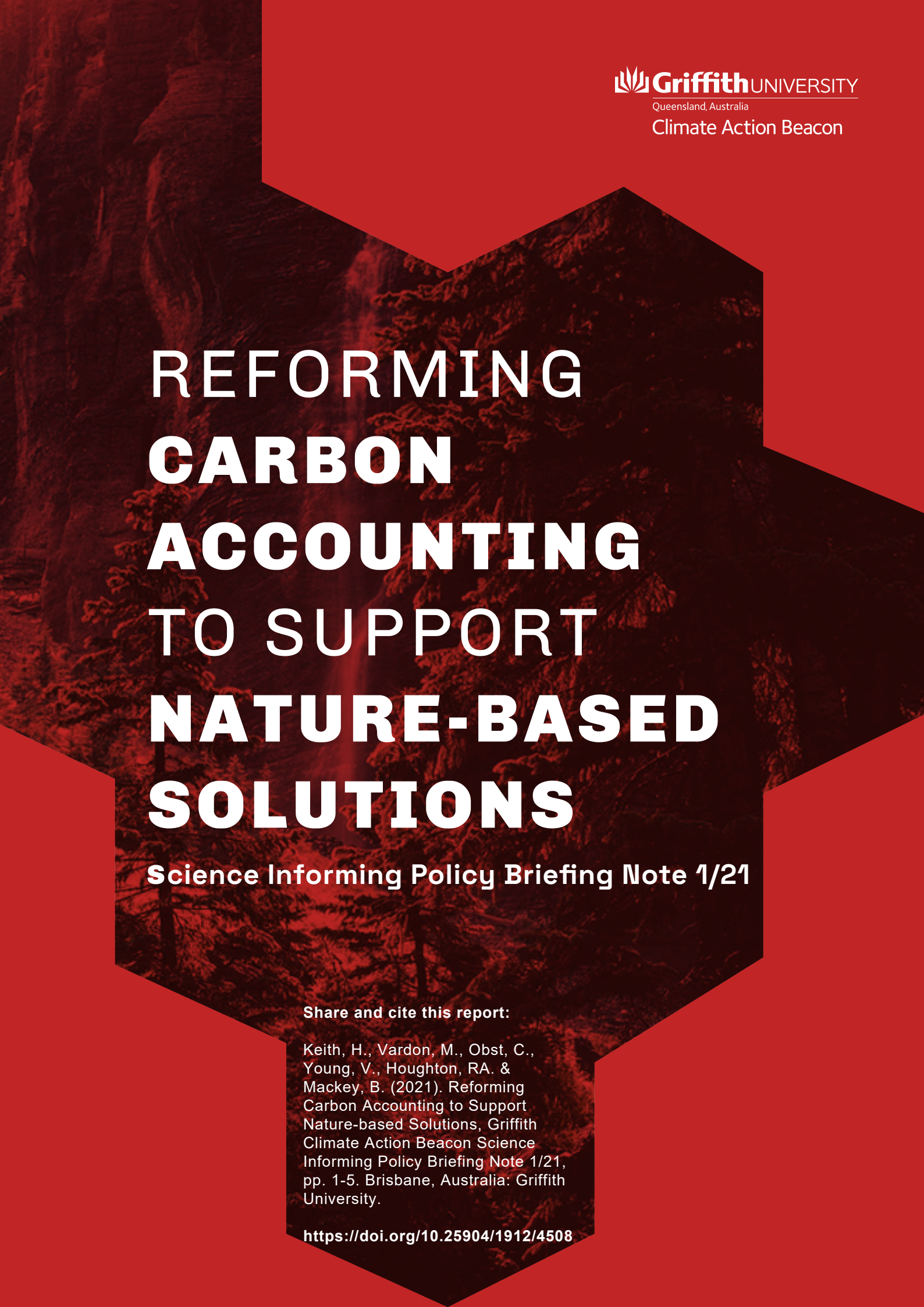

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REFORMING CARBON ACCOUNTING TO SUPPORT NATURE-BASED SOLUTIONS

Science Informing Policy Briefing Note 1/21

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CURRENT CARBON ACCOUNTING IS NOT FIT-FOR-PURPOSE FOR NBS

Nature-based solutions (NbS) offer the opportunity to make substantial contributions to climate change mitigation, biodiversity conservation and ameliorating environmental degradation. But those contributions are not materialising, because current carbon accounting is deficient for use in evaluating NbS. As a result, the Nbs framework is being used to support interventions and activities that are not necessarily producing meaningful mitigation outcomes, while the actions which do have mitigation efficacy are ignored.

