



making the case
for the environment

SOIL

Soil matters

What is soil?

What does soil do for us?

Our soil is valuable, but vulnerable

Where does SEPA fit in?

How can I help?

Where would we be without the soil beneath our feet?



Many of us rarely give 'soil' a second thought and yet life as we know it would not exist without soil.

It is often covered or hidden from sight – particularly in our towns and cities - and so we may not take time to think about how much soil affects our lives and how much we depend on it. If we do, we soon discover that soil provides us with a wide range of benefits. Healthy, well-managed soil indirectly feeds us; filters our water; supports our homes, workplaces and recreational space; can help to reduce the risk of flooding; stores carbon, exchanges greenhouse gases; and much more.

Soil may be out of sight, but should not be out of mind.



What is soil?

'Soil' means
different things
to different people.



To most people, soil is a material used for growing plants; to some, soil may be thought of simply as dirt; ecologists may think of it as a habitat; engineers may think of it as the underlying foundation of our buildings and transport infrastructure; developers may think of left-over soil as waste material; and others may recognise it as a filter for human, industrial and animal wastes.

However, soil specialists have long recognized that soil does more than just provide the elements essential for plant growth. It can be thought of as the 'Earth's dynamic skin'¹ - an active, ever-changing body with complex characteristics and processes that performs a broad range of essential functions.

In Scotland we have a wide range of soil types, mainly due to our diverse geology and climate. Typically our soils are acidic, carbon rich and nutrient poor compared with those found elsewhere in the UK and mainland Europe.

¹ [British Society of Soil Science](#)

Did you know?

Scottish soils are relatively young in geological terms, having begun developing around 10,000 to 15,000 years ago, at the end of the last ice age. To put this in perspective, soils from Africa and Australia are thought to be around 65-144 Million years old - formed in the Cretaceous period when dinosaurs ruled the Earth!

About 90% of Scotland is composed of four major soil types: peats; gleys; brown earths; and podzols.

Scotland's soils have been classified into 25 major soil subgroups, and more than 1,000 individual soil types have been identified. Visit [the James Hutton Institute](#) web site for more information about soil types.



What is soil?



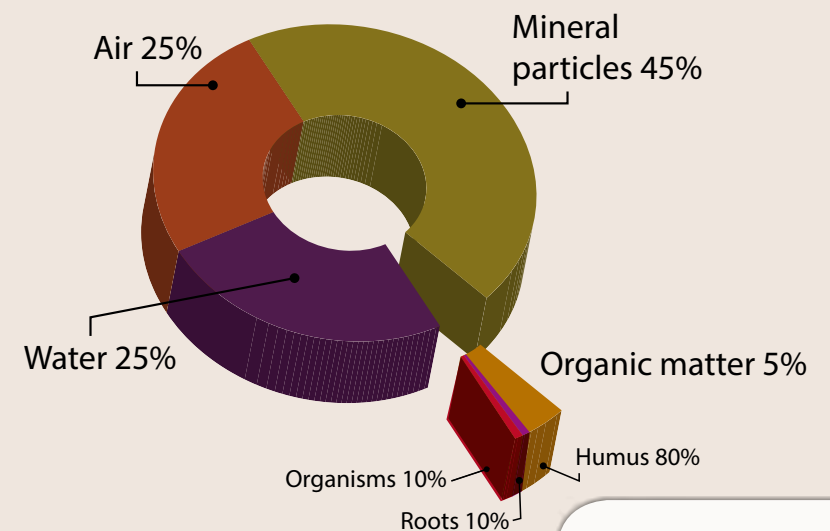
In simple terms, soil is the top layer of the Earth's crust. It is made from rocks and sediments broken down over thousands of years by the weather and the effects of plants, animals and micro-organisms, as well as people.

Soil consists of a mixture of minerals of different sizes, organic materials (including roots and living and dead organisms), as well as varying amounts of air and water filling the spaces in between the complex structure of solid particles. The relative amounts of these materials and what they are made of determines the properties of the soil.²

Organic matter is particularly important because it binds the soil together; it holds on to water, nutrients and other elements; and it determines the structure of the soil.

