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Independent Scientific Panel Inquiry
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PERTH WA 6850

Submission to the WA Fracking Inquiry

To whom it may concern,

I am writing in response to the Independent Scientific Panel's call for public submissions as part of the *Inquiry into Hydraulic Fracture Stimulation in Western Australia 2017* (Fracking Inquiry).

My expertise is in natural resource management, cultural resource management, ecology, and strategic environmental impact assessment and regulation (including working in the Australian Government on coal seam gas mining monitoring and audit). I am currently undertaking a Master of Philosophy research degree with The University of Queensland, focusing on the ecological impacts of forest roads for coal seam gas development on bird communities. As part of this research I am also reviewing the extent to which enigmatic impacts (e.g. cryptic, cumulative and indirect and secondary impacts) are accounted for in the Environmental Impact Statements of Australian coal seam gas developments. In addition, I currently work as an ecologist and environmental-cultural management expert for Environs Kimberley, based in Broome WA.

Below I address a number of points within the Fracking Inquiry Terms of Reference, namely: the potential ecological impacts of fracking in WA; impacts on human health and wellbeing; and the extent to which such industries can be adequately regulated by governments. These points are made based on my own expertise as well as peer reviewed literature and government reports. As I do not have the resources to undertake a thorough literature review of all matters discussed here, I have included a range of resources I think should also be considered as part of my submission, and represent an introduction to the matters raised. These are attached to my online submission, and where necessary, with any additional attachments emailed to the panel.

I attended the first public meeting for this inquiry, in Broome WA, on 27 February 2018. There I made a number of comments to the chair about ecological concerns related to

potential development of fracking industries in WA. These concerns were noted, and some are iterated in this written submission.

I ask the panel to note there is very little information on the ecological impacts of unconventional gas mining in Australia. What little research has been done, has targeted the coal seam gas industry, which is primarily based in Queensland. Regarding shale gas mining, which is the prime form of potential unconventional gas development in the northwest onshore environment, my review of online databases revealed no peer reviewed science about potential impacts of the industry on Australia's biodiversity. I suspect the situation is almost as dire for research on impacts to culture and heritage, social fabric, mental health and individuals.

This dearth of science is a familiar problem, it was the same one faced by regulators and decision makers when Australia's coal seam gas industry began in earnest, around ten years ago. And still now science lags years behind development. For industries like coal seam gas and shale gas, prone to a high level of uncertainty around spatial location of infrastructure, and a dispersed footprint that results in disproportionately high ecological fragmentation and edge effects, it is imperative development only follows after rigorous scientific examination and policy development. Types of infrastructure include gas wells (each with access roads and gathering pipelines), larger transport pipelines and processing facilities. The Western Australian Government must continue to take a leadership role in best practice policy and regulation development, by first completing a comprehensive research program before deciding whether the fragile and ancient WA environment can withstand a new industry like fracking.

Due to the lack of good science in Australia, I suggest the panel undertake a thorough literature review of the shale gas industry in other countries. This is one of the best methods currently available to the panel for understanding the potential risks to the environment.

I also note that although this inquiry is referred to as a scientific inquiry, the panel must acknowledge the process itself is not at all scientific. It does not appear to require any empirical research to be undertaken as part of the process. This is a major flaw. An additional flaw is the fact that any findings or recommendations are not required to be implemented by the Environment Minister. Thus, as has been the case so far, any rigorous or at least somewhat independent investigation of the impacts of unconventional gas in WA plays second fiddle to political concerns and power. Residents in areas around Perth currently enjoy peace of mind thanks to a permanent fracking ban, while other Western Australians do not – and in many cases must spend time and resources making their own investigations into how a fracking industry might affect their futures. This flaw draws into question the entire process, fairness and usefulness of the inquiry.

1 Northern WA

There is a lot to learn about the ecology of northern WA. Many faunal groups require a lot more taxonomic work to decide how many species exist and how they differ from each other. And due to the remoteness, and variable nature of its biotic and abiotic systems, it is likely there are still many undiscovered plants (not to mention invertebrates, including stygofauna). The WA Government is not currently funding its scientific organisations in a way that can address this lag, and so we must wait years to understand what actually exists up in the Kimberley and Canning Basin, after which

come the necessary tasks of ascertaining their biology, ecology, levels of threat and best practice conservation methods.

Northern WA is recognised for its irreplaceable culture and heritage value, paleontological importance, its biological diversity and stunning landscapes. These attributes are valued by Australians and people all around the world. These values must be protected if northern WA is to support thriving communities, maintain its successful tourism industry and provide a sustainable ecological bank for future generations to rely upon.

2 Ecological impacts

Shale and tight gas development in Australian really only have one related case study that can be used to understand ecological risks from a regulatory and environmental impact assessment perspective. The coal seam gas mining industry in Queensland was allowed to progress with no preliminary assessment of the risks of the industry as a whole, to people and the environment.

If the WA Government, Ministers and this fracking inquiry panel are to be considered as having undertaken due diligence and good quality policy development in the area of unconventional gas mining, they must begin this process with a whole-of-industry assessment of potential impacts. This means estimating the worst case scenarios if the industry was allowed to establish in WA. In the Canning Basin and across WA there is a need to understand not just how individual wells or developments might impact ecosystems, but how they might impact biodiversity collectively. Modelling for likely development scenarios, coupled with species habitat modelling and maps is a method that has already been used as a way of understanding impacts from regional development (e.g. for the Perth Peel Strategic Environmental Assessment undertaken by the Australian Government Department of the Environment and Energy). This sort of research should be done for the unconventional gas industry as a whole, prior to a decision by any WA Minister as to the acceptability of ecological impacts from this industry.

Land-based unconventional gas extraction (I refer primarily to shale gas, tight gas and coal seam gas) has a range of ecological impacts, including those listed below. These impacts will affect most matters of biodiversity – threatened species, birds, reptiles, amphibians, aquatic species, ecosystems (including threatened and priority ecosystems):

- Habitat loss (removal of habitat for infrastructure development)
- Fragmentation of habitat
- Edge effects
- Spills and contamination
- Cumulative impacts
- Other enigmatic impacts (such as secondary, cryptic and offsite impacts – refer to Raiter et al., 2014 for definitions of these terms), and
- Unforeseen impacts (unpredictable and perverse impacts).

One need only refer to the publicly available species management plans, environmental returns and approval conditions of the major coal seam gas projects in Queensland, to understand the scale of ecological impacts likely to be caused by unconventional gas development in Western Australia. For many species this consists of thousands of hectares of habitat removal, and for other species, such as marine turtles, measuring the

area or individuals impacted by coastal infrastructure development and shipping is almost impossible. Unfortunately the Australian and Queensland governments were woefully unprepared for the issues associated with estimating the impacts of these spatially/temporally massive projects. This is seen in the many variations to those projects' approval conditions (virtually all of these are requests from proponents to increase their approved habitat clearance limits).

The measurement of direct and indirect impacts is a complex and difficult task. As noted above, the major onshore unconventional developments in Australia have largely failed to provide transparent, repeatable and logical estimates of impacts. This is a serious concern, given the large and dispersed development footprints of these types of development. An example of some of these flaws is provided in the attached submission by myself (Miller, 2017), to a NSW Government assessment of the proposed Carrabin Gas Project (state reference number - SSD 6456, national assessment reference number - EPBC 2014/7376).

