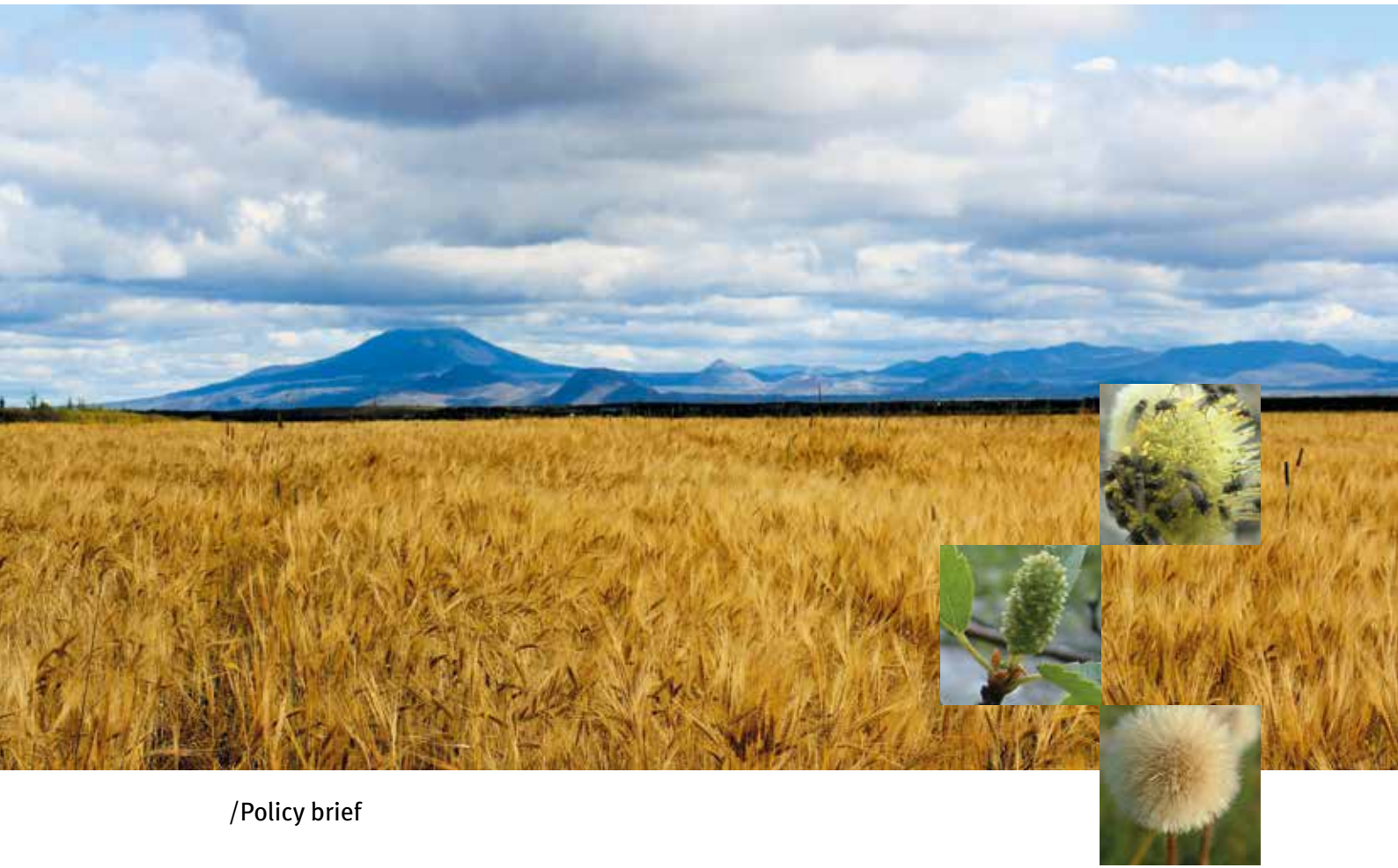
Soil Carbon Sequestration – for climate, food security and ecosystem services



/Policy brief

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Soil Carbon Sequestration – for climate, food security and ecosystem services

