

SOIL

the hidden part
of the climate cycle

soil



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Introduction

Soil is a natural resource which most of us either ignore or take for granted. Yet the thin layer of 'dirt' that covers much of the surface of the Earth is vital to the environment and invaluable to our societies.

However, soil quality is declining in many areas, meaning that it is less able to perform its essential functions. One area of concern is the effect of soil degradation on the climate, and vice versa.

Soil is the planet's second largest active pool of carbon after the oceans, but its ability to continue to retain the huge amounts of carbon it stores has been weakened in recent decades, largely due to unsustainable land-management practices and changes in land use. Research suggests that, as a result of these changes, soils are releasing large amounts of carbon into the atmosphere, threatening to undermine reductions in emissions made elsewhere, such as in industry or transport.

In addition, climate change is itself contributing to land-degradation processes. In Europe, many southern countries – prone to suffering from higher temperatures and changes in rainfall – face the growing risk of desertification. The problems are likely to expand northwards as climate change impacts become more intense.

Northern countries may receive more total rainfall and experience more intense rain storms. The capacity of water absorption and infiltration of soils will become even more important. In addition, the delicate ecosystems in the Boreal region are threatened by the rapid thawing of the frozen soils in permafrost areas and are releasing increasing amounts of carbon dioxide and methane into the atmosphere.

Although current trends may paint a worrying picture, soil can also be part of the solution to fighting climate change. With almost half of Europe's territory under farming and around 40% covered by forests, sustainable agriculture, forestry practices and good land management can help maintain or even increase the amount of carbon held in the ground.

The solutions are cost-effective and ready to use now, but concerted and urgent action is crucial. Better soil management and more efficient use of our land resources are needed across the EU to ensure this happens.

The links between soil and climate change are complex. This brochure aims to shed some light on the relationship between the two, explain the underlying processes, and highlight the urgent need to use this precious resource responsibly.

Soil: the hidden part of the climate cycle

Soil processes are an integral part of life on Earth. With constant fluxes of carbon between plants, the atmosphere and the ground, soil also plays a vital role in the global climate.



Made up of minerals, residues from plants and animals, water, air and living organisms, the soil beneath our feet is a complex and efficient ecosystem operating at a tiny scale.

The processes that take place underground in the soil are vital in providing many of the raw materials we depend upon – from the food we eat, to the clothes we wear, to the materials we build with. Soil processes are essential for clean water and ecosystem health, without which life as we know it would be impossible.

The fertility of soil and its ability to perform its key functions depend to a large extent on the levels of organic matter within it. Humus, besides giving the soil its brownish or dark colour, is one of the most complex elements of soils. Without this mixture of different organic components, including very stable and old humified substances, as well as more changeable plant and animal residues in the process of decay, soils would not support the wide variety of organisms that live within it.

These creatures – ranging from bacteria to worms and insects – recycle organic matter and make available the nutrients that plants depend on. Organic matter is the key to healthy soil, maintaining soil structure, providing nutrients from leaching, fixing pollutants and improving water infiltration and retention.

Carbon cycling

Because soil organic matter contains around 60% carbon, it is the defining factor in soil's influence on the global carbon cycle.

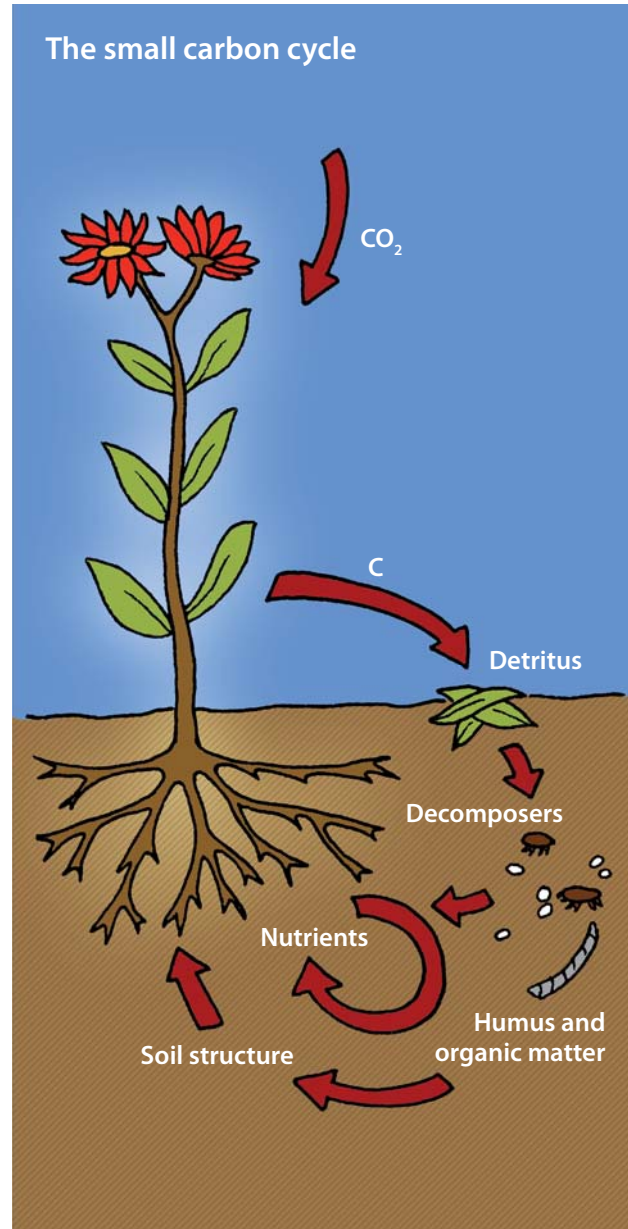
With around 1 500 billion tonnes of carbon found in the organic matter in soil worldwide, soils are the second largest active store of carbon after the oceans (40 000 billion tonnes). There is more carbon stored in soil than in the atmosphere (760 billion tonnes) and in vegetation (560 billion tonnes) combined.