Indirect impacts are notoriously difficult to understand and measure, and are rarely included in impact calculations and offset through associated biodiversity offset conditions. It is my suggestion that the WA Government investigate whether the range of enigmatic impacts, and even direct impacts from habitat removal/disturbance, can be measured in a way that is as consistent and transparent as other types of development. In my opinion unconventional gas development on large scales pose unprecedented challenges for quantification of ecological impacts – challenges that I have not yet seen resolved by scientists or policy makers. This issue needs serious consideration prior to any decision about whether the fracking moratorium should be lifted in WA.

3 Water extraction

Impacts of hydraulic fracturing on hydrogeological processes and resources are not discussed here as they are not my area of expertise. However, I have worked with hydrogeologists in relation to coal seam gas regulation, and I point out that there has been a substantial amount of work at Geoscience Australia and with government and industry in Queensland that should be considered by the panel. It would also be worth reading over the minutes of meetings and any publicly available reviews/evaluations from Geoscience Australia and the Independent Expert Scientific Committee on Coal Seam Gas and Large Mining Development. Both groups were involved in the review of coal seam gas water management plans in Queensland, particularly in relation to water cumulative impacts and ground water modelling.

4 Impacts to society and human health

The impacts of unconventional gas development on Australian communities and individual and collective health can barely be overstated. There are both positives and negatives of course, but typically I have seen politics, lobbying and media unduly influence the public debate around acceptability and quantification of social and cultural heritage impacts. Political debate should be allowed to influence a comprehensive and objective investigation into these types of impacts.

From personal experience working in coal seam gas-affected communities, I believe there needs to be a lot more research into the potential for increased mental health impacts associated with unconventional gas development. Due to the nature of the resources to be mined, and their location, the potential for rural and remote

communities to be disproportionately affected is high. These communities already have above average rates of a variety of mental health problems, including suicide. Notwithstanding the above comments, I am not an expert in social impact assessment. However, I am aware of the small body of research that has been undertaken in the Australian context, including several articles by de Rijke (e.g. 2013) and Benham (2016).

It is also worth noting the grey literature on the impacts to individuals in Queensland and NSW from coal seam gas development. There is a large body of evidence to suggest communities and individuals across Australia will suffer negative consequences, including divided communities, volatile property and housing markets and severe stress and mental health challenges (all typical of boom bust towns). No doubt there is also an extensive body of evidence from the research community in the US and Canada that should be considered by the panel.

Of particular importance is the process by which decisions are made about allocation of exploration and mining licenses, in terms of the potential to impact Aboriginal cultural heritage (which is often associated with connections across large areas). I note that a treaty/treaties have not been developed between First Nations peoples and the Australian Government. This and the entire western style of governance that imposes itself on the Aboriginal community, must be recognised as impediments to providing those peoples with a respected, empowered place at the decision making table. Aboriginal peoples must be supported and empowered to make their own decisions about how traditional lands are used and managed. This would enable those peoples to continue protecting their cultural heritage, heal past and current trauma, and to live and work on country in ways that they deem appropriate.

5 Environmental Regulation

(comments primarily relate to biodiversity, rather than air, noise, water, etc.)

5.1 Policy development and legislation

In my experience there are a number of risks associated with the entire regulatory process for unconventional gas projects in Australia and its states and territories. Foremost among these are the fact that there is rarely dedicated legislation that has been developed to address the unique issues around this type of development. If an onshore unconventional gas industry is allowed to proceed in WA there must be dedicated legislation drafted to regulate the industry. This legislation would need to be unambiguous in terms of the decision maker's responsibilities when assessing projects.

In other Australian jurisdictions (particularly Queensland and the Australian Government) legislation is far too open to interpretation. Inconsistency and ambiguity are allowed to influence regulatory outcomes at all levels and good quality regulation relies on leadership from Ministers and Senior Executive public servants. A high quality regulatory regime would not allow such levels of discretion and ambiguity to influence public matters. It would be the WA Government's challenge to devise a regime that can withstand political manipulation and inconsistent assessments by public servants.

5.2 Pre-approval process

Challenges with regulation of an unconventional gas industry begin with the environmental impact assessment process (and arguably with the steps leading up to this phase, such as allocation of exploration licenses).

One challenge is that governments in Australia typically rely on information provided by the proponent to undertake an assessment of the impacts and acceptability of proposed projects. I have seen first hand the way this approach to environmental impact assessment affects the material provided, and by progression, approval decisions. The current regimes simply allow too much subjectivity and opacity in terms of the ecological impact information supplied to the regulatory body. Specifically, it is suggested that the ideal situation is where the WA government hires its own independent assessors to develop impact assessment documentation on a project, paid for by the proponent. The next most preferable option is to require all consultants and relevant employees of the proponent be certified under a code of practice that ensures transparent and consistent conduct by those professionals. This would result in more reliable, higher quality information being provided to government and decision makers.

In addition, there would need to be strict guidelines produced that stipulate the minimum standards for environmental impact assessment documentation for unconventional gas mining. Such guidelines would need to include information on a best practice process for calculating areas of impacted habitat, which itself should include a robust way of ground truthing any modelling (e.g. through field ecological surveys).

While modelling and pseudo-modelling processes have set a precedent for impact assessment approaches in unconventional gas developments in Australia (i.e. Queensland and NSW), there is still the need to acknowledge that this is not the ideal scenario for understanding potential impacts on biodiversity. Smaller scale projects have a greater onus placed on them, as they are expected to survey their entire project footprint. This is perhaps a necessary inconsistency, given the impracticalities of assessing tens of thousands of hectares through onground surveys, nevertheless the risks posed by the country's largest projects being based on models must be formally acknowledged and managed.

Another problem associated with modelling the impacts of large-scale/mega developments is that environmental data is poor. Thus there is actually a practical need for much more onground survey work, especially in poorly researched areas of WA, irrespective of the matter of cost.

Here it would be convenient to point out the problem of acceptability when it comes to Ministers making decisions on whether a project should be approved or rejected. I am not yet intimately acquainted with the processes and standards required in the state of WA, but I would note that in most Australian jurisdictions there is a significant issue with an objective decision being able to be made as to whether a project has "acceptable" impacts on biodiversity. The rigour of such decisions could be improved with more information on, for example, population genetics and viability. There are some precedents for this standard of assessment within Australia. Given this country's renowned track record in species extinctions and habitat loss (since European colonisation) I would suggest it is imperative the public be given more opportunity to decide whether proposed large-scale impacts are acceptable or not.

Australia's terrestrial biodiversity continues to decline. The most cost-effective method for protecting species and slowing declines is to stop clearing habitat.

5.3 Post-approval process

When it comes to a government's job of monitoring projects once they are approved, enforceability of approvals and associated conditions and plans is paramount. The language used by both the proponent (in their legally binding environmental

management plans), and by the government when setting approval conditions, must be able to be used in court to make decisions on accountability and cost of reparation when things go wrong. Thus legal expertise and training for regulatory officers is a must.

Training of government officers is itself an important issue for consideration (both in the pre-approval and post-approval phases of regulation). The fact that large-scale unconventional gas mining is so new to Australia has resulted in public servants assessing project proposals without the necessary training and expertise. This will almost certainly be the case in WA, as there is no history of shale gas mining in the state or the country. This problem creates many risks to government, communities and the environment. Without appropriate training staff might be unaware of the appropriateness of their assessment methods; where data gaps might be; and how to negotiate and interact with proponents such that they are empowered to obtain the right information. To address this issue staff would need to be trained in unconventional gas mining – not just best practice impact assessment methods, but also in other aspects of the industry – e.g. how infrastructure is built and used, industry-specific terminology, common regulatory challenges in the post-approval phase, etc. It is highly likely this training would need to be sourced, or at least supported, by overseas experts.

