Soil Resources – The Basis of Human Society and the Environment

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1 Introduction

Soil is one of the most important ecosystems, and largely non-renewable. World-wide, all economies depend on the goods and services provided by their natural environment. – Soils as a natural resource perform a number of key environmental, social, economic and cultural functions (see Fig. 1). Agriculture and forestry depend on soil for the supply of water and nutrients and for root fixation. Soils perform storage, filtering, buffering and transformation functions, thus playing a central role in the protection of water and the food chain and the exchange of gases with the atmosphere. Moreover, soil is a biological habitat, a gene pool, an element of the landscape and a cultural heritage, as well as the physical basis for human infrastructures, such as houses, industrial premises, transport ways, parking lots and others. For the installation of these structures, soil provides raw materials.

Growing population and increasing energy consumption, transport and agricultural activities, linked to pressures, such as global climate variability and warming are adding increasing pressure on the reserve of natural resources in general and especially on the soil environment.

Threats to soil are causing social and economic damage in many regions of the world, amounting to billions of Euros each year, not only reducing the quality of life and the well-being of citizens, but also challenging the social and economic development in those regions at large. Therefore, without a sustainable use of soil, risks and insecurity will increase and economic opportunities will decrease.

Zusammenfassung

Es werden die europäische Bodenschutzstrategie ab 2002 und die darauf aufbauenden weiteren operationalen Schritte dargestellt. Neue Ansätze in der Bodenforschung, auf der Basis des DPSIR-Ansatzes, sollen dazu beitragen, die Kluft zwischen Wissenschaft auf der einen Seite und Politik und Entscheidungsfindung auf der anderen Seite zu überbrücken. Die dafür notwendigen, wesentlichen Forschungscluster und notwendigen Formen interdisziplinärer Zusammenarbeit werden im Einzelnen beschrieben. Als Beispiel für interdisziplinäre Forschung wird in drei nachfolgende wissenschaftliche Arbeiten eingeführt, die sich mit dem Verhältnis von Gesellschaft, Boden und Bodennutzung im historischen und aktuellen Kontext beschäftigen.

Schlagworte: Europäische Bodenschutztherapie, DPSIR-Ansatz, prioritäre Forschungscluster für interdisziplinäre Forschung, Brückenbildung zwischen Wissenschaft und Entscheidungsfindung.

Summary

Operational advances, following the European Soil Thematic Strategy after 2002, such as new approaches in soil research, aiming at bridging between science on one side, and politics and decision making on the other side, are described, including the DPSIR approach to soils, which facilitates new forms of inter-disciplinary co-operation. Moreover, main research clusters necessary for such endeavours are described in detail.
Finally, some remarks introduce the three following scientific papers, which deal with the relationship between society, soil and land use in the historical and current context.

Key words: European Thematic Strategy for Soil Protection, DPSIR-approach to soils, main research clusters for interdisciplinary research, brdiging between science and decision making.