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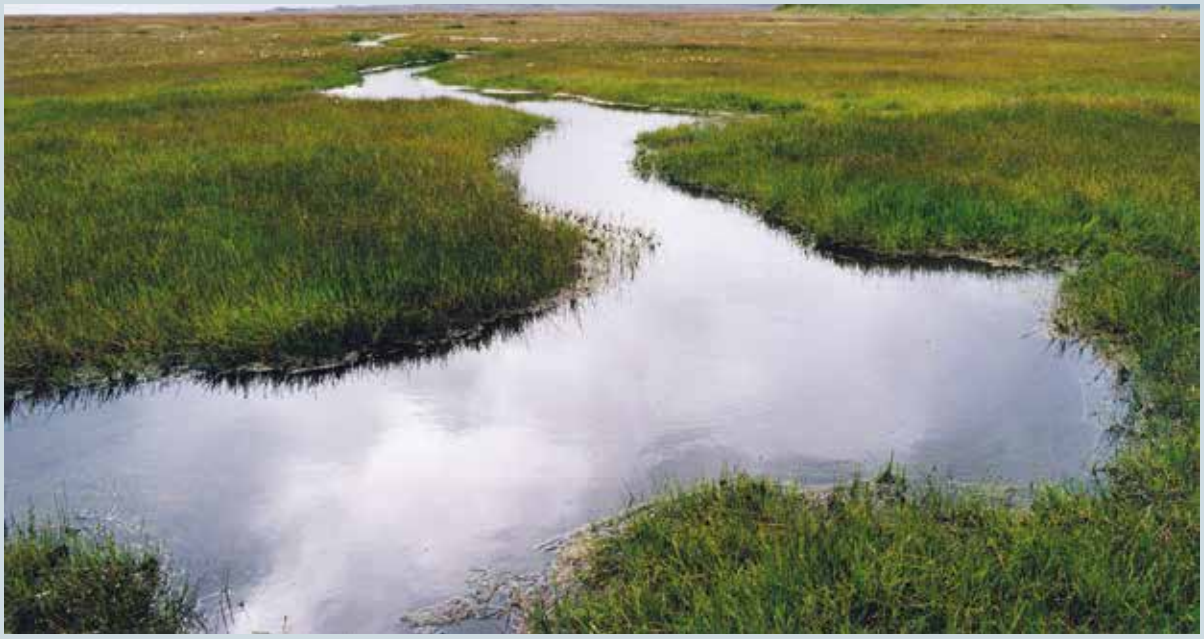

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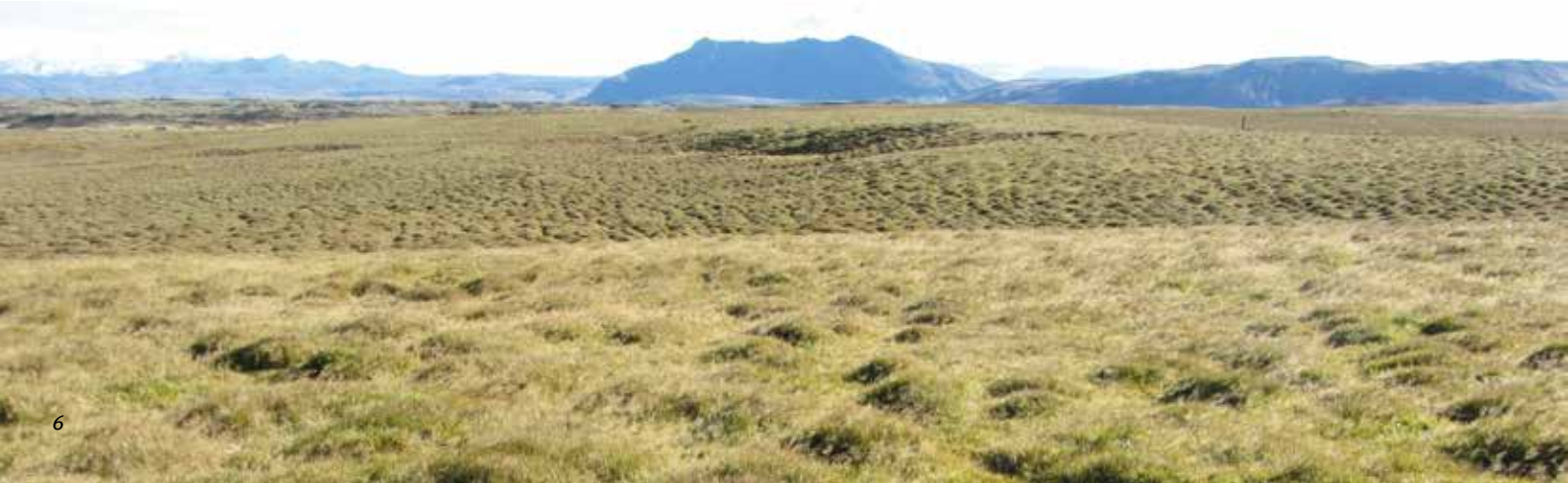
Conclusion and recommendations

