Need for interpreted soil information for policy making

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Abstract
There is a wealth of soil data being collected at all scales: local, national, regional and global. Most of these data turn out to be of little use for the increasing need by policy makers for updated soil information. New emerging policy areas are demanding detailed, updated and policy relevant soil information that can underpin the decision making process. These needs are not only present at local and national level, but are increasingly present at global scales. Global multilateral environmental agreements, like the climate change convention, the biodiversity convention and the desertification convention, are increasingly putting soils at the centre of their negotiations. Therefore policy relevant global soil information becomes increasingly demanded and is still largely based on obsolete data collected more then 50 years ago. New digital soil mapping technologies allow now developing a completely new high-resolution soil database for the globe that will form the basis for future global soil protection strategies and policymaking.

Key Words
Digital soil mapping, soil information, policymaking, sustainable development, climate change.

Introduction
Over the past 100 years a major shift in policy priorities related to soil science has been observed: From an early phase of exclusive focus of soil protection policies on the agricultural function of soils, there has been a rapid change in recent years towards a more comprehensive approach to soil related policies addressing the full multi-functionality of the natural soil cover. This old mono-functional view on soils was as well reflected in the early days of soil science (agro-geology), with a nearly exclusive focus on soils as agricultural substrate.
In recent years soil policies are more and more addressing aspects related to climate change, environmental protection, health and food security/safety, civil protection, renewable energies, raw materials, cultural heritage, biodiversity and spatial planning. This dramatic shift in policy relevance of soils has not been followed by an equivalent re-adjustment of the research priorities by the soil science community, with a growing gap between the academic soil science community and the policy making process. Bridging this gap between soil science and soil related policies will be one of the major challenges for the next years. Emerging priority topics, like the role of soils within climate change, will need a focused research effort in order to provide the urgently needed scientific background to the next phase of the climate change convention. Other important policy areas will as well require extended scientific data and information for their development.
Policy relevant soil data and information are needed at all scales, from local to global, and should to be easily interpretable by policy makers for decision making in relation to soils.
Currently available soil data are often obsolete, not documented by proper metadata and largely totally irrelevant for the needs of the policy makers. There is therefore the urgent need to collect and interpret policy relevant soil data from new soil surveys and soil monitoring exercises.

Current needs of soil information for policy making
There are a large number of policy areas that require soil information:

- Climate change
- Agriculture and food security
- Food quality and food safety
- Bio-energies including Biofuel
- Nature protection and biodiversity
- Water
- Waste (bio-waste)
- Desertification

These are just few of the major policy areas of current interest, but there are certainly more, given the crosscutting nature of soils as the interface between the atmosphere, hydrosphere, lithosphere and biosphere, recently termed the “critical zone”.

Climate change
Climate change is certainly the area of environmental policymaking which is attracting the wast majority of the political attention (and the funding) at the moment. Soils have played a relatively minor role during the early phases of the United Nations Framework Convention for Climate Change (UNFCCC) negotiations. The role of land use and land use change was essentially not considered of relevance compared to the urgent need of reducing emissions from industrial sources. Only forestry made it up on the negotiation agenda in a pretty early phase with the early introduction in negotiation documents of the term "Land Use, Land Use Change and Forestry (LULUCF)". Only recently the full recognition of the role of soils as the main terrestrial carbon sink has gained attention by negotiators. This increased interest unfortunately has not been underpinned with an increase of reliable data and information on this large terrestrial carbon pool. Not even the precise amount of the currently available carbon in soils at global scale can be determined, due to the lack of updated and reliable data. Some estimates are reported in table 1.

