Climate Change, Carbon Balance and LULUCF Activities:
Part 1. F(Utility) of Carbon Modelling & Conflict Assessment

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> "[A simulation model] *enables us to weave a tapestry in which threads of fact and fiction are combined to portray an impression of* [the environment]. *The result is a work of art, sometimes good, sometimes bad, but almost always giving the creator a feeling of euphoria. This euphoria often lives on for some time unless we make the mistake* [of validating the model output]."
>
> ***Passioura (1973)***

Land use, land-use change and forestry [LULUCF] activities can lead to a relatively cost-effective means for offsetting GHG emissions: Either by increasing the removal of GHG emissions *e.g. by managing forests*; or by lowering emissions *e.g. by reducing deforestation*.

In 1988, the journal of the American Association for the Advancement of Science reported an example of an offset, 6 years before the UNFCCC came into force: A United States company contracted with the World Resources Institute in

Washington to develop a plan to counter CO_2 emissions from one of its coal-fired power plants in Connecticut with a forestry project in Guatemala.

But there may also be areas of concern. In a media statement (on 9 March 2016), Queensland's Environment Minister Dr Steven Miles said that urgent action was required to address Queensland's carbon emissions:

"Land clearing in Queensland is now releasing more stored carbon into the atmosphere than at any other time in the past eight years".

Dr David Crisp, Leader of NASA's ***Orbiting Carbon Observatory-2*** ("OCO-2") Science Team sums up the position for science on the need to unravel global CO_2 fluxes: "*For society to better manage CO_2 levels in our atmosphere, we need to be able to measure the natural source and sink processes*."

A **carbon sink** *e.g. carbon in vegetation and soils*, removes more CO_2 from the atmosphere than it releases. A **carbon source** *e.g. burning of fossil fuels,* releases CO_2 emissions to the atmosphere.

The Meaning of LULUCF & its Application in Australia

Australia has adopted the Kyoto Protocol classification system for LULUCF - and its sub-classifications (or 'categories'): *deforestation, afforestation, reforestation, forest management, cropland management, grazing land management* and *revegetation*.

However, Australia has identified *deforestation, afforestation/ reforestation, and forest management,* to be the key LULUCF categories.

The focus on forests, by Australia, for LULUCF is not in dispute.

But it is surprising that semiarid bioregions, covering extensive areas of Australia and Queensland, that fall under the LULUCF category of "*grazing land management*", have not been identified as a key category? The omission of "*crop management*" as a key LULUCF category for Australia is also a source of concern!

It is relevant to note that carbon tracking by NOAA for the North American Continent found that "[Carbon] *sinks are mainly located in the agricultural*

regions of the U.S. and Canadian Midwest, and boreal forests in Canada."

Australia's National Greenhouse Inventory & Information Conflict

Management of global CO_2 levels is based on a mix of data obtained on land, global observation data obtained by satellite imagery - and the use of simulation models.

Australia has adopted the IPCC Guidelines to compile National Greenhouse Gas Inventories. The methodology estimates national GHG inventories as ***emissions originating from human sources*** as well as **removals by sinks**.

The National Greenhouse Inventory publishes Annual Reports for *"National Emission and Removal Related Trends"* for the Australian continent, under the UNFCCC, for six Sectors – including LULUCF[1]. For each year from 2010-2013, Australia was a net source of GHG emissions. Australia's LULUCF Sector was a net source in 2010, but a net sink from 2011-2013.

However, research published in the journal *Geophysical Research Letters* in October 2015 - using a different system for estimating natural sink and source processes - reached quite different conclusions for Australia.

Prominent Australian rangeland ecologist, Dr Bill Burrows, reviewed this study and makes the following incisive observation:

> *"A large enhanced carbon sink has been detected over Australia in GOSAT records from the end of 2010 to early 2012. It amounted to c. 2800 MT CO_2-e (equivalent) yr^{-1}. This contrasts with Australia's reported National Greenhouse Inventory emissions for 2011 of c. 552 MT CO_2-e (equivalent) yr^{-1}; less than one fifth of the land sink that was mostly excluded from the inventory's year's calculations".*

Two different systems for measuring and modelling atmospheric CO_2 levels have resulted in **different scientific conclusions and positions** on decision-making for environmental management and climate change. This is a classic information conflict over scientific data that needs to be resolved.

