Vegetation Management in Queensland - Some essential facts for politicians, rural industry and all Queenslanders

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Summary

- *This article is in response to the Queensland Government's stated intention to reintroduce (in early 2016) strict controls on the clearing of trees, shrubs and woody regrowth from the State's rural landholdings.*
- *Different satellite based sensors can now reliably detect changes in the aboveground biomass of vegetation, as well as carbon dioxide (CO_2) levels in the air column above the earth's land mass and oceans.*
- *Aboveground biomass increased in Queensland over a 20 year observation period (1993-2012), <u>even though this also coincided with different years of either well below or well above average rainfall, along with years of extensive ('panic') clearing</u> – in the highly publicised lead up to the passing of the State's Vegetation Management Act 1999.*
- *The satellite sensor observations are validated by a myriad of ground based and aerial photo interpretation studies. This research confirms that uncleared woody vegetation is "thickening" (increasing in stem density, stem size/basal area and/or canopy cover) on the State's rural landholdings. <u>This results in increased woody plant biomass and carbon storage, as well as providing strong competition that limits the growth of associated pasture.</u>*
- *Independent sensors on Japan's IBUKI and NASA's OCO-2 satellites now both show Queensland is a net annual sink for CO_2. In other words vegetation is currently removing more CO_2 from the air (atmosphere) above this State than is being added to it from the combined impacts of land clearing, plant respiration, fire, fossil fuel use, adjacent ocean outgassing etc.*
- *It is concluded that arguments for the reintroduction of strict tree/shrub clearing control bans on this State's rural landholdings are not supported by the evidence. Our 'intact' woody vegetation is not static, but on a definite 'thickening' trend overall. <u>This trend threatens the viability of many rural enterprises.</u> <u>Reintroducing strict restraints on the clearance of trees/shrubs from the rural landscape will only exacerbate this problem.</u>*
- *A review of research literature provides further support for these conclusions.*

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Bill retired from his position as Senior Principal Scientist in the Queensland Department of Primary Industries & Fisheries (now DAF) in 2004, after a 40 year career researching the ecology and management of Queensland's grazed woodlands. He is a past president of both the Australian Rangeland Society and the Tropical Grassland Society of Australia, and has authored or co-authored over 100 research and technical papers published in national and international scientific literature.

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Increasing tree and shrub cover in Queensland woodlands

A recent scientific paper published in *Nature Climate Change* (Liu *et al.* 2015)[1] reveals that the woodlands of northern Australia (predominantly in Queensland) are continuing to increase in biomass (i.e. "thicken up" = increase in stem number, stem size or crown cover). In fact the study indicates (Figure 1) that aboveground biomass has increased by c.1200 kg/ha/yr over a 20 year observation period (1993-2012). This result was obtained from passive microwave observations made with calibrated satellite sensors. It is net of any concurrent losses in biomass due to tree clearing, woody plant deaths and fires occurring during the monitoring period. The result is in close agreement with detailed ground based measurements (c.1060 kg/ha/yr increase in aboveground biomass) over the same general area and for analogous and overlapping time frames[2]. The distribution of the sites sampled in the latter study are shown in Figure 2. Note the close relationship between the location of these woodland sites and the area delimited by biomass increase (Figure 1).

