Vegetation thickening offsets deforestation in Australia and ensures the continent is a Net CO_2 sink

Bill Burrows#

Vegetation thickening (increases in tree and shrub cover and density in the landscape) is a well-known observation shared by rural landholders and the people living in country cities and towns that service them. However, it is far less understood by those who have a largely urban background and who visit Australia's countryside intermittently or not at all. And if urban dwellers do travel through the country as tourists, it is uncommon for them to repeatedly visit the same landscape over time. They do not 'see' the subtle and common unidirectional vegetation changes that are occurring.

The thickening that is taking place in our intact woodlands and adjacent grassland areas is best illustrated in the title of Darrell Lewis's seminal book "Slower than the eye can see". This book presents a photographic record that documents vegetation changes since the introduction of cattle grazing in the VRD district of the NT. (See below for some additional thickening examples in Australia's north). On the other hand, the MSM and conservation bodies are very quick to highlight any tree clearing that occurs in our 'bush' landscapes. [Although today they are seemingly silent about the devastation and destruction of forest and woodland flora and fauna which is inflicted by huge solar and wind turbine 'farms' on rural landscapes and high country wilderness areas].

The simple fact is that the biomass of vegetation and tree cover lost through clearing this century is less than that which has accumulated via vegetation thickening over the same time scale. We know this because at a continental scale Australia is a net sink for carbon dioxide [CO_2 , sometimes expressed as CO_2- e(quivalents) - See Table 1]. All dry vegetation is composed of approximately 50% carbon. This element is sourced predominantly from CO_2 in the earth's atmosphere. So, when the land mass is a net sink for CO_2 more of the gas is being absorbed from the atmosphere above, than is being released to it from the land beneath.

Table 1. Natural CO_2 flux (withdrawal from the atmosphere above the Australian land mass – expressed in common units (Mt CO_2-e/year)) and based on retrievals from three different satellite platforms, combined with inversion procedures [See reference links for methods and attributed uncertainty estimates].

Reference	GOSAT	OCO-2	TanSat	Retrieval Year
Detmers et al. 2015*	770	-	-	2010-11
Wang et al. 2019	958	806	-	2015
Villalobos et al. 2021	-	1500	-	2015
Chevallier et al. 2019	-	697	-	2017
Yang et al. 2021	-	205**	770	2017-18

GRAND MEAN (over all retrieval platforms and sampling years, n=7) ~ 815 Mt CO_2-e/year***

Superscripts on the following page refer back to Table 1:

*The flux is from the 2017 corrected version of this paper. See: https://doi.org/10.1002/2015GL065161

**See Table 1 in the Beef Central essay [linked here in the last paragraph, p.3] for possible reasons for this seemingly low value.

***Mean fossil fuel/cement manufacturing emissions for the retrieval years cited approximated 447 Mt CO_2-e/year. This results in the continent being a **net sink** of 815 – 447 = **368** Mt CO_2-e/year, well in excess of current reporting which claims Australia is a net emissions source to the atmosphere.

[All reference links cited here were accessible on 8 Jun 2025]

Some known additional[##] carbon sinks in Australia's 'pristine' grasslands and 'intact' open woodlands

[[##]These sinks are **additional** to what was present in all remnant vegetation communities when Europeans first arrived in these lands. If this is not the case, then the accumulating carbon store in the so-called remnant communities would be suggestive of an infinite biomass potential – Jack's beanstalk? And while it has been claimed that the increasing land sinks are solely due to vegetation recovery following widespread droughts, many examples of increasing carbon store over monitoring periods that encompass both wet & dry periods (La Niña & El Niño years) are known for these communities. Likewise, the range science literature is replete with examples of fence-line contrasts where vegetation growing under similar rainfall, the same atmospheric CO_2 concentrations and on 'identical' soil types and topography is notably different in structure and/or composition either side of the fence. i.e. vegetation on both sides of the fence is responding in different ways to variable **management** impacts, while conditions for plant growth are more or less the same on either side of the fence!].