Table 1. Recent estimates of global soil organic carbon (SOC) stocks

Source	Total SOC (0-100 cm)	Total SOC (0-30 cm)
HWSD	1,208 Pg	473 Pg[2]
NRCS	1,376 Pg	
IGBP	1,494 Pg	
FAO DSMW	1,455 Pg	554 Pg[2]
IPCC[1]	1,500 Pg	697 Pg[3]

[1] Global estimate from 4th IPCC Assessment Report
[2] Equivalent spatial coverage to IPCC
[3] Estimate from default reference values for mineral soils under native vegetation
Sources of data:
HWSD: Harmonized World Soil Database (http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/)
NRCS: Natural Resources Conservation Service (http://soils.usda.gov/use/worldsoils/mapindex/soc.html)
IGBP: International Geosphere-Biosphere Programme (http://daac.ornl.gov/SOILS/guides/igbp-surfaces.html)
FAO DSMW: Food and Agriculture Organization Digital Soil Map of the World (http://www.fao.org/nr/land/soils/en/)
IPCC: Intergovernmental Panel on Climate Change (http://www.ipcc.ch/index.htm)

Agriculture and Food security
Human population is still constantly rising, with estimates predicting more the 9 billion of humans on earth by 2050. Can the available soil resources of the planet earth provide the necessary food for this growing population? What are the available soil resources for food production today, and what could be the available soil resources in 50 years, taking into account climate change as well as land use changes? What is the extent of soil degradation today? Still most of these estimates are based on data collected in the 1950's and need urgent updated information. Soil degradation is still reported at global scale on the basis of the Global Soil Degradation (GLASOD) project of 1990.

Bio-energy and Biofuel production
Expansion of bio-energy crops is claimed to be not in competition with food production since it will expand on degraded and marginal soils. Is this assumption based on hard data and facts? Do we have the data about the degraded soils in the world in order to make any statement on this issue?

Nature protection and biodiversity
Soils are the host of a large pool of biodiversity. Still a large part of this soil biodiversity pool is not sufficiently characterized and may be lost before we will be able to classify all organisms present in the soils of the world. Land use changes as well as soil contamination are rapidly changing the flora and fauna in the soils of the world. Rare species maybe already lost and more will be lost in the future without a rapid action on the full characterization of soil biodiversity in the world. The problem has been well recognized by the Convention on Biological Diversity (CBD) that has launched a specific initiative on soil biodiversity. Still we are far away from a coherent global approach to soil biodiversity characterization. The European Commission has taken up the challenge of increasing the knowledge and awareness about the importance of soil biodiversity and will release in 2010 as a contribution to the International Year of Biodiversity a Soil Biodiversity Atlas.

Waste
Waste policy is closely linked with soils, given the fact that most wastes are still disposed in landfills and therefore end up in the soils. Changing the perception of soils as a waste dumping site will take a long time and will require a major educational effort. It is of crucial importance to reverse the current approach towards a vision of recycling treated wastes in soils. Of great interest is to the policy maker the potential use of soils for the disposal of organic wastes, thus increasing the soil organic carbon content and the fertility of depleted soils. Creating a partnership between urban and rural populations would allow closing the cycle of precious waste materials that could return to the soils for their benefit. Still insufficient data on health effects and long term stability of these materials in soils exist in order to take any final decision in this matter.

Water and desertification
Soils play a crucial role in the hydrological cycle. Still updated and detailed information on available water capacity of soils at global scale is missing. Water and soils are at the core of the negotiations of the desertification convention (UNCCD). A solid scientific basis for this convention is still missing, also due to the lack of global data about the extent and severity of desertification processes. A new Global Atlas of Desertification is in preparation under the coordination of the European Commission and may provide in the near future new updated information on desertification processes in the world.

The way forward
Policy makers usually cannot take any decisions on the basis of raw data. Traditional soil maps reporting soil names are not a basis for decisions by policy makers. There is the need to provide interpreted soil information that usually is only available after a complex process of data collection, integration of ancillary data, integration of models and scenarios, assessment and final reporting. The full process has been described by Dobos *et al*. and is illustrated in Figure 1. Modern digital soil mapping techniques can provide relevant soil data on properties that can be of use for the on-going policy making processes.