An equally important matter is whether governments are adequately staffed to carry out their duties in monitoring, audit and compliance of approved projects. In my experience, governments in Australia are not adequately resourced to do this. In my preliminary experiences with the WA Government I believe the problem is certainly at home here. A much greater investment in environmental departments in WA would be required if an unconventional gas industry were to develop in the state.

I attach two reports from the Australian National Audit Office, covering the adequacy of the Australian Government's environmental regulation of approved projects. The outcomes and recommendations will be a useful resource in establishing the WA Government's ability to carry the regulatory burden imposed by a new industry like unconventional gas mining.

5.4 Avoidance, mitigation and offsets

Prior to a decision by the Minister on whether the fracking moratorium should be lifted, they, and this panel, should consider the cost and resources involved in rehabilitating land, in establishing and managing offsets, and the effectiveness of any avoidance/mitigation measures likely to be proposed by proponents.

In my experience there is often very little evidence provided by proponents to support their proposed avoidance and mitigation strategies. (For example, if escape ramps or ladders are set up along open trenches for trapped fauna, do the animals actually use the ramps to escape?). This area of ecological-regulatory research is either lacking or for some other reason rarely used in environmental impact statements. I would encourage any government considering the establishment of an industry like unconventional gas mining to thoroughly investigate whether commonly used avoidance and mitigation strategies are actually backed up by science. This is particularly important if gas field layouts are developed in a stepped process over many years. As I noted in my comments at the public meeting in Broome, what has happened in Queensland (in relation to coal seam gas development) is that projects were approved without anyone having a good understanding of the likely ecological impacts. Part of the reason for this is because the proponents did not know exactly where their wells were going to be placed, and also, those projects were sometimes developed in stages, so that total/cumulative impacts could not be ascertained at the beginning. (Another reason for the poor understanding

of potential impacts is that equations and models were used instead of all areas being surveyed by ecologists beforehand).

I made a comment to the panel at the Broome public meeting in relation to the cost of rehabilitation. This has received considerable attention in the last couple of years following independent research into the cost of mining rehabilitation and the bonds currently held by governments. This matter is now being assessed by a Senate Inquiry. I urge the panel to review the interim outcomes of this inquiry and consider methods for devising adequate financial assurances from proponents to cover the cost of rehabilitation.

Given the large areas of habitat likely to be impacted were an unconventional gas mining industry to develop in WA, the concept of rehabilitation of disturbed lands must be considered. Specifically, there are a range of standards to which project developers are required to rehabilitate land, from simple measures such as soil stabilisation and weed management, to the gold standard 'ecological restoration'. I would recommend requiring a higher standard of repair, in line with current international best practice, as outlined by the Society for Ecological Restoration.

Offsets continue to be used as a regulatory tool by governments. This is despite an ever increasing body of research suggesting they are being abused to enable developments that would otherwise be considered unacceptable. While the policy development around offsetting has continued to improve, the broader question of whether it is a good tool for conservation and environmental management still remains. The Australian Government historically required the use of offsets to result in a net gain for biodiversity. These days their expectations are more conservative. If unconventional gas mining goes ahead in WA I would suggest serious reconsideration of offsets as a biodiversity protection mechanism. In any event, offsets should not be considered by a minister when deciding on the acceptability of a proposed development.

Another problem posed by offsets would be the fact that cultural heritage, natural heritage and certain ecological sites (like wetlands) are virtually impossible to 'offset'. They are, in all practical terms, irreplaceable. This is of significant concern given the large areas of cultural and natural heritage in northern WA.

6 Risk and Uncertainty

Risk assessment is one tool that can be used to manage the potentially high levels of uncertainty posed by unconventional gas mining. I have noted some of the ways risks and uncertainty could be addressed in the above paragraphs, but more broadly, risk frameworks are a useful tool for assisting any evaluation of a new project or new industry. I would encourage the panel to refer to the comments on risk made in the Australian National Audit Office reports and best practice risk assessment in the fields of policy development and environmental regulation.

Thank you for the opportunity to participate in this inquiry process.

Sincerely

Jessica Miller

Attached Resources list

Australian Government Office of the Chief Economist (2015). Review of the socioeconomic impacts of coal seam gas in Queensland. Department of Industry, Innovation and Science.

Australian National Audit Office (2017). The Auditor-General ANAO Report No.36 2016–17 Performance Audit. Monitoring compliance with Environment Protection and Biodiversity Conservation Act 1999 Conditions of Approval: Follow-on audit - Department of the Environment and Energy. Commonwealth of Australia.

Australian National Audit Office (2014). The Auditor-General Audit Report No.43 2013–14 Performance Audit Managing Compliance with Environment Protection and Biodiversity Conservation Act 1999 Conditions of Approval - Department of the Environment. Commonwealth of Australia.

Benham, C.F. (2016). Change, opportunity and grief: Understanding the complex social-ecological impacts of Liquefied Natural Gas development in the Australian coastal zone. Energy Research & Social Science. 14. 61-70. 10.1016/j.erss.2016.01.006.

Claudio, F., de Rijke, K. and Page, A. (2018). The CSG arena: a critical review of unconventional gas developments and best-practice health impact assessment in Queensland, Australia, Impact Assessment and Project Appraisal, 36:1, 105-114, DOI: 10.1080/14615517.2017.1364025

de Rijke, Kim (2013) "Coal Seam Gas and Social Impact Assessment: An Anthropological Contribution to Current Debates and Practices.," Journal of Economic and Social Policy: Vol. 15 : Iss. 3 , Article 3.

Espig, M. and de Rijke, M. (2016). Unconventional gas developments and the politics of risk and knowledge in Australia. Energy Research & Social Science, Vol 20, pp.82-90.

Farwell, A., Wood, P.B., Sheehan, J., George, G.A. (2016). Shale gas development effects on the songbird community in a central Appalachian forest. Biological Conservation 201 (2016) 78–91

Fleming, D.A and Measham, T.G. (2015). Local economic impacts of an unconventional energy boom: the coal seam gas industry in Australia. Australian Journal of Agricultural and Resource Economics, Jan 2015, Vol.59(1), pp.78-94

Lloyd, DJ, Luke, H & Boyd, WE (2013). Community perspectives of natural resource extraction: coal-seam gas mining and social identity in Eastern Australia. Coolabah, vol. 10, pp. 144-164.

Marsden, S. (2013). PROTECTING HERITAGE ON AUSTRALIA'S COASTS: A ROLE FOR STRATEGIC ENVIRONMENTAL ASSESSMENT? Journal of Environmental Assessment Policy and Management, 4 September 2013, Vol.15(03)

Miller, J. (2017). Narrabri Gas Project (SSD 6456; EPBC 2014/7376). Submission to the NSW Government on the above project. [written submission]. NSW Department of Planning and Environment

NSW Government Chief Scientist and Engineer (2014). Final Report of the Independent Review of Coal Seam Gas Activities in NSW. Author.

Queensland Government Department of Health (2013). Coal seam gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data March 2013. Queensland Government.

