EXECUTIVE SUMMARY

Leaves: *E. delegatensis*, Bago State Forest, southern NSW. Photo: Claudia Keitel.

E. nitens, Erinundra, East Gippsland (620 t C ha^{-1} of biomass carbon). Photo: Ern Mainka.

THE INTERNATIONAL COMMUNITY HAS NOW RECOGNIZED THE NEED FOR REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION (REDD) AS A VITAL COMPONENT OF A COMPREHENSIVE SOLUTION TO THE CLIMATE CHANGE PROBLEM.

Only since the 2007 United Nations Climate Change Conference in Bali (UNFCCC CoP 13) have international negotiations focused on the role of natural forests in storing carbon.

The Intergovernmental Panel on Climate Change (IPCC) has identified the need for forest-based mitigation analyses that account for natural variability, that use primary data and that provide reliable baseline carbon accounts. In response, we are conducting a series of investigations into the carbon stocks of intact natural forests over large geographical areas, inclusive of environmental factors operating at landscape and regional scales. We are also considering the carbon impacts of land-use activities, including commercial logging. The key question we are asking in our research is 'How much carbon can natural forests store when undisturbed by intensive human land-use activity?'

This report presents a summary of results from case studies in the eucalypt forests of south-eastern Australia. We use these results to frame a discussion of REDD and we make policy recommendations to help promote a scientific understanding of the role of natural forests in the global carbon cycle and in solving the climate change problem.

IN UNDERSTANDING THE ROLE OF NATURAL FORESTS IN THE GLOBAL CARBON CYCLE, AND CLIMATE CHANGE MITIGATION POLICIES, THE COLOUR OF CARBON MATTERS.

It is the biological, ecological and evolutionary dimension that distinguishes the 'green' carbon in natural forests from the 'brown' carbon of industrialized forests, especially monoculture plantations. Drawing on the same poetic licence, we refer to the inorganic carbon in the atmosphere (carbon dioxide) and the oceans (carbonate) as 'blue' carbon.

Natural forests are more resilient to climate change and disturbances than plantations because of their genetic, taxonomic and functional biodiversity. This resilience includes regeneration after fire, resistance to and recovery from pests and diseases, and adaptation to changes in radiation, temperature and water availability (including those resulting from global climate change). While the genetic and taxonomic composition of forest ecosystems changes over time, natural forests will continue to take up and store carbon as long as there is adequate water and solar radiation for photosynthesis.

The green carbon in natural forests is stored in a more reliable stock than that in industrialized forests, especially over ecological time scales. Carbon stored in industrialized forests has a greater

susceptibility to loss than that stored in natural forests. Industrialized forests, particularly plantations, have reduced genetic diversity and structural complexity, and therefore reduced resilience to pests, diseases and changing climatic conditions.

The carbon stock of forests subject to commercial logging, and of monoculture plantations in particular, will always be significantly less on average (~40 to 60 per cent depending on the intensity of land use and forest type) than the carbon stock of natural, undisturbed forests. The rate of carbon fixation by young regenerating stands is high, but this does not compensate for the smaller carbon pools in the younger-aged stands of industrialized forests compared with those of natural forests. Carbon accounts for industrialized forests must include the carbon emissions associated with land use and associated management, transportation and processing activities.

AUSTRALIAN NATURAL FORESTS HAVE FAR LARGER CARBON STOCKS THAN IS RECOGNIZED.

Our analyses showed that the stock of carbon for intact natural forests in south-eastern Australia was about 640 t C ha^{-1} of total carbon (biomass plus soil, with a standard deviation of 383), with 360 t C ha^{-1} of biomass carbon (living plus dead biomass, with a standard deviation of 277). The average net primary productivity (NPP) of these natural forests was 12 t C ha^{-1} yr^{-1} (with a standard deviation of 1.8). The highest biomass carbon stocks, with an average of more than 1200 t C ha^{-1} and maximum of over 2000 t C ha^{-1}, are in the mountain ash (*Eucalyptus regnans*) forest in the Central Highlands of Victoria and Tasmania. This is cool temperate evergreen forest with a tall eucalypt overstorey and dense *Acacia* spp. and temperate-rainforest tree understorey.

CARBON-ACCOUNTING MODELS MUST BE CAREFULLY CALIBRATED WITH APPROPRIATE ECOLOGICAL FIELD DATA IN ORDER TO GENERATE RELIABLE ESTIMATES FOR NATURAL FORESTS.

Access to appropriate ecological field data is critical for accurate carbon accounting in natural forests, as otherwise erroneous values will be generated. Models must be designed and calibrated to reflect the fact that the carbon dynamics of natural forests are significantly different to those of industrialized forests, especially monoculture plantations. Among other things, the carbon in natural forests has a longer residence time. We demonstrated this point by comparing our data with values of forest carbon accounts calculated from two commonly referenced sources.

