Carbon balance of NSW forests

This note summarises updated outputs from independent analysis of the carbon balance of NSW forests. This work was led by the Mullion Group with the support of the CSIRO and the NSW Department of Primary Industries as part of the NSW Forest Monitoring and Improvement Program.

A team of leading carbon accounting experts were engaged to quantify the carbon balance of NSW forests, and how they have changed in the past. The team delivered an initial assessment in 2022, followed by an updated assessment in 2023 by the Mullion Group that capitalised on new data and improved methods.

The outcomes of this project – both the initial and updated assessments – represent a significant advancement in understanding the trends in forest carbon across NSW.

What is the carbon balance of NSW's forests?

Changes in NSW's forest carbon stock over time are shown in **Figure 1**. According to this research, there was a general decline in forest carbon stocks from 1990 through to the mid-2000s, after which stocks increased through to 2019, prior to the fires.

Between 1990 and 2021 NSW forests lost an estimated 165 million tonnes of carbon (tC), with most of this loss due to the 2019-2020 wildfires.

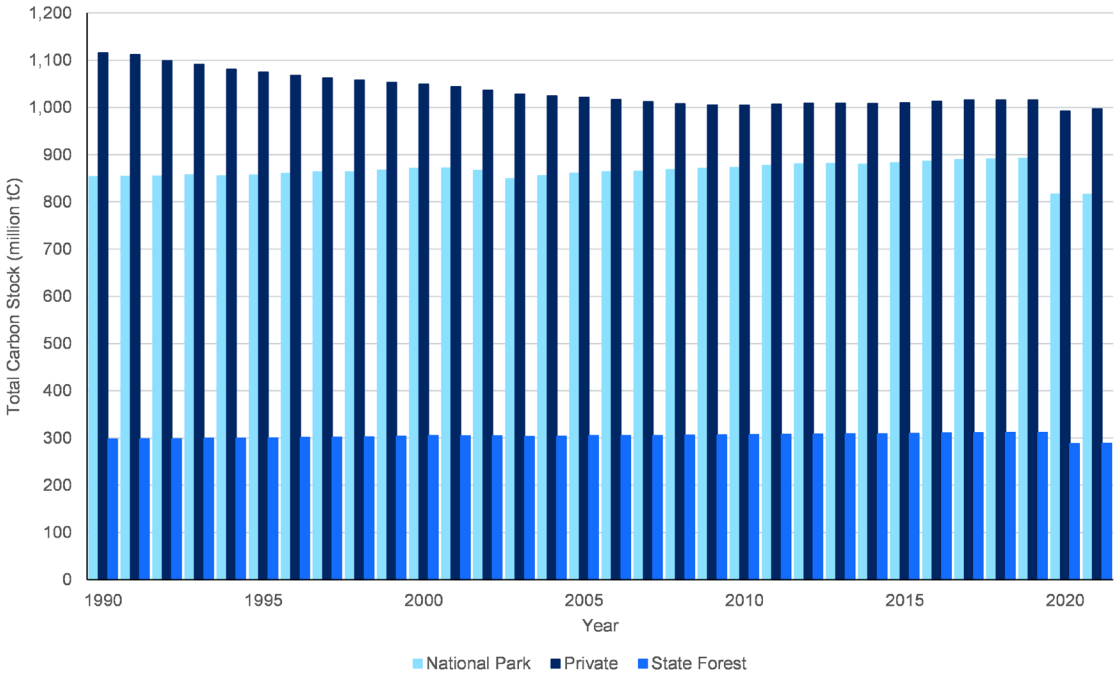

Figure 1: NSW Forest Carbon Stock 1990-2021, including Aboveground Biomass, Belowground Biomass, Dead Organic Matter and Harvested Wood Products in use

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The 2019-20 wildfires were the principal driver of forest carbon loss over the last 30 years. **Figure 2** highlights the magnitude of this disturbance compared with the net gains and losses in other years, as well as the slight increase in stocks in 2021 due to post-fire regrowth.