Raiter, K.G., Possingham, H.P., Prober, S.M. and Hobbs, R.J. (2014). Under the radar: mitigating enigmatic ecological impacts. Trends Ecol Evol. 29(11):635-44. doi: 10.1016/j.tree.2014.09.003

Turton, D.J. (2015). Unconventional Gas in Australia: Towards a Legal Geography. Geographical Research, Vol.53(1), pp.53-67

Walton, A., McCrea, R., and Leonard, R. (2014). CSIRO survey of Community Wellbeing and responding to change: Western Downs region in Queensland. CSIRO Technical report: CSIRO, Australia.

Review

CellPress

Under the radar: mitigating enigmatic ecological impacts

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Identifying the deleterious ecological effects of developments, such as roads, mining, and urban expansion, is essential for informing development decisions and identifying appropriate mitigation actions. However, there are many types of ecological impacts that slip 'under the radar' of conventional impact evaluations and undermine the potential for successful impact mitigation (including offsets). These 'enigmatic' impacts include those that are small but act cumulatively; those outside of the area directly considered in the evaluation; those not detectable with the methods, paradigms, or spatiotemporal scales used to detect them; those facilitated, but not directly caused, by development; and synergistic impact interactions. Here, we propose a framework for conceptualising enigmatic impacts and discuss ways to address them.

The problem of enigmatic ecological impacts

There is increasing recognition of the need to find ways to reduce the environmental impact of human development (e.g., [1–5]). This has led to a proliferation of approaches to evaluate, manage, mitigate, and offset the ecological impacts of developments. Evaluations of ecological impact, such as environmental impact assessments, biodiversity offset calculations, and conservation or land-use plans, are generally intended to account for the full range of foreseeable ecological impacts of proposed developments. However, despite the popularity of impact evaluations (see Glossary) and some substantial improvements over time, their effectiveness remains questionable [6].

In particular, impact evaluations tend to reduce complex impacts of human activity to simple, user-friendly metrics to streamline integration of economic and environmental concerns in decision making [7]. They are usually limited in scope to impacts on a predetermined subset of environmental values [4,8]. Impact evaluations are also limited by the knowledge and tools available for identifying impacts, the skills, interests, and motivations of the people conducting, approving, and auditing evaluations, and political dynamics [9–11]. Furthermore, data are often lacking for uncommon and localised species. Although some ecological impacts are simple and immediately apparent, others are subtle yet potentially far-reaching. Examples of the disparity between the full extent of impacts resulting from a development, and the impacts that have been accounted, are mounting [8,12–18]. Accounting for enigmatic impacts is not the only challenge inherent in mitigating development impacts (e.g., [3,10,19]), but addressing it is crucial: oversights in accounting for impacts undermine the ability of mitigation strategies to achieve their objectives (e.g., [12,18]).

Here, we provide a framework for conceptualising what we refer to as 'enigmatic' ecological impacts: impacts that are easily and often overlooked in impact evaluations. This framework can inform decisions regarding planning objectives, acceptable developments, offset requirements, and regional environmental mitigation strategies. We also explore ways in which the challenges of mitigating these impacts may be met.

Four categories of enigmatic impact

Our framework identifies four categories of impact that are often overlooked or inadequately addressed in impact evaluations: (i) cumulative; (ii) offsite; (iii) cryptic; and (iv) secondary impacts. Interactions between multiple impacts

Glossary

Ecological impact: : the effects or consequences of a current or proposed action on ecosystems, processes, and ecological values and services; that is, the difference between what would happen with the action and what would happen without it [68].
Enigmatic impact: : any one of a large range of ecological impacts that is not systematically accounted for in impact evaluations. We define four categories of enigmatic impact: (i) cumulative impacts: the combined effects of individually acceptable or negligible impacts that become significant at regional scales or over longer temporal scales; (ii) offsite impacts: impacts that occur away from the immediate locality of the disturbance or study area and may permeate far into apparently undisturbed areas; (iii) cryptic impacts: impacts that escape detection using existing methods, resources, or technology, under existing scientific paradigms, within assessment time frames, or at the spatial and temporal scales used in the evaluation; and (iv) secondary impacts: impacts that are not directly caused by the development in question, but are facilitated by it.
Impact evaluation: : any process, policy, or document that includes an evaluation of ecological impacts of development for the purposes of informing decisions or plans, or otherwise mitigating those impacts. This includes, but is not limited to, environmental impact statements and assessments, strategic assessments, applications for clearing permits or similar, works or project approvals, biodiversity offset or biobanking strategies and calculations, and conservation or land-use plans that include sustainable environmental management or biodiversity conservation (or similar) in their objectives.

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may also be overlooked. These categories, named after the reasons for which the impacts are excluded from impact evaluations, act as a checklist for scoping the various 'enigmatic' impacts that could result from a development or series of developments. As such, the categories are not mutually exclusive: an impact may be overlooked for multiple reasons.

Exactly which category an impact belongs to depends on the environmental, social, legislative, scientific, and technological context in which they occur, as illustrated by examples throughout this paper. Some will 'slip under the radar' in certain contexts but not in others. The first and fourth categories are adopted from existing literature and policies (e.g., [6,20]), and the second and third categories are reformulated from concepts elsewhere (e.g., [12,21,22]): the four categories have not previously been synthesised in a single paper.

Cumulative impacts: death by a thousand cuts

'Cumulative impacts' refer to the sum of individual impacts that alone are considered negligible, but accumulate over space and/or time and are so numerous that they are

Box 1. Cumulative and offsite impacts of oil sands development in Canada

Oil sand extraction from naturally occurring bitumen under the boreal forests of western Canada exemplifies the issue of cumulative impacts across a landscape [13]. The boreal forests of North America represent a quarter of the remaining intact forests worldwide, but are becoming increasingly impacted by seismic lines and infrastructure corridors associated with the expansion of *in situ* energy production. The amount of vegetation cleared appears small (conventional seismic lines are 5–8 m wide), but the cumulative disturbance footprint of drill pads and other infrastructure is large, estimated to reach 296 000 ha over the next 40 years [13] (Figure IA). Other impacts include: depletion of freshwater resources; damage to aquatic ecosystems; acidification of land and water; contamination events; production and desalination wastes and byproducts and accidental spills; and the loss of fens and wetlands by conversion to upland landscapes [13].

However, these impacts do not end at the edge of the disturbance footprint (Figure IB). Studies have shown that the threatened woodland caribou (Figure IC) tends to avoid areas less than 1 km from roads and wells. Roads further fragment caribou habitat by acting as semipermeable barriers to movement [13,69]. This is concerning given that woodland caribou populations are declining rapidly, with an approximate halving of populations every 8 years. Projected density of artificial edges caused by oil extraction may increase from 1.8 km/km^2 up to 8.0 km/km^2, with a decline in habitat availability from 43% to 6% of the land base over the next 20 years [13,70].

A suite of other species has also been found to avoid infrastructure in the boreal forests of Canada, including the yellow bellied sapsucker, lynx, marten, fisher, wolverine, boreal chickadee, brown creeper, rose-breasted grosbeak, red-breasted nuthatch, and various warblers [13]. According to Schneider and Dyer [13], 'it is the regional cumulative impact of multiple developments, not the impact at any specific site, that is of greatest concern'.

