Greenhouse gas emissions, flows & stores in a mixed grazing landscape in the New England region of NSW

Lower Apsley River Landcare Group

The Lower Apsley River Landcare Group area encompasses about 16,500 ha just east of Walcha on the Northern Tablelands of NSW.

The principal land use is fine wool production although meat sheep and beef are also produced. The grazing enterprises are supported predominantly by native and sown perennial pastures with occasional fodder cropping.

Formed in 1994, Lower Apsley River Landcare Group has focused its activity on revegetation for shelter and biodiversity and on works to improve the water quality of the river. The group won the NSW Landcare group award for 2007/08.

In 2007, prompted by concern about climate change issues, the group decided to investigate the place of carbon in the landscape. They started by organizing the Walcha Carbon Forum in June 2007 attracting 130 people from across the region. The interest generated encouraged the group to conduct this snapshot carbon study of their area.

Introduction

This brochure summarises the results of a study into greenhouse gas emissions, flows and stores in the landscape of the Lower Apsley River Landcare Group.

The group wanted to better understand greenhouse gas emissions from their farms and how these related to the wider carbon cycle in their landscape.

They were concerned that greenhouse gas emissions from agriculture, particularly the livestock sector, were being represented in a simplistic linear way in the general media.

They also wanted to put the level of agricultural emissions into perspective relative to the amount of carbon cycling and stored in the soils and vegetation of a rural landscape.

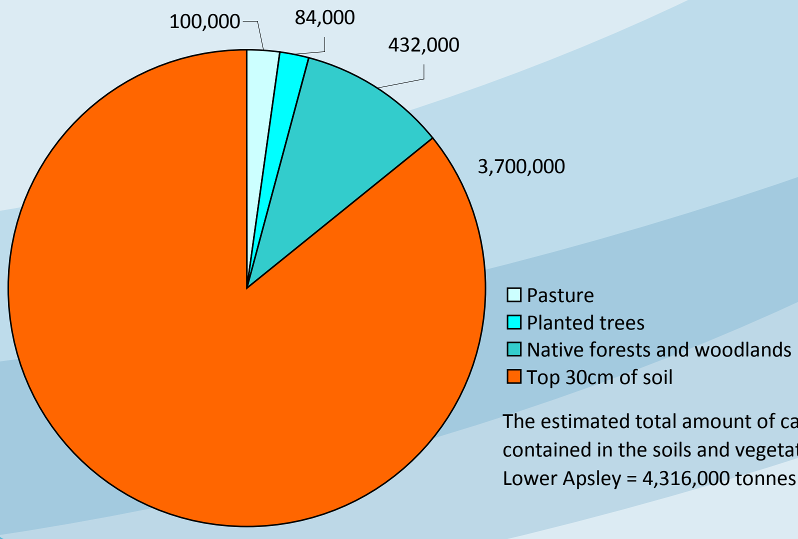
A summary of the methods used in the study occurs on the last page.

Greenhouse gas stores, flows and emissions in the Lower Apsley Landscape

Large amounts of carbon are stored in various parts of the 16,500 ha Lower Apsley landscape. The amounts dwarf the annual emissions attributed to ruminant livestock agriculture.

The soil alone was estimated to contain 3,700,000 tonnes of CO2-e and the native remnant trees a further 432,000 tonnes. Planted trees currently store about 84,000 tonnes and, at any one time, pastures contain about 100,000 tonnes CO_2-e (see Figure 1). Smaller amounts of carbon are contained in livestock, water body sediments and in timber structures and fences, but these were not assessed.

Figure 1. The estimated total amount of carbon (tonnes CO_2-e) contained in the soil and vegetation of the 16,500 ha Lower Apsley River Landcare Group area in 2009.