Carbon sequestration in soil can significantly contribute to both Nordic and international goals of limiting serious climate change. By linking global, national and local policies to global agreements we can develop a more comprehensive and robust approaches to soil protection and carbon sequestration through different actions than we currently have. The most efficient way would be the establishment of an international legal framework on soil to meet national obligations to sustainable soil use and soil carbon management that would be based on collaboration between all sectors and different hierarchical levels.

Soils are fundamental to our life and must be recognized and valued for their importance in global feedbacks to climate change and in particular their large potential to mitigate climate change. Therefore, sustainable use of soils is a key issue in climate change context. Even if just a small fraction of the carbon stored in soils would be released to the atmosphere, by e.g. changed management, land-use, soil degradation and erosion, it could offset the success that other sectors are achieving in restraining anthropogenic greenhouse gas emissions. On the other hand, building up carbon stocks in soil, through carbon sequestration resulting from proper management, is a promising cost-effective natural process to aid in limiting global warming, and has also numerous co-benefits.

Establishment of forests and changes in management of forests, cropland and rangeland have a high potential to sequester soil organic carbon and can be a win-win strategy for increased soil fertility, moisture retention and mitigating climate change. The importance of wetland protection and restoration of degraded ecosystems in climate policy needs to be acknowledged. Maintained or improved soil fertility is a prerequisite for a multitude of important ecosystem services including



sustainable provision of food and fibres. Therefore, restoration and protection of soil organic carbon are key solutions to many of the most pressing global challenges facing mankind today. Highlighting the importance of the soil and the multiple benefits of soil organic carbon sequestration has never been more needed than now.

The major conclusion from the conference "*SOIL CARBON SEQUESTRATION for climate, food security and ecosystem services*" is that the soil must be considered as an engineer in combating climate change and that its role is essential for finding the solution. The following actions are recommended to accomplish this:

- Communication and collaboration between scientists, land managers, the public and policy makers are needed in order to highlight the value of soil carbon and turn soil science into action.
- Hands-on education of the young needs to be put on the agenda.
- The environmental cost of production, such as costs of soil degradation, needs to be reflected in the pricing of agricultural goods.
- We need small but well oriented projects, developed by local people and based on sound local and innovative knowledge and holistic environmental management.
- The knowledge of smallholders, especially in developing countries, needs to be included in the search for solutions to land quality and climate change. Strategies for Climate Smart Agriculture (CSA) need to be advocated.
- Policy making needs to better incorporate the potential of private sector involvement in improving land management.
- There is a need to revive national infrastructures for a more systematic storage and management of soil data.
- Soil carbon and soil functions need to be placed at the centre of a global paradigm shift toward sustainable natural resource management. Establishment of a scientific panel within UNCCD could be an important step in this direction.

Linking science, policies and action on soil carbon sequestration

Building bridges between science, policy and action is urgently needed. Although almost all of our calories come from use of soils, soil issues are not on top of the agenda in the present policy framework. Soils are overlooked and taken for granted. This may relate to the fact that more than 50% of humans live in urban environments and are not in contact with soils. Therefore, scientists must realise that their job has just begun when scientific papers are published, as increasing interest in and common knowledge of soils are needed. Scientists must be active in this process.

There is a real concern about the lack of soil protection legislation at EU level and general guidelines for policy-makers on carbon management are urgently needed. In order to facilitate this, it is important to enhance the flow of information from the scientific community to regulators and the public on benefits of carbon sequestration and management.

There are solutions available to tackle soil loss and to improve natural resource management; but to ensure global progress; they need to be used more efficiently. Soils are currently a “policy gap” in climate policy, although soils are an important key to climate change mitigation and food security. Agriculture and land management have to become a part of major solutions to both the food and greenhouse gas problems.