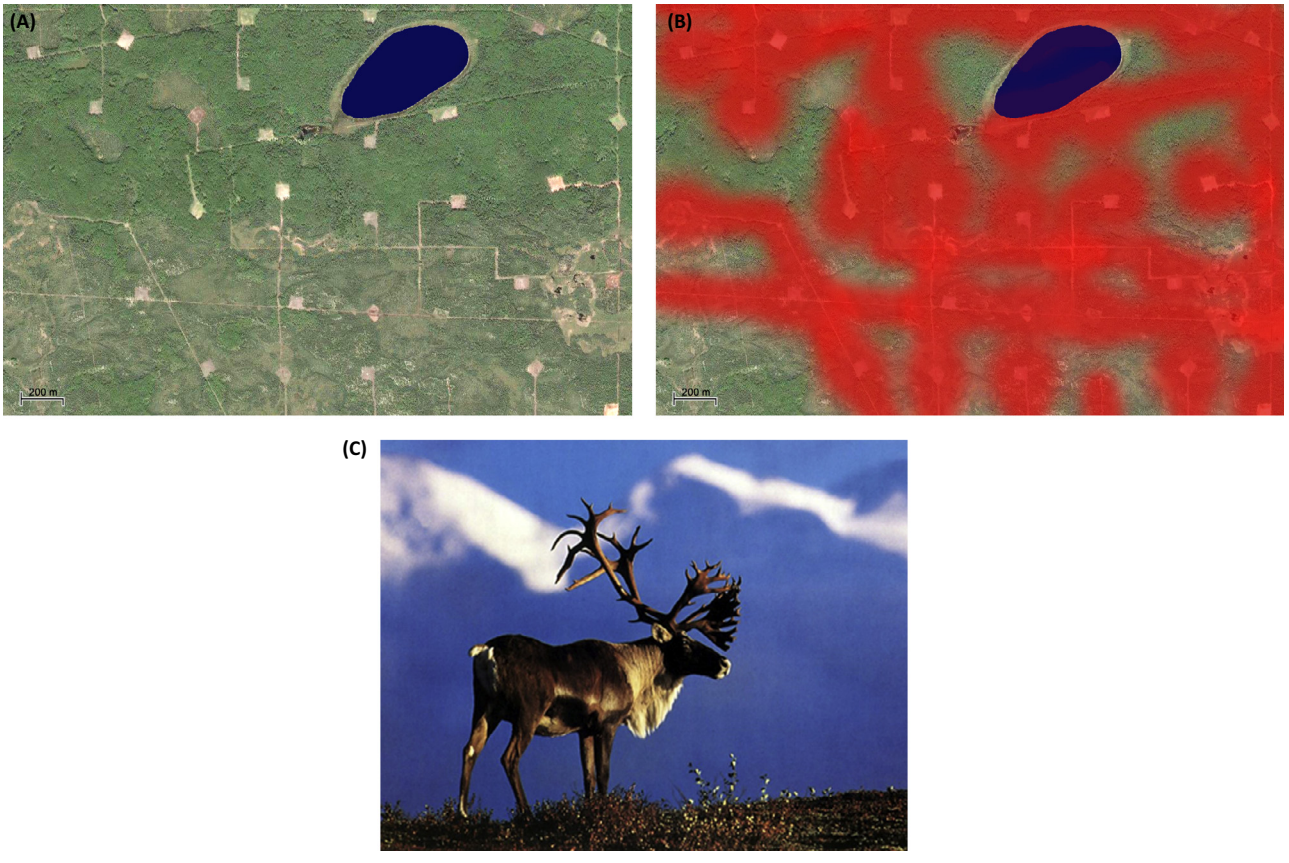

Figure I. Enigmatic impacts from oil sand extraction in Alberta, Canada. Satellite view of roads and well pads showing disturbance footprint **(A)**, satellite view of roads and well pads showing wildlife avoidance zones in red **(B)**, woodland caribou, threatened by multiple impacts of development **(C)**. Reproduced, with permission, from R. Schneider (A, B) and J. Bennett, Sierra Club Canada Foundation (C).

significant when considered in totality [23,24]. A common example of cumulative impacts is many small instances of habitat loss. Individual areas cleared for development, such as housing, drill pads, or roads, may be small but in sum could be unacceptable (Box 1). This concept was originally coined in economics as the 'tyranny of small decisions' [25] or 'death by a thousand cuts' [13].

Cumulative impacts are often overlooked because impact evaluations are often limited by laws that focus exclusively on project-by-project evaluations or impacts deemed to be 'significant', and/or 'reasonably foreseeable' [3,4,23,24]. The emerging fields of strategic and cumulative impact assessments attempt to address these issues, but in their present form are ineffectual or not applied widely [3,23].

Two concerns regarding cumulative impacts are that they can push natural systems over ecological thresholds and their consequences may not be merely additive [5]. Nonlinear relations (such as between remnant habitat area and species richness), feedback mechanisms (such as degraded habitat being less resilient to climate change), space–time lags, and critical tipping points mean that the accumulation of numerous small impacts can be catastrophic [5,23,26]. For example, Florida Bay changed abruptly from a clear-water system with seagrasses and manatees to a 'dead' system with murky water dominated by plankton blooms. The change was unexpected but was probably a threshold response to long-term pollution from septic systems for a long period preceding [27].

Offsite impacts: out of 'site', out of mind

Offsite impacts are those impacts that are difficult to account for in impact evaluations because they are outside the immediate location of the disturbance (the development footprint). Some offsite impacts are considered in impact evaluations (often as so-called 'indirect' impacts) but there are countless impacts that are not included because they are offsite or outside the designated project area or relevant jurisdiction.

Offsite impacts include effects that may occur at great distances from the development such as air, water, light, or noise pollution; or contamination of ecosystems with dust, salt, excess nutrients, or other toxins. They also include alterations to habitat quality away from the disturbance footprint or survey area, such as changed microclimates, altered foraging potential and susceptibility to predation near edges, barriers to wildlife movement and water flow, and changes in animal behaviour with flow-on effects for ecosystems [26,28]. Such changes have been identified even when disturbances are as minor as quiet, nonconsumptive recreation, which is a land use typically thought to be compatible with biodiversity protection [29].

The ecological impacts of hydrocarbons from the extraction, processing, transport, and use of crude oil in the Arabian Gulf exemplify offsite impacts. Hydrocarbons and other pollutants reach the waters of the Gulf by adsorbing to dust carried by wind to the marine environment or via ballast discharge, dredging, infilling, and spills [30,31]. Hydrocarbons can remain dissolved or suspended in water and ingested or absorbed by marine organisms and are often concentrated via food chains, with toxic and carcinogenic effects. However, these impacts are difficult to account for in impact evaluations relating to crude oil activities because of geographic and political separation between the contaminant source and sink [30,31].

More broadly, increasing flood risk to island nations and coastal areas from sea-level rise is an offsite impact of developments that produce greenhouse gases [32]. Many offsite impacts are also cryptic and are covered further later.

Cryptic impacts: the arsenic in the tea

Cryptic impacts elude detection and may be overlooked because of inherent limitations of impact evaluations, but they can be substantial. Reliable detection may be compromised by limited assessment time frames, spatial scales, statistical power, practitioner skill, technology and resources, and the practicalities of survey design [33]. Often only impacts on specific taxonomic groups, ecological communities, or environmental features are evaluated [4,8,12,18].

Cryptic impacts include: noise and light pollution effects on animal communication, movement, foraging, reproductive behaviour and success, visual capabilities, community structure, and predator–prey interactions [34,35]; air pollution impacts on ovule and pollen viability [36]; fragmentation of populations and loss of genetic connectivity [28]; and unwitting disease and invasive species introductions (further examples in Box 2). Furthermore, statistical noise frequently masks trends in ecological data to the extent that early-warning indicators fail to give sufficient warning of potential regime shifts, particularly where data are sparse [16].