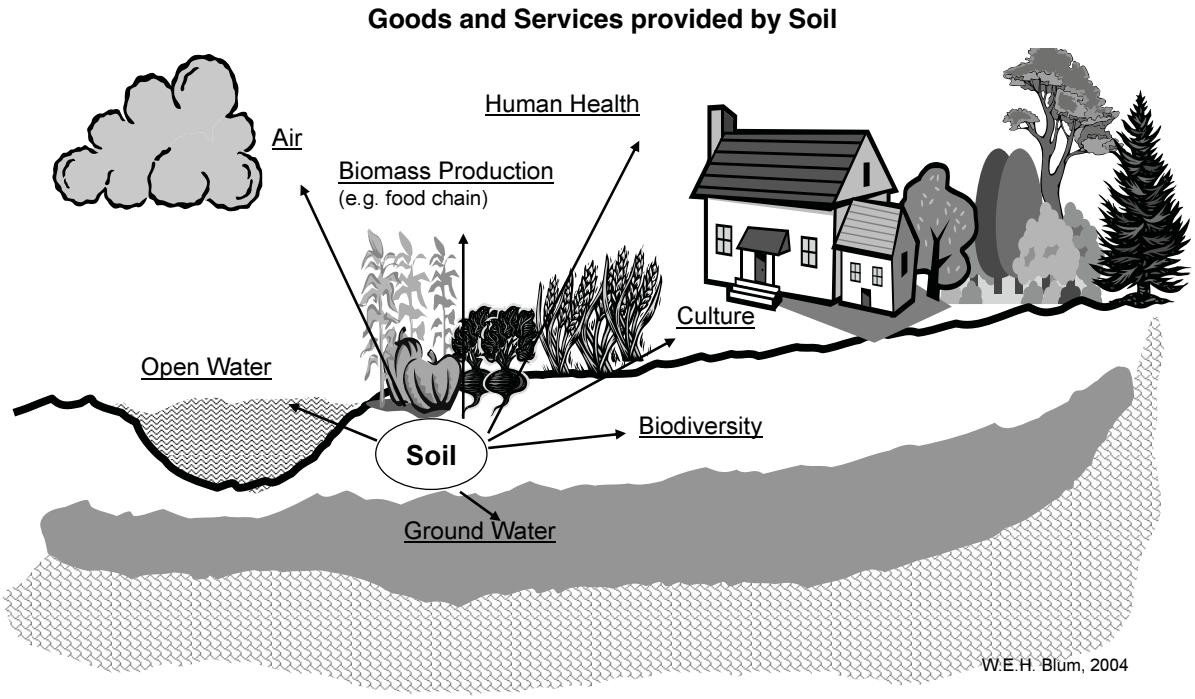

Figure 1: Key environmental, social, economic and cultural functions of soil
Abbildung 1: Schlüsselfunktionen des Bodens bezüglich Umwelt, Sozialsystem, Ökonomie und Kultur

This underlines the importance of protection and the sustainable use of soils.

In view of the situation in Europe, the European Commission developed a communication to the Council and the European Parliament, entitled: "Towards a Thematic Strategy for Soil Protection", which was ratified by 15 ministers of the environment of the EUROPEAN UNION IN 2002, EUROPEAN COMMISSION (2002).

The purpose of this communication was to build on the political commitment to soil protection in order to achieve a fuller and more systematic approach in the future. With this communication, Europe took a world-wide lead in the commitment to soil protection, because herewith, soil is recognised at the same level as other essential environmental media, such as air and water.

This communication defines the five main functions of soil for human societies and the environment, such as the production of food and other biomass, the capacity for storing, filtering and transformation, soil as a habitat and a gene pool, and soil as a physical and cultural environment for humankind and as a source of raw materials.

Moreover, 8 main threats to soils are listed, such as erosion, decline in organic matter, soil contamination (local and diffuse), soil sealing, soil compaction, decline in soil biodiversity, salinisation, and floods and landslides. It was also stated that these threats do not apply evenly across Europe, but that there is an evidence that degradation processes are getting worse.

Moreover, many European Union (EU) policy areas are of relevance to soil and its protection, especially those related to environment, agriculture, regional development, transport, development and research. It was also stated that knowledge of soil-survey monitoring systems and data networks, and other forms of information is uneven across Europe and that the development of an EU soil protection policy will take time and will require a precautionary approach, based on preventing soil degradation in the future.

2 Operational framework for the thematic strategy for soil protection

As a follow-up to the EU-communication, the European Commission, DG Environment, installed 5 Technical Working Groups (TWG) and an Advisory Forum in 2002. These 5 TWGs addressed all the 8 threats and additionally the issues of monitoring and research. In the following, the primary interest is in the outcome of the TWG Research, which developed new concepts for soil research within the Thematic Strategy for Soil Protection.

3 Technical Working Group on Research

The Research TWG had three mandates: A core specific mandate, dealing with research, and two additional mandates, dealing with sealing and cross-cutting issues.

