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4 March 2020

Chair, Senate Economics Legislation Committee
PO Box 6100
Parliament House
Canberra ACT 2600

Senator Malcolm Roberts
PO Box 6100
Senate
Parliament House
Canberra ACT 2600

Dear Chair and Senator Roberts,

RE: Additional Estimates for 2019-20 – Letter from Senator Roberts, 28 February 2020

I refer to the letter from Senator Roberts which I received on Monday night this week (attached). Thank you Senator for your questions and continued interest in CSIRO's research, particularly in the area of climate science. Responses to the specific questions are below and in the attachment.

While you consider this information, I would like to extend the invitation to expand our discussions to other areas of scientific research that we deliver to the nation, and provide a briefing on the critical work we are delivering right now on drought, bushfire response and battling the coronavirus (to name but a few).

I would also like to address the intimations you raise in relation to CSIRO's credibility and by inference, the people who work there. CSIRO stands behind its researchers and the integrity of the research produced by them. CSIRO's demonstrated record of scientific excellence is underpinned by our commitment to the full and transparent participation in the scientific peer review process which results in evidence-based science of the highest quality, including making data publicly available.

CSIRO is in the top 0.1% of the world for its four core fields of science, and in the world's top 1% for the other 14 fields. We are independently ranked by Thompson Reuter's in the world's top 20 most innovative government agencies. We rank in the top 3 of the world's national science agencies for our impact. Under Strategy 2020 we've delivered more real-world solutions from science than ever before and our ROI on the Government's roughly $800million investment in the CSIRO has been independently audited at 5:1 - a benchmark return for a venture fund let alone a government agency.

I mention solutions from science, because CSIRO's purpose is to solve Australia's greatest challenges with science - and given unprecedented global disruption of technology, geopolitics, disease, and environment, we need solutions from science more than ever before.

The science on climate change is settled, and after many hours spent with you, responding to Questions on Notice, questions posed at these hearings, and through the documents that our researchers have shared,

including those considered to be some of the world's leading climate scientists, I think it's safe to say you and I will not agree.

CSIRO works with industry and the community to work toward zero emissions, turning science into solutions to tackle the disruption and turn it to Australia's advantage. Examples include:

- Hydrogen as a renewable liquid fuel, and taking it a step further by working with major resources company, FMG, to creating a potential new industry, with new wealth and new jobs
- Future Feed, a cattle feed which reduces emissions from cows, and increases the nutritional value for the animals, helping to increase the bottom line;
- Liquid coal with emissions 30% lower than a petrol-powered car.

CSIRO's research is helping Australia respond to the challenges and opportunities of climate change.

As I have stated, CSIRO stands behind its researchers and the integrity of the research produced by them.

Yours sincerely,

Dr Larry Marshall
Chief Executive
CSIRO

Attachments: Responses to Senator Roberts questions received via letter, dated 28 February 2020
Letter received by Senator Roberts, dated 28 February 2020

Attachment: Responses to Senator Roberts questions

Empirical scientific evidence

The science of climate change and the uncertainties surrounding the field are complex and CSIRO's role includes:

- providing empirical scientific evidence (notably, measurement of atmospheric carbon dioxide levels and of ocean temperatures and sea levels); and
- by collaboration with national and global scientific peers to develop a better understanding of the science of climate change.

Although the empirical measurements on climate metrics include uncertainties (which is no different from other scientific activities), despite these uncertainties the empirical scientific evidence of climate change is clear: **globally observed carbon dioxide levels, temperature and sea levels are rising faster and can be attributed to human activities**.

The empirical measurements stand alone as important evidence, but that data is also used in modelling in order to explain the observed phenomena and to understand the dynamics of the global system. These models numerically simulate the processes of the climate system (somewhat analogous to weather prediction models) to understand what is clearly a complex and dynamic climate system. Although multiple approaches can be taken to such modelling, use of such modelling is established scientific methodology and can provide valuable perspectives - notwithstanding that this approach leads to discussion of methodological issues as a necessary element of consideration of the modelling.

Given the empirical evidence on climate change that CSIRO has pointed to in its publications and reports and in previous appearances is clear, it is therefore apposite that CSIRO's research programs are also directed towards identifying ways to mitigate and reduce greenhouse gas emissions and preparing for, and adapting to, climate change impacts that are now unavoidable.

