Forest researchers go underground

Scientists are building a global database on forest soils. The first analyses show how closely trees, soil organisms and climate are connected. 'We can now predict developments influenced by the climate.'

TEXT NIENKE BEINTEMA **ILLUSTRATION** STEFFIE PADMOS

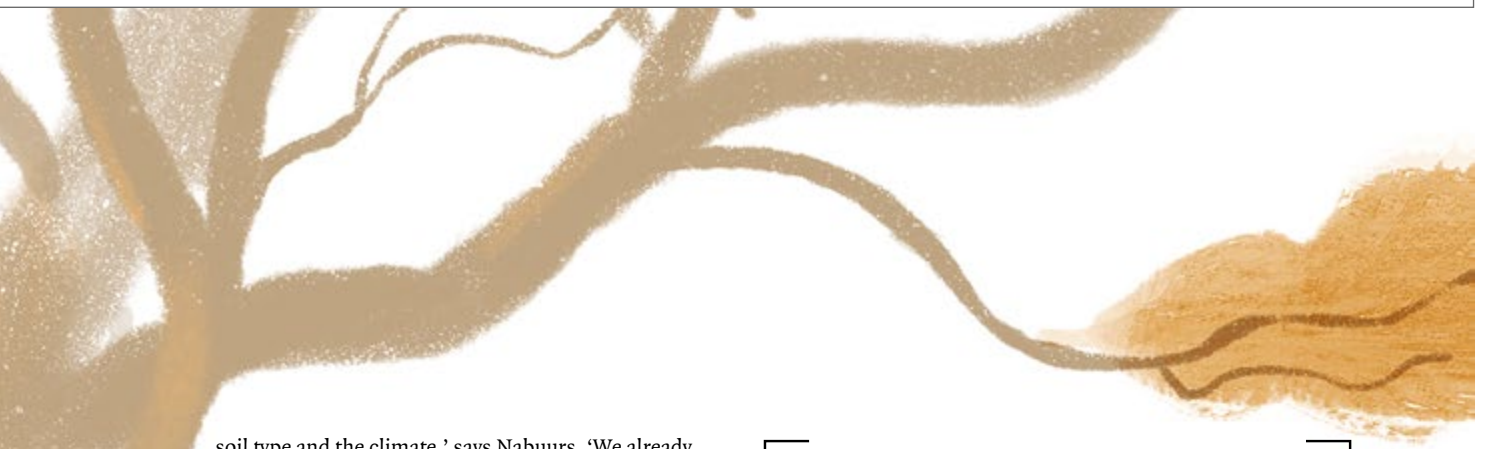
The soil below every forest harbours a jumble of fungi and bacteria which collaborate closely with the trees' roots. These fungi and bacteria free up nutrients in the soil for the roots, and in exchange the roots give the micro-organisms certain nutrients such as sugars. This collaboration goes on in every forest ecosystem, but the symbiosis looks very different in a tropical rainforest, in the northern taiga and on the Dutch Veluwe plateau. These differences around the world have now been documented for the first time. Wageningen researchers took part in the study, which was published in May in the top journal *Nature*.

'We have known how important the symbiosis between tree roots and micro-organisms is for a long time,' says Gert-Jan Nabuurs, professor of European Forests in Wageningen and co-author of the study. 'But we didn't know very much about it. That is partly because a lot of information was inaccessible, spread over databases in different countries.'

Nabuurs and his colleagues have been working for two decades to put together a European database. Five years ago they started gradually linking this database with data from countries all around the world. Nabuurs: 'It's unique: we now have access to data from 1.1 million measuring points around the world.'

The article in *Nature* came out of this Global Forest Biodiversity Initiative, started by Wageningen University & Research and partners.

'Researchers around the world collect data about forests, such as their density, the mix of species, the



soil type and the climate,' says Nabuurs. 'We already knew that you find different forms of symbiosis in the tropics, temperate and cold regions, and theoretical calculations had already been made to predict which forms are dominant and where. But now for the first time we can test those ideas against a whole lot of data.'

COMPUTER MODEL

The research showed that there are three main forms of symbiosis in forest soils: one variant in which tree roots collaborate with fungi in the soil (*ectomycorrhiza*), one in which the fungi live in the tree roots (arbuscular *mycorrhiza*), and collaboration between roots and nitrogen-fixing bacteria. 'We have made a computer model using the global measuring points,' says Nabuurs. 'It shows how factors such as soil chemistry, vegetation and climate determine which type of symbiosis predominates.'

Ectomycorrhiza turned out to be dominant in moderate and cold climates, where they play an important role in carbon storage in the soil. Arbuscular *mycorrhiza* are primarily found in the tropics, where they facilitate the fast recycling of carbon. Through climate change, the balance between these two types seems to be shifting in favour of the second. This negatively affects the soil's capacity to store carbon, and therefore itself becomes a contributing factor in climate change.

'Thanks to this model, we can now predict future developments in forests in great detail,' says Nabuurs. 'The differences, for example, under the influence of a warmer, drier or wetter climate.' That is where this research and the global map is of practical use, says Nabuurs. 'Once you know how forests react to changes, you can take that into account in your management of them.' The research shows that mixed forests are particularly rich in micro-organisms. 'It is our guess that this abundance makes a forest resilient,' says Nabuurs.

'We have data from 1.1 million measuring points around the world'

'The greater the diversity of micro-organisms, the more efficiently trees can use the available nutrients and water. In times of changes in particular, that could just be the difference between the survival and the disappearance of a given type of forest.'

However, adds Nabuurs, using this knowledge to adapt management strategies is easier said than done. 'We don't yet have a direct translation of this research into specific measures, but we have taken the first steps towards it. This research shows the existing relationships and patterns, and how they change. We can now use climate scenarios to predict what will happen to forests: which species we are going to lose, how far the boundaries of forest types are going to shift, and so on.'

But its immediate applications are not the biggest benefit of the research, Nabuurs emphasizes. 'At this stage, it is the ecological work that matters most to me. In the past, modelling how forests function was mainly done at the local level, and focussing on relationships above ground. Now for the first time we can look at global patterns, and also go underground. That is what makes this study cutting-edge. The fact that we can do that upscaling for the first time.' ■

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