Impacts of development on restricted-range endemics are often cryptic, with many species undescribed, poorly surveyed, and/or hard to find, owing to their cryptic nature [37–39]. In Western Australia, where restricted-range endemism is widespread, the Environmental Protection Authority has legislative responsibility to ensure that proposals do not threaten the viability of these species, but many impacts on such species remain unnoticed [38,39].

In 2009, a mining operation in the Great Western Woodlands of southwestern Australia was approved because the restricted-range ameirid copepod (i.e., a small invertebrate that inhabits underground water) found there was thought to occur elsewhere as well [38]. However, the rapid timelines imposed precluded detailed morphological or molecular determination of conspecificity. Subsequent examination found that the two populations belonged to different genera, with the initial population misidentified because of convergent morphology [38]. Consequently, the ameirid is threatened with extinction by dehydration of its habitat.

Secondary impacts: Pandora's box

Secondary impacts are not directly caused by developments but are facilitated by them, yet are generally not considered the legal responsibility of development proponents in impact evaluations. For example, secondary impacts of a hydroelectric dam include the (unintended) impacts of activities facilitated by the road network required for its construction and maintenance [40].

Box 2. Cryptic impact examples

Low-frequency effects on cephalopods

Low-frequency underwater noise produces substantial alterations of the structures responsible for regulating balance and position in cephalopods, such as cuttlefish (Figure IA). This work has shown that the type of noise that is produced by shipping, offshore industrial construction, resource exploitation activities, and naval manoeuvres in marine environments worldwide threatens the survival of these organisms. Little is known about flow-on effects for marine ecosystems worldwide, although they may be substantial [71].

Combining native forests and exotic tree plantations for forest survey

Exotic tree plantations (Figure IB) were lumped together with native forests through automatic analyses of satellite imagery by the Forest Survey of India. This resulted in misleading reports that forests in India expanded by 5% in the decade preceding 2009, when native forests are in fact estimated to have declined by 3.5% per year, driven primarily by forest cutting for fuel wood [12]. These rapid declines in an area that encompasses parts of three recognised biodiversity hotspots were obscured by inappropriate use and interpretation of analytical methods.

Effects of linear infrastructure on water movement and dependent vegetation

Roads can have cryptic impacts on landscapes by interrupting overland flow, upon which vegetation depends (Figure IC). The top half of Figure IC shows the upslope area with annual wind grass (*Aristida contorta*) cover. The lower half of the image shows the effect of water starvation by the road: water from upslope is directed along the road and into creek lines and no longer flows overland [72].

Introduction of microscopic pathogens

Phytophthora cinnamomi is an invasive plant pathogen almost invisible to the naked eye that is practically impossible to eradicate once introduced. This pathogen was inadvertently introduced to Australia and became widespread before it was discovered and its impacts understood. With devastating ecological impacts globally, it is listed as one of the key threatening processes in Australia [73]. Other examples of cryptic invasions include the destructive invasion by non-native earthworms in northern America [41], and devastation caused by invasive rodents on islands, tramp ants, and numerous weeds [20,74,75].

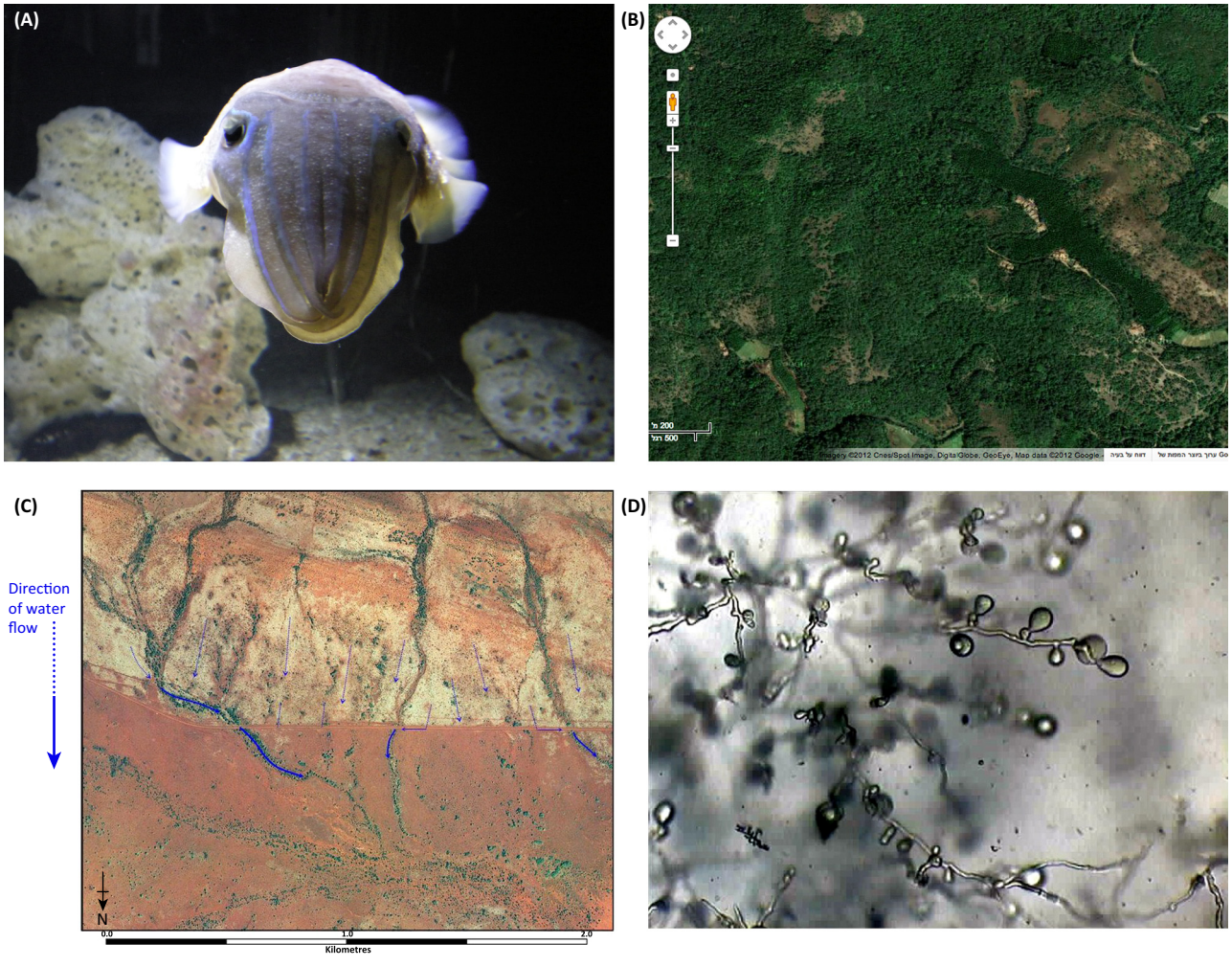

Figure I. Examples of cryptic impacts described in the literature. A cephalopod, whose survival can be threatened by industrial noise in marine environments **(A)**, a landscape of mixed native forests and exotic plantations in India **(B)**, a landscape in which annual wind grass has been severely impacted by a road diverting overland water flow **(C)**, and hyphal swellings of the invasive plant pathogen *Phytophthora cinnamomi* under a light microscope **(D)**. Reproduced, with permission, from Gbaddorf (A) and P.J. Waddell (C).