However, as with other carbon cycles, there are constant transfers of carbon between the soil and the atmosphere and vice versa, through plants. In fact, the emissions of CO₂ (carbon dioxide) from soils to the atmosphere are around ten times those from fossil fuels, but under natural conditions this is balanced by a similar flux in the other direction.

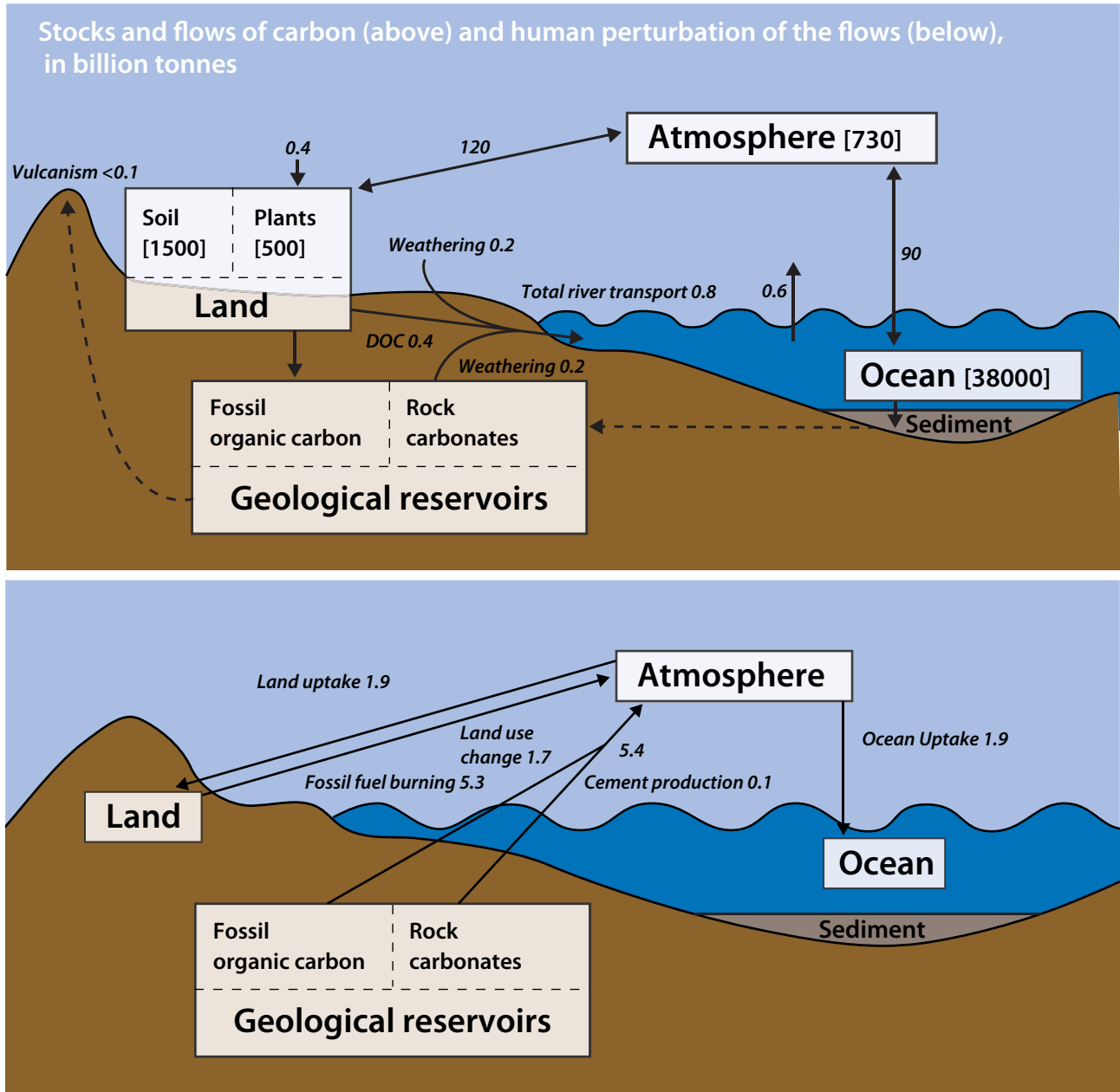
Plants absorb CO₂ from the atmosphere through the process of photosynthesis and use it to build their roots, stems or leaves. Carbon is mainly transferred into the soil through the release of organic compounds into the soil by plant roots or through the decay of plant material or soil organisms when they die.

Microbial breakdown of the organic matter finally releases the nutrients which plants use to grow. During this process of decomposition, some carbon is released as carbon dioxide through soil respiration, whilst other carbon is converted into stable organic compounds that are locked into the ground. How fast this happens depends on factors including temperature and rainfall, the soil-water balance, and the composition of the organic material.

Different organic matter sources decompose at different rates. If the addition of new material is less than the rate of decomposition, soil organic matter declines and, conversely, if the rate of addition is greater than the rate of decomposition, soil organic matter will increase. However, in general the process



Source: Adapted from Fig. 2-18 on p. 76 of http://ec.europa.eu/environment/soil/pdf/biodiversity_report.pdf



Source: Carbon cycle, from CLIMSOIL (p.24) http://ec.europa.eu/environment/soil/review_en.htm

leading to losses of carbon from the soil happens more quickly and easily than the process of rebuilding carbon stocks.

