Climate Change, Carbon Models and LULUCF Activities
Part 2. Conflict Management: Resolving Divergent Scientific Opinion

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Different sampling strategies and computational tools to guide global decision-making to better manage atmospheric CO_2 levels have led to different conclusions on carbon balance and natural sinks and sources.

A conflict over scientific information exists. This is not surprising as the primary source of conflict for any environmental conflict will inevitably be a conflict over scientific information.

Conflict over scientific information can arise from a lack of information, misinformation and scientific uncertainty. *However, conflicts over scientific information can also arise through different interpretations of the same information; or different opinions on what information is reliable and relevant.*

Conflict over scientific information is reflected in **divergent scientific opinion**. This leads to **different positions** associated with different systems for the measurement and modelling of atmospheric CO_2 levels that are considered to be scientifically sound and relevant to all countries.

Evaluating a Scientific Finding: *Science v Law*

To evaluate the accuracy and reliability of a scientific finding, science applies the enduring criteria of *testability, objectivity and impartiality* - together with the following test for acceptance of a finding: *Widespread consensus within the scientific community following peer review and publication*.

A landmark decision of the United States Supreme Court *(in "Daubert's case*[1]*)* established an even stricter test, compared to science, for the assessment of expert scientific evidence. The test was to ensure that the underlying reasoning or methodology in expert evidence was scientifically valid in order to be properly applied to the facts at issue.

For expert scientific evidence to be "***both relevant and reliable***", so as to comply with the Federal Rules of Evidence, the Supreme Court prescribed a number of considerations that were required to be assessed. They included:

- *"Whether the theory or technique in question can be (and has been) tested;"*
- *"Whether it has been subjected to peer review and publication";*
- *"Its known or potential error rate"; and*
- *"The existence and maintenance of standards controlling its operation, and whether it has attracted widespread acceptance within a relevant scientific community. The inquiry is a flexible one, and its focus must be solely on principles and methodology, not on the conclusions that they generate."*

There would be little dispute that the approach of the United States Supreme Court in *Daubert's* case is consistent with the standards and criteria used by science for evaluating the accuracy and reliability of a scientific finding.

Conflict Management: The Role of Objective Criteria

A key feature of conflict management is its focus on one of the four underlying principles of the *"interest-based approach"* to negotiated outcomes.

This principle is the foundation for resolving divergent scientific opinion and information conflict. Specifically: To "***insist on using objective criteria***" - not only to understand the scientific information – but also to evaluate it for its relevance and reliability.

The most obvious question that arises is how do you develop objective criteria to evaluate different systems for measurement and carbon modelling in order to better manage atmospheric CO_2 levels?

Clearly, the objective criteria must be based on accepted scientific knowledge.

Objective criteria used to evaluate the accuracy and reliability of scientific methods for measuring atmospheric CO_2 levels would need to be based on the accepted knowledge base for sampling processes and strategies.

The foundation for developing objective criteria to evaluate carbon models must be based on procedural steps, accepted by science, as being essential to construct the model.

(i) Evaluating the Methodology for Measuring Atmospheric CO_2 Levels

The "*Daubert standard*" could be applied as 'objective criteria' to systematically evaluate the sampling process, or sampling strategy, used to measure atmospheric CO_2 levels.

Sampling strategy has many elements. For example, *the number of sampling locations, as well as their global distribution, for measurement in the CO_2 observation network*[2]**.** This is probably the most basic element for ensuring that the scientific database acquired for measuring CO_2 fluxes will be accurate and statistically reliable.

Problems arise where the sources and sinks of CO_2 emissions are highly variable in space and/or time; and the number of sampling locations 'sparse' and spread over long distances.

The measured data may become a source of scientific uncertainty if it does not provide a **representative sample** of the global atmosphere in time and space.

Limitations in the sampling strategy or sampling process that leads to uncertainty or inaccuracy in the CO_2 database - and later used in a carbon model to locate, identify and measure the natural source and sink processes - will have a "flow-on effect". In particular, the weight given to the model's predictions to guide decision-making on managing CO_2 levels.

(ii) Evaluating the Accuracy and Reliability of Carbon Models

Simulation models may be of varying accuracy. The sources of any inaccuracy, or uncertainty, in the reliability of the output from a carbon model will reflect the extent that accepted procedural steps - *based on accepted scientific knowledge to construct models* - have been adhered to.

The following procedural steps for constructing a model warrant consideration as objective criteria to evaluate the accuracy of carbon models.

Carbon Balance Model: Some Key Procedural Steps

i. Ensuring accuracy and the statistical reliability of the experimental database arising from the sampling strategy for measuring atmospheric CO_2 levels.

ii. In constructing the basic framework for the model: The validity of the underlying assumptions on how the system operates as well as the parameters shortlisted and selected to be included in the carbon model;

ii. An independent validation of the accuracy of the model output carried out against field data other than the data upon which the model was constructed; &

iii. Some form of sensitivity analysis to address any uncertainty or weakness in the model's predictions associated with the parameters used in the model. Sources of uncertainty may be a lack of data or an understanding of key driving processes and variables.

The Scientific Round-Table & Conflict Management

The scientific round-table[3] is a joint fact-finding strategy that is the cornerstone for conflict management. It is based on a framework of alternative dispute resolution ("*ADR*") processes. An independent dispute resolver with expertise in ADR processes and the subject matter of the information conflict convenes the round-table.

The representatives at the **scientific round-table** are scientific professionals, having special expertise or knowledge in the subject matter of the issues in dispute.