The total carbon stock of NSW forests at the end of the assessment period (in 2021) was calculated to be 2.1 billion tonnes of carbon (tC), which is 165 million tonnes of carbon (tC) less than the calculated balance in 1990 at the start of the assessment period.

How does the forest carbon balance compare across tenures?

Overall, **Figure 1** and **Figure 2** both highlight that while all tenures have experienced gains and losses in forest carbon stock, there have been significant loss events, particularly as a result of fire, as well as a pattern of loss of forest carbon stock on private[1] land prior to 2009. Changes in native vegetation management regulations on private land reduced the area of native forest cleared and led to reduced losses and small net gains in private forest carbon stocks in subsequent years, with the exception of fire related net losses in 2020 (**Figure 3**).

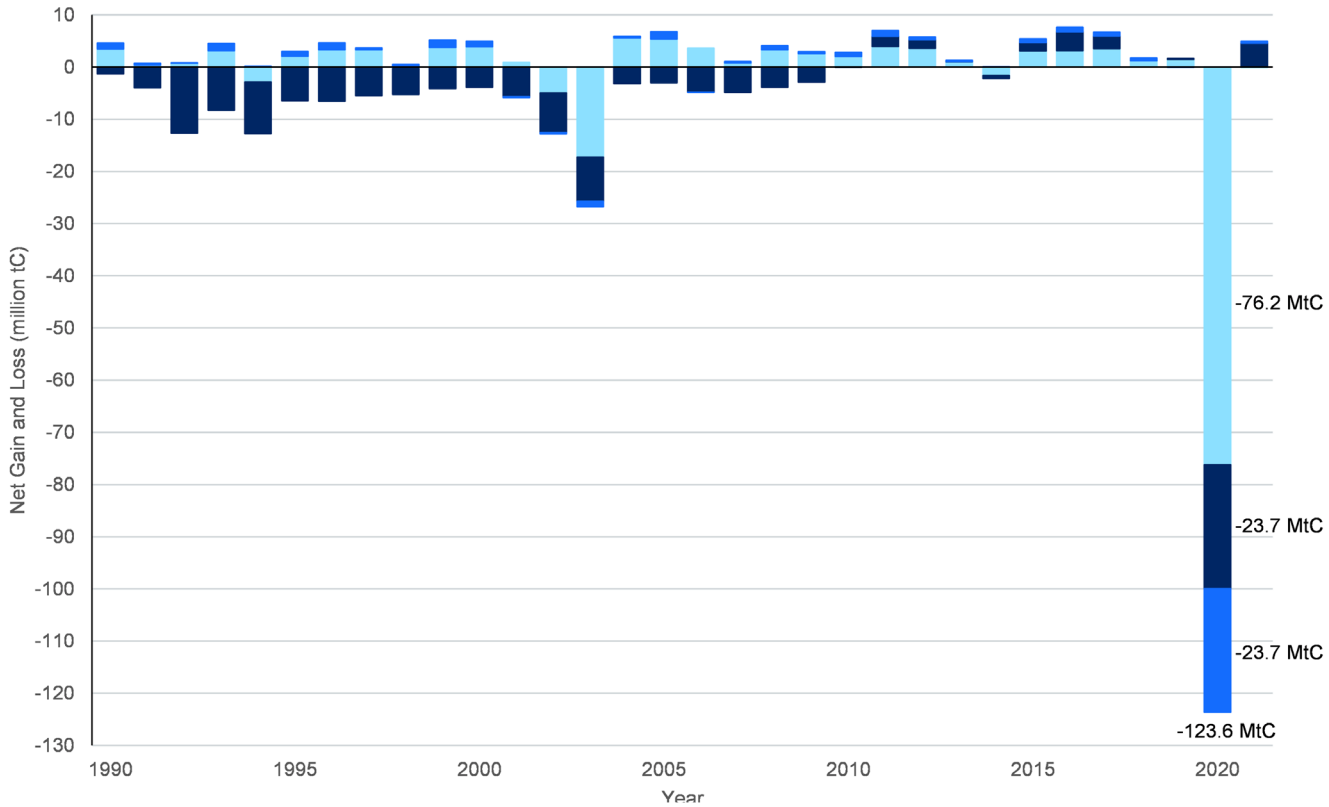

Figure 2: Net gain and loss in Forest Carbon Stock 1990-2021, including aboveground biomass, belowground biomass, dead organic matter and harvested wood products in use