Soil carbon and soil functions should be at the centre of the needed global paradigm shift towards sustainable natural resource management. To accomplish this soil awareness must be raised in the international arenas. In the global perspective, soil has not been ranked as a priority target, e.g. regarding the post 2015 Sustainable Development Goals (SDG), and there are currently no SDG for land and soils. The establishment of a scientific panel within UNCCD could be an important step to return this trend.

Identifying the economic value of ecosystem services related to soils can be an important step toward better soil protection. Ecosystem services related to soils can be evaluated via e.g. direct market pricing; biomass production; and hedonic pricing methods, although such economic evaluations are only a rough estimation of the true value of soils and the ecosystem services they provide to mankind.

In order to protect the soil resource, soils need to be part of the agenda in an interdisciplinary way, including not only social and economic aspects but also ethical and aesthetic values. International agreements, such as the Zero net Land Degradation, have the potential to globally highlight the importance of soils. The newly established Global Soil Partnership (GSP) is an example of that. The aim of the GSP is to work with stakeholders on local, national and global scale on gathering information on soils; raise awareness on soil conservation and provide solutions on how to tackle ecosystem degradation and poor land management.

The mandate of the GSP is to improve governance of the limited soil resources of the planet in order to guarantee healthy and productive soils for a food secure world, as well as support other essential ecosystem services, in accordance with the sovereign right of each State over its natural resources. The GSP should become an interactive and responsive partnership.

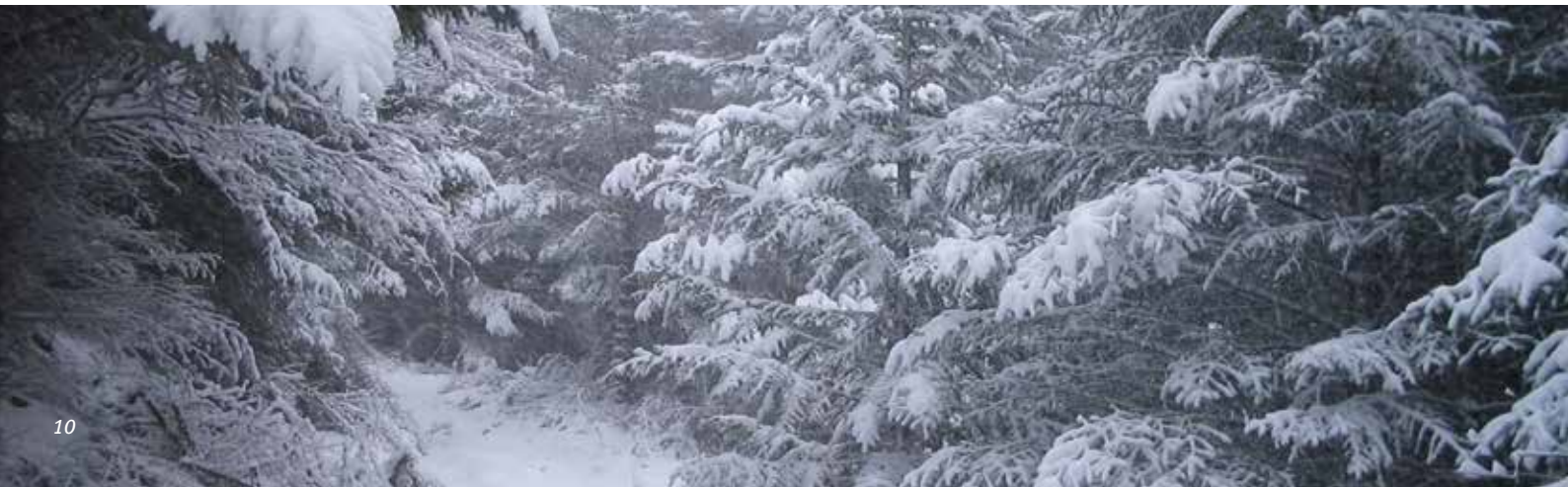
Key finding 1: Forests

In general, establishment of forests on cropland, heathland or degraded land results in significant increases in soil organic carbon, whereas conversion of grassland to forest is less effective. Secondary forest development after logging of primary forest can restore organic soil stocks, but conversion of native forest to plantation often leads to losses of soil carbon.