The core problem is that data reported under the UNFCCC for net emissions and removals related to human activities are insufficient for the understanding of the carbon dynamics of ecosystems. Hence, NbS mitigation activities cannot be evaluated fully.

The inadequacies of current carbon accounting are seen in the perverse outcomes that have occurred as a result of activities that cause degradation, such as:

- converting carbon-dense forests and peatlands into fast-growing plantations,
- preventing forests from reaching maturity because of the false accounting preference for young, fast-growing forests,
- harvesting forests for wood products and bioenergy that results in loss of carbon stocks where replacement of these stocks will only occur decades into the future, thus creating a carbon debt,
- erroneously considering carbon stocks in reservoirs of different longevities and risk of loss as fungible.

REFORMING CARBON ACCOUNTING

The system of carbon accounting employed is a critical issue because accounting rules influence the reported emissions reductions, and thus directly impact policy outcomes. If the accounting rules do not fully reflect the mitigation outcomes, then a gap opens up between policy goals and actual mitigation achieved, thus undermining credibility as well as contributing to mitigation failure. The ways in which the characteristics of ecosystems are defined, measured and reported have major implications for how ecosystems are perceived, valued and managed. A more holistic and comprehensive approach to carbon accounting is needed if the potential of NbS actions is to be realised and the most effective options prioritised.

UNDERSTANDING THE GLOBAL CARBON CYCLE

Information needed to manage the interactions between human activities, impacts on the carbon cycle, and consequences for the atmosphere and climate is based on an understanding of the components of the global carbon cycle.

Components of the global carbon cycle have different characteristics and cycle at different rates (Figure 1).

GEOCARBON – carbon stocks in fossil fuels, as well as sedimentary rocks particularly limestone in the lithosphere, that operate on a very slow cycle of accumulation and turnover under natural environmental conditions, but very rapid loss under human disturbance.