Whether soils are accumulating or losing carbon – and thus acting as carbon sinks or carbon sources – depends on a number of factors, especially how the land is used and on climatic conditions.

In addition to CO_2 , soils also play a significant role in the balance of other greenhouse gases. Nitrous oxide (N_2O) emissions, a greenhouse gas almost 300 times more potent than CO_2 , are associated with the decomposition of organic matter and the use of nitrogen fertilisers. Methane (CH_4) is a greenhouse gas about 20 times stronger than CO_2 and is produced in soils under anaerobic conditions.

Organic matter – the fabric of life

Organic matter is the mixture of residues from plants, animals and other organisms that exist in the soil in various degrees of decomposition.

This material breaks down, reforms, and recycles as plants, bacteria, worms, fungi and the myriad of creatures that inhabit the soil, live and die and devour each other.

The end products of these processes are extremely complex molecules of humic substances of varying sizes and stability. When the organic compounds become stabilised, they are known as **humus** and are no longer easily broken down further by soil organisms. The timescale for this process can vary from decades to hundreds or even thousands of years.

These humic substances are extremely large – each one is between 100 000 to 200 000 times the weight of a hydrogen atom – and they come in an infinite number of shapes and sizes, with no two ever the same.

There can easily be 250 tonnes of humus in a hectare of fertile soil. The abundance of humus forms is essential to all the biological processes in soil, meaning they are essential to the very fabric of life.



Carbon stocks in European soils

Changes in land use are threatening the soil's ability to act as a carbon sink. Small but widespread variations in the levels of organic carbon in soils can have dramatic impacts on the concentration of greenhouse gases in the atmosphere.

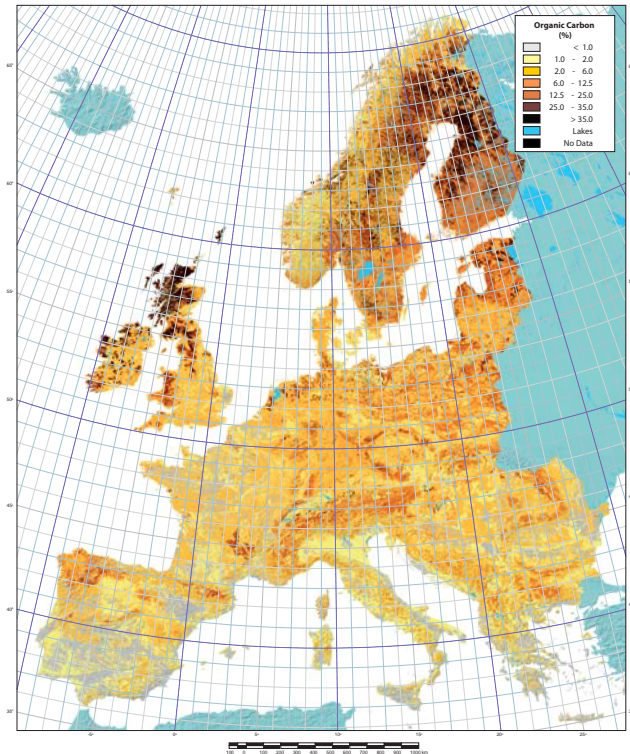
Containing an estimated total of about 75 billion tonnes of carbon in the topsoil layer alone – equivalent to 275 billion tonnes of CO₂ – European soils are a huge reservoir of carbon. Given that the EU's annual emissions of CO₂ are just over 4 billion tonnes, releasing even a tiny fraction of the carbon in the soil into the atmosphere would have a significant effect on efforts to fight climate change.

For example, a release of just 0.1% of the carbon now contained in Europe's soils would be equal to the annual emissions from 100 million cars.

Europe's soil resources – and the amount of organic carbon they contain – vary widely, reflecting diverse geology, climate,



Organic carbon content of European soils



Source: Joint Research Centre, European Soil Data Centre

topography and land use. In general, soils in northern Europe have higher levels of organic carbon content compared with southern Europe soils, where soils with very low levels of organic material are quite common.

Different land uses have significant effects on the levels of organic carbon in the soil and the amounts of carbon they can store. Farming – which covers more than 40% of the EU land area – has a particularly significant influence. For instance, soils under arable farming store on average 110 tonnes of carbon per hectare, whilst pastures hold 160 tonnes per hectare, although there can be large variations across the EU.

This means that when land use is changed the carbon in the soil changes too. For example, if land is converted from pasture to arable, carbon can be released, and in this case the soil becomes a source of greenhouse gas emissions. The soils with the highest emission potential are those with the highest organic matter content.

Sink or source?

