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Implications of the field sampling procedure of the LUCAS Topsoil Survey for uncertainty in soil organic carbon concentrations.

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The LUCAS Topsoil survey is a pan-European Union initiative in which soil data were collected according to standard protocols from 19 967 sites. Any inference about soil variables is subject to uncertainty due to different sources of variability in the data. In this study we examine the likely magnitude of uncertainty due to the field-sampling protocol.

The published sampling protocol (LUCAS, 2009) describes a procedure to form a composite soil sample from aliquots collected to a depth of between approximately 15–20. A v-shaped hole to the target depth is cut with a spade, then a slice is cut from one of the exposed surfaces. This methodology gives rather less control of the sampling depth than protocols used in other soil and geochemical surveys, this may be a substantial source of variation in uncultivated soils with strong contrasts between an organic-rich A-horizon and an underlying B-horizon.

We extracted all representative profile descriptions from soil series recorded in the memoir of the 1:250 000-scale map of Northern England (Soil Survey of England and Wales, 1984) where the base of the A-horizon is less than 20 cm below the surface. The Soil Associations in which these 14 series are significant members cover approximately 17% of the area of Northern England, and are expected to be the mineral soils with the largest organic content. Soil Organic Carbon content and bulk density were extracted for the A- and B-horizons, along with the thickness of the horizons. Recorded bulk density, or prediction by a pedotransfer function, were also recorded.

For any proposed angle of the v-shaped hole, the proportions of A- and B-horizon in the resulting sample may be computed by trigonometry. From the bulk density and SOC concentration of the horizons, the SOC concentration of the sample can be computed. For each Soil Series we drew 1000 random samples from a trapezoidal distribution of angles, with uniform density over the range corresponding to depths 15–20 cm and zero density for angles corresponding to depths larger than 21 cm or less than 14 cm. We computed the corresponding variance of sample SOC contents.

We found that the variance in SOC determinations attributable to variation in sample depth for these uncultivated soils was of the same order of magnitude as the estimate of the subsampling + analytical variance component (both on a log scale) that we previously computed for soils in the UK (Rawlins et al., 2009). It seems unnecessary to accept this source of uncertainty, given the effort undertaken to reduce the analytical variation which is no larger (and often smaller) than this variation due to the field protocol. If pan-European soil monitoring is to be based on the LUCAS Topsoil survey, as suggested by an initial report, uncertainty could be reduced if the sampling depth was specified to a unique depth, rather than the current depth range.

LUCAS. 2009. Instructions for Surveyors. Technical reference document C-1: General implementation, Land Cover and Use, Water management, Soil, Transect, Photos. European Commission, Eurostat.

Rawlins, B.G., Scheib, A.J., Lark, R.M. & Lister, T.R. 2009. Sampling and analytical plus subsampling variance components for five soil indicators observed at regional scale. *European Journal of Soil Science* **60**, 740–747