55% of the sediment reaching the outlet of the watershed originates from stream bank *(See table/figure above adapted from Mbaye et al., 2020)*

- This provides a key information that can help for a better soil and water management of the watershed investigated

References

Blöschl, G. et al. (2016). The Hydrological Open-Air Laboratory (HOAL) in Petzenkirchen: a hypothesis-driven observatory. *Hydrology and Earth System Sciences*, 20, 227-255.

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