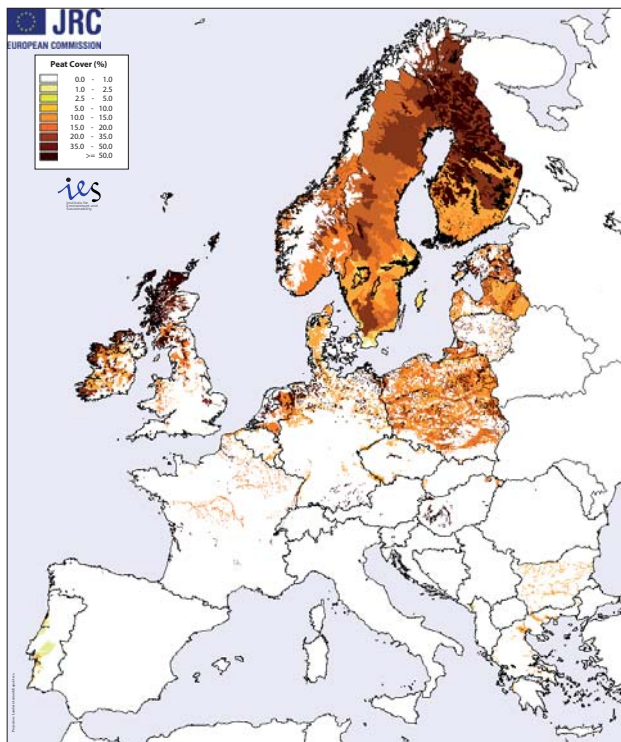
Many soils in Europe – largely those under grassland, forests and natural vegetation – are accumulating carbon and thus act as carbon stores or ‘sinks’. On the other hand, soils converted to arable land tend to release carbon into the atmosphere, because of the increased mineralisation rate of tilled soil and the more limited amount of organic materials left on-site or brought back as manure to the fields.

Conversion of cropland to forest or grassland can sequester significant amounts of carbon in the soil. As grasslands are more efficient than forests at storing carbon in the soil, the afforestation of grasslands generally leads to a loss of soil carbon, although this is counteracted by the accumulation of plant biomass.

Despite a lack of EU-wide data, several long-term studies suggest that the total amounts of organic carbon held in soils across Europe are gradually decreasing. Figures from England and Wales show an average of 0.6% of their organic carbon content was lost each year between 1978 and 2003, and similar patterns have been observed in France, Belgium and Sweden.

Changes in land use – including the conversion of grasslands to arable land, deforestation to make space for the construction of buildings and infrastructure, and the drainage of peat soils – may be some of the key trends behind this lowering in levels of organic matter in soils across Europe. Meanwhile, at a global level, desertification and deforestation are additional factors in the release of carbon from soils, in addition to that lost from vegetation.

Occurrence of peat-covered land in the EU



Source: Joint Research Centre, European Soil Data Centre

The importance of peat

The undisputed hot spot of CO₂ emissions from soils comes from the drainage of peatlands (organic soil). Almost half of the total amount of carbon held in soils in the EU-27 is found in Sweden, Finland and the United Kingdom, because of the large areas of peatland in these areas. Other areas with highly organic soils in northern European countries include Ireland, Poland, Germany, Norway and the Baltic states.

Apart from negative consequences for the water cycle and biodiversity, it is clear that changes in land use in these areas

could have a significant influence on the climate. Many of these peatlands are under threat from unsustainable practices, such as continued drainage, conversion to grassland, cropland or forestry and, to a lesser extent, direct extraction of peat for use in horticulture and as a fuel, the effect of fires and the impact of changes in the climate itself.

Recent studies estimate that almost half of all European peatlands have been drained already: 28% (90 000 km²) for forestry, 20% (65 000 km²) for agriculture, and 0.7% (2 273 km²) for direct extraction. Total emissions from the draining of organic soils for grassland and cropland have been evaluated at up to 100 million tonnes of CO₂ annually, although official estimates by Member States are much lower than that.

The importance of protecting these highly organic soils is underlined by the fact that although peatlands represent only around 2% of the crop area in Europe, they are responsible for more than 50% of CO₂ emissions from croplands.

Other threats

In southern European countries, such as Portugal, Spain and Italy, soil organic carbon stocks are at greater risk from desertification, face higher levels of erosion and increased threats of wild fires – factors which also mean they are losing organic matter and releasing increasing amounts of carbon into the atmosphere.

Meanwhile, intensively managed soils, especially in major agricultural areas, including France, Germany, the Netherlands and the United Kingdom, are vulnerable to loss of soil carbon due to common agricultural practices, such as the ploughing of arable soils, application of mineral fertiliser, drainage of organic soils, and crop rotations with reduced proportion of grasses or no crop rotation at all.

The negative trend in soil carbon stocks could be exacerbated by the growing demand for bio-energy production, when either

the whole crop (e.g. maize) or the crop residues (e.g. straw) are harvested or taken off-site without returning any of the biomass that otherwise would be used by the soil micro-organisms to produce new organic matter.

The damage done to soil resources – and a decline in the levels of organic carbon within them – cannot be reversed quickly. The use of Europe's soils has to be more sustainable to ensure that they can perform their essential functions – and continue to hold their stocks of carbon. In particular, the drainage of peatlands should be stopped and reversed to a maximum extent, and unsustainable farming systems or practices should be altered if soils are to retain their organic matter and reduce the risk of further desertification.

Changes such as these – supported by effective agricultural policies – can ensure that soils play a positive role in climate change, preventing the release of more carbon into the atmosphere and contributing further to the problem.

What is peat?

Under normal circumstances, all plant residues are broken down by micro-organisms. However, very wet and anaerobic conditions in soils may hamper this breakdown, leading to a large accumulation of partially decomposed plant material and the formation of peat soils.

Compared to mineral soils, peat soils contain huge amounts of organic matter – and thus huge amounts of carbon. Whilst an average grassland soil contains some 100 tonnes of carbon per hectare in its top 30cm, for a peat soil the figure can be much higher than that, and this to a depth of metres rather than centimetres. However, once exposed to oxygen, the carbon in peat soil is quickly lost to the atmosphere.