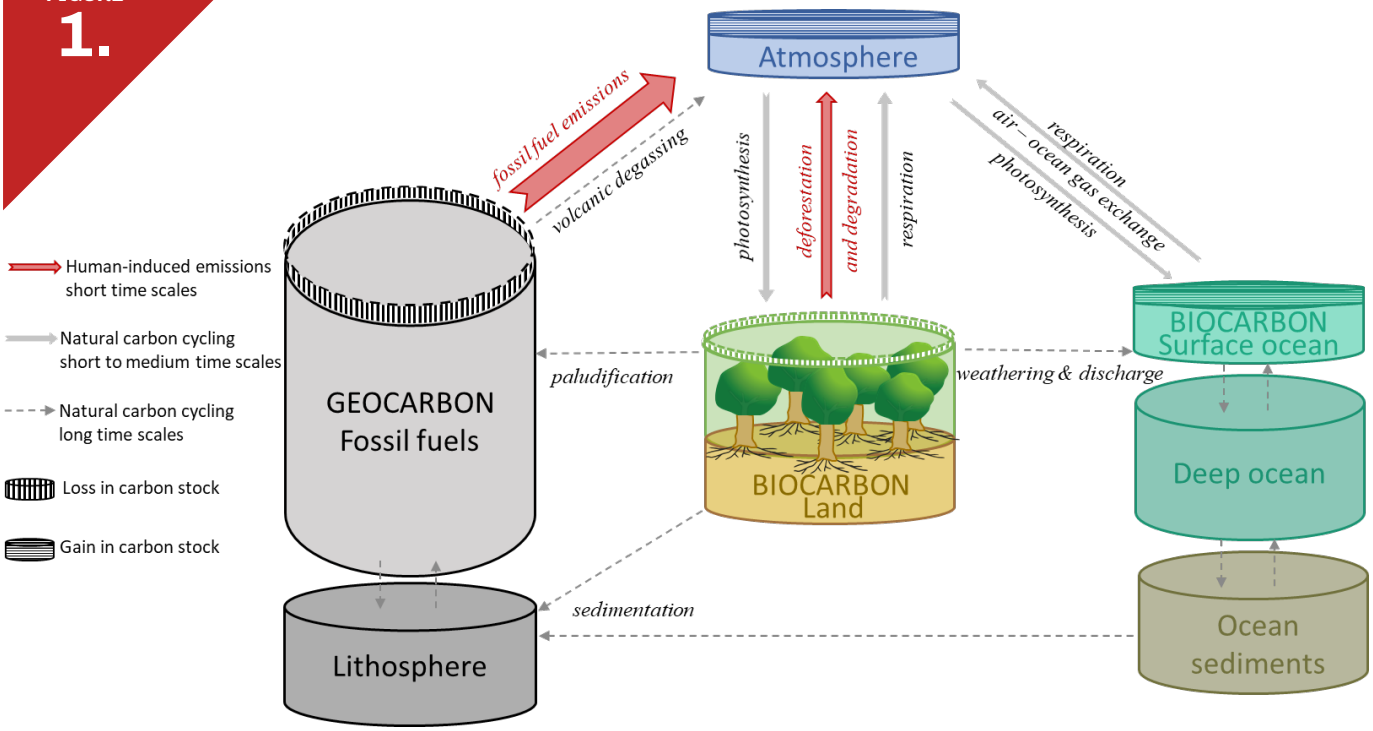
BIOCARBON – organic carbon stocks in the land and surface ocean that are transferred via gaseous exchange with the atmosphere and via hydrological fluxes into rivers and the ocean at medium to short time scales, depending on the characteristics of the ecosystems.

Transfers of carbon stocks from the very slow geocarbon reservoirs and faster biocarbon reservoirs into the atmosphere creates the problem of climate change.

PROPOSED CARBON ACCOUNTING SYSTEM

Comprehensive carbon stock and flow accounts following the **System of Environmental-Economic Accounting – Ecosystem Accounts** (SEEA-EA) framework provide a comprehensive information system. This system makes the underlying data transparent, allows understanding of the processes involved in the carbon cycle, and the potential responses to management actions.

FIGURE 1.



Global carbon cycle showing the natural and human-induced flows between reservoirs and differentiating between slow-medium time scales and slow time scales. Losses and gains in carbon stock are shown for each reservoir. Reservoirs are drawn in proportion to their estimated global carbon stock: fossil fuels (3700 PgC), lithosphere (estimated 100 million PgC in sedimentary rocks – not in proportion), land (2700 PgC), atmosphere (600 PgC), surface ocean (900 PgC), deep ocean (37,000 PgC – not in proportion), ocean sediments (1750 PgC).

The main features of the SEEA-EA carbon account with stocks and flows include:

- all land and associated ecosystems that are spatially referenced,
- all stocks disaggregated into categories of carbon reservoirs, e.g. biocarbon, geocarbon,
- classification of the quality / condition of carbon reservoirs in terms of stability, longevity and resilience of their carbon stocks, e.g. primary forests, secondary or semi-natural forests, plantations, gross flows reported, i.e. gains (additions) and losses (reductions) of carbon stocks,
- all carbon pools within ecosystems, e.g. above- and below-ground living and dead biomass and soil carbon pools,
- ecosystem carbon stocks assessed against a reference level that represents ecosystem integrity (i.e their natural state),
- physical measures of carbon stocks and flows within ecosystem assets are linked to the economic system through land use and ownership, valuation of ecosystem services, and sectors that benefit.

The SEEA-EA system of carbon accounting enables management activities desig nated as NbS to be evaluated in terms of the response of the carbon cycle through the biosphere and atmosphere, and this is linked to human activities, their economic impacts, and the sectors of society that benefit. For example, protecting carbon stocks in native forests, thus avoiding emissions and enabling removals, contributes to stabilising the carbon stock in the atmosphere, and this benefits all sectors of society. In contrast, harvesting native forests produces an immediate economic gain for the forestry and timber industry, but reduces the carbon stock in the biosphere, which is to the detriment of all society.