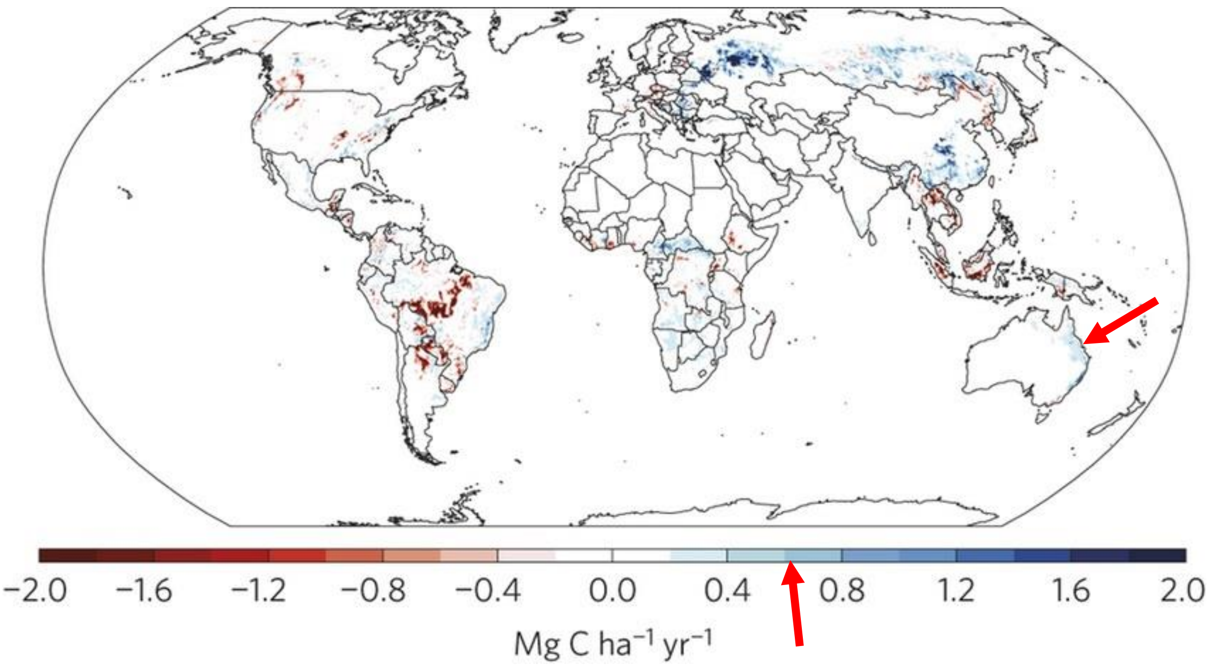

Figure 1. Visualisation of the mean annual change in aboveground biomass carbon (C) between 1993 and 2012 (Liu et al. 2015)[1]. The remotely sensed data highlight the fact that Queensland's grazed woodlands are increasing in density and/or woody plant cover. [Note: 1 Mg C ≈ 2 Mg (= 2000 kg) of biomass].

The cumulative change in woody plant biomass reflects seasonal conditions throughout the 20 year observation period (Figure 3), but the overall trend for north-eastern Australia clearly remains one of increasing biomass in the woody savannas – irrespective of any concurrent clearing activity.

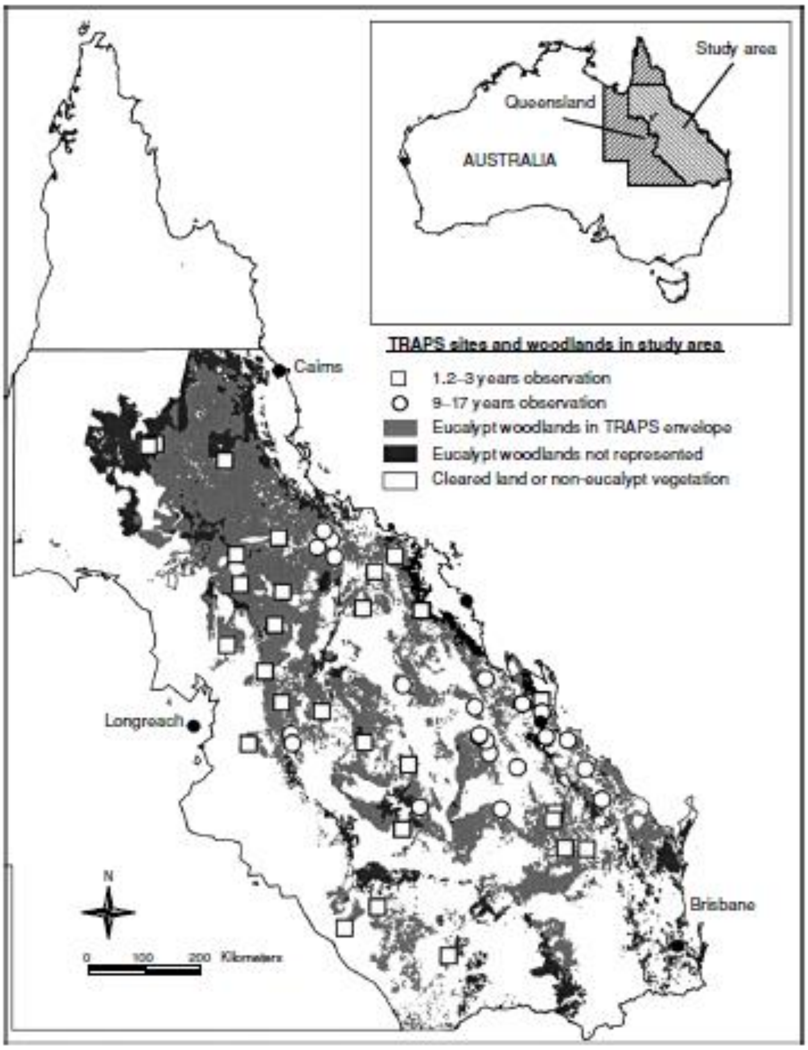

Figure 2. Location of sites sampled for above ground biomass change (Burrows *et al.* 2002)[2] on Queensland grazing land.