Most peatlands were formed in lowlands collecting water from catchments, but large and frequent amounts of precipitation in humid areas can lead to the formation of bogs on hills and slopes.

Peat soils represent the highest concentrations of organic matter in all soils. Currently, the area of peatland in the EU is more than 318 000 km², mainly in the northern areas.

At the global level, peatlands hold at least one-fifth of the total soil carbon pool, which is equivalent to approximately half the amount of CO₂ in the atmosphere.



How climate change will affect soils

Changes to temperatures and weather patterns will impact soil processes and will add to soil degradation in many parts of Europe.

The pressures on soils across the EU have been growing in recent decades. They face erosion from wind and water, compaction from heavy machinery, sealing from building and urbanisation, salinisation caused by irrigation practices, acidification from inappropriate fertiliser use, as well as contamination from industrial or agricultural operations.

Climate change, particularly the more frequent extreme weather events it brings, is exacerbating some of these negative trends, with impacts on temperatures, precipitation patterns and the concentrations of gases in the atmosphere. There is evidence that average temperatures have increased in recent decades and these increases are likely to accelerate in future.

The latest scenarios developed by climate scientists show generally warmer temperatures across the whole of Europe, with drier summers and wet winters. Northern Europe is expected to experience increased precipitation and warmer winters, while southern regions are likely to have even warmer and drier conditions. For soil, temperature increases should lead to raised biological activity, creating more mineralisation of the organic matter in soil and thus more carbon loss. However, the magnitude of this effect could be reduced by lack of water during summer droughts.



The impacts on soil carbon stocks are significant. Studies have suggested that the heatwave that Europe experienced in 2003 – where temperatures were up to 6°C higher than usual average temperatures – caused the release of up to twice the annual amount of carbon emissions produced by fossil-fuel burning.

Adding to the pressure

In some cases, these changes could be positive. For instance, warmer temperatures in northern Europe might increase productivity, open up the possibility of cultivating new crops and create longer growing seasons. Increased productivity is also likely to increase inputs of organic matter in the soil pool, although the impacts will be reduced by increased mineralisation. However, in many areas these changes in the climate are expected to add to the pressure on soil resources in future and exacerbate existing declines in soil quality, with desertification as the final result of the degradation.

Climate change is increasing the risk of erosion – the wearing away of the land surface by water and wind – particularly because

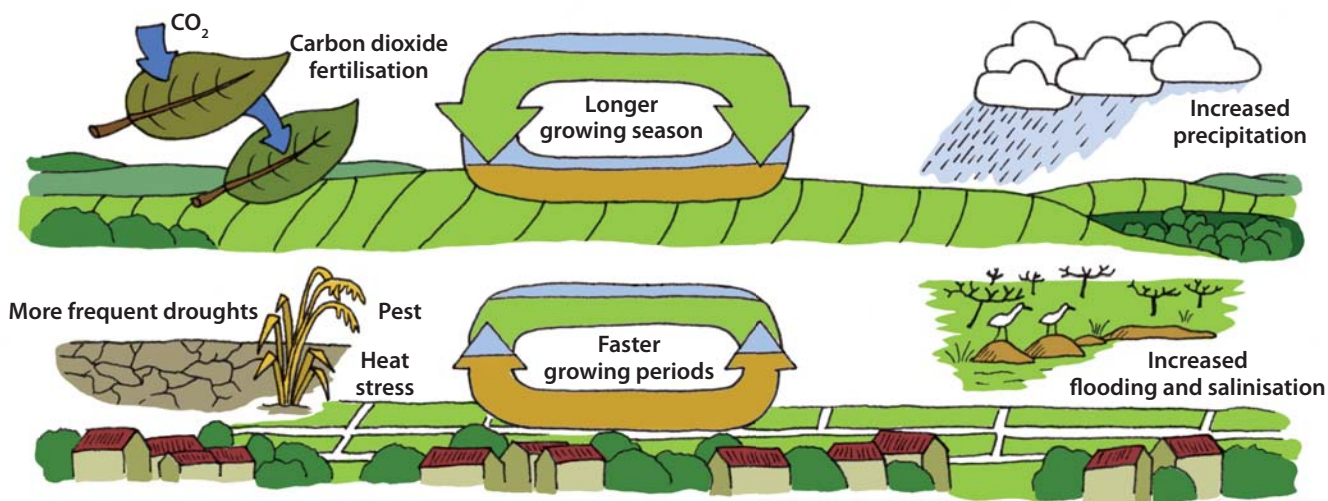
of changes in rainfall patterns and intensity. Whilst droughts can remove or weaken protective plant cover and leave soils more exposed to erosion, very heavy rain storms directly wash away topsoils.

Some 16% of Europe's land area – around 105 million hectares – are at risk from water erosion. The Mediterranean region is particularly susceptible because it experiences long dry periods followed by spells of heavy rain. In many of these southern areas, soil erosion is already at the irreversible state, whilst in the worst-affected areas it has stopped because there is simply no soil left.

In northern Europe, water erosion is less visible because, in general, there are higher levels of vegetation cover. Nevertheless, it still poses a major threat to the fertility of soils, especially in cropland areas and on other land with little vegetation.

Meanwhile, wind erosion is a serious problem in many parts of Europe, notably areas in northern Germany, eastern Netherlands,

Impacts on agriculture are complex and can be both positive and negative



Source: International Institute for Applied Systems Analysis (IIASA), 2007

eastern England and the Iberian peninsula. Soil losses in these areas can easily exceed 10 tonnes per hectare per year.

