The Australia Institute
Research that matters.

CSIR…who?

A closer look at recent research on coal seam gas environmental impacts

A recent study claiming minimal impact of fracking on water and soil in Queensland's Surat Basin is presented as CSIRO research, but is actually by an alliance dominated by gas companies. The study is based on a sample of just six wells, all chosen by Origin Energy. Its results say little about the other 19,000 wells in the state.

Mark Ogge
July 2020

INTRODUCTION

In late April, Minister for Resources, Water and Northern Australia Keith Pitt published a press release titled *CSIRO report confirms CSG fracking is safe for the environment*.[1] The Minister's claim is misleading to say the least.

The study in question was not written by the CSIRO, but by the Gas Industry Social and Economic Research Alliance (GISERA). The CSIRO is a member of GISERA, along with Santos, Origin Energy, QGC (owned by Shell, China National Offshore Oil Corporation and Tokyo Gas) and Australia Pacific LNG (owned by Origin, ConocoPhilips and Sinopec).[2]

[1] The Hon Keith Pitt MP, Minister for Resources, Water and Northern Australia (April 27, 2020), *CSIRO report confirms CSG fracking is safe for the environment*, https://www.minister.industry.gov.au/ministers/pitt/media-releases/csiro-report-confirms-csg-fracking-safe-environment

[2] Gisera (n.d.) *About us*, https://gisera.csiro.au/about/; APLNG (n.d.) *About us*, https://www.aplng.com.au/about-us.html; Shell (n.d.) *About QGC*, https://www.shell.com.au/about-us/projects-and-locations/qgc/about-qgc.html

GISERA's media release described its *Air, Water and Soil Impacts of Hydraulic Fracturing in the Surat Basin, Queensland* study as:

> A comprehensive three-year scientific study into the air, water and soil impacts of hydraulic fracturing in Queensland has found little to no impacts on air quality, soils, groundwater and waterways.[3]

While it may be true GISERA "found little to no impacts" in its study, a closer look at the study reveals it is in no way comprehensive and its results say little about fracking for coal seam gas (CSG) in the rest of the state, or elsewhere in Australia.

The study analysed air, water and soil samples taken before, during and up to six months after hydraulic fracturing operations in coal seam gas wells in the Surat Basin in Queensland. It was based on a sample of just six wells out of approximately 19,000 in the state.[4,5]

The media release neglects to mention that the research itself explicitly states that the results only apply to the specific fracking activity at the study sites:

> The study design presented here is specific to [hydraulic fracturing] activity being carried out in the well sites identified in this study design in the Surat Basin. The representativeness of this study and the scalability of data to other well sites in the Surat Basin or other locations will depend on a number of factors including the representativeness of the [hydraulic fracturing] processes employed, underlying geology, structure of the coal seams, well depths, etc.[6]

Even a cursory examination of the methodology shows why the results cannot be extrapolated beyond the six wells studied.

---

[3] GISERA (27 April 2020) *Media Release: Australian first research by CSIRO'S GISERA examines hydraulic fracturing impacts on air quality, soils, groundwater and waterways*, https://gisera.csiro.au/wp-content/uploads/2020/04/CSIRO-GISERA-media-release-AWS-Impacts-of-Hydraulic-Fracturing-final.pdf

[4] GISERA (March 2020) Assessing the potential impacts of hydraulic fracturing on water and soil quality in the vicinity of well sites in the Surat Basin, Queensland, Project W12 Final report, https://gisera.csiro.au/wp-content/uploads/2020/04/Water-12-Milestone-7-final-report.pdf

[5] GISERA (27 April 2020) *Media Release* ibid.

[6] Dunne et al ((July 2017) *Design of a study to assess the potential impacts of hydraulic fracturing on air quality in the vicinity of well sites in the Surat Basin, Queensland (Draft 3 – Revised study design for Combabula site)* P.39 https://gisera.csiro.au/wp-content/uploads/2018/03/Water-11-Milestone-4-Report-1.pdf

FLAWS IN GISERA RESEARCH

Sites selected by Origin

Samples must be randomly selected to avoid bias. As such the selection of a sample for research, in this case fracking wells, is fundamental to the research methodology.

If Origin influenced the selection of the wells, or only made certain wells available for study, the selection would not be random. Origin could select wells with less risk of contamination, or use a different mix of fracking chemicals. Origin has a strong interest in ensuring there is no contamination at these particular wells and may employ a higher level of precaution and potentially different practices, which may not be representative of the gasfields as a whole.