The results of the TWG Research, with about 65 participants from all over Europe were elaborated during four Meetings and a Workshop at the Universität für Bodenkultur in Vienna, from October 28-29, 2004.

During this Workshop, a broad scientific community was invited to discuss the achieved results, and to establish a priority list for research areas in soil protection and the management of Europe's natural soil resources (BLUM et al., 2004).

All the results were based on the DPSIR approach (EUROPEAN ENVIRONMENT AGENCY, 1999), distinguishing between the Driving forces (D), which develop Pressures (P), resulting in a State (S), which by itself creates Impacts (I) and for which Responses (R) are needed (see Fig. 2). For example, a "D" can be the demand for more space for industrial production, lodging, transport facilities, sports and recreation facilities, the dumping of refuse and others. The "P" deriving from this demand is urbanisation in a broad sense, which means the construction of new industrial premises, new houses, transport ways, such as roads or streets, parking lots and others. The "S" created through this pressure is a sealed soil, which means a considerable loss of agricultural and forest land. The direct "I" is less agricultural (and forest) biomass production, less rainwater infiltration, less biodiversity, and other impacts, with the indirect "I" that farmers have to give up their profession, because there is no land available any more for agricultural or forest production. Moreover, these farmers might move into other areas, causing social and economic problems there. Another indirect "I" of sealing involves the emissions caused by activities on the sealed surfaces, such as air and water pollution, and – in some cases – also water pollution through concentrated surface water flow under uncontrolled conditions, creating sedimentation and pollution of soils and sediments. The "R" should, whenever possible, be directed at the "D", e.g. towards satisfying the demand for new urban structures by means other than the sealing of new land, e.g. by recycling old, industrially used sites,