Desertification is the process when the land becomes so degraded that soil functions collapse completely. With higher temperatures and increasingly long dry spells, climate change is a major factor in the process of desertification in Europe and this effect is likely to become stronger in future.

Recent research estimates that more than 8% of areas in southern, central and eastern Europe are at very high risk of desertification, affecting around 14 million hectares of land in some of the poorest and most vulnerable parts of the EU.

Melting influence

At the global level, the effect of higher temperatures could lead to soils having a significant influence on the climate itself.

How farming can contribute to soil conservation – the SoCo project

What is the status of soil degradation in the EU? What are effective soil conservation practices? And what measures will encourage farmers to adopt systems that protect soil resources? The Sustainable Agriculture and Soil Conservation (SoCo) project – which ran from 2007 to 2009, having been initiated by the European Parliament – set out to answer these questions and to see what steps would be effective at the European level.

The first stage was to assess the current state of affairs in different countries. It considered the effect that current agriculture practices have on the main soil-degradation processes and then the difference that alternative farming practices could make. Ten case studies on farms in different EU regions looked at how soil conservation works in practice.

SoCo focused on two specific farming systems: conservation agriculture – which involves reduced or no tillage, permanent soil cover and crop rotation – and organic farming – which strictly limits chemical inputs and focuses on sustainable production cycles.

Both systems were found to increase organic carbon stocks, helping to improve soil functions, biodiversity and water retention and quality whilst reducing erosion and nutrient run-off.

However, the project highlighted that these systems require extra training for farmers, additional investment and they need to be adapted to local circumstances.

The project recommended that more efforts are made in monitoring the uptake of voluntary incentives by farmers, in order to help establish the correct measures. It also highlighted the importance of better information and advice on soil conservation for farmers, many of whom do not recognise its importance or benefits at the moment.

For more information see: <http://soco.jrc.ec.europa.eu/>

Permanently frozen soils in the northern circumpolar region, known as permafrost, currently hold around 500 billion tonnes of carbon. Increased melting of these soils will release huge amounts of greenhouse gases and rapidly intensify the effects of climate change.

The consequences of climate change will be felt throughout Europe. Loss of soil fertility due to depletion of organic matter, erosion and desertification will threaten food security. Likewise, more stress on fresh water availability will necessitate wider use of desalination technologies, with the likely result that the need for increased irrigation, and hence the costs of agricultural production will also rise.

Meanwhile, degraded soils will be less able to regulate water supply so the risk of flooding will become more likely. The damage caused to economic activities and private property, as well as communities and individuals, by such weather-related disasters can be considerable, as many parts of the EU have experienced in recent years.

Eight countries in central Europe suffered serious flooding in the summer of 2010, Poland being the worst affected, with 23 000 people having to be evacuated and the economic costs totalling around €2.5 billion. One report by British insurers estimated that the costs of flooding in Europe could increase to over €100 billion each year.

Recent droughts in Europe, such as those in 2003 and 2008, have highlighted the impact of desertification and the large economic costs that it brings. A recent EU study estimates the costs of droughts in Europe over the last 30 years have reached at least €100 billion. The drought of 2003 in central and western Europe alone caused an estimated economic damage of more than €12 billion.

Climate change impacts on soil systems

Although it is very difficult to predict accurately the effects climate change will have on varied and complex soil systems, recent studies have looked at various scenarios to assess the main impacts.

Higher temperatures promote the faster breakdown of organic matter in the soil due to a thermal boost to microbial activity. This accelerates the release of carbon dioxide and methane into the atmosphere through increased soil respiration, although it can also stimulate higher levels of plant growth with increased inputs to the soil. Raising emissions can, in turn, contribute to more warming.

Changes in precipitation and more extreme hydrological cycles are predicted for many parts of Europe – meaning that they will either experience heavier rain or snowfalls or prolonged periods with lower levels of precipitation.

The rate of decomposition decreases in soils with less moisture but will increase when more water becomes available. Combined with fluctuations in temperature, the changes in rainfall will affect soil structure, acidity and, in turn, its ability to store water and sustain many of the organisms that live within it.

Both drought and more intense rainfall can increase the risk of erosion which can cause the release of extra carbon into the atmosphere in addition to the climate-induced changes.



Soil and climate: the way forward

Better use of soils can ensure they play a positive role in efforts towards reducing climate change. However, given the international nature of the problem, a coordinated response is needed along with better information and monitoring to fully assess the state of soils across the EU.

Ambitious climate change mitigation objectives cannot be achieved without considering the behaviour of terrestrial carbon stocks, such as soils, as they represent a key element of the carbon cycle. If current trends continue, soils are likely to go on releasing large amounts of CO₂ into the atmosphere, adding to ongoing climate change and potentially cancelling out savings in emissions made by other sectors, such as industry and transport.

Improved soil management in the EU is needed to be able to tap the considerable mitigation potential soils offer, as well as to counteract the effects of climate change on soils, increasing their resilience to higher temperatures and extreme weather events.

Such action should help reverse soil degradation and ensure that soils are capable of supporting ecosystems and preserving their essential functions even under a changing climate.



Action to enhance soil quality can actually help to mitigate climate change by taking more carbon out of the atmosphere and storing it in soils. After all, among the different players in the climate system – the atmosphere, oceans, rocks, vegetation – soil is one carbon storage that we can actively influence in the relatively short term.

As climate change does not respect national borders, there needs to be a common approach to tackle the problem. A priority should be to protect those soils with the highest carbon content – namely peat soils and carbon-rich permanent pastures and forests. This is the most realistic option to both maintain and improve soil carbon stocks in the EU.

