PEATLAND ATLAS

Facts and figures about wet climate guardians

2023

HEINRICH BÖLL STIFTUNG

BUND FRIENDS OF THE EARTH GERMANY

Global Peatlands Initiative

Succow Stiftung

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TABLE OF CONTENTS

FOREWORD

Peatlands are a mixture of elements: they are both water and land at the same time. They form where the soil is wet all year round. Waterlogging prevents dead plant material from decomposing, creating their characteristic organic soils over thousands of years. And peatlands can be found all over the world, from the Arctic to Europe and the tropics, all the way to Tierra del Fuego at the tip of South America. They are impressive ecosystems, rich in rare animal and plant species. Their peat soils store enormous amounts of carbon, so they play a decisive role in climate protection – as long as they stay wet.

In the past, people in continental Europe showed a great deal of respect – and sometimes fear – for peatlands. They were shrouded in myth: they were dangerous places, home to mysterious creatures which were better avoided or treated with deference. Then, a few centuries ago, people began to make use of these fascinating watery landscapes, draining bogs and fens to make way for houses, woods and fields.

Today, peatlands provide vital services to the communities that live in and around them: they regulate water levels, maintain water supplies, and moderate floods and droughts. Indigenous communities who have lived in peatlands for generations have deep-rooted cultural ties to the land. They fish, hunt and gather medicinal plants from the peatlands.

> Peatlands are impressive ecosystems that occur all over the world.

But peatlands are still being destroyed all over the world. In Central Europe, well over 90 percent of the peatlands are affected; in the tropics and elsewhere, healthy peatlands are being lost ten times faster than the peat can grow. Agriculture and forestry are the main culprits. In Europe, much of the peatland is used for livestock, particularly for beef and dairy production and for growing fodder. Many governments, and the European Union (EU) through its Common Agricultural Policy (CAP), even subsidize agriculture on drained peatlands. Peatlands are also used to extract peat for fuel and as substrates for horticulture. In the tropics, the destruction of peatlands has proceeded apace, driven by multinationals from the Global North. This has far-reaching consequences for the regions, including the use of fire to clear land for palm oil plantations, and the felling of valuable tropical timber. These peatlands are often peat swamp forests, where giant trees stand on deep layers of peat, so storing large amounts of carbon in the wood and the soil below. Such rainforests provide a refuge for unique plants and animals such as orangutans and lowland gorillas, and at the same time protect people and nature from drought and flooding. All this is now imperilled.

More than 10 percent of the world's 500 million hectares of peatlands have already been drained, and a further 500,000 hectares are destroyed every year. This destruction is both accelerating species extinction and fuelling the climate crisis. Once they dry out, peatlands change from being carbon sinks to sources of greenhouse gases like carbon dioxide (CO_2). Worldwide, drained peatlands are responsible for around 4 percent of all anthropogenic greenhouse gas emissions, peat fires excluded. Intact peatlands must be kept wet and be protected to prevent

> It takes a major peatland transformation to achieve the climate goals.

further emissions. It is also possible to reduce emissions by rewetting drained peatlands. This preserves the peat and retains the carbon it has built up over centuries.

For far too long, many institutions have ignored what is now widely recognized: protecting and restoring peatlands is an important part of tackling the climate crisis. And therefore, we need a fundamental change in the way peatland is managed. Livestock raising and plantations on drained peatland must be reduced. Alternatives to conventional intensive agriculture are needed to use large areas of wet peatland: alternatives that combine agricultural use with climate and biodiversity protection – such as paludiculture. To make the transition, farmers need certainty and support. Protecting the climate is a task for society as a whole because it is about the preservation of an environment worth living in for everyone.

It is clear that we need more effective and joined up governance of peatlands so that they deliver a triple win for the climate, people and the planet urgently. There is growing awareness of the importance of peatlands with countries and stakeholders adopting peatland-related resolutions under different international frameworks. The sustainable management of peatlands can be included in Nationally Determined Contributions and Long-Term Strategies for the Paris Climate Agreement. Peatlands restoration and conservation can help parties meet targets under the Global Biodiversity Framework and Land Degradation Neutrality principles.

The use of drained peatlands damages the environment and should no longer be subsidized. Instead, we need legally binding targets for peatland restoration and attractive financial support for alternative, wetter uses of agricultural and forestry land. We need to act now. This requires effective incentives, public and private intitiatives and regulatory and planning mechanisms. Relying on voluntary action is no longer enough.

In all policy areas, peatland conservation must be considered together with the future prospects of local communities, Indigenous peoples, agriculture and forestry in a regional context. Both policymakers and society as a whole must play their part.

The Peatland Atlas 2023 highlights not only the consequences of the destruction of these unique habitats, but also the potential of wet peatlands for mitigating climate change. It outlines strategies to protect and use them to encourage change by all stakeholders. Climate crisis is not in the future: we are already living through it. Summer droughts and record-breaking heat demand swift and effective action. Peatlands, those natural climate reservoirs, can play a vital role. Peat must be wet!

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12 BRIEF LESSONS

ABOUT PEATLANDS

1. Peatlands exist on all continents. They are the result of **PEAT FORMATION** in soils with soils that are saturated with water.

2. Worldwide, peatlands cover **3 PERCENT OF THE EARTH'S LAND SURFACE** – but they store about twice as much carbon than the biomass of all the world's forests combined.

3. Peatlands are being lost ten times faster than they are growing. Due to human activities, **500,000 HECTARES OF PEATLAND ARE DESTROYED EVERY YEAR.** Intact peatlands urgently need to be protected.

4. Natural peatlands draw considerable amounts of the greenhouse gas carbon dioxide (CO_2) from the atmosphere, which they **STORE AS CARBON IN THE PEAT.** But if they are destroyed, they release large amounts of CO_2 – and damage the climate.

5. A large part of all drained peatlands worldwide is **USED FOR AGRICULTURE.** In the EU: one quarter of all peatlands. They are used primarily for animal husbandry.

6. Peatlands play a crucial role in the **WATER CYCLE.** They filter and store water and help alleviate drought and flooding. The **CLIMATE CRISIS** makes peatlands drier and increases the risk of fires that produce a lot of emissions.

7 Peatlands are home to rare and endangered **PLANTS** and **ANIMAL SPECIES.** Their greatest threat worldwide is artificial drainage and deforestation for agriculture and forestry.

8 To achieve the goals of the **PARIS CLIMATE AGREEMENT,** 1 million hectares in Europe must be rewetted every year – and 2 million hectares worldwide.

9 Emissions from drained peatlands can be greatly reduced without giving up farming: by raising water levels and converting to **PALUDICULTURE** such as growing reeds and raising water buffaloes.

10 For centuries, peat was used mainly as a **FUEL.** Today it is mainly used as **POTTING SOIL** in horticulture. Ecological alternatives must be promoted more strongly.

11 Over the centuries, peatlands have been destroyed. We need to recognize the **VALUE OF WET PEATLANDS** for biodiversity and the climate.

12 In many parts of the world, there are **FOREST-COVERED PEATLANDS:** alder swamps in Europe – or tropical rainforests. They store a particularly large amount of carbon and must be preserved or restored at all costs.

WHAT ARE MIRES AND PEATLANDS?

A VERY SPECIAL ECOSYSTEM

Mires are intact peatlands and home to rare plants, rare animals – and enormous amounts of carbon. But draining them for economic reasons puts them and their resident organisms at massive risk. It poses a massive threat to the climate too.

Mires have long shaped many landscapes around the world. They are fascinating ecosystems, whose development is inseparable from the presence of water. This comes either solely from rainwater or additionally also from groundwater. Unlike as in a lake, this water does not fill a depression in the ground, but it fills pores in the soil. The high water level excludes air from the soil. As a result, dead plant material does not decompose completely, and peat forms, by perhaps a millimetre a year.

One thing that all peatlands – both the natural, undrained mires and also drained peatlands – have in common is that they are long-term and very space-efficient carbon stores. To put that in numbers: peatlands cover just 3 percent of the Earth's land surface, but they harbour around twice the amount of carbon as the biomass in all of the planet's forests. Worldwide, they store 600 billion tonnes of carbon. But peatlands nearly everywhere around the world are threatened by human activities.

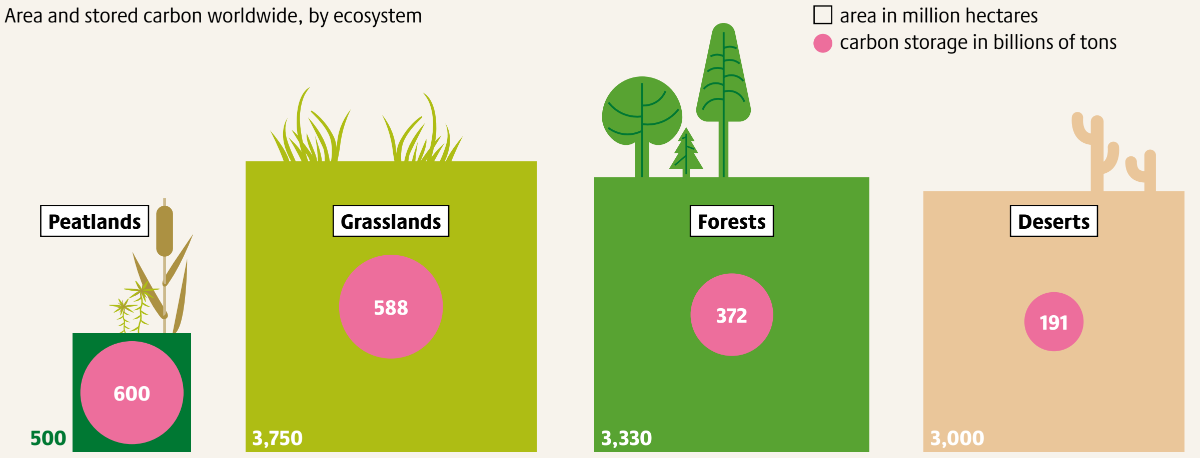
The two main mire types are distinguished based on their water supply. Bogs are fed only by rainwater. They are poor in nutrients, more acidic and with water tables higher than in their surroundings. Fens, on the other hand, depend on groundwater, spring water or seepage. They are more rich in nutrients and less acidic compared to bogs. The majority of peatlands in Europe are fens.

Mires have also an enormous significance for biodiversity. They provide unique habitats for rare animals and rare plants that are adapted to a wet environment. They are often the last refuges for many rare and threatened species, such as the aquatic warbler, shoebill or orangutan. Many mires are typified by their extent, their openness, and many open water bodies they contain. They offer waders and waterfowl numerous opportunities for rest and overwintering. Not only that: mires improve the quality of water by filtering out pollutants it contains.

Plant genera such as peat mosses occur throughout the world, and numerous species exist that are large, sturdy and colourful, all of which can form peat. Mires in the boreal and temperate regions are often open landscapes with moss and grassy vegetation and relatively few trees. Tropical mires, on the other hand, are often covered with forest. These peat swamp forests are impenetrable areas that are home to species such as lowland gorillas, forest elephants, chimpanzees, bonobos and the Allen's swamp monkey.

Peatlands cover only a small portion of the earth, but they store more carbon than any terrestrial ecosystem

IT IS MORE THAN A MATTER OF SIZE
Area and stored carbon worldwide, by ecosystem



WIDESPREAD LANDSCAPES

Types of peatlands

Peatlands ...

... are areas with a naturally accumulated peat layer at the surface, whether wet or drained

Mire ...

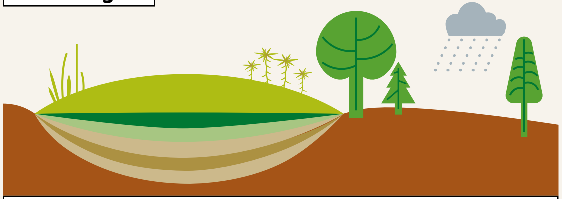
... refers only to intact, undrained peatlands with a vegetation that forms peat

Wetlands ...

... are areas that are inundated or saturated by water to an extent that its vegetation is dominated by plants that are adapted to life in anoxic soil conditions. They do not necessarily contain peat

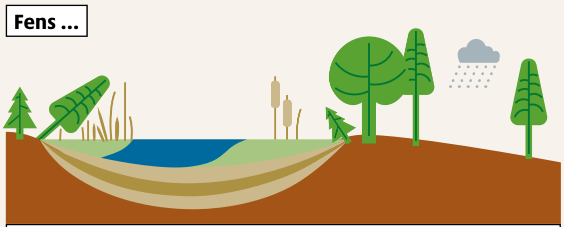
bog peat · transition peat · fen peat · organic silt · mineral subsoil · open water

Raised bogs ...



... are fed exclusively by rainwater. Due to extreme environmental conditions, only a few specialized animal and plant species live and grow here. Most often raised bogs are treeless

Fens ...



... rely on groundwater input. Because of higher nutrient content, there is often more species richness in fens than in raised bogs. However, very species-poor fens also exist

Humankind has used peatlands for thousands of years. Nowadays these lands are used mainly for farming, forestry and peat extraction. As largely applied today, these forms of use require the peatland to be drained. But water is necessary for mires: take it away, and the environment changes dramatically. Oxygen penetrates into the soil, the peat decomposes, and the greenhouse gas carbon dioxide (CO_2) is released – turning the mire into a drained peatland and a climate problem. Drainage also deprives the typical mire species of their habitat.

Europe is the continent that has so far lost the most natural peatlands. Some 10 percent of its erstwhile peat cover has been lost through drainage. Of the remaining peatland area – around 100 million hectares – one-quarter is degraded or damaged. Within the European Union, the figure is one-half.

Drained peatlands are responsible for around 5 percent of all greenhouse gas emissions in the European Union. Drained peatlands no longer act as a carbon sink, but also release greenhouse gases into the atmosphere. This disastrous role becomes even clearer if we look at the emissions from farming, 25 percent of which are caused by drained peatlands. And that is even though peatlands cover just 3 percent of the agricultural area. That is why drained peatlands are one of the major fields of action for climate protection in agriculture and land use.

The central role of water in the functioning of peatlands makes them particularly vulnerable to disturbances. Besides drainage, other threats facing peatlands include road construction, reservoir creation, oil-sands mining, overgrazing and pollution. Europe is a global peatland degradation hotspot because of widespread land-use changes for agriculture, forestry and peat extraction. Next to Europe, major hotspots are Northeastern China, Southeast Asia and the American Midwest. The degree of drainage directly affects the amounts of greenhouse gas emissions released annually from degraded peatlands.

A number of European peatlands are nature reserves. Since many peatland areas have been destroyed, their number is small

According to numerous studies, some of the damage to peatlands caused by drainage cannot be repaired; the landscape is permanently changed. That makes it all the more important to stop peatland drainage before it is too late, and to protect mires and peatlands, because if dried-out areas are rewetted, the release of carbon dioxide can be stopped. Such rewetting is one of the central tasks for the present and future.

A comprehensive protection of peatlands can succeed if peatland conservation and land use are brought into harmony. Instead of a total stop to the use of peatlands, what is needed is a range of new, wet ways of managing the land, ranging from wet wilderness to high-intensity paludiculture. That is why technical specialists and environmental groups call on policymakers to provide more support for such socio-ecological transformation through a combination of incentives and regulation.

PEATLANDS AROUND THE WORLD

UNDER THREAT ALMOST EVERYWHERE

Peatlands exist in the mountains, in lowlands, along rivers and at the coast. Their vegetation and condition vary from one climate zone to another, but all types of peatland have one thing in common: their continued existence is in danger.

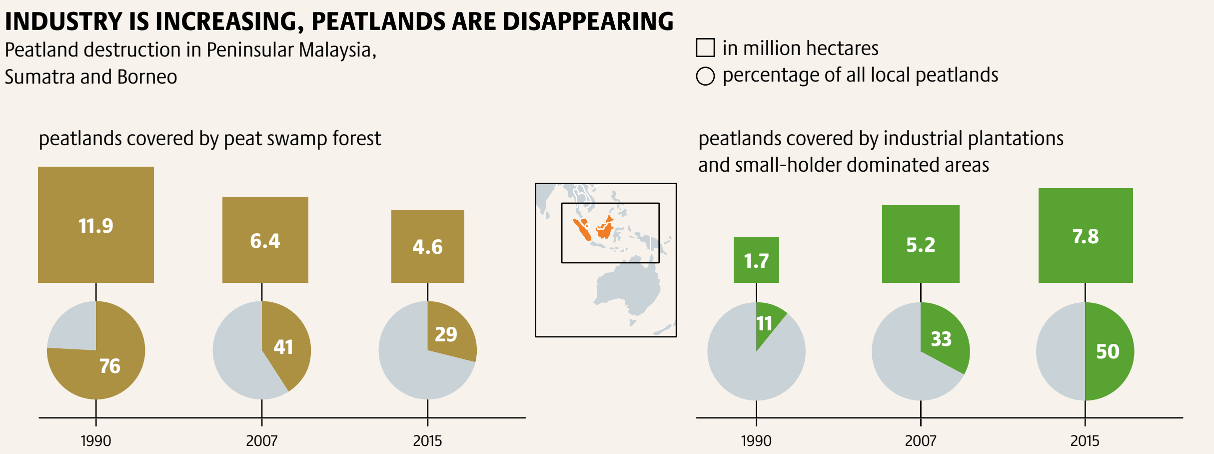
Ever since the 17th century, peatlands have been systematically drained – for peat extraction, settlement, forestry and farming. Beginning in the second half of the 20th century, the industrialization of agriculture accelerated large-scale drainage, especially in temperate zone of the northern hemisphere. As a result, some industrialized countries now have little of their natural peatlands left. Worldwide, over 50 million hectares are currently covered by drained peatlands, and the trend is rising.

In many countries and especially in the Global South there is little data on peatlands. Only enhanced mapping will reveal the true extent of peatland drainage and its consequences for climate crisis. What is certain: worldwide, peatlands are often found in climate zones that mostly have either very high rainfall or very cold temperatures – or both. These are mainly in the tropics at a band around the Equator and in the sub-arctic, boreal and temperate oceanic zones of both the northern and southern hemispheres. The climatic conditions in these regions cause biomass to be broken down only very slowly, favouring the formation of peat.

Peatlands are relatively less widespread in subtropical regions because moisture is scarcer in these areas. But even here, peat formation is possible under certain circumstances. Some areas receive enough water from large rivers from regions with higher precipitation, such as mountain ranges. As a result peatlands can develop in lowlands and in the deltas of large rivers such as the Brahmaputra in Bangladesh, the Rio Paraná in Argentina, and the Zambezi in Zambia. The total area of peatlands around the globe is estimated at 500 million hectares. But this figure is just an approximation: many large areas are imprecisely mapped, and innumerable smaller peatlands remain undiscovered.

Peatlands occur along coasts worldwide, in saltmarshes and saline reedbeds, and in the tropics often in mangroves – coastal woodlands in areas where seawater and freshwater mix. Peat formation is favoured by marine currents and the humid air masses that are associated with them, such as along Europe's western sea coast and in the Caribbean. On land, flat terrain slows down the natural flow of water on the land surface, resulting in the creation of the huge peatlands in

Islands and peninsulas in Southeast Asia are full of tropical peatlands. But industries pose a threat to unique ecosystems



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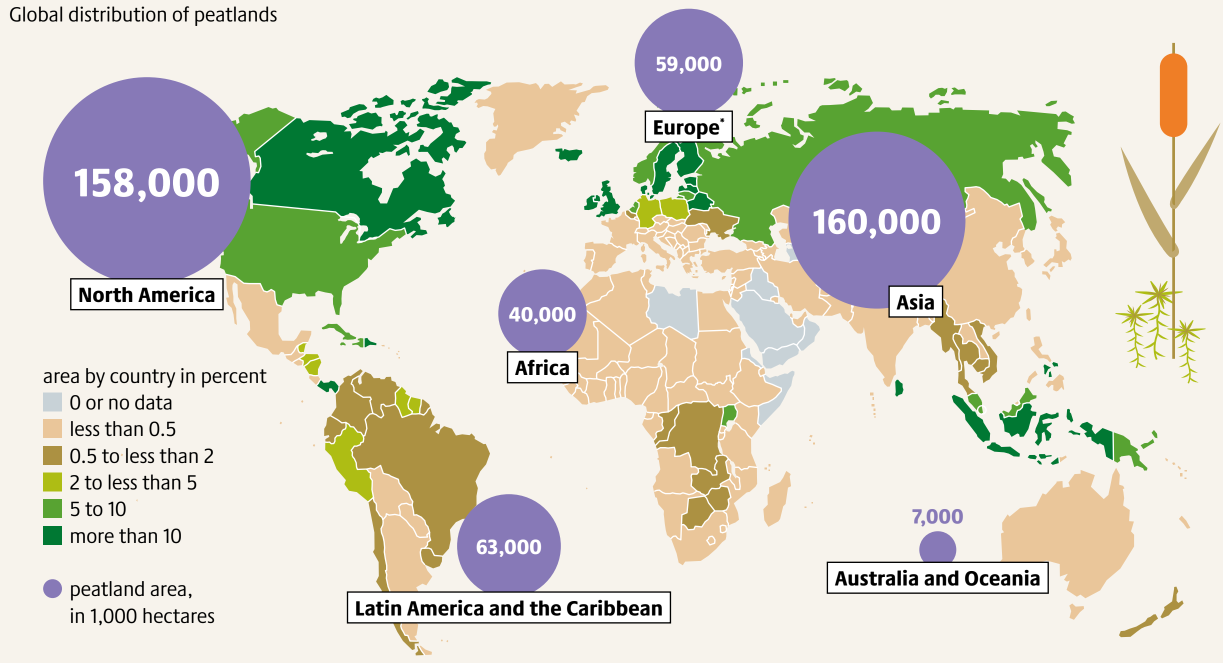
MILLENIA OLD, WITH A SIZE OF MILLIONS AND MILLIONS OF HECTARES

Global distribution of peatlands



*including European Russia

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western Siberia, Southeast Asia, the Congo Basin and the western Amazon. Finally, peat can occur anywhere where the local climate and terrain permit permanently high and stable water levels in the soil.

These differences in climate, water source, water quality and the resulting vegetation produce diverse types of peatland. Essentially they all have one feature in common: the presence of a layer of peat in the soil.

In cold subarctic and boreal cool humid oceanic regions, the peat forms mainly from the remains of mosses. Especially in Siberia and over vast areas of Canada and Alaska, fairly treeless peat landscapes are found: seemingly endless expanses dominated by mosses. In the temperate continental and subtropical parts of the world, grass-like plants such as reeds, sedges and rushes take over the role of peat producers and dominate the peatland vegetation. Here, the peat accumulates in the first few feet under the surface, as the underground shoots and roots of these plants grow into the older peat material where they die off. These peatlands reside as grasslands with reed beds of various sizes along rivers, in silted-up lakes and in depressions of different sizes. In tropical lowlands, the peat is often formed by the deep roots of tall trees. Huge, forested peat landscapes cover these tropical peatlands for example in the Congo Basin, Indonesia and Peru.

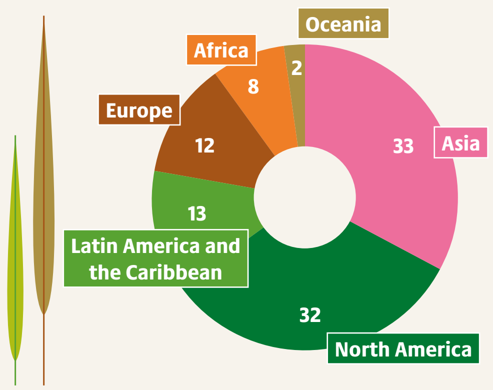
Peatlands exist in 90 percent of all countries. Many of them are located in the sparsely populated areas of Canada, Amazonia and Siberia

Peatlands in an intact or near-natural state are multi-talented: they protect biodiversity, mitigate the climate crisis and are a key factor for flood protection

For the last 20 years these peat swamp forests of the tropics have been increasingly deforested, drained and used for timber production and intensive agricultural production. For many years the hotspot of this trend was in Southeast Asia, especially Indonesia. Infrastructure development and clearing are now increasingly taking place in the extensive peatlands of the Congo and Amazon basins. A further threat to peatlands not only in the subtropics of Africa and South America: the climate crisis. ●

A GLOBAL PHENOMENON

Share of global peatland area, by continent in percent



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PEATLAND DESTRUCTION

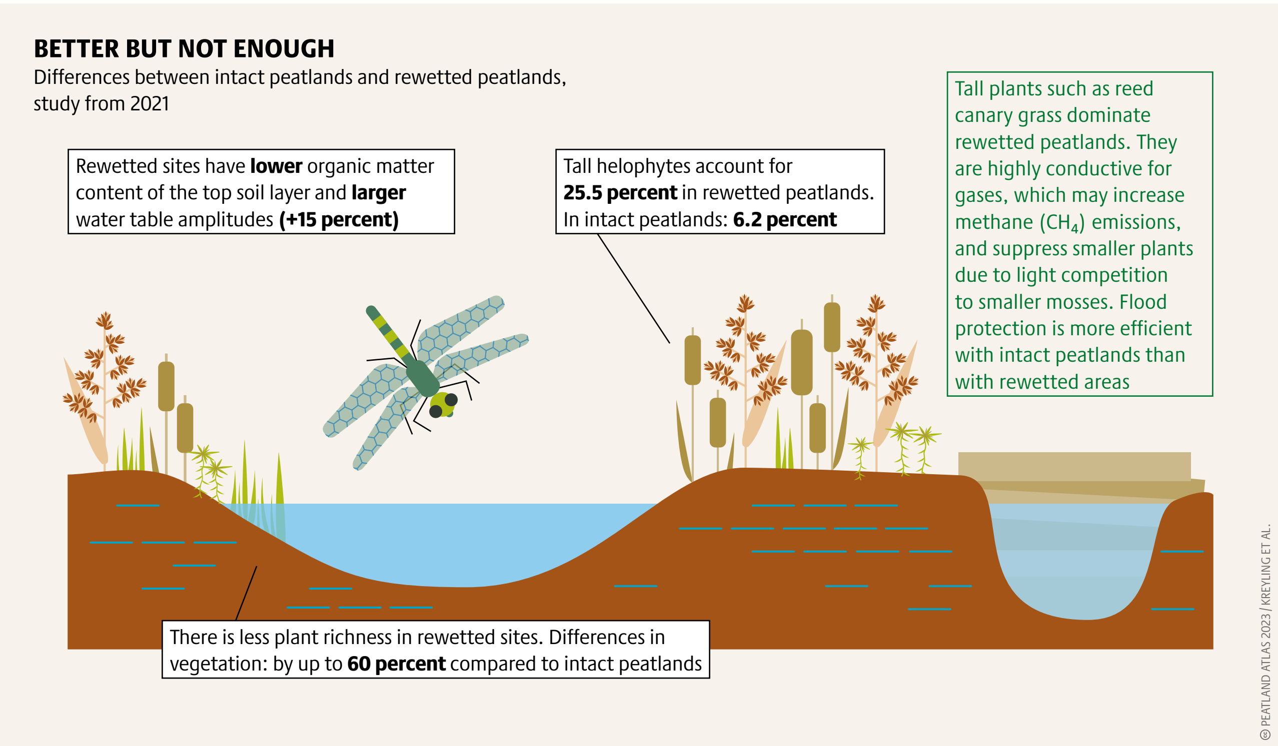
HELP NEEDED

Huge areas of peatland around the world have already been destroyed. In the tropics, peat swamp forests are being cut down and the land drained. Fires and climate crisis also pose threats. Attempts to protect the peatlands have so far had little success.