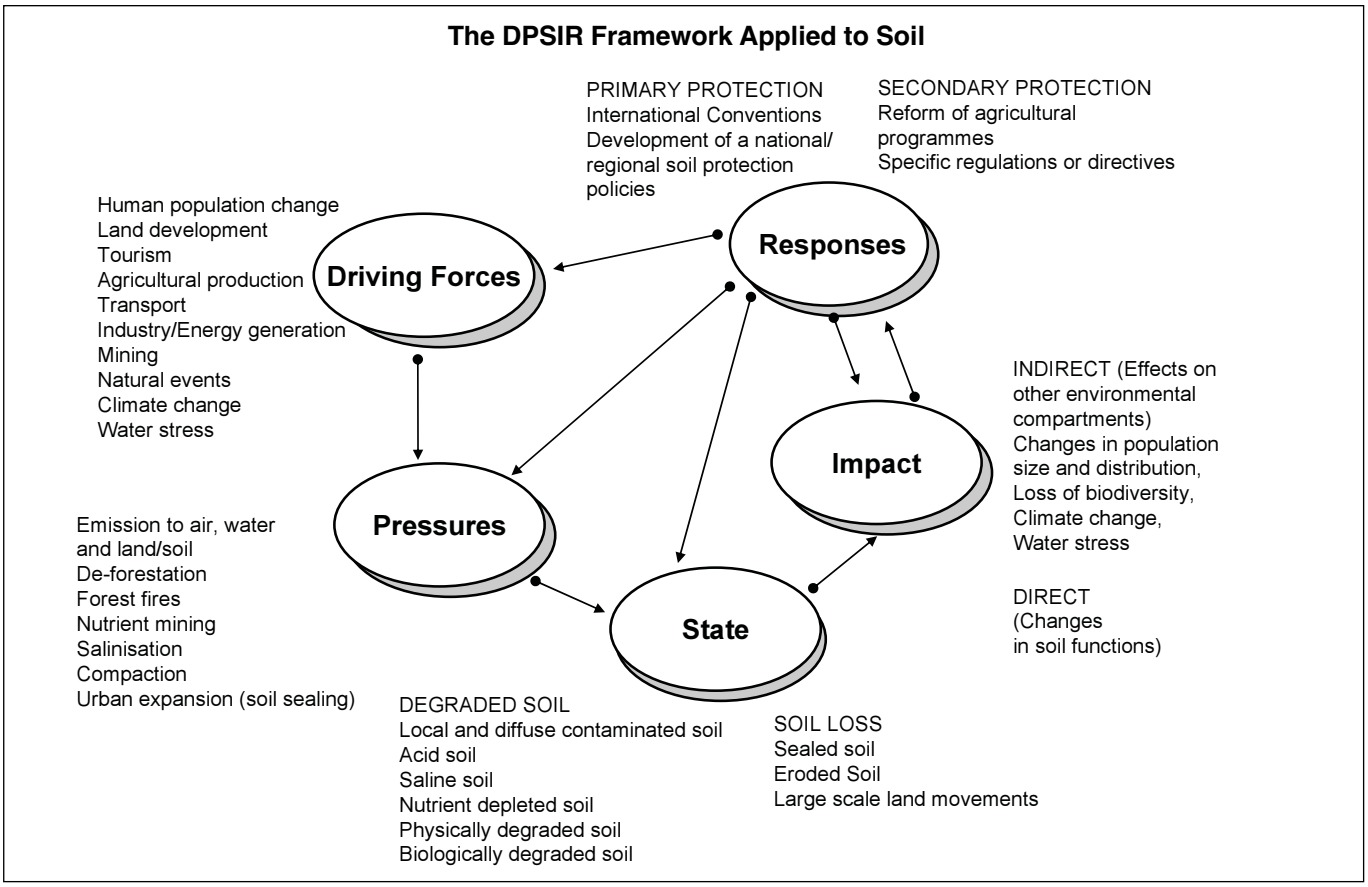

Figure 2: DPSIR framework applied to soil
Abbildung 2: DPSIR-Ansatz für Boden und Bodennutzung

building on partly polluted or reclaimed old industrial land. This means the "R" would be in the form of incentives, social or economic measures or legal regulations, in order to reduce urban sprawl.

Therefore, the DPSIR framework allows for key questions to be answered in the understanding of complex soil and environmental as well as social, economic and cultural systems, such as:

- What is the "D" behind a problem?
- What are the "Ps" deriving from the "Ds"?
- What is the "S" which the "P" creates?
- What are the "Is" that result from the "S"?

It also allows for "Rs" to change the change the "Ds", in order to alleviate or reverse the problem, developing solutions through the implementation of operational measures.

Based on this approach, new concepts for research were developed by the TWG Research, to deal with the following specific tasks:

1) identifying and structuring the existing information;
2) identifying barriers that prevent the full use of existing results for policies and recommendations on how to improve the transfer of information;
3) identifying research gaps with indications of the times within which these can be closed (short-, medium- and long-term).

4 Priority research areas for soil protection and the management of Europe's natural resources based on DPSIR

This task was accomplished by developing a concept for integrated research in soil resource management and soil protection, see Tab. 1. In this table, the main research goals, research clusters, and the sciences involved are shown. The five main research clusters can be seen in Fig. 3, showing that the analysis of processes, the development, harmonisation and standardisation of methods for the analysis of the

Table 1: Concept for integrated research in soil resource management and soil protection
Tabelle 1: Konzept für Forschungszusammenarbeit in Bodenbewirtschaftung und Bodenschutz