The estimated total amount of carbon contained in the soils and vegetation of the Lower Apsley = 4,316,000 tonnes of CO_2-e

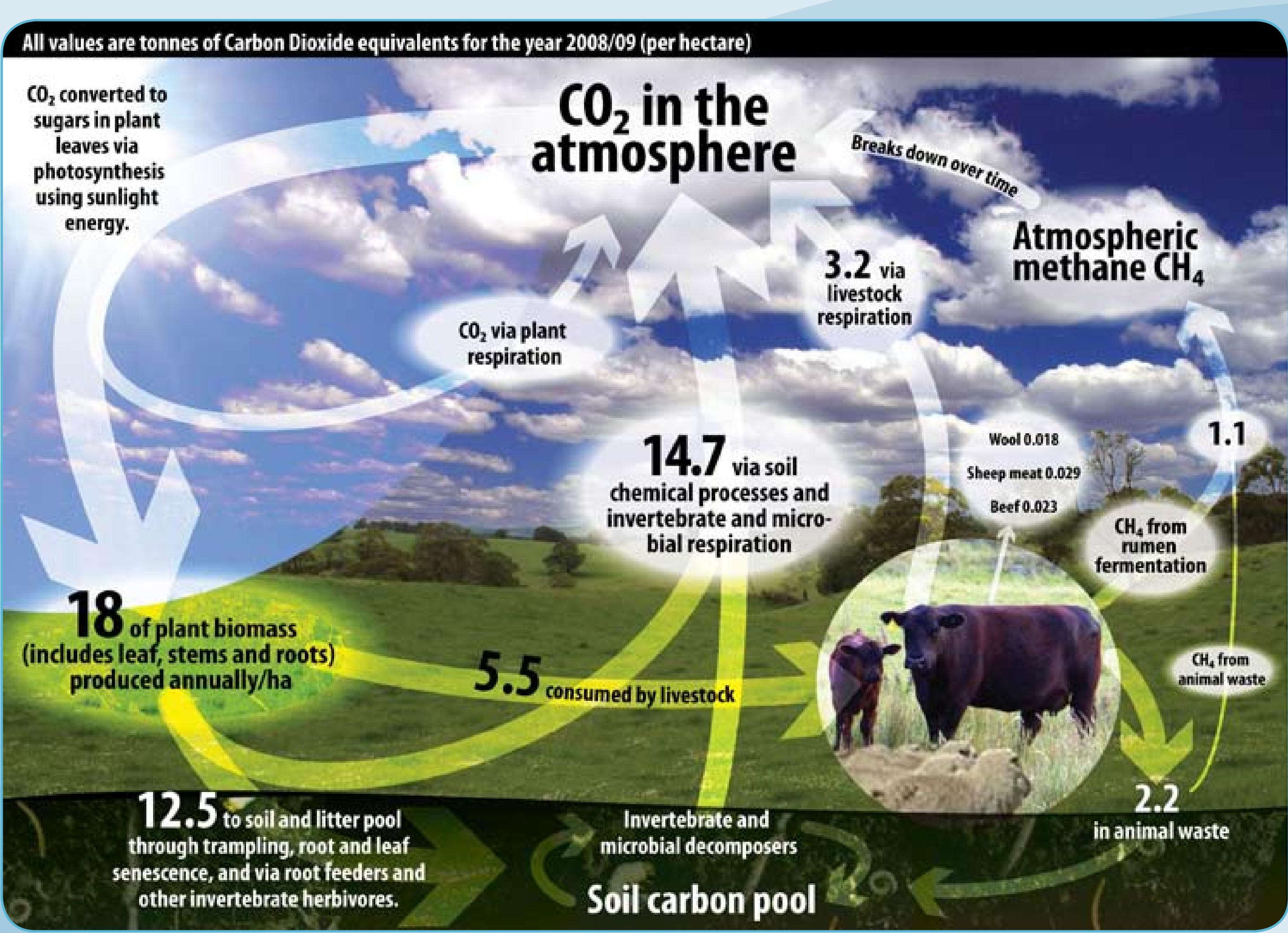


Figure 2. Carbon flows in the atmosphere/pasture/livestock/soil carbon cycle averaged for a hectare of Lower Apsley pasture in 2008/2009.

Pasture plants are not a long-term carbon store

Unlike trees, pasture plants do not form wood and therefore do not hold long term carbon stores. At any one time the amount of carbon held in pasture vegetation varies dramatically according to season and livestock consumption, often changing weekly.

The amount of carbon contained in pasture (shown in Figures 1 and 4) is a very approximate average. In a holistic view of the carbon cycle, pastures are more important in terms of their potential to **fix carbon in the soil** (see Figure 2) rather than the amount of carbon contained within them at any one time.

