UNEP Year Book 2014 emerging issues update
Securing Soil Carbon Benefits
Managing soils for multiple economic, societal and environmental benefits

Soil is essential for agricultural production. The carbon in soil plays a vital role in regulating the world’s climate, water supplies and biodiversity – and therefore in providing numerous ecosystem services. However, soil carbon is highly vulnerable to human activities.

Around 60% of the carbon in the world’s soils and vegetation has been lost since the 19th century. The current rate of change in soil organic carbon is mainly attributable to worldwide intensification of land use and conversion of uncultivated land for food, feed, fibre and fuel production. As a result of soil carbon losses in the last 25 years or so, one-quarter of the global land area has declined in agricultural productivity and the ability to provide ecosystem services.

Over double the amount of carbon held in the atmosphere is stored in the top metre of the world’s soils. Accelerated decomposition due to land use change (e.g. deforestation) and unsustainable land management practices causes soils to release carbon dioxide (CO₂) and other greenhouse gases.

Soil erosion associated with conventional agricultural practices can occur at rates up to 100 times greater than the rate at which natural soil formation takes place. Peatland drainage worldwide is causing carbon-rich peat to disappear at a rate 20 times greater than the rate at which it accumulated. If present trends continue, there will be rapid losses of soil carbon to the atmosphere in the future, exacerbating climate change and increasing the extent of global soil degradation. These losses will put food, feed, fibre and fuel crop production at risk, while a wide range of vital ecosystem services will continue to be diminished.

Because of its central role in so many ecosystem services, soil carbon also offers hope for solutions to global challenges. Soil is an integrating component of the Earth’s surface that links the above-ground and below-ground environments, collectively termed the Earth’s Critical Zone. Thus soil is a vital control point where managed human interventions to increase soil carbon stocks can provide multiple, wide-ranging benefits for food and water security, biomass production and greenhouse gas mitigation.

Read more about soil carbon benefits in the UNEP Year Book 2012.

The Earth’s Critical Zone

The Critical Zone, linking the above-ground and below-ground environments, is referred to as ‘critical’ because this thin surface layer provides most life-sustaining resources. Soil is an essential link in the chain of impact that propagates the effects of above-ground environmental change, such as climate and land use transitions, throughout the Critical Zone.

Global variation in soil organic carbon (SOC) density, 0-1 m depth

Source: FAO/IMASA/ISRIC/ISSCAS/JRC, 2012
Improved soil management: crucial for climate change and food production

Scientific understanding of the benefits of soil carbon has increased in recent years – stimulated by the potential contribution of soils to climate change mitigation and the need for more sustainable agricultural development, including better management of soils. Due to the complexity of soil systems, knowledge about soil carbon is fragmented across many science disciplines and economic sectors. Recently, scientists undertook a Rapid Assessment Process integrating scientific evidence of the multiple benefits of soil carbon and exploring how new policy and management practices can help deliver these benefits more rapidly and more widely around the world.

Studies continue to show that soil carbon stocks throughout the world are strongly affected by land use and land management, as well as by environmental conditions. Soil organic carbon is the largest constituent of soil organic matter, which also contains nutrients essential for plant growth such as nitrogen, phosphorus, sulphur and micronutrients. The amount and dynamics of soil organic matter are major determinants of the quantity and quality of ecosystem services. Improving land use and management to enhance carbon storage is integral to global efforts to feed a growing population and address climate change (e.g. through carbon sequestration).

Rapid assessment process on soil organic carbon

Following production of the UNEP Year Book 2012 chapter on soil carbon, the Scientific Committee on Problems of the Environment (SCOPE) initiated a Rapid Assessment Process that amassed scientific evidence from more than 80 experts worldwide, resulting in the preparation of 27 chapters over an 18-month period on the multiple benefits of soil carbon and their implementation in policy and practice. This work culminated in a five-day workshop in 2013 that prepared four cross-cutting chapters of recommendations for policy in soil and land management practice and a SCOPE publication.

Intensive commercial agriculture tends to reduce carbon stocks, while sustainable agriculture has the potential to increase them. Significant changes in soil organic carbon stocks can occur within several decades. The results of sustainable soil management could be noticeable over similar periods.