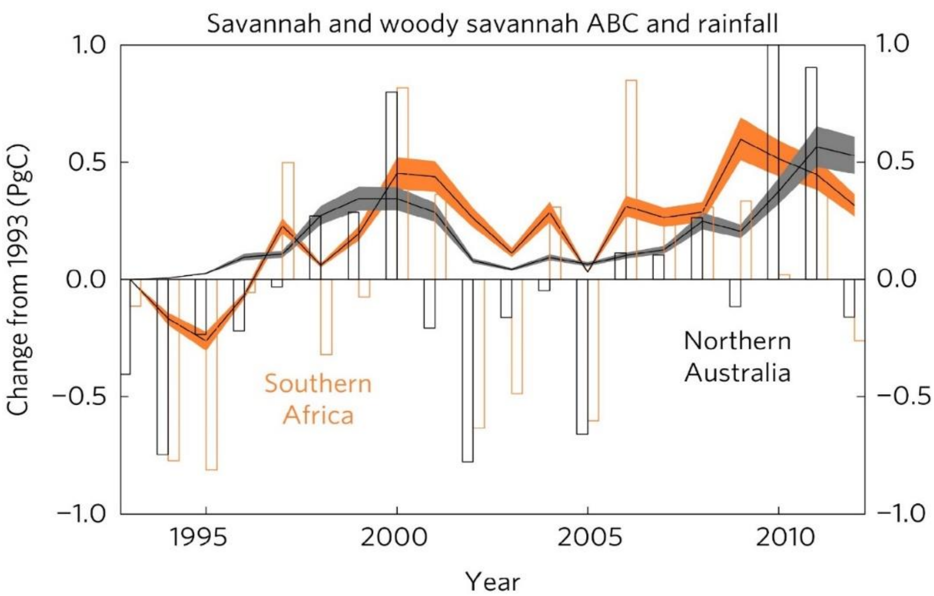

Figure 3. Cumulative change in above ground biomass carbon (ABC) in the woody savannas of northern Australia over a 20 year (1993-2012) observation period [Grey band]. Conversion factors as for Figure 1. [1 Pg = 1 x e^9 tonnes]. (After Liu *et al.* 2015)[1].

Supporting research

Queensland has c. 50-60 M ha of woodland and open forest on its' agricultural holdings, within a total land area of c.174 M ha. [To provide some perspective this area of woody plant dominance on rural land is larger than the sum total of **all** rural holdings in NSW]. Those proposing the reimposition of strict tree clearing bans on such land, which has been assigned by government for agriculture purposes, do so with scant regard for vegetation history, the welfare of rural landholders, sustainable management of rural resources and many desirable conservation outcomes as well.

There are good reasons why conservation should be an integral part of the management of rural lands, but there are also many practical considerations why conservation has to be subservient to the needs of agriculture, on land designated for the latter purpose. Fundamental to this assessment is the strong evidence that the structure and composition of the 'intact' (uncleared) woodlands on agricultural lands have changed markedly over the past 150 years, with trees and shrubs continuing to 'thicken up' under current management. Consequently, vegetation frequently claimed for conservation in our agricultural woodlands is representative of communities present here now, and not necessarily of what was here when Europeans first arrived with their domestic livestock. Moreover, if we allow this 'thickening' trend to continue we are putting at risk the viability of many existing agricultural enterprises.

The 'intact' woodland which is the subject of the present discussion has previously been set aside by government for **agricultural land use** (farming and grazing). The import of this is that, when bans on broad-scale tree clearing were first contemplated by the State and Commonwealth, it was accepted by both levels of government and the major political parties that this would detrimentally impact agricultural production. This still applies. It was therefore agreed that compensation needed to be offered to affected landholders for productivity foregone. [That the extent of compensation actually delivered, amounted to far less than that initially promised is another matter].

Compensation was considered because governments acknowledged that tree clearing was a long held and generally necessary practice to maintain or increase productivity on Queensland's rural lands. Indeed it was a mandated requirement (condition of lease) on large tracts of country opened up for closer settlement during much of the twentieth century. Calculations of "living areas" for selectors were commonly based on the developmental potential of the lease. This determined the ability of the lessee/manager to responsibly increase livestock carrying capacity or farming potential of the holding, which hopefully in turn, enabled it to be managed as an on-going business.

Some holdings (e.g. balloted brigalow blocks) were simply not viable as an agricultural enterprise, unless cleared when first taken up. Many other land types were, and remain subject to increased "thickening" of the over-storey or sub-canopy tree and shrub cover, or both, over time. Likewise trees are actively encroaching on some native grasslands[3,4] Examples of this changing structure and composition of the vegetation include mulga thickening in country east of the Warrego River [5,6], gidgee encroachment onto Mitchell grasslands[7], increased eucalypt cover in the Desert Uplands[8] and Central Highlands/Burdekin Catchment[9,10,11] and tea tree invasion of grasslands in Cape York[12]. Even National Parks and reserves abutting grazing land are subject to ongoing tree thickening e.g. the disappearing grassy balds of the Bunya Mountains[13], acacias invading grasslands on Moorinya N.P.[14] and rainforest invading wet sclerophyll forest in the wet tropics[15].