Healthy peatlands around the world are being degraded at an alarming rate – through clearing, deforestation, slash-and-burn agriculture and drainage. Drained peatlands are used to establish fast-growing pulpwood or palm oil plantations, or for arable farming, pasture and forestry. Or they are subject to peat extraction or covered with buildings. Of the 500 million hectares of peatland worldwide, over 50 million have already been degraded to such an extent that peat can no longer accumulate, and remaining peat is under threat. Of the peatlands that are still accumulating peat, another 500,000 hectares are destroyed every year by human activities. In many fertile and easily accessible areas where human populations are growing, natural peatlands have been completely lost – as in central and eastern Europe and Southeast Asia. In the European Union, around half of all the peatlands have been drained. Most of the still-intact peatlands are found in thinly populated areas that are unsuited to agriculture – especially in the northern parts of the globe in Canada, Alaska, Siberia, and in inaccessible rainforest areas near the Equator, such as in the Congo and Amazon basins. Countries in Europe whose peatlands are considered to be well preserved include Sweden, Norway and Bosnia-Herzegovina. There they are 75 to 100 percent still intact.

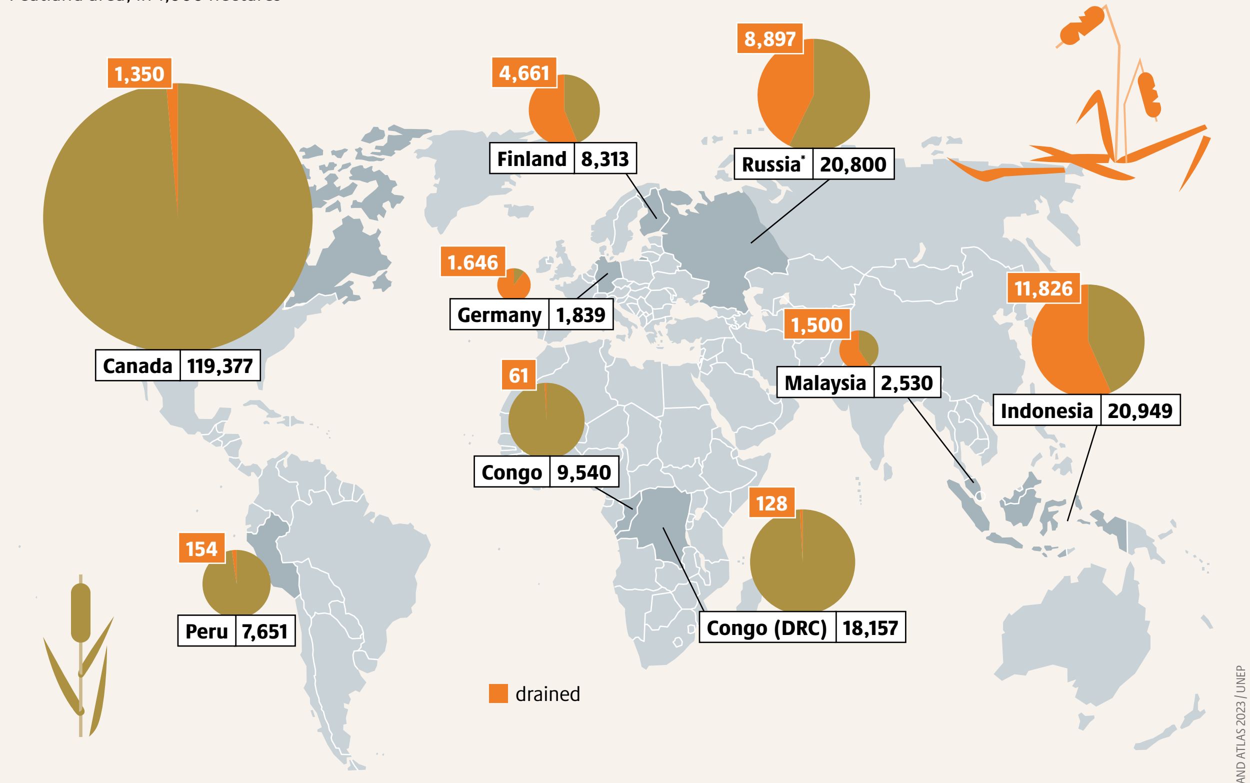
Especially in the tropics, the destruction of peatlands is currently continuing, with catastrophic consequences. In these regions, the peatlands consist mostly of rainforest where massive trees grow on layers of peat that are metres thick. The trees offer shelter for orangutans, forest elephants and many other species. Rainforests also store enormous quantities of carbon in their vegetation and in the soil. The most effective store is the peat itself. The tropical peatlands of Cuvette Central in the Democratic Republic of the Congo and the neigh-

Rewetting? There is no alternative! But even rewetting can restore old conditions only to a limited extent. So a priority must be the preservation of intact areas



DESTROYED, LOST, DISAPPEARED. FOREVER?

Peatland area, in 1,000 hectares



*European part. The peatland area in the Asian part of Russia is similar in size to the Canadian peatland area

bouring Congo cover only 4 percent of the total area of the Congo Basin, but their peat stores around 30 billion tonnes of carbon, the same amount as in the rainforest vegetation of the entire basin.

Over half of the known tropical peatlands are found in Southeast Asia. Many of them are drained and degraded. Over the last 20 years, huge areas of peatlands have been converted to palm oil and acacia plantations, especially in Indonesia and Malaysia. The global production of palm oil has risen from 15 million tonnes in 1994 to over 74 million tonnes in 2019. This massive rise was permitted by the increasing use of palm oil as fuel, processed food and in washing and cleaning products. Acacia plantations, for their part, are used to produce pulp and paper.

Especially in Southeast Asia, uncontrolled, large-scale forest and ground fires have been blazing repeatedly since the 1990s. Under moist natural conditions, peat soils usually do not catch fire, but they burn well when they dry out. Big companies often set fires, either legally or illegally, to clear the land and create space for new plantations. Climate crisis has made many areas even more susceptible to forest fires. Indonesia has recently undertaken greater efforts to raise the water levels in its peatlands again. Its drained peatlands emit more greenhouse gases than any other country in the world. But in the meantime the government has set up a state agency for peat restoration and has already rewetted an area of over 2 million hectares.

Agriculture destroyed Indonesian peatlands. In recent years, the Indonesian government has committed to restore them in a very comprehensive way

Permafrost soils, which partly consist of frozen peat, are especially threatened by climate crisis. If they thaw, the organic matter they contain breaks down, releasing the carbon in form of the greenhouse gases carbon dioxide (CO_2) and methane (CH_4). In the Arctic, where most permafrost soils are found, the temperature has risen in the last 40 years almost four times faster than the global average.

In the Cuvette Centrale in the Congo Basin in Central Africa, which was scientifically recorded only a few years ago, the government of the Democratic Republic of Congo (DRC) has launched an oil and gas auction that would allow oil companies extensive licenses to exploit the area. With its area of 16.7 million hectares, the Cuvette Centrale is one of the largest contiguous areas of peatland worldwide. It includes more than one-third of the total area of all tropical peatlands, and contains more than a quarter of the carbon they store. If the oil auctions are not stopped, companies may be able to start chopping down trees, establishing palm oil plantations and drilling for oil there.

SUSTAINABILITY GOALS

LIFE-GIVING MOISTURE

Peatlands and other types of wetlands foster biodiversity and protect humans and nature from drought and flooding. But they are some of the most threatened ecosystems on the planet. Current efforts to conserve them have so far proven inadequate.

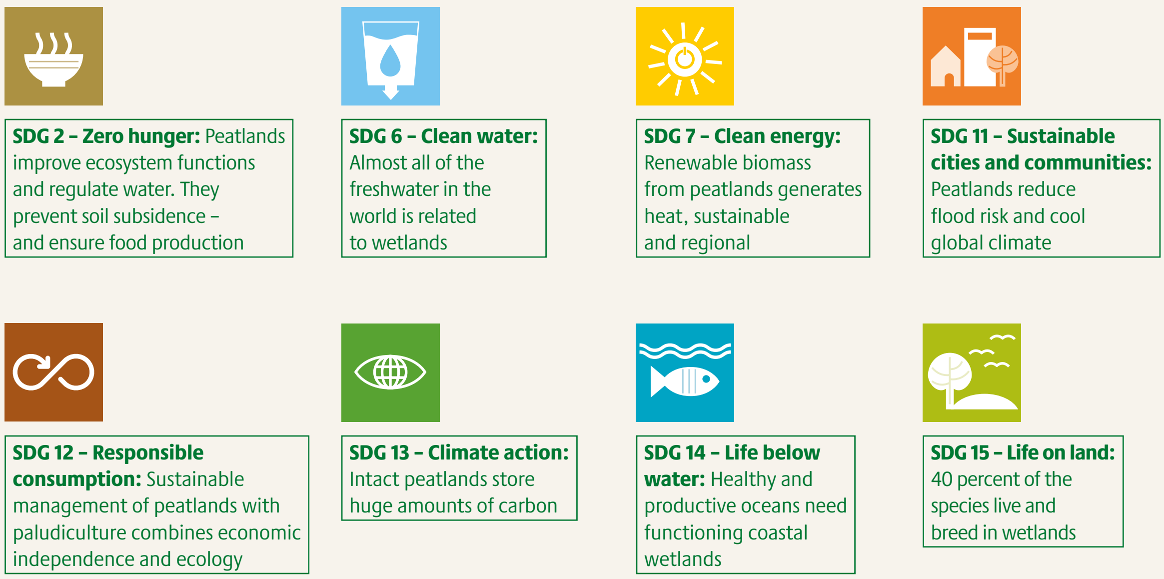
The term wetlands includes a range of different ecosystems: marshes, water meadows, peatlands, floodplains, swamps, rivers, lakes, mangroves – and diverse coastal areas. What they all have in common is lots of water. They are sometimes described as the Earth's kidneys, because they act as natural filters to absorb pesticides and other chemicals and remove nutrients such as nitrate and phosphorus from the water. Covering a total of at least 1.6 billion hectares, wetlands are found all over the world. They have long been under threat: they are disappearing three times faster than forests. Just since 1970, some 35 percent of all wetlands have been destroyed. This has happened either as a result of deliberate drainage, which has increased markedly since the 1960s, or indirectly through falling groundwater levels. Globally, some 350 million hectares of wetlands have already disappeared, of which 50 million hectares used to be wet peatlands. These drained peatlands are the source of at least four percent of worldwide greenhouse gas emissions. The biggest losses of wetlands today are the result of unsustainable forms of agriculture and forestry, the pumping of groundwater, and increasing water pollution. The expansion of industry and infrastructure also contributes to the destruction. In all, one percent of the remaining wetlands are lost each year.

60 percent of humanity lives and works in coastal regions protected by wetlands from flooding. One hectare of wetland can absorb up to 5.6 million litres of floodwater. The continuing destruction of wetlands makes it harder to cope natural disasters, whose numbers have risen tenfold since the 1960s. Floodings, droughts and storms are responsible for up to 90 percent of all the climate-related disasters each year, and the Global South is especially hit hard. People who live in poverty and who have contributed the least to climate crisis are suffering the most.

To fight inequality and overexploitation, the United Nations has committed itself to 17 sustainability goals. They can only be achieved with peatland protection

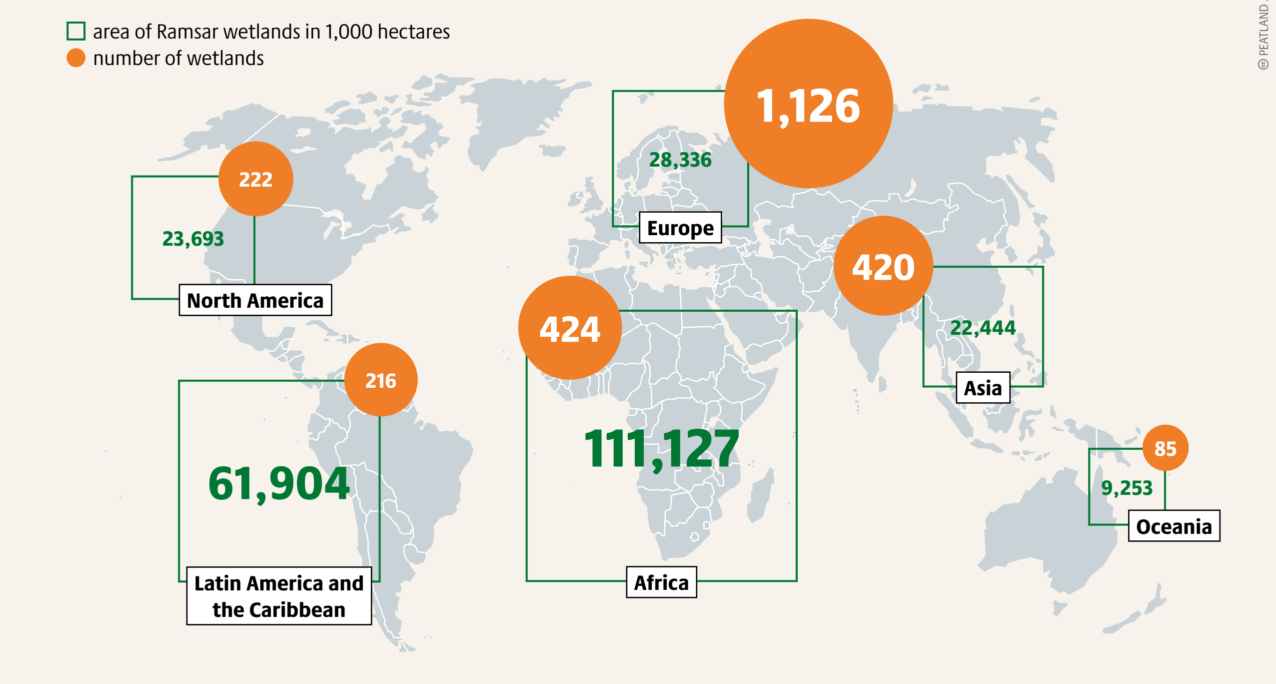
PEATLAND AS A FACTOR

Impact of peatlands and wetlands on selected United Nations Sustainable Development Goals (SDGs)



SEAL OF APPROVAL, ALSO FOR PEATLANDS

Wetlands declared to areas of protection by the Ramsar Convention, ratified by 172 countries



657 peatlands covering an area of over 60 million hectares are Ramsar sites. This does not yet grant them protection, but attention

Some 40 percent of the world's species live and reproduce in wetlands. This biodiversity is at risk: in the past five decades, 81 percent of the plant and animal species in inland wetlands have suffered decline, along with 36 percent of the species in coastal and marine areas. The climate also is hugely affected. Although they cover only 1 percent of the Earth's surface (including the oceans), wetlands store around one-fifth of global carbon – as long as they remain intact. If they are drained, the stored carbon oxidizes into carbon dioxide (CO_2) and escapes into the atmosphere.

Although the many ecosystem services provided by wetlands have direct links to the Paris Climate Agreement and the 17 global Sustainable Development Goals of the United Nations, there is only a single international agreement that places their protection centre-stage. The Ramsar Convention goes back to 1971, but it is not legally binding. A total of 172 states have acceded to the Convention. These states provide a list of internationally significant wetlands, similar to UNESCO's list of World Heritage sites. A total of 2,493 sites around the globe, covering a total of 256 million hectares, are currently listed – an area as large as Argentinia. For decades the Ramsar Convention neglected peatlands: they were first brought under the protection of the Convention just 20 years ago. However, because of their importance, these peatlands now account for about one-quarter of the designated wetland areas in the Ramsar registry.

Even if a wetland makes it onto the list, it is not automatically granted protected status. The European Union, however, has various guidelines which can be used to place such areas under special protection. For example, they can be classified as a nature reserve or a flora-fauna habitat.

The United Nations has designated 2021 to 2030 as the Decade on Ecosystem Restoration. In 2019, the United Nations Environment Assembly (UNEA) passed a resolution that focuses on peatlands for the first time, giving new impetus to efforts to protect this land type. All countries of the world expressed their intention to attach greater importance to the sustainable use and restoration of peatlands. The Kunming-Montreal Global Biodiversity Framework of 2022, part of the Convention on Biological Diversity, focuses on the protection of threatened ecosystems such as wetlands and peatlands, and is the largest commitment ever made by the international community for habitat protection. By 2030, at least 30 percent of particularly degraded land and marine areas are to be restored, so these areas can again perform their ecosystem services. In addition, one-third of all land and marine areas are to be placed under protection by 2030. Like the Ramsar Convention, the Montreal-Kunming framework and the UNEA Resolution are not compulsory. But binding agreements are precisely what experts demand: to be able to restore and protect ecosystems, legally enforceable frameworks are vital.

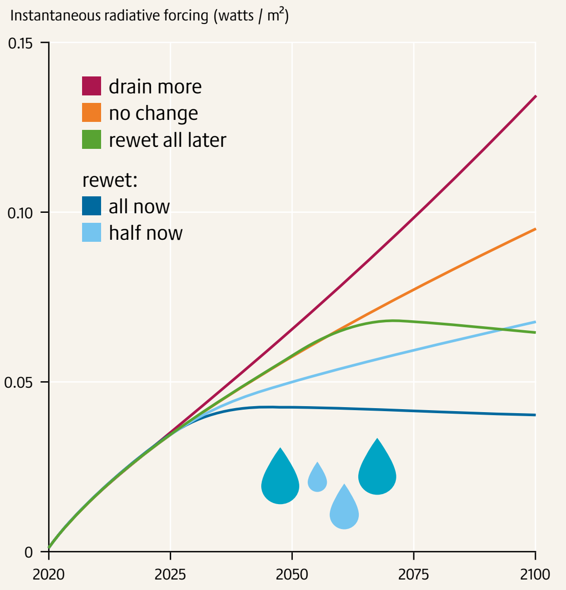
DRAINED PEATLAND RESULTS IN HEATED PLANET

Because they take up greenhouse gases, peatlands cool the climate – but only as long as they are intact. But these peat-covered areas have been – and still are being – drained for agriculture, forestry, peat extraction and human settlement, exacerbating global warming.

Over thousands of years, peatlands have accumulated thick layers of peat – remains of dead plants, under permanent-wet soil conditions. In the oxygen-free environment under water, the plant remains decay only very slowly and are conserved, similar to pickled gherkins. The main component of peat is carbon. Peatlands cover only 3 percent of the Earth's land surface but store in their peat a disproportionate quantity of carbon, around 600 billion tonnes. That is around twice the carbon stored in the biomass of all the Earth's forests on 27 percent of the world's land.

PROCRASTINATING ONLY MAKES IT WORSE

Climatic effects of time-dependent rewetting of drained peatlands



Radiative forcing is the change in energy flux in the atmosphere; it indicates the warming of the earth's surface

When they were alive, the plants that now make up the peat took the carbon out of the atmosphere as the greenhouse gas carbon dioxide (CO_2) and changed it by photosynthesis into plant material. As long as the peatland remains wet, the carbon stays largely in the peat. A small part of the carbon is, however, emitted as methane (CH_4), a powerful greenhouse gas. Wet peatlands emit around 30 million tonnes of methane per year – about one-third of the global emissions from livestock and manure. However, this emission does not burden the climate, because in the atmosphere methane quickly reacts with oxygen, changes into the weaker greenhouse gas CO_2, and thus loses its strong climate effect. Methane emissions raise the methane concentrations in the atmosphere only when the peatland starts to form. Afterwards the methane concentrations do not keep rising – even with continuous emissions – but soon reach a steady state. The same amount of methane is broken down as is simultaneously emitted. On the other hand, the ongoing sink for CO_2 that natural peatlands represent continuously reduces the CO_2 concentration in the atmosphere. In this way, peatlands have lowered the average global temperature over the last 10,000 years by about 0.6 degrees Celsius.

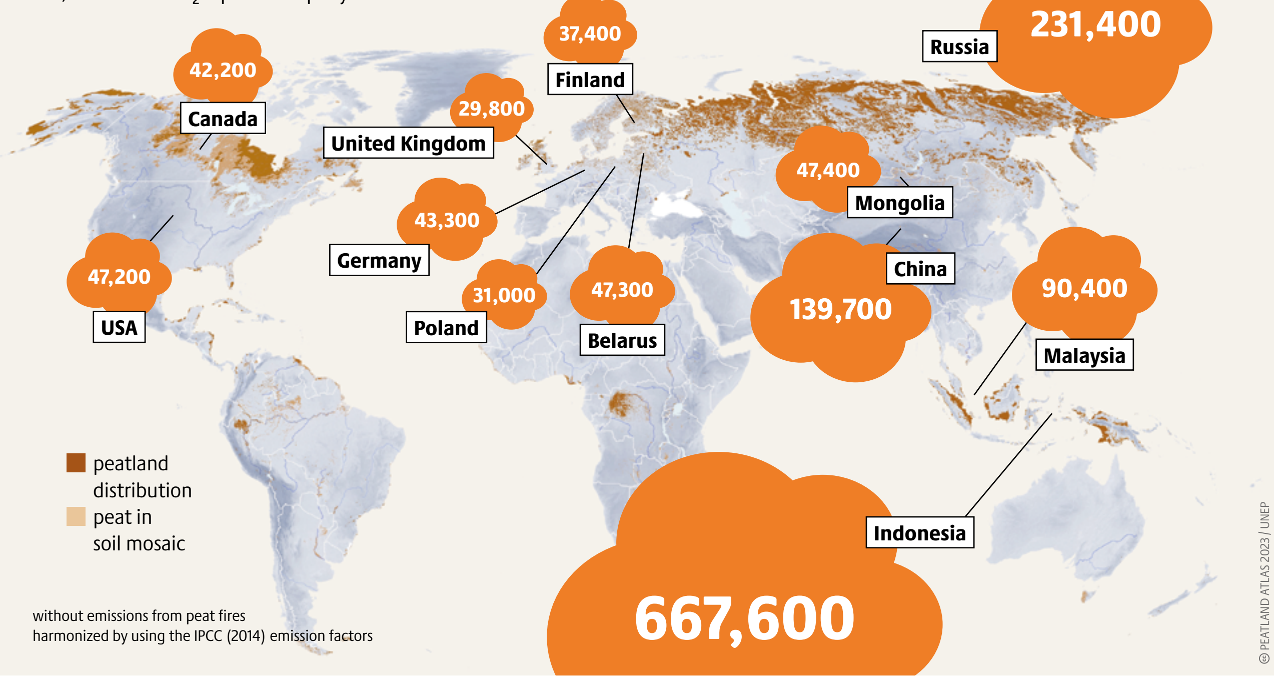
Globally, around 88 percent of the world's peatlands are still in a largely natural state. But more than 50 million hectares of peatlands have been drained so strongly that no new peat is formed any longer. On the contrary, the penetration of oxygen into the drained peat soil results in its continuous decomposition. That produces CO_2 and nitrous oxide (N_2O). The global warming effect of various greenhouse gases is expressed in terms of CO_2-equivalents. In Central European peatlands, a drop of the average water table of 10 centimetres results in an extra 5 tonnes CO_2-equivalent of emissions per hectare per year. In the tropics, the figure is as high as 9 tonnes.

Every year, drained peatlands emit almost 2 billion tonnes CO_2-equivalent, which is twice as much as the whole of global aviation. Almost 90 percent of these emissions consists of CO_2, the rest of methane and nitrous oxide. On top of that are the emissions from peat

A study of 2020 shows: A key factor in climate crisis mitigation is the prompt rewetting of all drained peatlands

FEW STATES CAUSE GREAT DAMAGE

The twelve countries with the world's largest greenhouse gas emissions from drained peatlands, in 1,000 tonnes CO_2 equivalents per year



without emissions from peat fires
harmonized by using the IPCC (2014) emission factors

fires. Peat fire emissions vary considerably over time and are difficult to measure – but on average they may amount to between 500 million and a billion tonnes of CO_2-equivalent a year. Apart from emitting greenhouse gases, peat fires also produce dangerous levels of air pollution, which can spread far beyond its region of origin. According to studies, more than 100,000 people have died as a result of large peat fires in Indonesia in 2015. Over half a million people had acute respiratory problems; the national economic damage is estimated at up to 40 billion euros.

Although drained peatlands make up less than half a percent of the Earth's land area, they are responsible for around 5 percent of all human-induced emissions – peat fire emissions included. Most peatland emissions come from Indonesia, the European Union (EU) and Russia. Within the European Union, half of the emissions come from Germany, Finland and Poland. By far the biggest share of these emissions originates from drained agricultural land.

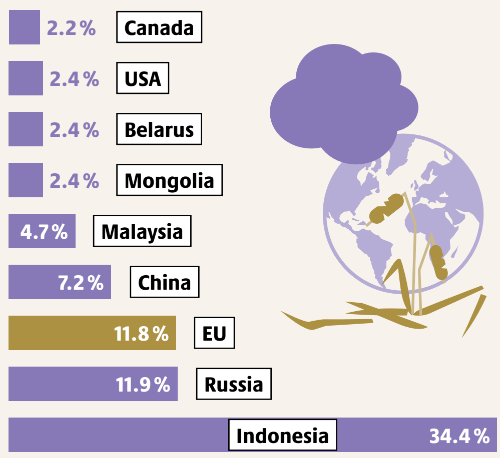
Without effective policy countermeasures, emissions from drained peatlands could by the end of the century use up over 40 percent of the greenhouse gas budget remaining to keep global warming below 1.5 degrees Celsius. To comply with the goals of the Paris Climate Agreement, net CO_2 emissions must be reduced to zero by 2050. Experts have pointed out that this goal can be achieved only through the immediate and complete rewetting of all drained peatland. That means that globally 50 million hectares of peatland must be rewetted. In the EU, that means 500,000 hectares each year – and worldwide 2 million hectares.