Case Study: *Baseline GHG Emission Projections, LULUCF and Land Clearing in Queensland, Australia*

One element of the 'Purpose' of Queensland's vegetation management legislation [at Section 3 (1)(g)] is to regulate tree clearing in a way that reduces GHG emissions. The Queensland Government now intends to introduce greater regulatory controls on tree clearing to cut GHG emissions.

A study into baseline GHG emissions projection for Queensland between 2013 and 2030 undertaken by Queensland's Environment Department provides the foundation for the intended legislative changes.

Changes in atmospheric CO_2 levels were assessed for 10 Sectors: *LULUCF, Energy, Fuel Combustion, Electricity, Direct Combustion, Transport, Fugitive Emissions, Industrial Processes, Agriculture* and *Waste.*

The study enabled a comparison between what emissions are for each Sector - and what emissions would be, without additional policy intervention.

Modelling predicted significant increases in 'carbon pollution' from 2013 to 2030 if Queensland did nothing to reduce carbon emissions: *A 35% increase for Queensland's carbon emissions in 2030 compared to 2013 levels. Emissions would increase sharply between now and 2020, followed by a more gradual rise in emissions to 2030.*

For the LULUCF Sector, the study concluded that the projected increases in carbon emissions, from 2013-2030, would be primarily due to an increase in land clearing.

The Queensland Environment Department's study was based on historical emissions from 1990-2013 for Queensland based on the National Greenhouse Inventory[2] Reports; the study then projected baselines for 2013-2030.

But, as noted in this article (at p.3), the GOSAT estimates for the Australian continent for 2010-2012 differs from the National Greenhouse Inventory estimates. This is a source of scientific uncertainty for regulatory control of tree clearing in a way to reduce GHG emissions in the LULUCF sector.

Conflict Assessment & Scientific Information
Knowns, Unknowns & Managing Atmospheric CO_2 Levels

Conflicts over scientific information are the primary source of conflict when the environment is in issue. Understanding concepts from **conflict assessment** and **conflict management** are the cornerstones for resolving the information conflict for managing atmospheric CO_2 levels.

Conflict assessment is the **first stage** for resolving any environmental conflict. It is a well-established procedure used to evaluate, amongst other things, whether there is a reasonable likelihood of managing or resolving an environmental conflict by negotiation.

One of the foundations for conflict assessment is a scoping exercise to identify - and prioritize - the issues in dispute when scientific uncertainty exists; as well, to identify issues where common ground exists.

What issues might arise from a scoping exercise that could be the focus for resolving the information conflict over different systems for measurement and modelling of global atmospheric CO_2 levels?

The observations of Donald Rumsfeld on *'facts and the varying degrees of scientific uncertainty'* provide a framework for summarising the likely key issues for conflict assessment.

(i) "Known knowns: Things we know, we know"

That the global carbon cycle has a ***central role*** in regulating atmospheric CO_2 levels and the earth's climate. This aspect is part of a body of scientific knowledge that is accepted as a reliable body of knowledge.

Common ground on this specific issue, would exist independent of the system of measurement and modelling adopted for managing atmospheric CO_2 levels.

(ii) "Known unknowns: Some things we do not know"

The IPCC acknowledges that there are possible sources of scientific uncertainty – as well as potential inaccuracies that may lead to bias – in different

systems for measuring and modelling atmospheric CO_2 levels that can be applied to LULUCF activities.

Scientific uncertainty can arise from limitations in the sampling processes - as well as the precision of satellite imagery - used for the measurement of atmospheric CO_2 levels. The complexity associated with modelling highly variable sources of emissions over space and time, especially for some biological sources, can also be problematic.

Emissions or removals for LULUCF activities, modelled by changes in carbon stocks, can be uncertain or inaccurate. Inaccuracy may arise from a lack of data or incomplete knowledge of the key driving processes for the carbon balance.