Throughout grazing lands the development of dense woody weed layers beneath predominant canopy species has also been a widespread phenomenon. [In NSW such woody weeds are known as invasive native scrub (INS)]. Familiar examples of native woody weeds in Queensland are burrum or currant bush[16], wattles, false sandalwood[17], green turkey bush[18], butterbush/silver cassia[19], grey turkey bush/hop bush/poplar box[20]. Some species e.g. cypress pine can be both valuable timber species as well as damaging woody weeds[21]. Others such as mulga can be important sources of drought fodder[22] and weedy species limiting pasture production and hindering mustering in better seasons[23]. At 'weed' densities trees and shrubs are also often safe havens for excessive kangaroo and feral animal populations.

The cause of this move towards woody plant dominance is widely thought to be changed fire regimes which followed the introduction of domestic livestock, and/or the elimination of indigenous management along with its' associated burning practices [24],[25],[26]. This vegetation 'switch' is not restricted to Queensland [27],[28], [29],[30] ,[31] and seems universal wherever Europeans and their domestic livestock have displaced hunter-gatherer societies[32] previously inhabiting woodland/savanna landscapes. [The 'switch' also contributes to grazed woodlands becoming net carbon dioxide sinks – see following discussion on net emissions].

The paradox of fire is that it has been difficult to emulate this influence under livestock grazing, while it undoubtedly played a key role in the evolution of our vegetation and its 'open' woodland community structure [33],[34], especially under indigenous management. First, livestock consume much of the fine fuels which would otherwise be available to carry fire. 'Ungrazed' pastures can also increase the spread and intensity of fire, which contributes to keeping woody plant populations in check. Second, the reality of our variable climate results in stock managers being reluctant to burn pastures for fear of exhausting feed supplies early in drought situations. [So when it was legal to do so much woody regrowth was stick-raked rather than burnt, because the former process conserved fodder growing within the regrowth, while the latter consumed it].

It is widely accepted that the indigenous people regularly burnt country to attract game (and facilitate human movement). This objective would be best achieved if patch burning was followed on some type of rotational basis. If such a burning regime led to land carrying a fire every 2-3 years many regenerating woody plants would be eliminated before they became sufficiently established to be able to survive fire[35],[36]. A neat biochemical analysis of grass tree stems reveals just such a fire frequency adopted by the Noongar people in pre-European SW Western Australia[37]. It is therefore my personal perspective that grazing by domestic livestock is incompatible with the re-establishment of true remnant vegetation within Queensland's grazed woodlands[38]. In fact only a conservation zealot would expect that the maintenance of true remnant vegetation is compatible with agricultural land use.

Woody plants (native trees and shrubs) are considered to be weeds on agricultural holdings if they limit pasture productivity or prevent the cultivation of land required for more intense pasture or crop production. It is therefore highly relevant that a large number of studies show there is a strong negative exponential relationship existing between potential pasture production and woody plant basal area (or stem density or canopy cover) for most of the species listed above[39],[40],[41],[42]. Thus the presence of relatively few woody plants per unit area can significantly depress pasture yields.

The widespread and ongoing "thickening" of the canopy and sub-canopy layers in Queensland's grazed "intact' forest and woodland communities has not deterred the Regional Ecosystem (RE) classifiers within government from continuing with the charade of describing much of this thickened vegetation as "Remnant" – clearly implying (in the vernacular sense, as well as in publication[43]) that the vegetation structure and composition presently on site, is a residual and identical to that present in 1788.

As an example of this deception I am familiar with a property in SW Queensland where the original Lands Department surveyors in 1895 described an area of vegetation as "open patches of gidgee and box flats – fairly grassed, chiefly mulga grasses". An aerial photograph taken in 1952 appears to still reflect this structure, while 2011 imagery suggests the same land was then completely dominated by woody plants. Yet since 2005 (and earlier[44]) this woody plant invaded site has been described as a "remnant" plant community. Additionally, a dense understorey of native shrubs (*Dodonaea, Eremophila and Senna* species), observable in 2006, does not appear to have been present on this area in 1895 or 1952.

One wouldn't expect those conservationists who are opposed to any development to understand, but a common maxim of rural landholders is to develop the best country (that capable of the greatest productivity improvement) first. Yet in generally marginal country there can often still be found what I call "pockets of viability" on most holdings. These may be small flats in the vicinity of streams or drainage lines, patches of gidgee or blackwood, box flats on more favoured sites, or areas of better class soils suited to more intensive land use. Development of these zones can often turn a marginal enterprise into an acceptable living area.