² Read more in [Scotland's soils](#)

Soil composition



What does soil do for us?

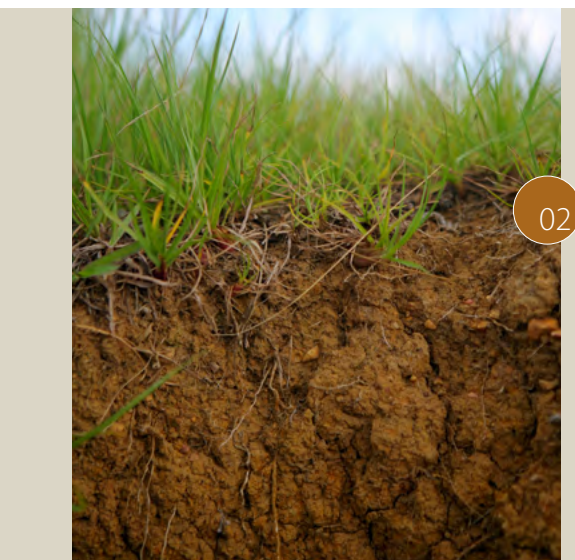
Soil provides us with a wide range of benefits and performs 'functions' that are important for our environment, society and economy.



01 Growing food and trees

Almost 80% of Scotland's land area is used for agriculture – that's over 6 million hectares. Approximately 80% of this is used as grassland for supporting successful livestock and dairy industries. The remainder of our agricultural land is mostly used for arable farming, with the most productive arable soils, ideal for growing crops like wheat and barley, located in the East of Scotland.

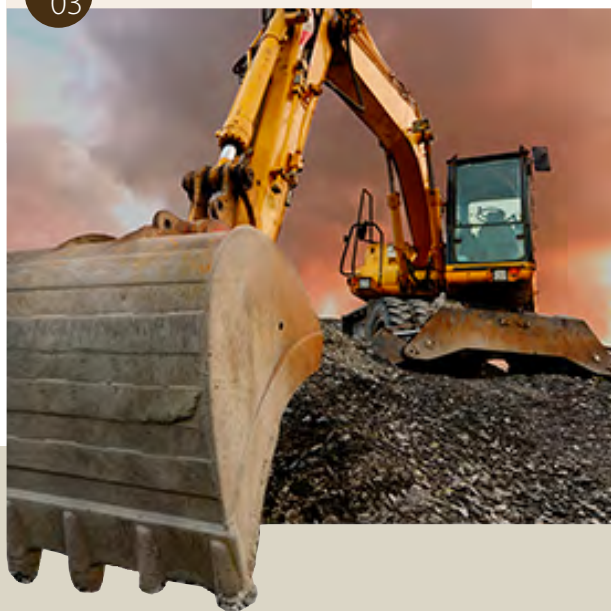
Some of this agricultural land is woodland which contributes to the 18% of Scotland covered in trees.



02

Storing carbon and maintaining the balance of gases in the air

Scotland's soils are a major **carbon store** but can also be a source of greenhouse gases. When we disturb the soil – by draining or cultivating land or building on it, for example - CO₂ emissions may result. Soils are also an important source of the greenhouse gas nitrous oxide (N₂O) with fertilized agricultural soils being responsible for the majority of Scotland's N₂O emissions.



03

Providing raw materials

Soils can be used as raw materials, such as the sand and gravel used in the construction industry. Historically, **peat** has been used as a growing medium in horticulture, or as a fuel, but these practices are now discouraged to conserve our peatland.



04

Providing a platform for buildings and roads

Once built on or sealed, soil loses, to a large extent, its capacity to carry out any other functions.



05

Controlling the flow and quality of water

Soil filters water helping to purify it and prevent water pollution. It also slows down the flow of rainwater to rivers and is key to preventing or reducing the risks of flooding.

07

Preserving cultural and archaeological heritage

Soils preserve a record of previous cultural influence, life, environmental change, historical landforms, landscape and pattern of land use.



06

Providing valuable habitats, plants and animals

Soil ecosystems are amongst the most diverse on earth and their complex functions are not yet fully understood. Scotland's soils also support a number of habitats of international significance including blanket bog and **machair**.