In 2015, peat fires in Indonesia released more greenhouse gases than Japan in the whole year

CO_2-equivalent is a unit of measurement comparing the climatic effect of greenhouse gases such as methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2)

THREAT TO ALL CLIMATE GOALS

Share of global emissions from drained peatlands, in percent



without emissions from peat fires

ENVIRONMENTAL HISTORY

FALLACIES OF IMPROVEMENT

Humans have drained peatlands for centuries to provide land for farming and settlement. History may help us recognize the fallacies of supposed improvement, remember the presence of destroyed and often invisible peatlands in our landscapes, and advocate for the protection and restoration of peatlands.

In many parts of Europe, peatlands have largely disappeared as visible elements of the landscape. Centuries of drainage have reduced flood-protection areas and damaged habitats for plants and animals. Drainage has also held important implications for the global climate. Intact peatlands store more carbon than any other ecosystem in the world. When they are drained, the carbon that has accumulated and has been sequestered in the peat over thousands of years is exposed to oxygen, releasing vast amounts of the greenhouse gas carbon dioxide (CO_2) into the atmosphere. Wildfires on drained peatlands accelerate this process. The history of peatland drainage is therefore a crucial chapter in the history of the current biodiversity and climate emergency.

Mentions of peatland drainage go back thousands of years. In continental Europe, wetland reclamation gained momentum in the 18th century, when monarchs, bureaucrats and educated elites developed drainage schemes to render peatlands useful. They often took inspiration from the Netherlands, where drainage and peat extraction contributed substantially to the country's economic power in the early modern period. Europe's elites believed that peatlands were mistakes of nature which had to be corrected through active human intervention for the sake of cultural and economic progress. Their ambition to improve the nature of peatlands devalued more sustainable uses of these ecosystems, such as fishing, hunting or the gathering of plants.

The reclamation of the Oderbruch – a marshland located along the Oder river in eastern Germany – under Frederick the Great of Prussia is a paradigmatic example of the modern drainage frenzy which caused the destruction of wetland ecosystems as a means of civilization. As a driver of settlement and agricultural expansion, the drainage of the Oderbruch has been celebrated as a triumph of human reason over recalcitrant nature and allegedly backward ways of life. It inspired drainage schemes in other parts of Europe.

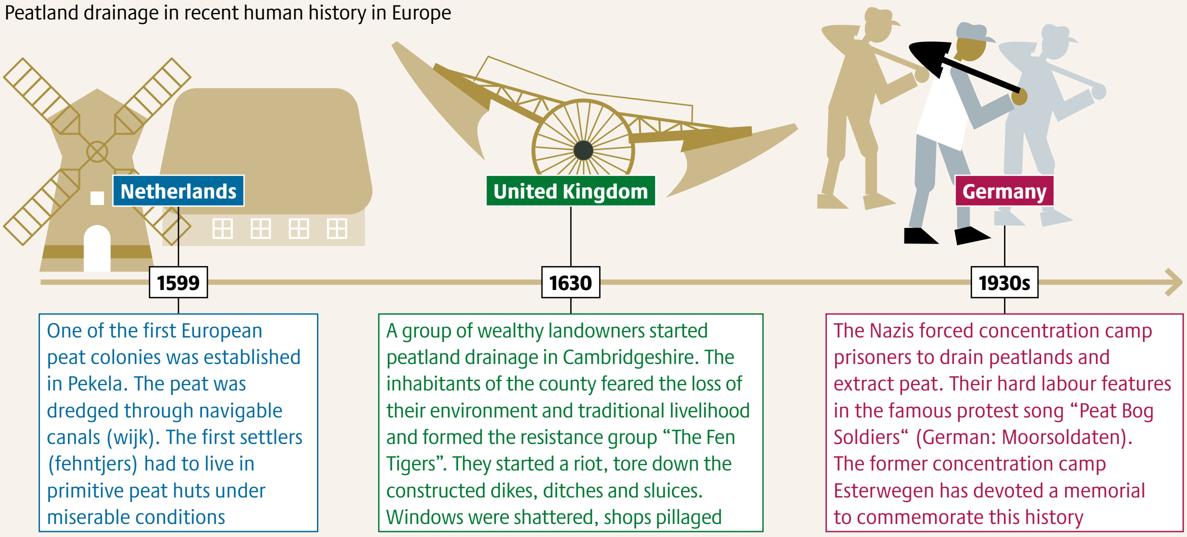
Drainage schemes always reflected the social and political conditions of their time. The cheap, sometimes unfree, labour of marginalized population groups or convicts was repeatedly mobilized for the laborious reclamation work. Drainage appealed to various political regimes and projects. In the late 19th and early 20th century, it appeared to be a means to prevent the exodus of the rural population and to modernize the countryside. Land drainage became tied to autarky politics and social engineering efforts during the interwar period, when the governments of Poland and the Netherlands, among others, launched ambitious land-reclamation schemes.

In Germany, the Nazi regime openly linked land reclamation of peatlands with racist ideology. During World War II, Nazi planners sought to drain the land along the Pripyat River in present-day Belarus and northern Ukraine, which they wanted to be settled by German peasants instead of the Jewish and Slavic population. Although these plans were not implemented, the wetlands of eastern Europe became sites of the mass atrocities and genocides committed by the German occupation forces.

One hectare of drained peatland emits more CO_2 than a car driving 280 billion kilometers

SHADOW OF THE PAST

Peatland drainage in recent human history in Europe



In the second half of the 20th century, peatland drainage became a function of agricultural productivism, commercial forestry and rural development on both sides of the Iron Curtain, often with the support of national governments. In the UK, landowners could avail of specifically designed drainage grants. In 1950, the West German government agreed to invest considerable resources to develop the Emsland, a poor region in Lower Saxony bordering the Netherlands. The construction of extensive drainage systems was a key element of the scheme, which profoundly changed the environment of the area. State involvement in peatland drainage was most intense in the socialist countries of eastern Europe, particularly in the Soviet Union. After the Soviet government established a Ministry of Land Reclamation and Water Management in 1965, the extensive peatlands of the Baltic republics, Ukraine, Belarus and in northern and western Russia became subject to massive drainage campaigns. The German Democratic Republic (GDR) also carried out ambitious reclamation works, most famously in the Friedländer Große Wiese in the country's northeast.

Drainage reclamation has left deep scars in the landscapes of Europe. Elements of agricultural and forestry infrastructure are markers of the damage done to people and land over centuries of peatland destruction. Livelihoods that used to accommodate intact peatlands have largely disappeared. Animals and plants that once inhabited these wet environments have shrunk in number or completely disappeared.

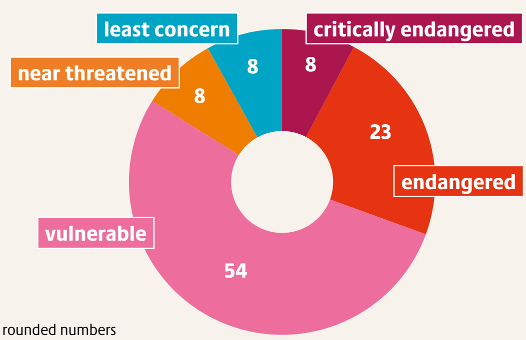
In modern times, peatlands were considered an obstacle to progress. In Western Europe, they have since been converted into farmland to a large extent

Adressing the ecological amnesia surrounding peatlands, history plays an important role as we try to reimagine human–peatland relationships

After centuries of peatland destruction a new paradigm has recently taken shape. While peatlands were long considered useless or dangerous spaces, they are now valued as unique environments. Despite increased support, however, the enormous potential lying in peatlands is far from being exhausted. Often used as farmland or grassland, drained peatlands have generally little in common with their wet, species-rich ancestors. Many are not even recognizable as peatlands. Taking a conscious look into the past makes us aware of the tremendous human and environmental damage linked to the history of drainage and reminds us that supposed improvement has rendered many peatlands invisible.

GIVE PEAT A CHANCE

Vulnerability of peatlands in the EU28, in percent



rounded numbers

BIODIVERSITY

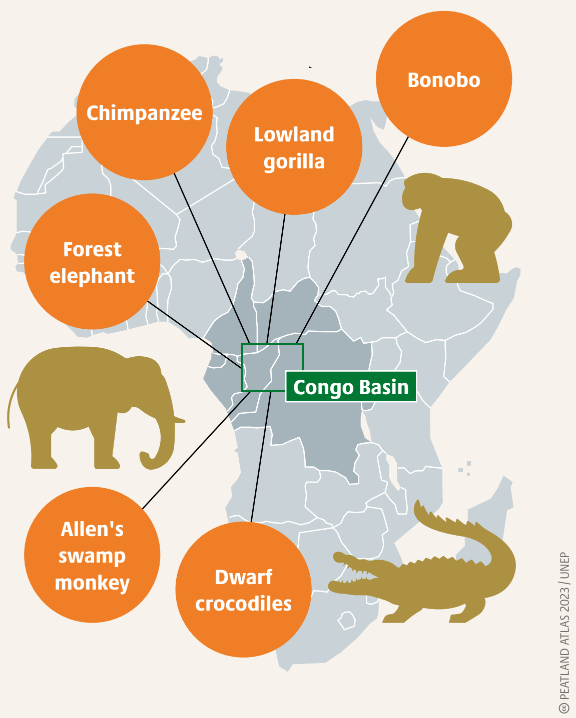
SAFE HAVENS FOR ECOSYSTEMS IN DANGER

Peatlands all over the world sustain a rich range of habitats and species, including a wide range of threatened and endemic ones. Policymakers are called upon to protect these unique landscapes.

Peatlands are one of a wide range of varied landscapes on our planet, along with forests, grasslands, lakes, marshes, mangroves and other wetlands, all of which contribute to global landscape diversity. Under different conditions, peatlands may be flat, raised or bowl-like. They may have ribbed, polygonal or mounded patterns on the surface, as in the Arctic tundra or the taiga, or be smooth, as along the coast. They may get water from the atmosphere, groundwater, river floods, permafrost or surface flow. They may be covered with trees or reeds – as in the tropics – or mosses, sedges and dwarf trees, as in the taiga.

NOT ONLY REEDS AND BIRDS

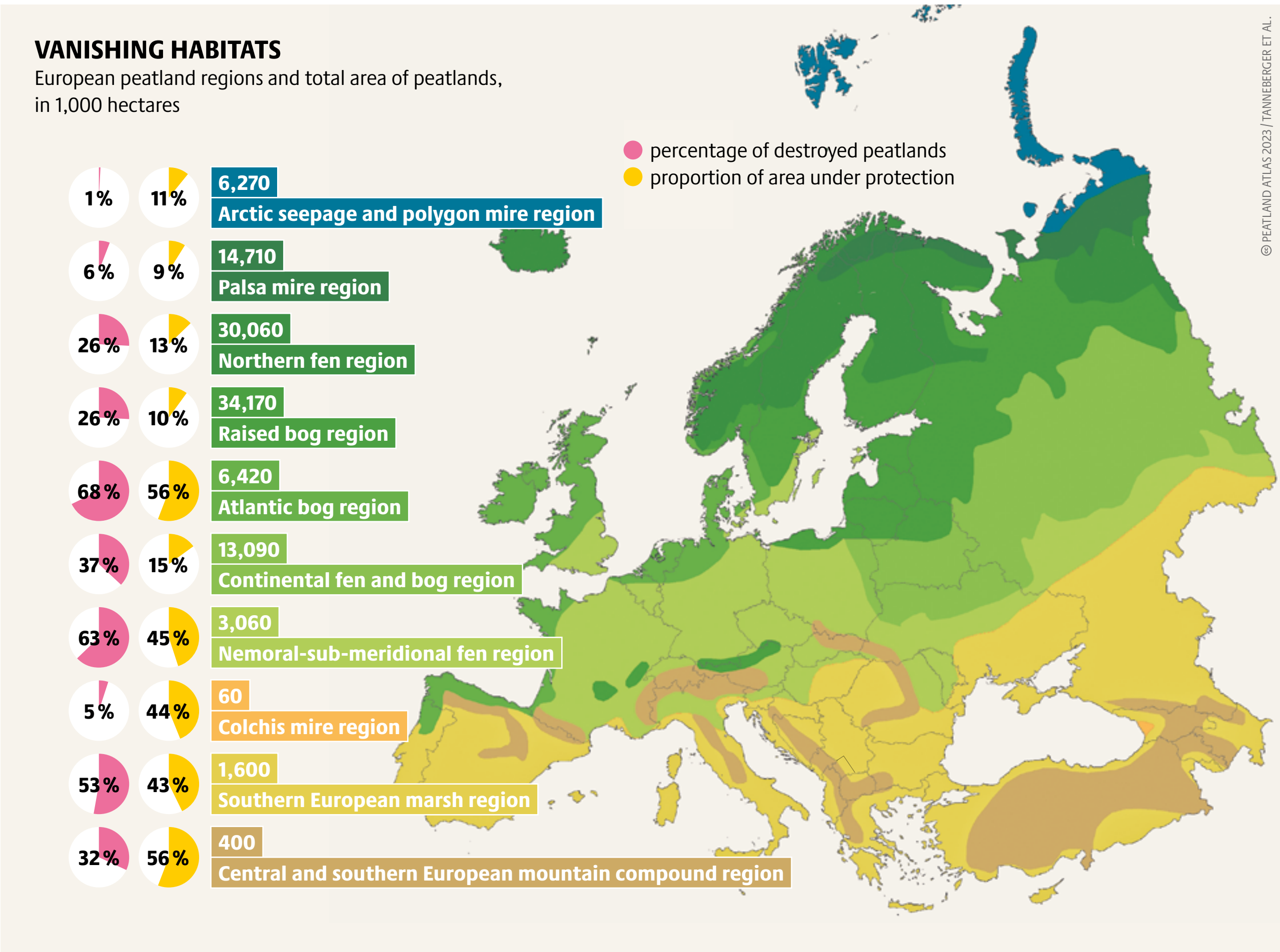
Megafauna populations in Cuvette Centrale peatlands in the Congo Basin, Central Africa



The surface of a peatland often looks like a piece of art. In the Arctic, where permafrost sculpts the landscape, polygon patterns like ice crystals form on the peatland surface. In the temperate zone, water running from a peat dome creates ridges and hollows. In tropical peatlands, lace-like patterns reflect the former banks of rivers and lakes. All this fascinating diversity of patterns visible from above perform a crucial role in biodiversity: they create a great diversity of habitats within relatively uniform ecological conditions. All habitats in peatlands are densely occupied due to the diversity between and within species of organisms. It has taken thousands of years of evolution to create such highly specialized living communities. Some species have adapted so closely to the extreme conditions of peatlands that they are unable to live in any other habitat. For plants in the temperate zone of Eurasia, there are no more than 15 species that grow exclusively in peatlands: they include the round-leaved sundew or pod grass. In Southeast Asia, some 45 species are recognized as restricted to peat swamp forests, for example, the tropical tree Meranti Bakau, and the woody liana Akar Jitan. In North America, the wood frog is the only species that can successfully reproduce in highly acidic bog waters and can survive deep freezing. The pitcher plant mosquito lays its eggs in the water at the bottom of the pitcher, the larvae is unaffected by the digestive enzymes of the plant – and even providing bacteria to the host plants to help them digest the exoskeletons of other insects that have fallen into the pitcher. Butterfly larvae are tied to plant species at the hormone level: larvae of the ocellate bog fritillary feed on the cranberry only, Cranberry blue lays eggs on blueberry.

There are many other examples of how peatland specialists can survive in challenging environmental conditions. Peatland plants build a microcosm for specific birds, small and large mammals, insects, soil invertebrates, fungi and bacteria. The specialists and their microcosm cannot survive the loss of their habitats when peatlands are drained and changed to other landscapes. If one species disappears, all other organisms that are dependent on it through symbiosis, food,

Peatlands are a patchwork quilt of different types of vegetation and animals. They differ from region to region, continent to continent



More than half of all pristine peatlands in Europe have been lost – and peatland degradation continues. Biodiversity is at stake

shelter or behaviour also disappear. Peatlands also have less-equipped species as visitors – neighbours, nomads or refugees. Species that live in the neighbourhood pay short visits to peatlands during droughts or in the berry season, for nesting or mating, or in search of a wintering ground. Migrating species come to peatlands only to stop over, feed and rest. They usually stop at exactly the same peatland each year, as their ancestors have done for hundreds or even thousands of years. For example: Cranes stop in the German Teufelsmoor on their way to the South, Swedish swifts winter in the Congo Basin. These species lose their landmarks and crucial resting grounds if important peatlands are drained and disappear. Finally, in times of rapid and dramatic loss of other habitats, peatlands are a refuge for species from other landscapes, such as grasslands or forests. Invasive species brought from peatlands in other continents are able to spread in suitable locations. Examples are the insectivorous purple and yellow pitcher plants. These were brought to Europe from North America as ornamentals, and have successfully populated raised bogs in the Alps and the British Isles during the last 20 years, bringing a serious imbalance into these ecosystems.

But why do we need this landscape, geographical, habitat, species and intraspecies diversity in peatlands? Peatland landscapes have a significant function in maintaining sustainable and resilient socio-ecological systems. The peatlands themselves are built up by the biota that they host. Due to their special features, only the organisms living in peatland can build up peat. Wet peat stores large amounts of carbon and water. That both helps to mitigate climate crisis and provides resilience to landscapes while climate crisis is resulting in much more extreme weather events. Peatland biodiversity not only maintains itself but also sustains very valuable ecosystem services for humanity. The Convention on Biological Diversity and the Kunming-Montreal Global Biodiversity Framework of 2022 call for all countries to protect biodiversity. At least 12 percent of global peatlands are already destroyed. The profits from the use of drained peatlands do not benefit communities that have lost their ecosystem services. We need clean water, settlements near rivers that are protected from flooding, moderated climate conditions, and productive fields and forests. That is why there is need to give strong consideration to biodiversity when restoring and using peatlands.

PEAT

PEATLANDS' RAW MATERIAL

Peat consists of dead organic matter accumulated over thousands of years. Since centuries, peat soils have been exploited to obtain fuel or raw material for growing media. Peat extraction and use is harmful to the environment. Sustainable alternatives will only prevail if politicians act.

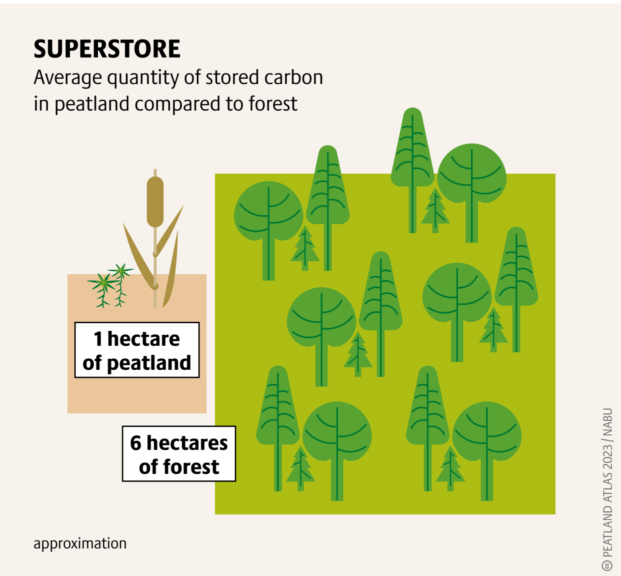
Unlike wood or coal, the temperature at which peat burns is reasonably constant and easy to regulate. Peat was already used as a fuel over 4,000 years ago in the Bronze Age. It is still used today as a source of electricity and heat, particularly in Finland, Ireland, Russia, Belarus and Rwanda. Since the middle of the 20th century, it has been used in horticulture as a raw material for growing media. Peat accumulated from peat mosses in particular has many advantages for horticultural use. Its high porosity enables this peat to retain air and water – and release it when required. It also has a stable structure, which is useful especially for long-lasting plant cultures. At the same time, peat contains very few nutrients, pollutants or pathogens.

Smaller amounts of peat are also used for other purposes. Peat can absorb liquids quickly, which is why it is used both in livestock bedding and in diapers. Because peat contains hormone-like substances and humic acids and is effective against bacteria, viruses and inflammation, it is considered to be a natural remedy and is used in balneological baths and packs. Dry peat can be used as insulation material, because it contains a lot of air. In agriculture, peat is applied to improve mineral soils, loosen them up and enrich them with humus. Peat is also used as a raw material in the production of activated charcoal, which is used as a filtering material in industry. Textiles can be made from peat fibre – the name given to the leaf sheaths of sheathed cottongrass, a common plant species of bogs. These fibres are sifted out of the peat when it is being processed for horticultural uses. Peat is also a famous flavouring agent: during the malting process in whisky production, barley is dried slowly over a smouldering peat fire, giving the whisky its famous smoky taste. In Iceland and Germany, people in the past often built houses from peat sods, due to the lack of wood.

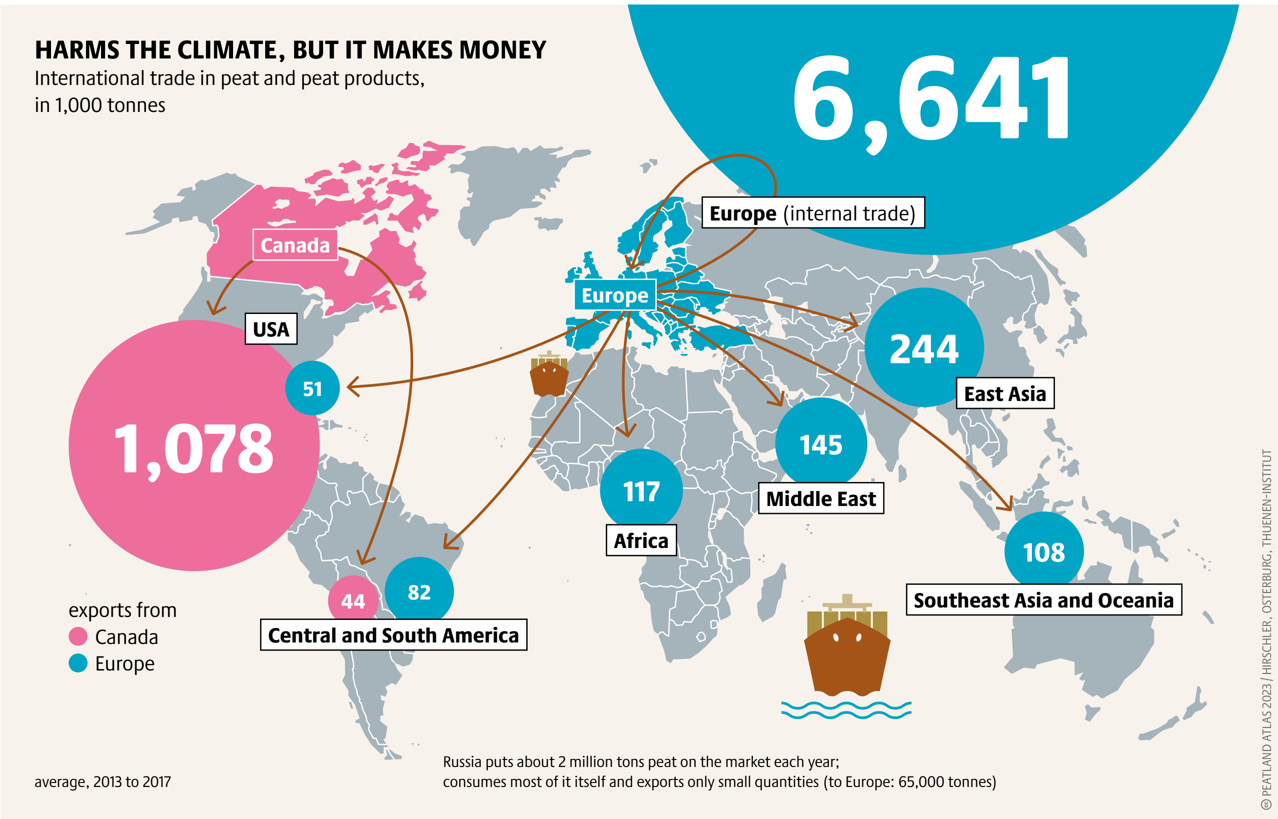
Global peat deposits are estimated at up to 13.8 billion cubic metres. Worldwide, around 24 million tonnes are extracted each year – of this some 83 percent are extracted in Europe alone. Until 2017, more than half of the peat extracted was used as fuel – though this amount decreased considerably in recent years. About 10.3 million tonnes of peat, or 41 million cubic metres, are extracted each year to produce horticultural substrates and potting soil. While peat fuel is generally burned in the country where it is extracted, peat for horticultural use is traded internationally, both as a raw material and mixed into substrates. In Europe, peat extraction for horticulture is concentrated in the Baltic States, Germany, Fennoscandian Peninsula and Ireland. Outside of Europe, peat is also massively extracted in Canada, mostly for export to the USA. Peat extraction for horticulture also exist on a smaller scale in the USA, Russia, Chile and Argentina. The biggest producers and end-users of peat-based substrates are Germany, the Netherlands and the United States.

In the coming decades, the industry expects a strong increase in demand for growing media worldwide, especially in Asia. To meet the societal demands of today, fossil peat should not be used for this purpose, but efforts to produce renewable materials regionally should be significantly increased.

Peatlands store some 600 billion tonnes of carbon, or about one-third of the world's total land-based carbon stores. Peat extraction and use in the European Union (EU) are responsible for greenhouse gas emissions



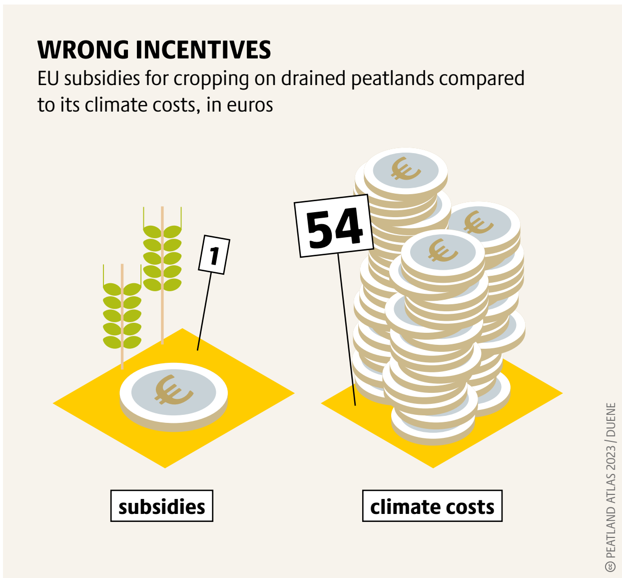
Garden centres sell good, peat-free potting soil. Using only this would save 400,000 tonnes of CO_2 a year in Germany



in the order of 21.4 million tonnes of carbon dioxide (CO_2)-equivalent a year. That amounts to about one tenth of the total EU emissions from peatlands. However, the extraction and use of peat, by releasing carbon particularly quickly, result in the highest emissions per hectare of all peatland uses. The Intergovernmental Panel on Climate Change classifies peat as a fossil resource and warns that its use is no longer appropriate in the face of the climate crisis.