Likewise the development of "high value agriculture" is practical recognition that this can be a significant influence on whether an enterprise is viable or not. Many years ago I came across a trite but insightful phrase that simply stated - "the only sustainable agriculture is profitable agriculture"[45]. It is true that over short time frames agriculture can be profitable, but ultimately unsustainable. But more commonly, when faced with a non-viable enterprise, the owners will tend to flog their stock, the country and themselves before they surrender the land to their financial institution or eventually 'walk off'. None of these outcomes can be beneficial for either agricultural production, sustainable land use or conservation. So I find it passing strange that many conservationists (e.g. Taylor 2013)[46] rail against 'high value agriculture'.

The conservation lobby is also opposed to the recent removal of bans on the clearing of regrowth. The resilient nature of Queensland's woody vegetation means that one pass clearing is rarely fully effective in controlling woody species that limit agricultural production. In fact it is usually recognised that it may be necessary to treat a targeted area several times, before the woody plants are no longer competitive.

Regrowth is a consequence of clearing an area of designated agricultural land for which a permit was provided by the appropriate government agency, or for which a permit to clear was previously not required (e.g. on freehold land). No clearing operation is inexpensive. So allowing land to be cleared and then preventing subsequent (and necessary) regrowth control amounts to the imposition of damaging retrospective legislation, without compensation for the financial harm inflicted. This is obviously unjust, inequitable, and even darn right vindictive - targeting as it does landholders who did nothing illegal in the first place.

In any event regrowth following clearing is often of different woody plant composition to the pre-clearing community it replaced. In mixed eucalypt communities 'thickened' narrow leaved ironbark and gums are relatively simple to control, leading to regrowth that may be dominated by harder to kill bloodwoods. Likewise root suckering species are favoured post-clearing, compared with species that only regenerate from seed. This in turn can lead to significant changes in the fauna supported as well. Consider a community originally composed of brigalow, belah and wilga. Following clearing the regrowth will be predominantly a monospecific stand of dense brigalow suckers. Allowing the brigalow suckers to grow out will not restore the previous food source of glossy black and Major Mitchell cockatoos (belah seed cones) or eastern spinebills (nectar from the flowers of mistletoe parasitising wilga).

Donald Franklin [47] utilized reliable RAOU records, going back to the 1800's, to show that the marked decline in granivorous - grass seed eating - bird assemblages in Queensland's northern savannas, including the Desert Uplands, <u>preceded any land clearing activit</u>y. However woodland thickening over a centennial time scale is well documented for this Desert Uplands environment in the State's central west[48],[49],[50]. Meanwhile, as previously referenced[39 – 42], increasing tree/shrub cover severely depresses understorey grass production – especially on dry, infertile sites. In other words – more trees, less grass, fewer granivorous birds.

It is of particular interest that the Lake Dunn pollen record[51] from the Desert Uplands not only mirrors the woodland thickening that followed the commencement of livestock grazing, but it also captured (through the sharp decline in the presence of eucalypt family pollen from 1990) the widespread tree clearing + drought that took place in the area after that time. [This tree clearing was motivated by new techniques, the demonstrable benefits for pastoralism and the widely anticipated and telegraphed clearing bans that culminated in the VMA 1999]. Now here's the rub. A 2009 IBRA report has noted a recent <u>increase</u> in grassland birds in this region "*possibly reflects the increase in cleared land*"[52]. *Ipso facto* **land clearing is helping to restore biodiversity values, lost as a consequence of past tree thickening.**

This last example is mirrored in the recovery process for the endangered golden shouldered parrot endemic to native grasslands on Cape York. Habitat restoration recommended for golden-shouldered parrot recovery entails the reversal of tree invasion of the grassland. Burning trials in golden-shouldered parrot habitat have shown that open parrot habitat with occasional broad-leaved tea-tree can be completely lost to dense woodland in around 20 years, if left unburnt[53].

Net emissions of greenhouse gases in the grazed woodlands

Under Kyoto Protocol accounting rules Australia is said to have one of the highest per capita net emissions of carbon dioxide equivalent (CO_2-e) gas in the world. This claim is then advanced as additional justification for placing clearing bans in Queensland's grazed woodlands, ostensibly to avoid additional CO_2 being released to the atmosphere. The negative effect such bans would have on the productivity and viability of impacted agricultural holdings is now obvious, yet conveniently ignored by proponents of the bans.

Surprisingly however, sensors on Japan's IBUKI satellite and NASA's OCO-2 satellite both independently reveal that the Australian continental land mass is actually an annual net sink for CO_2. Importantly these data sets are for years of above and below average rainfall respectively.