Flows of carbon through the pasture system are similarly large with an estimated average 18 tonnes CO_2-e of pasture biomass grown, consumed and decomposed annually for every hectare of pasture in the Lower Apsley (see Figure 2).

Methane emissions from ruminant animals form part of the carbon cycle. These emissions totalled an estimated 1.07 tonnes CO_2-e per hectare of pasture for 2008/2009, representing about 6% of the total carbon flows in CO_2-e terms. Methane remains temporarily (about 12 years) in the atmosphere before breaking down and returning to the atmospheric carbon pool for re-use through the green plants of the carbon cycle (see Figure 2).

However, methane emissions were by far the largest compared to all other sources of annual greenhouse emissions (17,600 tonnes CO_2-e for the whole 16,500 ha Lower Apsley in 2008/2009).

Nitrous oxide emissions from nitrogenous fertiliser and animal waste were estimated at 1,720 tonnes CO_2-e for 2008/2009.

Native forests and woodlands occupy about 15% of the Lower Apsley area, planted vegetation occurs on about 2.6%, with open pastures dominating the remainder.

Fossil fuel carbon dioxide emissions from electricity, and petrol/diesel use in vehicles, farm machinery and homesteads totalled an estimated 540 tonnes (see Figure 3).

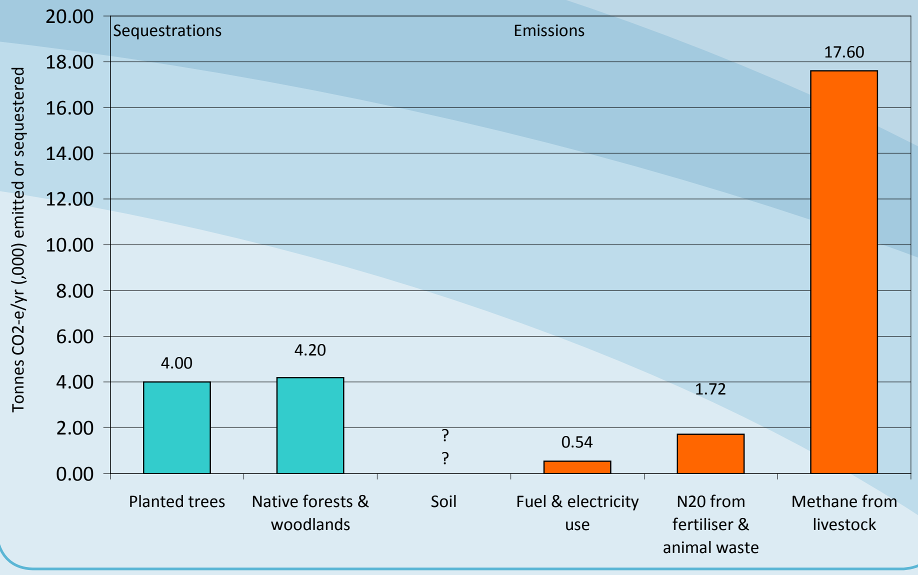
Planted farm trees are currently sequestering about 4,000 tonnes of CO_2-e annually and native vegetation about 4200 tonnes (Figure 3). Collectively annual carbon sequestration in woody vegetation is about 41% of the levels of total annual greenhouse gas emissions.

Although not measured or estimated in this study, potentially large amounts of carbon could be sequestered in the soil of the Lower Apsley. A 0.1 percentage point increase in carbon in the top 30 cm of soil across the 16,500 ha would sequester more than 10 times the total annual emissions from all sources for 2008/2009 (i.e. approximately 200,000 tonnes CO_2-e).

Figure 4 summarises diagrammatically the estimated current carbon stores and flows and the greenhouse gas emissions from various components of the Lower Apsley landscape in 2008/2009.

The figure includes the amount of carbon flowing (cycling) in the pasture system, which was estimated to total 270,000 tonnes CO_2-e.

Figure 3. Estimated total annual greenhouse gas emissions and annual carbon sequestration levels in various features of the 16,500 ha Lower Apsley River Landcare Group area in 2008/09.



