Science of the Total Environment xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Assessing soil biodiversity potentials in Europe

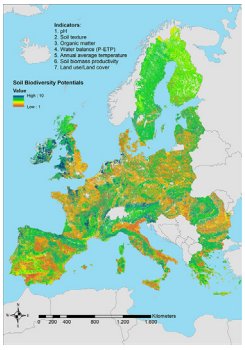
Ece Aksoy [a,*], Geertrui Louwagie [b], Ciro Gardi [c], Mirko Gregor [d], Christoph Schröder [a], Manuel Löhnertz [d]

[a] European Topic Centre on Urban, Land and Soil systems (ETC/ULS), University of Malaga, Malaga, Spain
[b] European Environment Agency (EEA), Copenhagen, Denmark
[c] European Food Safety Authority (EFSA), Italy
[d] ETC/ULS, Space4environment, Niederanven, Luxembourg

HIGHLIGHTS

- The overall potentials for soil biodiversity throughout Europe is assessed and mapped
- Some indicators that might affect the conditions of soils are used with thresholds
- Close to half of European soils (47%) has an average soil biodiversity potential
- The highest potentials in soil biodiversity levels found in pastures and grasslands
- Ireland, Slovenia and Sweden has the highest soil biodiversity potentials

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 9 December 2016
Received in revised form 20 February 2017
Accepted 21 February 2017
Available online xxxx

Editor: D. Barcelo

Keywords:
Soil functions
Biodiversity pool
Mapping
Earthworms
Biological activity
Environmental variables

ABSTRACT

Soil is important as a critical component for the functioning of terrestrial ecosystems. The largest part of the terrestrial biodiversity relies, directly or indirectly, on soil. Furthermore, soil itself is habitat to a great diversity of organisms. The suitability of soil to host such a diversity is strongly related to its physico-chemical features and environmental properties. However, due to the complexity of both soil and biodiversity, it is difficult to identify a clear and unambiguous relationship between environmental parameters and soil biota. Nevertheless, the increasing diffusion of a more integrated view of ecosystems, and in particular the development of the concept of ecosystem services, highlights the need for a better comprehension of the role played by soils in offering these services, including the habitat provision. An assessment of the capability of soils to host biodiversity would contribute to evaluate the quality of soils in order to help policy makers with the development of appropriate and sustainable management actions. However, so far, the heterogeneity of soils has been a barrier to the production of a large-scale framework that directly links soil features to organisms living within it. The current knowledge on the effects of soil physico-chemical properties on biota and the available data at continental scale open the way towards such an evaluation. In this study, the soil habitat potential for biodiversity was assessed and mapped for the first time throughout Europe by combining several soil features (pH, soil texture and soil organic matter) with environmental parameters (potential evapotranspiration, average temperature, soil biomass productivity and land use type). Considering the increasingly recognized importance of soils and their biodiversity in providing ecosystem services, the proposed approach appears to be a promising tool that may contribute to open a forum on the need to include soils in future environmental policy making decisions.

© 2017 Elsevier B.V. All rights reserved.

* Corresponding author.
E-mail addresses: Ece.aksoy@uma.es (E. Aksoy), ciro.gardi@efsa.europa.eu (C. Gardi), gregor@space4environment.com (M. Gregor), Christoph.schroder@uma.es (C. Schröder), loehnertz@space4environment.com (M. Löhnertz).

http://dx.doi.org/10.1016/j.scitotenv.2017.02.173
0048-9697/© 2017 Elsevier B.V. All rights reserved.

Please cite this article as: Aksoy, E., et al., Assessing soil biodiversity potentials in Europe, Sci Total Environ (2017), http://dx.doi.org/10.1016/j.scitotenv.2017.02.173

1. Introduction

Soil is one of the most diverse habitats on earth and contains the most diverse assemblages of living organisms. Soils are home to over one fourth of all living species on earth, and one teaspoon of garden soil (about one gram) may typically contain one billion bacterial cells (corresponding to about ten thousand different bacterial genomes), up to one million individual fungi, about one million cells of protists, and several hundreds of nematodes (EU, 2010). Therefore, soils are a key reservoir of global biodiversity, which ranges from micro-organisms to flora and fauna (FAO, 2015).

Soil biodiversity refers to all organisms living in the soil. Turbé et al. (2010) defines it as "the variation in soil life, from genes to communities, and the ecological complexes of which they are part, that is from soil micro-habitats to landscapes". The biodiversity of a soil is vital as it is the engine driving soil-based ecosystem services such as food production, nutrient cycling, carbon sequestration, soil formation, decontamination and bioremediation of pollutants, control of pest outbreaks and water purification (Turbé et al., 2010). Soil biodiversity should also be considered as a guardian of food security and ecosystem services in the face of climate change because of its "considerably more complex and thus more resistant structure to change than aboveground organisms (Veresoglu et al., 2015)".

