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Is it time to rethink Australia's carbon abatement contracts?

Australia's total net CO_2 emissions are much lower than implied by the National Greenhouse Gas Inventory. Averaged across years, we are highly likely to remain a net sink.

Native tree/shrub 'thickening' (an increasing carbon sink) over 15 years in eucalypt woodland in Central Queensland in 1984 (top) and in 1999 (bottom).

It is often said that Australia is one of the world's leading per capita emitters of carbon dioxide (CO_2). This statement is a consequence of our small population, coupled with an advanced economy and relatively large land area. Crucially, it also resulted from sources and sinks 'arbitrarily' included or excluded from the National Greenhouse Gas Inventory (NGGI) when inputs from the Land Use, Land Use Change and Forestry (LULUC&F) sector were allocated to it.

Therefore, huge areas of native vegetation have not been taken into account when compiling our carbon budgets. This nation has essentially reported CO_2 emissions that are conveniently 'measured' and directly identified with human activities – rather than those that mirror Australia's true input to CO_2 content in the global atmosphere.

A less selective and more meaningful analysis of CO_2 fluxes would report *net* emissions – the resultant when all known sinks (sequestered amounts) of CO_2 are subtracted from all known sources (the amount released to the atmosphere as a result of fossil fuel consumption, cement manufacture, land clearing, plant respiration/decomposition, fires, adjacent ocean outgassing, etc.).

Fortunately, satellite-based spectral sensors now enable net CO_2 emissions to be measured with accuracy and precision. The fact that we are an island continent adds to the integrity of the values reported (compared with countries in Europe, for example, where a nation's air mass can cross borders at daily – or even shorter – time intervals).

TWO SATELLITES

Two such satellites monitor CO_2 in the atmosphere today – Japan's GOSAT (Greenhouse Gases Observing Satellite) and NASA's OCO-2 (Orbiting Carbon Observatory-2). The former has been in orbit since 2009, while the latter (with a better coverage of the Earth's surface and about four times the precision of GOSAT) became operational in September 2014.

Both sets of satellite sensors record the column-averaged dry air mole fraction of CO_2 (X_{CO2} - ppmv) from the top of the Earth's atmosphere to its surface. The sensors integrate the net atmospheric contributions from all CO_2 sources and sinks, with no distinction made as to whether the recorded gas is anthropogenic or naturally occurring. Clearly it is the concentration of CO_2 in the atmosphere, rather than its origin, which is of most interest in monitoring it.

Prior to the space-based observations provided by GOSAT and OCO-2, carbon fluxes derived from ground-based measurements were problematic. This notably applied to those observations made for LULUC&F sector. To determine carbon fluxes in vegetation from field data it is necessary to obtain sequential recordings of carbon stocks in the above-ground and below-ground components of the vegetation, as well as in the soil supporting it.

Sampling problems are immense, particularly in native plant communities, and at any time weather patterns, vegetation age and disturbances, such as clearing, harvesting, fire and grazing, can impact the flux being estimated.

On the other hand only space-based measurements can provide the robustness, spatial coverage and sampling density/frequency, as well as the accuracy and precision necessary to determine the *Australia-wide* flux inversion of column-averaged CO_2.

Results from GOSAT and OCO-2 missions have been slow to be published. But two recent data sets suggest this country would be wise to embrace the technology and its outputs, especially given the significant budget allocations set aside by the Australian Government to buy Carbon Abatement Contracts (CACs).

A **carbon sink** is anything that absorbs more carbon that it releases.
A **carbon source** is anything that releases more carbon than it absorbs. Forests, soils, oceans and the atmosphere all store carbon, which moves between them in a continuous cycle.

CARBON SINK

A large enhanced carbon sink was detected over Australia in GOSAT records from the end of 2010 to early 2012, which amounted annually to some 2800 Mt CO_2-e (equivalent). This contrasted with Australia's reported NGGI emissions for 2011 of some 552 Mt CO_2-e – less than one-fifth of the land sink that was mostly excluded from that inventory year's calculations.