While increases in soil carbon in the top 5-10 cm of soil are sometimes reported by farmers, significant changes in land management are often required to achieve even very modest changes over the full 30 cm profile.

The Lower Apsley carried an average of about 8 dry sheep equivalents per hectare in the 2008/2009 season.

Annual agricultural production averaged 12.3 kg of wool, 65 kg of sheep meat and 50 kg of beef per hectare for the Lower Apsley during 2008/2009.

Soil carbon sequestration

The plant - consumer - decomposer pathway is the principal pathway for building soil carbon levels.

In Figure 2, the amount of carbon being returned to the atmosphere, through invertebrate and microbial respiration and soil chemical processes, assumes that the soil carbon pool is in equilibrium (no net gain or loss).

Should the pasture be managed in such a way that soil carbon levels are increasing each year, then CO_2 emissions from invertebrate and microbial respiration and soil chemical processes will be a lower proportion of primary production than that represented on the diagram (i.e. some of the carbon will be fixed in the soil).

Of course the opposite will occur if soil carbon levels are in decline.

Native vegetation: carbon storage high, sequestration rate low

The native forests and woodlands of the Lower Apsley are largely already mature (50 to 150 years old with some older individual trees) and are likely to be close to maximum carbon accumulation. That is, little new net growth is occurring, with young tree growth being balanced with old tree death and decay.

Hence, this vegetation is likely to be sequestering less carbon per hectare compared to the much younger and immature (and therefore more rapidly growing) planted vegetation.

What's CO_2-e?

Figures displayed in this publication for carbon or other greenhouse gases are expressed in carbon dioxide equivalents (CO_2-e).

Different greenhouse gases have different atmospheric warming potentials. Methane is approximately 21 times more potent than carbon dioxide (despite its short lifetime in the atmosphere) and nitrous oxide is more than 300 times more potent when considered over a 100-year period.

This is one of the reasons agricultural emissions are considered so important in national greenhouse gas accounting.