Answer to specific questions

Question (page 1): *what evidence CSIRO has to prove any change in climate, climate factors, and climate processes over the past 150 years and separately over the last 10,000 years that indicate a statistically significant process change in climate, being "climate change". .... When ... CSIRO climate team respond with a claimed change in climate process variability in time series data on climate factors, please specify in detail the statistical analysis method(s) used to identify any claimed significant change in natural climate variability.*

Answer: CSIRO has provided this empirical evidence to the Committee on a number of occasions. To summarise, I provide several headline observations:

- **Carbon dioxide concentrations in the atmosphere today are unprecedented over at least the past 800,000 years** (see page 5 of answer SI-124); See below for further information of the CSIRO research on this issue;
- Gases in addition to carbon dioxide affect climate; i.e. methane, N2O, CFCs and tropospheric ozone; and also that aerosols have masked some of the GHG warming;
- **The rate of rise in global mean temperature is unprecedented in the past 10,000 years** (see page 4 of answer SI-123). Temperatures were warm in the early part of the Holocene, then cooled until the Industrial Revolution, and then have risen rapidly since then. Note that whilst the temperatures at the moment are not unprecedented in the last 10,000 years, **global temperature has risen from near the coldest to the warmest levels of the Holocene within the last century, reversing the long-term cooling trend that began 5000 years ago.**

In 2017, CSIRO presented the scientific evidence in relation to climate change to Senator Roberts, and the transcript of those discussions is on the public record including having been tabled at this Committee.

Question (page 2): *I please request that you provide the following in regard to the UNIPCC's Fifth Assessment Report 2014, specifically its report AR5 Climate Change 2013: The Physical Science Basis:*

- *The location, including specific page numbers, of the empirical scientific evidence within a causal framework scientifically proving that carbon dioxide from human activity affects climate and needs to be cut;*
- *The location, including specific page numbers, of anything unprecedented in climate during the last 10,000 years together with the empirical scientific evidence proving that it was/is due to carbon dioxide from human activity; and*
- *The location of any statistically significant change in climate variability.*

Answer: CSIRO contributed to the Climate Change 2013: The Physical Science Basis report and notes that the conclusions drawn in that report are consistent with CSIRO's own analysis of the scientific evidence. In 2017, CSIRO presented the scientific evidence in relation to climate change to Senator Roberts in a meeting, including evidence that is presented in this report, and the presentation and a transcript of those discussions has been tabled at this Committee and published. See the answer below in relation to CSIRO's research in relation to carbon dioxide levels.

Question (page 2): *I request that you provide the following in regard to the State of the Climate Report 2018 that CSIRO produced in conjunction with the Australian Bureau of Meteorology:*

- *The location, including specific page numbers, of the empirical scientific evidence within a causal framework scientifically proving that carbon dioxide from human activity affects climate and needs to be cut;*
- *The location, including specific page numbers, of anything unprecedented in climate during the last 10,000 years together with the empirical scientific evidence proving that it was/is due to carbon dioxide from human activity; and*
- *The location of any statistically significant change in climate variability.*

Answer: The evidence provided in the State of the Climate shows observed changes in the concentration of carbon dioxide in the global atmosphere over the last ca. 2,000 years and 800,000 years. This evidence has been provided previously to the Committee - see pages 5 and 8, respectively, of answer SI-124 - and for that reason the answer will refer to that record. The graphs show observations that are sourced from:

i. Measurements in the air via in-situ analysers; or analysing air samples taken in clean flasks.
ii. Measurements of samples of firn air, extracted from the upper layer of the Antarctic ice sheet
iii. Measurements of samples of air from bubbles trapped in Antarctic ice cores;

Note that ii) and iii) are needed to extend observations back to before the instrumental record that is derived using i).

As to causality, evidence from the isotopic composition analysis demonstrates that the carbon dioxide added to the atmosphere has come from burning fossil fuels, see pages 9 and 10 of answer SI-124. These carbon dioxide observations are a highly credible, national data set with global standing and CSIRO stands by the quality of these observations of atmospheric carbon dioxide. CSIRO have already provided to the Committee extensive briefing materials and publications, explaining the scientific basis for the conclusion that the warming observed over the last century is due to human activities.

