# Scientist highlights urgent need for new computer models to address climate change

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Two papers published in the journal Science today by Microsoft Research ecologist Drew Purves together with research colleagues at Princeton University and universities in Madrid, Spain, highlight how an improved understanding of forest dynamics is needed to better predict environmental change. The research suggests that a new generation of realistic forest modelling, which is urgently needed and now within reach, will significantly improve an understanding of how forests work, how tree species respond to deforestation, and how forests impact climate regulation and environmental change.

The research points out that forest dynamics (how populations of trees interact with each other and the environment) remains the single most important outstanding component in fully understanding climate change. There trillions of trees on the planet, made up of more than 100,000 species, which contain as much carbon as is currently in the atmosphere and serve as home to two-thirds of the planet's terrestrial biodiversity. However, while other climate change factors such as ocean dynamics are now well researched, the effects of changes to the world's forests are still largely unknown.

The paper "Predictive Models of Forest Dynamics" by Purves and Princeton's Stephen Pacala explores dynamic global vegetation models (DGVMs), which simulate the reaction of forests to past, present and future climate.

"DVGMs have shown that forests could be a crucial part of the way the

Earth's climate responds to man-made CO2 emissions, but insufficient understanding of forests, and insufficient data and computing power, have made their predictions highly uncertain," Purves said. "This kind of uncertainty helps climate sceptics, who erroneously conclude that because the Earth is a complex but poorly understood system, we should not change our behaviour. However, we suggest that the convergence of recently developed mathematical models, improved data sources and new methods in computational data analysis could produce more realistic models. That would give us truly invaluable information to help manage the world's forests and understand their impact on our climate."

"Until now, one of the most important pieces of the climate change jigsaw has been missing," Pacala said. "We argue that we can significantly further our understanding of forest dynamics if scientists work together to use new computational techniques and data sources — provided governments and others make more data available in useful forms. We feel that these discoveries could unlock the climate change mysteries of forests on a global scale in as little as five years."

The second paper published in Science today, "Animal vs Wind Dispersal and the Robustness of Tree Species to Deforestation," by Daniel Montoya from the Universidad de Alcalá in Madrid and Purves in Cambridge, with Miguel A. Rodríguez of the Universidad de Alcalá and Miguel A. Zavala of Centro de Investigación Forestal, Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA-CIFOR) in Madrid, examines what happens to individual tree species in the face of deforestation. Using data from nearly 90,000 survey plots in the Spanish peninsula, the paper found tree species that rely on wind to disperse seeds, rather than animals, are more vulnerable to deforestation.

Montoya said, "By applying various methods in computational data analysis to a large source of forest data, we have confirmed that, in Spain at least, plants with animal-dispersed seeds are less vulnerable to habitat loss, because animals provide trees with an intelligent dispersal mechanism, travelling and distributing seeds between areas of remaining forest. In contrast, a wind dispersal method is more susceptible to habitat loss, as seeds are more likely to fall in inhospitable environments. Using methods like this, conservationists can identify the species at most risk following deforestation, and use this knowledge to develop new strategies to mitigate the effects of widespread habitat loss and help to protect species diversity."

The research also concludes that when no animal dispersers exist in the ecosystem, animal-dispersed tree species are the most vulnerable to deforestation. This means that protecting plant-animal interactions must also be a cornerstone of conservation policy, because the interactions not only create and maintain biodiversity, but also increase resistance to disturbances to the ecosystem.

Both papers underline the importance of forest dynamics in understanding and predicting climate change and biodiversity, highlighting the urgent need for additional study and resources. Purves said, "It is imperative that we create the tools and science to accurately understand the reaction of ecosystems to climate change and other forces — not just for plants and animals, but for our children and succeeding generations."

This research is part of the recently established Computational Science Research at Microsoft Research Cambridge. This team of ecologists, biologists, neuroscientists, mathematicians and computer scientists is pioneering novel theoretical frameworks, computational tools and scientific methods to tackle the greatest scientific and societal challenges of this century, from climate change and declining biodiversity to understanding how living things work.

"Predictive Models of Forest Dynamics" and "Animal vs Wind Dispersal and the Robustness of Tree Species to Deforestation" are published in *Science* today and will also be available from www.research.microsoft.com/cambridge

Source: Microsoft Research Cambridge

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