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GEMAS: CNS concentrations and C/N ratios in European agricultural soil

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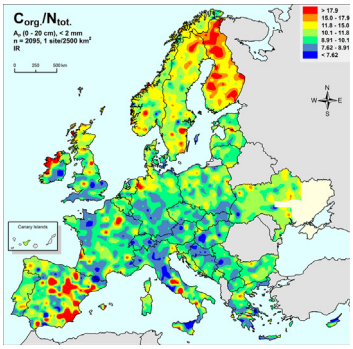
HIGHLIGHTS

- The distribution of total C, N and S, and TOC in European agricultural soil is presented.
- First complete dataset with extensive quality control at the European scale
- Continental-scale processes control regional TC, TN and TS and their distributions become visible.
- Soil status (TC, TN, TS) is dominated by natural drivers (geology, climate) at the continental scale.

GRAPHICAL ABSTRACT



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ABSTRACT

A reliable overview of measured concentrations of TC, TN and TS, TOC/TN ratios, and their regional distribution patterns in agricultural soil at the continental scale and based on measured data has been missing – despite much previous work on local and the European scales. Detection and mapping of natural (ambient) background element concentrations and variability in Europe was the focus of this work. While total C and S data had been presented in the GEMAS atlas already, this work delivers more precise (lower limit of determination) and fully quantitative data, and for the first time high-quality TN data. Samples were collected from the uppermost 20 cm of ploughed soil (A_p horizon) at 2108 sites with an even sampling density of one site per 2500 km^2 for

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one individual land-use class (agricultural) across Europe (33 countries). Laboratory-independent quality control from sampling to analysis guaranteed very good data reliability and accuracy. Total carbon concentrations ranged from 0.37 to 46.3 wt% (median: 2.20 wt%) and TOC from 0.40 to 46.0 wt% (median: 1.80 wt %). Total nitrogen ranged from 0.018 to 2.64 wt% (median: 0.169 wt%) and TS from 0.008 to 9.74 wt% (median: 0.034 wt%), all with large variations in most countries. The TOC/TN ratios ranged from 1.8 to 252 (median: 10.1), with the largest variation in Spain and the smallest in some eastern European countries. Distinct and repetitive patterns emerge at the European scale, reflecting mostly geogenic and longer-term climatic influence responsible for the spatial distribution of TC, TN and TS. Different processes become visible at the continental scale when examining TC, TN and TS concentrations in agricultural soil Europe-wide. This facilitates large-scale land-use management and allows specific areas (subregional to local) to be identified that may require more detailed research.

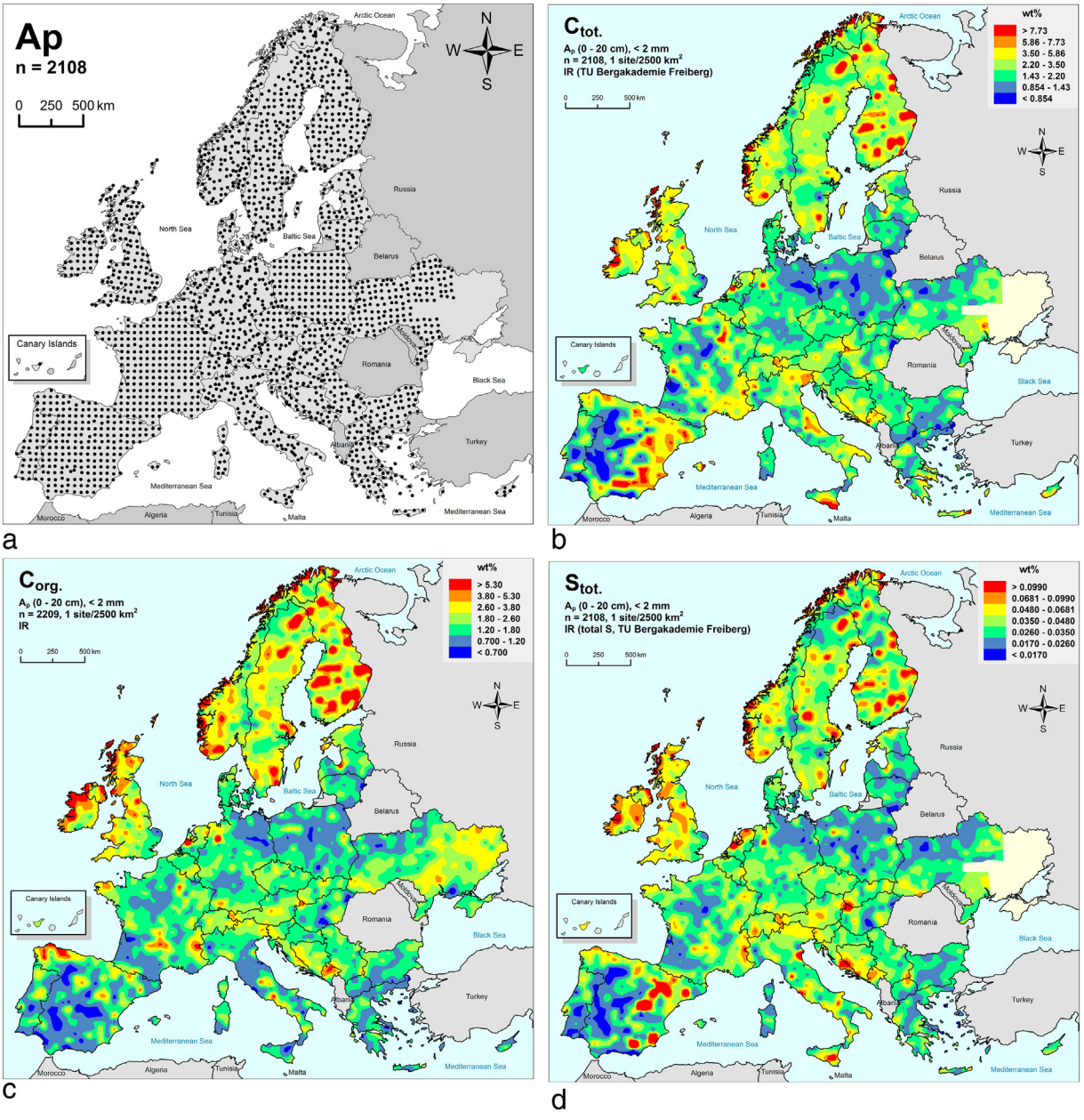

Fig. 1. a. Sampling sites for the GEMAS Ap materials. Each dot represents an individual site, where a composite sample was taken. **b**. Total carbon (C_{tot}) distribution across the European continent (kriging based). Concentrations (wt%) in Ap soil material (0–20 cm depth). **c**. Organic carbon (C_{org}) distribution across the European continent (kriging-based). Concentrations (wt%) in Ap soil material (0–20 cm depth). **d**. Total sulphur (S_{tot}) distribution across the European continent (kriging based). Concentrations in Ap soil material (0–20 cm depth).