"Uncertainty analysis" conducted by Australia, in accordance with IPCC methodologies, reveal that the uncertainty surrounding estimates of emissions for CO_2 are higher for the agriculture and LULUCF sectors compared to energy consumption.

(iii) "Unknown unknowns: The ones we don't know we don't know"

The unknown relates to the progress in the existing body of scientific knowledge in our understanding of carbon balance and its applications to LULUCF activities?

The opinion of Dr Albert Parker[3] *(Intelligent Systems, Information and Modelling)* at James Cook University, Australia, is a relevant consideration: That *"different experimental and computational tools are still providing very different results.* [Should] *we look forward for more and more truly measured CO_2 data not corrected for compliance with models?"*

Conflict Management & Interest-Based Negotiation

Conflict management focusses on an *"interest-based approach"* to negotiation i.e. one based on understanding ***"needs and concerns"*** to resolve a scientific information conflict.

The "Rumsfeld framework highlights a key ***concern*** that is at the core of the "*Known unknowns"* and the *"Unknown unknowns*": The accuracy and reliability of different systems for measurement and modelling to better manage atmospheric CO_2 levels.

The IPCC has highlighted the ***need*** for GHG inventory methods and practices which are scientifically sound and relevant to all countries. *Achieving this need* is essential for all UNFCCC parties to estimate and report their emissions originating from human sources and removals of GHGs: That this information is essential for international negotiations to limit climate change.

Adopting and maintaining a ***position*** to support one system for measurement and modelling of atmospheric CO_2 levels – *rather than effectively addressing needs and concerns for the system itself* - will act a "log in the road" for resolving this scientific information conflict.

Conclusions

i. The IPCC has highlighted the need for GHG inventory methods and practices which are scientifically sound and relevant to all countries.
ii. It is not in dispute that systems for the measurement and modelling of national GHG inventories will improve over time.
iii. Improvements to provide more precise measurements of how sinks and sources vary by season, year and location will be made in accordance with new information that emerges from sampling processes combined with international advances in the capabilities of satellite imagery and high-performance sensors.
iv. But, there is now a classic scientific information conflict over conclusions arising from different systems for measuring and modelling atmospheric CO_2 levels - *IPCC, GOSAT* - and concerns over their accuracy and reliability.
v. Emissions or removals for LULUCF activities, modelled by changes in carbon stocks, pose specific problems because of potential uncertainties or

inaccuracies.

vi. Resolving the information conflict over the accuracy and reliability of carbon modelling will have significant applications at both the international and national levels; and for LULUCF activities in particular.

vii. At the international level, the appropriate body to undertake this task for the IPCC would be the Task Force on National Greenhouse Gas Inventories. The Task Force is responsible for assessing and developing inventory methods and practices.

viii. At the national level for Australia – *and the case for the State of Queensland* – there is a prudent path for Government to now take: To ensure that the system of measurement and modelling, relied on by the Queensland Environment Department to better manage atmospheric CO_2 levels in the LULUCF sector of Queensland, is accurate and reliable.

This path should be taken before Queensland introduces new legislative amendments to guide regulatory control of tree clearing in a way that reduces CO_2 emissions.

Part 2 of this article will focus on *"Conflict Management and the Scientific Round-Table"*, a dispute resolution process that is the cornerstone for resolving an information conflict over scientific data.

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End Notes

[1] All Energy (Stationary Energy, Transport, and Fugitive Emissions); Industrial Processes; Solvents; Agriculture; and Waste.

[2] The Australian Government's National Greenhouse Inventory Reports are published annually. They contain national GHG emission estimates for the period 1990-2013. They are compiled using methodologies for measurement and monitoring that conform to the international guidelines prepared by the IPCC and adopted by the UNFCCC – the 2006 IPCC Guidelines for National GHG Inventories (IPCC 2006) and the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC 2014).

[3] *"Discussion of the NASA OCO-2 Satellite Measurements of CO_2 Concentrations."*
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