Indeed, secondary impacts are frequently associated with increased access to relatively undisturbed areas through such road networks. Such accessibility can attract poachers, loggers, miners, graziers, arsonists, land speculators, recreationalists, and even researchers. These uses almost inevitably result in further impacts that can extend far beyond the initial impacts of a development both in space and time, such as introductions of invasive organisms with major ramifications for ecosystems (e.g., [41]). Thus, secondary impacts are also called 'human invasions', or the 'Pandora's box effect' [20,26].

For example, numbers of forest elephants in Central Africa have been reduced by an estimated 40% by illegal poaching for ivory. Intense poaching is a result of a combination of issues, including poverty, weak regulatory powers, and corruption, but access to elephant habitat via new roads is a demonstrated key factor determining poaching rates [42]. Despite providing much-needed economic benefits to human populations, road expansion is associated with increasing threats and local extinctions worldwide [42,43].

Other examples of secondary impacts include the growing contributions of human-ignited fires, 'spontaneous colonisation', uncontrolled logging, mining, and slash-and-burn farming to deforestation in the Amazon basin, that are secondary consequences of an aggressive development strategy of the Brazilian Government [26,44,45]. The strategy includes US$40 billion worth of new and upgraded highways, roads, hydroelectric reservoirs, and power lines, and has been predicted to cause deforestation and severe degradation of up to 500 000 and 2.37 million ha of forest per year respectively, with the majority of impacts above and beyond the direct impacts of the developments [44].

Impact synergies

For every pair of impacts, there are possible synergies that exacerbate environmental damage. The combined effect of the two impacts could be greater than their sum, or one phenomenon might facilitate another. For example, the synergistic effects of multiple species extinctions on ecosystem function are often greater than the additive effect of each extinction, were it to occur in isolation; also, forest fragmentation can facilitate fires [44,46]. It is difficult to predict interactions between different threats and stressors on multiple temporal and spatial scales, and how often they create problematic synergies [47,48]. Nevertheless, history shows that synergistic phenomena can have substantial ecological impacts [48], as outlined in some examples in Box 3.

Challenges and opportunities

Evaluating impacts is the first step to mitigating them. Some impacts are overlooked because they are difficult to detect, quantify, and attribute. In other cases, ignoring them may simply be convenient or politically expedient from a development perspective (e.g., [12,49]).

The difficulty of accounting for enigmatic impacts is not the only hurdle to achieving credible impact evaluations. The effectiveness of many impact evaluations can be undermined by a suite of political and economic constraints including corruption, poor governance, attitudes of governments and regulatory agencies, and persistent weaknesses in rigorous scientific input and meaningful public participation [6,33,43,49].

Quantifying all the enigmatic impacts and their interactions for each development is unlikely given constraints of money and knowledge. However, given the imperatives of conservation and development, governments and proponents need to develop approaches to prevent enigmatic impacts where possible, manage the more predictable impacts, and build mechanisms to account for and mitigate the remainder in a more generic sense. Examples of such mechanisms are presented in Box 4. This process should follow the mitigation hierarchy of (i) avoid, (ii) minimise, (iii) restore, and (iv) offset, with reconsideration of approval for developments that are expected to have large enigmatic impacts [6,50].

Strategic and large-scale evaluation and planning

Developments in regional land-use planning, cumulative and strategic assessments, strategic offsets, and integrated resource management have the greatest potential for mitigating impacts that are inadequately accounted for in project-level evaluations. Such approaches can respond proactively rather than react to developments and provide a much needed mechanism for addressing cumulative impacts [4]. They can also help to ensure that evaluations are designed in ways that maximise their power to detect enigmatic impacts, such as allowing sufficient survey time

Box 3. Impact synergies in space and time

Possibly the most overlooked impacts lie beyond the full extent of individual impacts: in their interactions. Interactions may be antagonistic, additive, or synergistic; that is, the combined effect may be less than, equal to, or greater than the sum of their isolated effects, respectively [48]. Synergistic impacts may also result when one impact facilitates another. Interactions between impacts that are separated by long time periods or operate over different spatial scales are perhaps the most likely to be overlooked.

Coverdale *et al.* [47] investigated a latent, historical synergistic interaction between mosquito ditching that occurred on Cape Cod, Massachusetts, during the 1930s, and recent predator depletion caused by recreational fishing in developed areas. Historical construction of ditches to drain flooded mosquito breeding habitats expanded existing low-marsh cord grass (*Spartina alterniflora*) into areas formerly dominated by high marsh, but this had little effect for decades. Recently, however, recreational fishing reduced predator abundances, such that native herbivorous crab (*Sesarma reticulatum*) populations exploded, causing herbivore-driven saltmarsh die-offs where low-marsh cord grass existed. The synergistic interaction between these impacts resulted in amplified die-off events, despite the historical impact having been dormant for decades.

Local and global impact synergies can also present significant challenges for impact evaluation. For example, global warming can cause direct physiological stress to seagrasses, and excessive local nutrient inputs can cause increased growth of phytoplankton and epiphytes, but the two in combination can have more deleterious impacts on seagrass meadows than their individual impacts combined [48].

Other examples of impact synergies include interactions between habitat degradation and dominance hierarchies of reef fish that substantially alter the mechanisms that structure reef fish communities [76]. In the Amazon basin, increased fire incidence, decreased carbon storage, and changes in forest dynamics caused by logging and fragmentation of forests are amplified by changes in the climate, with potential for dangerous feedback between impacts [26,77,78].

Box 4. Addressing enigmatic impacts in practice

The Nature Conservancy's Development by Design: cooperative mitigation of offsite impacts

The Nature Conservancy was recently commissioned by global gold miner Barrick Gold to develop a cooperative mitigation plan for their Kanowna Belle operations in Western Australia [2,79]. The objective of the plan was to implement Barrick's corporate goal of no net loss of biodiversity.

The Nature Conservancy used the science-based Development by Design mitigation planning process to develop a plan for mitigation and offsetting that included a number of elements designed to account for commonly overlooked impacts. These comprised the inclusion of a 1-km buffer zone around mine footprints and roads in the calculation of impacts for offsetting purposes (to account for 'indirect impacts'; Figure I), a consideration of risks inherent in achieving successful offset outcomes, and a disturbance index based on the cumulative density of mapped disturbance features to inform offset options and priorities.

Environmental risk management and liability insurance for cryptic impacts

If combined with laws that place responsibility for environmental impacts on development proponents, environmental liability insurance can act as a decentralised means of ensuring high regulatory compliance that could reduce oversights in addressing cryptic impacts. Insurance is an effective risk management mechanism because of its capacity to segregate and spread risk effectively, allow for the monitoring and control of behaviour, and encourage loss reduction measures [67]. Importantly, insurance schemes have a lower regulatory burden than most other forms of enforcement.

Although insurance has been used extensively for managing environmental risks to humans from natural disasters, it has only rarely been used to manage the risks of environmental calamities caused by human activities. Section 112(r) of the 1990 US Clean Air Act Amendments provides one example: it offers an opportunity to utilise insurance coupled with third-party inspections to encourage firms to reduce their risks of pollution events from accidents and disasters [67]. At present, impacts that are covered by insurance firms are restricted to human loss of life and injury, and environmental and social impacts remain negative externalities. There clearly is potential to include these other impacts into the insurance equation.

