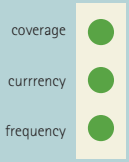

Forest biomass and carbon stocks

Indicator 5.1a

Total forest ecosystem biomass and carbon pool and, if appropriate, reported by forest type, age class, and successional stages

Rationale

Estimates of total forest biomass allow changes in total carbon pool over time to be assessed. Estimation by forest type and age class allows better understanding of these changes.

Estimated total biomass in Australian forests, including above-ground biomass, roots and the forest floor, is 23 400 million tonnes (Mt or 10^{12} grams). Estimated total mass of carbon, excluding soil carbon, is 10 500 Mt. About 0.8 per cent of the total biomass is in plantations and the remainder is in native forest. Eucalypt woodlands account for 46 per cent of total biomass and carbon stock.

Forests are an important component of the global carbon cycle, and forest carbon stocks are a key indicator of sustainable forest management at the national level.

Forests account for almost 60 per cent of the carbon that exists in the vegetation and soils of the earth's land surface. International concern about the effects on climate of increased atmospheric concentrations of greenhouse gases such as carbon dioxide has focused policy attention on the dynamics of carbon in terrestrial vegetation and soils. Forests absorb carbon dioxide (CO_2) from the atmosphere during photosynthesis and release it during respiration and the decay of dead plant material. Forests remove CO_2 from the atmosphere and store the carbon in woody tissue when actively growing. The rate of carbon absorption and hence the magnitude of the carbon sink, is greatest in the earliest stages of regeneration and declines as forests mature.

The amount of carbon stored in forests can change over time because of:

- natural variation in climatic factors such as temperature and rainfall;
- the natural developmental or successional dynamics of vegetation; or
- disturbances such as fires, storms, or pest and disease outbreaks.

Forest management activities such as timber harvesting, site preparation and fire management also influence the uptake and release of greenhouse gases.

On balance, global terrestrial ecosystems—mainly forests—have been a comparatively small net source of carbon over the past 300 years. Between 1850 and 1990, an estimated 212 000 Mt of carbon was emitted to the atmosphere from fossil fuel combustion and 121 000 Mt of carbon from forest clearing. About 82 000 Mt of carbon was removed from the atmosphere in regrowth, resulting in an estimated net source from forests over this period of 39 000 Mt.

Total forest carbon stock in Australia is estimated to be 10 500 Mt (Table 69). Almost all (99.2 per cent) of total carbon stock is in native forests. Estimates of above-ground, below-ground and forest floor biomass were provided by the Australian Greenhouse Office (AGO) using data and methods from the National Carbon Accounting System (Australian Greenhouse

Office, 2002). Estimates are provided for areas meeting Australia's definition of forest (greater than 20 per cent canopy cover and greater than 2 metres tall) and are presented by forest classes in the National Vegetation Information System, which differ slightly from those used by the National Forest Inventory. The forest area base for these estimates differs from other parts of the report because of different technical approaches to assessing forest extent such as differences in the scale of mapping used by the AGO.

Only values with high level of certainty are included in the analysis, providing a conservative estimate of the extent of forest and amounts of biomass. The total is less than the estimate in the 1998 State of the Forests Report. The estimate of plantation carbon stock is lower because in this report each age class was estimated separately assuming different average rates of carbon accumulation for hardwood and softwood plantations. They are considered to underestimate total biomass.

Table 69: National forest type by area and carbon biomass

Major Vegetation Group	Above Ground Biomass (MtDM)	Root Biomass (MtDM)	Forest Floor Biomass (MtDM)	Total Biomass (MtDM)	Total Carbon (MtC)
Rainforest and Vine Thickets	844	84	403	1 331	599
Eucalyptus Tall Open Forest	670	94	429	1 193	537
Eucalyptus Open Forest	4 091	1 841	1 853	7 785	3 503
Eucalyptus Low Open Forest	35	16	14	64	29
Eucalyptus Woodland	3 206	1 315	851	5 372	2 417
Tropical Eucalyptus Woodland/Grassland	1 242	509	378	2 130	958
Acacia Forest and Woodland	445	200	300	945	425
Callitris Forest and Woodland	66	30	24	119	54
Casuarina Forest and Woodland	33	15	24	72	32
Melaleuca Forest and Woodland	311	140	76	526	237
Mallee Woodland and Shrubland	311	298	73	682	307
Low Closed Forest and Closed Shrubland	60	57	4	121	54
Other Forest and Woodlands	1 512	916	477	2 905	1 307
Total Native Forest	12 824	5 515	4 905	23 244	10 460
Softwood Plantation	82	57	3	142	71
Hardwood Plantation	23	9	1	33	17
Total Plantation	105	66	4	176	88
Total Forest	12 929	5 581	4 909	23 420	10 548

Source: Australian Greenhouse Office (2003)

In order to reduce CO_2 emissions, the forests from which wood is harvested need to be managed so as to maintain total forest carbon stocks. That is, these forests need to be regenerated following harvesting and left to grow long enough to reach previous levels of carbon stock. Removing trees for wood products from forests with a high carbon stock and replacing them with regrowth forests may result in a temporary loss of carbon stock in the forest, and a reduction in the overall stock in forests and products.