Consider these tree thickening examples:

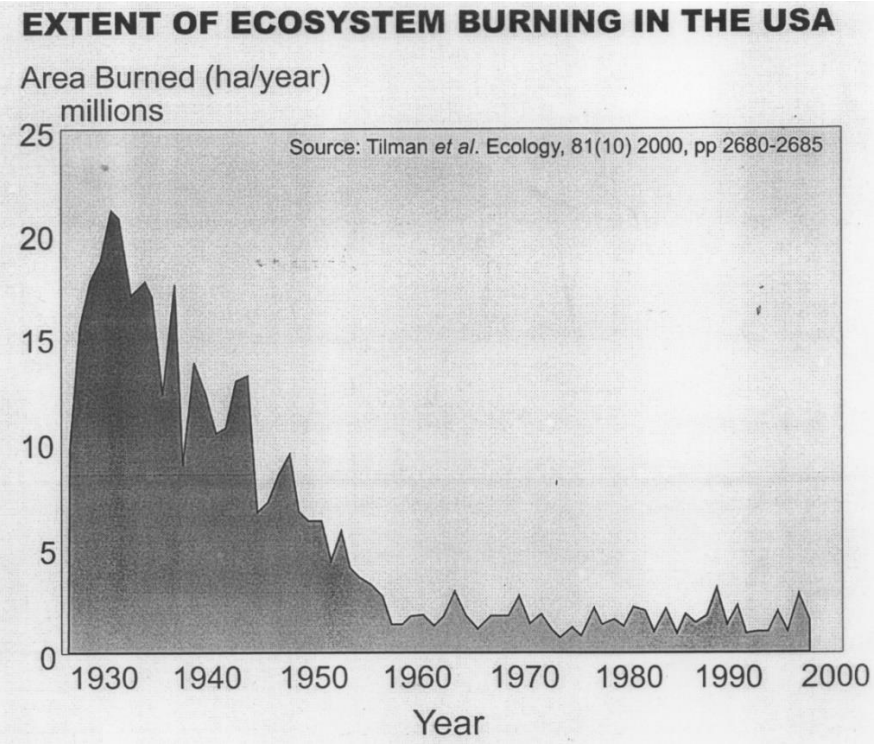
1. Mitchell grasslands – invaded by gidgee (e.g. 'Strathdarr', Longreach and by Prickly Acacia in the Richmond, Winton and Barcaldine districts
2. Mitchell and Bluegrass downs invaded by *Acacia* (blackwood, gidgee and boree trees) on Moorinya National Park [which was established to preserve the most eastern extent of Mitchell grasslands (from invading native *Acacia* trees!)].
3. Cape York grasslands – variously invaded in modern times by ti-tree and rainforest.
4. Patchy Plain Brigalow – invading/thickening/coalescing clumps in Bauhinia Downs area (analogously at 'South Terrick', SW of Blackall).
5. Open woodland invaded by INS (invasive native species) in the Cobar-Byrock area of NSW (Royal Commission 1901)
6. Thickening of the Pilliga scrub in NSW (Eric Rolls (1981) "A million wild acres")
7. Thickening and invasion of White Cypress Pine in NSW and southern Queensland (Binnington, K. (1997). *Australian Forest Profiles* 6. White Cypress Pine.)
8. The disappearing grassy balds of the Bunya Mountains – Rod Fensham
9. Thickening mulga – Boatman & Thrushton N.P. (Rosemary Purdie – mulga symposium)

10. Invasion of trees into the grasslands of the VRD, NT (Darrell Lewis – "Slower than the eye can see")

[Citable references are available for all 10 examples of tree-shrub thickening listed here].