That is why several countries are preparing to move away from peat use. One example is Ireland, which aims to end the extraction and use of peat as a fuel by 2030. Finland, currently the European Union's biggest consumer of peat-based energy, aims to cut its consumption by 50 percent by the end of the decade. However, changes in the geopolitical situation since Russia's invasion of Ukraine have thrown such plans into doubt: Finnish companies have cited energy supply uncertainties in announcing plans to resume peat extraction. In several countries, the extraction and use of horticultural peat is being addressed as part of national climate and peatland policies. Germany, for example, plans to phase out the use of peat in hobby gardening by 2026, and to largely replace it in commercial horticulture by 2030. Doing so will require increased investments in research and production of peat substitutes. These could come from renewable resources such as wood fibre, bark, compost or coconut fibre, or from biomass produced in paludiculture. Paludiculture is the sustainable production for example of peat moss or bulrush on rewetted peatlands. Demand for such materials is already rising in Europe. ●

The global trade in peat is booming. In search for profits, it destroys a fundamentally important carbon store



Europe's agriculture policies continue to favour climate-harming farming methods. Protecting peatland would be a better economic option

LIVESTOCK

THE COWS THAT EAT PEAT

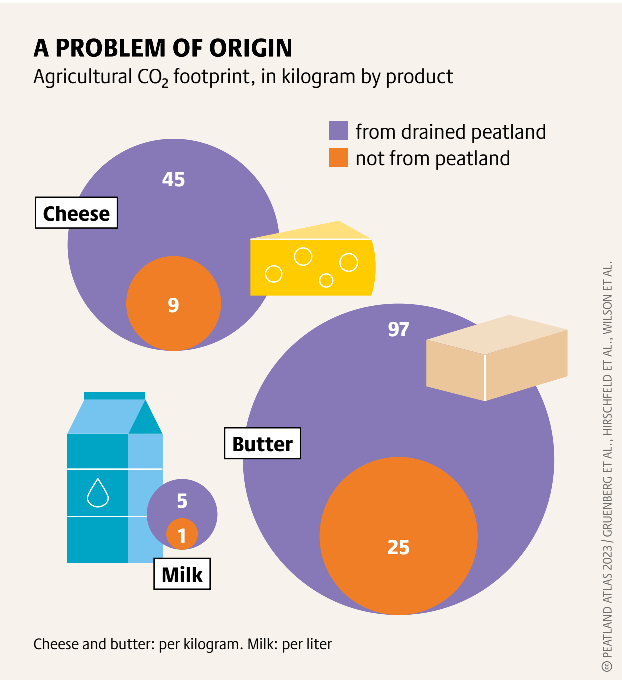
Our consumption of livestock products has an effect on the climate – through the emission of greenhouse gases and the conversion of natural landscapes into agricultural land. Even more greenhouse gases escape into the atmosphere when peatlands are drained to allow livestock-keeping or to grow fodder crops.

Half of all drained peatlands worldwide outside the tropics are now used for farming. In countries such as Germany and the Netherlands, the figure rises to almost three-quarters of all peatlands. Most are used for keeping livestock, especially as grassland for cattle. European peatlands and other wetlands have historically been used for animal husbandry involving the hand-mowing of fodder, the drying of hay or bedding in nearby higher and drier areas, and grazing on the drier margins of the peatlands. In other parts of the world, these forms of extensive wetland utilization are still common. In Kazakhstan and China, herders harvest fodder and bedding material and allow their animals to graze easily reachable reed beds. In the Flooding Pampa in Argentina or the Pantanal in Brazil, large-scale grazing takes place in wetlands that undergo alternating periods of drought and flooding. But overgrazing and degradation is often a severe problem, for example in Mongolia, where around 80 percent of the country's cattle are concentrated on peatlands.

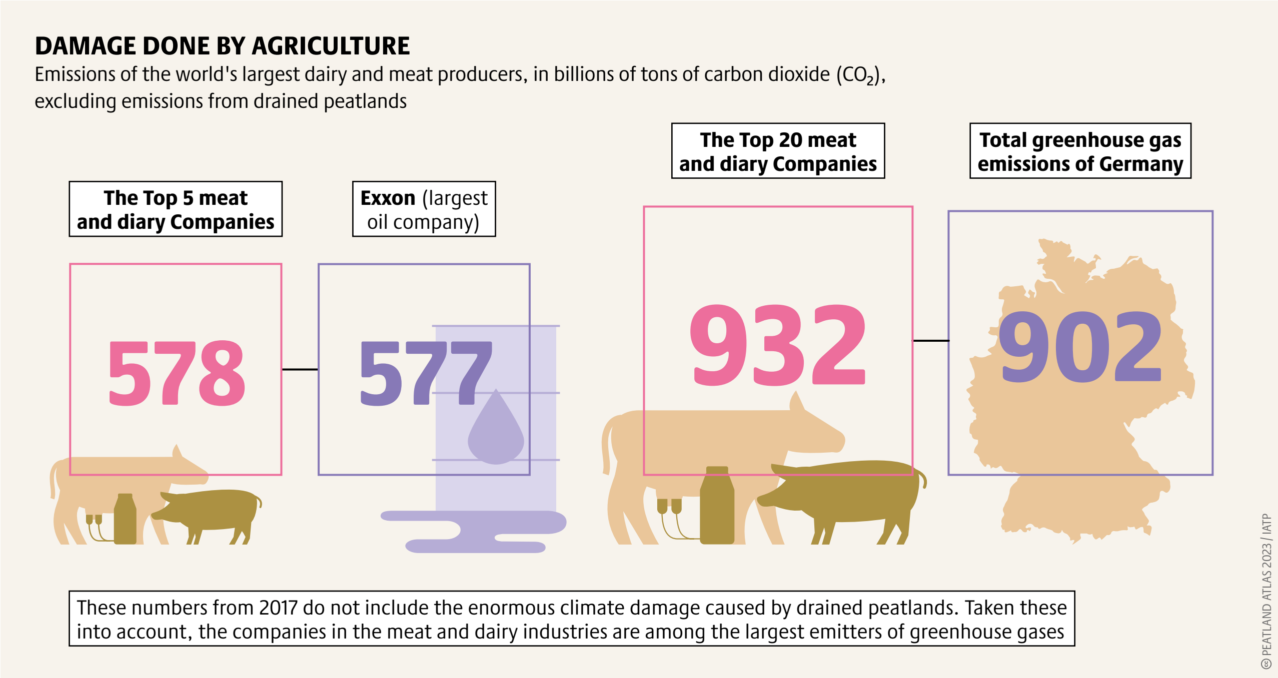
While peatlands drained for farming are dominated by meadows and pastureland, they are also used as arable land to grow fodder crops such as silage maize. That requires draining, fertilizing and cultivating the land, which results in very high greenhouse gas emissions. Although peatlands occupy only around 3 percent of the agricultural area of the European Union, their drainage is responsible for 25 percent of the emissions from agriculture and agricultural land use.

Not only is arable farming harmful to the climate; but so is intensive grassland farming on drained peat soils. These areas are used to grow feed, for example for dairy cattle that require high-quality, energy-rich feed. The emissions of carbon dioxide (CO_2) and nitrous oxide (N_2O) caused by drainage can reach 20 to 50 tonnes per hectare per year on intensive grassland. On top of that the high-performance grasses, high fertilization rates and cutting frequencies of four or more mowings a year result in a monotonous, species-poor grassland. Peatlands are used for intensive dairy farming in north-western Germany, Finland, and especially the Netherlands. The city of Gouda, which gave its name to a world-famous type of Dutch cheese, is located in the centre of a peatland that was drained back in the 11th century.

Beef cattle farming can be slightly less harmful to the climate. Fodder quality requirements are lower than in dairy farming, and synergies with biodiversity objectives are possible. The extensive grazing with beef cattle, especially on non-peat soils, can maintain grassland habitats that harbour threatened plants and animals. Cattle eat what humans cannot digest, and so do not compete with us for nutrients. On peat soils, extensive grazing allows for reduced drainage. This can cut annual emissions to less than 20 tonnes of CO_2 per hectare. To preserve the peat and meet climate targets, however, high water levels are needed that cannot be achieved with such grazing. The ground would be too soft for common cattle breeds and the animals would sink into the mud. In addition, the cattle's digestive system is less able to deal with feed from wet pastures, and hoof diseases and parasites such as liver flukes and lungworms are more of a problem. The actual carbon



CO_2 price: arable land and grassland on drained peatlands can hardly be profitable. But carbon costs are currently externalized



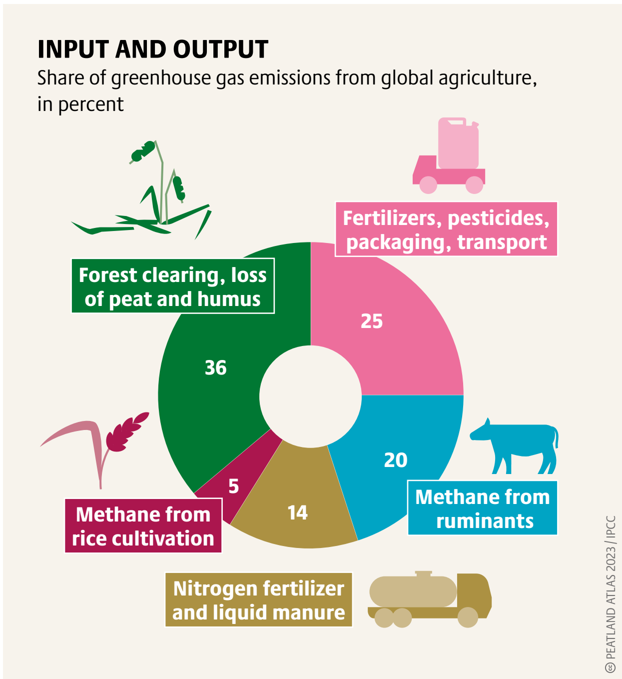
footprint of beef products varies, and depends heavily on the type of husbandry and the organic content of the soil. If cattle are kept on drained peat soils, the carbon balance includes not only their methane (CH_4) emissions but also the emissions due to peat degradation. In case of suckler cow husbandry, additional emissions of approximately 80 kilograms of CO_2-equivalent per kilogram of slaughter weight are calculated just for the rearing phase of the calves.

The consumption of meat and milk accounts for a large part of the greenhouse gas emissions attributable to the food system. The effects on the climate are much larger if the animals are kept on drained peat soils. Experts and environmental organisations therefore call for other more sustainable utilisation options for large peatlands. As soon as drained peatlands are rewetted – which is indispensable in order to meet climate targets– only the higher-lying parts are suitable for traditional, extensive grazing. Water buffaloes are an exception since they can also be kept in swampy areas. Around 95 percent of the world's population of water buffaloes are kept in Asia, and especially in India, Pakistan and China. They are used for work in rice fields and for transport. Their meat and milk are an important food source for buffalo keeper in these countries. For Germany it was shown that herd management and marketing are much more demanding than with conventional cattle.

Many farms face major economic challenges in renouncing the use of peatlands. For these farms, paludiculture could offer an opportunity. This is a sustainable use of wet or rewetted peatlands. Plant species are cultivated that thrive on permanently waterlogged soils and that produce raw materials that can help decarbonize the economy. Using peatlands in this way enables a double transformation: the necessary withdrawal of livestock from rewetted peatlands meets the need for healthier, climate-friendly diets. ●

Global drainage of peatlands causes twice as much CO_2 emissions as global air traffic

Corporations whose business is based on peatland destruction often refuse transparency when it comes to peat-related emissions



FORESTRY

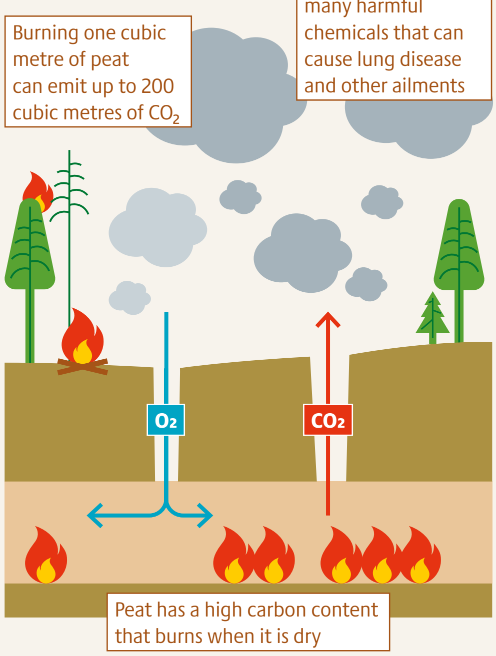
PEAT, WIND & FIRE

Three percent of the world's peatlands have been destroyed for forestry purposes, releasing large quantities of greenhouse gases into the atmosphere. Drained peat soils are the scene of devastating fires that are used to clear land.

Around the world, some 15 million hectares of peatlands have been drained to make way for plantations or forestry. Often enough the term forestry also means the monocultural cultivation of trees such as pines in plantations. When we refer to peatlands and forests, three drainage-based land use changes can be distinguished: the drainage of already forested mires, the drainage of open, rather treeless peatlands for afforestation, which mostly occurs in the nordic countries, and the drainage of naturally forested peat swamp forests in the tropics for the establishment of plantations after clearcutting the original forest. All can be conducted by large enterprises but also by smallholders, facilitated by the industrialization of forestry and agriculture.

Drainage for intensive, even industrialized land use always leads to a decline in biodiversity. In dense tree plantations, hardly anything can grow on the ground or in the undergrowth. In Europe, the largest areas of peatlands that have been drained for forestry are found in Finland and Russia, where they cover an area of 6.6 million hectares. One-third of Finland's forests are on peat soils, making peat-forest management very important for the country's economy. Since the middle of the last century, Finland has drained more than half of its peatlands – though the government is now making effort to restore them by reversing the drainage. In the tropics, drainage of peat swamp forests accelerated during the past decades due to an increasing global demand for tropical crops, timber and pulp wood such as from palm oil or acacia. Especially Southeast Asia has been a hotspot of peatland drainage, but also other tropical peatland forests are currently under threat as the need for arable land and forestry increases. The dilemma of forestry on drained peatlands is that newly planted trees sequester carbon, but at the same time the drained soils release vast amounts of greenhouse gases into the atmosphere. The decomposing peat emits carbon dioxide (CO_2), while the drainage ditches and canals release methane. Emissions of nitrous oxide may also rise, especially if fertilizer is applied. Drained organic soils are also susceptible to forest and peat fires. Large, long-lasting peat fires occur in the high-latitude parts of Canada and Eurasia, as well as in tropical areas and pose an additional great threat to the climate. Furthermore, these fires produce large amounts of toxic smoke that can be deadly for people and animals. To prevent fires from raging each year and causing loss of biodiversity, significant health issues, massive emissions, widespread destruction and loss of life, it is necessary to maintain and restore moisture levels in peat soils. Rewetted peatland forests provide good conditions for sustainable forestry. Society can benefit in many ways from the climate effect of wet peatland forest, if on the one hand the carbon remains bound in the peat, and on the other hand additional carbon is sequestered in long-lasting timber products. Like other wetlands, peatland forests also act as local cooling: shade and respiration by the natural vegetation

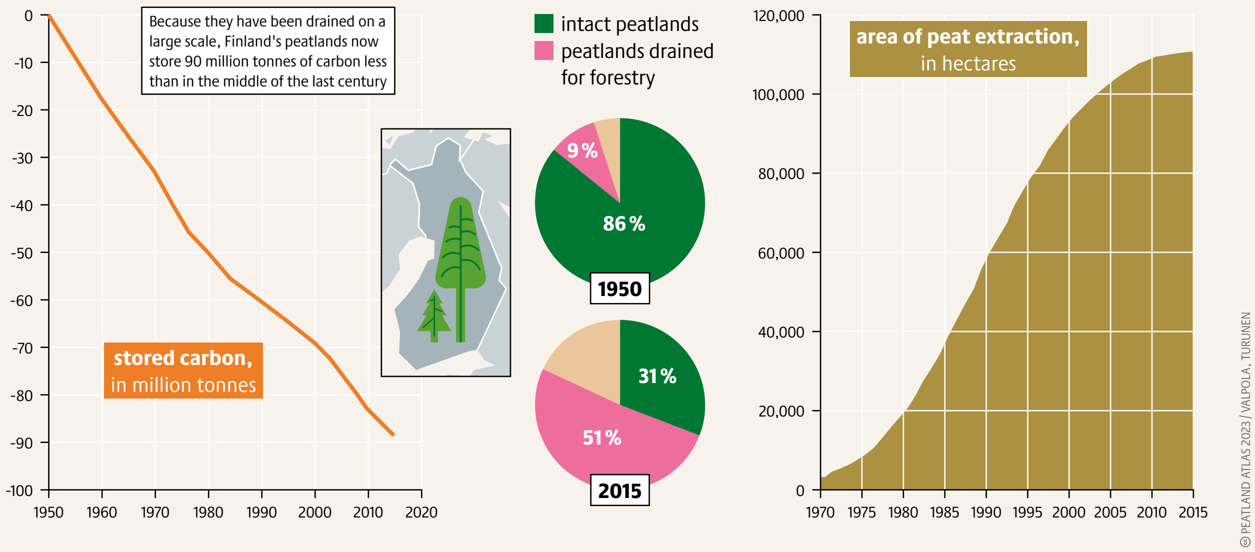
ETERNAL FLAME
How a smouldering fire develops in drained peat



Peatland fires, for example in Asia, are often caused by fires used to clear land for industry and forestry

CAN'T SEE THE PEAT FOR THE TREES

Carbon storage in wet peatland in Finland, and area used for peat extraction



create a microclimate with cooler temperatures and fresh air.

In temperate climates, black alder can grow in areas with high water tables. Its average rotation length – the time from planting to harvest of a stand – is between 60 and 80 years. The wood of the black alder is suitable for special construction purposes and is cheaper than oak or birch. Still, the profitability of such forests is low because of the trees' growth forms as well as their harvest is difficult on soft, wet peat soils, in regions where these soils do not freeze.

A similar problem occurs in tropical peatland forests. There, some large individual trees are so valuable that it is economically profitable to harvest only them, leaving the surrounding trees standing. However, dense stands of other trees and soft ground make it difficult to use machinery. Often, trees are felled illegally, with individual logs being floated down narrow, hand-dug canals. These uncontrolled channels can lead to the lowering of the water table and the gradual degradation of the peat swamp forest, causing emissions and subsidence. To limit both uncontrolled and intended drainage, policies, social and financial incentives, as well as monitoring and law enforcement are needed to manage the land sustainably. Paludiculture, the cultivation of plants adapted to wet peatland environments, and sustainable peat swamp fisheries can combine the preservation of ecosystem services with production of food, feed, fuel, fibre and other goods.

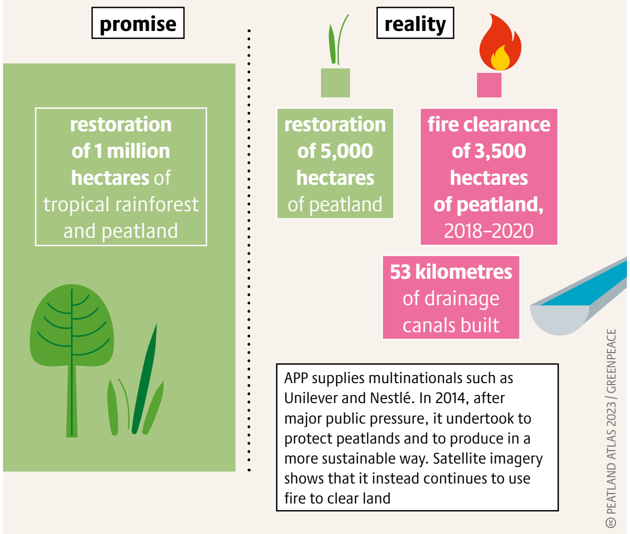
Companies advertise their green credentials – but without legal measures, they cannot be prevented from continuing to overexploit nature

One-quarter of Finland is covered in peat, mainly in forested areas. Some regions of Finland have lost up to 90 percent of their peatland

Already in 2002, the International Mire Conservation Group and the International Peatland Society, proposed a framework for the Wise Use of peatlands. In 2014, the Food and Agiculture Organization of the UN (FAO) has published the report Towards climate-responsible peatlands management. It also highlights the need for capacity development and information dissemination, community engagement, and good governance.

MUCH SMOKE

Activities of the paper firm Asia Pulp & Paper (APP) in Indonesia



REWETTING

FILL IT UP TO THE TOP

Drainage pipes and ditches are still being used to drain peatlands. Rewetting is urgently needed to protect both the climate and biodiversity. But how does this work – and what do we have to consider?

To protect the climate, a peatland should have a water table that is close to the surface of the soil. The majority of intact or rewetted peatlands do not look like a lake, but rather are swampy areas with scattered pools of water. They may have open vegetation or be thickly forested. Because every peatland is different, the rewetting process must be planned for each one individually. Waterflow must be identified, the height differences of the land surveyed, and drillings made in the soil. The soil samples reveal the thickness of the organic layer and the characteristics of the peat – whether it is very permeable or highly decomposed and impervious to water. This information forms the basis for a plan on how to retain water in this particular peatland, and what optimal water level should be aimed at. The rewetting of larger, hydrologically connected areas is usually practical and less demanding. After the conversion works are completed, comprehensive monitoring will be needed to check how the water levels and the habitat for peatland-typical species develop.

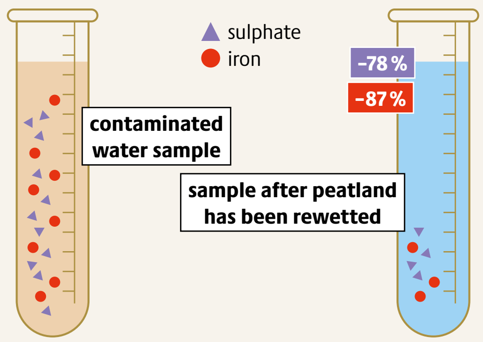
For all peatland types, the first step is to bring water back into the peat. In general that means turning off the pumps, pulling the drainage pipes out of the ground, and blocking up the ditches. Special excavators are used to do this. They ride on extra-wide caterpillar tracks so they do not sink into the soft ground.

The subsequent process of rewetting depends on the type of peatland. If it is rain fed, as in raised bogs, dams are often built to prevent the water from running off to the sides. To build these, suitable peat is heaped and compacted by driving over it with excavator tracks to reduce the flow of water underneath the dam. In some peatlands, it may make more sense to insert a solvent-free pond liner vertically into the ground, creating a kind of enormous bathtub that will fill up with rainwater. The previously dried-out peat will then soak up the water and swell. Adjustable overflows make it possible to set the water level at the optimal height for peat forming. In fens, which are fed mainly by various groundwater and surface water flows, it is necessary to take wider areas into consideration during rewetting. A stream that flows through the depression can be used to provide water to the rewetting of the peat body. By filling in ditches and removing drainage pipes, sufficient water will pond up in the fen. In the ideal situation, this water will be low in nutrients. That allows peatland-typical species that are used to a nutrient-poor environment, such as small sedges and orchids to reestablish. Nutrient-rich and polluted water, which often comes from the surrounding agricultural land, should, if possible, be dammed up in the marginal areas. In this way, the nutrients can be deposited or broken down by chemical processes. Too many nutrients result in more rapid decomposition of the peat and would pollute the peatland.

In order to maintain the peat body and also to stimulate peat formation, a certain water level is essential. In addition, erosion caused by too fast water flow should be avoided by giving the water enough space permitting an even distribution. The type of adapted land management will depend on how the peatland will be used in the future. After establishing a suitable water level, land management needs to ensure the establishment of vegetation to protect the peat soils. Especially, in the tropical peatlands that are often fed by heavy rainfalls the reestablishment of peat swamp

NATURE'S KIDNEYS

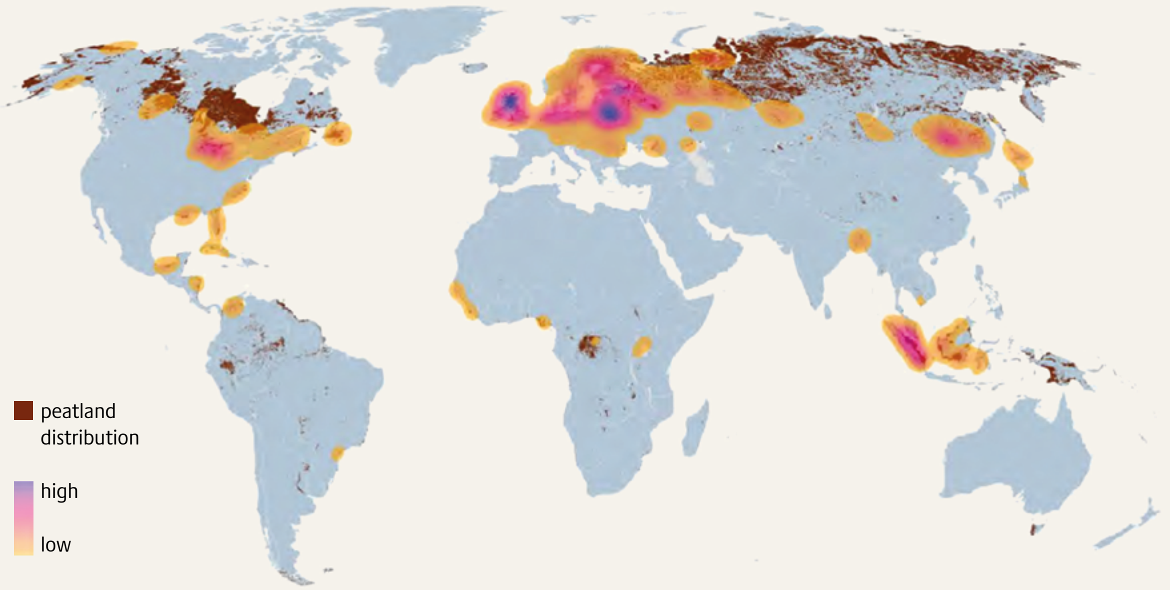
Effect of rewetted peatlands on polluted water



Research from 2022 studied contaminated water in former mining areas such as the Lausitz in eastern Germany

Water cleaning through chemical reactions: if rewetted with contaminated water, peatlands extract the pollutants

BAD INFLUENCE
Hotspots of human impact on peatlands



Anthropogenic changes in peatlands like drainage cause major challenges. Effective governance of peatlands can deliver solutions

forest vegetation is crucial to slow down run off and avoid erosion.

