A NEW RESEARCH CONCEPT FOR HARMONIZING ECOLOGICAL, TECHNICAL, ECONOMIC, SOCIAL, LEGISTIC AND CULTURAL APPROACHES IN SOIL AND WATER CONSERVATION

by

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EXTENDED ABSTRACT

The need for soil and water conservation derives from the fact that these resources are increasingly threatened by human activities. In the following, we will focus mainly on the protection of soil resources.

Due to increasing soil degradation and soil losses in Europe, in 2002 a communication from the European Commission to the Council and the European Parliament, entitled: "Towards a thematic strategy for soil protection" (1) was developed and ratified by the 15 ministers of the environment of the European Union. The purpose of this communication was to build on the political commitment to soil protection in order to achieve a more comprehensive and more systematic approach in the future.

In this communication, the five main functions of soil for human societies and the environment were defined, such as the production of food and other biomass, the capacity for storing, filtering and transformation, the soil as a habitat and a gene pool, and the soil as a physical and cultural environment for humankind and as a source of raw materials. Moreover, eight main threats to soil were distinguished, 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 clearly outlined, that these threats do no apply evenly across Europe, but that there is evidence that degradation processes are getting worse. Looking into the European Union policy areas, it becomes evident that many of them are of relevance to soil and its protection, especially those relating to environment, agriculture, regional planning and development, transport, development and research. There are clear indications that soil degradation and soil losses are often due to wrong policies or policies which do not take into consideration sustainable soil and land management issues.

For promoting soil protection, an operational set-up was put to work, involving several Technical Working Groups (TWGs), with more than 400 participants, mostly scientists from all over Europe, dealing with the different threats, monitoring issues and research.

In the following, the outcome of the TWG on Research and the new concepts developed for soil research within the "Thematic strategy for soil protection" will be discussed.

The principally new approach in the development of research concepts within the "Thematic strategy for soil protection" was the introduction of the DPSIR-framework

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(Fig. 1), distinguishing between 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 (e.g. a "D", can be insufficient market regulations, which do not allow a farmer to gain enough income by selling his or her agricultural commodities. The "P" deriving from this misbalance is nutrient mining, which means that the farmer has no money for replacing the nutrients which he extracted from the soil by his harvest. The "S" created through this pressure is a nutrient depleted soil, which means a considerable threat to further agricultural production including the livelihood of the farming population. The direct "I" is less agricultural biomass production, due to a lack of nutrients, with the indirect "I" that farmers have to give up, because the fertility of soils is too low for agricultural production. Moreover, under these conditions, the farmers might move into other areas, causing social and economic problems there. Another direct "I" might be soil erosion, because the farmer cannot afford to take anti-erosive measures, because of a lack of income. The consequences are flooding, and the sedimentation of water storages with soil material. The "R" should, whenever possible, be directed at the "D", e.g. by changing the market conditions in such a way that the farmer can create enough income from his agricultural commodities, thus allowing him to replace the harvested nutrients himself. The distribution of fertilizers to the farmers would be a wrong signal. – In this case, the "R" would be incentives, other social or economic measures or legal regulations, in order to establish the right market conditions for the farming population.