A pre-condition is to ensure that all reliable scientific information known to be published, and which is relevant to the issues in dispute, is disclosed and made available through information exchange between all experts, prior to commencing.

The goal for the scientific experts at the round-table is to reach agreement by consensus on each scientific issue in dispute. This goal is facilitated by using a common set of objective criteria to evaluate disputed scientific issues.

The same objective criteria would be used to evaluate different systems for the measurement and modelling of atmospheric CO_2 levels.

Conclusions: The Scientific Round-Table & LULUCF Activities

At the international level, the *Task Force on National Greenhouse Gas Inventories* would be the appropriate body to consider using the scientific round-table process to resolve the scientific information conflict over the accuracy and reliability of different systems for measuring and modelling atmospheric CO_2 levels. The Task Force is responsible for assessing and developing inventory methods and practices which are scientifically sound and relevant to all countries.

Some specific issues, that may be problematic for accurate and reliable modelling the natural source and sink processes, are outlined: They warrant careful consideration for the LULUCF sector:

- A crucial step for assessing the accuracy of any model requires an independent validation of the model's predictions. For LULUCF activities and, in particular its "*grazing land management*" and "*crop management*" sub-classifications, annual changes in soil carbon may be small. Where this is the case, long-term field investigations may be required to ensure that a reliable database for soil carbon gains or losses exists that can be used for **model validation**.
- A further cautionary note for crop management/LULUCF in Australia is the suggestion that a robust modelling capability will require comprehensive field datasets to calibrate models and for model validation: The reason, *"the diversity of climate, soil types, and agricultural practices in place across Australia".*
- **Sensitivity analysis** is a significant step for identifying any **shortcomings in a model's predictions,** based on its underlying assumptions and parameters: For example, the scale of its predictions? Will the predictions apply at the continental level only? With the appropriate sampling strategy, will model predictions apply at the sub-continental level; or biome; or the Kyoto Protocol definition for LULUCF and all its sub-classifications; or the bioregion[4]?
- Modelling the **net carbon balance of plants** for LULUCF activities is problematic. The net balance between *CO_2 "uptake" in photosynthesis* and *CO_2 "release" in respiration* will differ, depending on the **type of photosynthetic pathway**: C_3 *(e.g. temperate crops; woodlands and forests)* or C_4 *(e.g. tropical grasses and tropical crops*) pathway[5].
- There are significant differences between C_3 and C_4 plants in **photosynthetic rates** as well as diurnal (*day/night*) **respiration rates**. Photosynthetic rates are generally greater in C_4 compared to C_3 species. Photorespiration is high in C_3 plants; but, in comparison, minimal (or nil) in C_4 plants. There may be little difference in dark respiration rates between C_3 plants compared to C_4 plants.
- A research study over a three-year period for 15 European forests concluded that, in general, **ecosystem respiration** is the main determinant of **carbon**

balance in European forests. If this observation has wider application to global forest ecosystems, the diurnal photosynthesis/respiration balance is a relevant consideration for the measurement and modelling of natural source and sink processes for LULUCF activities e.g. GOSAT, NASA's OCO-2[6].

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Ted Christie is an environmental lawyer and scientist with a keen interest in the use of alternative dispute resolution and effective public participation processes for finding solutions for environmental conflicts: Solutions that are sustainable and where environmental justice prevails.

Ted is the author of the cross-disciplinary (*law/science/negotiation*) book, "*Finding Solutions for Environmental Conflicts: Power and Negotiation*" (2008, 2009) Edward Elgar Publ., Cheltenham, UK.

End Notes

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1 *Daubert v Merrell Dow Pharmaceuticals Inc.* 509 U.S. 579 (1993)

2 Atmospheric CO_2 observations are contributed to the U.S. Department of Commerce's *National Oceanic & Atmospheric Administration* ("**NOAA**") through a *global network involving widespread collaboration with over 160 sampling locations in 46 countries.*

For Australia, CSIRO collaborates with NOAA at five locations: Northern Territory, at *Gunn Point;* Queensland, at *Cape Ferguson* and *Arcturus (near Emerald*); Victoria, at *Otway;* Tasmania, at *Cape Grim.*

3 The scientific round table has been developed and used by the author for managing information conflicts, where negotiation is undertaken to resolve environmental conflicts, external to and independent of the courts. It is a structured process for evaluating divergent viewpoints on scientific and technical issues in environmental conflicts.

4 In Australia, landscapes are classified, into geographically distinct **bioregions** based on common climate, geology, landform, native vegetation and species information.

There are 13 bioregions recognised in Queensland. Bioregions where regulatory control of tree clearing or regrowth and GHG emissions are in issue include: The Mulga Lands; Brigalow Belt North; Brigalow Belt South; and the Gulf Plains.

5 For LULUCF/ *'Grazing Land Management'* in Queensland, there are extensive areas of C_4 native tussock grasses e.g. Mitchell grass (*Astrebla spp*.), Kangaroo grass (*Themeda spp*.), Spear grass (*Heteropogon spp*.) and introduced C_4 tussock grasses e.g. Buffel grass (*Cenchrus spp.);* and C_3 woodlands (Mulga, *Acacia aneura;* Brigalow*, Acacia harpophylla*). C_4 crops grown are sugar cane, sorghum and maize.

6 NASA's Orbiting Carbon Observatory-2 ("OCO-2") samples the global atmosphere above land and water: Over "*100,000 precise individual measurements of CO_2 over Earth's entire sunlit hemisphere every day*".