Main research goals	Research Clusters (see Fig. enclosed)	Sciences involved
1 To understand the main processes in the eco-subsystem soil; induced by threats	Analysis of processes related to the 8 threats to soil and their interdependency: erosion, loss of organic matter, contamination, sealing, compaction, decline in biodiversity, salinisation, floods and landslides	Inter-disciplinary research through cooperation of soil physics, soil chemistry, soil mineralogy and soil biology
2 To know where these processes occur and how they develop with time	Development and harmonisation of methods for the analysis of the **State** (**S**) of the 8 threats to soil and their changes with time = **soil monitoring** in Europe	Multi-disciplinary research through cooperation of soil sciences with • geographical sciences, • geo-statistics, • geo-information sciences (e.g. GIS)
3 To know the driving forces and pressures behind these processes, as related to cultural,	Relating the 8 threats to **Driving forces** (**D**) and **Pressures** (**P**) = cross linking with EU	Multi-disciplinary research through cooperation of soil sciences with political
social, economic, ecological or technical, local, regional or global developments	and other policies (agriculture, transport, energy, environment etc.)	sciences, social sciences, economic sciences, legistic sciences, historical sciences, philosophical sciences and others
4 To know the impacts on the ecoservices provided by the subsystem soil to other environmental compartments (eco-subsystems)	Analysis of the **Impacts** (**I**) of the 8 threats, relating them to soil eco-services for other environmental compartments: air, water (open and ground water), biomass production, human health, biodiversity	Multi-disciplinary research through cooperation of soil sciences with geological sciences, biological sciences, toxicological sciences, hydrological sciences, physio-geographical sciences, sedimentological sciences and others
5 To have operational tools (technologies) at one's disposal for the mitigation of threats and impacts	Development of operational procedures for the mitigation of the threats = **Responses** (**R**)	Multi-disciplinary research through cooperation of natural sciences with engineering sciences, technical sciences, physical sciences, mathematical sciences and others

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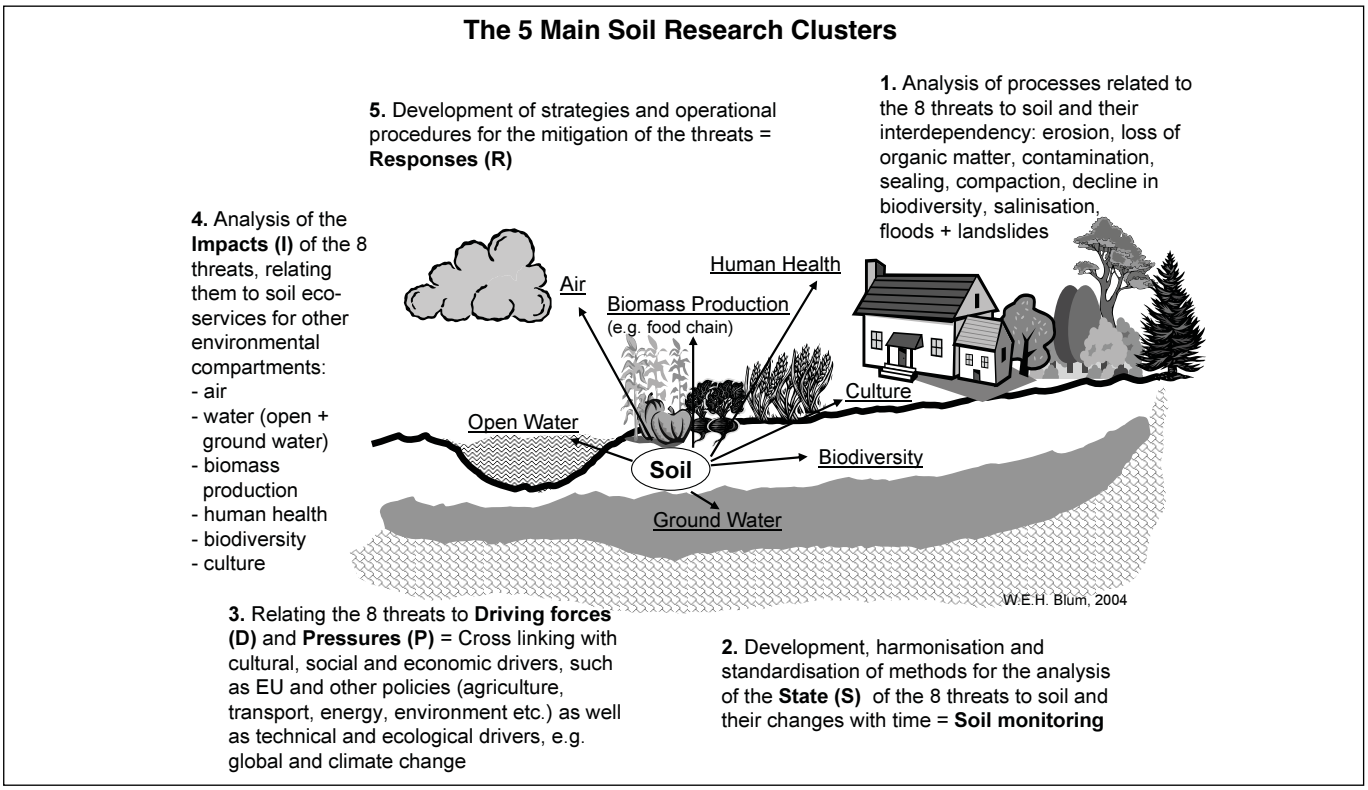