1 Private land category includes small areas of forest on other tenures (e.g. other crown land, Indigenous Protected Areas)

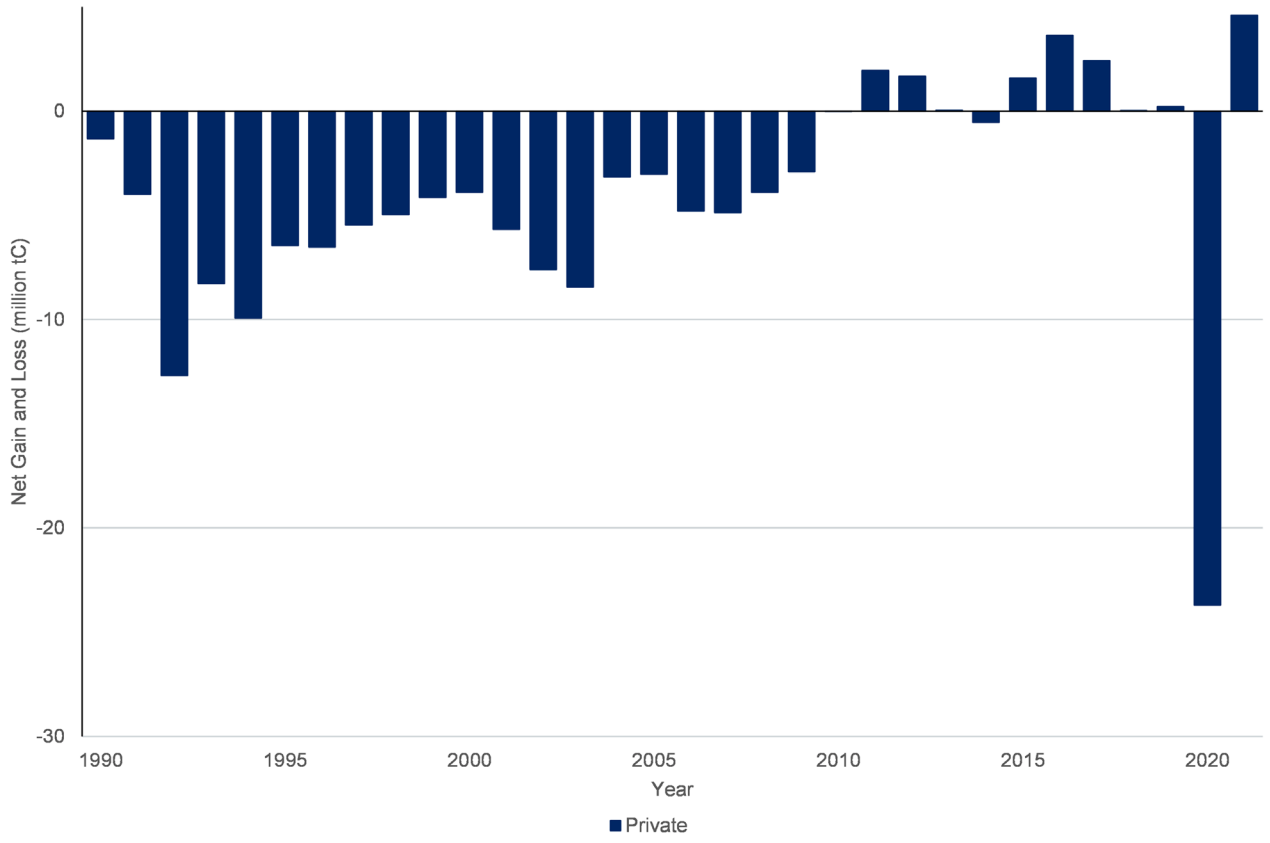

Figure 3: Net gain and loss in native Forest Carbon Stock 1990-2021 on private land, including aboveground biomass, belowground biomass and dead organic matter

What is driving the change?