The *Design Report* for the research makes it clear that site selection was effectively outsourced to Origin, and as such the selection of wells cannot be considered random:

> Origin Energy has granted CSIRO access to development areas addressed in the approved Origin Energy–APLNG Hydraulic Fracturing Risk Assessment.[7]

GISERA research has encountered similar problems before. In a 2014 survey of methane leakage from CSG wells, the sample wells "were selected on an ad hoc basis in the order that companies agreed to participate." That report only examined well pads. It excluded emissions from sources outside the well pads including water treatment and processing plants, vents on water and gas gathering lines and other CSG infrastructure, despite noting significant emissions from sources outside the well pads[8] This report was incorrectly presented by GISERA showing that Australian CSG emissions are "lower than the US" [9]

It is of additional concern that Origin, who have a clear vested interested in not finding negative impacts of their fracking activities, paid for around 75% of the $330,800 research budget for the design of the project. They also made a "400k in kind contribution", which is greater than the entire research budget for the design phase of the project.[10]

[7] Dunn et al (July 2017) Op. cit. P.18

[8] Day et al (2014) *Field Measurements of Fugitive Emissions from Equipment and Well Casings in Australian Coal Seam Gas Production Facilities*,

[9] Barrett and Day (2014), *Coal seam gas emissions lower than US: first Australian study*, https://theconversation.com/coal-seam-gas-emissions-lower-than-us-first-australian-study-29699

[10] GISERA (2016) *Project Order: Air, water and soil impacts of hydraulic fracturing*, https://gisera.csiro.au/wp-content/uploads/2018/01/Water-11-Project-Order.pdf

Size of sample

The GISERA report that analysed water and soil samples, *Assessing the potential impacts of hydraulic fracturing on water and soil quality in the vicinity of well sites in the Surat Basin, Queensland, Project W12 Final Report*, measured the concentrations of a range of fracking chemicals in surface water, groundwater bores and soil around hydraulic fracturing operations at six coal seam gas wells over a six month period at Condabri and Combabula in Queensland.[11]

The report notes there are 19,000 productive coal seam gas wells in Queensland with several thousand more planned, and estimates that between 10-40% of wells are fracked. [12] That gives a population of fracked wells of 1,900 to 7,600 which will rise as thousands more wells are drilled.

As described above, if the wells are not selected in way that excludes potential bias, the research will not be representative CSG activities in Queensland as a whole. However, even if the sample had been randomly selected, the small size of the sample (six wells) would have an enormous 40% margin of error, meaning it could say little about the risk of contamination from fracking of CSG wells in Queensland.

If 1% of CSG fracking operations resulted in serious contamination, it would equate to between 19 and 76 incidents at current well numbers. The GISERA study would have had a 6% chance of detecting any of these incidents. Given it appears Origin selected the wells to be studied and was aware of the monitoring, it would be even less likely that the study would detect this kind of incident.

Fracking uses many chemicals dangerous to human health and the environment. It also liberates dangerous substances from coal seams or shale formations allowing them to migrate into other aquifers and surface water. As the US-based Physicians for Social Responsibility (PSR) note in regard to fracking chemicals in their compendium of the demonstrated harms of fracking:

> Of the more than 1,000 chemicals that are confirmed ingredients in fracking fluid, an estimated 100 are known endocrine disruptors, acting as reproductive and developmental toxicants. Adding to this mix are heavy metals, radioactive elements, brine, and volatile organic compounds (VOCs), which occur naturally

[11] GISERA (March 2020) Op. Cit. Page 2
[12] GISERA (March 2020) Ibid. Page 1.

> in deep geological formations and which can be carried up from the fracking zone with the flowback fluid.[13]

GISERA was informed by Origin of the mix of fracking chemicals being used in the wells used in the study. The mix included a number of toxic chemicals including biocides. There is no reason that fracking companies in Queensland cannot use other mixes of fracking chemicals at the thousands of other fracking operations that are not part of this study.

In fact the GISERA study found concentrations of chemicals above, in some cases well above, the thresholds of Australian guidelines were found at the wells.