These observations of atmospheric carbon dioxide concentrations are measured from a range of locations: in situ at Australia's Cape Grim station run by BoM and CSIRO in Tasmania; from other similar stations around the world; from air bubbles trapped in ice cores that are extracted from sites in Antarctica with the Australian Antarctic Program and ANSTO. The measurements from each location were all made using a common set of sophisticated instrumentation located at CSIRO's GASLAB Facility in Melbourne, using the same calibration; and link from the present day back to 2000 years ago. They are constantly updated with new data as measurements and new ice cores become available. The credibility of the observations is demonstrated by the peer-reviewed papers in which our scientists routinely publish the methods, the data, and the scientific conclusions. This is supported by participation in international calibration intercomparison and benchmarking studies (including independent and objective review of all procedures and adherence to international guidelines and standards such as the World Meteorological Organisation). Furthermore, the data are publicly available on international databases for researchers, industry, governments and public to use. These are the data that the broader climate science community and stakeholders refer to (e.g. the IPCC) and use.

The use of a common set of analysers as described above enables us to compare measurements taken at different places, e.g. from air trapped in ice cores from 100,000's of years ago to air measured last year; and combine these into a continuous time series such as seen at page 8 of answer SI-124. And it means that we can quantify the precision and accuracy of the measurements. The error on the published measurements (see page 8 of SI-124) are plotted on that graph; they are 1 ppm or less for carbon dioxide. As such, the error margins are two orders of magnitude smaller than the increase in carbon dioxide that is measured over the last 150 years or so. These errors are calculated using standard error analysis methods that include errors linked to instrument accuracy, calibrations and sample quality and size.

The high degree of consistency across multiple sites and multiple experiments, utilising multiple lines of evidence, has led to the scientific community to regard these conclusions as extremely robust. A key example of this is the period of the record when we have air samples available from ice cores and firn air (extracted from Antarctic ice sheets) and in-situ measurements (from Cape Grim and other sites in the Southern Ocean/Antarctic region). We have published the results of this analysis and comparison to demonstrate that these two records – one continuous and one constructed from discrete-in-time samples – agree to within 1 to 2 ppm (for carbon dioxide). Again, the error margins are orders of magnitude smaller than the increase in carbon dioxide observed in the last 150 years.

The confidence in our assertion that the current carbon dioxide concentrations are unprecedented in the last 800,000 years is based on the most recent carbon dioxide records that use ice cores extracted from sites where there are large accumulations of ice every year - which means that we can achieve high temporal resolution of the observations. Combined with the use of multiple samples and multiple ice cores to provide replication, this means we achieve a high sampling density which minimises any chance of missing a short-lived spike in atmospheric carbon dioxide levels. Furthermore, carbon dioxide is a long-lived gas and so any emission would lead to a sustained increase in concentration that would be very likely to be detected.

Question (page 4): *... I would hope that you would agree that CSIRO has a duty to taxpayers and to our nation to provide rigorous and proper scientific and statistical analysis and advice. If you disagree please say so in your reply.*

Answer: As we have discussed previously, CSIRO is an impartial, authoritative and respected source of independent science-based information for the community and government. Our staff conduct and apply their research with honesty, rigour, transparency, respect and accountability. That includes robust peer review analysis of research output in scientific publications, reports and high integrity data sets to ensure the quality of the scientific information. CSIRO provides independent, expert, technical advice to

government as appropriate, to inform government's policy processes and program activities but CSIRO does not make government policy.

Question (page 4): *... human history, empirical experience and/or empirical science show that past warmer temperatures and past higher levels of atmospheric carbon dioxide levels have led to enormous economic, humanitarian and/or environmental benefits. Has CSIRO assessed the cost benefits of warming if it were to occur ? If so please provide such analyses and have such reports been presented to governments at any time ?*

Answer: The most relevant initiatives undertaken by CSIRO with respect to your questions are the Australian National Outlook (ANO) reports.

The original ANO released in 2015 was the most comprehensive quantitative analysis of the interactions between economic growth, water-energy-food use, environmental outcomes and living standards in Australia. The project used integrated modelling aimed at a comprehensive exploration of the relationship between the physical economy and natural resource use in Australia.

It attempted to understand and analyse the connections in Australia's physical environment many decades into the future by exploring over 20 possible futures for Australia out to 2050 against the backdrop of the previous 40 years. The results showed that energy and other resources could remain a pillar of the Australian economy well into the future, and that energy intensive industries could be well positioned to continue to grow, even in scenarios where the world is taking global action to significantly limit greenhouse gas emissions.

