Geophysical Research Abstracts
Vol. 17, EGU2015-7068-1, 2015
EGU General Assembly 2015

Soil functional types: surveying the biophysical dimensions of soil security

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Soil is a natural capital that can deliver key ecosystem services (ES) to humans through the realization of a series of soil processes controlling ecosystem functioning. Soil is also a diverse and endangered natural resource. A huge pedodiversity has been described at all scales, which is strongly altered by global change.

The multidimensional concept soil security, encompassing biophysical, economic, social, policy and legal frameworks of soils has recently been proposed, recognizing the role of soils in global environmental sustainability challenges. The biophysical dimensions of soil security focus on the functionality of a given soil that can be viewed as the combination of its capability and its condition [1]. Indeed, all soils are not equal in term of functionality. They show different processes, provide different ES to humans and respond specifically to global change. Knowledge of soil functionality in space and time is thus a crucial step towards the achievement soil security. All soil classification systems incorporate some functional information, but soil taxonomy alone cannot fully describe the functioning, limitations, resistance and resilience of soils. Droogers and Bouma [2] introduced functional variants (phenoforms) for each soil type (genoform) so as to fit more closely to soil functionality. However, different genoforms can have the same functionality. As stated by McBratney and colleagues [1], there is a great need of an agreed methodology for defining the reference state of soil functionality.

Here, we propose soil functional types (SFT) as a relevant classification system for the biophysical dimensions of soil security. Following the definition of plant functional types widely used in ecology, we define a soil functional type as "a set of soil taxons or phenoforms sharing similar processes (e.g. soil respiration), similar effects on ecosystem functioning (e.g. primary productivity) and similar responses to global change (land-use, management or climate) for a particular soil-provided ecosystem service (e.g. climate regulation)". One SFT can thus include several soil types having the same functionality for a particular soil-provided ES. Another consequence is that SFT maps for two different ES may not superimpose over the same area, since some soils may fall in the same SFT for a service and in different SFT for another one.

Soil functional types could be assessed and monitored in space and time by a combination of soil functional traits that correspond to inherent and manageable properties of soils. Their metrology would involve either classic (pedological observations) or advanced (molecular ecology, spectrometry, geophysics) tools. SFT could be studied and mapped at all scales, depending on the purpose of the soil security assessment (e.g. global climate modeling, land planning and management, biodiversity conservation).

Overall, research is needed to find a pathway from soil pedological maps to SFT maps which would yield important benefits towards the assessment and monitoring of soil security. Indeed, this methodology would allow (i) reducing the spatial uncertainty on the assessment of ES; (ii) identifying and mapping multifunctional soils, which may be the most important soil resource to preserve.

References

[1] McBratney et al., 2014. Geoderma 213:203-213.
[2] Droogers P, Bouma J, 1997. SSSAJ 61:1704-1710.