> The chemicals measured at concentrations above Australian default guideline values (DGVs) for freshwaters were ammonia, boron and seven trace metals: chromium, copper, manganese, lead, nickel, silver and zinc. Many of the exceedances were marginal and were mainly confined to the early stages of well production, an exception being boron which was consistently present at concentrations above the Australian DGV of 0.37 mg/L.[14]

International experience has shown that fracking can cause serious cases of pollution. In Pennsylvania 343 private drinking water wells were found to be contaminated over an 8 year period.[15] In Australia, AGL suspended its operations at Gloucester in NSW when banned BTEX chemicals were found in flowback water from a fracking operation at one if its four pilot wells.[16]

The margin of error expresses how much the sample result could differ from the actual result, for a given confidence interval, because of sampling error. It assumes a normal distribution of resuts. The smaller the sample relative to the size of the population, the larger the margin of error will be. It is expressed as range, subject to various confidence levels.

Even if we assume the bottom of the range of estimated, that only 10 percent of the 19,000 CSG wells (1,900 wells) in Queensland are fracked, there is a 40 percent margin error. This means that any results found in the survey could by up to 40 percent higher

[13] PSR (2019), *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction) Sixth Edition*, https://www.psr.org/wp-content/uploads/2019/06/compendium-6.pdf

[14] GISERA (2020) Op. Cit. P.118

[15] PSR (2019) O. Cit. P68

[16] ABC (January 2015), *AGL suspends operations at Gloucester coal seam gas project after discovery of potentially toxic chemicals*, https://www.abc.net.au/news/2015-01-27/agl-suspends-operations-at-gloucester/6049922

or lower with a 95% level of confidence. This is an extradinarily high margin of error. The margin of error in academic and scientific research is commonly between 4% and 10%.

The margin of error only captures errors related to the size of the sample, and there could be further errors in the sampling process itself. This report does not examine the methodology of the sampling of the few wells that were examined.

It is important to emphasise that if the wells were not chosen randomly, and it appears they were not, then the sample would not be in any way representative of the wider population of wells no matter how large it was.

But most important of all, this assumes that the sample is drawn from a population in which the results, in this case the level of contamination, are distributed normally. That may not be the case.

While fracking techniques may be similar, the impacts may differ depending on geology and chemicals used.

Of most concern is that there will be a bimodal distribution in the results depending on whether or not there has been a spill, well failure or some other kind of accident. In these cases, the level of contamination could be far higher than the normal distribution of results found where fracking operations run smoothly.

A major spill of fracking fluids or a well failure is likely to result in contamination events that are far more serious than the contamination found in this survey where no spills or well failures occurred. This would mean the level of contamination could be far higher than the 40% margin of error.

The GISERA report found no examples of soil contamination, as there were no spills at the 6 wells studied. However a study in the US found 6,678 significant spills of fracking fluid in four states over 9 years with 2-16% of wells reporting spills, and an estimated 5% of all fracking fluid lost to spills.[17]

Given the small sample size of only six wells studied in the GISERA study, the question arises as to the likelihood of this report identifying serious cases of contamination if they do exist.

As noted above, there are 19,000 CSG wells in Queensland and 10% to 40% percent are subject to fracking. That gives a population of fracked wells of 1,900 to 7,600.

[17] Patterson et al (2017), Unconventional Oil and Gas Spills: Risks, Mitigation Priorities, and State Reporting Requirements https://pubmed.ncbi.nlm.nih.gov/28220696/

The case of 1,900 fracked wells

Assuming the 10% minimum estimated proportion of wells are fracked, if for instance there were serious pollution incidents at 5% of fracked wells it would mean there were 85 serious incidents of pollution. Testing one well will have a 95 percent chance of missing such an incident. Testing 6 wells will have a 73.5 per cent chance of missing it. The reasoning is:

- The chance of the first well tested finding no pollution is 95%.
- The conditional probability of the second also finding no pollution is 95% of 1,815 minus 1 divided by 1,900 minus 1,
- The conditional probability of the third also finding no pollution is 95% of 1,815 minus 1 divided by 1,900 minus 1, times 1,815 minus 2 divided by 1,900 minus 2,
- And so on until we get to the sixth term.

A good approximation to three significant figures is 0.95 to the power 6 (= 73.5%).

This result is important – if 5% of 1,900 fracked wells are polluted and you test six, there is a 73.5 per cent chance you will not find evidence of pollution. There is only a 26.5 per cent chance of finding pollution.

If instead the pollution events occur at 1% of fracked wells, or 19 out of 1,900 wells, by testing six there is a 94% chance of not finding any pollution. There is only a 6% chance of finding pollution.