Estimates of total biomass and carbon stock remain uncertain. The National Carbon Accounting System was established by the Commonwealth Government, primarily to reduce

uncertainties in reporting greenhouse gas emissions from land use change and forestry. This initiative, while still continuing to develop, has significantly reduced reporting uncertainties in carbon stocks and emissions estimates through a variety of field studies, data synthesis and modelling processes, with field verification supporting the accuracy of approaches.

Further reading

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Long term carbon storgage in a decaying tree

Forest contribution to the carbon budget

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Indicator 5.1b

Contribution of forest ecosystems to the total global carbon budget, including absorption and release of carbon (standing biomass, coarse woody debris, peat and soil carbon)

Rationale

This indicator provides information on emissions and removals of carbon from forest ecosystems over time for comparison with other land cover types or other sectors of the economy.

Net carbon dioxide (or equivalent) emissions from land-use change and forestry account for about 7 per cent of total national greenhouse gas emissions. The net emissions from this sector are estimated to have declined over the last ten years. There is still considerable uncertainty about estimates of uptake and release of carbon across the forest estate.

Net carbon dioxide equivalent emissions, including emissions of methane, from the 'land-use change and forestry sector' were estimated to be 42.3 million tonnes (Mt) of carbon dioxide equivalents (CO_2-e) in 2000 (Australian Greenhouse Office 2000b). This is about 7 per cent of the net national CO_2-e emissions (Table 70). The category 'changes in forest and other woody biomass stocks' comprises emissions and removals from changes in managed native forests, plantations, commercial harvest, and fuelwood consumption. In 2000, this is estimated to have constituted a net sink of 23.7 Mt CO_2-e. 'Forest and grassland conversion' comprises emissions and removals from deforestation, estimated to be 64.8 Mt CO_2-e in 2000. It includes emissions from the burning and decay of cleared vegetation and from soil disturbed in the clearing process, and removals due to the subsequent regrowth of vegetation.

Table 70: Estimated carbon dioxide emissions and removals from Australian forests

	Carbon dioxide (CO_2) equivalent emissions (Mt)			
Greenhouse gas source and sink categories	CO_2	Methane (CH_4)	Nitrogen dioxide (N_2O)	Total
Changes in forest and other woody biomass stocks	-23.7	–	–	-23.7
Forest and grassland conversion	60.8	3.5	0.4	64.8
Non-CO_2 emissions from wildfire and prescribed burning	–	0.9	0.3	1.2
Total				42.2

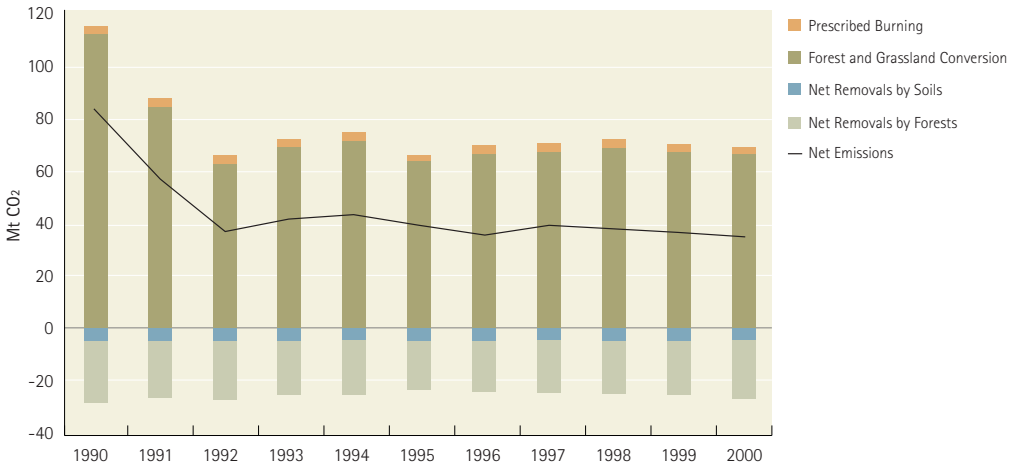
Source: Australian Greenhouse Office (2002)

Note: Does not include CO_2 emissions and removals from agricultural sources

Net carbon dioxide (or equivalent) emissions are estimated to have declined over the last 10 years from 85.9 Mt in 1990 (Figure 46). Figure 47 shows the total CO_2 removals associated with the growth of plantations and managed forests were 77.9 Mt CO_2 in 2000, an increase of 6.6 Mt (9.2 per cent) from 1990.