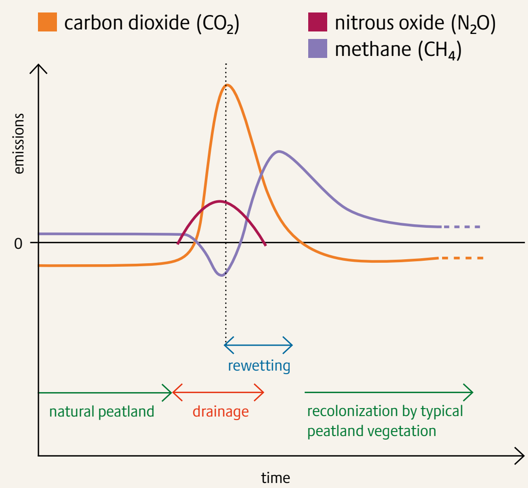
If everything works out, the peatland will again become a functioning store of water and carbon. That is good not just to climate protection, but also helps mitigate the already present effects of climate crisis. The peatland will act as a sponge to absorb heavy rain and as a natural air conditioner that cools the air.

But despite these urgently needed benefits, not all peatlands can be rewetted immediately. Most of the drained peat soils all over the world are still used for farming or forestry. Transforming them for use under waterlogged conditions will require careful preparation and planning. The complete rewetting of a peatland can only be successful if enough surplus water is available. Such a surplus is not any longer available in all peatlands. Especially in these times the proceeding climate crisis can locally lead to falling groundwater levels and more frequent periods of drought. That said, wet peatlands can counteract precisely these water shortages by retaining precipitation over a large area during wetter times of the year, so contributing to a more even water balance.

Dealing with these complex interactions requires political will – complemented by the right expertise. Planning departments and construction firms still have too few staff with experience in rewetting techniques and who are familiar with water balances, peat characteristics and the specific flora and fauna of peatlands. Training such local peatland specialists will be a decisive factor in ensuring the success of peatland transformation. Understanding for rewetting is required among the population, which can be achieved by raising awareness for peatland climate protection and by creating alternative sources of income. ●

Greenhouse gases prevent solar energy from being retransmitted into space – thereby heating the Earth up

RECOVERY TAKES TIME
Greenhouse gas emissions from drained and rewetted peatlands



schematic representation

EUROPEAN UNION

DEFENDING DIVERSITY

Europe is rich in peat landscapes, which differ widely according to the region and climate. But one thing that the European Union's programmes to protect peatlands have in common is that they are not very effective.

Peatlands cover a total of 35 million hectares in the European Union (EU). The EU country with the highest proportion of peatlands is Finland, where peat covers around 25 percent of the land surface. Some 20 percent of Ireland and Estonia are covered by peat, followed by Sweden with 15 percent. Uncertainties in data show that the figures are not directly comparable between countries. For example, peatlands are not designated as such in some countries.

Peatlands in the European Union have a long land use history. Around half of the peatlands are classified as degraded due to peat extraction and drainage for agriculture or forestry. Southern Europe has the highest proportion of degraded peatlands, although this region also has more peatlands in protected areas, for example in EU Natura 2000 sites. LIFE, the EU's programme for nature, is also financing peatland projects across EU, but their spatial extend remains limited. Most intact areas where peat is still accumulating are located in the northern parts of the continent. In the European Union, around 120,000 hectares, or just under one percent of the total drained area, has so far been rewetted.

The European Union has a concerted agricultural policy for the last 60 years – the Common Agricultural Policy (CAP). With an annual budget of 55 billion euros, it has a major influence on the direction of agriculture. The use of drained peatlands is fully eligible for support, whereas rewetting has in the past usually led to a loss of support due to the change of use involved. Only 12 of the EU's 27 Member States have included peatland conservation in their national plans for implementing the CAP. And on only two percent of peatlands water abstraction via drainage is banned. Between 2014 and 2020, only 2,500 hectares were actively restored under the CAP.

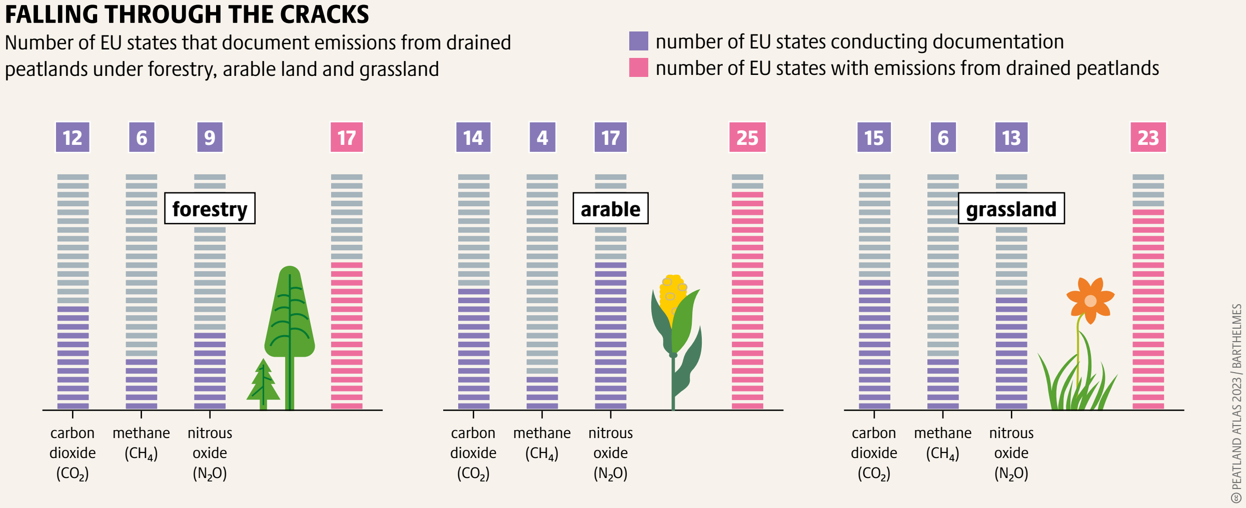
With the start of a new funding period in 2023, it is now possible for Member States to subsidize rewetted areas via the CAP's direct payments mechanism. That makes raising the soil water levels more attractive to farmers, but at the same time payments for drained agricultural sites continue. Also, scientists say that the protection of peatlands in national implementation plans is far from sufficient, with only a minority of Member States making use of this option.

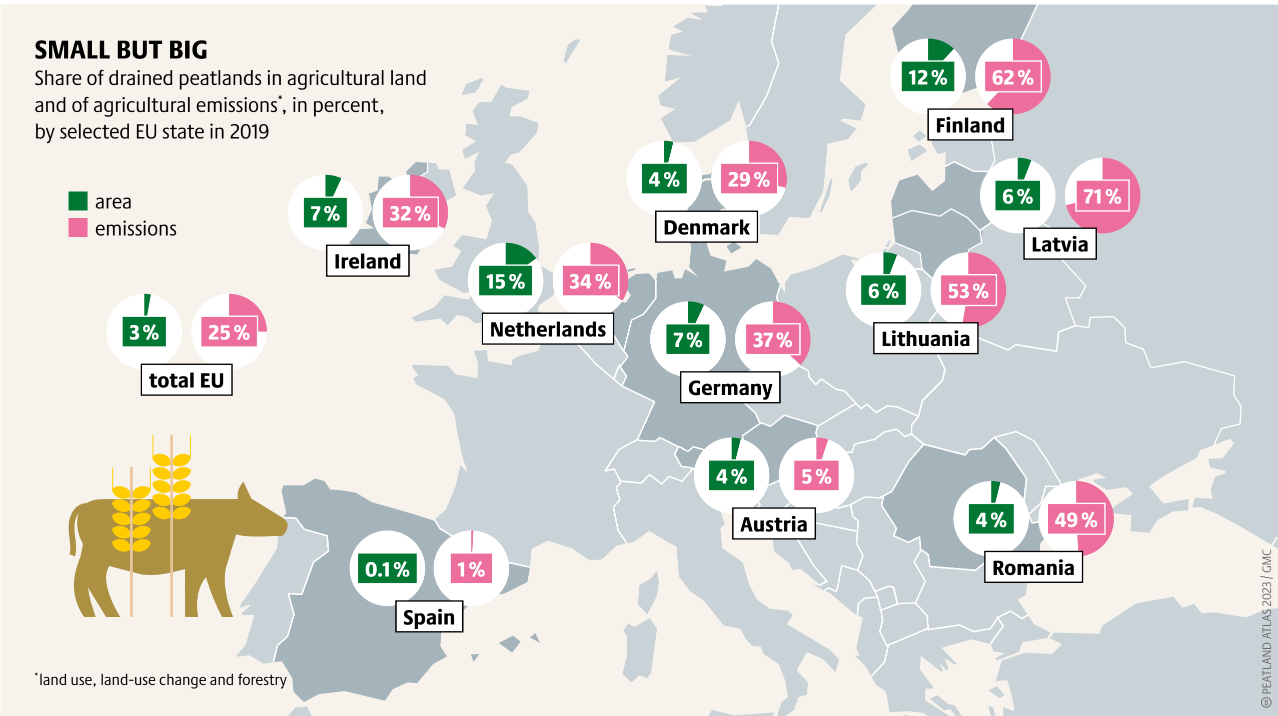
Beyond the flat-rate area payments, there are at least some promising efforts to improve the situation of peatlands in the EU through targeted support measures such as organic farming schemes and agri-environmental and climate schemes. But it is still too early to judge their success. This will depend largely on the

Many states fail to take part in the EU-wide documentation of peatland emissions. Member States often lack data and knowledge

FALLING THROUGH THE CRACKS

Number of EU states that document emissions from drained peatlands under forestry, arable land and grassland





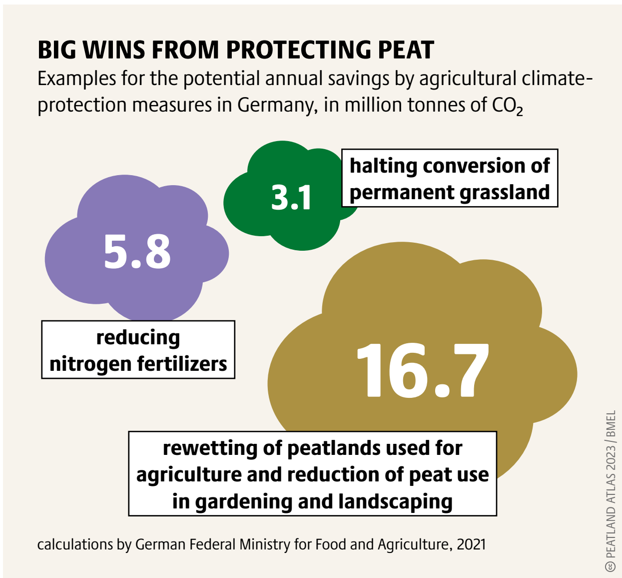
budget available and farmers' acceptance of the tailored measures.

The European Green Deal is more promising to bring about a change in the right direction as it covers biodiversity, land use and soil policies in a coherent manner. As part of the deal, the European Commission proposed the Nature Restoration Law in June 2022. This aims to set concrete, legally binding goals for restoring ecosystems for the Member States. The proposal includes a special role for peatlands. It requires that the Member States step by step restore 70 percent of their degraded and agriculturally used peatlands by 2050, half of it through rewetting. Yet this law has seen strong resistance by parts of the EU legislator. The Council of the EU has adopted its position in June 2023, yet introduced more flexibility for Member States. It has also reduced the area of peatlands, which has to be restored to 50 percent. The European Parliament on the other hand has completely deleted the peatland restoration targets as part of agricultural lands in its position. Trilogue negotiations between Parliament, Council and EU Commission are ongoing, yet it can be expected that the final law will be less ambitious than the original proposal by the EU Commission. Scientists and environmental NGOs state that even with the Commission's proposal an insufficient area of peatlands would be rewetted to reach overarching goals for example for climate action or biodiversity conservation.

The climate crisis means we must change the way we farm. Protecting peatlands will play a crucial role

It can be very effective: in many countries, rewetting peatlands could save large amounts of agricultural emissions

European legislation requires individual Member States to balance emissions and carbon storage in their land use. Despite the current rules, emissions from drained peatlands have not yet decreased significantly. Peatlands in the European Union currently emit 220 million tonnes of CO_2-equivalent per year. Overall, drained peatlands are responsible for 7 percent of the EU's greenhouse gas emissions – they are by far the largest source of emissions from agricultural land use and forestry.



THE CONSEQUENCES OF CONSUMPTION

The consumption and production of commodities such as timber are major drivers of deforestation and forest degradation. They also cause peatland degradation on a grand scale.

Europe is a major hotspot for peatland degradation because of peat extraction and the use of peatlands for agriculture and forestry. Other major hotspots are Northeastern China, Southeast Asia and the American Midwest. An estimated 88 percent of the world's peatlands remain largely unused and undrained. But these ecosystems are increasingly threatened. This is particularly true in the tropics, where only in the last decades peatlands have been extensively drained and their land use converted to provide food, fibre, timber, fodder and fuel. The three main commodities on global peatland are palm oil, cattle and rice. Especially in Southeast Asia, many of the most peatlands are form under forests.

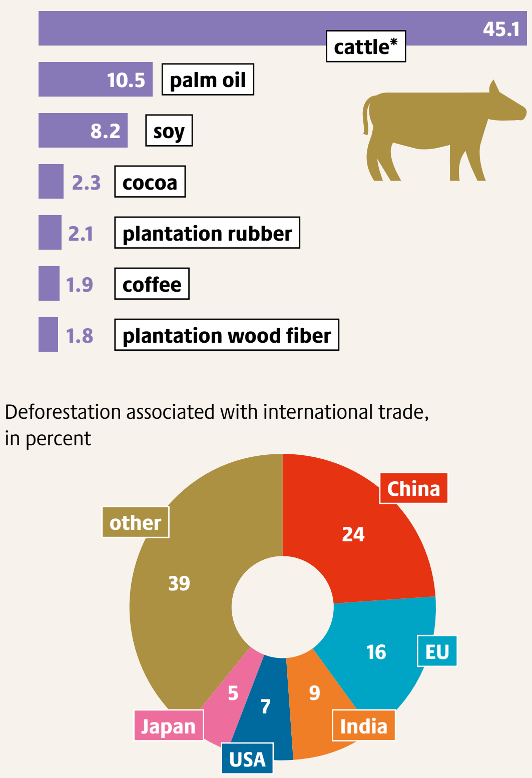
Palm oil is well known for its link to deforestation. This crop is the most efficient producer of vegetable oil, accounting for about 30 percent of world production. After India, the European Union (EU) is the second largest importer, importing 6.3 billion euros worth of palm oil and palm oil products in 2021, mostly for biofuels. Indonesia and Malaysia are the largest producers of palm oil from drained peatlands. Together they supply almost 75 percent of the EU's imports.

Meat and dairy products also put pressure on peatlands. Eighty percent of Mongolia's cattle graze on degraded and natural peatlands, for example, though these cover only 2 percent of the country. On the other side of the world, the Pantanal in Brazil – a major wetland including peatlands – is under pressure from cattle production and widespread forest fires used to clear land for expanded pasture. The Pantanal's wetland area has shrunk by almost one-third since the 1980s, but a recent law allows extensive cattle ranching and tourism in protected areas in the region. In 2022, Brazil was the EU's largest source of agri-food imports, accounting for 12 percent of its total imports. In 2022, around 52,342 tons of meat (excluding poultry) were imported from Brazil to the German market. The import value in that year was about 111 million euros.

The EU imports around 1.2 million tonnes of milled rice per year, mainly from Southeast Asia. Peatlands and rice production have a troubled history. The most notorious example of rice production on peatlands was the Mega Rice Project, launched in 1996, which aimed to drain and convert 1 million hectares of peatland on the Indonesian island of Kalimantan. The project failed to produce rice on a commercial basis and was abandoned after three years. It failed because the peat, which was more than half a metre thick, provides fewer nutrients than mineral soil, and because it was difficult to control the water levels – which are crucial for rice production. However, Indonesians

CHAINSAWS AND SUPPLY CHAINS

Total forest replacement 2001–2015, by commodity in million hectares

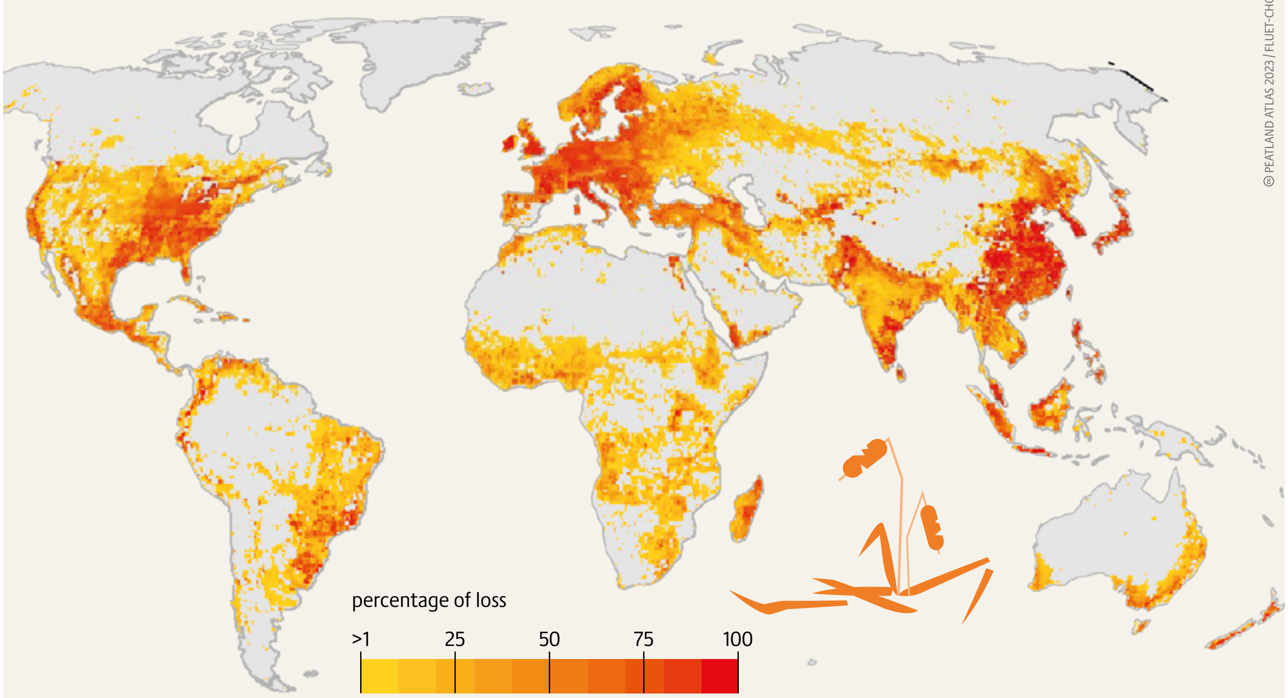


*pasture as land use

Since 2000, Indonesia lost almost 20 percent of tree cover. The EU is the second largest importer of tropical deforestation

20 PERCENT OF THE WORLD'S WETLANDS HAVE BEEN DESTROYED

Loss of wetlands since 1700



are still suffering the consequences of the large-scale drainage undertaken for the project, as it is difficult to restore such peatlands to their functioning state. Fires in the former Mega Rice Project area released 173,000 tonnes of carbon each year and created a haze that blanketed the region and forced many activities to come to a halt. Despite this, the Indonesian government has shown interest in restarting rice production in the project area. It is negotiating a free-trade agreement with the EU to increase trade and investment while promoting sustainable development – which should include peatland management issues.

To reduce damage to forests worldwide, the European Union recently adopted a law on deforestation, which came into force in June 2023. It requires companies to trace the commodities they are selling back to the plot of land where they were produced. This is a step forward for forest protection and management, and many forest organisations have welcomed the law and its aim to promote trade of deforestation-free products in EU markets. But the law's scope is limited to forests, so it could have the effect of encouraging commodity production to shift away from forest land to peatlands and other ecosystems, putting these areas under additional threat. This is despite the legislators' recognition that efforts to protect forests should not lead to the conversion or degradation of other natural ecosystems. Reviews of the law in 2024 for other wooded land, and in 2025 specifically for wetlands and peatland, will provide an opportunity to expand its scope to include peatlands and peatland-friendly supply chains.

Using 3,320 records, scientists found out that wetlands larger than India were destroyed globally in the last three centuries

Many countries lack accurate inventories of their peatlands. This makes it difficult to monitor the volume of imports into the EU that have been produced on drained peatlands. Data collection and monitoring of agricultural production on drained peatlands are urgently needed to support peat-rich countries to invest in alternative production practices, such as paludiculture, which have proven benefits for climate and biodiversity. A good example is the EU-funded "People for Peat" project, which supports better peatland management in Southeast Asia. Global agricultural, forestry, mining, food and beverage industries need to invest in product certification and in making their supply chains peat-friendly by ensuring that they avoid the additional loss of peat and do not cause further degradation. The certification scheme of The Roundtable on Sustainable Palm Oil (RSPO) is an example: it does not allow the establishment of new plantations on peatlands. Non-government organisations urge that such measures be included as well as better data collection and monitoring in future revisions of the EU's deforestation law, and for the law's scope to be extended to include peatlands by 2025. ●

PALUDICULTURE

MORE FROM THE MARSH

Reeds are used to make thatch for roofs, and grass fibres are used to make furniture: paludiculture combines peatland conservation with agriculture. Strong political support is needed to give this sustainable way of using rewetted peatlands a chance of success.

Many peatlands were originally drained to create husbandry or for peat extraction. Rewetting does not mean that they should be left unused. The use of wet and rewetted peatland for agriculture or forestry is called paludiculture. This concept was developed more than 20 years ago. The name comes from *palus*, the Latin word for swamp. While drainage aims to subject an organic soil to a particular type of land use, paludiculture allows it to be used in accordance with the natural conditions. It stops peat decomposition and reduces greenhouse gas emissions. The idea is to maintain high water levels that keep the peat completely waterlogged all year round, so preserving the peat.

Typical paludiculture plants are those that can cope well with these high moisture levels and whose above-ground biomass has an economic use: they include reeds, peat mosses, rushes, papyrus, alder, sedges and other grasses. Paludiculture does not focus on food production, but on renewable raw materials that can be used in construction, as insulation or in manufacturing. Biomass from paludiculture can also be used to produce paper, cardboard, other packaging materials, and bio-based chemicals used to make pharmaceuticals, along with resins and bioplastics. It is also possible to raise livestock on wet, swampy land. Water buffaloes, for example, have wide hooves that make them suitable for use in landscape maintenance. Peat moss, bulrushes and reed produce a variety of raw materials for substrates for peat-free horticulture. Energy can also be produced with paludiculture biomass. Local power stations can burn hay harvested from wet meadows to produce heat for many homes.

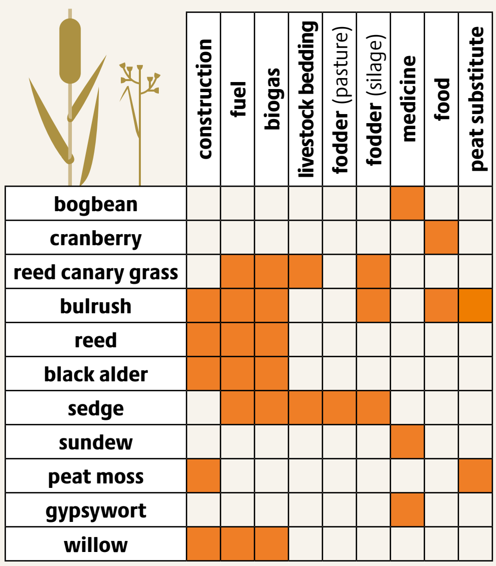
Papyrus is a highly productive aquatic perennial with stout stems that can reach 4 to 5 metres in height. It typically dominates valley peatlands in Africa, but also forms floating mats along lakeshores or in permanent wetlands. It has a long history of being used to make paper, boats, mats, baskets and thatch. It is also burned as fuel in cooking stoves. Sanitary pads can be made from the fibres, and are marketed in Uganda under the name MakaPads. Papyrus is harvested mostly from natural stands. It is important to harvest such stands sustainably to promote regrowth and to generate a reliable income, but recommendations on how to do this are often not available, or are not followed.

In Indonesia, there are approaches that combine rewetting, the revegetation of peat-swamp forest, and the revitalization of rural livelihoods around peatlands. Several tree species are being cultivated in rewetted, degraded peatlands and used by smallholders. One of these is Jelutong, which produces a latex used in dentistry, insulation materials and chewing gum.