It should be noticed that sequestration of carbon in forest soil is highly dependent on site properties, land use history and tree species used. Mixed stands can be superior to pure stands in this respect, and less intensive management, as well as silvopastoral management systems, can lead to increased sequestration of organic carbon. Agroforestry systems in the tropics also have a positive impact on soil carbon sequestration. Increased temperatures due to global warming can lead to increased carbon sequestration in forest soil as a result of higher productivity, but this may be counteracted by increased losses of organic carbon by decomposition due to higher soil temperatures and moisture.

Better data are needed on several factors in order to optimize carbon sequestration in forest soil. This includes the effects of climate change, tree species diversity, forest management system, soil properties, and belowground processes and the role of soil biota. We need also to better understand how we can direct organic matter into stable mineral soil carbon pools.

The forest ecosystem stores huge quantities of carbon in biomass, which is important to offset net carbon emission. Forest biomass can also be used to replace fossil fuels. Therefore, it is important to account for the whole carbon budget of the forest ecosystem.



Key finding 2: Cropland

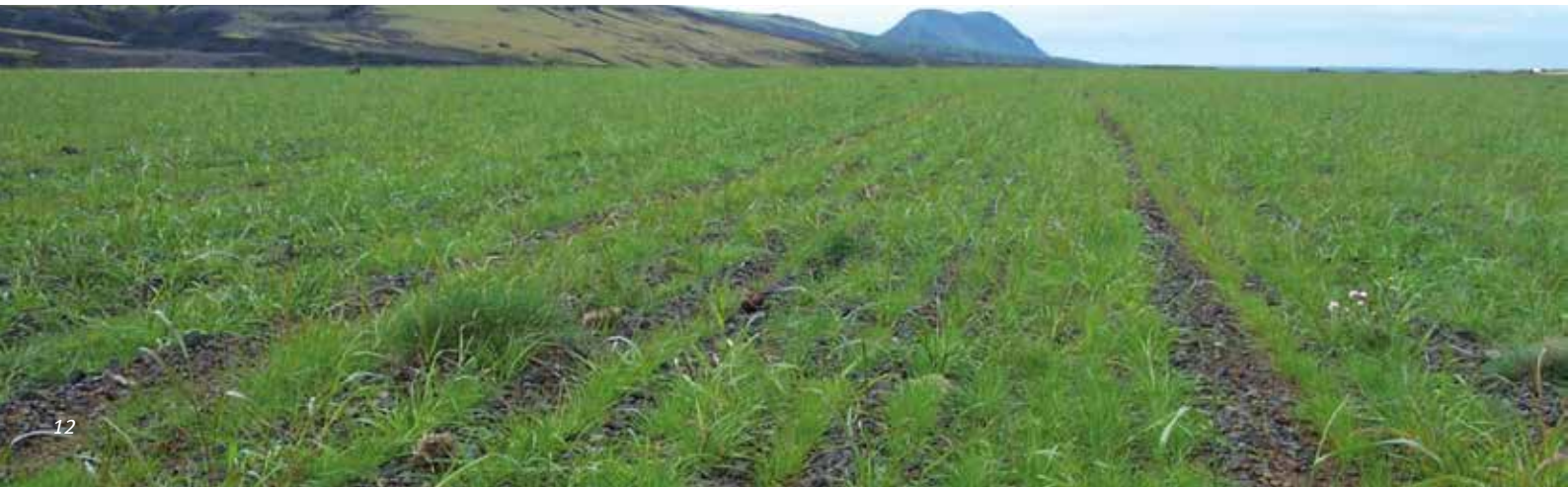
Changes in cropland management have a high potential to sequester soil organic carbon and can be a win-win strategy for increased soil fertility, soil quality and food production and for mitigating climate change. However, local increases in soil carbon are not necessarily true carbon sequestration. Therefore, it is important to perform life-cycle analysis to include all emissions involved with changed cropland management to sequester soil organic carbon. Only maximizing carbon sequestration in croplands may not always be the best policy option; substitution of fossil fuels by using crop residues for bio energy may be as effective for reducing atmospheric CO_2.

Changes in land use, climate and farm management can have significant effects on carbon sequestration in cropland. Abandonment of agricultural land can result in large carbon sequestration. Adaption of less intensive tillage practices works to sequester organic carbon in croplands mostly in warmer climates – but less so in colder climates. Fertilization generally increases carbon stocks in croplands since carbon inputs to soil increase, but this can be counteracted by increased N_2O emissions. Application of manure and crop residue return increases carbon stocks in cropland. Studies show that an increase in aridity, due to climate change, can cause significant decrease in soil organic carbon stocks. However, this could be mitigated by land use change.