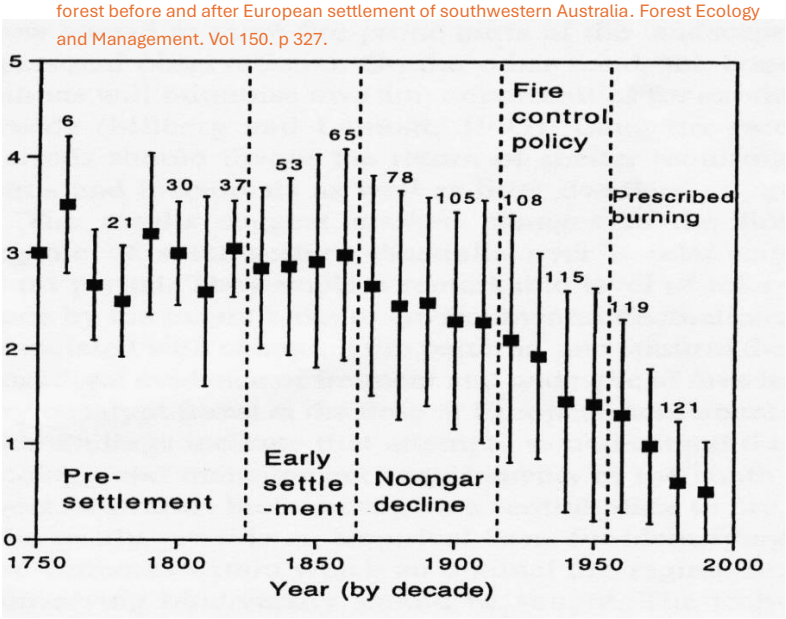
For more backgrounding click on: https://www.beefcentral.com/wp-content/uploads/2022/05/Australia-is-already-a-net-zero-CO2emitter-thanks-to-our-forests-and-rangelands-2.pdf . Note the DSIR link in this May 2022 article appears to be broken. I am awaiting a reply from the Australian Parliament for an archival link for readers to follow-up, if they wish to do so. Also, Table 1 (above) is based on Table 1 data in the Beef Central essay just linked here - with an additional citation and data added based on the Villalobos *et al.* paper.

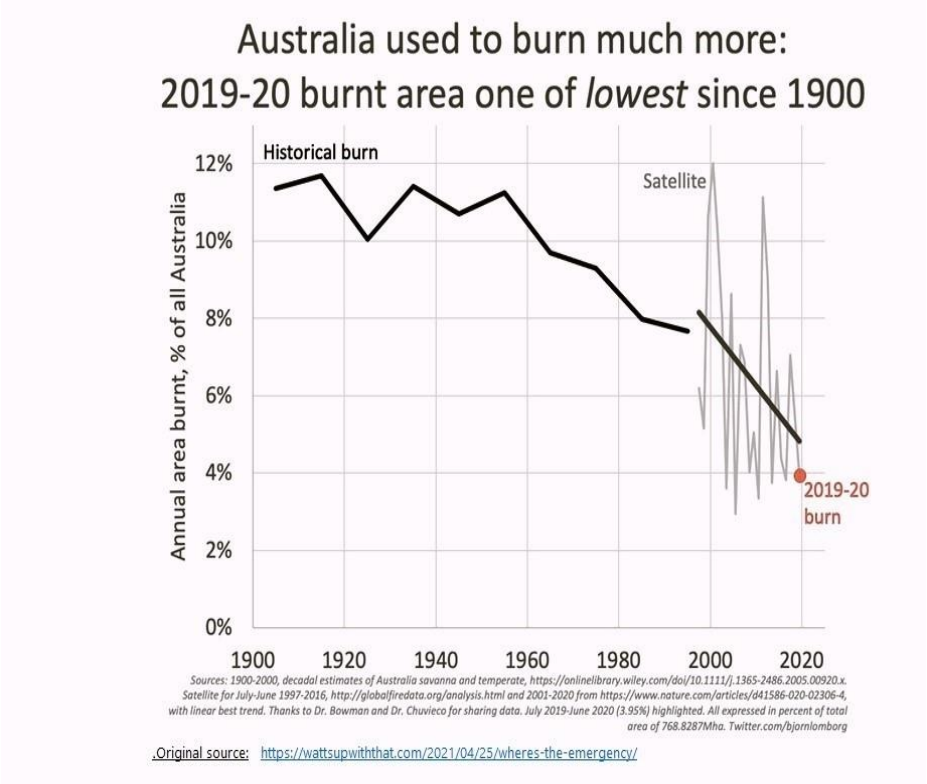
Addendum 1: The following three figures demonstrate that the incidence of fire and the area affected by burning have significantly decreased in countries where European management and livestock grazing practices have replaced hunter-gatherer societies over the past two centuries. This trend has been further supported by modern firefighting practices that became widespread after World War II. There are convincing data and reports which indicate that 'intact' Australian woodlands & forests were <u>far more open under the previous indigenous management than they are today</u>.