Carbon stock within NSW forests is subject to change due to both:

- natural disturbances – fire, drought, natural regeneration
- anthropogenic activities – land clearing, reforestation, prescribed fire and timber harvesting[2].

As shown in **Figure 4**, the most significant impacts on NSW forest carbon stocks during the assessment period were from large wildfire events, particularly in 2020[3] (122 million tC loss) but also in 2003 (35 million tC loss) and 2002 (15 million tC loss). During the assessment period, fires also accounted for 69 percent of carbon released to the atmosphere from live biomass and dead organic matter.

2 Fluxes due to timber harvesting include public native forests and all plantations. Data was not available for harvesting in private native forests.

3 Carbon stocks are reported on an annual basis. The change in carbon stocks associated with the 2019/20 wildfires are reported against 2020.

Clearing[4] of forest on private land was the next largest factor driving change in carbon stocks, particularly between 1990 and 2007 when fluxes from live biomass to dead organic matter ranged from 5.75 million tC to a high of over 33 million tC. Trends in the annual change in carbon stocks due to forest clearing on private land decreased after 2009.

Compared with fire and forest clearing on private land, movements of carbon associated with timber harvesting are relatively low (**Figure 4**). Timber harvesting moves carbon from the live biomass pool to the harvested wood products in use pool and to the dead organic matter pool. From here, carbon is slowly released to the atmosphere through decomposition as wood products come to the end of their usable life. At the same time, harvested forests regrow and contribute to net primary productivity.