Incidentally, if there were evidence that 1 per cent of wells in other jurisdictions were polluted and you wanted to be 95 per cent confident that Australian pollution levels were below that figure you would have to test at least 44 wells chosen at random. But of course, even that does not eliminate the possibility there is pollution, only that we are 95 per cent sure the portion of wells polluted is below 1 per cent.

The case of 7,600 fracked wells

With 1,900 wells we found that the simplification using the power function was accurate to 3 significant figures and with a bigger sample the power simplification is even more accurate so we do not need to do any further calculations for the larger number of fracked wells. We need only note that if there are 4 times as many fracked wells there are four times the number of undetected wells when only 6 are tested.

Timeframe and other limitations

The relevance to Queensland CSG as a whole is further diminished because samples were taken over only six months. Contamination can occur any time over the

production lifetime of the well, or the decades beyond. Not all fracking fluid is recovered and it can migrate through groundwater systems over a long period of time, as can contaminants from disrupted coal seams.

The report itself acknowledges that it does not consider:

- The long term effects of hydraulic stimulation (fracking)
- Impacts of drilling and well construction
- Impacts of hydraulic fracturing on deep ground water
- Groundwater contamination with methane
- Ecological risk assessment
- Impacts on human health

CONFLICT OF INTEREST

GISERA has a conflict of interest at its core. While it represents itself and its reports as the CSIRO, this is not the whole story. It is an alliance of five of the largest coal seam gas companies operating in Australia, and the CSIRO.[18] These companies have an enormous vested interest in not finding negative impacts from fracking.

Gas industry executives oversee the research

Gas industry executives make five of the nine voting members of the National Research Management Committee (NRMC) and are on all the Regional Research Advisory Committees (RRACs).[19] These committees decide on which research projects will be undertaken including their scope, and oversee the research.

While GISERA dismisses concerns over conflicts of interest because only of a minority of members of the RRAC's are gas industry executives. This is unconvincing.

Two of the seven members of the Queensland RRAC are gas industry executives employed by companies that have a clear vested interest in not having negative findings on the impacts of CSG. Negative findings could have a large financial impact on these companies because policy makers rely on the findings to design regulations, grant licenses or even maintain or lift moratoriums which will dictate whether the industry will be allowed to operate at all in various states. These executives have deep

[18] GISERA (2018) *Second variation to alliance agreement*, https://gisera.csiro.au/wp-content/uploads/2019/02/GISERA-Alliance-Agreement_Variation-2.pdf

[19] GISERA (2020) *National Research Management Committee*, https://gisera.csiro.au/research-independence/national-research-management-committee/

technical expertise on committees otherwise made up of community members who do not have similar expertise, meaning they are unable to ensure the independence and objectivity of the research. Other members are researchers who rely on industry for funding. In these circumstances the gas industry members of the committee are in a position to have significant influence on the committee.

Having members on the committees with such a clear conflict of interest undermines the credibility of GISERA's research. There is no reason to have gas industry executives on these committees.

GISERA also has a stakeholder roundtable meeting once per year, which The Australia Institute has participated in. This group has no influence on GISERA research and no access to any information about GISERA research and processes that is not in the public domain.[20]

Gas industry funding of research

Gas companies Santos and Asia Pacific LNG (APLNG) paid 75 percent of the $2.26 million research budget of the GISERA project.[21]

There is a rich academic literature on the effects of industry funding on research where the industry will benefit from a predetermined outcome. Studies that have looked at the results of pharmaceutical device research have shown that industry sponsored studies are more likely to have favourable results for the sponsoring industry than studies without industry funding.[22]

A recent example of this is a Sydney University study that claims industry funding lead to bias in artificial sweetener research.[23] The study found that industry sponsored research into the effectiveness of artificial sweeteners in weight loss was 17 times more likely to deliver a favourable result than non-industry funded research.

