Scientific Aspects of the Garnaut Review

[The author is a senior officer in an organisation which would take a dim view of this contribution being publicly attributed to him]

Abstract

There are significant flaws in the handling of scientific issues in the Garnaut Climate Change Review. The Review presents incorrect basic data on greenhouse gases (GHGs) and an over-simplified picture of the greenhouse effect. It fails to identify the key points of scientific disagreement about the scale of human influence, and too confidently attributes current and future climate changes to human-induced GHG changes. Its treatment of climate projections neglects to make adequate allowance for model uncertainty and error. These faults reflect pre-judgments incorporated in Garnaut's terms of reference, his early decision to rely on "mainstream science", and the consequent discouragement of independent scientific input.

Basic data on GHGs

Some basic errors in data on GHGs persisted through the Garnaut Review's interim, draft and final reports:

- GHGs are said to make up "just 0.1 per cent of the atmosphere by volume".[1] The correct figure is about 0.4 per cent for water vapour and 0.04 per cent for all other greenhouse gases combined.[2] Garnaut correctly recognises water vapour as a GHG[3], so his estimate is too low by a factor of 4-5.
- the anthropogenically-driven rise in carbon dioxide (CO2) since the industrial revolution is claimed to be "about double the normal 'operating range' of carbon dioxide during glacial-interglacial cycling".[4] In fact the rise (from 280 to 385 ppm) is slightly less than the range (180 to 300 ppm[5]).
- the draft and final reports give the radiative effect of GHG changes since the industrial revolution as "2.63",[6] omitting the unit of measurement (watts per square meter). The effect is said to be "equivalent to the warming effect of 455 ppm"[7] of CO2, when in fact it is only equivalent to the warming effect of raising CO2 from 280 ppm (the pre-industrial level) to 455 ppm (the level that would now obtain if all increases in GHGs in the industrial era had been in the form of CO2).[8]

Some other errors were picked up between the draft and final reports. The latter corrected a statement implying that the pre-industrial level of CO2 was "similar to" the bottom of the range of CO2 over the history of the earth[9] (in fact it is more than 50% higher than the bottom of the range). The final report also dropped the illogical assertion that if there were natural as well as anthropogenic causes of recent warming, this could increase the importance of reducing the anthropogenic influences.[10] Still, the errors that remain suggest some lingering unfamiliarity with basic GHG parameters.

Radiation and climate dynamics

Garnaut presents the greenhouse effect thus:

The earth's atmosphere acts like the roof of a greenhouse, allowing short-wavelength (visible) solar radiation from the sun to reach the surface, but absorbing the long-wavelength heat that is emitted back.[11]

This is a common, but unfortunate, misconception. The roof of a greenhouse does <u>not</u> act by absorbing long-wavelength heat. Rather, it blocks convection, i.e. the upward movement of warm air. Moreover, the atmosphere's greenhouse effect arises not from its absorbing heat emitted back from the surface, but from its subsequent re-emission of long-wave radiation in all directions, including toward the surface, and from the complex dynamics that result.[12]

Garnaut's description of heat in the climate system focuses solely on radiative properties such as scattering, absorption, reflection, or re-emission:

The composition of gases in the atmosphere plays a big part in the amount of heat that is retained in the climate system, but there are many other influences. Aerosols (Box 2.1) can scatter the incoming radiation so that it never reaches the surface, and can also cause changes in cloud cover. More clouds will reflect more sunlight from their upper surfaces, but also absorb more heat radiating from the earth. Variations in land cover affect the amount of sunlight that is reflected from the surface (the 'albedo effect'), and how much is absorbed and re-emitted as heat.[13]

This presents each element of the system as part of a static radiative framework, omitting atmospheric dynamics. Yet the fact is that most heat transport in the lower atmosphere is accomplished by thermodynamic processes such as convection, advection by winds, evaporation and condensation – and not by the radiative transfers Garnaut describes.[14]

The atmosphere's thermodynamic responses to radiative forcing constitute the essential problem in predicting what climate change might arise from increases in GHGs. This is also the key issue that divides believers and doubters of the catastrophic greenhouse scenario. Both sides agree that the radiative effect of doubling CO2 would result in a warming of up to 1 degree Celsius if there were no consequent effects (feedbacks).[15] But they disagree on the feedbacks that would then arise in the dynamic processes of the atmosphere. Believers think feedbacks would amplify warming to between 2 and 4.5 degrees; doubters think they would constrain it to between 0.3 and 1.5 degrees.

Garnaut describes the doubters' position thus:

The scientifically reputed 'sceptics', to the Review's understanding without exception, accept that an increase in carbon dioxide concentrations in itself leads to warming (Lindzen 2008). The 'sceptics' variously contest the relationship between human-induced anthropogenic emissions and atmospheric concentrations, or the relative importance of the enhanced greenhouse effect and other factors that influence climate.[16]

This omits two essential points: (i) that warming from doubling CO2 "in itself" is no more than about 1 degree, and (ii) the sceptics' belief that feedbacks may be small and could reduce the warming.

