

> Soil – A Geological Resource, Economic Driver and Ecosystem Service Provider

Recommendations for pooling scientific expertise in soil and land management

acatech POSITION PAPER – SUMMARY AND RECOMMENDATIONS



Soil is fundamental to human existence. It forms the uppermost layer of the Earth's crust, supporting life and comprising a base of mineral and organic materials together with water, air and living organisms. The soil is where the lithosphere (our planet's crust and upper mantle) meets the atmosphere (air), hydrosphere (water) and biosphere (flora and fauna). Its position at the interface between these four environmental compartments makes soil a highly sensitive and complex system. The rate at which new soil can be created is limited, meaning that soil loss is often irreversible. Even in the best-case scenario, when land is misused or degraded it can take decades or even centuries to restore soil to a state where it performs its full range of functions. Because the amount of land is finite it is no longer sustainable to consider that new soil may be brought into cultivation, e.g. by clearing forested lands. Arable land is, thus, a finite resource that should be used responsibly.

Ecosystem service provider and economic driver

Soil performs a range of functions. Soil is necessary to grow plants which can then be used as raw material as well as for feeding humans and animals and generating energy. In addition to biomass production, soil provides a number of other important ecosystem services that make it indispensable in the provision of healthy food and drinking water. Soil filters rainwater that passes through it to form groundwater and is particularly good at turning organic pollutants into less harmful substances or breaking them down completely. The nutrients stored in soil feed the plants that grow in it, which in turn provide an indispensable source of nourishment for humans and animals. The organisms that live in and on top of the soil break down plant matter, transforming it into stable humus that plays an important role in climate regulation. The decomposition process recycles the nutrients contained in rotting plant matter by feeding them back into the biological cycle. In other words, healthy soil ensures smooth functioning of the nutrient cycle.

Healthy soil is indispensable for guaranteeing ecosystem environmental services that are essential for both humans and the environment. These include preserving biodiversity, guaranteeing biomass production even in the face of extreme climate conditions and stabilising landscape structures.

However, soil's significance is not confined to its use in agriculture and forestry. Housing, roads and other types of infrastructure are all built on top of soil. Moreover, it also provides a surface for a variety of human leisure pursuits.

Economic growth has benefited for many centuries from the role played by soil in production. Soil underpins all bio-based value chains and is, thus, a key economic driver. The food industry is Germany's fourth biggest industry, with a turnover of approximately 150 billion euros in 2010. Meanwhile, a total annual turnover of 20 billion euros is forecast for the bioenergy industry by 2020, whilst the raw materials industry had a turnover of 2.4 billion euros in 2010. Moreover, it should not be forgotten that most land is privately or publicly owned and often has a high monetary value.

The challenges facing soil and land management

Climate change has both negative and positive impacts on the role of soil in production and in the ecosystem. Fluctuations in crop yields between regions and from one year to another are not the

At a glance

- Healthy soil provides us with indispensable ecosystem services. It preserves biodiversity and is key to biomass production. It also provides us with a surface for housing, infrastructure and leisure pursuits.
- Soil underpins all bio-based value chains and is thus a key economic driver.
- Arable land is a finite resource. Climate change and rising demand for biomass are resulting in increasingly fierce competition between different land uses.
- Soil science research in Germany is fragmented and lacks prominence on the international stage.
- Interdisciplinary cooperation between soil scientists should be promoted in order to find comprehensive solutions to the challenges of soil and land management and ensure that they receive international attention.

only consequence of changes to our climate. Changes in climate, such as rising average temperatures and shifts in rainfall distribution could disrupt the delicate balance of the physicochemical processes and transformation of materials that occur in the soil. This could impair the potential productivity of fertile land, particularly in developing nations. On the other hand, higher rainfall can make it possible to start farming previously infertile land, whilst rising temperatures can increase productivity in cooler parts of the world.

Despite uncertain and often unfavourable climatic conditions and the fact that the available area of productive land is decreasing throughout the world as a result of land degradation and urban and associated development, our soil is nonetheless expected to somehow meet the growing demand for biomass. By 2050, we will need to feed a global population of around nine billion, about a third more than today. Meanwhile, biomass-based renewable energy and biofuels are becoming increasingly popular. Higher demand for renewable raw materials and food brings a rise in demand for fertile land, leading to fierce competition between different land uses. Moreover, the shift towards sustainable energy production is resulting in the emergence of a new rival in the shape of land-intensive large-scale wind farms and storage facilities. There simply isn't enough land to meet all these different requirements. It is, therefore, necessary to reduce land consumption for housing and transport purposes whilst at the same time increasing the productivity of existing agricultural and forestry land. It is also important not to lose sight of the fact that this should be done in a sustainable manner. Furthermore, the resulting value chains should be as efficient as possible and keep waste to a minimum.

Interdisciplinary research

It is important for research in the field of soil and land management to address these land use challenges. As a result of

their historical development, the scientific disciplines in this area are extremely wide-ranging and this is reflected in the structural diversity of the relevant research institutions in Germany. The upshot is that this subject area receives different degrees of attention from different research institutions. However, the new circumstances facing us today require strategic coordination of research topics and comprehensive, interdisciplinary responses – something that Germany's fragmented research community is currently in no position to provide. In addition, the proliferation of different soil science disciplines in Germany detracts from their prominence on the international stage. If things continue as they are, Germany will be unable to regain its position at the forefront of international research in this field. It is, therefore, imperative for German soil scientists to undertake interdisciplinary cooperation on the key research topics.

Recommendations

- More should be done to highlight the economic and social importance of soil as a finite geological resource at a national, European and global level
- Land productivity should be increased without impairing ecosystem services
- Land management practice should be adjusted to ensure a rapid response to the effects of climate change and innovative approaches should be developed for managing competition between different soil and land uses
- A consensus should be built regarding key research priorities
- Technical expertise should be pooled and interdisciplinary institutional cooperation between the relevant actors and stakeholders in Germany should be promoted
- Measures should be taken to ensure knowledge and technology transfer from the scientific community to businesses and practitioners

CONTACT

acatech – NATIONAL ACADEMY OF SCIENCE AND ENGINEERING, January 2013

Munich Office
Residenz München
Hofgartenstraße 2
80539 München

Berlin Office
Unter den Linden 14
10117 Berlin

Brussels Office
Rue du Commerce/Handelsstraat 31
1000 Brüssel

T +49 (0) 89 / 5 20 30 90
F +49 (0) 89 / 5 20 30 99
www.acatech.de

This summary is based on the following publication: acatech (Ed.): *Soil – A Geological Resource, Economic Driver and Ecosystem Service Provider: recommendations for pooling scientific expertise in soil and land management* (acatech POSITION PAPER), Heidelberg et al.: Springer Verlag 2012. Project lead: Prof. Franz Makeschin (Dresden University of Technology)

The original version of this publication is available at www.springer.com or www.acatech.de