Even though no legislation or regulation exists that specifically targets soil biodiversity, the European Commission acknowledged the importance of soil biodiversity in the role of ecosystem functioning, stating that "these functions are worthy of protection because of their socio-economic as well as environmental importance" (Stone et al., 2016). Further, "biodiversity pool, such as habitats, species and genes" soil function is mentioned in the UN "Sustainable Development Goals (SDGs)" for the period 2015–2030 by relating the topics "ensure healthy lives and promote well-being for all at all ages" and "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (Keesstra et al., 2016). FAO also recognises the fundamental role of soil biodiversity in supporting and safeguarding soil functions and soil ecosystem goods and services in principle 8 of the revised World Soil Charter (FAO, 2015). Moreover, the decline in soil biodiversity is identified as one of the 8 main soil threats in the Thematic Strategy for Soil Protection (COM (2006) 231). The threat is considered as the reduction of forms of life living in soils, both in terms of quantity and variety (Jones et al., 2005) and of related soil functions (Huber et al., 2008). Whenever soil biodiversity decline occurs, it can significantly affect the soils' ability to normally function, respond to perturbation and recover. Decline in soil biodiversity is usually related to other deteriorations in soil quality and can be linked with other threats like erosion, organic matter depletion, salinization, contamination and compaction (Stolte et al., 2016). Soil biodiversity assessment and biological monitoring is required to correctly assess soil degradation and correlated risks and also soil quality (Menta, 2012).

Despite its importance in global ecosystem functioning, the sustainability of agriculture, and the high value of the numerous ecosystem services that it provides, soil biodiversity has often been overlooked in global assessment and mapping studies (Constanza et al., 1997; Pimentel et al., 1997; Gardi et al., 2013). This has occurred for various reasons, including the fact that the soil biota is usually hidden from view and so suffers from being 'out of sight and so out of mind' (Jeffery and Gardi, 2010). Furthermore, there is a lack of soil biodiversity data at different scales (from field scale up to regional scales and beyond) and the lack of awareness of the value of soil biodiversity. Therefore, the spatial assessment of the potential of soils to serve as a biodiversity pool across Europe, which is the main goal of this study, is very important.

1.1. Threats to soil biodiversity

This connection of soil biodiversity with other soil degradation processes was already recognized by Turbé et al. (2010) who describe the main threats to soil biodiversity as soil degradation, land use management and human practices, climate change, chemical pollution as well as genetically modified organisms (GMOs), and invasive species. Gardi et al. (2013) and Orgiazzi et al. (2016) added or further specified habitat fragmentation, intensive human exploitation, soil organic matter decline, soil compaction, soil erosion, soil sealing, and soil salinization as important threats.

To mitigate the threats to soil biodiversity; the development of indicators and establishment of monitoring schemes to track soil biodiversity (Stone et al., 2016), as well as reaching adequate levels of knowledge by assessing spatial and temporal (Menta, 2012) distribution of soil biodiversity potential along with threats to soil biodiversity are considered important solutions. At the same time, assessing soil biodiversity potentials is also a helpful tool for building monitoring schemes for soil biodiversity, as such assessments highlight regions with high and low potentials, giving an indication where monitoring stations may be most appropriate.

1.2. Soil biodiversity data for mapping purposes

Although there are several studies on assessing soil properties (e.g. LUCAS topsoil survey (Toth et al., 2013), Global gridded soil information; SoilGrids (Hengl et al., 2014), SOC distribution with combined dataset (LUCAS, BioSoil and CZOs) (Aksoy et al., 2016)) and soil threats (erosion (Panagos et al., 2015), compaction, pollution, desertification, etc.) at European level, indicators related to (the decline of) soil biodiversity are measured very rarely at an appropriate scale or resolution (Morvan et al., 2008).

The general state of soil biodiversity is well described in the European Atlas of Soil Biodiversity (Jeffery et al., 2010) with the contribution of the distribution maps of soil faunal groups (e.g. Tardigrades, Rotifers, Nematodes, etc.) of Europe, which show the estimated number of species per biogeographic areas or countries in NUTS-0 level.

Rutgers et al. (2016) have recently published the map of earthworm communities in Europe where earthworm data were collected and harmonized for the Netherlands, Germany, Ireland, Northern Ireland, Scotland, France, Slovenia, Denmark and small part of Spain. Griffiths et al. (2016) recently published a study on predicting and mapping soil bacterial biodiversity using European and national scale data sets using geostatistical methods.

Further, there are a number of national surveys which include soil biodiversity, such as in the Netherlands (BISQ; Rutgers et al., 2009), France (RMQS; Cluzeau et al., 2009), the UK (Countryside survey; Black et al., 2003), and Germany (BDF; Römbke et al., 2013) (Breure, 2004; Stone et al., 2016). Some EU projects have equally looked into monitoring schemes for soil biodiversity over the last 20 years (ENVASSO - Kibblewhite et al., 2008; Bispo et al., 2009; EcoFINDERS -Stone et al., 2016; BioSoil - Hiederer et al., 2011).

Despite the availability of these studies, Tsiafouli et al. (2015) highlight the lack of an integrative approach, with many of the above studies focussing on only one aspect of soil biodiversity (e.g. species richness, abundance, food webs, community structure), promoting the need for more multi-factorial approaches. Similarly, a map reflecting the spatial distribution of the potential of soils to serve as a biodiversity pool across Europe, synthesising information across soil biota, has not been generated until now. Therefore, the main objective of this study is assessing and mapping the overall potentials for soil biodiversity in Europe based on available variables.

1.3. Driving factors

Soil is a challenging habitat and finding clear and unambiguous relationships between soil characteristics and the overall soil biodiversity is very difficult. However, as a rule of thumb it can be considered that soil biodiversity will increase with increasing variability of the micro-

Please cite this article as: Aksoy, E., et al., Assessing soil biodiversity potentials in Europe, Sci Total Environ (2017), http://dx.doi.org/10.1016/j.scitotenv.2017.02.173

Download English Version:

https://daneshyari.com/en/article/5751549

Download Persian Version:

https://daneshyari.com/article/5751549

Daneshyari.com