Key finding 3: Grassland – rangeland – eroded land

The predominant land use of grassland/rangeland is livestock grazing, which, together with fire and drought, is the main disturbance factor in these ecosystems, often leading to soil erosion. Erosion and desertification are the major drivers for loss of soil organic carbon in grasslands. Therefore, sustainable land use and revegetation of eroded land is highly important. Rangelands and degraded land, considering their areal extent globally, have high potentials for soil carbon sequestration. Globally, it would be possible to sequester 0.34 billion tons of carbon per year in rangeland soils with proper management and revegetation measures.

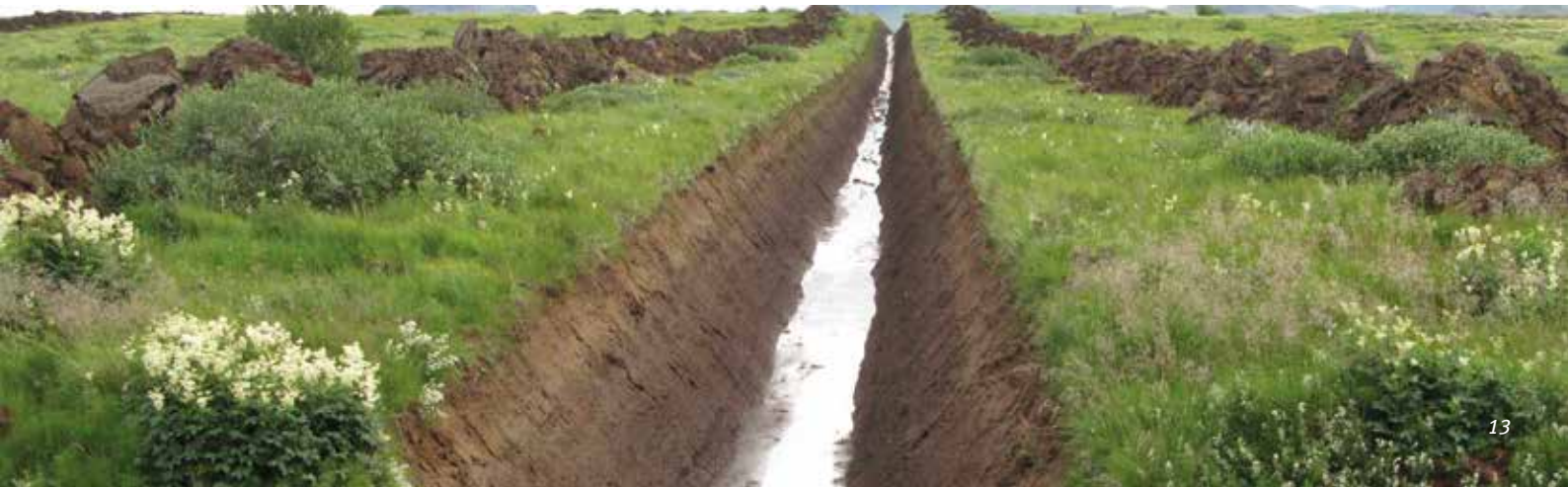
The build-up of soil organic carbon through natural succession on eroded areas is a very slow process which may take centuries. However, a rapid build-up of carbon stocks during early stages of ecological restoration can result from revegetation actions. Different management practices on grassland/rangeland, involving internal nutrient cycling on farms, have been shown to result in fast increases in soil carbon and lower energy use of non-renewable sources. Climate change can pose a threat to carbon stocks in grassland/rangeland as higher temperatures lead to acceleration of decomposition of organic carbon in litter and soil and decreased soil moisture, resulting in loss of carbon and ecosystem degradation.



Key finding 4: Wetland

Wetlands cover about 3% of the global land area, but contain 20–30% of the terrestrial stocks of soil organic carbon. It is highly important to protect these vulnerable stocks which are seriously threatened by drainage and climate change. Wetland protection and restoration (rewetting) needs to be a significant factor in climate policy and now UNFCCC has accepted to include wetland restoration as valid action to reduce net GHG emission. However, GHG fluxes in wetlands are complicated and involve many GHG gasses. Better understanding of the dynamics of this important ecosystem is a necessary prerequisite to its effective management.