The work was undertaken by a team of 40 CSIRO experts and university collaborators, drew extensively on observed data and analysis, utilised a world-class suite of nine linked models, included input from more than 80 experts and stakeholders from over ten organisations, and underwent rigorous international peer review. The report was underpinned by more than 10 journal papers including a *Nature* journal paper, and the project was a Eureka Award finalist.

The scope of ANO 2019 was significantly broader than ANO 2015 with a greater focus on economic modelling as well as a consideration of cities, infrastructure, productivity and services.

This report explored nationally significant issues, risks and opportunities, and how Australia's long-term future growth and prosperity can be secured out to 2060. It focused on two core scenarios; 'Slow Decline', which represented a base case with relatively poor outcomes and 'Outlook Vision', which showed improved economic, social, and environmental outcomes.

The National Outlook involved more than 50 senior participants from businesses and non-government organisations. It drew on CSIRO's world-leading integrated modelling and assessment capabilities to model outcomes for a number of scenarios that Australia is likely to face out to 2060. ANO placed climate change as an important economic, environmental and social driver for Australia, that will have a significant effect on agriculture, forestry, fisheries, water security, energy security, infrastructure, transport, health, tourism, finance and disaster risk management.

The ANO project report together with the 468 page Technical Report are publicly available on the CSIRO website.

Senator Malcolm Roberts
One Nation Senator for Queensland

Friday, 28 February 2020

Dr Larry Marshall
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Black Mountain
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Dear Dr Marshall

Further to my questions in October's Additional Estimates and my letter to you of 25 October 2019 I now clarify my simple request because CSIRO's responses seem to show that your climate team does not understand fundamentals for identifying change statistically nor for proving scientific causation.

Before doing so I remind you of the following timeline showing presentations and responses from your CSIRO climate science team to me and my office team:

- 26 September 2016 - a presentation responding to my request for CSIRO to provide its empirical scientific evidence proving that carbon dioxide from human activity affects climate and needs to be cut. CSIRO failed to provide such empirical evidence and instead relied ultimately upon unvalidated climate models, and further, failed to provide the scientific logic necessary to prove causation of climate variability;

- 13 April 2017 – a written response, albeit undated, after Minister Senator Sinodinos instructed you to respond to my written response to your climate team's September presentation. CSIRO's response could, in my view, most kindly be described as unscientific;

- 10 May 2017 – a presentation responding to my request of CSIRO to identify anything unprecedented in climate during the last 10,000 years. In its response, the only climate factor that CSIRO identified was temperature and during our discussion CSIRO admitted that <u>today's temperatures are not unprecedented.</u> CSIRO cited and relied upon only one paper on temperatures, Marcott (2013) whose lead author himself admitted that the paper's 20th century temperatures were not robust. Our team thoroughly discredited CSIRO's reliance on Marcott (2013) and on Harries (2001), the latter being the only paper CSIRO presented on carbon dioxide;

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- 26 July 2017 – CSIRO repeated its presentation using two papers provided in support of its claim of unprecedented rates of temperature rise yet both failed under scrutiny.

Concurrent with the process of engaging CSIRO, my office and I engaged the Chief Scientist requesting a presentation from him on the empirical scientific evidence proving that carbon dioxide from human activity caused climate change and justifying the reduction of carbon dioxide output from human activity. After about 20 minutes or so into his presentation and in response to our cross-examination, the Chief Scientist admitted that he is not a climate scientist and that he did not understand climate science.

I now turn to the reasons for this letter. Firstly, in Senate Estimates on Thursday 24 October 2019 we discussed types of variation possibly present in the time series measurement of an unchanged process such as climate. These can include inherent natural variation and seasonal and cyclical variation in climate factors such as temperature; rainfall; snowfall; storm frequency and severity; flood frequency and severity; drought duration, frequency and severity; snowfall; wind speed and direction; humidity; soil moisture; solar factors; ocean currents; volcanic activity; cloud cover; and, atmospheric water vapour to name only some.

My request in Senate Estimates and my letter of 24 October were not answered in any way adequately. Specifically I need to know what evidence CSIRO has to prove any change in climate, climate factors, and climate processes over the last 150 years and separately over the last 10,000 years that indicate a statistically significant process change in climate, being "climate change."