The DPSIR Framework Applied to Soil

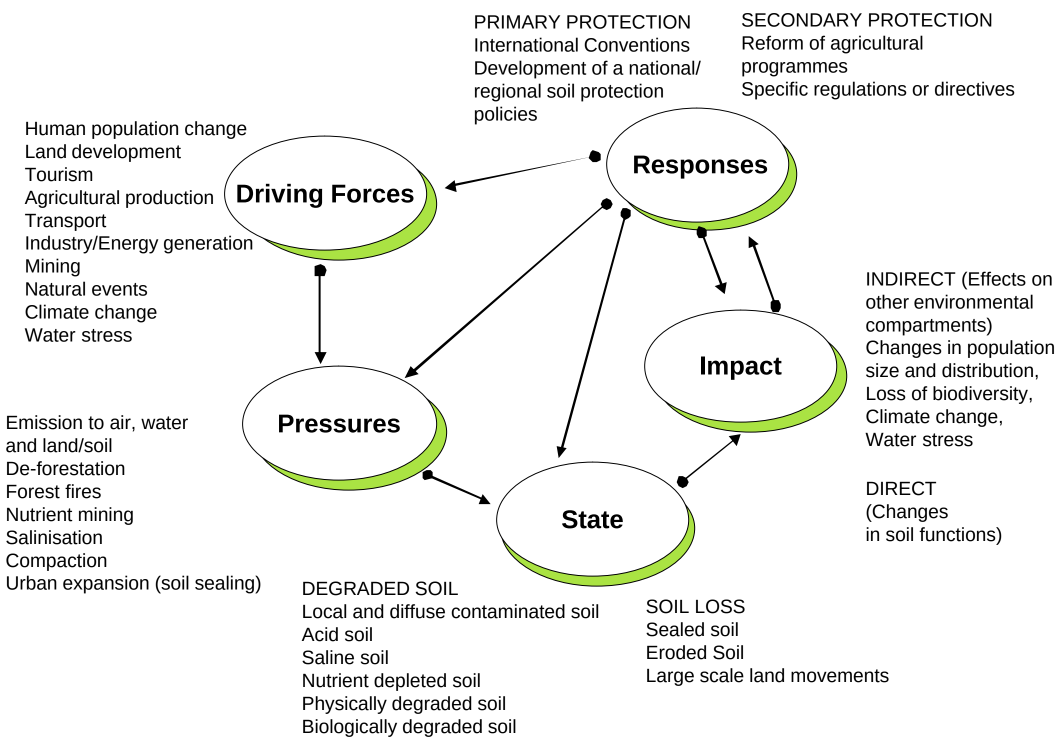

Fig. 1: DPSIR-Framework applied to soil

This example shows that the DPSIR-framework allows for key questions to be answered in the understanding of complex soil and environmental 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" so as to change the "Ds" in order to alleviate or reverse a problem, developing solutions through the implementation of operational measures.

Based on this approach, a new concept for integrated research in applied ecology, with the example of soil was developed, by defining the main research goals, the necessary research clusters in order to meet these goals and the sciences involved, see Tab. 1. From this table, it becomes clear that 5 steps, based on the DPSIR-approach are necessary.

1. to understand the main processes in the eco-subsystem soil, induced by threats;
2. to know where these processes occur and how they develop with time;
3. to know the driving forces and pressures behind these processes as related to cultural, social, economic, ecological, technical, local, regional or global developments, e.g. expressed by policies;
4. to know the impacts on the eco-services which are provided by soil to other environmental compartments and to the human society; and
5. to develop operational tools (technologies) for the mitigation of threats and impacts. – The 5 main research clusters derived from these goals are shown in Fig. 2. The sciences to be involved in all these endeavours can be seen in the third column of Tab. 1.

CONCEPT FOR INTEGRATED RESEARCH IN ECOLOGY – EXAMPLE SOIL

	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 co-operation 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 co-operation 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, social, economic, ecological or technical, local, regional or global developments	Relating the 8 threats to **Driving forces (D)** and **Pressures (P)** = cross linking with EU and other policies (agriculture, transport, energy, environment etc.)	Multi-disciplinary research through co-operation of soil sciences with political sciences, social sciences, economic sciences, legistic sciences, historical sciences, philosophical sciences and others
4	To know the impacts on the eco-services provided by the sub-system 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 co-operation 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 co-operation of natural sciences with engineering sciences, technical sciences, physical sciences, mathematical sciences and others

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Tab. 1: Concept for integrated research in ecology – Example soil