Figure 3: The 5 main soil research clusters
Abbildung 3: Die 5 zentralen Forschungsfelder

state, the relating of the 8 threats to driving forces and pressures, the analysis of the impacts on soil eco-services for other environmental compartments, and finally the development of strategies and operational procedures for the mitigation of the threats, delivering responses, is a necessary consequence of research steps needed to protect the soil resources.

From Table 1 and Figure 3 it also becomes clear that not only natural sciences, but also social sciences, economic sciences, historical sciences, philosophical sciences, legal sciences and others have to be involved (BLUM et al., 2004 b).

Therefore, at the beginning of the Workshop in Vienna, scientists from other areas than soil science were invited to describe and to determine the larger context in which soil protection can be achieved.

5 Soil – Society – Interdisciplinarity and Transdisciplinarity

In her contribution "Soils and Society – An Environmental History of Challenge and Response" Verena Winiwarter gave an overview of concepts and approaches for the study of relationships between soil and society, based on a non-anthropocentric view on the history of soils. She elucidates, the DPSIR-model and concepts of environmental hazard, as well as the role of myths about nature in livelihood strategies. From this, she concludes that environmental impacts should be investigated with the inter-action model of social ecology, and that representations of nature have to be analysed in terms of power-relations. Only in this way, changes in the relation between soils and societies become visible in historical reflection. Finally, through the introduction of models of social change, requirements for social soil research were defined and discussed.

The contribution of Helmut Haberl, "Interdisciplinary Perspectives on Soil Protection in a Sustainable Context" reveals that the pattern of production and consumption in industrial societies is unstable. Moreover, it cannot be generalized across the world. A transition towards sustainability will require changes of a proportion similar to the industrial revolution, e.g. the transition from agrarian society to the present one. Sustainability in this context is conceptionalized as an attribute of socio-ecological systems, which

means of systems that emerge through the interaction of socio-economic and ecological processes. The science of sustainability requires inter- and trans-disciplinary co-operation and therefore needs approaches that bridge the gap between disciplines, between local and global scales and between the integration of user needs and scientific excellence. The paper also discusses the potential usefulness of the concepts of socio-economic metabolism and the colonisation of terrestrial ecosystems (e.g. land use) for bridging gaps between social sciences, including economics, and natural sciences, such as soil science. Using Austria 1830–2000 as an example, Haberl demonstrates, how changes in resource utilisation and technology resulted in fundamental changes in land use and therefore in impacts on soil.

In a final contribution, "Man is Made of Mud – Soil Bio-Logical Facts and Fiction and Environmental History", Bernd Herrmann resumes aspects of an anthropology of soil. These features are constitutive for human approaches to soil, but are mostly overlooked in environmental history. Starting with the derivation of the term "Man" from ideas related to soil in the Old World, the paper transforms "soil" into "space" and considers bio-related issues, and to which extent soil materials influence the bodily composition of humans. On this basis, deliberations about the fields of offspring, genealogy and determinism are communicated.

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