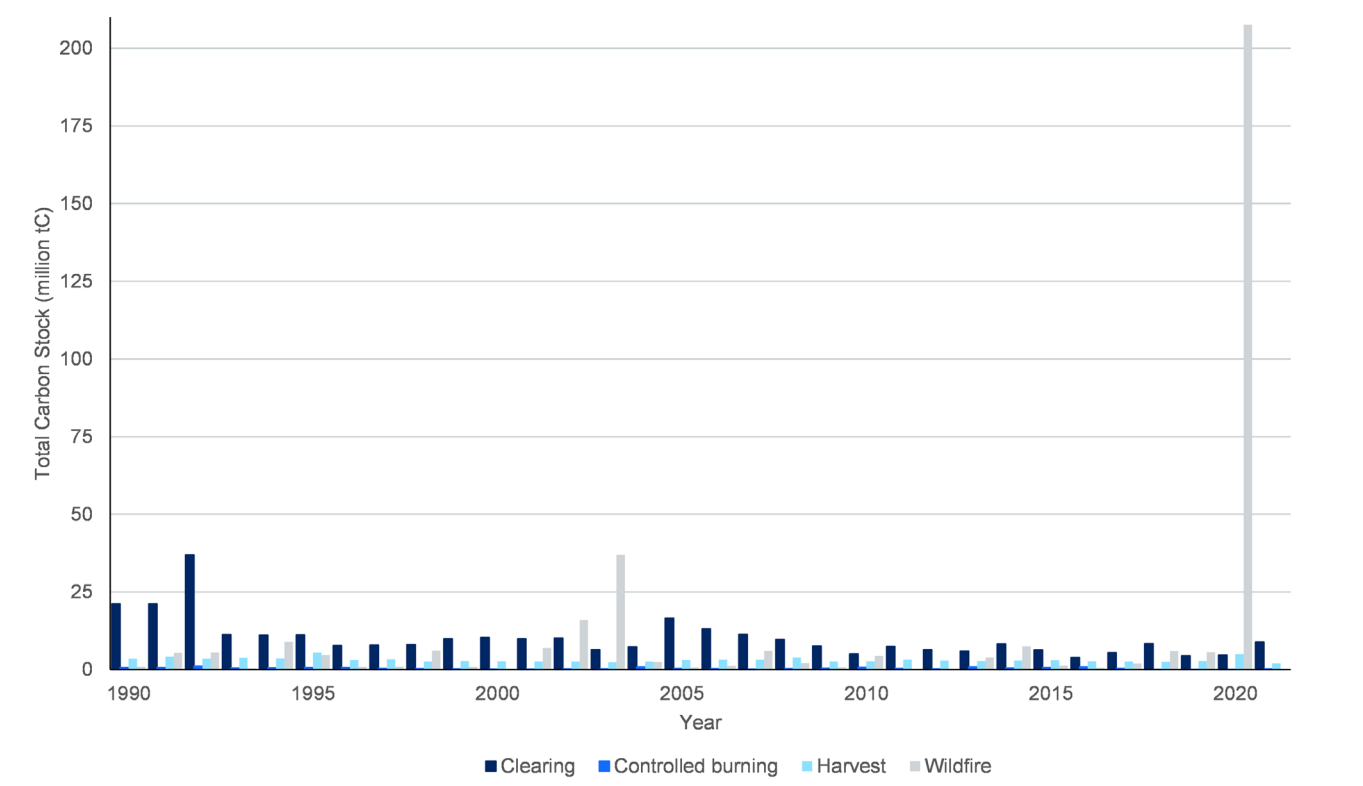

Figure 4: Total carbon fluxes[5] by event type from 1990-2021

4 Forest clearing is the removal of tree cover to a level below the forest threshold (20 percent canopy cover). A 'clearing' event is defined as a forest cover loss detected in the remote sensing product that was not associated with timber harvesting activities or fire. This includes natural (e.g., drought) and human induced changes, as well as any remote sensing omission and commission errors.

5 Carbon flux is the movement of carbon from one carbon pool to another. This does not represent emissions to the atmosphere.

Why was this research undertaken, and how will it be used?

This research aimed to simulate the contribution of NSW forests to regional and global carbon cycles. It also sought to identify opportunities to enhance carbon storage in NSW forests.

The outputs were designed to represent 'what the atmosphere sees', allowing all forest carbon stocks and fluxes to be reported without applying national and international reporting rules that exclude some land uses and carbon fluxes. Using this approach, this research was able to provide more comprehensive and flexible outputs than are available through the State and Territories Greenhouse Gas Inventory (STGGI) for NSW produced by the Commonwealth Department of Climate Change, Energy, the Environment and Water.

The results can be used to identify the location and principal drivers of change in NSW forest carbon stocks to support forest policy and management decision-making.

Who and how was the research undertaken?

Carbon stocks and the movement of carbon between different pools were calculated using FLINTpro, which is a specialised software system that uses models and simulations to assess natural capital, land carbon and greenhouse gas emissions.

The methods and data used were consistent with the approach used for Australia's national greenhouse gas inventory (NGGI), with the addition of improved or NSW-specific data when available. There are limitations to the analysis due to incomplete or missing datasets, particularly for forests outside State Forests and the NSW Reserve system. Better information is particularly needed about forest soil organic carbon, fire severity prior to 2017, private plantations and private land use.

The initial assessment work in 2022 was carried out by a team from the Mullion Group, NSW Department of Primary Industries and the CSIRO. Dr Robert Waterworth, an Intergovernmental Panel on Climate Change (IPCC) author and former Eureka science prize winner, led the work. The updated assessment in 2023 was carried out by a team from the Mullion Group. All of the work was overseen by the NSW Forest Monitoring and Improvement Steering Committee chaired by the Natural Resources Commission with independent experts and agency representatives.

Where to find more information?

Reports detailing the full findings of the carbon balance assessments, as well as further information about the data sources and methodologies used, can be found on the Commission's **website**.

This research was funded under the **NSW Forest Monitoring and Improvement Program**.