THE 5 MAIN SOIL RESEARCH CLUSTERS

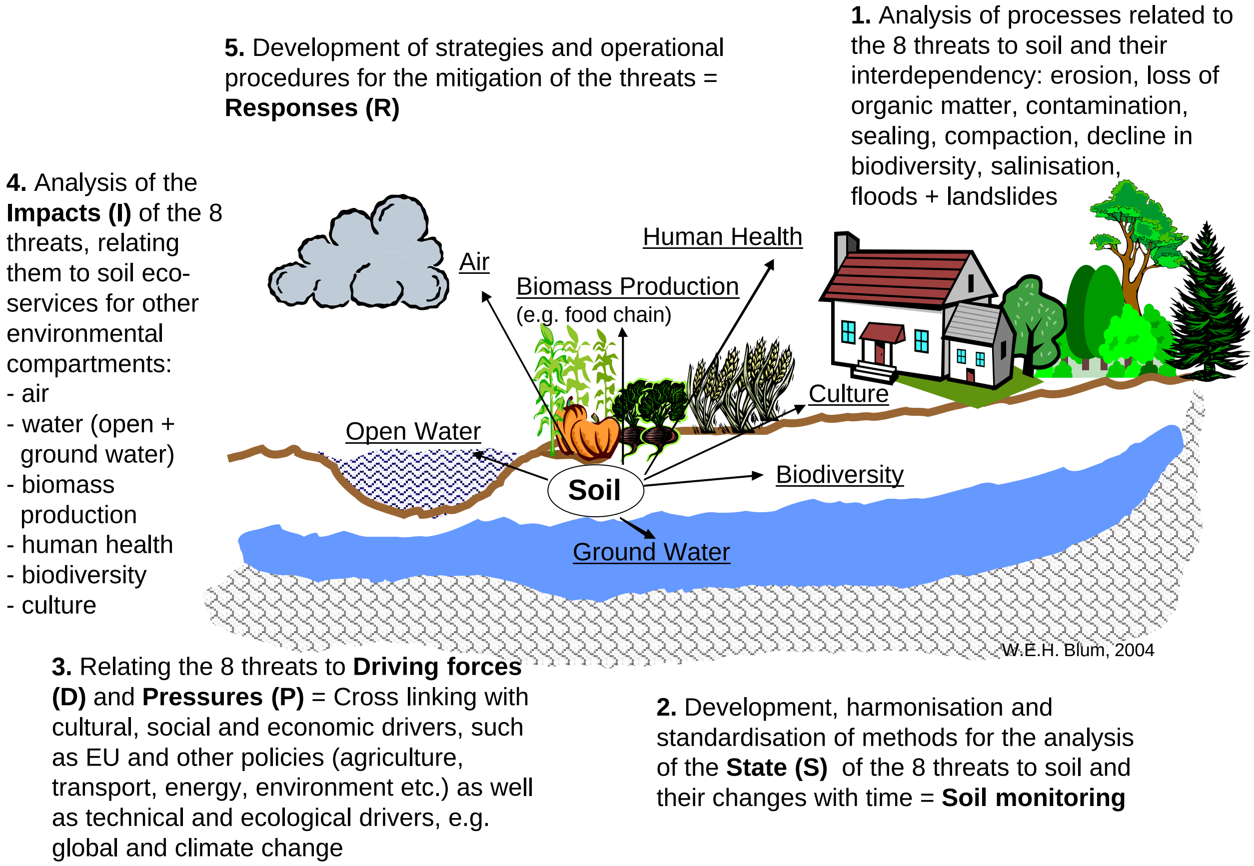

Fig. 2: The 5 main soil research clusters

Based on this concept, it is possible to understand the functional interdependencies between the 8 threats to soil, as well as the strong inter-dependency between these threats and the different local, regional and global policies. Moreover, it becomes clear that each of the threats is impairing specific ecological soil functions and services to other ecological compartments, such as air, open water and ground water, biomass production, human health and biodiversity.

In conclusion, it can be said that this new research concept is contributing to the basic understanding of processes and their impacts, occurring in the soil and water systems. Moreover, it allows for controling these processes, not only by scientists, but also by stakeholders, decision makers and politicians, thus bridging between those who have information and those who need it.

References:

(1) European Commission COM(2002)179 final. 2002.

(2) European Environment Agency. Environment in the European Union at the Turn of the Century. EEA. Copenhagen. Denmark. 1999.

(3) Blum W.E.H., J. Buesing, L. Montanarella: Research needs in support of the European thematic strategy for soil protection. Trends in Analytical Chemistry, Vol. 23, 680-685, 2004.