

The upsurge of soil science and the new global soil map

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Abstract

There has been widespread pessimism on the status of soil science in most parts of the world. This was mainly due to dwindling research budgets, reduced number of students and the perception that soil science and pedology were dead and buried. Climate change, water scarcity, environmental degradation, increased agriculture production for food, feed and fuel have all brought soils back onto the global research agenda. These key issues brought up in many recent reports by UN and other international organizations. There is increased interest for soils in the popular press and media, and soils have entered the policy arena. For the global soil science community, there are challenges ahead and there is a direct need to educate a new generation of soil scientists. Knowledge of the world soil resources is fragmented and dated and in order to respond to the current requests there is a need for accurate, up-to-date and spatially referenced soil information. This need coincides with an enormous leap in technologies that allow for accurately collecting and predicting soil properties. We are working on a new digital soil map of the world using state-of-the-art and emerging technologies for soil mapping and predicting soil properties.

Introduction

Soil science has changed dramatically in the past decades. In the 1970s, soil science became linked to wider environmental aspects. Research shifted to a whole range of new subjects including, for example, soil pollution, eutrophication and ground water contamination. After the Bruntland report of 1987 on 'Our Common Future' and the 'Earth Summit' in Rio de Janeiro in 1992, there has been a wide debate on the issue of sustainability, particularly in relation to soils, land and agriculture. With the increased perception and quantification of soil degradation in the tropics, came the call for the design and study of sustainable land management systems. The reports on "Our common future" (Bruntland, 1987) and Agenda 21 of the Rio declaration on sustainability were politically influential, but had no major impact on soil science funding and research capacity.

Climate change and soils came on to the global agenda in the 1990s and especially after the Kyoto protocol from 1997. Much research has been geared towards carbon stocks and the relation between climate change and food production (Sanchez, 2000). Currently, there is new concern about feeding the world and the land needed for energy (biofuels), food (hunger alleviation, increased demand) and feed (increased animal production).

The environmental and soil impact of the shift towards growing crops for energy or increased food production is not known but it is widely realised that global soil information is not accurate or digitally available, and, certainly not up-to-date. Other important themes that are currently on the agenda include biodiversity, water scarcity and carbon accounting (Hartemink and McBratney, 2008). This paper briefly summarises the upsurge in soil science and a global response to increased need for accurate and up-to-date soil information.

The upsurge

There are many reports from UN and other international organisations (e.g. IPCC and various conventions) in which the need for studying soils and the provision of adequate soil information is emphasised. In September 2000 world leaders adopted the United Nations Millennium Declaration which set out the Millennium Development Goals (MDGs). In the MDG reports a range of recommendations on soil health are made and the links between poverty, unhealthy people, unhealthy soils and poor soil management are reinforced in the MDG approach.

Since 1990 UNDP has published an annual Human Development Report to measure and analyze developmental progress. There was no mention of soil until the 2000 Human Development Report and in 2003 soils were referred to in only several parts of the report, mostly in relation to nutrient depletion and soil degradation. In successive reports, issues like land rights (2004) and indigenous soil knowledge (2006) were brought up. The most recent report focuses on climate change and soils are referred to in terms of acting as sinks and sources of greenhouse gases. There is also mention of soil erosion and soil fertility decline and its impact on food production. Soils have now also entered the UNDP reports, and these are widely used by decision and policy makers.

Soils have also entered the policy arena and in several countries and continents soil legislation is being developed. The largest effort to effectively bring tools for soil legislation has been in the EU through its Soil Thematic Strategy, and more recently in the USA through the adoption of a Resolution in the US Senate. Environmental policies in Europe started in the 1970s. These strategies included air quality, marine environment, sustainable use of resources, waste prevention and recycling, pesticides, the urban environment, and soil quality. The thematic strategy on the protection of

soil was started in 2002 and adopted by the European Commission in September 2006. The strategy is aiming to give soil the same importance as air and water; it sets out a roadmap to address soil degradation by preserving and restoring soil and its functions.

