THE GIVE AND TAKE OF AIR AND EARTH

Climate and soil influence each other in many ways: the climate helps form the soil, and the soil in turn affects the composition of the atmosphere – in particular the amount of carbon dioxide and other greenhouse gases.

Climate, an active factor of soil formation, is intricately linked with soil and its attributes. At any point in time, soils are in a dynamic equilibrium with the climate.

Take a spade and dig a pit in the ground, about 50 cm deep. Smooth the pit walls and you will see a series of layers: probably black at the top, but then fading into brown or grey, perhaps with bands of black or red.

The layers are called "horizons" and they are characteristic for particular climates. The coniferous forests that stretch across northern latitudes have a typical grey band that looks like ash; they are called "podzols". Many humid tropical soils are red or yellow because of the iron and aluminium they contain; they are called "ferralsols".

The layers are caused by the climate. Rain dissolves certain minerals and salts, and leaches them downwards. Evaporation and capillary action bring them upwards again, depositing them in distinctive layers, or even on the surface. Fine particles may accumulate at a particular depth, forming a hardpan. Water and acid gnaw at the rock below, breaking it up and forming new soil. The interplay of climate, this parent material and the topography, as well as human activities such as ploughing and irrigation, produce soils that are sandy, silty or clay-like, acid or alkaline, waterlogged or well-drained, fertile or infertile.

The climate also influences the soil through the vegetation that grows on it and the animals and microorganisms that live in it. Plant roots and fungal mycelia bind the soil and extract water and nutrients; earthworms, moles and insects dig and burrow. When they die, plants decompose into humus – the black layer near the surface of many soils. This organic matter is vital for soil fertility; it binds soil particles together and traps water and nutrients where roots can find them.

A lack of vegetation – after ploughing, for example, or in drier areas – leaves the soil exposed to the elements. Raindrops break up clods and wash particles away. Heavy rain pounding the surface can form crusts, which prevent water from sinking in quickly. The runoff carries precious topsoil with it, turns rivers brown and silts up reservoirs. During dry periods, the wind can whip up dust and sand, blowing it hundreds of kilometres.

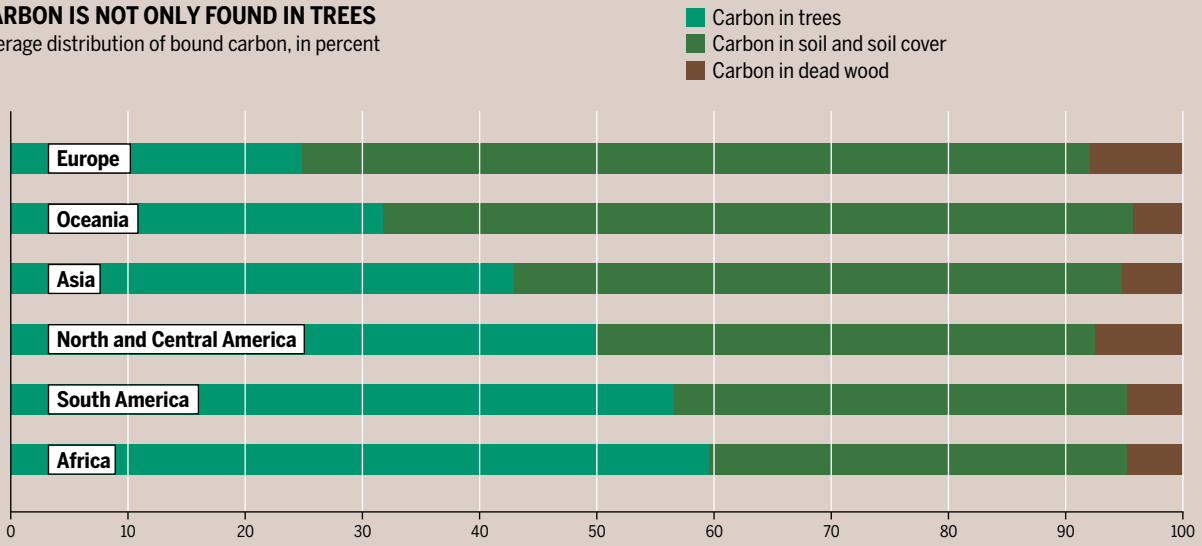
So the climate affects the soil – but the soil also influences the climate. Carbon dioxide and other greenhouse gases are especially important. The soil is a huge carbon sink; it contains more carbon than the atmosphere and all terrestrial vegetation combined. Relatively small changes in the amount of organic matter in the soil can have a major effect on the atmosphere – and on global warming.