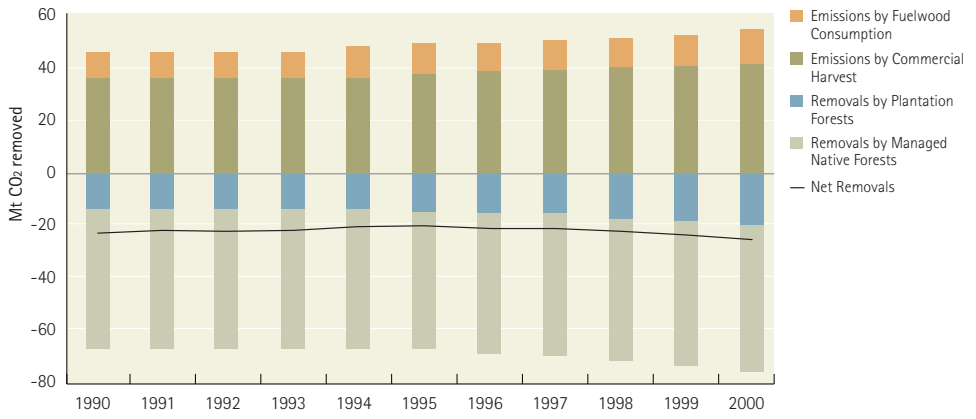
All of the increase occurred after 1994 and was attributed to plantations; CO_2 removals by managed native forests were assumed to be constant. The increase in removals was more than offset by a 7.5 Mt CO_2 increase in emissions from commercial harvesting (17.7 per cent) and fuelwood gathering (10.8 per cent), between 1990 and 2000. Therefore net removals actually declined by 3.6 per cent, from 24.6 Mt CO_2 in 1990 to 23.7 Mt in 2000. Growth in removals by plantations was associated with an increase in the area of plantations. Plantations established since 1990 are estimated to have sequestered approximately 10 Mt of CO_2 in 2000.

Figure 46: Emissions from land-use change and forestry, 1990–2000



Source: Australian Greenhouse Office (2002c)

Figure 47: Carbon dioxide emissions and removals by plantations and managed forests, 1990–2000



Source: Australian Greenhouse Office (2002c)

CSIRO Scientists studying emisssions and uptake of greenhouse gases

Estimating uptake of carbon and emissions in forests is difficult due to inherent uncertainties associated with measuring anthropogenic and natural exchanges of greenhouse gases between the biosphere and the atmosphere. There is currently no comprehensive monitoring system for forests in Australia that covers all forest types and tenures. Areas of continuing high uncertainty include growth rates of privately managed forests and native forests that are managed either for commercial harvest or fuelwood gathering. The area of forest that is actually managed for wood production is also uncertain.

The estimates included here are based on a relatively small proportion (9 per cent) of the total area of native forests that included all known-age multiple-use forests and forests available for timber production on other Crown land and Private land. The focus on emission estimation to date by the National Carbon Accounting System has been on areas of deforestation and plantation establishment. Over the coming period the available information will be supplemented and analysed to provide more certain estimates of carbon stock changes in native forest across all forest tenures (Australian Greenhouse Office, 1999). They do not include forest in nature conservation reserves and exclude some public forest and large areas of privately managed forests that are currently used, or have been used in the past, for timber production or that have been subjected to other forms of anthropogenic disturbance likely to affect carbon stocks and fluxes. The fluxes of soil carbon under land-use change are also uncertain, and are subject to ongoing research by the CRC for Greenhouse Accounting and other groups.

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Forest products and the global carbon budget

Indicator 5.1c

Contribution of forest products to the global carbon budget

Rationale

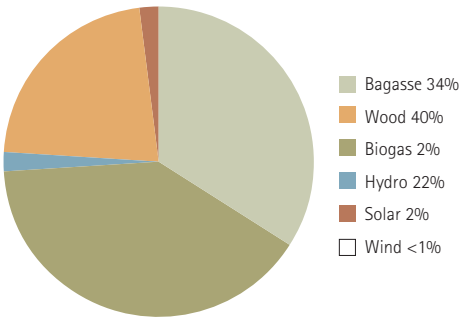
This indicator provides information on the amount of carbon stored in wood products and the extent to which use of wood products is reducing or increasing atmospheric carbon dioxide concentration.

Initial studies indicate that the carbon stock in wood products, including imports, in Australia was 69 million tonnes (Mt) in 1998 and is currently increasing by about 0.4–0.5 Mt per year.