Garnaut's presentation of the greenhouse mechanism is simplistic and inhibits his ability to understand the basis for the sceptics' view that foreseeable GHG increases may have a negligible impact on climate.

The role of GHGs in observed climate changes

Chapter 5 of the final Garnaut report highlights studies and events that suggest the greenhouse effect may be at least partly responsible for observed climate changes in Australia. Several examples omit inconvenient facts or obvious alternative explanations, e.g.:

- the Report attributes higher temperatures in southeast Australia to human-induced climate change,[17] and then points to a recent record number of warm nights in Sydney,[18] without mentioning the growing urban heat island effect that now raises nighttime Sydney temperatures by 2-4 degrees.
- it ascribes the 70% decrease in streamflow into Perth's dams since 1975 to reduced rainfall in southwestern Australia due in part to "human-induced climate change."[19] No mention is made of (i) the effects on streamflow of irrigation, forest regrowth, and catchment management practices, (ii) the fact that the rainfall decline was only 10%, or (iii) that this decline occurred before 1975.[20]

In these and other examples, Garnaut is too eager to blame greenhouse gases for recent climate changes, especially unpleasant ones.

Overconfidence about future climate

Garnaut spotlights the role of GHGs in future climate change as follows:

Even if there were no further human-induced increases in aerosols and greenhouse gases, the long-lived greenhouse gases would remain for hundreds and even thousands of years, leading to continued warming. Aerosols are removed from the atmosphere over much shorter periods, so their cooling effect would no longer be present. Therefore, in the long term, the major influence of humans on the climate will be through activities that lead to increased concentrations of greenhouse gases in the atmosphere.[21]

This is too simple. If there were no further increases in GHG or aerosol concentrations, both would simply exert their current forcings in accordance with their respective concentrations. And other human influences on climate, such as land use changes, might eventually have a greater influence than GHGs, depending on their magnitude. Then again, natural factors may trump all human influence. But Garnaut's reduction of climate prediction to human GHG emissions emboldens him to make many unqualified predictions (our bolding):

*As a result of past actions, the world **is already committed** to a level of warming that could lead to damaging climate change.*[22]
*The human-induced warming and the associated changes in climate that **will occur** over the next few decades **will largely be the result** of our past actions and be fairly insensitive to our current actions.*[23]
*Climate model simulations **show** that, as temperatures increase, there **will be** increased precipitation in the tropics and at high latitudes, and decreased precipitation in the subtropical and temperate regions*[24]
*Rainfall **is set to increase** at high latitudes and over equatorial oceans*[25]
*By 2030, annual average temperature over Australia **will be** around 1ºC above 1990 levels*[26]

These predictions are too presumptive. Even IPCC reports deal with the phenomena mentioned only in terms of probabilities. At other points in his report, Garnaut recognizes this, so he should not have made such unqualified statements.

Probabilities of climate changes

Garnaut states that:

The likelihood of a particular outcome can be assessed through the use of a range of models. However, outcomes at the high or low end of a range of model results may also be plausible.[27]

This underestimates the uncertainties involved. Given current scientific knowledge, it is not possible to predict future climate.[28] Spreads of model outputs are not true estimates of the likelihood of outcomes, since the models are simplifications of climate that have known systematic errors.[29] As a recent CSIRO report explains, the true range of uncertainty extends beyond the range of model results to incorporate model uncertainty, expert judgment on the models, and possible error in expert judgment.[30]

All the probabilistic statements in the review need to be viewed in the light of these limitations, but some specific statements raise further questions, for example:

The mainstream Australian science estimates that there may be a 10 per cent chance of a small increase in average rainfall.[31]

This statement is given as a "Key Point" at the beginning of Chapter 5 of the final report, but with no timeframe or supporting reference. Section 5.3.2, which deals with future rainfall, does not contain the claim, or indeed any estimate of the chance of an increase in Australian rainfall, or any mention of a 10 per cent chance of anything. Moreover, the statement is at odds with the latest IPCC report, which shows 25 per cent of models predicting rainfall increases of greater than 8 per cent in northern Australia and greater than 3 per cent in southern Australia.[32]

The probabilities cited in the Garnaut report need to be taken with a large grain of salt.

Writing off the doubters

Professor Garnaut's terms of reference restricted his consideration to the "likely effect of **human-induced** climate change" and directed him to "take into account" the "weight of scientific opinion" on necessary emission reductions by developed countries.[33] His interim report also stated that he was unable to independently evaluate the science and would therefore take majority opinion as a starting point.

Garnaut was therefore bound to rely on "mainstream science". This became steadily more apparent as the Review progressed. He met early on with a variety of scientists, including several leading experts who reject the alarmist view. His interim report promised recommendations "on expanding and strengthening the pluralist character of the Australian research efforts in climate change science."[34] But the subsequent reports failed to make such recommendations, and progressively dropped references to dissenters' views.