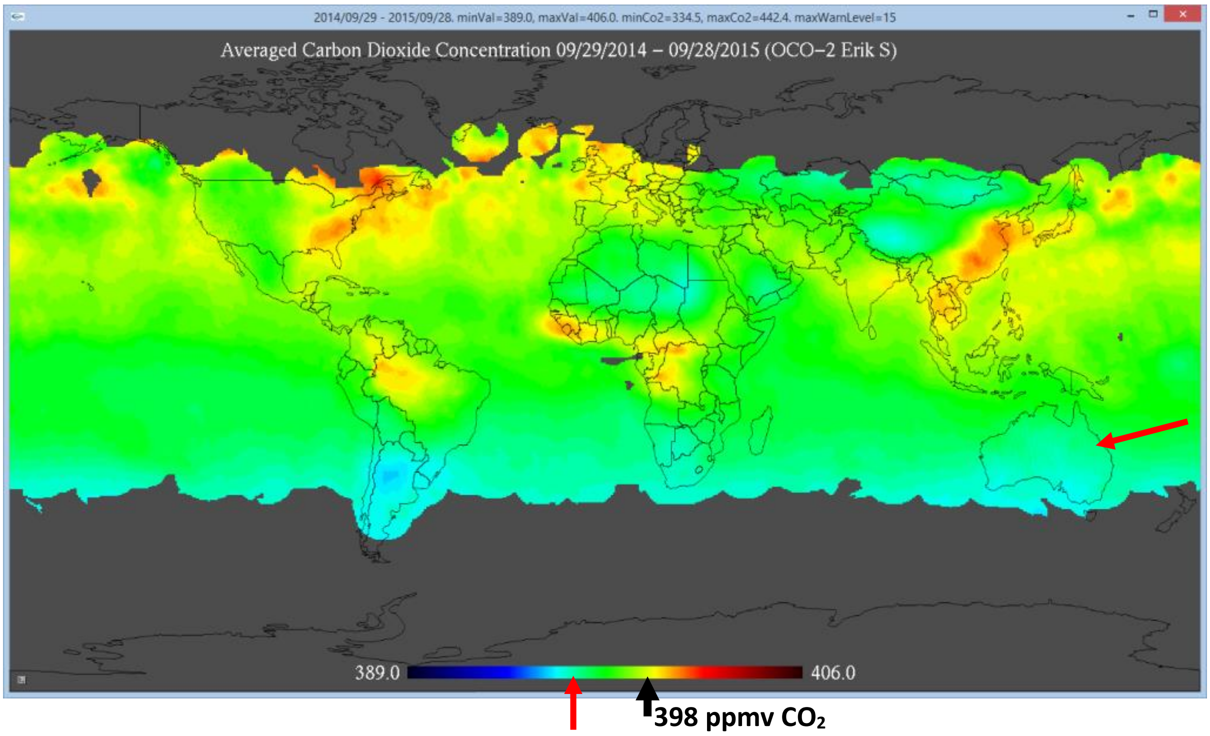

Figure 4. Visualization of net mean CO_2 concentrations in the world's atmosphere as recorded by sensors on NASA's OCO-2 satellite (for the 12 month period Oct 2014-Sept 2015 inclusive). Visualization prepared by Erik Swenson[54] from data sourced from NASA's JPL Laboratory [Mean global atmospheric CO_2 levels over the sampling period c. 398 ppmv – see text].

The IPCC states that CO_2 is a gas well mixed in the atmosphere[55]. Globally mean atmospheric CO_2 concentrations increased from 396.2 ppm in October 2014 to 398.7 ppm in October 2015 – an increase of c. 0.63%; whereas over the same time frame the increase in Australia's atmosphere was c. 0.5% (Dr David Crisp NASA JPL, pers. comm. 16.12.15). Since, for example the USA, China and Western Europe have CO_2 concentrations in the air column (above their respective land mass) that exceeds the global average, many other countries (including Australia) will have CO_2 in their air column <u>below the global average for this well mixed gas</u> – supporting the contention that such countries are net sinks for CO_2.

Therefore, in Australia's case more CO_2 is absorbed each year in growing vegetation at a continental scale, and/or dissolved in the surrounding ocean, than is emitted back to the atmosphere via the combined consumption of fossil fuels, fires (including land clearing), ocean outgassing and plant respiration.

The visualisation (Figure 4) shows that the atmosphere above the Australian continental land mass contains a lower CO_2 concentration than the mean global troposphere CO_2 concentration for the same sampling period (c. 398 ppmv – JAXA GOSAT data, Nov 2015). Since the visualisation requires some interpretation an alternative presentation[56] based on 2010 data downloaded from the IBUKI satellite sensors is also provided (Figure 5). [Also see: Detmers *et al.* (2015)[57] and Parker and Ollier (2015)[58] for similar results obtained over analogous time frames].