A considerable proportion of the carbon in forests is contained in the woody trunks of trees. When trees are harvested and converted to wood products, carbon remains stored in these products for varying lengths of time depending on the nature of the product and the means of its disposal.

The generation of energy by burning firewood or processing waste from sustainably managed native forests and plantations—often called biomass energy or bioenergy—may replace energy generated from fossil fuels and result in an overall reduction in emissions of carbon dioxide to the atmosphere. It is estimated that in 2000–2001 wood supplied 40 per cent of Australia's renewable energy (Figure 48), or 2.1 per cent of the total energy supply. This could increase under the Australian Government Mandatory Renewable Energy Target of 9 500 gigawatt hours of extra renewable electricity per year by 2010.

Figure 48: Australian renewable energy use in 2000-2001



Source: ABARE (2003)

For this indicator, estimates of carbon stocks in wood products were derived from studies undertaken for the Australian Greenhouse Office National Carbon Accounting System, which were based on national forest product statistics. Estimates of decay of different product classes were derived from industry surveys and published literature.

Accounting for carbon in wood products is complicated by the fact that products are traded internationally. Australia imported about 1.64 Mt of wood products (mainly paper) in 1998,

with an estimated carbon mass of 0.82 Mt, and exported 4.48 Mt of mainly hardwood and softwood woodchips with an estimated carbon mass of 2.24 Mt. The total estimated carbon stock of 69.2 Mt in 1998 includes products made from imported wood products and wood removed from Australian forests that remains here.

The estimated stock in wood products is only a small proportion (0.2 per cent) of the estimated stock in forests. About 80 per cent of the wood products stock is in the long-lived pool that is assumed to take 90 years to decay (Table 71). Carbon stock in wood products in Australia is currently increasing by about 0.4–0.5 Mt per year (Figure 49), although this rate has decreased from previous years.

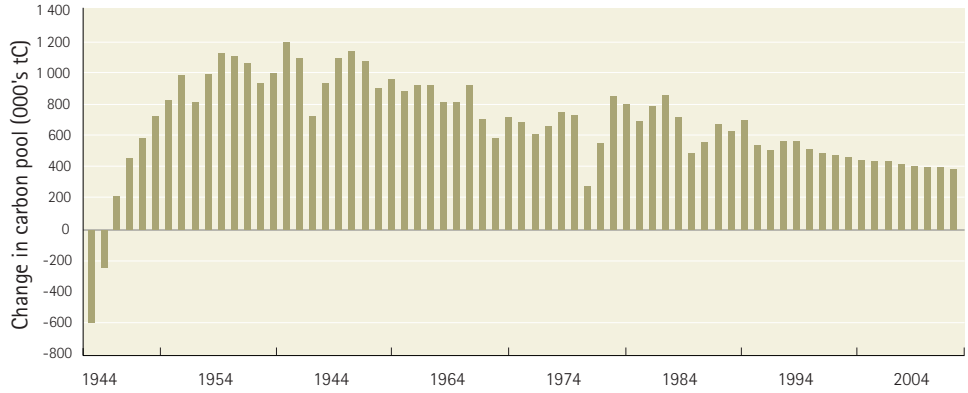
Table 71: Estimates of carbon stocks in different product pools based on historical production data

Product pool	Assumed years to decay	Estimated carbon stock (Mt)
Softwood pallets, cases, plywood form board, paper and paper products	3	5.2
Hardwood pallets, palings, particle and fibre board used in shop-fitting and DIY, and hardboard packaging	10	1.0
Plywood, particle and fibre board in kitchens and bathrooms	30	4.5
Preservative treated pine, softwood furniture and hardwood poles, piles and girders	50	2.8
Softwood and hardwood framing, flooring lining and furniture timber particle and fibre board used for flooring and lining	90	55.7
Total		69.2

Source: Jaako Poyry Consulting (2000)

Note: This includes carbon in products produced from Australian forests and imported

Figure 49: Estimated annual change in carbon stocks in wood products in Australia since 1944



Source: Jaako Poyry Consulting (2000)

Estimates of energy use reported here are considered accurate. However, estimates of carbon stocks in wood products are regarded as preliminary. They are based on relatively untested assumptions about the average service life and decay rates post service of different wood products such as sawn timber, panelboard, plywood and pulp and paper products. Further research to determine the carbon concentration of different timber species is ongoing, and work on improved estimates of the lifespan of different timber products and to investigate

the fate of wood products after disposal is also progressing in collaboration between the CRC for Greenhouse Accounting and the National Carbon Accounting System. For example, initial studies suggest that wood and paper products disposed of in closed landfills have decomposed little after many years.

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Long-term carbon storage in furniture