THE DECLINE OF FIRES IN AUSTRALIA

Source: Ward *et al.* (2001). Grasstrees reveal contrasting fire regimes in eucalypt forest before and after European settlement of southwestern Australia. Forest Ecology and Management. Vol 150. p 327.

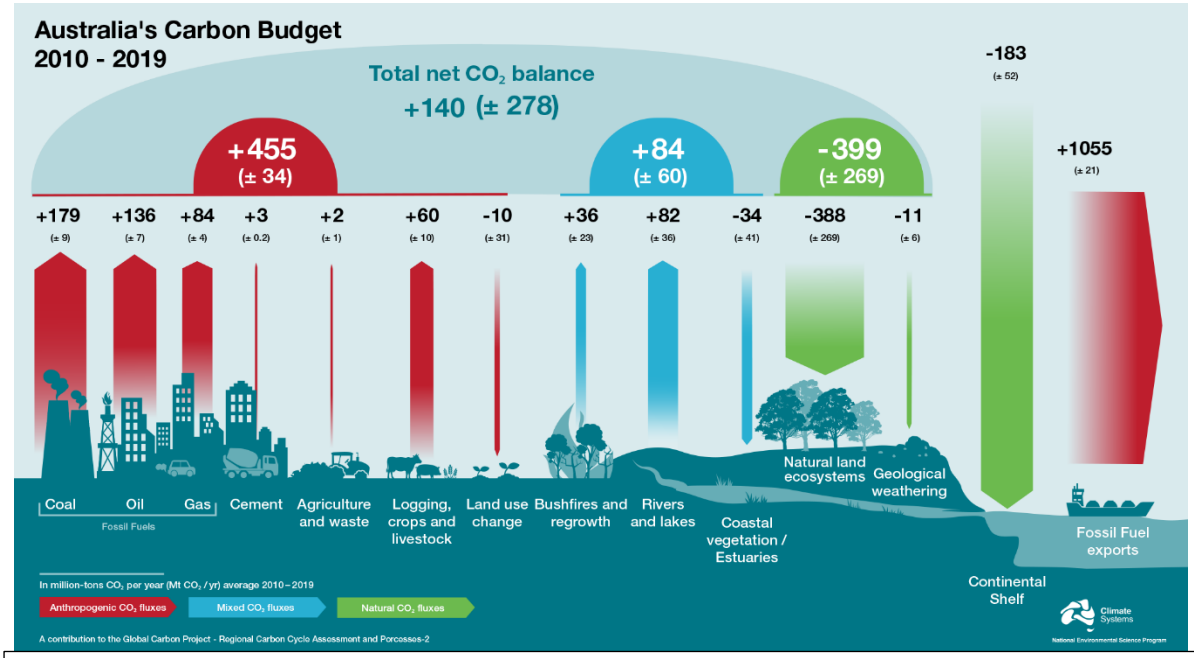




.Original source: https://wattsupwiththat.com/2021/04/25/wheres-the-emergency/

Addendum 2: CSIRO presents Australia's "Carbon" Budget in million tonnes CO_2 per year (Mt CO_2/yr) between 2010 and 2019. See: https://www.csiro.au/-/media/Environment/SOTC-2024/Figures/SotC24_Box_NESPCarbonBudget.png . Average annual emissions from fossil fuels during this period were 455 Mt (± 34 Mt). Mixed source emissions were estimated at 84 Mt (± 60 Mt). 'Natural' ecosystems absorbed on average 399 Mt per year (± 269 Mt).).

Australian fossil fuel exports contributed an annual average of 1,055 Mt (± 21 Mt). [Note: *The UNFCCC & IPCC do not include emissions from fossil fuel exports in the budgets of the country of origin but include them in the budget of the country where the fuels are consumed* e.g. exported oil and gas from Saudi Arabia are not considered to contribute to that country's emissions. Nor are exports of fossil fuels from Australia included in our net emission calculations when following IPCC methodology].