The final Garnaut report contains what appears to be a veiled attack on the motives of doubters:

...the large effects of possible policy responses on levels and distributions of income [invite] intense and focused involvement in the discussion by those with vested interests"[35]

and he was openly dismissive of their viewpoint in presenting this report to the media:

He dismissed the so-called sceptics, who argue man-made climate change is not real or dangerous, or that temperatures are falling, not rising. "It's very understandable. You get crank religious movements that reinterpret the evidence around them whenever humanity faces a great challenge."[36]

Only history will show whether this crushing verdict was justified. But it was an oddly confident dismissal from one who had disclaimed scientific knowledge from the start, and stated that he only accepted majority opinion "on the balance of probabilities, and not as a matter of belief".[37]

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[1] GFR, p. 24.
[2] IPCC AR4, p. 131.
[3] GFR, pp. 24, 28 (Figure 2.2), 30 (Figure 2.3), 31, 32 (Table 2.1), 33, 34, 38.
[4] GFR, p. 25.
[5] IPCC AR4, p. 435. GFR p. 26 gives 180-280 ppm citing Steffen (2004).
[6] GDR, p. 67; GFR, p. 38.
[7] GFR, p. 38.
[8] Given that the radiative forcing of additional CO2 declines logarithmically, the effect of the increase from 280 ppm to 455 ppm is an order of magnitude lower than that of 455 ppm.
[9] GDR, p. 49.
[10] GDR, p. 52.
[11] GFR, p. 24.
[12] For the fact that a greenhouse roof inhibits convection, a completely different physical process from the radiative effect of GHG increases, see National Oceanic and Atmospheric Administration, "Greenhouse Gases and Aerosols",

www.oar.noaa.gov/climate/t_greenhouse.html and cf. IPCC AR4, p. 115. For an understanding of the radiative greenhouse effect and its consequences, which are more complex than the standard representation, see R. S. Lindzen, "Taking Greenhouse Warming Seriously", *Energy and Environment, 18:7+8,* 200, p. 939; J. Zillman, "Uncertainty and Climate Change: The Challenge for Policy" at www.assa.edu.au/publications/op/op22005.pdf, pp. 6-7; and especially W. Kininmonth, "Climate Change: A Natural Hazard", Multi-Science Publishing, 2006, pp. 7-9.

[13] GFR, p. 29.

[14] Lindzen, loc. cit.

[15] IPCC TAR, 1.3.1; IPCC AR4, p. 114.

[16] GDR, pp. 48-9.

[17] GFR, p. 106.

[18] GFR, p. 112.

[19] GFR, p. 106.

[20] A geologist, Warwick Hughes, has compiled extensive resources on this topic at www.warwickhughes.com/water. See also Bureau of Meteorology graphic for Southwestern Australia Annual Rainfall at www.bom.gov.au/cgi-bin/silo/reg/cli_chg/timeseries.cgi?variable=rain&region=swaus&season=0112.

[21] GFR, pp. 29-30. Garnaut's characterization of mean residence times is too sweeping. IPCC AR4 (p. 77) is more correct in saying "Some greenhouse gases have relatively short atmospheric lifetimes (decades or less), such as CH4 and carbon monoxide, while others such as N2O have lifetimes of the order of a century, and some have lifetimes of millennia, such as SF6 and PFCs.[…]Removal of CO2 emitted to the atmosphere occurs over multiple time scales, but some CO2 will stay in the atmosphere for many thousands of years."

[22] GFR, p. 75.

[23] GFR, p. 85.

[24] GFR, p. 92, referring to IPCC AR4, p. 750.

[25] GFR, p. 92.

[26] GFR, p. 113.

[27] GFR, p. 84.

[28] "In climate research and modeling, we should recognize that we are dealing with a coupled non-linear chaotic system, and therefore that the long-term prediction of future climate states is not possible. The most we can expect to achieve is the prediction of the probability distribution of the system's future possible states by the generation of ensembles of model solutions." IPCC TAR, Chapter 14.2.2.2. On the relation of these ensembles to expert judgment, see CSIRO, *Climate Change in Australia*, Technical Report, 2007, pp. 43-7.

[29] See workshop presentations on systematic climate models errors at www-pcmdi.llnl.gov/wgne2007/presentations/.

[30] See CSIRO, *Climate Change in Australia*, Technical Report, 2007, p. 44.

[31] GFR, p. 105.

[32] IPCC AR4, p. 856. Note that relevant latitude and longitude coverages include only Australia, not New Zealand.

[33] www.garnautreview.org.au/terms.htm, our bolding.

[34] GIR, p. 9.

[35] GFR, p. 23.

[36] Sydney Morning Herald, 29/9/2008.

[37] GFR, p. 23.

Key to endnotes: GIR=Garnaut Interim Report; GDR=Garnaut Draft Report; GFR=Garnaut Final Report; IPCC TAR= Intergovernmental Panel on Climate Change, Third Assessment Report; IPCC AR4=Intergovernmental Panel on Climate Change, Fourth Assessment Report.