Sustainable measures

Improvements in soil-management practices can have considerable impact on carbon stocks. Changes to agriculture techniques can help minimise carbon losses, at the level of crop and crop residues, and ensure that soils are protected against erosion through increased vegetation cover, less-intrusive and less-frequent soil tillage techniques, and reduced use of heavy machinery.

The widespread adoption of such practices could not only avoid the release of carbon from European soils, but would help sequester between 50 and 100 million tonnes of carbon per year (estimating the maximum economic potential without considering non-economic barriers). However, measures must be implemented consistently across the EU, especially in view of the global nature of climate change and its impacts.

In addition to the climate aspect, the close links between soil quality and other environmental issues, such as biodiversity, water management, and degradation of pollutants, further underline the need for widespread action to sustain this sensitive, complex and essential resource.

Soil management practices

Suitable strategies to maximise soil storage for different land uses include:

On **cropland**, soil carbon stocks can be increased by:

- ▶ return of biomass to the soil;
- ▶ tillage and residue management;
- ▶ water management; and
- ▶ agro-forestry.

On **grassland**, soil carbon stocks are affected by:

- ▶ grazing intensity;
- ▶ grassland productivity; and
- ▶ species management.

On **forest lands**, soil carbon stocks can be increased by:

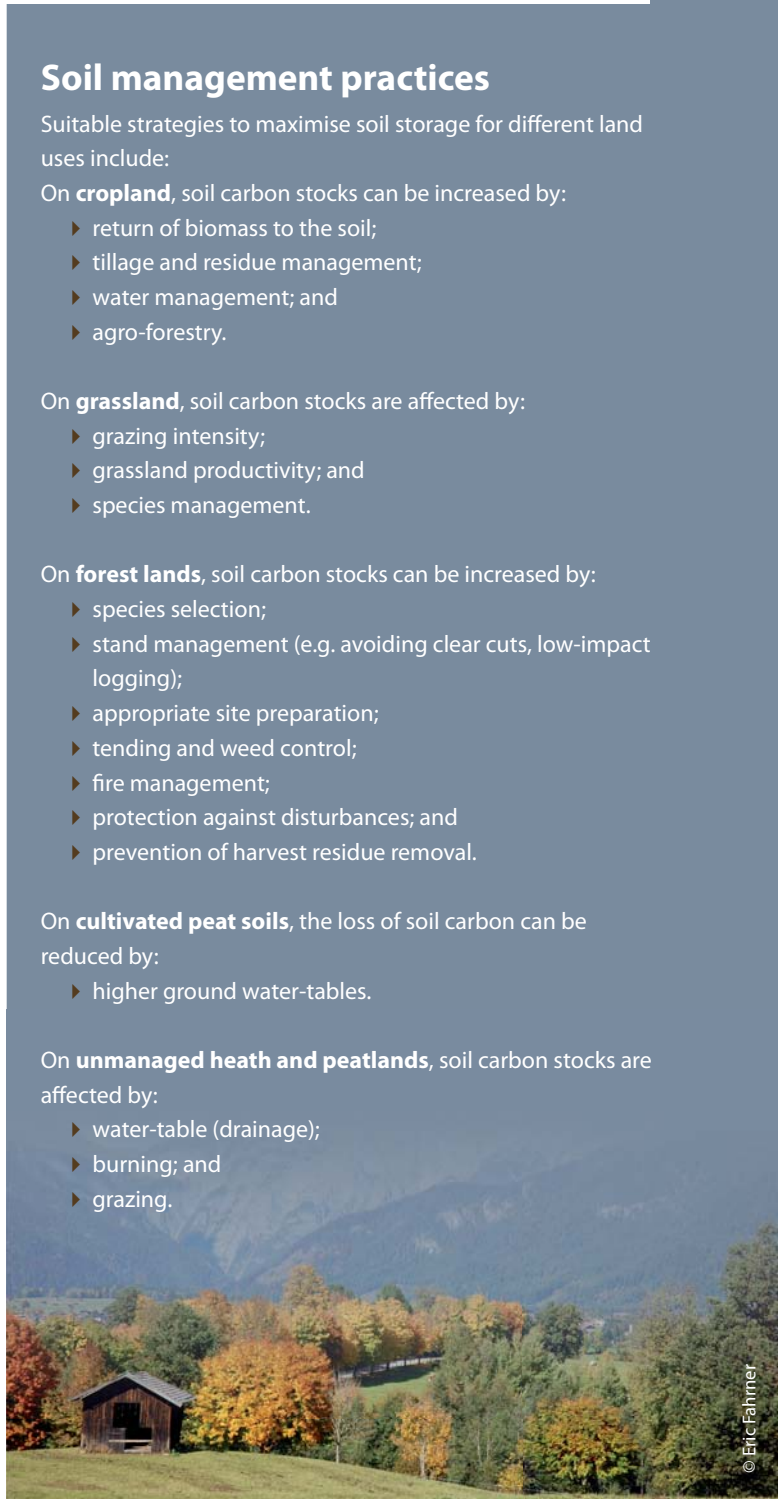
- ▶ species selection;
- ▶ stand management (e.g. avoiding clear cuts, low-impact logging);
- ▶ appropriate site preparation;
- ▶ tending and weed control;
- ▶ fire management;
- ▶ protection against disturbances; and
- ▶ prevention of harvest residue removal.

On **cultivated peat soils**, the loss of soil carbon can be reduced by:

- ▶ higher ground water-tables.

On **unmanaged heath and peatlands**, soil carbon stocks are affected by:

- ▶ water-table (drainage);
- ▶ burning; and
- ▶ grazing.