The vast CO_2 sink observed in 2011 has been attributed to the La Niña rainfall pattern experienced then, together with CO_2 fertilisation impacts on vegetation and perhaps reduced fire incidence.

This has led some to caution that Australia would not necessarily be a sink in years of below-average rainfall (such as El Niño years). This may be true, although a 12-month visualisation of CO_2 concentrations in the air above the Australian continent (September 2014 to September 2015) is highly indicative that the continent remained a net sink, even as the very strong 2015 El Niño was developing.

Several authors have further suggested this anomalous sink in 2010–12 was mainly the response by dryland vegetation to the higher rainfall. It was therefore implied that sinks developed in La Niña years would quickly dissipate with the return of more 'normal' seasonal conditions and wildfires.

But this belies Australia's extensive areas of woody vegetation in the arid zone and elsewhere. In 2001 native vegetation covered 6.7 million km^2 of the continent, with about 64 per cent dominated by woody plants. Perennial drought-resistant spinifex accounted for 74 per cent (1.7 million km^2) of remaining native grasslands.

A rising trend in woody biomass carbon was also reported in our northern savannas for the 20-year period 1993 to 2012, including years of well-above and well-below average rainfall, through observations obtained from satellite-borne passive microwave sensors.

The result is net of any concurrent loss in biomass due to tree clearing, woody plant deaths and fires occurring during the monitored period. Validation is provided by many published ground-based and aerial photo interpretation studies.

QUESTIONS

Given these findings one may well ask why has the Australian Government (through 'Direct Action') committed up to $2.5 billion to purchase CACs?

So far these contracts seem to be mostly based on modelling of native vegetation systems with questionable accuracy and precision surrounding the inputs. For example:

- Where is the evidence that confirms the history, structure and composition of vegetation on remotely sensed, remotely located and extensive Carbon Estimation Areas (CEAs), which can individually cover thousands of hectares?
- What field measurements are undertaken – and with what accuracy and precision – to validate inputs and outputs of the Emissions Reduction Fund's FullCAM modelling tool applied to each claimed CEA?

The simple fact is that any carbon flux in the vegetation contributing to these contracts is already captured by inversion of CO_2 detected by GOSAT and OCO-2 sensors.

At the very least, Australia's total net CO_2 emissions are much lower than has been implied by the NGGI. Averaged across years we are highly likely to remain a net sink.

Why pay $2 billion dollars or more for CACs with greatly limited land coverage, when a spatially comprehensive, accurate and precise accounting of net CO_2 fluxes for *all* of continental Australia can be derived from satellite sensors – at minimal cost to Australia's budget? ⊙

■ *Article sources are available from the author.*

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LIVESTOCK EMISSIONS CAN BE REDUCED

Scientists say the global livestock sector can maintain the economic and social benefits it delivers while significantly reducing emissions.

A new analysis published in *Nature Climate Change* estimates that livestock could account for up to half of the mitigation potential of the global agricultural, forestry and land-use sectors, which are the second largest source of emissions after the energy sector.

The global livestock sector supports about 1.3 billion producers and retailers around the world, and is a significant global economic contributor.

The lead author of the study, CSIRO's Dr Mario Herrero, said this new account of the mitigation potential for the global livestock sector is the most comprehensive analysis to date as it considers both the supply and demand sides of the industry.

"A key finding is that we can get the best mitigation potential from the livestock sector if we take an integrated view of land use and practice change that considers the whole of agriculture and forestry, as well as looking at dietary patterns and how we address the needs of global nutrition," he said. "Livestock has a role in a healthy and sustainable diet, and the sector has an important economic and social role, particularly in developing countries. We need to balance these health outcomes and the economic and social benefits, while also capturing the mitigation potential the livestock sector can offer.

"New management practices such as rotational grazing and dietary supplements can increase livestock production and reduce greenhouse gas emissions.

"If appropriately managed with the right regulatory framework, these practices can also achieve improved environmental health over and above the greenhouse gas benefits delivered, for example through improved ground cover and soil carbon."

PHOTO: ILRI/STEVIE MANN

A communal dairy centre in Yunnan, China.