If we accept the CSIRO figures at face value (and ignore fossil fuel exports for the reasons outlined above) we get:

Anthropogenic CO_2 fluxes	+455 (±34)* Mt CO_2/yr
Mixed CO_2 fluxes	+84 (±60) Mt CO_2/yr
Natural land system CO_2 fluxes	-399 (±269) Mt CO_2/yr [*but cf. Table 1 data p.1 here]*
Coastal sea CO_2 fluxes (shore to the continental shelf)	-183 (±52) Mt CO_2/yr
∴ Σ (All CO_2 fluxes in or over Australia's land mass + CO_2 fluxes in waters out to the continental shelf)	**= - 43 Mt CO_2/yr (= a net GHG sink)**** [WHB - adding the maximum error estimate to each value we would get (455+34+84+60) – (399+269+183+52) = - 270 Mt CO_2/yr]

* Note: By convention, a positive (+) sign indicates emissions to the atmosphere (are a source) and a negative (–) sign indicates net absorption (withdrawal) from the atmosphere (= a sink). Vaues in brackets = error ranges for each flux.

** While still a net GHG sink this value is more than an order of magnitude lower than the mean sink in Table 1 (p.1) derived from published peer reviewed data obtained from satellite sensors and inversion procedures. The latter involve a much greater sampling intensity than the CSIRO data. Nevertheless, Australia is in absolute terms a net GHG sink **when all CO_2 fluxes over the continent + within its continental shelf are accounted for.** It is portrayed as a net emitter (red arrows in the chart) at a continental and per capita scale simply because the data on which these claims are based are only a **partial** accounting, which essentially excludes the data depicted by the blue and green arrows in the above chart. It is inarguable that Natural land systems have changed markedly under the management regimes imposed since 1788. By any common sense reasoning the consequent changes in net GHG gas emissions occurring on these land systems today should be accounted for in our reported GHG budgets. That they are not is at best a demonstration of ecological ignorance and/or a display of agenda driven zealots 'cooking the books' to portray our country in the worst possible light. Just because systems are described as "natural" does not mean they are not subject to human (anthropogenic) management – this is obvious for grazed native grasslands & woodlands but applies as well to huge land areas managed for National Parks & reserves e.g. by fire control/prescribed burning. See next discussion.

Definition of the Managed Land Proxy (MLP)

Managed land is land where human interventions and practices have been applied to perform production, ecological or social functions (IPCC 2006)

In effect all land in Australia is "managed" because government makes decisions to assign it for particular **production** (e.g. forestry, agriculture, grazing), **ecological** (e.g. national parks, reserves) or **social functions** (aboriginal land, towns, cities. infrastructure purposes, defence etc). Despite this the National Greenhouse Gas Inventory (NGGI) is only a partial budget of the nation's CO_2 fluxes as it is based on 'bottom up' (ground based) sampling and modelling. It is not physically possible to sample all our country's managed land with the accuracy and precision necessary for a rigorous NGGI using a 'bottom up' approach. This is only possible at a continental scale via 'top down' methods (e.g. Table 1, p. 1).

And it is obvious from Table 1 and the chart (p. 5) that Australia is a net GHG sink. This is not promoted because politicians and their advisers today are wedded to an agenda that says the country is a net GHG emitter – harking back to the 1997 Kyoto Protocol. This agenda arose because the compilers of our NGGI for the KP did (or would) not recognise that the vast majority of Australia's landscape was actively managed as rural enterprises.

Subsequently, as a signatory to the Paris Agreement the nation further committed itself to supporting a Net Zero Policy – not recognising/accepting that Australia qualified as a 'net zero country' already. This simple truth must surely be known amongst senior bureaucrats, if not by some in the political class today. But:

"It is difficult to get a man to understand something when his salary [and his reputation-WHB] *depends on his not understanding it"* – Upton Sinclair

Managed Land in the USA

https://doi.org/10.1029/2021GL093565 See section 2.4 Inventory data.