POLICY APPLICATIONS

Once comprehensive data are produced in the format of the SEEA-EA carbon accounting system for stocks and flows at local, regional, national or international scales, then the data can be used in different forms to support a range of policy applications. The benefit of having a single comprehensive accounting system is that the data used for different applications are consistent. The system allows informed choices about mitigation actions based on understanding of the carbon cycle processes that are amenable to human interventions.

The following points describe principles for using the carbon accounting data for policy applications:

- Data for components of the SEEA-EA carbon account can be extracted to inform specific policies, such as the UNFCCC targets. The time series data shows progress towards meeting these targets.
- Different targets are needed for different components of the global carbon cycle because they have different characteristics, particularly the longevity of their carbon stocks, e.g. the longevity of geocarbon and biocarbon stocks.
- Mitigation activities aimed at targets for one component should not be offset against targets for another component e.g. emissions from fossil fuel combustion should not be offset with removals by tree planting.
- Selection criteria are needed to provide guidance about which activities and sectors to include within NDC mitigation targets, for examples criteria based on classifications within the carbon account and understanding of carbon cycle processes.

NbS as climate change mitigation activities should be prioritised to:

- Avoid carbon stock loss from long-lived, stable reservoirs in fossil fuels and stable ecosystems, such as primary forests.
- Increase carbon stocks through restoration and recovery of secondary natural forests.
- Manage the cycling of carbon at time scales relevant for climate change mitigation, i.e. to 2030 and 2050. For example, a carbon debt is created for decades to centuries by using wood to substitute for other products or energy.

EXAMPLE APPLICATION TO INFORM FOREST POLICIES

The example uses the comprehensive accounting for all carbon stocks and flows based on the SEEA EA system to develop an account for a forest ecosystem. This allowed assessment of scenarios of forest management strategies in terms of their mitigation benefits.

The data show the decrease in carbon stocks in the biosphere (vegetation, soil and products) and the increase of the carbon stock in the

atmosphere due to conversion of primary forest to secondary forest to plantation.

It is the final carbon stock in the atmosphere that is critical in determining the impact on the climate. Using data only for the annual rates of flow between the biosphere and atmosphere is not adequate to assess the mitigation outcome. If the carbon stocks in the biosphere are not known, or not counted completely, then the potential for losses or gains due to human activities cannot be evaluated fully. Carbon storage is represented by the long-term average carbon stock in an ecosystem at a landscape scale, irrespective of temporal variability in emissions and removals and spatial variability due to disturbance or climate variability (Figure 2).

CONCLUSIONS

The SEEA EA system presents a holistic and comprehensive approach to carbon accounting for stocks and flows. It enables the effectiveness of NbS activities for climate change mitigation to be evaluated and then prioritised. Accounting for carbon stocks in ecosystems as their long-term average at the landscape scale is the key metric by which to assess the exchange between the biosphere and atmosphere. Monitoring temporal variability in flows of emissions and removals is not an adequate metric. Climate change depends on the total stock of carbon dioxide in the atmosphere and the increase that has occurred due to transfers from the geocarbon and biocarbon reservoirs.

SOURCE REFERENCE

Keith H, Vardon M, Obst C, Young V, Houghton RA, Mackey B. 2021 Evaluating nature-based solutions for climate mitigation and conservation requires comprehensive carbon accounting. Science of the Total Environment 769:144341

