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Review

Soil monitoring in Europe: A review of existing systems and requirements for harmonisation

X. Morvan[a,b,*], N.P.A. Saby[a], D. Arrouays[a], C. Le Bas[a], R.J.A. Jones[c], F.G.A. Verheijen[c], P.H. Bellamy[c], M. Stephens[c], M.G. Kibblewhite[c]

[a]INRA Orleans, Infosol Unit, US 1106, BP 20619, 45166 OLIVET Cedex, France
[b]University of Reims Champagne-Ardennes, Gegena Laboratory, EA3795, 51100 REIMS, France
[c]Cranfield University, Cranfield, Bedfordshire, MK43 0AL, United Kingdom

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ABSTRACT

Official frameworks for soil monitoring exist in most member states of the European Union. However, the uniformity of methodologies and the scope of actual monitoring are variable between national systems. This review identifies the differences between existing systems, and describes options for harmonising soil monitoring in the Member States and some neighbouring countries of the European Union. The present geographical coverage is uneven between and within countries. In general, national and regional networks are much denser in northern and eastern regions than in southern Europe. The median coverage in the 50 km × 50 km EMEP cells applied all over the European Union, is 300 km^2 for one monitoring site. Achieving such minimum density for the European Union would require 4100 new sites, mainly located in southern countries (Italy, Spain, Greece), parts of Poland, Germany, the Baltic countries, Norway, Finland and France. Options are discussed for harmonisation of site density, considering various risk area and soil quality indicator requirements.

Contents

* *Corresponding author*. INRA Orléans, Unité Infosol, avenue de la pomme de pin, BP 20619, 45166 OLIVET Cedex, France. Tel.: +33 2 38 41 48 02; fax: +33 2 38 41 78 69.
E-mail address: xavier.morvan@orleans.inra.fr (X. Morvan).

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1. Introduction

Soil is a vital non-renewable resource providing essential support to ecosystems and to human life and society. Soils deliver valuable ecosystem goods and services (De Groot et al., 2002), e.g. nutrient release from soil organic matter; water storage and transfer (Lavelle and Spain, 2001); water filtering (Morvan et al., 2006, Weber and Miller, 1989); food security (Carvalho, 2006), cultural heritage, etc. Therefore, it is imperative to the environment and society that soil functions (Blum, 1993) and their quality are maintained. A proposal has been made for establishing a directive of the European Commission for a common strategy for the protection and sustainable use of soil (European Commission, 2006a).

Soil monitoring is the systematic determination of soil variables so as to record their temporal and spatial changes (FAO/ECE, 1994). Soil monitoring is essential for the early detection of changes in soil quality. Such early detection enables the design and implementation of policy measures to protect and maintain the sustainable use of soil so that it continues to deliver ecosystem goods and services. A Soil Monitoring Network (SMN) is defined here as a set of sites/areas where changes in soil characteristics are documented through periodic assessment of an extended set of soil parameters. The use of a harmonised methodology is essential to provide data which is comparable among sites and between countries. In this paper, we focus mainly on classical soil analytical measurements. It is appreciated that other approaches have been proposed, such as the use of 'proxy' indicators easily detectable by surveyors in the field. A typical example is the Land Use Land Cover Annual Survey (LUCAS) that includes some direct field observations on more than 1,000,000 observation points over Europe. However, the results from such surveys are crucially dependent on the expertise of the field surveyors and the harmonisation of the results.

The Communication of the European Commission 'Towards a Thematic Strategy for Soil Protection' identifies eight threats to Europe's soils (European Commission, 2002, 2006a,b; Van-Camp et al., 2004): soil erosion, decline in soil organic matter, soil contamination, soil sealing, soil compaction, decline in soil biodiversity, soil salinisation and landslides. We also considered desertification as a threat to soil in our study. Relevant measurable indicators of the threats to soil have been proposed (Table 1, after Huber et al., 2007).

The objective of this paper is to review existing SMNs in the Member States of the European Union (EU) and Norway, and to identify and describe options for harmonising soil monitoring in these countries. Therefore, in this paper, the soil monitoring network in Switzerland is not taken into account, although it is known to exist (Schmid et al., 2005; Bucheli et al., 2004). Considering the need to produce comparable and consistent results between countries, it is important that differences among EU SMNs are highlighted and that ways of overcoming them are identified. Using these data, we studied the representativeness of the spatial coverage of the monitoring sites in Europe. Using data on the extent of some environmental pressures which are relevant to soil threats and measured within the SMNs, we also studied the representativeness of the spatial coverage of sites in relation to these pressures.

Table 1 – Soil threats and their selected indicators

Soil threats	Main relevant indicators for SMN
Soil erosion	Estimated soil loss
	Measured soil loss
Decline of soil organic matter	Organic matter or organic carbon content
	Bulk density
	C:N ratio
Soil contamination	Heavy metal content
	pH
	Nutrients content
Soil sealing	*Not relevant for SMN*
Soil compaction	Bulk density
	Organic matter content
	Particle size distribution
	Soil water retention
	Saturated hydraulic conductivity
	Observation of soil structure
Decline of soil biodiversity	Earthworm diversity
	Collembola diversity
	Microbial respiration
Soil salinisation	Salt profile
	Electrical conductivity
	Exchangeable sodium percentage
Landslides	*Not relevant for SMN*
Desertification	Organic matter content
	Salt content
	Electrical conductivity