What does soil do for us?



Soil can carry out more than one function at a time, providing us with a range of benefits in the same place.

Healthy soil allows us to grow food and valuable raw materials. It cleans our water and can help to reduce the risk of flooding. We build our homes on it and it supports habitats and biodiversity. Soil plays an important role in the battle against climate change by storing carbon and it helps to maintain the balance of gases in the air. It also preserves our heritage.

We can define the quality of soil in terms of its ability to provide these benefits.

Did you know?

Almost all of the antibiotics that we take to help us fight infections were first made using soil micro-organisms.

Following the discovery of penicillin's antibacterial effect in the early part of the 20th century – attributed to Scottish scientist and Nobel laureate Alexander Fleming - its phenomenal success led to the search for other antibiotic-producing micro-organisms, especially from soil environments.

Soil is the major reservoir of micro-organisms that produce antibiotics. Soil is densely packed with micro-organisms and many bacterial and fungal species have evolved over millions of years to develop ways of inhibiting their neighbours for the benefit of their own growth. An antibiotic made by a microbe can inhibit other soil microbes and many of these antibiotic compounds have served as the basis for commercially sold antibiotics.



Did you know?

Almost one half of the world population (3+ billion people) lives or works in buildings constructed of soil [[British Society of Soil Science](#)].

Across the world soil has been, and is still, used as a primary building material. Well known examples include the adobe-built Pueblo homes in the south western United States of America and the rammed earth buildings of Africa, Asia and beyond.

Earth was the principal material used in Scottish construction until the 18th century and Scotland retains a rich heritage of earth construction with much regional variety, reflecting the geology of the landscape and the available soil types in the area. [Historic Scotland](#) and [National Trust for Scotland](#) are actively working to preserve this heritage.



What does soil do for us?



Healthy soil can be compared with a rain forest or coral reef in terms of the amount of living organisms (biomass) it contains and the variety of life it supports (biodiversity).

Although not obvious to the naked eye, there can be more creatures in a tablespoonful of good quality soil than there are people living on our planet – that's more than 7 billion!

Soil is a complex and dynamic ecosystem that provides a habitat for billions of organisms - varying in size from microscopic protozoa up to large burrowing animals such as badgers and rabbits - which interact and contribute to the global cycles that make all life possible. For good reason, it has been referred to as 'the living soil'.³



³ The Living Soil (1943), Lady Eve Balfour

Did you know?

One gram of healthy soil can contain approximately one billion organisms, including 5 million bacterial cells, 10,000 protozoa, 200m of fungal hyphae and around 100 nematodes. [[The Scottish Government: Farm Soils Plan](#)]



12,000 species of fungi are found in Scotland and many are protected under international legislation. [[Scotland's soils](#)]

By area, the largest organism ever discovered in the world is the [honey fungus](#) in Oregon, USA which covers nearly 10km² – more than 1,600 football pitches – and is thought to be 2,400 years old.



What does soil do for us?



The total value of soil to the Scottish economy is immeasurable, but there are industry indicators which underline its significance.

Intrinsically, soil is vital for the agriculture and forestry industries that make a valuable contribution to our economy: in Scotland, around 65,000 people are directly employed in agriculture producing output worth around £2.3 billion per year, and accounting for much of Scotland's £400 million food exports;⁴ and Scotland's Forest and Timber Industries, employing around 40,000 people, are worth in excess of £1.7bn to the economy.⁵

Soil also plays a huge part in contributing to Scotland's £5 billion tourism sector,⁶ which employs more than 200,000 people. Our soil is a prerequisite for the breath-taking mix of stunning landscapes, wildlife and flora that we enjoy and which attract visitors to Scotland from across the globe.



⁴ NFU Scotland

⁵ Scottish Forest & Timber Technologies

⁶ The Scottish Government

What does soil do for us?



Globally, soil stores about twice as much carbon as the atmosphere and three times as much as vegetation, making it a significant factor when considering climate change.

However, soil in Scotland stores over 3,000 million tonnes of carbon which is sixty times as much as in our vegetation. To put this in context, losing just 0.5% of our soil carbon as CO₂ would be roughly the equivalent of Scotland's total annual greenhouse gas emissions.