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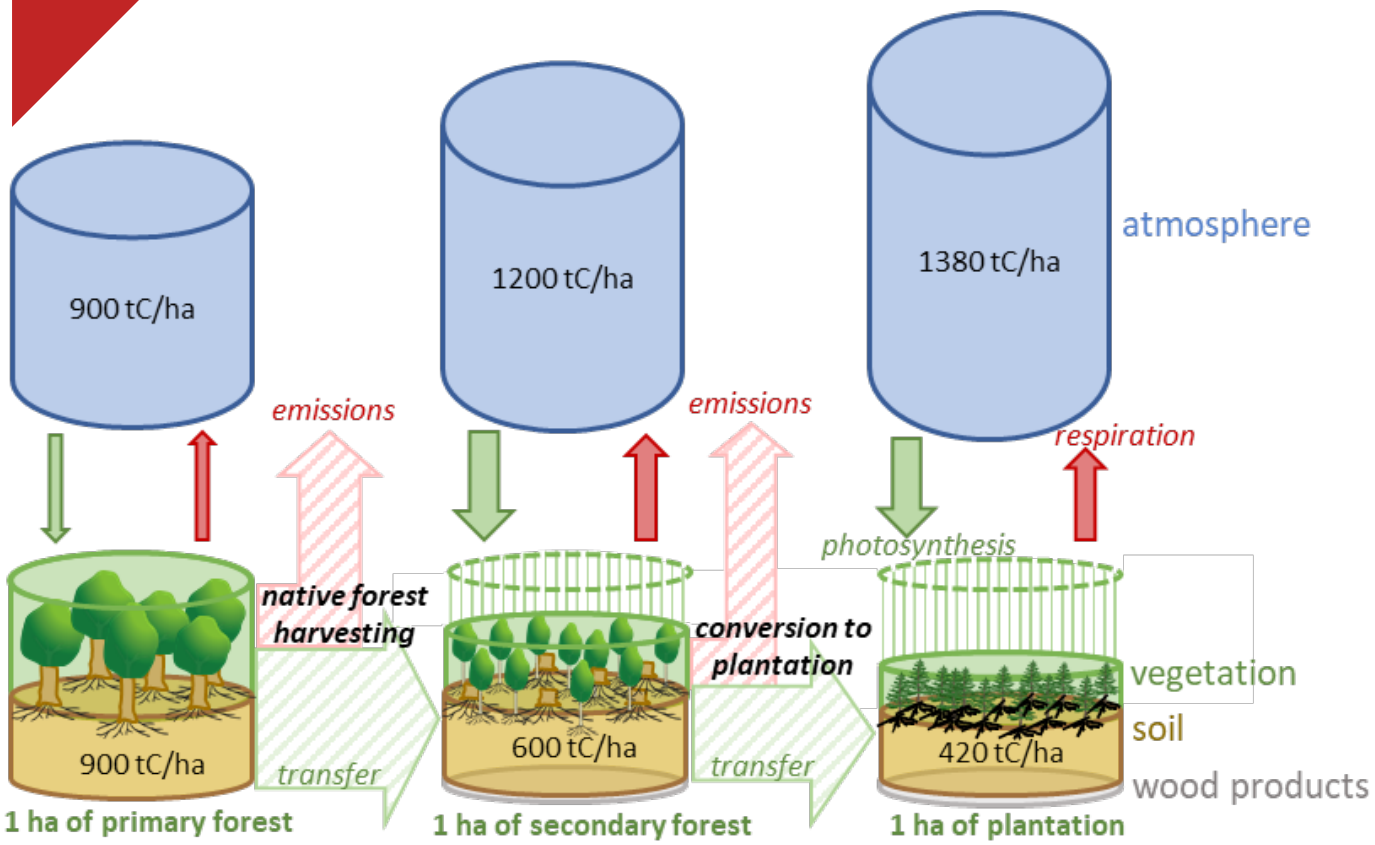
FIGURE 2.



Carbon stocks and flows in a wet, temperate eucalypt forest in SE Australia. Transfers of carbon between reservoirs of the biosphere and atmosphere are depicted as occurring within a vertical cylinder of 1 ha, with the amounts of carbon representing long-term averages at the landscape scale for the forest management type. Carbon stocks and stock changes are depicted in proportion to 1 ha of primary forest as a reference level. Forest management scenarios are (i) primary forest managed for conservation, (ii) secondary native forest managed for commodity production, (iii) plantation forest managed for commodity production. Conversions of forest management types result in transfers of some of the carbon stock but also emissions.