For instance, the definition of **managed land** for the USA fills a whole page of the corresponding National Inventory Report (NIR) and includes various considerations on the LULUCF category, the type of existing and past activity, the fire protection measures, and the proximity to infrastructure (Section 6.1 in USA, 2020). …….. In contrast, for example, in Sweden all forests and grasslands are considered managed (Section 6.2 in European Union, 2020).

https://unfccc.int/documents/223808 **USA National Inventory Report 2020 Section 6.1**

The total land area included in the United States Inventory is **936 million hectares** across the 50 states. Approximately **886 million hectares** of this land base is considered managed, and 46 million hectares is unmanaged, which has not changed much over the time series of the Inventory (Table 6-7). In 2018, the United States had a total of 282 million hectares of managed Forest Land (0.03 percent decrease compared to 1990). There are 162 million hectares of cropland (7.2 percent decrease compared to 1990), 337 million hectares of managed Grassland (less than 0.01 percent decrease compared to 1990), 39 million hectares of managed Wetlands (1.8 percent increase compared to 1990), 45 million hectares of Settlements (34 percent increase compared to 1990), and 22 million hectares of managed Other Land (2.4 percent increase compared to 1990) (Table 6-7). Wetlands are not differentiated between managed and unmanaged with the exception of remote areas in Alaska, and so are reported mostly as managed.[10] In addition, C stock changes are not currently estimated for the entire managed land base, which leads to discrepancies between the managed land area data presented here and in the subsequent sections of the Inventory (e.g., *Grassland Remaining Grassland* within interior Alaska).[11,12] Planned improvements are under development to estimate C stock changes and greenhouse gas emissions on all managed land and ensure consistency between the total area of managed land in the land-representation description and the remainder of the Inventory.

Managed Land in Australia
Land use, land use change and forestry (LULUCF) [Australia] for UNFCCC submissions

https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-accounts-2020/state-and-territory-greenhouse-gas-inventories-data-tables-and-methodology

The LULUCF sector is made up of several sources, including:

- 'Forest land' includes all lands with a tree height of at least 2 metres and crown canopy cover of 20% or more and lands with systems with a woody biomass vegetation structure that currently fall below but which, in situ, could potentially reach the threshold values of the definition of forest land. Young natural stands and all plantations which have yet to reach a crown density of 20% or tree height of 2 metres are included under forest. So are areas normally forming part of the forest area which are temporarily unstocked as a result of either human intervention, such as harvesting, or natural causes, but which are expected to revert to forest. Forest land does not include woody horticulture which meets the forest threshold parameters; this land is classified as croplands. Australia has adopted a minimum forest area of 0.2 ha.
- 'Cropland' includes all land that is used for continuous cropping and those lands managed as crop-pasture (grassland) rotations. Non-CO_2 emissions from 'cropland remaining cropland' are reported in the 'Agriculture' sector.
- The 'grassland' category represents a diverse range of climate, management and vegetation cover. The 'grassland' category also includes sub-forest forms of woody vegetation (shrubs).
- 'Settlements' include areas of residential and industrial infrastructure, including cities and towns, and transport networks. The area of the 'settlements' land use classification is based on information sourced from the ABARES catchment scale land use data. It includes additional land use classes such as manufacturing and industry, commercial services, transport and communications including airports etc. Land areas that meet the definition of forest land are reported under the 'forest land' category.
- 'Wetlands' include areas of perennial lakes, reservoirs, swamps and major water course areas derived from the Australian Hydrological Geospatial Fabric (AHGF) data published by the Australian Bureau of Meteorology. It also includes all existing wetlands as defined in the Directory of Important Wetlands in Australia (DIWA) dataset published by our department. Land areas that meet the definition of 'forest land', such as mangroves, are reported under the 'forest land' category.
- The 'other land' category includes bare soil, rock and other land areas that do not fall into any of the other five categories according to ABARES' catchment scale land use map of Australia (version 5).

The allocation of forest conversion areas to 'cropland' or 'grassland' is designated by the relative frequency of the management practices within the particular ABS Statistical Local Areas and soil type in which it occurred.