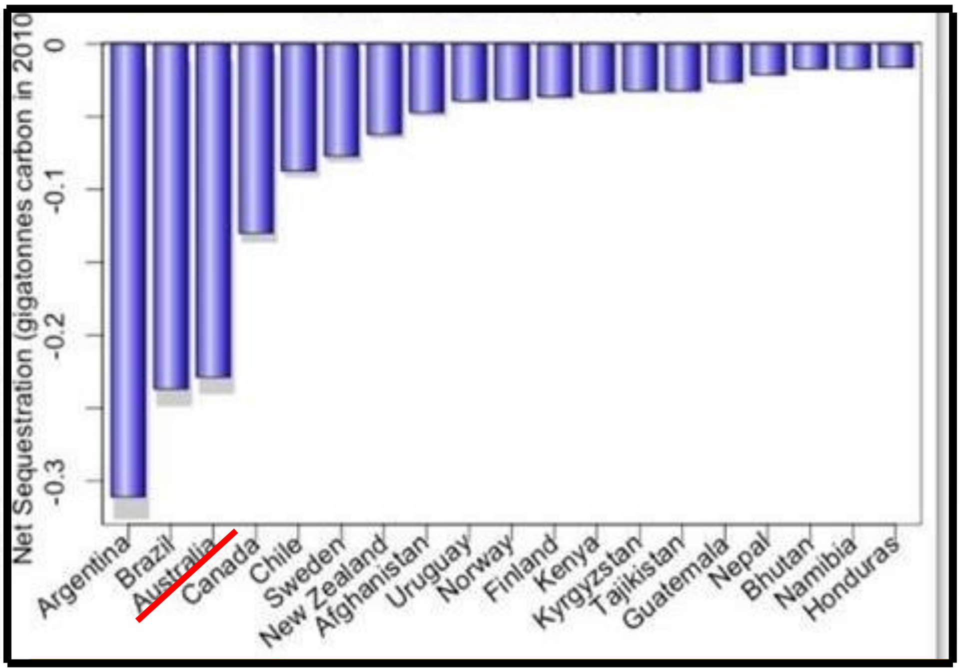

Figure 5. Top 20 nations recorded by the IBUKI satellite sensors[56] as being net CO_2 sinks in 2010. The data are presented as gigatonnes of carbon sequestered. To convert carbon to CO_2 – e (equivalent) multiply the C content by 3.7. [Please note: negative values indicate that more CO_2 is being withdrawn from the atmosphere above each nation's landmass overall, than is being added to it; an analogous diagram depicting the Top 20 net CO_2 emitting nations is displayed for completeness in Appendix 1].

Conclusion

This analysis has shown that:

- Queensland's tree/shrub cover increased its aboveground biomass and carbon content over the 20 year period 1993 – 2012. This is despite the fact that this timeframe coincided with a period of active broad scale tree clearing. The conclusion is based on satellite sensor measurements, with the findings strongly supported by a large number of complementary studies employing many different monitoring techniques. Failure to understand woody population dynamics in Queensland's grazed woodlands has no doubt contributed to the seeming inability of government to settle on a realistic and stable woodland management policy, applicable to agricultural lands.

- The proposal to reintroduce strict 'tree clearing' bans[59] is not justified in light of the above compelling evidence that 'intact' woody vegetation continues to 'thicken' in this State. Perhaps because of this reality it is now suggested that another reason to re-introduce clearing bans is to increase the capacity of the land as a greenhouse gas sink. However the data presented here show that this State is already a strong carbon sink and indeed would appear to be the State making the greatest contribution to Australia being a net sink for CO_2 overall. Thus Queensland is more than pulling its weight today, both nationally and internationally, in ameliorating CO_2 build-up in the atmosphere. Likewise, restricting tree/shrub clearing to simply further increase carbon sequestration on land assigned for agricultural purposes, seems to be an unnecessary impost, devoid of fairness to the landholder

The most important message that rural landholders can convey to people in other industries and their urban cousins is that the business they are in is agricultural production – the production of food and fibre for Australian and international markets. It is not conservation. If the two can be combined while not limiting the sustainable agricultural production potential of a property - well and good. But conservation superimposed on agricultural land use can (intentionally or not) restrict responsible development and management of woodland resources and so impact the viability of the rural enterprise. For example, it is made very clear in the documentation of most grazing homestead perpetual leases (GHPL) that the Purpose of the Lease is for 'grazing and agriculture'. This of course applies to agricultural land in general.

Yet it is obvious from the WWF's "Bushland at risk of renewed clearing in Queensland" document[46] that conservationists want to ignore this inconvenient fact. Instead they are essentially demanding that woodlands on agricultural holdings should be seen as a simple extension of the State's National Park and Reserve system. Or, if that demand can't be justified, they argue that the grazed woodlands should be "locked up" for carbon sequestration. However, as noted above, it is now well established via satellite based sensors, that the woodlands already contribute to Queensland and Australia being a net sink for carbon dioxide (after accounting for all the CO_2 contributing to the flux in this gas above the nation's land mass)*.