[20] GISERA (2019) *Stakeholder Roundtable Group*, https://gisera.csiro.au/research-independence/stakeholder-roundtable-group/

[21] GISERA (April 2020) *Project Order, Variations and Research Progress Project Title: Air, water and soil impacts of hydraulic fracturing: Phase 2,* https://gisera.csiro.au/wp-content/uploads/2020/04/Water-12-Progress-Report-April-2020.pdf P.16

[22] Lundh et al. (2012) Industry sponsorship and research outcome. https://www.ncbi.nlm.nih.gov/pubmed/28207928

[23] Mandrioli et al. (2016) Relationship between Research Outcomes and Risk of Bias, Study Sponsorship, and Author Financial Conflicts of Interest in Reviews of the Effects of Artificially Sweetened Beverages on Weight Outcomes: A Systematic Review of Reviews, https://www.ncbi.nlm.nih.gov/pubmed/27606602

These are examples of the type of research that is at risk of bias. A finding that artificial sweeteners help in weight loss or that pharmaceutical devices are effective is likely to see a greater demand for those products. This will occur regardless of whether artificial sweeteners actually help with weight loss or the pharmaceutical device is effective. The industry has a predetermined outcome that will make it more profitable regardless of the scientific facts.

The research GISERA undertakes is the same in this regard. A finding that fracking is safe increases the likelihood of the fracking being permitted which can have a benefit of potentially hundreds of millions of dollars for the companies involved.

Research on the health impacts of smoking paid for and overseen by tobacco companies would have little credibility. This is no different.

Conflict of interest policy inadequate.

The GISERA conflict of interest policy deals mostly with GISERA employees. However the fundamental conflict of interest is with GISERA's gas industry alliance members who are also proponent companies with an enormous vested interest in the outcomes of the research, and are not employees of GISERA. One obvious example is the gas executives of the proponent companies on GISERA research management committees as described above.

The conflict of interest policy only requires project proponents to self-evaluate their conflict of interest, and discuss it with the GISERA Director, who they ultimately fund. This is totally inadequate.

> Project proponents are required to identify known conflicts of interest in completing their Project Orders, based on the criteria above, and to discuss any emerging potential conflicts of interest, or their likelihood, with the GISERA Director, who will advise as to the most appropriate responses, in accordance with the policy details outlined below.[24]

Undermining the credibility of the CSIRO

The CSIRO has a lot of credibility with the Australian people in the areas of science and technology. People trust the integrity of its research, but this trust has been hard won over many decades. This trust can also be lost if the CSIRO does not maintain the high

[24] GISERA (2017), *Managing conflict of interest within GISERA Policy for GISERA partners and participants,* https://gisera.csiro.au/wp-content/uploads/2017/11/National-GISERA-conflict-of-interest-Nov-2017.pdf

standards that Australians have come to expect from their premier science organisation.

Those standards are outlined in the CSIRO Code of Conduct. They include that the CSIRO:

> Be an impartial, authoritative and respected source of independent information and advice on science for the community and government, a trusted advisor.[25]

The CSIRO has a long history of close associations with industry, including in instances where there is a potential conflict between research objectivity and industry need. But industry funding usually occurs when the research is about improving the productivity of a particular industry. For example research into crop varieties that require less water or are more resistant to disease.

Gas and oil industry funded CSIRO research has previously centred on assessing the quantity and location of resources and improving engineering associated with drilling and extracting resources. Industry funding of this type of research does not usually lead to any conflict of interest, because the industry does not stand to gain unless their productivity is improved through genuine scientific progress.

However GISERA reports are different to this kind of research. GISERA does not aim to improve industry productivity, rather it evaluates the social, economic and environmental impacts of the activities of the gas companies. Its findings are used to inform decisions of governments and regulators that will have a large bearing on the profitability of the industry, whether the findings are correct or not.

If the industry influences the findings of GISERA, and governments are persuaded that the potential impacts are low, it can influence the regulatory rules on that protect the community, including health and the environment. Less stringent rules usually increase the profitability of the industry, but can have negative impacts on the community and the environment. Findings can also influence decisions to allow gas development in entire states and territories. These decisions can result very large financial gains for the industry, potentially at the cost of large social and environmental impacts for the community.

[25] CSIRO (2019) Code of Conduct, https://www.csiro.au/en/About/Policies-guidelines/Working-at-CSIRO/Code-of-Conduct

Allowing industry funding and oversight of this kind of research is neither impartial nor independent advice on science for the community and government as required by the CSIRO's code of conduct.

Recommendations

- GISERA should publicly correct the inaccurate claim of Minister Pitt's media release that the "CSIRO report confirms fracking is safe for the environment"
- GISERA should remove all gas company executives from its research management committees.
- Future research into the impacts of unconventional gas should be independent research groups at Australian universities.
- Commonwealth or state governments should levy gas companies to fund necessary research and commission independent research bodies at Australian universities to carry out the research. This will remove the problematic link between gas funding and research.