Science for Environment Policy

Agricultural management practices influence copper concentrations in European topsoils

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1. The Land Use and Coverage Area frame Survey (LUCAS) is coordinated by the EU Statistics Office (EUROSTAT), and supported by the JRC for the soil component. See: https://esdac.jrc.ec.europa.eu/projects/lucas

2. Preventing and Remediating degradation of soils in Europe through Land Care (RECARE) was supported by the European Commission under the 7th Framework Programme. See: http://recare-project.eu/.

3. See: Ebden, M. (2008). Gaussian Processes for Regression: A quick Introduction: ftp://ftp.tuebingen.mpg.de/pub/ebio/chrisd/GPtutorial.pdf.

4. The data on copper distribution in European Union topsoils are available at European Soil Data Centre (ESDAC): https://esdac.jrc.ec.europa.eu/content/copper-distribution-topsoils.

Copper (Cu) is frequently used in underlined agricultural practices, particularly in fungicides, used extensively in the management of permanent crops, such as vineyards, olive groves, and fruit orchards — all crops of significant economic importance to the EU. An investigation into the factors influencing Cu distribution in the topsoils of 25 EU Member States has identified that, in conjunction with other factors such as topsoil properties, land cover, and climate, such agricultural management practices play a role in influencing Cu concentration. The analysis used 21 682 soil samples from the EU-funded Land Use and Coverage Area frame Survey (LUCAS)[1] and found that vineyards, olive groves, and orchards had the highest mean soil Cu concentrations of all land use categories. The findings highlight the major impact of land use and agricultural practices on soil Cu concentrations and emphasise a need for more sustainable land management practices.

Soil contamination poses a risk to both the environment and human health, and, therefore, represents a threat to the EU. Pollution by heavy metals in agricultural soils is a concern, as it has an adverse impact on food safety and security. Soil Cu concentration depends on complex interactions, notably involving the soil parent material and the physical and chemical properties of the soil; the anthropogenic factors are no less significant, however. In recent decades, Cu has been extensively used as a fungicide in agricultural management to combat mildew, especially in vineyards.

This study investigated the factors influencing Cu distribution in EU topsoils, and aimed to identify which areas of the EU may be most affected by Cu accumulation linked to human activity. The research was conducted under the EU-funded Preventing and Remediating degradation of soils in Europe through Land Care (RECARE)[2] project and used data from the above-mentioned LUCAS soil sampling from 25 EU Member States. A variety of statistical methods (Generalised Linear Models, regression analysis, Gaussian Process Regression[3] and kriging) were used to investigate the factors driving Cu distribution in EU soils, and to reveal the importance of topsoil properties, land cover, and climate in estimating Cu concentration, as well as to map Cu concentration in topsoils, to identify high Cu hotspots and to evidence the presence of outliers (any value that is numerically distant from most of the other data points in a set of data).

A number of factors had a combined effect on Cu soil concentrations: anthropogenic activities and the use of Cu as a fungicide; soil properties such as high pH; soil texture; humid and wet climatic conditions. The highest Cu concentrations were found in wet areas that experienced frequent fungicide treatments. Compared to the overall average Cu concentration of 16.85 milligrams per kilogram ($mg\ kg^{-1}$), vineyards had the highest mean soil Cu concentration ($49.26\ mg\ kg^{-1}$) of all land-use categories, followed by olive groves ($33.49\ mg\ kg^{-1}$) and fruit orchards ($27.32\ mg\ kg^{-1}$).

This study examined total Cu, rather than differentiating between Cu that is less easily extracted from the soil or more bioavailable, so it is hard to precisely assess the associated environmental and health risks. However, the overall findings indicate that land use and management are the major cause of soil Cu variation. Further, they suggest that, at least in some areas of the EU, Cu accumulation is also correlated to soil properties and environmental factors that influence soil Cu retention. From a policy perspective, the researchers identify areas that may be particularly vulnerable to Cu accumulation, such as regions of Italy and France that have a wet and humid climate and where fungicide treatment is exceptionally frequent in vineyards and orchards. Managing land sustainably, in a way that balances agricultural, environmental, and economic goals[4], would limit the environmental and health risks associated with high Cu concentration.

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