The Geochemical Soil Atlas of the Netherlands: a tool for environmental management and ecological risk assessment

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For environmental impact or risk assessment, knowing the total soil content of a potential harmful element is not enough. For example, questions about bioavailability, mobility, plant uptake, and leaching to groundwater of past and present diffuse contamination cannot be answered directly. Information about geochemical reactive soil contents and porewater concentrations are a prerequisite for providing the answers. It is therefore that the Geochemical Soil Atlas of the Netherlands not only provides maps of total element contents but also maps of the reactive and porewater leachable contents. Besides maps of the spatial distribution of 40 elements, the atlas contains cumulative frequency diagrams and scatter plots depicting the relation of these elements with clay mineral content (i.e. Al_2O_3). Clay mineral content can be used as proxy for trace element contents under pristine soil conditions, therefore the scatter plots may indicate enrichment, which can be related to past anthropogenic diffuse contamination

For the atlas, soil samples were taken at 358 locations from both the topsoil (0-20 cm) and the subsoil (usually the C horizon, approx. 100-120 cm). The locations were selected through a stratified simple random sampling design, in which lithology and geographical region were the stratifying criteria. The samples were analysed in the laboratory with X-ray fluorescence spectrometry, ICP-MS analysis after HF-based destruction (total concentration), ICP-MS and ICP-OES after a 0.43M HNO_3 extraction (reactive concentration), and ICP-MS after a 0.01 $CaCl_2$ extraction (porewater leachable).

The data underlying the Atlas is, for example, used to estimate the leaching of contaminants towards groundwater, both for soils containing enhanced element contents as a result of (past) diffuse contamination, as for scenarios that include effects of (future) soil management according to current soil legislation. Another example is the use of the reactive contents to assess the ecological risks of the diffuse soil contamination, showing that reactive contents are an improvement compared to the current used ‘near-total’ (aqua regia) contents.

The new information about soil chemistry in the Netherlands combined with new knowledge on soil processes is sparking new ideas for soil policy, soil management, and for setting soil guidelines. Some ideas are already in debate with policy makers to improve the legal guidelines for soil quality and management in the Netherlands. Knowing the impact of diffuse contamination, past and present, in relation to behaviour and speciation of geochemical elements, provides the fundamental knowledge to discuss sustainable soil- and groundwater policies.

At the conference we will show the Atlas in detail and give some examples of how such data can be used for soil policy, soil management and risk assessment. The Atlas is published as open access publication.

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