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Future warming could cause trees to dominate peat bogs

Research suggests that climate change could alter the structure and function of temperate peat bogs and that these changes are primarily driven by rising temperatures, rather than periods of temporary drought. An average temperature rise above 1°C could permanently shift moss-covered peat bogs into bogs predominately covered with trees, affecting their ability to store carbon and the existing carbon stocks in them.

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Peatlands cover about 3% of the world's land surface, but contain about 30% of the global terrestrial carbon store. The impact of climate change, particularly warming temperatures and more extreme precipitation and droughts events is threatening the structure and functioning of peatlands, especially moss-covered peat bogs (one type of peatland) found in northern climates where there is a concentration of these peat bogs. This has led to concerns about the amount of stored carbon that could be released to the atmosphere from drying peat bogs.

In this study, the researchers modelled the impact of warmer conditions and temporary droughts on the vegetation structure of temperate peat bogs, dominated by *Sphagnum* moss. Six types of drought events, ranging from gradual decreases in summer rainfall to intense droughts, were combined with a series of temperature increases to assess whether a moss-dominated ecosystem state could be tipped into a tree-dominated state.

The results indicate that, as temperatures increase, the structure of the moss-covered peat bogs will change, with an increase in tree growth and a decrease in moss cover. A 1°C rise in average temperature would result in trees replacing grasses, but not the moss. A 1.5°C temperature increase would be sufficient to cause the ecosystem state to change dramatically and trees would become established at the expense of the moss. In addition, with both a lower water table and warmer temperatures, suitable conditions for tree growth would last longer, increasing from 2.2 to 3.7 months for a 0.5°C and 2.0°C increase respectively.

Summer droughts of varying intensities and frequencies appeared to enable trees to become established, but would not permanently tip a moss-dominated peat bog into one dominated by trees. Trees appeared to develop more quickly during a long drought period, as opposed to the other drought scenarios. All types of droughts would cause the water table to fall during summer, the model suggests. For example, combined with a 1°C rise in temperature, the researchers noted a corresponding 34 cm fall in the water table below the moss surface during frequent summer droughts, and a 42 cm fall during long droughts, defined as nine consecutive dry summers in this study. Lowering the summer water table encourages tree growth, but not moss growth, which in turn causes the water table to fall even further, because more water from the ground is released to the air via the trees. At the end of the ninth dry summer, the water table was predicted to fall 52 cm below the surface of the moss, which dries out in the summer.

When the researchers modelled the return of wet summers, the water table rose which was favourable for moss recovery and growth and although some trees had become established, the temporary drought conditions had not been able to cause a permanent change to a tree-dominated state. The shade from the trees reduced the evaporation from the moss surface, which is considerable under wet summer conditions, and this compensated for the increased loss of water through the trees. This shows that the moss-dominated peat bogs can survive some drought conditions and are resilient to temporary droughts.

However, as temperate peat bogs are sensitive to temperature change, responses of the bogs to future warming are likely to have important feedbacks that potentially promote tree growth and could trigger a permanent change in vegetation state.