Better knowledge

There has been little focus on the role of soil in the climate change debate, even though the effect of land-use changes on soil is a key source of greenhouse gas emissions.

Currently, there is a lack of consistent and comparable data on soil trends and the stocks of carbon that they contain across the EU. National soil-monitoring systems, where they exist, provide little coherence between different countries' data. This is why evaluating changes in soil characteristics and functions throughout Europe is so difficult at the moment.

Several efforts are focusing on developing suitable indicators to improve the situation. The Envasso (Environmental assessment of soil for monitoring) project looked at how to develop 27 priority indicators for the key threats to soil that could be used to assess

current and future soil status. However, it found that a lack of data in many Member States prevented suitable assessment, including reliable estimates on carbon stored in peatlands.

Meanwhile, the Ramsoil (Risk assessment methodologies for soil threats) project investigated how to create common methods across the Union to assess the risks of soil compaction, erosion, landslides, organic matter decline and salinisation. It also found a lack of harmonisation across the EU on how data on soil is collected and assessed.

Other EU-funded efforts, including the 'Sustainable Agriculture and Soil Conservation' (SoCo) project (see page 14) have assessed how to make agriculture more sustainable and how rural development policy can ensure that there is greater focus on soil and its role in climate change.

Improvements are needed in the monitoring of soil carbon stocks – aiming at EU-wide coverage – to ensure that the link between soil and climate change is better understood and policies can be adopted to ensure that the role of soil as a natural solution is maximised.

Policy approaches

Realising that soil needs at least the same level of attention and protection as air and water, the European Commission has proposed a common approach to soil protection and the sustainable use of soils which aims to preserve essential soil functions and improve the collection of coordinated data on the state of soil resources in the EU Member States (see box on p. 19).

Ongoing reforms to the EU's common agricultural policy (CAP) encourage better farming practices that help maintain soil fertility and organic matter levels. These include organic farming, conservation agriculture practices, such as reduced or no tillage, crop rotation and cover crops, whilst still ensuring minimum standards of good agricultural and environmental condition to

The Global Soil Partnership

In the context of the Millennium Development Goals, in 2010 the Food and Agriculture Organization of the United Nations (FAO) began preparatory activities for a Global Soil Partnership for Food Security and Climate Change Adaptation and Mitigation. The partnership aims to develop a worldwide initiative towards the sustainable management of soil resources.

Soils are a limited natural resource, and can be considered as non-renewable in the time frame of human activities. Fertile soils are limited and are increasingly under pressure by competing land uses for energy production, infrastructure and housing, and the extraction of raw materials. Maintaining the minimum volume of soils needed to feed the growing world population should be one of the guiding principles of the Global Soil Partnership.

achieve soil protection. Farmers will be encouraged to implement agri-environmental measures that increase carbon sequestration and provide other environmental benefits.

In addition, more attention is needed in international climate change negotiations regarding the role of soil – both in the mitigation of and adaptation to climate change. A recent initiative by the FAO for a Global Soil Partnership for food security and climate change (see box on p. 18) is going in the same direction and should be further developed. These global aspects underline why the EU needs a common and solid approach ‘back home’ when trying to negotiate with others on appropriate climate change measures. The Commission is currently assessing how changes in biospheric carbon stocks, such as those in soils, could be included in the Union’s greenhouse gas emission reduction commitments.

A common European approach to soil

The European Commission’s proposal for a Soil Framework Directive, which was backed by the European Parliament in 2007 but is awaiting agreement by EU Member States, proposes three types of action to encourage sustainable use of soil and preserve its essential functions:

Preventative measures: to assess the impacts current policies have on soil quality in areas such as agriculture, waste, urbanisation or industry, and to ensure the sustainable use of soil and its functions.

Assessing threats: national authorities should identify areas at risk of erosion, decline in organic matter, salinisation, acidification, compaction or landslides. They should draw up an inventory of contaminated sites.

Planned actions: Member States should develop programmes to deal with the risks, along with remediation strategies for contaminated land and actions to limit soil sealing.

The Commission’s strategy also sets out requirements for harmonised information on soil across the EU. In its wake, the European Commission’s Joint Research Centre has established a European Soil Data Centre (ESDAC) to improve assessment and develop more comprehensive databases that can help refine the necessary soil-protection measures.



Further reading

For more information on soil and climate change, see:

The following European Commission's policy pages:

<http://ec.europa.eu/environment/soil/>

<http://eusoils.jrc.ec.europa.eu/>

http://ec.europa.eu/clima/news/index_en.htm

http://ec.europa.eu/agriculture/climate_change/index_en.htm

The European Environment Agency's pages on soil:

<http://www.eea.europa.eu/soer/europe/soil>

Report on the study 'Review of existing information on the interrelations between soil and climate change' (CLIMSOIL):

http://ec.europa.eu/environment/soil/review_en.htm

The Sustainable Agriculture and Soil Conservation (SoCo) project:

<http://soco.jrc.ec.europa.eu/>

Projects on soil, land use and agriculture funded through the EU's LIFE programme:

<http://ec.europa.eu/environment/life/themes/soil/index.htm>

Conferences on soil and climate change organised by the European Commission:

http://ec.europa.eu/environment/soil/biodiversity_conference.htm

http://ec.europa.eu/environment/soil/conf_en.htm

The Soil Atlas of the Northern Circumpolar Region of the Joint Research Centre of the European Commission:

<http://eusoils.jrc.ec.europa.eu/library/maps/Circumpolar/index.html>

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