It is therefore vital that we keep this carbon in the soil and don't lose it as greenhouse gas to the atmosphere.

Did you know?

Peat soils only cover **22%** of the land area of Scotland (predominantly in northern Scotland and notably in Lewis and Shetland) but hold more than half of the total soil carbon in the country.

Scotland has passed the most ambitious climate change legislation anywhere in the world, requiring reductions in Scotland's greenhouse gas emissions of at least 42% by 2020 and 80% by 2050 from a 1990 baseline. [[The Climate Change \(Scotland\) Act 2009](#)]



Our soil is valuable, but vulnerable



Globally, in spite of our dependence on it, we often treat soil as an inexhaustible resource which we do not need to care for.

However, soil is essentially a finite, non-renewable resource. It forms very slowly - taking hundreds of years to form a few centimetres - so we can't just replace it in our own lifetime. Although soil has a degree of resilience to disturbance, it can be easily damaged or destroyed.

We live in a time when we are using the soil much more intensively than ever before. The fast growing population is increasing consumption, pollution, demand for food production and land development (for new houses and workplaces) at a time when fears over energy security are prompting some countries to plant biofuel crops in place of traditional food crops.

Our soil is under pressure.

Did you know?

According to the [United States Census Bureau](#), the population in the world has grown from 1.65 billion to 6 billion during the 20th century alone and is expected to reach 9 billion people by 2040.

Both human and natural activities are damaging soil, to the extent that 25% of the Earth's lands are highly degraded.

(Source: [FAO](#))



In the last 40 years, around 15% of the Earth's land area of soils has been degraded through human activity [[Overseas Development Institute](#)]



Our soil is valuable, but vulnerable



Did you know?

Landslides are one of the more visible, potentially life-threatening, events that pose a risk to our soil.

Landslides are a mass movement of soil, rock or debris that flow down a slope as a result of gravity. They are often sudden and unpredictable, having a major impact on society, causing destruction, disrupting the lives of thousands and causing unquantifiable economic damage to local communities.

Landslides often occur after periods of high rainfall due to factors such as ground saturation, reduction in soil and rock strength and material being washed away. In Scotland they are caused mainly by soil saturation after heavy rain fall or snowmelt.

Soil is primarily under pressure due to changes in land use, land management practices and due to our changing climate. These pressures can damage soils in a number of ways:



Loss of organic matter



Erosion



Soil sealing



Compaction



Loss of soil biodiversity



Addition of contaminants/
loss of essential elements

If a soil is damaged, its ability to provide the range of benefits we expect may be reduced.⁷ Soil sealing, for example, occurs when the soil surface is permanently covered with an impermeable material to create housing, roads or other buildings. Sealing the soil is effectively an irreversible process and although it allows us to build on the soil it results in the loss of many of the other benefits provided by soil.

In addition to a loss of expected benefits, further consequences of soil damage may include water pollution, increased flood risk, decreased crop yield, land contamination, and increased emission of greenhouse gases to the atmosphere contributing to climate change.

⁷ Read more in [Scotland's soils](#)

Soil has a close and complex relationship with our climate

Soils affect climate by exchanging greenhouse gases with the atmosphere; and climate affects soil because how warm or wet the soil is can affect the amount and type of gases emitted.

Scotland's climate is changing. Over the last century it has become warmer, with drier summers, wetter winters and more frequent heavy rainfall.⁸ Left unchecked, global climate change will accelerate, further pressurising our soil resources. This will affect the world's most vulnerable communities and have far-reaching effects on Scotland's environment, its economy and its people.⁹



⁸ [Scotland's Climate Trends Handbook](#)

⁹ Read more in [Our Climate Challenge](#)

Our soil is valuable, but vulnerable



What is Machair?



The word 'machair'¹⁰ is Gaelic, meaning an extensive, low-lying fertile plain and has become a recognised scientific term for a specific coastal feature. It is defined by some as a type of dune pasture that is subject to local cultivation, and has developed in wet and windy conditions.

Machair is one of the rarest habitats in Europe, found only in the north and west of Britain and Ireland. Almost half of the Scottish machair occurs in the Outer Hebrides, with the best and most extensive in the Uists and Barra, and also Tiree.