The current attention and upsurge in soil science could lead to a fruitful and highly productive new era. The link with real-world issues (climate change, food production and hunger alleviation, environmental degradation) is essential as is the development of fundamental research (Bouma, 2001). Now the importance of soils is recognised, action is needed and is already been taken at some fronts. There are many novel techniques and methods available for soil scientists and there is a range of software and hardware that needs exploring and further development, including digital soil mapping. Such techniques have exceptional promise when combined with the demand for accurate and up-to-date soil information (McBratney et al., 2006). Another sign of the current vigour of soil science is its steady increase in publications with increased impact (Minasny et al., 2007) and the relatively large number of job vacancies, a consequence both of a retiring generation of soil scientists and various new projects.

The new global soil map of the world

We are working on a new digital soil map of the world using state-of-the-art and emerging technologies for soil mapping and predicting soil properties. The aim is to map the global land surface in 5 years – the resulting maps will depict the primary functional soil properties at a grid resolution of 90×90 m. The name of the project is *GlobalSoilMap.net*. It is being developed to provide primary soil data in a form that will meet the demands of a broad range of users including governments, natural resource managers, educational institutions, planners, researchers and agriculturalists. The online system will provide access to the best available soil and land resource information in a consistent format across the globe – the level of detail and reliability will depend on the survey coverage and field data available in each region. A priority will be to provide the global scientific community with soil information in form that can be readily used for modelling and evaluation studies (e.g. options for climate adaptation, carbon dynamics, potential food production) (Sanchez et al., 2009).

GlobalSoilMap.net will provide access to fine grain data on a consistent set of soil functional properties that define soil depth, water storage, permeability, fertility, and carbon. Users may want to simply view and manipulate the data online (e.g. compare the soil patterns with satellite imagery or maps of land use). They may then compose and print local maps by combining several sources of online data (e.g. soil, climate, terrain and infrastructure). More sophisticated users may have portable computers with online geographic information systems that give field investigators access to useful information for their work. High-end users may take the outputs from *GlobalSoilMap.net* and supply them as inputs to sophisticated computer models for estimating food production or carbon dynamics.

GlobalSoilMap.net will provide users with an estimate of the uncertainty of each attribute for each grid cell. In the longer term, new sources of data will feed automatically into *GlobalSoilMap.net* and the uncertainties for attributes will decrease. While the information on uncertainty provides useful qualitative advice to a user, the real benefit will be for scientists, engineers and planners who need to translate their analyses of food security, impacts of climate change and so forth, into assessments of risk for decision makers. The final results may be expressed in a relatively simple form (e.g. the farming districts of Region A will fail to produce sufficient grain for local communities in 1 year out of 5) but the underlying computations will have been sophisticated.

The *GlobalSoilMap.net* project has started well with excellent support from key funders (e.g. Bill and Melinda Gates Foundation, lead agencies for each Node). However, significant new funds are needed to ensure the project can help rectify years of under-investment in one of our most fundamental resources for life on Earth – the soil. This need is greatest in South America, North Africa, East Asia and Oceania.

References

- Bouma, J. 2001. The role of soil science in the land use negotiation process. *Soil Use & Management* 17:1-6.
- Bruntland, G.H. 1987. Our common future. World commission on environment and development Oxford University Press, Oxford.
- Hartemink, A.E., and A.B. McBratney. 2008. A soil science renaissance. *Geoderma* (in the press).
- McBratney, A.B., B. Minasny, and R. Viscarra Rossel. 2006. Spectral soil analysis and inference systems: A powerful combination for solving the soil data crisis. *Geoderma* 136:272-278.
- Minasny, B., A.E. Hartemink, and A. McBratney. 2007. Soil science and the *h* index. *Scientometrics* 73:257-264.
- Sanchez, P.A. 2000. Linking climate change research with food security and poverty reduction in the tropics. *Agriculture Ecosystems & Environment* 82:371-383.
- Sanchez, P.A., S. Ahamed, F. Carre, A.E. Hartemink, J. Hempel, J. Huising, P. Lagacherie, A.B. McBratney, N.J. McKenzie, M.D. Mendonca-Santos, B. Minasny, L. Montanarella, P. Okoth, C.A. Palm, J.D. Sachs, K.D. Shepherd, T.G. Vagen, B. Vanlauwe, M.G. Walsh, L.A. Winowiecki, and G.L. Zhang. 2009. Digital Soil Map of the World. *Science* 325:680-681.