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Into the forest

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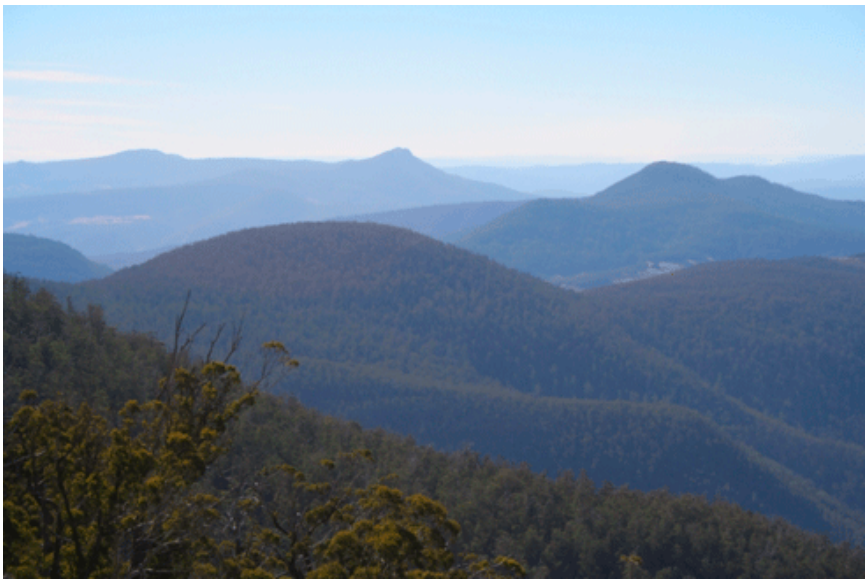
As the International Year of Forests (IYF) draws to a close, *ECOS* reviews CSIRO's recent contributions to global forest research – beginning with the role of trees in locking up carbon.



Credit: Nick Pitsas/scienceimage

This year, an international research team discovered that the world's forests remove 2.4 billion tonnes of carbon from the atmosphere per year – equivalent to one-third of global annual fossil fuel emissions.

It's the first time the amount of greenhouse gases absorbed from the atmosphere by tropical, temperate and boreal forests has been so clearly identified.

'This is a timely breakthrough,' says CSIRO's Dr Pep Canadell, a co-author of the paper published in *Science* and Executive Director of the Global Carbon Project.

'We can now clearly demonstrate how forests and changes in landscape, such as wildfire or forest regrowth, impact the removal or release of atmospheric carbon dioxide,' he explains. 'This research tells us that forests play a much larger role as carbon sinks as a result of tree growth and forest expansion.'

Data from forest inventories, models and satellites were combined to form a profile of forests as major regulators of atmospheric carbon dioxide, with deforestation emitting 2.9 billion tonnes of carbon per year – a much larger amount than previously thought, according to Dr Canadell. This means the potential benefits of avoiding deforestation through the United Nations-backed Reduced Emissions from Deforestation and Degradation (REDD) scheme are also much larger than assumed.[1]

Another surprising finding was the carbon storage capacity of tropical forest regrowth following logging, slash-and-burn land clearing, and forest plantation.

‘We estimate that tropical forest regrowth is removing an average of 1.6 billion tonnes of carbon per year,’ says Dr Canadell.

‘Unfortunately, some countries have not looked on forest regrowth as a component of REDD, and so are missing a very important opportunity to gain even further climate benefits from the conservation of forests.

‘Combining the uptake by established and regrowth forests plus emissions from deforestation, the world’s forests have a net effect on atmospheric carbon dioxide equivalent to the removal of 1.1 billion tonnes of carbon every year.

‘Carbon exchanges from tropical forests have the highest uncertainties in this analysis, and this research has required a concerted effort to refine them to our best knowledge.’

Credit: Credit : CSIRO

Forest conservation in the Pacific

Australian tree species are adapted to poor soils, tolerant of extreme conditions, and can be easily propagated and regenerated. This makes them highly valued worldwide; Australian species are estimated to make up 40 per cent of all tropical plantations.

The Australian Tree Seed Centre (ATSC) in Canberra is a long-running CSIRO success story. For decades, the centre has been conserving Australian tree species for use here and overseas, to restore degraded environments and to provide a fuel source for basic needs such as cooking.

ATSC is now using its expertise to help establish a tree and crop seed centre for the Pacific Islands – where climate change, pests and diseases are threatening native plants. Island plant populations are particularly vulnerable to loss of genetic diversity. By sharing seed and plant tissue for propagation, these small nations can maintain enough biodiversity to adapt to such environmental threats.

Credit: CSIRO

Through ATSC, CSIRO has supported the establishment of the Pacific Islands Tree Seed Centre (PITSC) managed by the Centre for Pacific Crops and Trees based in Fiji. The centre will facilitate the safe supply and exchange of genetic material from woody plants between Pacific communities and nations, enabling them to conserve and use their forest resources in a sustainable way.