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* Australia has ignored much of the CO_2 sequestered on its landmass in the past, simply because of measurement problems and arbitrary accounting rules. But by now recognising "avoided deforestation" etc. as being eligible for sale as an entity under the Australian Government's 'Carbon Abatement Contract' process (either via Labor's CFI or the Coalition's Direct Action), the nation is effectively signalling that all carbon stored will be credited, if it can be documented. The sensors on Japan's IBUKI and NASA's OCO-2 satellites **integrate all sources and sinks of CO_2 in the air column above the Australian continent**. Thus they offer a more accurate assessment of the nation's true **net** CO_2 emissions – rather than relying on only partial sampling of sources and sinks e.g.as occurs for our vegetation – especially as in current estimates for our woodlands using the government's FullCAM model.

Politicians and conservationists who truly cared for the welfare of rural landholders and the contribution the latter make to the Australian economy, along with world food and fibre supplies, would not target an individual landholder's ability to run a viable farm business. In turn, when farm businesses are profitable, they might be surprised to find the Queensland economy and good conservation outcomes benefit as well.

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[38] As an agriculturalist, as well as an ecologist, I believe that landholders managing holdings assigned by government for agricultural production should have access to the best genotypes (plant and animal) available and appropriate to their environment. This is because our farm products generally have to compete on a world market. This does not rule out native organisms where that is the optimal choice e.g. there is no pasture more productive and better adapted to arid Mitchell grasslands than – Mitchell grass. Likewise buffel grass + Leucaena maintain ecological processes on former brigalow lands, but these introduced species are far more stable and productive than their native pasture alternatives. It is an absolute nonsense to imply that agricultural enterprises in Queensland should be solely dependent on native plants and animals – as some extreme conservationists are want to do.

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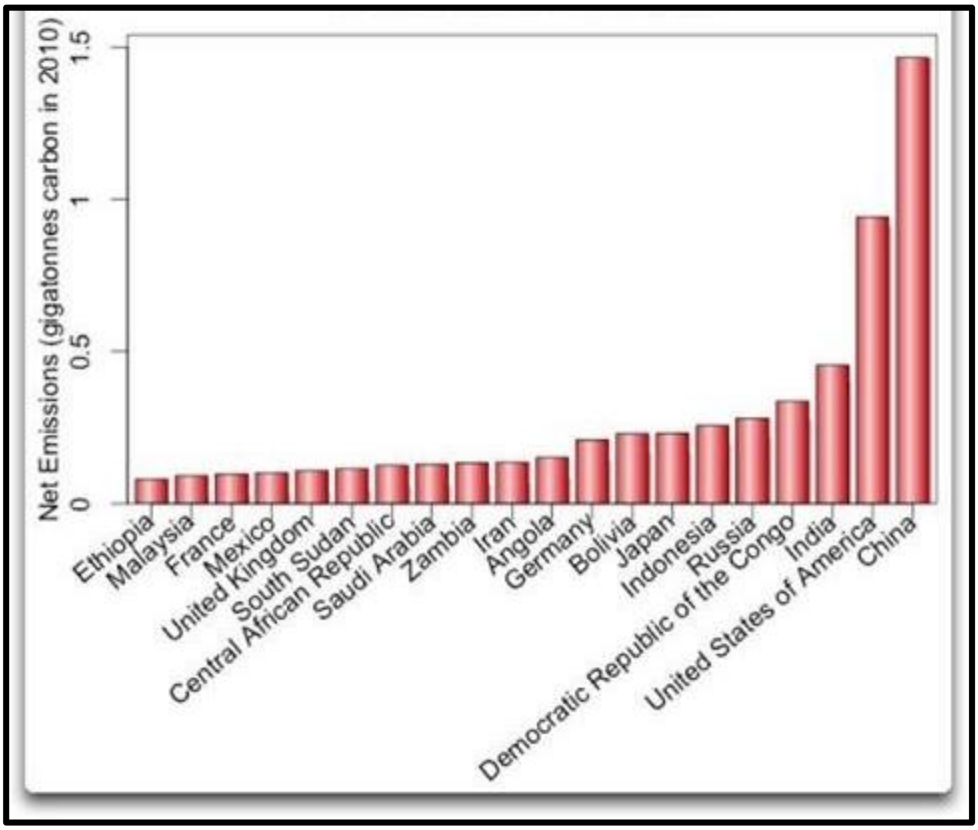
Appendix 1



Appendix 1. Top 20 nations recorded by the IBUKI satellite sensors[56] as being net CO_2 emitters (sources) to the atmosphere in 2010. The data are presented as gigatonnes of carbon emitted. To convert carbon to CO_2 –e (equivalent) multiply the C content by 3.7.

[An earlier version of this article is also available, courtesy Beef Central : http://www.beefcentral.com/wp-content/uploads/2015/12/Vegetation-Management-in-Queensland-Background-notes-for-State-MPs-Dec-20152.pdf]

WHB – January 2016