Croplands, which cover about 1,500 million hectares worldwide, tend to have less organic matter than

In Europe more carbon is stored in the soil than in the vegetation – the opposite is true in Africa

CARBON IS NOT ONLY FOUND IN TREES

Average distribution of bound carbon, in percent



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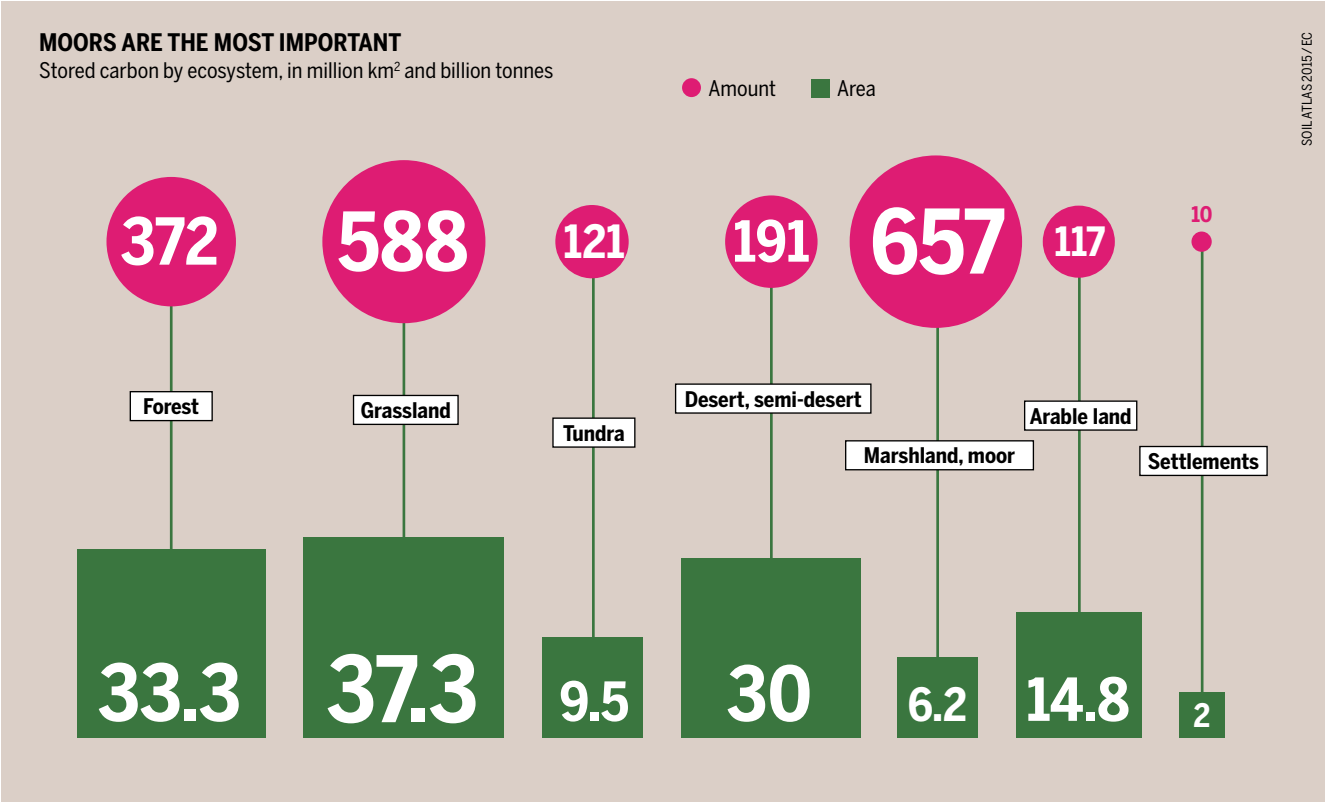

neighbouring soils under natural vegetation. Ploughing arable land and harvesting crops accelerate the release of carbon dioxide back into the atmosphere. Growing paddy rice releases methane, a greenhouse gas that is 25 times more potent than carbon dioxide. Applying nitrogen fertilizer results in emissions of nitrous oxide, 310 time more potent. Improved management can put carbon back into the soil; techniques include reduced ploughing, preventing erosion, planting cover crops, and applying compost and manure.

Grazing lands cover about 3,500 million hectares around the world. Cattle and other ruminants are a major source of greenhouse gases: burping, flatulence and manure emit both methane and nitrous oxide. Grazing lands in dry areas can absorb relatively little carbon per hectare. But they cover vast areas and so collectively can absorb large quantities of carbon if they are managed well – for example by controlled grazing, preventing fires, planting trees, conserving soil and water, restoring eroded and saline land, and rehabilitating wetlands.

Forests cover about 4 billion hectares globally. The soils that support tropical rainforests are surprisingly infertile; rain quickly washes soil nutrients away. Most of the plant nutrients and carbon in rainforests are contained in the vegetation itself. When organisms die, they decompose rapidly in the hot, wet climate, and the nutrients are recycled into new plants. Cutting or burning the trees releases large amounts of carbon into the atmosphere. The soils beneath the vast boreal forests of North America, Scandinavia and northern Russia, on the other hand, contain large amounts of carbon, especially in peat bogs.

Europe emits more greenhouse gases than it stores. The quality of its soils is declining. The less the soil lives, the less carbon it can store

Conserving and restoring moors and marshland is especially worthwhile. But no ecosystem should be neglected

With the right management, soil has the potential to absorb large amounts of carbon, and so combat global warming. Restoring the soil's ability to lock away carbon is an important way to reduce the impact of climate change.