A new generation of soil data and information is needed, not anymore responding to the needs of a limited scientific community, but opening up to a wider horizon of users and stakeholders. Traditional ways of soil data collection, based on soil profile descriptions, can not respond anymore to the needs of a modern society requiring data responding to stringent QA/QC requirements and allowing for informed decision making in soil related matters. The starting point of any soil information system will remain the point observations based on sampling at different depth and measurements of chemical, physical and biological properties. But new technologies will allow improving the spatial extrapolation of the point observations, giving maps with quantified uncertainties associated with each mapping unit and value reported. Field observations will remain at the core of soil information systems, but will have to be extended to cover the actual priorities set by policy makers. The traditional vision of soils for their single function as agricultural substrate will have to be abandoned towards a much more holistic and multidisciplinary vision of soils having multiple functions for humans, as formally identified in the EU Thematic Strategy for Soil Protection: Storage, filtering and buffering of chemicals; archive of cultural heritage; stock of biodiversity; pool of atmospheric carbon; source of raw materials; surface for housing and infrastructure; substrate for biomass production.

Future soil classification systems will have to respond to this expanded vision on soils. This will require introducing new concepts in soil classification, reflecting not only physical and chemical properties, but also biological properties. It will also require a re-definition of the actual object to be classified, not anymore restricted to the pedogenetic horizons, but classifying the full unconsolidated material from the surface to the bed rock.

Given the increasingly global dimension of all policy relevant assessments related to soils, there is the need for developing such a new paradigm for soil classification and soil data collection at global scales.

Conclusion
There is a growing need for interpreted soil information for policy making. The soil science community has still to adapt to these needs by providing the relevant scientific data and background information on the various emerging topics. Soil science alone will not be sufficient for assessing all aspects of soil policy. Integrated approaches incorporating also other scientific disciplines will be needed, particularly for addressing the socio-economic aspects of soil protection and sustainable soil management. The new initiatives (Sanchez *et al*. 2009) towards the compilation of high resolution digital soil maps of the world are certainly very promising and will provide the needed interpreted soil information for global policy making in the near future

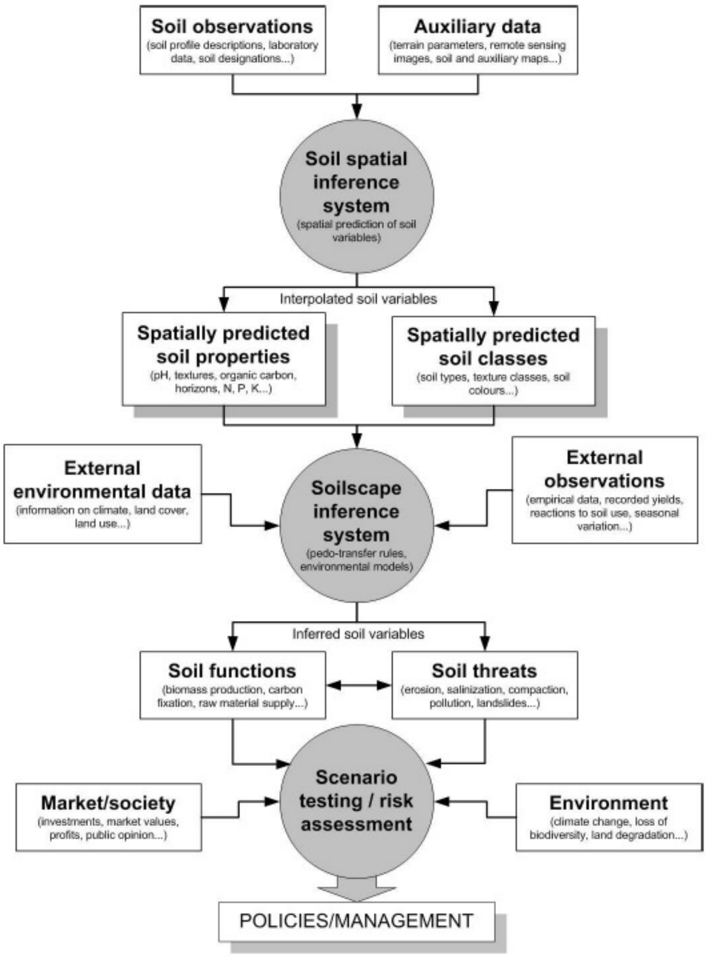

Figure 1. Digital Soil Mapping steps for decision-making and policies management (from Dobos *et al*. 2006).

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