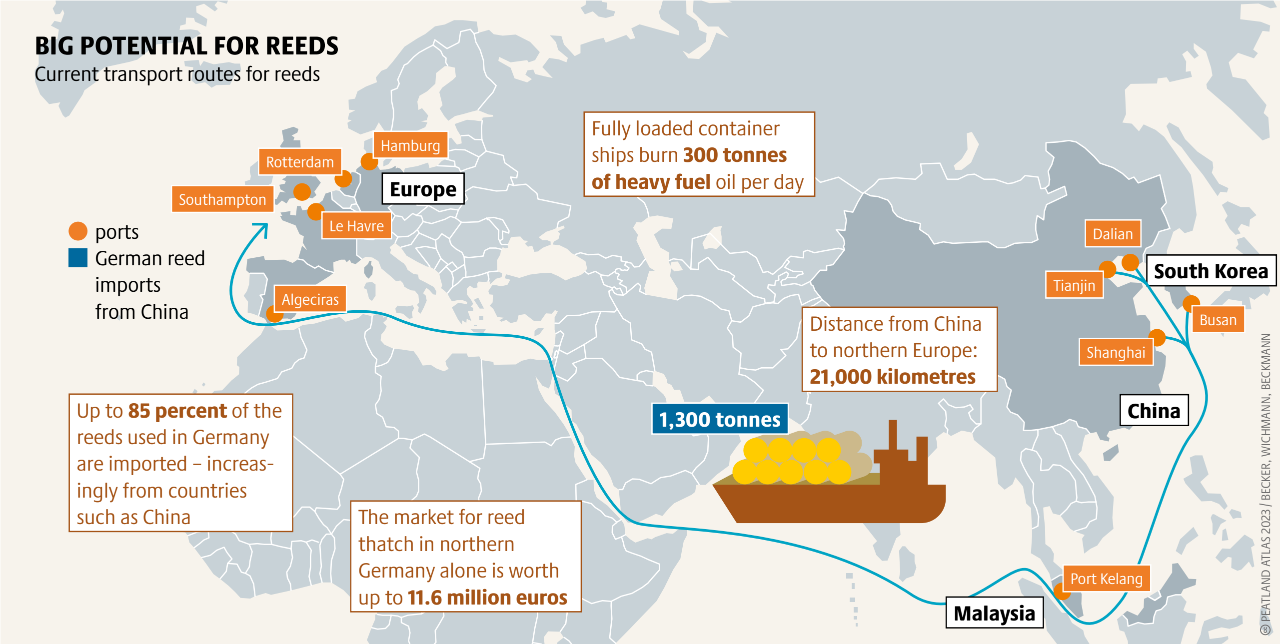
As a result of their adaptation to the special habitats, many wetland plants have developed specific characteristics that can be put to very good use. Peat moss, for example, acts as a sponge, making it an ideal substitute for peat as growing media for plants. One kilogram of peat moss can hold up to 30 litres of water. Bulrushes have air-conducting tissues in their leaves which they use to transport air to submerged parts of the plant. These tissues give the plants great stability,

SUPPLIES FROM SOGGY SOIL

30 examples of paludiculture



Examples of the variety of paludiculture species with special economic interest. The bogbean for example can be used to treat liver problems

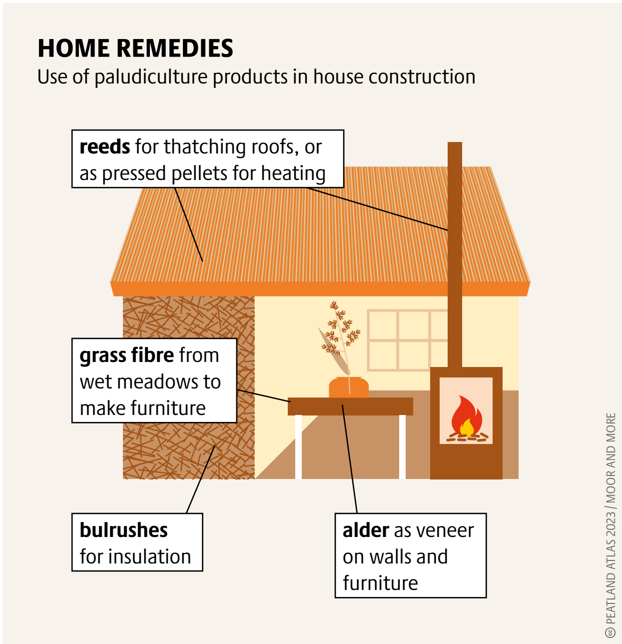


Rather than shipping reeds halfway round the world, they can be grown more cheaply and sustainably in Europe using paludiculture

making bulrush a promising raw material for building and insulation materials.

For farmers and foresters, switching from a system based on draining the peat to paludiculture poses an enormous challenge. They have to establish new plantations, raise water levels and purchase new equipment. They often need to carry out construction work, so they have to plan and obtain the necessary permits. To cultivate wet peat soils at all, they need adapted vehicles that exert a low pressure on the ground. And because the crop can no longer be processed like palm oil or used to feed dairy cattle, they need to develop new processing methods and distribution channels. Without political support, farmers will not be able to cope with this mammoth task.

Blown-in wall- and attic-insulation made from bulrush, or furniture boards made from grass fibres: many prototypes from paludiculture products already exist. In Europe, for example, they already are an ecological alternative to raw materials that would otherwise have to be imported from far away. But there are still few paludiculture products on the market: there is simply not enough rewetted peatland yet to grow the raw materials that is needed to produce them in larger scale. This means that there is not enough raw material for processing companies to invest in the new production methods needed to switch to paludiculture. Experts are therefore calling for public investment along the entire value chain. Public construction projects could set an example by using climate-friendly building materials from regional paludiculture. Paludiculture products have multiple positive impacts on the climate: rewetting the land reduces greenhouse gas emissions from peat oxidation and helps to store carbon in the soil. Paludiculture products replace materials produced from non-renewable resources using fossil fuels. Product labelling, subsidies or area payments could provide stronger incentives for farmers and companies to switch to this sustainable form of production. ●



Paludiculture products have so far been used mainly in tiny houses. But they can be used in regular houses too

SCORCHED EARTH

People have been using peat for heat since the Bronze Age. They still do so today in countries like Finland, Belarus and Rwanda. This is not sustainable – but there are new, climate-friendly ideas for how peatlands can help generate heat and power.

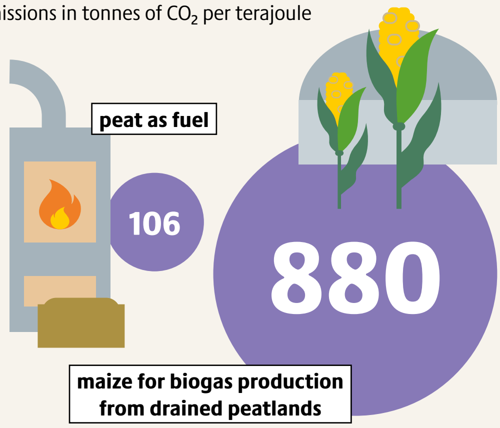
Extracting and burning peat not only destroys layers of organic matter that have accumulated over thousands of years. Extracting the peat requires draining the peatland, releasing huge amounts of carbon that had been drawn from the atmosphere and stored in the ground in the form of peat. Although it has long been known that burning peat affects the climate, the material is still extracted for energy, mostly from raised bogs. In 1999, over 21 million tonnes were extracted in Europe alone, mainly in the northern and eastern parts of the continent. Different reporting standards across Europe mean that there are few reliable figures for more recent years. Peat is still an important energy source in Belarus and Finland. In 2020, peat accounted for 3.4 percent of Finland's total energy consumption. The Finnish state is a major shareholder in Fortum, an energy company that is helping to build a peat-fired power plant in Rwanda, among other projects. This climate-damaging but potentially very profitable project is being carried out under the guise of development aid.

The Rwandan government has commissioned two peat-fired power plants, one at Gishoma, near Lake Kivu, with a capacity of 15 MW, and the other at Gisagara, on the Akanyaru River, with a capacity of 80 MW. The Gishoma plant was due to start operating in 2017 and the Gisagara plant in 2020. According to projections, by 2024 peat will account for 17 percent of the country's energy mix. However, both plants have yet to come on stream due to furnace malfunctions and seasonal flooding. Nevertheless, peat extraction is already underway near both plants, with some of the peat being used as fuel by nearby cement factories.

To stop the destruction of peat and the huge greenhouse gas emissions caused by drainage, the waterbody in peatlands must be restored to its original level. This rewetting process goes hand in hand with other forms of land use. One way of reconciling agriculture and peat conservation is paludiculture. This type of peatland use depends on high water levels. Biomass from paludiculture offers the opportunity to switch regional energy supplies to renewable resources. It is not dependent on wind and sunshine and can therefore be an important part of the energy transition. Unlike wood, the biomass can be harvested every year. Burning it releases only as much carbon into the atmosphere as was sequestered in the previous year – not over decades as with wood. Despite harvesting the above-ground biomass, peat can still accumulate because plants such as sedges produce peat from their roots, which are not harvested. They remain in the wet soil and turn into peat over the years. Biomass from paludiculture can be used in thermal power stations or biogas plants. Suitable species from wet meadows include sedges, reed canary grass, as well as reeds and rushes. Their biomass can be burned using combustion systems adapted to the high ash content and critical components of the biomass. This avoids unwanted emissions of carbon monoxide and nitrogen oxides and prevents premature wear and tear on power plants. Biodiversity also benefits when mowing is scheduled outside the breeding season of reeds or meadow breeding birds. Biomass must be harvested when dry, as only dry material has a high calorific value. Once dry, it can be rolled into bales for storage or pressed into pellets. Pilot projects show how this can work. Since 2014, a power plant in Malchin, a town in northeastern Germany, has been producing 3,500

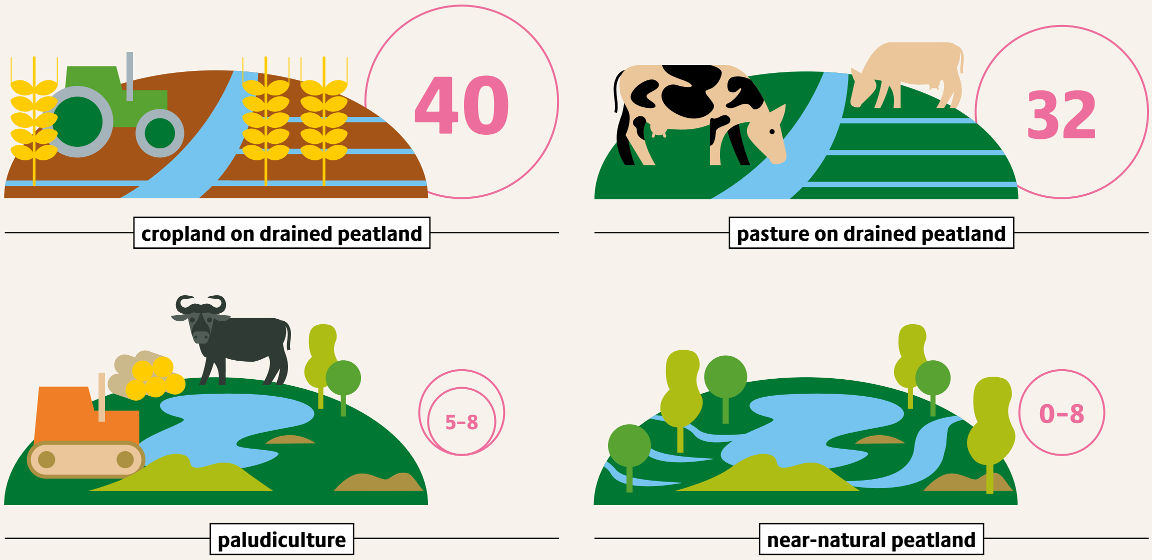
NO CHOICE BUT TO GET WET

Emissions in tonnes of CO_2 per terajoule



When burned, biomass from drained peatlands emits more CO_2 than fossil fuels. There is no way around it: peatlands must be rewetted

INTENSIVE USE HARMS THE CLIMATE MORE
Annual emissions of greenhouse gases, in tonnes of CO_2 equivalents per hectare



megawatt hours of heat from local wet meadows. This is enough to supply around 500 homes, as well as several schools and offices, via a heating network.

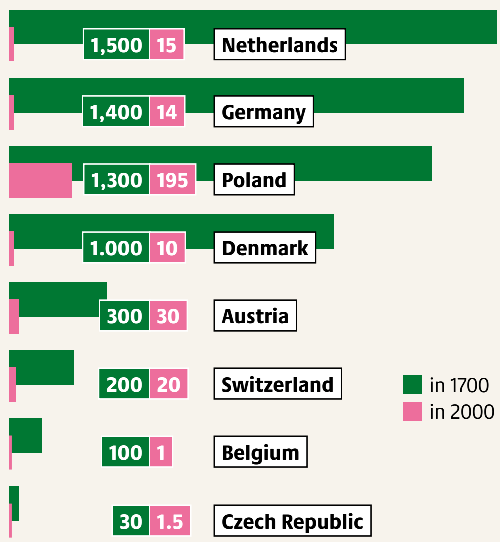
Wind turbines and solar farms can also be built on peatlands. But up to now the necessary rewetting of peatlands has often not been taken into account in the planning of such wind and solar farms, even though it is essential for meeting our climate targets. The systems that have been built are not adapted to wet conditions, which hinders peatland restoration and thus the reduction of greenhouse gases from peatlands. A further difficulty is that rewetted peatlands need to develop a continuous vegetation cover to protect the peatland. Solar farms must therefore allow enough light to pass through to ensure plant growth under the solar panels. There is still a lack of suitable demonstration sites where it can be clearly shown that such renewable energy systems can be successfully installed on wet and unstable soils.

One step in this direction is Germany's Renewable Energy Sources Act of 2023, which prohibits subsidies for solar farms on drained peatlands, but provides additional financial support for solar farms on permanently rewetted peatlands that were previously used for agriculture. As peatlands also play an important role in preserving biodiversity, experts are urging that the feasibility and environmental impact of such systems is tested first. Depending on their suitability and the rewetting process, solar farms on peatlands should be restricted to drained, degraded or cultivated areas outside actual or potential protected areas. And the effects of wet peatlands and solar farms to each other need to be monitored in order to counteract any negative consequences.

Centuries ago, peat was an important source of fuel in Germany. It came mainly from bogs, which have been particularly damaged by peat extraction

Harvesting biomass for heating and grazing water buffaloes: paludiculture makes a sustainable and profitable use of peatlands possible

VERY LITTLE LEFT
Area of raised bogs in Europe, in 1,000 hectares



EUROPE

SMALL CONTINENT, ANCIENT LANDSCAPES

Few peatlands in Europe are located within protected areas, and even there, they are not always protected adequately. National agricultural policies provide little or no support for the development of sustainable peatland-management practices.

Peatlands can be found in all countries in Europe except Malta. They are concentrated in north-western and eastern Europe and in the Nordic countries. In southern Europe, peatlands are less common. Areas with a natural surface peat layer more than 30 cm thick cover almost 59 million hectares in Europe, this equals 12 percent of the world's peatlands. If shallower peatlands are included, the total area is 100 million hectares, or about 10 percent of the total surface area. Europe's main mire regions vary substantially in size, mire diversity, peatland condition and protection. Throughout Europe, only 16 percent of the peatland area is located within protected areas, and often this does not equal adequate protection.

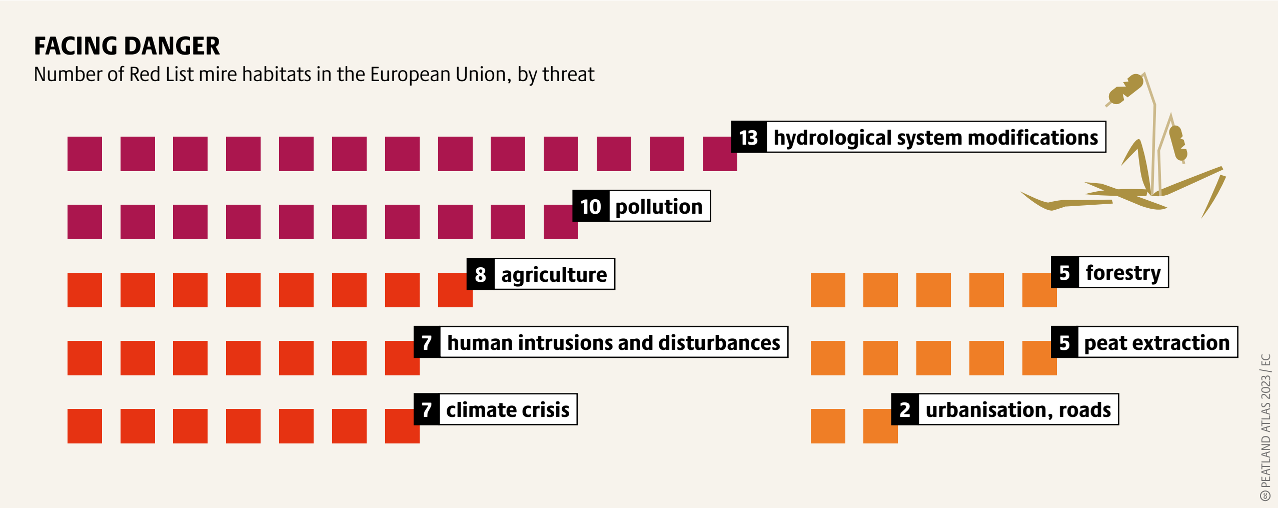
The largest peatlands in Europe are a 178,000-hectare mire named Ocean in the Republic of Komi, and the 96,000-hectare Polisto-Lovatsky mire in Pskov Oblast in western Russia. The smallest peatlands are located in the highlands and steppes and cover only a few square metres. Across Europe, the average depth of peat is 3 to 4 metres, with maximum depths typically 10 to 12 metres. The deepest peatland in Europe can be found in northern Greece at up to 190 metres: The Philippi peatland. This area provides a unique opportunity to study the transition from peat to coal at a depth of around 120 m.

The EU's European Red List of Habitats, which covers the EU, the rest of western Europe and the Balkans, includes 13 treeless peatland habitats, three of which are considered as vulnerable and one as critically endangered. Including non-EU countries in eastern Europe would result in a different list of rare peatland habitats. Bogs and spruce-dominated peatlands are not endangered in the Carpathians and Urals or in the Russian part of the East European Plain.

Mire landscapes often include rather few species, but highly specialised ones. The proportion of endangered species in peatlands is often higher than in other ecosystems. The IUCN's Red List of Threatened Species includes nine European vascular plants and five types of birds. Important umbrella or flagship species in European fens are the aquatic warbler, the fen orchid and for bogs the golden plover and the wood sandpiper.

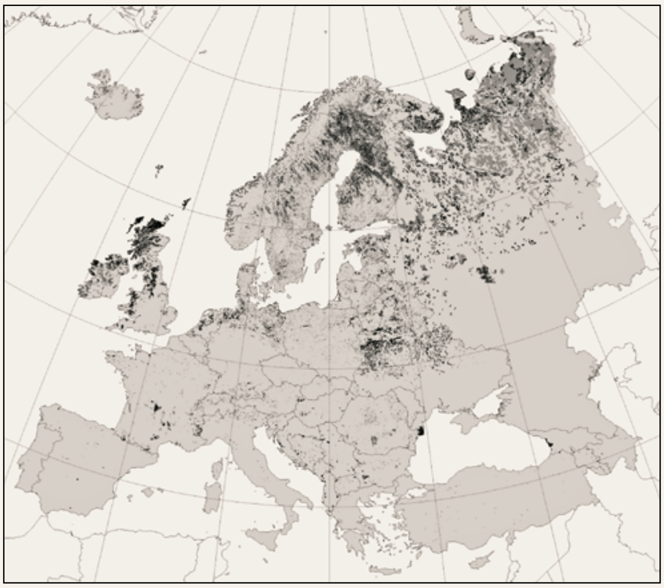
Europe has a long history of peatland use and degradation. Human impacts have included using peatlands for food, fodder, fibre and fuel, and draining them for

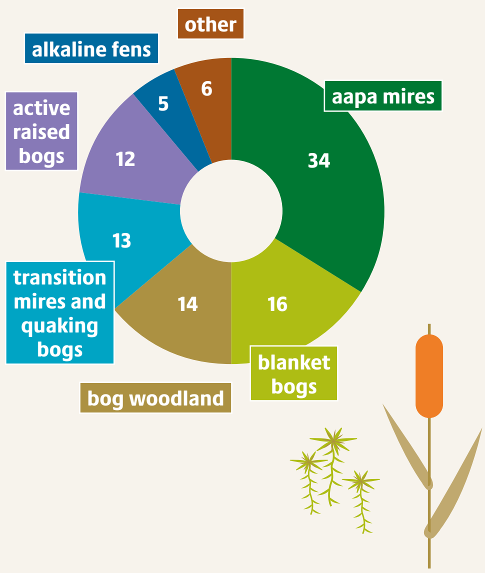
13 mire habitats – all defined as open and treeless wetlands with vegetation on accumulating peat – are assessed in EU28's Red Lists



ACROSS EUROPE BUT MAINLY IN THE NORTH

Distribution of peatlands in Europe





small and sparsely distributed peatlands are slightly enlarged for better visibility

Factors like temperature influence the distribution of distinct mire types. Peatlands cover about 60 million hectares of Europe's land area

intensive agriculture, forestry and peat extraction. Peatlands have also been used for urban, industrial and infrastructural development. More recently, large areas of peatland have been cleared to make way for water reservoirs or windmills to generate electricity. Human impact has also been indirect. For example, as early as 3,000 years ago, the anthropogenic deforestation of upland areas led to changes in the flow of rivers and the consequent widening of estuaries, resulting in massive peatland erosion in the perimarine floodplains of the Netherlands. However, human activities have also led to the creation and expansion of peatlands in Europe through interference with landscape hydrology. In oceanic parts of the continent, blanket bogs have formed as a result of land clearing, burning and livestock grazing. Such blanket bogs often occur in mosaics with heathlands that were established some 3,000 to 4,000 years ago.

Europe is the continent with the largest proportional loss of actively accumulating peatlands, due to its long history, high population pressure and climatic suitability for agriculture as the main driver of peatland drainage. As peat extraction and human-induced oxidation and erosion have transformed many former peatlands into mineral soils, about 10 percent of the maximum peatland area during the Holocene (the period since the last ice age, 10,700 years ago) no longer exists as peatland. Nineteen European countries each have more than 100,000 hectares of severely degraded peatlands. In Finland, nearly 60 percent of the peatland area was destroyed during Europe's most ambitious peatland drainage programme, especially in the 1970s, when about 300,000 hectares were drained each year. In countries such as the Netherlands, not a single peatland has been left untouched, and only a very small remnant of peatland remains undrained. Nevertheless, Europe still has a significant diversity of mires, which are often the last wilderness areas in a predominantly cultivated landscape.

The high degree degradation makes Europe the world's second largest emitter of greenhouse gases from drained peatlands, after Indonesia. The climate crisis is also causing peat loss from undrained peatlands as a result of prolonged droughts and heatwaves, fires, vegetation change and permafrost degradation. Large and rapid losses of ancient permafrost carbon have only recently begun and will increase in the future, according to studies.

Problems associated with unsustainable peatland management, including drainage for agriculture and forestry, have not been fully addressed in land use and climate policies in Europe. Furthermore, EU and national agricultural policies, with their established subsidy systems, do not or only little support the development of sustainable peatland management practices. As a result, the problems associated with peatland drainage in Europe are far from being solved. The continent lags far behind Indonesia – a country that has already rewetted more than 20 times the area that Europe has rewetted in its entire history.

NORTH AMERICA

ICE AGE LEGACY

One-third of the world's peatlands are in North America. Those landscapes close to urban areas have suffered severe degradation, and urgent repair work is needed to restore them. In the north of the continent, peatlands are increasingly threatened by the oil and mining industries.

North America's peatlands take on a wide variety of forms: from the fens and sedge marshes of the Everglades, to the cypress swamps of the eastern United States, to the bogs and fens of the boreal forests of Canada and Alaska, which make up the majority of North America's peatlands. The whole continent has a total of 158 million hectares of peatlands, which are currently estimated to store 185 billion tonnes of carbon.

Although more than 98 percent of North America's peatland remains intact, drainage in more populated regions has resulted in significant degradation. Nearly 2 million hectares have been drained for agriculture, which accounts for most of the area converted, while additional areas have been lost to development.

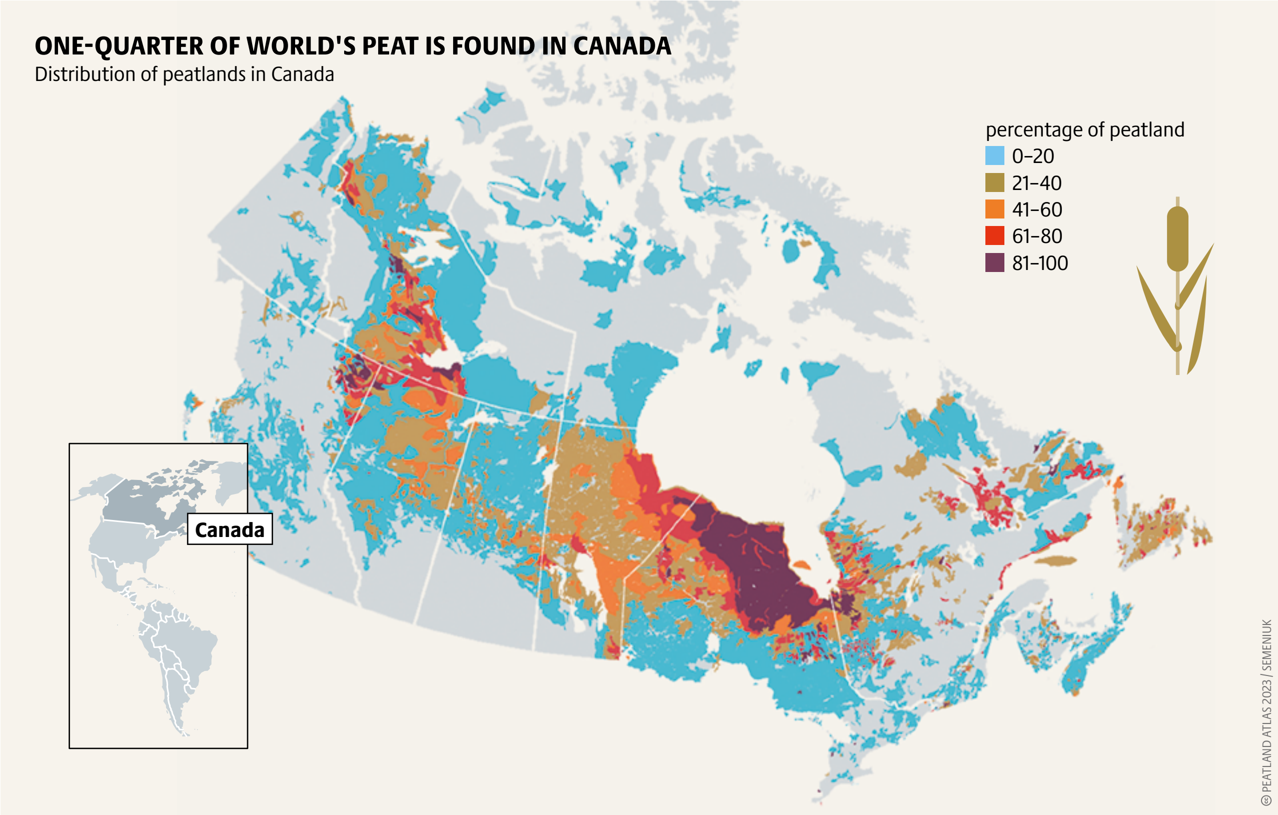
The remaining peatlands are increasingly threatened by the northward spread of the oil and mining industries. These have already disturbed at least 500,000 hectares of peatland and may expand further in the coming decades. There are numerous mining claims on peatlands in Canada. Resource exploration and access to mine sites require additional infrastructure such as roads, which further affect the landscape in ways that are still poorly understood. Large areas of boreal forest have been flooded to create reservoirs for hydroelectric power plants. Such disturbances have contributed to the decline in the number of woodland caribou in Alberta.

Climate crisis poses an additional threat to North America's peatlands. In the south, warm, dry summers can dry out the peat and exacerbate the risk and severity of wildfires. In the north, much of the peat is underlain by permafrost. As this thaws in a warming climate, it changes the hydrology and releases large quantities of carbon in the following years. However, climate crisis may also cause the peatland to expand northwards. It is uncertain whether the peat will continue to absorb carbon as the climate continues to change.