In the landscape, organic soil wetlands are an integrated part of a network of forests and croplands on higher/drier sites and often linked by streams and lakes. A considerable part of the soil organic carbon can be transported by water, mostly by horizontal transport within surface soil layers. This can be modified by management and must be taken into account in relation to mitigation efforts.

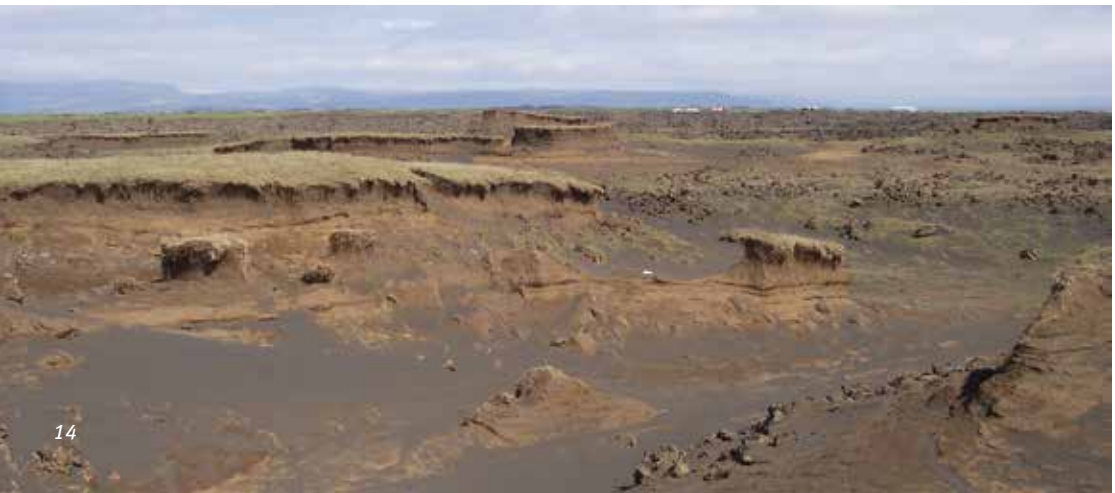


Key finding 5: Verification and permanency of carbon sequestration

Accurate accounting of soil carbon stocks and changes is highly important and permanency of carbon sequestration measures has to be considered. Soils can hold huge stocks of organic carbon and measurements of changes in these stocks can be difficult. In addition to that, soil organic carbon is found in different forms, some are stable and unlikely to be released while other are relatively labile and more likely to be released to the atmosphere in case a disturbance is imposed on the ecosystem.

There is a need to enhance routines of monitoring and mapping soil organic carbon for global use and assess timely changes in organic matter quality. It is critical to improve national reporting on emissions for UNFCCC and to develop a world-wide data set of carbon stocks. Within the EU, more cooperation is required from member countries in estimating organic carbon stocks. This relates to the fact that there is no legislation to oblige EU member countries to supply data. There is also a need for identifying the main drivers for soil carbon change and greenhouse gas emissions from agricultural activities and to quantify the impact of various mitigation practices. Tools are urgently requested by advisors and land managers for valuating site-specific measures that could be implemented for carbon sequestration and mitigation of greenhouse gas emissions.

There are large differences between biomass production chains when expressed as a function of CO_2 emission and therefore it is important to consider the whole chain of production in decision-making. Developing "Toolboxes for soil carbon management" could therefore be beneficial for various user groups. There is a need for standardizing methodologies for mapping/identifying soil carbon – in particular from the local to the regional level. It is important to identify the challenges for monitoring organic soil carbon at different levels and scales and in different ecological zones. This information should be linked with regional characteristics, such as climatic conditions.



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Soil carbon sequestration and preservation of present stocks reduces net global greenhouse gas emission and can contribute significantly to both Nordic and international goals of limiting serious climate change. In order to achieve this, sustainable use of soil resources, better soil and water management practices, and restoration of degraded soils is needed. Protection and restoration of soil organic carbon are also key solutions to many of the most pressing global challenges facing mankind today. Highlighting the importance of the soil and the multiple benefits of soil organic carbon sequestration has never been more needed than now.

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