Machair sand has a high shell content, sometimes 80-90%, helping to distinguish it from the 'links' of eastern coasts, which are formed from more mineral-based sand.

Most soils in Scotland are not managed intensively. Soils suitable for arable farming are largely limited to eastern Scotland and these relatively small areas have produced very high crop yields. It is acknowledged that some agriculture and forestry practices can lead to soil erosion and compaction and there are concerns about the consequent ecological and climate impacts of developments on peat soils (including wind farms, for example). However, there are many policies and guidelines in place that encourage good soil management practices to prevent negative consequences.

Many vulnerable areas – including peat bogs and Machair sites – also receive additional protection as Sites of Special Scientific Interest, Special Areas of Conservation, Natura sites and other [local, national and international designations](#).

The Scottish Government has recognised that Scotland's soils are 'valuable, but vulnerable' natural assets and has developed the [Scottish Soil Framework](#) to identify the future focus for soil protection, key soil outcomes, and actions across a range of sectors.

A [progress report](#) was published in December 2013 outlining what had been achieved since the framework was published. Following on from this, we have an opportunity to take action to better understand, protect and, where necessary, improve the quality of our soil in a sustainable manner to make sure it is there for future generations.

¹⁰ Read more about [Machair](#) and [Conserving Scottish Machair](#)

¹¹ Read more about [peat](#) (Scottish Natural Heritage)

What is peat?



Peat¹¹ is the partially decomposed remains of plants which have accumulated at the surface of the soil profile forming an organic layer. In Scotland, peat soil is defined as having an organic layer more than 50 cm thick.

Peat is formed under waterlogged conditions. Low temperatures, high acidity and nutrient deficiency also favour peat formation. Scotland therefore has ideal peat forming conditions and Scottish soils in general have high organic matter concentrations.

Soil organic matter is predominantly carbon, so our peat soils are important carbon stores.

However, if peat ceases to be waterlogged, the organic matter gradually decomposes, resulting in the release of greenhouse gases to the atmosphere and dissolved organic carbon to the water environment.

Where does SEPA fit in?



As Scotland's environmental regulator and adviser to the Scottish Government, the Scottish Environment Protection Agency has an important role to play in protecting and restoring Scotland's soils, whether these are in rural or urban environments.¹²

Working alongside Scottish Natural Heritage, local authorities and other public agencies, we undertake a broad and varied regulatory role. There is currently no single piece of policy or legislation specifically protecting all benefits provided by all soils. However, we implement policies for a range of related areas - including water, waste, industrial pollution and biodiversity – that contribute indirectly to soil protection.

Taking a broad-based approach, we regulate and control activities from rural, industrial and domestic land use posing a risk to our soil, air and water quality. For example:

- By reducing the erosion of sediments and nutrients into rivers and lochs, we help to prevent diffuse water pollution. Keeping soil in the fields also ensures that the nutrients are available for the plants.
- By reducing ammonia emissions from intensive agriculture – including pig and poultry farms – we help to prevent ammonia from being emitted to the air and subsequently deposited on the land. This helps to protect the soil, as well as vulnerable habitats and species.
- By ensuring the application of organic materials to land is controlled we help to ensure that the soil is not inadvertently damaged when we enhance its productivity

Where there is a significant risk to soil from regulated activities, our scientists sample the soils to determine the impact of the activity and assess the likelihood of environmental harm.

¹² To find out more, visit the [SEPA website](#)

Where does SEPA fit in?



In addition to regulating activities, we provide advice and guidance to help improve the way people manage and protect soil, including guidance for farmers, land managers, developers, owners of contaminated land and priority catchment managers.¹³ As a statutory consultee in the planning system we also provide advice to planning authorities to help ensure that proposed developments minimise their impact on soils and the carbon stored within them.

We promote and encourage research to increase our knowledge on soil and we report on the state of Scotland's soils. The Natural Scotland *State of Scotland's soils* report,¹⁴ for example, was written in conjunction with partners across Scotland to assess the state of our soil and examine the consequences of the many threats to soil quality.