Wetlands are part of the traditional territories of many Indigenous communities. They rely on the land to survive

INDIGENOUS PERSPECTIVES ON PEATLANDS
Artwork "Our Connection to the Land" by Omushkego artist Gerry McComb, 2023

"Our ancestors walked and traveled these lands for thousands of years, the peatlands have been forming beneath our feet and storing carbon for thousands of years cooling the planet for the Omushkego and the whole world. They are too precious to be disrupted or drained. We need them to be whole for our survival and renewal as a people."



Six of ten most severe wildfires in Canadian history occurred within the past decade – and destroyed many peatlands

Major peatland areas in North America include the Everglades and the Hudson Bay Lowlands. The Everglades, in southern Florida, is a subtropical peatland that developed about 5,000 years ago. It has been designated as a wetland area of global importance by the Ramsar Convention. Originally 1.1 million hectares, almost half has been converted to agricultural and urban use. A huge system of drainage canals was begun in the late 1800s, and by the early 1980s most of the remaining Everglades had been surrounded by dykes. Massive drainage and water management efforts were undertaken to prevent flooding of agricultural land and coastal settlements. The supply of water to the Everglades was reduced, causing some peatlands to dry out and decompose or burn. This in turn led to enormous carbon losses: The Everglades have lost 75 percent of peat stocks, releasing 1.3 billion tonnes of carbon dioxide (CO_2) into the atmosphere. This poor water management has made the Everglades one of the largest wetland contributors to emissions in North America. In 2000, the US Congress authorized the Comprehensive Everglades Restoration Plan to restore, preserve and protect the wetland ecosystem. A key measure is to reestablish the natural hydroperiod, which will reduce greenhouse gas emissions while providing for the region's other water-related needs, including water supply and flood protection. At a cost of 23.2 billion US dollars and due to be completed by 2050, it will be the largest hydrological restoration project ever undertaken in the United States.

The Hudson and James Bay Lowlands in Canada are one of the largest continuous peatland complexes in the world. It stores an estimated 30 billion tonnes of carbon, or more than 15 percent of the carbon contained in all North America's peatlands. The area covers 33.5 million hectares along the Hudson and James Bay coastlines. This region is home to Indigenous communities who have been stewards of the land since time immemorial. The peat has developed over the last 7,000 years, slowly accumulating up to 3 metres of organic matter. The depth and age of the peat are strongly influenced by the legacy of the last ice age, where land was exposed along the coast as it rebounded from the weight of the ice sheet. This process still is occurring today, with the land rising at a rate of 1.2 metres every 100 years. The slow accumulation of peat over millennia means that the carbon stored in the soil is particularly vulnerable to development, as the organic matter cannot be replenished in the timescale needed to mitigate climate crisis. Although the region remains relatively pristine, threats include mineral exploration and development. Protecting these peatlands will be critical for mitigating climate change. Conservation should be led by Indigenous people to protect the social and ecological values of the landscape for the people who live there. ●

LATIN AMERICA AND THE CARIBBEAN

YOU CANNOT PROTECT WHAT YOU DO NOT KNOW

From lowland swamps dominated by tall palms to the treeless cushion bogs of the high Andes, Latin America and the Caribbean are home to a huge range of peatlands. But relatively little is known about them – making conservation difficult.

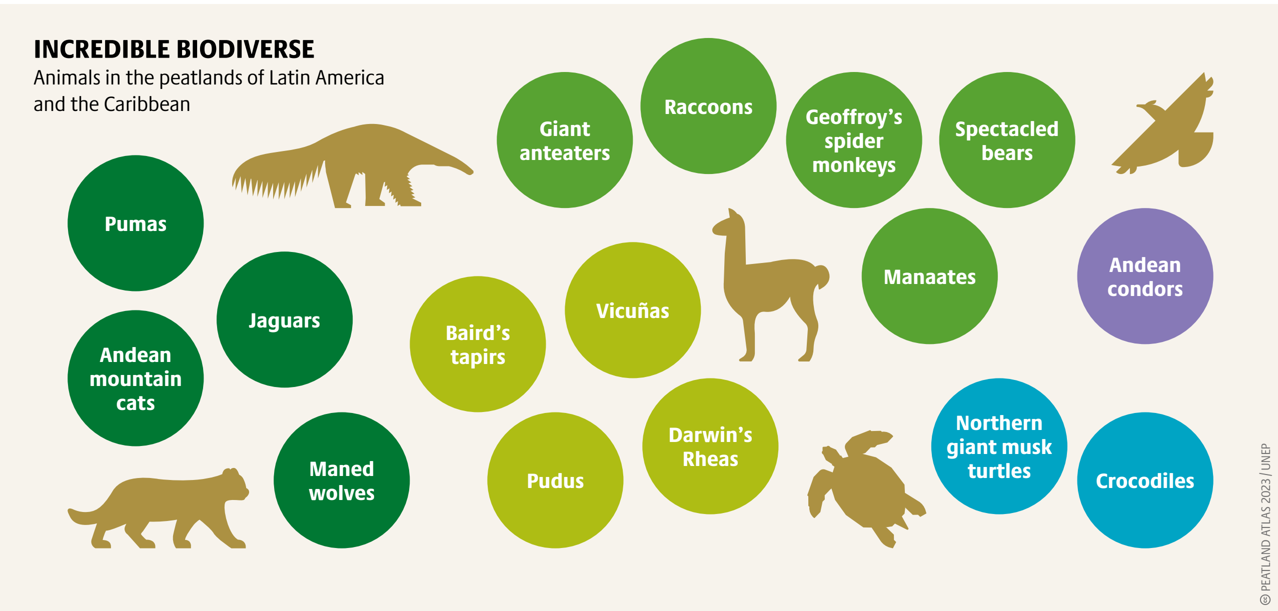
Latin America and the Caribbean have a wide range of peatland types: palm and freshwater swamps, mangroves, a variety of forests, shrublands and grasslands, and moss and cushion peatlands in high Andean mountains. They vary in their appearance, dominant vegetation, and main source of water. They are home to unique plants, shelter rare, endemic and endangered animal species, and provide resting and breeding sites for migratory birds. Lowland Amazonian peatlands host particularly high levels of regional species diversity.

The region's peatlands also supply products for local consumption and trade: fruits, flowers, leaf fronds and fibres, building materials and honey. Aguaje palms in the Amazon swamps produce fruit for eating or for processing into drinks, ice cream or oil. They are an important source of income for many families in rural areas of Peru and in the city of Iquitos on the Amazon. Herders in the Andes and Patagonia use peatlands known as bofedales as pasture for the native alpacas and llamas, as well as for sheep, cattle and horses. The peatlands are also an important source of water for several large cities and for agriculture.

More than 3 percent of the region's peatlands are degraded. Throughout the region, and especially in Central America and the Caribbean, peatlands are drained for cultivation or pasture. Peat is also extracted for commercial use, particularly for horticulture. While in some countries such as Peru, the peat is dug on a small scale by informal businesses, in Chile and Argentina, peat and peat moss are extracted on a larger scale from pristine peatlands. This industry is regulated by mining policies and is a growing threat. In Chile, the exportation of dry Sphagnum fibre has increased fourfold between 2001 and 2019, to 4,615 tons worth 21 million US Dollars.

The greenhouse gas emissions from drained peatlands in Latin America and the Caribbean are estimated at 91 million tonnes of carbon dioxide equivalent

Peatlands in Latin America and the Caribbean are a biodiverse Ecosystem; home to mammals, reptiles, amphibians



ACCOUNTED FOR ALMOST 50 PERCENT OF THE GLOBAL TOTAL OF TROPICAL PEATLANDS

Distribution of peatlands in Latin America and the Caribbean, in 1,000 hectares

Most countries in Latin America and the Caribbean lack peatland inventories. The area of peatlands could be significantly larger than previously assumed

per year. Yet few countries have policies that specifically address peat or peatlands and their conservation and restoration. Argentina, for example, has designated specific areas for peatland conservation. Peru banned the commercial peat extraction in 2021, allowing only traditional and domestic use. Ecuador has a water fund that conserves and rewets high-altitude peatlands. But other countries allow, or even encourage, the draining of wetlands for agriculture, especially for sugarcane, bananas, palm oil and rice, or for urban growth, as in Brazil, Cuba, Mexico, Panama and Peru. Drainage is not the only threat. Other drivers of change include the extraction of oil, gas and peat for fuel, overgrazing, mining, fires and climate crisis. New concessions for oil and gas, hydropower, logging and palm oil may outstrip current threats.

Research on peatlands in the region is still in its early stages, so knowledge and data are scarce. Many governments are unaware of the presence or importance of peatlands within their borders. There are several reasons for this lack of awareness: the history of colonialism, the lack of common terms and classifications, and the diversity of peatlands complicates their recognition. In addition, in many countries only few scientific institutions conduct research on the subject. Most peat research is carried out by foreign institutions, so linguistic or cultural barriers can hinder the spread of information and hamper conservation, restoration and sustainable management efforts. A lack of governance and regulation are common challenges, as are corruption and poverty. However, Indigenous and local communities have traditional knowledge of how to manage water, grasslands and livestock, and how to use resources and manage peatlands in a sustainable way.

The situation of the peatlands in the Peruvian Amazon is an example of what can happen when the existence and value of peatland ecosystems are recognized. Policies had put peatlands on a path of extractive use, neglecting their value in storing carbon and providing ecosystem services. This began to change in the last years, when the extent and importance of tropical peatlands in Latin America were recognized, leading to growing national and international interest, and to initiatives in research, sustainable management and conservation. Traditional knowledge about the classification and use of these ecosystems is now being studied, and the strong spiritual connection of Indigenous peoples to peatlands is being recognized. The Peruvian government now acknowledges the importance of peatlands as a carbon sink. While the situation in Peru has improved, much more needs to be done in terms of research and policymaking there and in other countries in the Amazon basin to ensure that the peat there is protected.

SOUTHEAST ASIA

PROGRESS FOR PEATLANDS

Southeast Asia is home to wide areas of tropical peatlands, but many have been damaged by drainage and huge peat and forest fires. But Indonesia and other countries have been making significant progress in peatland conservation, with a big impact on mitigating the climate crisis and conserving biodiversity.

Peatlands cover about 24 million hectares in Southeast Asia, about 40 percent of the world's tropical peatlands. The largest area of peatlands is in Indonesia, with about 20 million hectares, followed by Malaysia, with 2.6 million hectares. Most have developed on lowland floodplains in areas of high rainfall. Peat accumulates mainly in swamp forests, forming deposits up to 20 metres thick. It forms much faster than in temperate regions because of the year-round growing conditions, but it can also degrade much more quickly when drained or cleared.

The region's peatlands are of global importance for biodiversity conservation. The peat swamp forests are highly diverse, with more than 1,000 species of higher plants recorded, including 45 that are unique to this habitat. Some sites have more than 250 tree species. The fauna is also very diverse, with 123 mammal species, 268 different birds, 75 reptiles, and 219 fish species recorded. About 45 percent of the mammals and 33 percent of the bird species are on the International Union for Conservation of Nature's Red List of Threatened Species. The peatlands also provide habitat for many rare and endangered fish species, with more than 30 new species described in recent years, many of which are restricted to single sites.

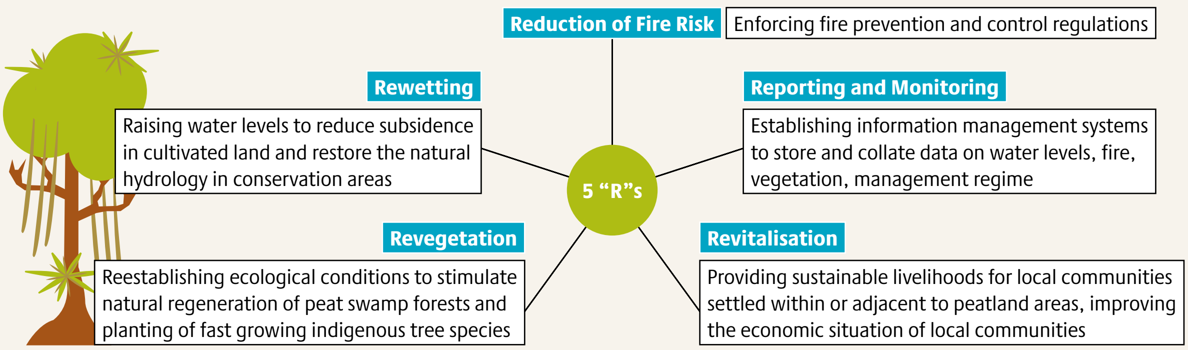
In addition, the peatlands in Southeast Asia provide a range of ecosystem services, including water and food supply, flood control and carbon storage. They store an estimated 68.5 billion tonnes of carbon, making them one of the largest terrestrial carbon stores. And they are also an important source of timber and of many non-timber forest products like fish, rattan, honey and latex. Peatland ecosystems provide significant benefits to Indigenous peoples and local communities who live in and around them.

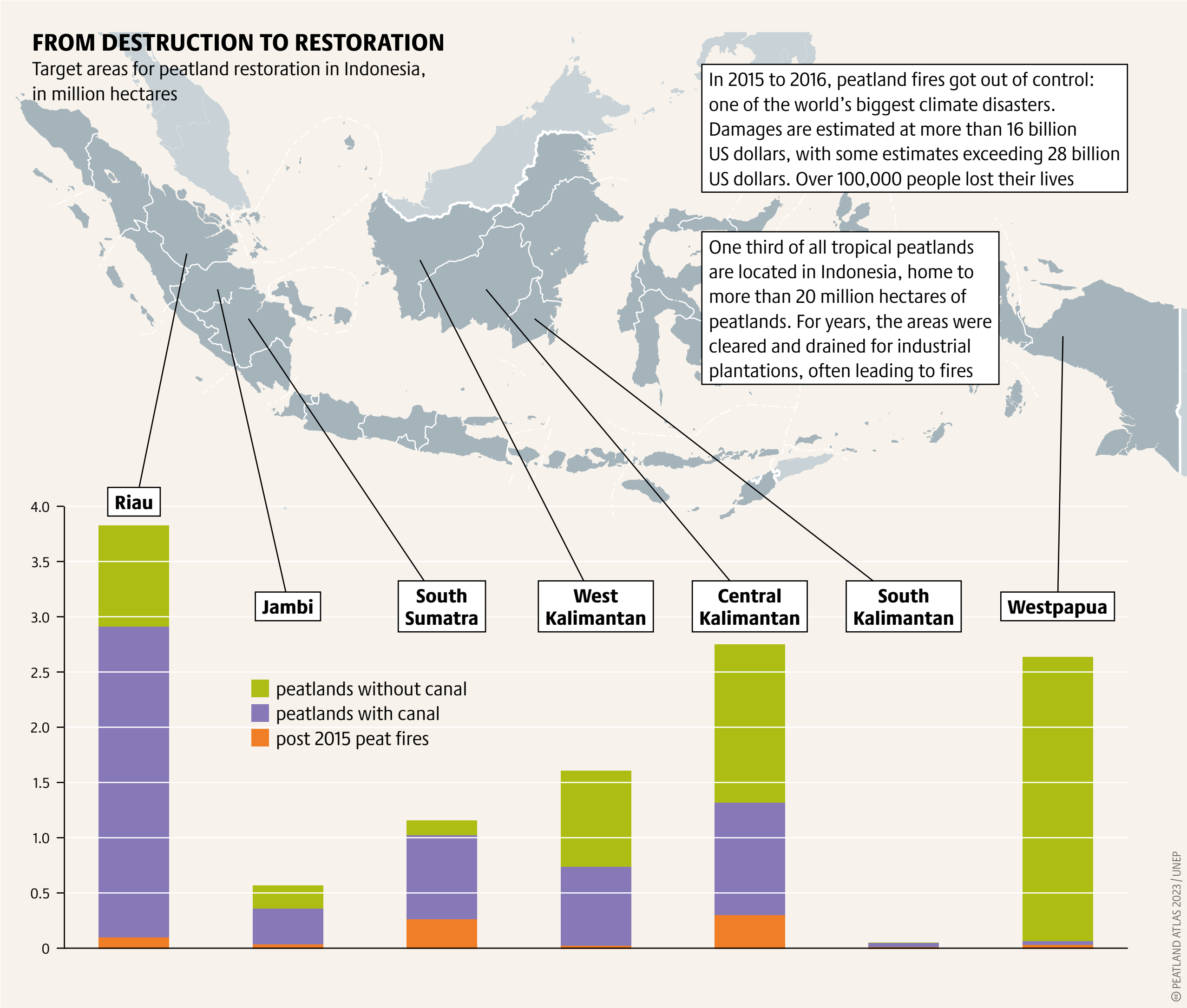
During the past 30 years, the region's peatlands have been degrading very rapidly. In Sumatra, Kalimantan and Peninsular Malaysia (which account for almost two-thirds of the region's peatlands), the area of peatland covered by swamp forests fell from 76 percent in 1990 to just 29 percent in 2015. A mere 6 percent is classified as pristine. Drainage of peatlands in Southeast Asia is responsible for 15 percent of the global CO_2 emissions from land use, land use change and forestry. Fires in degraded peatlands in the region are estimated to additionally emit a similar amount on average and significantly more CO_2 in drought years, making drained peatlands one of the largest sources of greenhouse gas emission in the region and globally. The protection and restoration of peatlands has therefore

Measures like the 5R Peatland Management Approach can help achieving ecological restoration goals, while obtaining local communities endorsement

A LONG WAY TO LONG-TERM SUSTAINABILITY

The community-led five "R"s of the 5R Peatland Management Approach in Southeast Asia





become an important component of national strategies for climate mitigation, as well as for biodiversity conservation and efforts to combat land degradation. The main causes of degradation have been the large-scale development of palm oil and forest plantations, combined with logging, drainage and fires.

Peatland degradation and fires have had massive social, environmental and economic impacts. The approximately 6 million hectares of peatlands that have burned in the last 25 years (particularly during El Niño-related droughts) have produced massive clouds of smoke, or haze, affecting more than 50 million people. The 2015 haze caused an estimated 100,000 premature deaths in the region, and economic losses of between 16 and 28 billion US dollars in Indonesia alone.

The Association of Southeast Asian Nations (ASEAN) adopted their Peatland Management Strategy for the years 2006 to 2020. This has been extended to 2030. It provides a broad framework for the long-term protection and sustainable use of peatlands and for the development of national action plans and landscape management plans.

Established in 2016, the Indonesian Peatland Restoration Agency was mandated to rehabilitate millions of hectares of peatland

Indonesia, with the region's largest area of both peatlands and peat fires, has undertaken major reforms. It has halted the conversion of peatlands for agriculture and plantations, and adopted a wide range of new regulations and policies. It has pioneered an approach to manage the hydrology of peatlands. All peatlands in the country must be mapped and divided into conservation and utilisation zones based on their hydrology, peat depth and importance for conservation.

More than 50 percent of the peatlands in the country have been zoned for conservation, although only 15.6 percent of these peatlands are in formally protected areas. Groundwater management structures have been installed and improved on nearly 4 million hectares. As a result, peatland fires have significantly declined, degradation and subsidence of production areas have decreased and good progress has been made with restoration.

AFRICA

GUARDIANS OF BIODIVERSITY AND CLIMATE STABILITY

Some of the world's most important and most recently recognized peatlands can be found on the African continent. They are home to unique and rare flora and fauna – and threatened by the oil companies' greed for money.

Peatlands cover nearly 40 million hectares across Africa. The largest area, in the Congo Basin, stores around 30 billion tonnes of carbon, while the Nile Basin – where nearly more than half of all the peatlands are now drained – has another 10 billion tonnes. Africa's peatlands are renowned for their unique biodiversity. The South African palmiet wetlands are dominated by the endemic palmiet, a semi-aquatic shrub which provides a home for many rare and valuable species. The Bale mountains in Ethiopia, dominated by cushion plants unique to the Afroalpine zone, are home to more than half the global population of the Ethiopian wolf, the rarest canid in the world.

In the centre of the continent – in the heart of the Congo Basin Forest, the second largest tropical forest after the Amazon – lies the Cuvette Centrale peatland complex. It is shared by the Democratic Republic of Congo (DRC) and the Congo. Covering 16.7 million hectares, it is one of the largest contiguous peatland complexes in the world. The Cuvette Centrale is a major carbon store, a very unique and invaluable ecosystem, a biodiversity hotspot and a lifeline for local communities. It accounts for more than a third of the world's tropical peatlands and contains more than a quarter of the carbon stored in such areas. This makes it very essential for mitigating climate crisis.

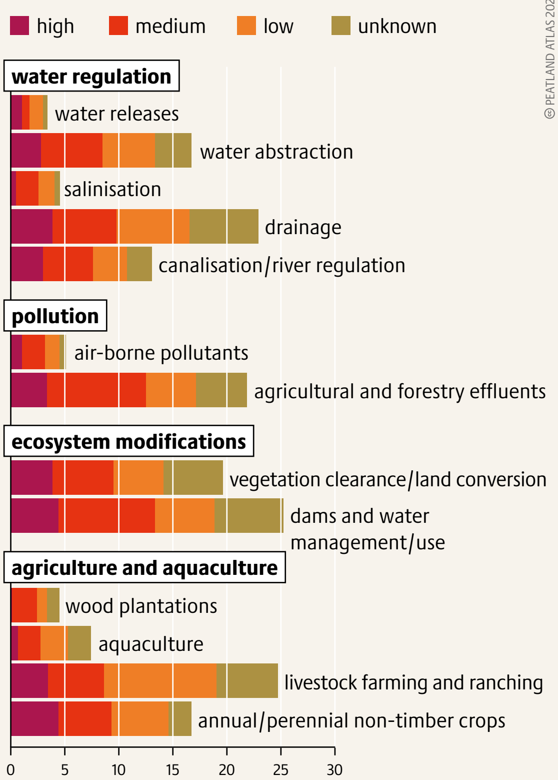
Most of the peatlands in the Cuvette Centrale occur near rivers, in large basins between rivers, or under rare, palm-dominated swamp forests that cover old river channels. The area boasts an astonishing array of biodiversity: a rich tapestry of species, many of which are unique, such as forest elephants, western lowland gorillas and Allen's swamp monkeys. The diverse habitats of the peatlands, ranging from open marshes and swamps to open water channels and forested islands, contribute to the stability and resilience of the biodiversity throughout the region. At 6.5 million hectares, the Tumba-Ngiri-Maindombe wetlands, the world's largest Ramsar wetland site of international importance, overlap with the Cuvette Centrale.

The vast wetland ecosystem of the Cuvette Centrale plays a vital role in water regulation, maintaining local water sources, regulating floods and droughts, and supporting agricultural activities. Communities in and around the peatlands depend on these water resources. Indigenous communities have lived in the region for generations and have deep-rooted cultural ties to the land. They fish, hunt and gather medicinal plants in the peatlands.

Despite its immense value, the Cuvette Centrale

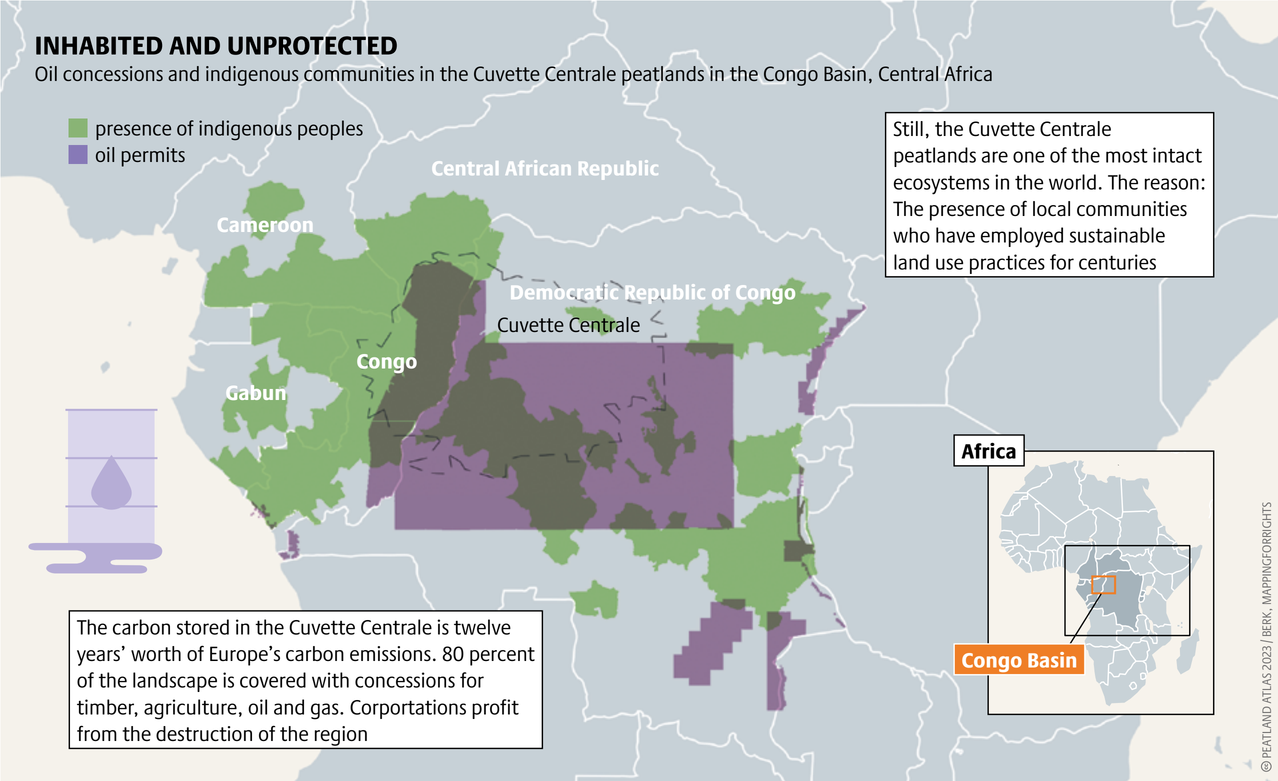
MAYOR THREAT

Percentage of wetlands affected by agricultural impacts



Study focuses on List of Ramsar Wetlands of International Importance

Agriculture is likely to have several negative effects on many global wetlands. Water extraction and diversion are one of them



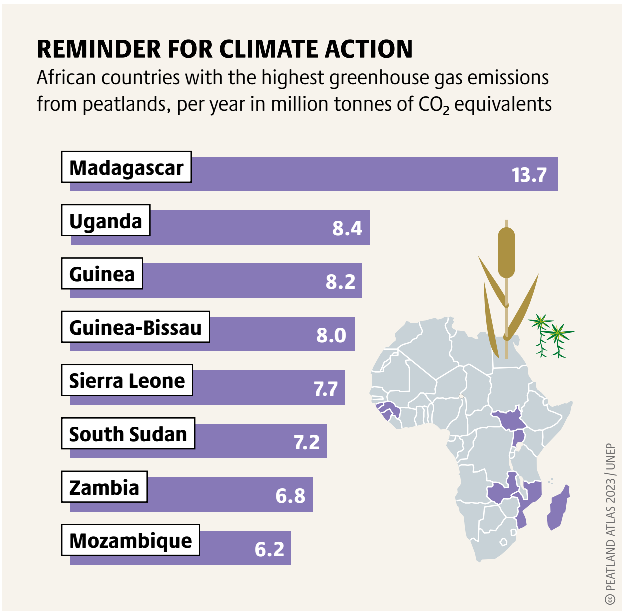
faces several threats. Expanding agricultural activities, oil and logging concessions, and infrastructure development pose significant risks to this fragile ecosystem. In November 2021, the government of the Democratic Republic of Congo signed a 10-year agreement to protect the Congo Basin forest, including its peatlands. But just a few months later, it announced its intention to auction off concessions for 27 oil and 3 gas exploration blocks. Several of the blocks overlap with the Cuvette Centrale peatlands. The results of the auction are expected in March 2024. In the meantime, a civil society-led campaign is trying to persuade oil companies not to bid for the concessions and is pressuring the government not to proceed with the auction.

