**Long-term monitoring of organic pollutants in soil: a conceptual approach to select chemicals potentially accumulating in soil**

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The Swiss Soil Monitoring Network NABO was set up in the mid-1980s to detect temporal changes of soil quality in the long-term. For that purpose, about 100 soil monitoring sites were defined across Switzerland covering various aspects. Soil samples are taken every five years according to standard operation protocols and stored in a soil archive. As a response to the political agenda in the 1980s, soil pollution by heavy metals and soil acidification were the main issues soil monitoring had to deal with. However, other soil threats, such as decline of organic matter, loss of biodiversity, or soil pollution through persistent organic compounds, moved into the focus of public and political perception recently. With regard to the huge number of organic chemicals released into the environment, soil monitoring is confronted with the challenge to select the substances relevant in terms of mass flux, potential to accumulate in soil, and toxicity to threaten soil quality in the long-term. Consequently, a conceptual approach is needed to define those organic chemicals that should be integrated with priority in soil monitoring.

In contrast to well defined analytical methods to detect inorganic soil pollutants, there is a wide variety of methods for organic chemicals, many of them applied in research studies, but not established as standard methods including quality assurance for monitoring purposes. The only exception in soil monitoring holds typically for PAH, PCB, and dioxins which are considered in soil legislation of some European countries. However, technological development in chemical analysis of organic soil pollutants improved remarkably in the last decade. Consequently, soil monitoring networks in Europe are able to integrate a larger array of organic soil pollutants with more diverse physicochemical properties using either samples from new sampling campaigns as well as archived soil samples. However, due to limited financial resources, infrastructure and manpower, it is of crucial importance to follow a transparent and well defined conceptual approach to select which organic chemicals need to be monitored.

We present a conceptual approach involving four stages:

1. Prediction: hypothesis regarding the environmental behaviour of pollutants; verification by measurements of selected soil samples; comparison of measured vs. expected concentrations.
2. Status survey: systematically applying the methodology used in (i) to a larger set of soils, e.g. Swiss monitoring sites.
3. Risk assessment: ecotoxicological interpretation of the concentrations found.
4. Monitoring: Substances and monitoring sites are selected given the findings in the previous stages.

Organic soil pollutants might enter the soil locally (on field scale) through the agricultural management (e.g. pesticides, herbicides, pharmaceuticals via animal manure) or through diffuse atmospheric deposition. Consequently, these two different pathways will be distinguished in our concept; the four stages mentioned above are applied separately to both. Two examples from the first stage will be provided: one for pesticides and one for diffuse (air) pollution. For the former, nearly thousands of active pesticide substances are registered in Switzerland. Based on long-term monitoring of agricultural soil management at some of the NABO sites (1985-2014) we identified about 250 chemical substances that were applied. Furthermore, a generic analytical method was developed to detect pesticides and transformation products in soils (Krauss & Keller 2010). Now status survey (stage ii) is in progress. For the case of diffuse pollution we identified about 18’000 chemical compounds that are registered in Switzerland (Scheringer et al. 2015). They are in use e.g. as humancare products, in the industry, or as biocides. Currently, a procedure is applied to identify organic chemicals that have a potential for accumulation in soil (stage i). First, databases with registered chemicals are processed, their chemical properties determined, and their fate in the environment is modelled. Subsequently, suitable soil monitoring sites are selected and a target screening and suspect-screening of selected soil samples is conducted (Chiaia-Hernandez et al. 2015).

References

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