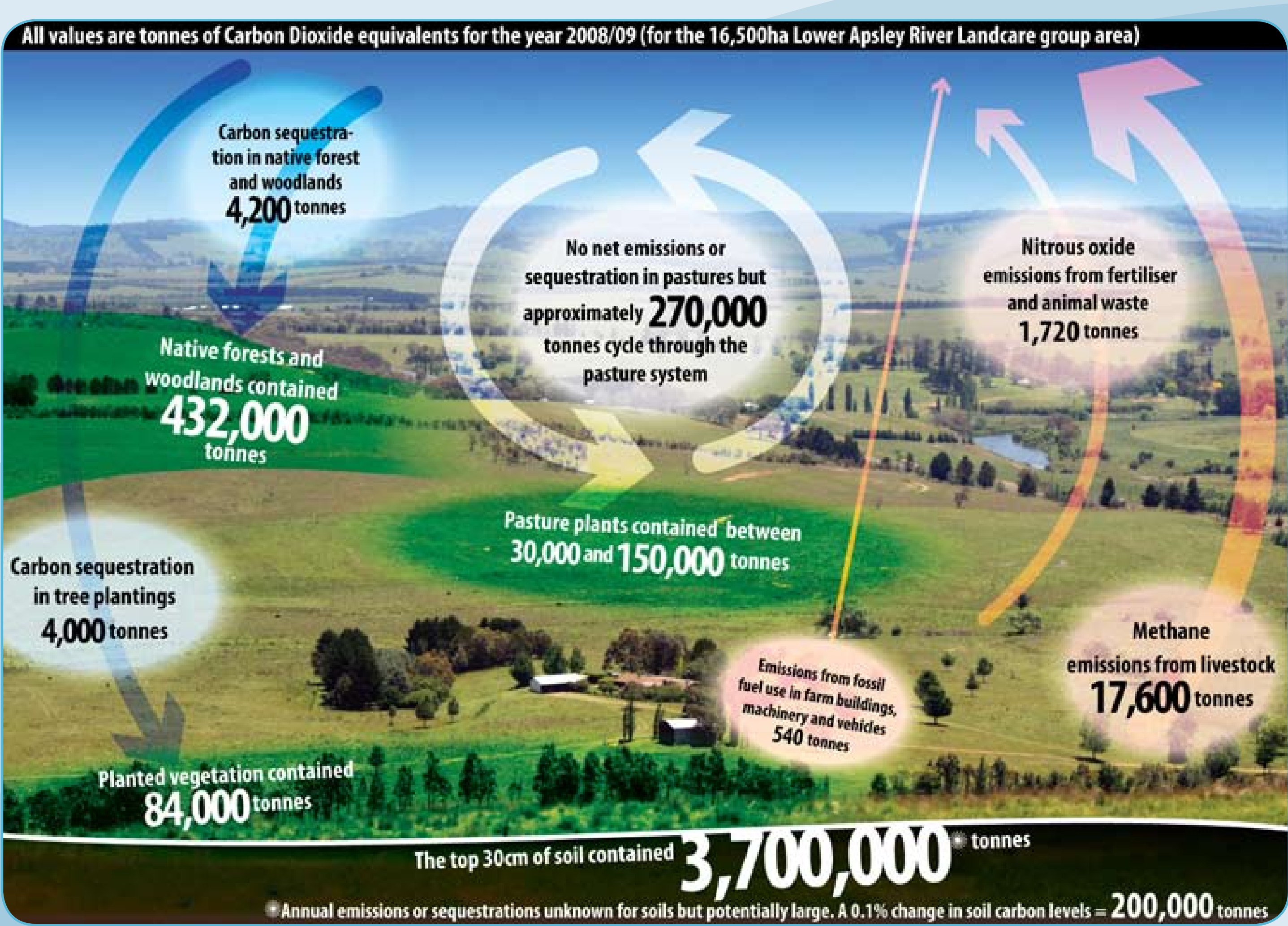


Figure 4. The estimated current carbon stores and flows and the greenhouse gas emissions from various components of the Lower Apsley landscape.

Measurements and estimations used

The study utilised the freely available FarmGAS calculator (The Farm Institute website, 2009) to estimate agricultural emissions (from 8 participating farms over the season 2008/2009).

The FullCAM model (National Carbon Accounting System, Australian Greenhouse Office, 2005) was used to estimate carbon sequestration in planted vegetation.

Age and composition of planted vegetation was available from participating farmer records collected during the 'Decade of Landcare' project (Southern New England Landcare, 2003) with the records updated in 2007.

The carbon stored in natural woody vegetation was estimated by mapping the various vegetation classes using SPOT imagery and sub-sampling them in the field for total biomass (27 sites).

The Carbon Sequestration Predictor (NSW DPI website, 2008) was used to estimate carbon sequestration in the native vegetation.

The carbon content of the soils was estimated by stratifying the landscape into various vegetation/parent material classes and taking representative soil samples to 30 cm depth and having them analysed for total carbon (30 sites).

Fossil fuel-sourced carbon emissions were estimated by fuel and electricity use records kept by participating farmers (8 farms).

The carbon flows in the pasture cycle were estimated by using the data generated from the FarmGAS calculations. Average pasture intake per hectare was derived from the FarmGAS output and converted and partitioned empirically using local expert opinion and known relationships between pasture use, average pasture utilisation rates for New England farms, participating farmer animal production records and estimated animal respiration rates.

Acknowledgements

This brochure was produced by the Lower Apsley River Landcare Group and kindly co-funded by QANTAS.

Special thanks to those who provided support, modelling expertise and key information that made possible many of the calculations and estimations used in this study: Patrick Madden (NSW Department of Industry and Investment), Dr Lewis Kahn (Agricultural Information and Monitoring Services), Dr Sandra Eady (CSIRO), Dr Brian Wilson (NSW Department of Environment, Climate Change and Water), Dr Annette Cowie (National Centre for Rural Greenhouse Gas Research, UNE), Dr Judi Earl (Agricultural Information and Monitoring Services), and Professor Bob Martin (Primary Industries Innovation Centre, UNE).

The project was also supported by Southern New England Landcare, particularly Carina Johnson and Jackie Bowe.

Much of the data collation and field sampling was conducted by members of the Lower Apsley River Landcare Group who were enthusiastically coordinated by their Chairperson, Ross King.