Despite the importance of the Cuvette Centrale, binding national regulations for peatland protection are not in place. A key factor protecting the peatlands is current inaccessibility. If the oil auction is successful, oil companies will enter the deep forest and open up roads to allow exploration and access. This will also allow other forms of exploitation, such as logging, which will accelerate degradation.

International cooperation, such as the Central African Forest Initiative, research projects and partnerships with local communities are essential to the conservation of the Cuvette Centrale peatlands. Conservation efforts should focus on establishing protected areas, implementing sustainable management practices and monitoring conservation efforts. Sustainable land-use practices must be prioritized in partnership with indigenous communities, and awareness of the importance of peatland conservation for biodiversity and climate stability must immediately be raised. ●

Africa contains some of the world's biggest peatlands. The emissions resulting from degradation are around 130 million CO_2 equivalents per year

NGOs fear a total clearcut logging since the Democratic Republic of the Congo recently announced plans to lift its moratorium on new logging



NOT JUST A CRIME SCENE

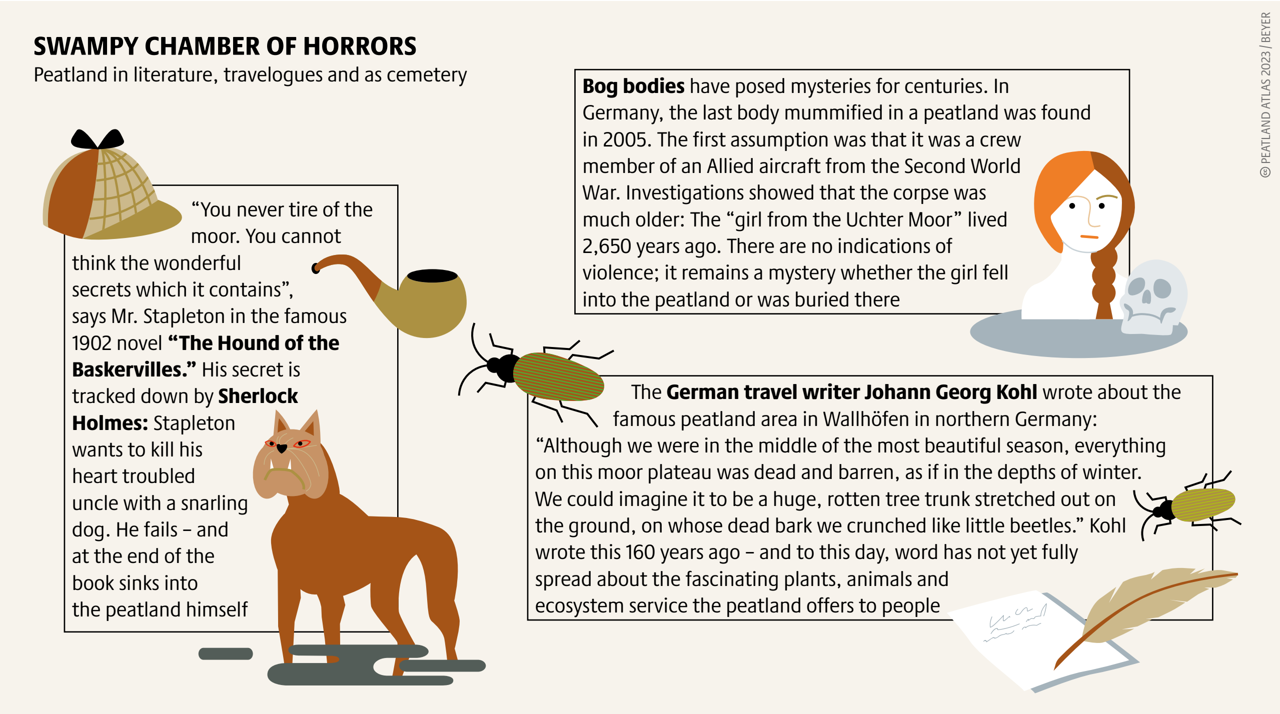
For thousands of years, peatlands have served as the backdrop for horror stories. In gruesome legends and lore, they swallow people and even whole towns, are the home of ghosts, the devil, and many other supernatural spectacles.

If our ancestors had come up with the idea of equipping the world with information boards and warning signs, the pathways to peatlands would long ago have been decorated with signs saying things like "Warning: Entrance to Hell" or "Caution: Beware of the ghosts". Many a solitary wanderer who ventured into a peatland was never seen again. What could possibly be to blame, if not the evil beings that lurked in these inhospitable places? The legends of such dangerous outings through the peatlands at night were crystallized into a well-known poem by the German author Annette von Droste-Hülshoff, whose "Boy on the Moor" is haunted by all the eerie noises and figures that local legends can offer: unholy spinners, a cursed woman, and ghostly gravediggers. All are damned souls from whom only the innocent can, with luck, escape.

There even exist legends of peatlands that have engulfed entire villages and towns. Some of these contain a historical kernel of truth, as with a village in the Red Moor of the Rhön, a range of hills in central Germany, that was in fact destroyed in the Thirty Years War. In another legend, a village was overtaken by divine punishment. It sank into the waters because of the sinful lives of its inhabitants. According to sayings, spooky voices can be heard at night, and on particularly holy days, the town rises so high that in the hours before midnight, its church spires can be seen emerging above the surface.

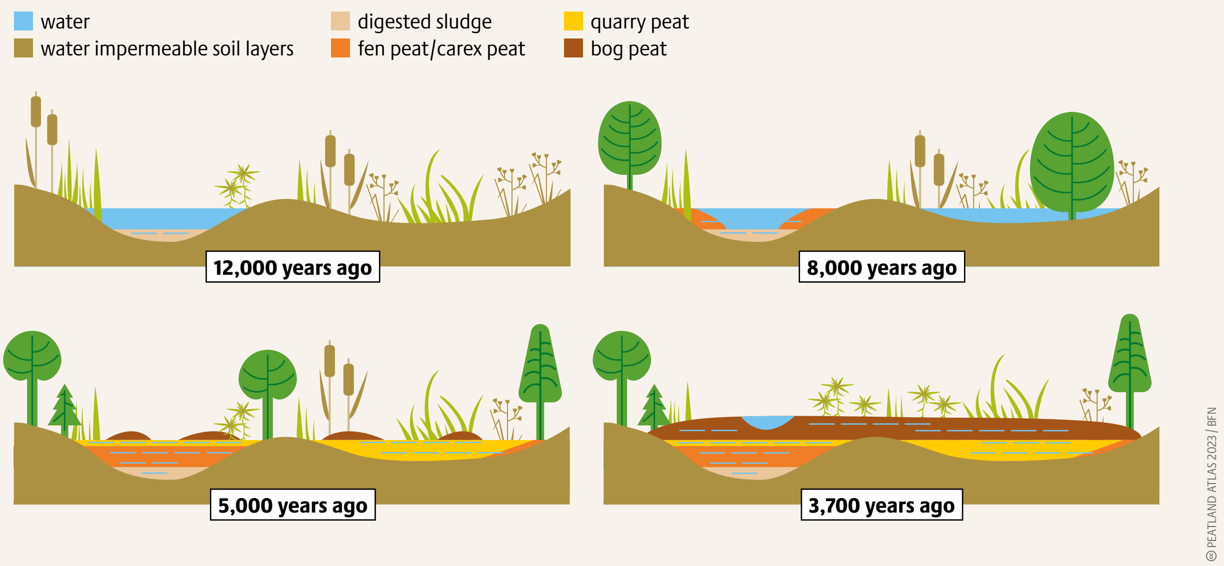
In Ireland, people still talk about the púca, or pooka: a mythical being that wanders through the bogs and can take on different forms – a black horse, a rabbit, or a human. The púca is always up to something. The Irish historian P. W. Joyce describes its deceitful nature "as a contradictory mix of merriment and malignity". The Okavango Delta in Botswana is guarded by a mythical, dragon-like snake called Mukisi. This Mukisi is a type of demon that protects the whole river system from overuse. If one were to kill the Mukisi, everything else would die along with it. Such guards have a monumental task: they try to protect remote, scarcely touched

Myths about peatlands have always grown in people's minds like bulrushes in peat



GROWTH OF ONE MILLIMETER PER YEAR

Development of a raised bog



environments that are threatened on all sides, for example by forest fires, droughts, habitat destruction, industrial development, excessive hunting and charcoal production, as well as by the wounds left to following generations by colonialism, war and the displacement of Indigenous peoples.

Will-o'-the-wisps have a firm place in the mythology of peatlands. Eyewitnesses describe them as bright flames, sometimes as jumping blue flames, or perhaps as similar to candlelight. This variability may have contributed to the different roles they play in the world of legends: sometimes as the souls of the deceased who must wander the Earth for all eternity because of their evil deeds, or as the souls of the victims of murder, who cannot find their rest. Or as goblinlike creatures who either guide travellers on their way through the peatland, or lead them to their ruin, or simply play tricks on them. Today we explain the phenomenon of will-o'-the-wisps as gases produced by the rotting of organic material that spontaneously ignite when they escape from the ground.

Peatlands were long regarded as areas that do not belong to this world. They are a kind of intermediate realm, neither water nor land. They symbolize the manifold functions of water, which stands for life, renewal and cleansing, but also for death and destruction. Peat water was allocated powers of healing and fertility, and today people still enjoy the effects of moor bathing – immersing themselves in a mix of peat and water from the peatland. But on the other hand, peatlands were places for punishment, where sacrilegious deeds or ways of life were to be atoned for. This happened not just in legends, but also in fact. The evidence for this takes the form of the so-called bog bodies. For

In Europe, peatlands are relicts of the last Ice Age. They formed in locations with excess water from melting glaciers

hundreds of years, peat cutters have repeatedly found corpses whose well-preserved status made people of the time uneasy. We now know that the lack of oxygen and the highly acidic environment slows down the process of decomposition. But it is still not completely clear how such bog bodies came about. Some show signs of "overkill" – multiple possible causes of death – such as Lindow Man from England, who had axe blows to the skull, knife wounds in the chest and signs of strangulation. One theory is that criminals were executed in the peatland; another is that human sacrifices were made there. There are also bodies that were buried after a natural death. It is thought that the peatland was used for emergency burials, as the last resting place for people who were excluded from society.

"Death for the first, misery for the second, bread for the third" goes a German saying that summarizes the experiences of three generations to transform the Teufelsmoor, large peatlands near Bremen in northern Germany to wrest cultivable fields from it, or to cut peat – once an important fuel like lignite. One might add a fourth phrase to the saying: "Pictures for the fourth." At the end of the 19th century, numerous artists settled in northern Germany. They founded a famous artists' colony in the village of Worpswede, on the edge of the Teufelsmoor. Through their paintings of the barren landscape and the life of poor farmers in the area, they developed their own visual language, a modern, realistic and nonetheless legendary image of the peatlands.

TRANSFORMATION

A FEASIBLE OPPORTUNITY – WITHOUT ALTERNATIVE

Rewetting drained peatlands will be a major challenge for societies all over the globe. Achieving success will take innovativeness, political initiative and a paradigm shift in the global economy.

For much of Western history, draining peatlands was regarded as a cultural and technical achievement. In many regions, removing water from the land was a first, vital step in the economic development of an area. But the ecological crises of our times now force us to start over again, as peatlands fulfil many important functions for both humanity and the environment. The cultural and technical achievements of the present and future will be to develop and establish new ways to coinhabit these wet landscapes.

Paludiculture, wetland restoration and solar farms are among the many promising ways of replacing previous land uses for fens and bogs. Such transformation is necessary to mitigate the climate crisis, it will help to preserve biodiversity and to enhance flood protection. In technical terms, rewetting is fairly easy: ditches must be blocked, pumps converted, and drainage stopped. But managing the social, cultural and especially the economic shifts are much more complex. To transform non-sustainable social habits of using peatlands, simultaneous changes are needed at various levels. For example, the legal framework has to be adjusted to remove the financial incentives for draining wetlands.

Stricter regulations of supply chains are needed, along with stronger controls, especially for large companies. Local authorities and organisations responsible for managing soil and water face the major task of adapting the infrastructure and ownership situations to the necessary water levels. Agricultural and forestry enterprises require new forms of management to completely upend their current approaches. Experts point out that if they are to succeed in making this huge adjustment, farming and forestry enterprises and smallholders will need public financial support, which must ensure planning security and promote new markets for the products from wet peatlands.

Every peatland has different prerequisites, in hydrological terms as well as in political terms. There can therefore be no general template for rewetting: each peatland will require a specific solution for the rewetting, and for the land use and coinhabiting afterwards. Decisions on shaping the transformation process should be made at the regional level – preferably in a joint effort by local and regional authorities, farm enterprises, soil and water associations, nature conservation bodies, Indigenous peoples and local residents, environmental groups, the companies involved, and spatial planners. These actors can all bring knowledge for the future management of the peatlands based on experience in their field. Policymakers have the responsibility of establishing participatory mechanisms to combine this knowledge and interlink different levels from local to higher levels of government and the international community.

At the European Union level, the Common Agricultural Policy (CAP) is an important mechanism for managing how peatlands are used. This stipulates that areas used for paludiculture are eligible for financial support. But these efforts conflict with other parts of the CAP that continue to support types of farming that rely on drainage. In the European Union alone, half a million hectares of peatland have to be rewetted every

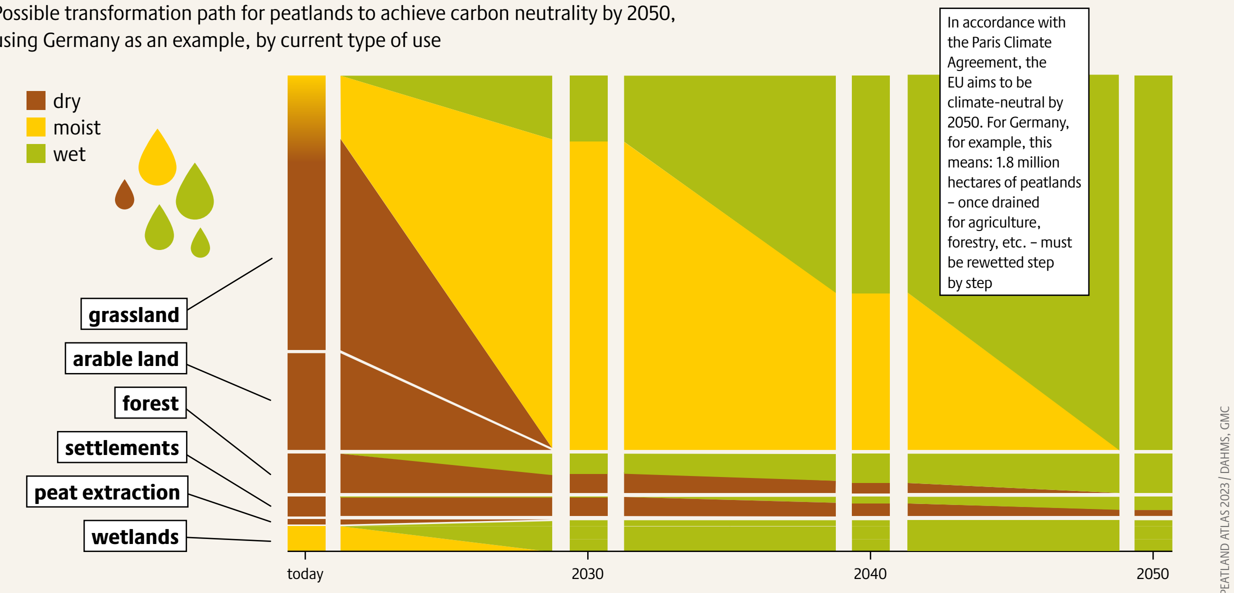
THEORY WITHOUT PRACTICE

Area of peatland that a country like Germany have to rewet annually, in hectares

To meet the goals of the Paris Climate Agreement, peatlands must be restored – immediately

REWETTING FOR FUTURE

Possible transformation path for peatlands to achieve carbon neutrality by 2050, using Germany as an example, by current type of use



year to meet the Paris Agreement. With above-average emissions, the EU is still one of the main contributors to the climate crisis and holds historical responsibility for the current global inequalities.

Carbon credits might be a possible incentive for rewetting land to conserve peat voluntarily. Incentives and freedom of action are also needed for companies and cooperatives that work on paludiculture. To successfully transform the peatlands, it is necessary to take serious people's worries about the loss of a familiar environment with which they identify, as in some parts of the world peatlands have been drained for decades. Regional cooperation can link different issues – from agriculture to product development and marketing, to tourism and nature conservation. All this will require a strong willingness for political, social and ecological innovation.

This peatland transformation – as every other socio-ecological transformation – can only be successful if the omnipresent drivers of the destructive neo-colonialist economy are overcome. It is a chance to strengthen social and political processes that declare cooperation instead of competition to be the principle of action. This processes target the preservation of natural resources and are not based on exploitation of nature and people.

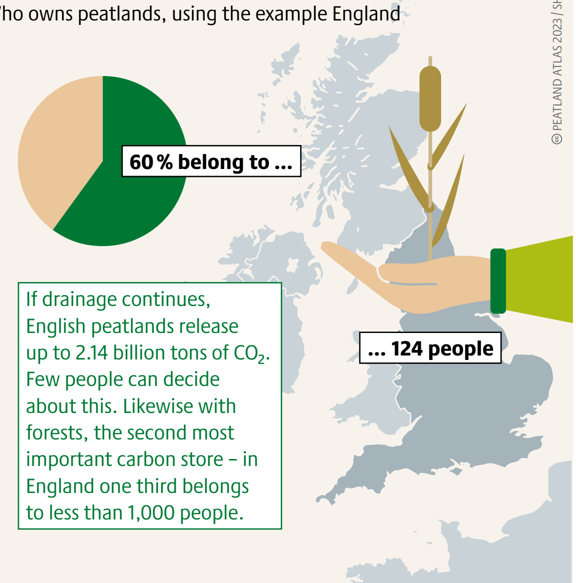
Ideas of responsible land use, equal distribution of resources and consumption within ecosystem boundaries are not limited to peatland utilization. Current negotiations of land use claims follow a competitive mindset. We are in urgent need of abandoning one-dimensional utilitarian way of thinking in favour of more complex thinking that understands and respects peatlands as more than mere usable landscapes, instead promotes the protection of these essential habitats for the benefit of all living beings. Only with both, ecological resilience and a just social foundation, the global society can confront the climate crisis. ●

Studies show without doubt: If rewetting of peatlands is delayed, it will be impossible to achieve the 1.5-degree target

England's peatlands are the country's largest carbon store in the country. Property rights hinder necessary measures for protection and rewetting

PEATLANDS AND PROPERTY

Who owns peatlands, using the example England



TO READ AND STUDY

AUTHORS AND SOURCES FOR DATA AND GRAPHICS

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UNDER THREAT ALMOST EVERYWHERE by Alexandra Barthelmes

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SAVE HAFENS FOR ECOSYSTEMS IN DANGER by Tatiana Minayeva

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PEATLANDS' RAW MATERIAL by Greta Gaudig and Olivier Hirschler

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PEAT, WIND & FIRE
by Harri Vasander
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FILL IT UP TO THE TOP
by Jutta Walter and Mathias Büttner
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DEFENDING DIVERSITY
by André Prescher and Christian Rehmer
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THE CONSEQUENCES OF CONSUMPTION
by Lea Appulo and Thomas Westhoff
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MORE FROM THE MARSH
by Anke Nordt and Susanne Abel
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SCORCHED EARTH by Monika Hohlbein
p. 40: John Couwenberg, Biomass energy crops on peatlands: On emissions and perversions, 2007. IPCC Emission Factor Database, https://bit.ly/3H5acDw. – **p. 41 top:** Greifswald Moor Centrum, Klimaschutz auf Moorböden. Lösungsansätze und Best-Practice-Beispiele, 2019, https://bit.ly/3FcZBoP, Thünen-Institut, 2020, https://bit.ly/3HtbacV. – **p. 41 bottom:** Bundesamt für Naturschutz, https://bit.ly/3XMa3e1.

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SMALL CONTINENT, ANCIENT LANDSCAPES
by Franziska Tanneberger and Asbjørn Moen
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ICE-AGE LEGACY by Maria Strack,
Marissa Davies and Curt Richardson
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46–47 LATIN AMERICA AND THE CARIBBEAN
YOU CANNOT PROTECT WHAT YOU DO NOT KNOW by Mónica Maldonado-Fonken and Cristina Malpica-Piñeros
p. 46: UNEP, Global Peatlands Assessment, 2022, https://bit.ly/3GWm6j3. – **p. 47:** UNEP and GRID Arendal, Smoke on Water. Countering global threats from peatland loss and degradation, 2017, https://bit.ly/3pIAdCn. UNEP, Global Peatlands Assessment, 2022, https://bit.ly/3GWm6j3.

48–49 SOUTHEAST ASIA
PROGRESS FOR PEATLANDS by Faizal Parish, Serena Lew Siew Yan and Linda Archibald

p. 48: Dilvia Terzano et al., Community-led peatland restoration in Southeast Asia: 5Rs approach, 2022, https://bit.ly/3XI3ycI. – **p. 49:** UNEP and GRID Arendal, Smoke on Water. Countering global threats from peatland loss and degradation, 2017, https://bit.ly/3pIAdCn.

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GUARDIANS OF BIODIVERSITY AND CLIMATE STABILITY by Irene Wabiwa Betoko, Samer Elshehawi and Inka Dewitz

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52–53 OF MIRES AND MYTHS
NOT JUST A CRIME SCENE by Elmar Tannert

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54–55 TRANSFORMATION
A FEASIBLE OPPORTUNITY – WITHOUT ALTERNATIVE by Uta Berghöfer, Sabrina Hüpperling, Jan Peters and Ricardo Rozzi

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MICHAEL SUCCOW STIFTUNG, PARTNER IN THE GREIFSWALD MIRE CENTRE

After being awarded the 1997 Right Livelihood Award, Michael Succow founded one of the first nature conservation foundations in eastern Germany in 1999. Since then, the Succow Stiftung has been actively involved in the preservation of valuable landscapes and sustainable land use guided by the precept: "Preserve, sustain, value". At home and abroad, it renders important contributions to the protection of peatlands and climate, to biodiversity conservation through the development of protected areas, and to ecological education. It is a founding partner in the Greifswald Mire Centre (GMC). As an interface between science, politics and practice, the GMC works locally and worldwide with over 70 peatland experts from various disciplines.

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GLOBAL PEATLANDS INITIATIVE

The Global Peatlands Initiative (GPI) is an international partnership launched at UNFCCC COP 22 in Marrakech, Morocco, in late 2016. Led by the United Nations Environment Programme (UNEP), its goal is to protect and conserve peatlands as the world's largest terrestrial organic carbon stock and to prevent this carbon stock from being lost and emitted into the atmosphere. Drawing attention to peatland issues and helping countries and partners to understand and make evidence-based decisions about their management enables the Initiative to contribute to several Sustainable Development Goals. The GPI makes an impact by highlighting cases, gathering lessons and sharing best practice examples from different types of peatland ecosystems found all around the world.

UN Environment Programme, United Nations Avenue, Gigiri PO Box 30552, 00100, Nairobi, Kenya, https://globalpeatlands.org

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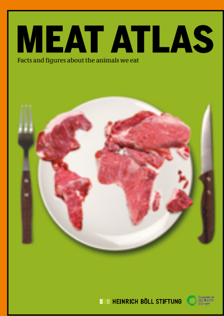

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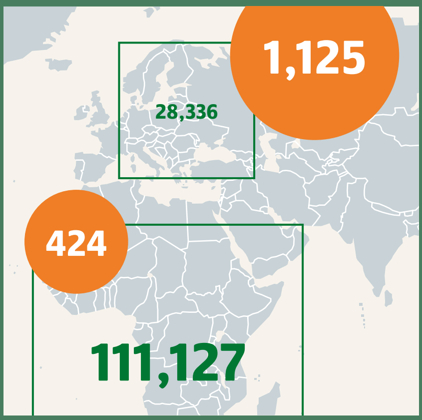

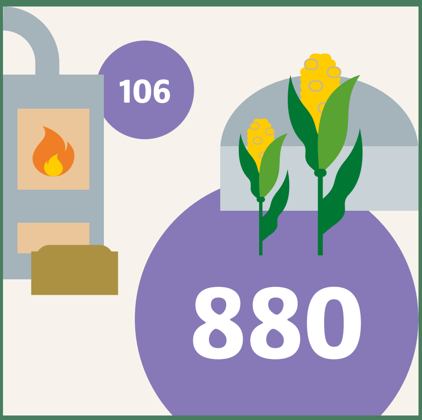

Wet peatlands are habitat for specialized animal and plant species.
They store more carbon than any other terrestrial ecosystem.
from: A VERY SPECIAL ECOSYSTEM, page 12

Drained peatlands emit greenhouse gases.
This exacerbates the climate crisis.
from: DRAINED PEATLAND RESULTS IN HEATED PLANET, page 20

Tropical peatlands host significant biodiversity.
They are under threat from politics and corporations.
from: GUARDIANS OF BIODIVERSITY AND CLIMATE STABILITY, page 50

Climate targets require area-wide rewetting of peatlands.
Paludiculture enables their sustainable use.
from: MORE FROM THE MARSH, page 38