Collectively, SEPA's varied endeavours aim to protect and improve our essentially non-renewable soil resources to ensure that they are in a good state to provide the benefits we have come to expect. In this way our soil can continue to contribute to improving the health and wellbeing of the people of Scotland whilst supporting sustainable economic growth.¹⁵

¹³ To find out more, read www.sepa.org.uk/making_the_case/soil/priority_catchments.aspx

¹⁴ [The State of Scotland's Soils \(2011\)](#)

¹⁵ To read more, visit the [SEPA website](#)



Where does SEPA fit in?

Watch the video

Watch the video

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Mark Aitken, Principal Policy Officer

My main role in SEPA is to lead on policy for agriculture, forestry and soils. Soil is extremely important because of how it can affect the wider environment and even influence climate change. For example, the way we manage soil can affect water quality and it can affect the risk of flooding in Scotland. SEPA actively works with farmers to reduce diffuse pollution and protect water courses and we have a role to play in ensuring that soils do not receive large amounts of potentially toxic material from sewage sludge and other wastes applied to soils. Also, as a statutory consultee for planning authorities, we can comment on the impacts of development proposals on soils and soil functions.

Lucy Filby, Land Specialist

There are two parts to my job. One part would be awareness raising and advising how people can reduce diffuse pollution, part of that with good soil management. Another part of it is visits to land managers, farmers, forestry managers and green keepers to discuss ways they can better manage pollution risks on their pockets of land ... Good soil management is an important part of reducing diffuse pollution from rural land. Somebody looking after their soils means that they are keeping nutrients in the right place in the fields and they are not being washed off into water courses causing pollution in river systems.

Dr Emma Goodyer, Scientist

As SEPA's wetland ecologist I frequently work with peatland habitats and peat soils. This includes providing advice on the design layout, management and restoration of various developments, such as upland wind farms and hydroschemes, to try to reduce their environmental impact. The advice I give seeks to minimise the excavation of peat as disturbance of these carbon rich soils can release carbon into both the water environment and the atmosphere.

How can I help?

Many governments, international organisations and environmental groups are working to protect, improve and promote sustainable land and soil management practices around the world.

Treat soil with care

By taking small steps to look after soil in a sustainable way, you too can make a difference to Scotland's soil, now and for future generations:

- You could help to transform your urban environment by supporting, creating or maintaining more 'green spaces' where you work or live for your local community.¹⁶
- You could use sustainable soil management techniques in your garden or allotment.¹⁷
- Making compost with left-over food and garden waste will minimise waste and help to add more nutrients to your soil.
- By ensuring that you use only the required amount of fertiliser to feed your soil you will optimise the quality of your soil.
- If you use only peat-free growing materials you will be helping to reduce the depletion of our precious peat soils.
- You may choose to garden organically, using natural techniques and products rather than using synthetic commercial herbicides, pesticides and fertilisers.
- You could avoid 'hard landscaping' – laying paving stones, for example - that could seal the soil in your garden.
- Taking extra care not to compact your soil, particularly when wet, will also help to improve the quality of your soil.
- You could perhaps use your garden or allotment to grow your own food.¹⁸
- Or if you simply consider buying organically produced foods and products with strong ethical credentials – those endorsed by the [Soil Association](#), for example - you will be making a contribution.

If you are a land manager, you should follow published guidance on protecting soils (refer to [SEPA website](#)).

¹⁶ Visit the [Scottish Government](#) or [Greenspace Scotland](#) for details of local greenspace and development projects.

¹⁷ Visit [Royal Horticultural Society](#).

¹⁸ Visit [Greener Scotland](#) or read [Garden for Food](#)



Get involved

Soil is one of the world's most important natural resources and yet it is often taken for granted. You can help change this by spreading the word in your community about the importance of our soil and why we need to protect it.

Explore the range of resources on Scotland's Environment website, including [volunteering projects](#), discussions and downloadable guides on Citizen Science.



Reporting Pollution

If you are aware of any polluting incidents in any of the places you visit, you can phone our Pollution Hotline on 0800 80 70 60 (24 hour service – calls are free from a BT landline, mobile users please check your service provider for charging details).

A full list of external agencies that look after the various aspects of our land environment can be found on our website.