A wide range of ecosystem services require healthy soils and soil biodiversity. Yet the pressure on soil for various land uses remains enormous, undermining the very basis of agricultural production. It is clear that maintaining minimum levels of soil organic carbon is essential to overall soil health, apart from the contribution this resource makes to climate change mitigation. Increasing soil organic carbon above minimum levels is a form of pro-active management to achieve additional benefits. While governments consider goals and targets for food security, soil scientists are carrying out assessments and looking for practical ways to determine, measure and maintain healthy levels of soil organic carbon.
Maintaining and enhancing soil carbon benefits

In agriculture, the purpose of many ongoing research and development efforts is to improve land management. For example, *conservation agriculture* initiatives in developing countries are aimed at increasing soil organic carbon and reducing its losses while improving farmers’ incomes and alleviating poverty. The effectiveness of measures to increase carbon inputs to agricultural soils and reduce carbon losses depends on local conditions, including soil types and climate.

### Conservation agriculture

The purpose of conservation agriculture is to achieve sustainable and profitable agriculture, and improved livelihoods for farmers, through the application of three principles: minimal soil disturbance, permanent soil cover, and crop rotations. Conservation agriculture was reportedly practised on 117 million hectares worldwide in 2010.

The rate of global forest clearance has accelerated due to population growth and demand for food, feed, fibre, fuel – and living space. Over 5 million hectares of forest has been cleared annually in recent years. Soil carbon is lost rapidly as a result of forest clearance. Preventing forest loss and degradation (e.g. under the UN-REDD programme) has multiple benefits in addition to protecting and enhancing carbon stocks. These benefits include water regulation and biodiversity conservation.

The Food and Agriculture Organization (FAO) Global Forest Resources Assessments are produced every five years to provide an update on the state of the world’s forests and how they are changing. The recently launched Global Forest Watch is an online forest monitoring and alert system that gives near real-time information about changes in forests. Its goal is to empower people everywhere to better manage forests – which can have significant impacts on soil carbon stocks. Created by UNEP, the World Resources Institute and more than 40 partners, it uses satellite technology, open data and crowd sourcing to support monitoring of global forest status.

Conserving and restoring *peatlands* and improving their management can greatly benefit soil carbon conservation and contribute to avoiding greenhouse gas emissions. The first international conference on the use of emergent wetland plants, ‘Reed as a Renewable Resource’, took place in 2013. This is one of a number of research and other activities carried out in recent years to encourage wetlands protection, restoration and utilization to provide multiple ecosystem services, including carbon sequestration and storage.

### Peatland protection

Peatlands cover about 3% of the Earth’s land area, but contain some 30% of total soil carbon. While the majority of peatlands are still in a natural state, many have been drained and degraded. Unlike carbon emissions associated with forest clearance – which are largely instantaneous – those from drained peatlands continue as long as the peatland remains drained. Drained peatlands emit almost 6% of anthropogenic CO₂ emissions. Peatland conservation, restoration and improved management is therefore critical for climate change mitigation.

For video links please go to http://www.youtube.com/watch?v=YXbiRCKWTFU

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Seeking synergies with other policy objectives

Appropriate soil management helps to meet some of the greatest challenges the world faces, including food and energy security, water availability and quality, climate change adaptation and mitigation, biodiversity conservation, and the health and well-being of billions of people.

Opportunities exist at every level (global, regional, national, local) to enhance soil carbon and avoid losses of this precious resource. In some countries these may include, for example, restricting the conversion of woodland and grassland to arable crops. A major challenge is to improve understanding of the urgency of using these opportunities. This is essential if adequate resources are to be made available for planning, developing and implementing the necessary policies, actions and incentive mechanisms.

Policy-makers are increasingly called upon to make decisions that involve conflicting demands for food, feed, fibre, fuel and forest crops, as well as climate regulation, water, biodiversity conservation, living space and other needs. It may be necessary to protect soils that provide important soil carbon storage and other benefits, such as peatlands, despite pressures to convert them to uses that could be more economically profitable in the short term.

The Global Soil Partnership, an international initiative launched in 2011 and operated by the FAO, is aimed at improving global governance of soil resources by advocating (and coordinating) initiatives to ensure that knowledge and recognition of soils are appropriately represented in global change dialogues and decision-making processes. Its work is carried out under five pillars of action.

Recommendations made during Global Soil Week 2013 (convened within the framework of the Global Soil Partnership) included strengthening the policy-science interface and increasing soil carbon synergies in policy-making process through the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), the United Nations Convention to Combat Desertification (UNCCD) and

The Global Soil Partnership’s five pillars of action

- Promote sustainable management of soil resources for soil protection, conservation and sustainable productivity
- Encourage investment, technical cooperation, policy, education, awareness and extension in soil
- Promote targeted soil research and development focusing on identified gaps and priorities and synergies with related productive, environmental and social development actions
- Enhance the quantity and quality of soil data and information through data collection and generation, analysis, validation, reporting, monitoring, and integration with other disciplines
- Harmonize methods, measurements and indicators for the sustainable management and protection of soil resources

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