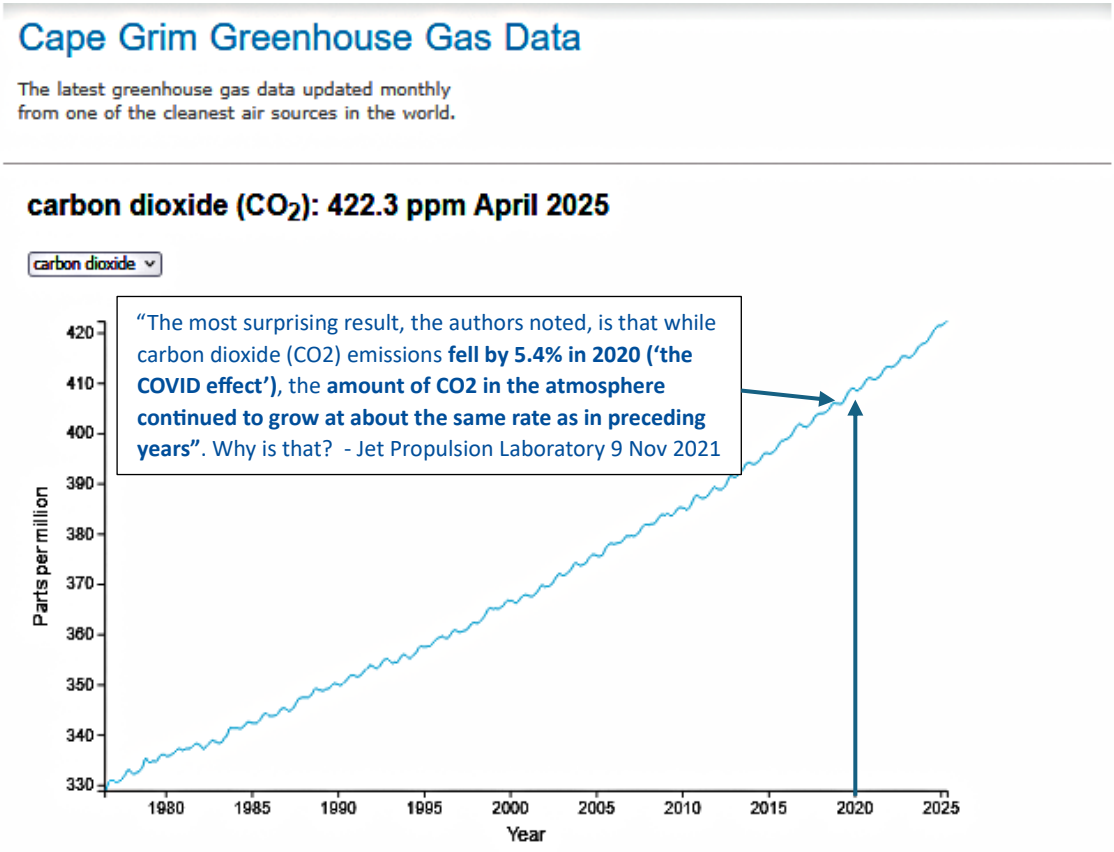
Where there has been direct human-induced conversion from grass to forest, these lands are classified and reported as 'land converted to forest'. This includes observed regrowth on previously cleared lands. The generation of woody vegetation on 'grassland' from natural

seed sources is classified as ‘land converted to forest land’ or ‘grassland remaining grassland’, depending on whether the vegetation meets the criteria for ‘forest land’.

In cases where there is a temporary change in forest cover, due to a forest harvest or fire, the land remains in the ‘forest land’ category unless a subsequent land use change is identified.

The permanent conversion of ‘forest land’ to other land uses is distinguished from a temporary removal or loss of forest cover. Changes in forest cover due to natural events (e.g. fire, drought) or changes that occur within land tenures where it is expected that the land will revert to forest (e.g. harvested forest, national park) are monitored for a period of time, depending upon the type of forest land use. In the absence of land use change, areas without forest cover that have entered the monitoring system continue to be classified as ‘forest’ provided that the time since forest cover loss is shorter than the number of years within which tree establishment is expected. After that time period, lands that have lost forest cover due to direct human-induced actions, have undergone land use change, and failed to regenerate are classified as converted to the appropriate non-forest land use classification.

Addendum 3: Trends in CO_2 concentrations at Cape Grim. See: https://capegrim.csiro.au/



FOOD FOR THOUGHT? SURELY NET ZERO IS A BUM STEER?

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