In terms of global biomes, Australian forests are classified as temperate forests. The IPCC default values for temperate forests are a carbon stock of 217 t C ha^{-1} of total carbon, 96 t C ha^{-1} of biomass carbon, and a NPP of 7 t C ha^{-1} yr^{-1}. The IPCC default values for total carbon are approximately one-third, and for biomass

carbon approximately one-quarter that of the average values for south-eastern Australian eucalypt forests, and one-twentieth of the most biomass carbon dense eucalypt forests. We calculate the total stock of carbon that can be stored in the 14.5 million ha of eucalypt forest in our study region is 9.3 Gt[(1)], if it is undisturbed by intensive human land-use activities; applying the IPCC default values would give only 3.1 Gt.

The difference in carbon stocks between our estimates and the IPCC default values is the result of us using local data collected from natural forests not disturbed by logging. Our estimates therefore reflect the *carbon carrying capacity* of the natural forests. In heavily disturbed forests, the current carbon stocks reflect land-use history. The difference between the two is called the '*carbon sequestration potential*'—the maximum carbon stock that can be sequestered as the forest re-grows.

We also tested the Australian Government's National Carbon Accounting System (NCAS) (Australian Greenhouse Office 2007a) and found it underestimated the carbon carrying capacity of natural forests with high biomass stocks. NCAS was designed to model biomass growth in plantations and afforestation/reforestation projects using native plantings. The empirically based functions within NCAS were calibrated using data appropriate for that purpose. But, this meant that NCAS was unable to accurately estimate the carbon carrying capacity of carbon dense natural forests in south eastern Australia. However, the kinds of field data used in our study could be used to recalibrate NCAS so that it can generate reliable estimates of biomass carbon in these forests.

THE REMAINING INTACT NATURAL FORESTS CONSTITUTE A SIGNIFICANT STANDING STOCK OF CARBON THAT SHOULD BE PROTECTED FROM CARBON EMITTING LAND-USE ACTIVITIES.

THERE IS SUBSTANTIAL POTENTIAL FOR CARBON SEQUESTRATION IN FOREST AREAS THAT HAVE BEEN LOGGED IF THEY ARE ALLOWED TO RE-GROW UNDISTURBED BY FURTHER INTENSIVE HUMAN LAND-USE ACTIVITIES.

Our analysis shows that in the 14.5 million ha of eucalypt forests in south-eastern Australia, the effect of retaining the current carbon stock (equivalent to 25.5 Gt CO_2 (carbon dioxide)) is equivalent to avoided emissions of 460 Mt[(2)] CO_2 yr^{-1} for the next 100 years. Allowing logged forests to realize their sequestration potential to store 7.5 Gt CO_2 is equivalent to avoiding emissions of 136 Mt CO_2 yr^{-1} for the next 100 years. This is equal to 24 per cent of the 2005 Australian net greenhouse gas emissions across all sectors; which were 559 Mt CO_2 in that year.

1 Gigatonne (Gt) equals one billion or 1.0 x 10^9 tonnes.

2 Megatonne (Mt) equals one million or 1.0 x 10^6 tonnes

If, however, all the carbon currently stored in the 14.5 million ha of eucalypt forest in south-eastern Australia was released into the atmosphere it would raise the global concentration of carbon dioxide by 3.3 parts per million by volume (ppmv). This is a globally significant amount of carbon dioxide; since 1750 AD, the concentration of carbon dioxide in the atmosphere has increased by some 97 ppmv.

REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION (REDD) IS IMPORTANT IN ALL FOREST BIOMES — BOREAL, TROPICAL AND TEMPERATE — AND IN ECONOMICALLY DEVELOPED AS WELL AS DEVELOPING COUNTRIES.

From a scientific perspective, green carbon accounting and protection of the natural forests in all nations should become part of a comprehensive approach to solving the climate change problem. Current international negotiations are focussed on reducing emissions from deforestation and forest degradation in developing countries only. However, REDD is also important in the natural forests of countries such as Australia, Canada, the Russian Federation, and the USA.

Part of the ongoing international climate change negotiations involves debate on the technical definition of key terms. 'Forest degradation' should be defined to include the impacts of any human land-use activity that reduces the carbon stocks of a forested landscape relative to its natural carbon carrying capacity. The definition of 'forest' should also be revised to recognize the differences between the ecological characteristics of natural forests and industrialized forests, especially plantations. These differences include the higher biodiversity, ecosystem resilience, and carbon residence time of natural forests.

E. regnans, Dandenong Ranges National Park, Victoria (900 t C ha^{-1} of biomass carbon). Photo: Sandra Berry.