When you or your CSIRO climate team respond with a claimed change in climate process variability in time series data on climate factors, please specify in detail the statistical analysis method(s) used to identify any claimed statistically significant change in natural climate variability.

I require the description of the data used and its source including, for example, data sampling interval. I will accept only data from scientifically peer-reviewed papers or publications whose authors allow ongoing public scrutiny of their data and specified methodology, as is the standard for scientific papers.

If, as Dr Mayfield offered during Senate Estimates last October, CSIRO references past presentations to me, please advise the specific location(s) in such presentations of the specific scientific evidence of statistically significant variation proving claimed changes in climate factors, in climate processes and in climate itself.

With the CSIRO's proclaimed expertise in science, climate and statistics I would expect that my request could be met easily from CSIRO's existing analyses and research of climate over the last forty years. This is particularly the case since claims of climate change such as those CSIRO has made or implied during the last four decades would need to be based on statistically valid analyses of climate variability resulting in identification of statistically significant change as the basis for CSIRO claims, announcements and advice.

To have based CSIRO's claims on anything other than this would be unscientific, negligent and dishonest.

As we have discussed in the past, Dr Marshall, prominent politicians have cited reliance on CSIRO for their justification of spending billions of dollars on climate-related policies such as those affecting energy, water and land use. These policies impose burdens and inefficiencies projected to impact our national economy to the extent of trillions of dollars and jeopardise the basic freedoms and rights of many Australians.

We have become concerned about CSIRO's unscientific and inadequate responses to our fundamental and basic yet simple requests.

Secondly, as previously stated, I am concerned about your references to material from the UN IPCC, particularly after CSIRO cited and/or endorsed UN IPCC reports yet did so without conducting due diligence on the UN IPCC and its reports.

For that reason, I please request that you provide the following in regard to the UNIPCC's Fifth Assessment Report 2014, specifically its report AR5 Climate Change 2013: The Physical Science Basis:

- The location, including specific page numbers, of the empirical scientific evidence within a causal framework scientifically proving that carbon dioxide from human activity affects climate and needs to be cut;

- The location, including specific page numbers, of anything unprecedented in climate during the last 10,000 years together with the empirical scientific evidence proving that it was/is due to carbon dioxide from human activity; and

- The location of any statistically significant change in climate variability.

Thirdly, I request that you provide the following in regard to the State of the Climate Report 2018 that CSIRO produced in conjunction with the Australian Bureau of Meteorology:

- The location, including specific page numbers, of the empirical scientific evidence within a causal framework scientifically proving that carbon dioxide from human activity affects climate and needs to be cut;

- The location, including specific page numbers, of anything unprecedented in climate during the last 10,000 years together with the empirical scientific evidence proving that it was/is due to carbon dioxide from human activity; and

- The location of any statistically significant change in climate variability.

I would appreciate these being made available at Senate Estimates next week and would hope that as part of any claimed thorough analysis of climate over the last four decades and in particular since 2013 such analyses would be readily available within your climate research and reporting team.

Fourthly, Dr Marshall, when governments implement policies costing trillions of dollars and destroying our nation's economic advantages and productivity, I would hope that you would agree that CSIRO has a duty to taxpayers and to our nation to provide rigorous and proper scientific and statistical analysis and advice. If you disagree please say so in your reply.

Yet CSIRO has repeatedly failed to do so. It is my belief as a senator serving the people of Queensland and Australia that it is your responsibility as Chief Executive to either provide what is requested or admit you lack such evidence.

In my view, the responses received to date reflect poorly on CSIRO and on its Chief Executives.

Fifthly, human history, empirical experience and/or empirical science show that past warmer temperatures and past higher levels of atmospheric carbon dioxide levels have led to enormous economic, humanitarian and/or environmental benefits.

Has CSIRO assessed the cost benefits of warming if it were to occur? If so please provide such analyses and have such reports been presented to governments at any time?

Sixthly, for how much longer will you tolerate the sloppiness in CSIRO's climate "science"? To fulfil your responsibility to the taxpayers who pay your salary package that I understand to be more than $800,000 per year as head of CSIRO, what action will you take to restore the scientific process and method to CSIRO's climate analysis, publications and advice?

I look forward to your answers to my fundamental questions and to engaging with you and your climate team in Senate Estimates.

Yours Faithfully

Senator Malcolm Roberts
Senator for Queensland

c.c. Peter Mayfield

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