Recently, ATSC began a training program through which PITSC staff will spend time in Australia, learning how to document and store seed and about biosecurity aspects of seed store management. A course in seed technology is also being developed for government staff and industry representatives in six Pacific countries. PITSC ultimately aims to become an information hub for tree-seed technology in the Pacific.

Genes for growth

Almost 150 million hectares of native forest and 2 million hectares of forestry plantations cover about 19 per cent of the Australian continent.

In a project dubbed ‘Blue Gum Genomics’, a CSIRO forestry research team is searching for genetic markers to make plantation forestry more sustainable and productive.

Led by CSIRO Plant Industry scientist Dr Simon Southerton, the project is an extension of the ‘Hottest 100’ project, in which CSIRO collaborated with Gunns Ltd, Forestry Tasmania and Forest and Wood Products Australia (FWPA) to identify molecular markers associated with tree pulp yield and growth rate.

Tree breeders are using the markers identified through the Hottest 100 project to substantially increase the speed and intensity of the breeding process.

Credit: Dean Williams

‘With just six markers, we have shown that we can increase pulp yield by over two per cent and growth rate by 10 per cent,’ says Dr Southerton.

‘This will translate into a large increase in plantation productivity, as millions of tonnes of pulp are produced globally each year from eucalypt plantations. Less land and resources will be required to produce the same amount of pulp.’

After studying variation in around 100 genes from shining gum (*Eucalyptus nitens*), CSIRO scientists in the Hottest 100 project identified 11 molecular markers associated with pulp yield. In the new project, jointly funded by the CSIRO, FWPA and four forestry companies, the team is applying new genomic technology to examine variation in more than 1000 genes from Australia’s major plantation eucalypts – shining gum and blue gum (*E. globulus*).

‘We are confident that in the Blue Gum Genomics project, we will identify more molecular markers that will enable tree breeders to breed trees with pulp yields of over 60 per cent,’ says Dr Southerton.

‘We are also seeking to identify markers for selecting plantation trees that produce better-quality sawn timber. The findings of this research will make plantations much more profitable and help reduce our reliance on native forests.’

Fire and forest ecosystems

With the size, intensity and frequency of large bushfires predicted to increase under climate change, understanding bushfire behaviour and mitigation has never been more important.

CSIRO has become a world leader in research aimed at understanding and predicting fire behaviour and informing mitigation strategies. Its 25-metre-long ‘L’ shaped wind and fire tunnel – known as the CSIRO Pyrotron – enables researchers to study the chemistry of combustion and behaviour of bushfires under a range of simulated environmental conditions. The Pyrotron is unique in Australia and one of only two in the world.

As well as filming fires, researchers use sensors inside the tunnel to study fire behaviour in grasses, forest leaf litter and small logs. The Pyrotron is providing better information about emissions under different burning conditions, as well as the amount of carbon sequestered through charcoal formation.

Credit: CSIRO

CSIRO researchers are also developing a National Fire Behaviour Prediction System to provide managers with better models for simulating bushfire scenarios, and implementing prescribed burning, suppression, risk and biodiversity management programs.[2]

The prediction system consists of four primary components: fuel models, fuel moisture models, wind models and fire behaviour models. The fire behaviour models predict fire characteristics such as the rate of spread, flame height, fireline intensity and onset of crowning/spotting potential.

The system is designed to predict bushfire behaviour in Australia's main fuel types: eucalyptus forests, exotic pine plantations, grasslands, shrublands and Mallee heath. Importantly, the system will enable more accurate simulations of the impact of different climate change scenarios on fire risk.

Sustainable forestry in the developing world

Australian trees such as acacia, casuarina and eucalyptus constitute about two-thirds of tree plantations in India, where they are an important resource to meet the country's fuel, pulp and environmental needs.

Fifteen years ago, CSIRO and the Institute of Forest Genetics and Tree Breeding (IFGTB) in India initiated several tree breeding programs to meet the high demand for genetically improved seed while maintaining affordable prices for small-olume tree farmers.

This project is now part of an AusAID-funded program. CSIRO scientists Khongsak Pinyopusarerk, Aljoy Abarquez and David Bush are working with their counterparts from IFGTB and the Forest Department of Tamil Nadu and Puducherry to find ways of encouraging local farmers to expand their plantations, thus protecting native forests.

The program's main objective is to transfer knowledge and skills to these farmers, enabling them to take over full management of the two seed production hubs by the project's end.

Credit: W. van Aken/ScienceImage

This work is supporting India's efforts to address local timber demand, protect native forests, improve household income of local communities and address the impacts of climate change.

CSIRO scientists are also assisting South-East Asian countries to develop sustainable forestry practice.

1 This research comes under the umbrella of Australian Climate Change Science Program, funded jointly by the Department of Climate Change and Energy Efficiency, the Bureau of Meteorology and CSIRO.

2 This work is conducted in partnership with state land management agencies, rural fire authorities and the Bushfire Cooperative Research Centre.

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