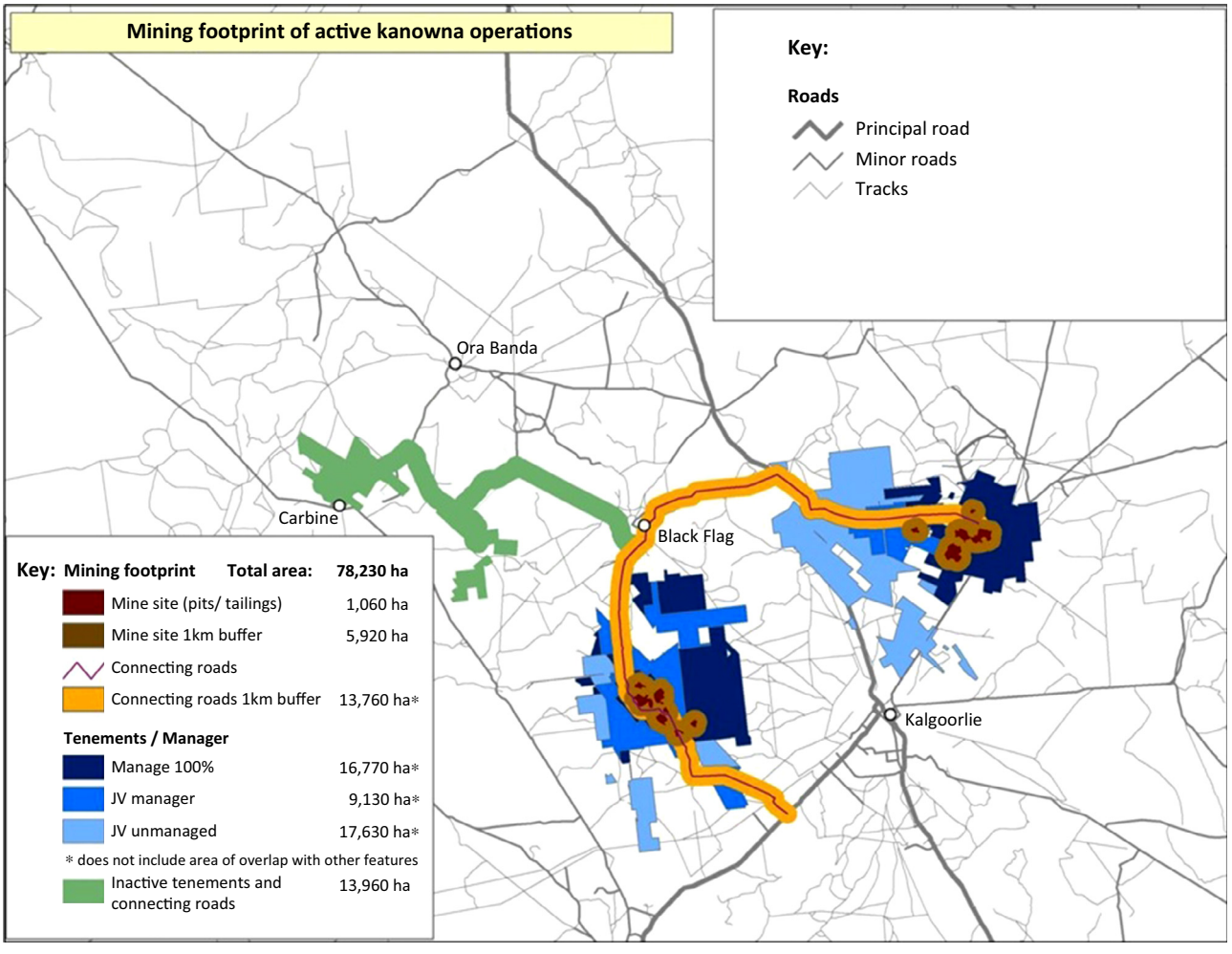

Figure I. An example of an offset calculation in which offset impacts have been taken into account with buffers around disturbed areas in a cooperative mitigation plan developed by the Nature Conservancy for Barrick Gold's Kanowna operations. Reproduced, with permission, from J. Kiesecker, The Nature Conservancy.

frames, considering regional implications beyond individual projects, identifying ancillary impacts, and predicting secondary impacts [3,4,18,44].

However, many such approaches are severely limited, not widely implemented, and are 'underdeveloped' [3,5,6,23]. For example, in the Appalachian region of the USA the impacts of mountaintop mining are only considered for aquatic ecosystems, and severe terrestrial impacts are systematically overlooked [18]. Similarly, fewer impacts would evade consideration if evaluations were broadened from assessing impacts defined as 'significant'.

Trade-offs associated with expanding the scope of impact evaluations could include increased difficulty in decision making regarding approval and prioritising mitigation actions. However, a more realistic picture of probable impacts can only serve to better inform such decisions, and numerous impacts could be grouped or weighted to ensure straightforward yet robust outcomes.

While strategic assessments can facilitate more comprehensive evaluation of enigmatic impacts, other strategic approaches can help to mitigate those impacts. For example, the benefits of offsetting numerous, small developments may be questionable when compensatory activities are implemented separately for individual impacts, but strategic offset funds can provide consolidated sources of funding for offset activities while reducing overall costs. Such approaches would require simple rules for calculating offset requirements and could target regional environmental priorities. Importantly, they can also address cumulative impacts that are commonly too small to offset because the transaction costs of implementing the offset are higher than the cost of implementing the compensatory activity.

Manage, concentrate, and protect

Many enigmatic impacts could be reduced substantially by concentrating developments in areas that are already disturbed, incorporating buffer zones into land-use planning processes and impact evaluations, and establishing no-development zones (or protected areas) in relatively undisturbed areas [51,52]. Roads and developments that penetrate into previously inaccessible areas are disproportionately associated with secondary (and other enigmatic) impacts and could be avoided as a priority [20,26]. Limits on linear infrastructure density could be imposed in other areas. Infrastructure can be shared and consolidated where possible, and investment made into overcoming the barriers to sharing; a strategy also likely to generate cost savings [51,52]. The probable benefits of linear disturbances such as roads and firebreaks that are to be used for 'public good' purposes, such as fire management or ecological monitoring, should be assessed against possible deleterious impacts.

Conserve wilderness or intactness. Other planning policies can complement efforts to concentrate developments and establish no-development zones. Wilderness conservation policies, such as the US Wilderness Act of 1964 [53], effectively prevent countless enigmatic impacts by restricting development in relatively undisturbed areas and represent cost-effective means for long-term biodiversity conservation [54]. However, wilderness is a much debated concept and is embedded in policy only in certain parts of the world [54]. Intactness indices offer a proxy for identifying areas that are less likely to be impacted by enigmatic impacts and may provide an alternative tool for avoiding them [55,56].

Address historical impacts and mitigate co-occurring impacts. Deleterious interactions between multiple impacts, including historical disturbances and global changes, need to be addressed by the societies that have benefited from these developments and by industries that further impact those ecosystems. Where little is known about managing such synergisms, developers can at least minimise their occurrence by measures such as actively rehabilitating disturbed areas, managing species invasions, and facilitating faunal movement across linear infrastructure.

Access management. Secondary impacts can be reduced by restricting public and commercial access along designated-purpose roads, addressing off-road access, and rehabilitating linear infrastructure corridors immediately after project completion. This approach may be difficult to implement in areas where the rule of law is limited and appropriate substitutes may need to be developed, such as creating alternatives to poaching or logging for income generation. Access management may also need to be balanced with community demands for infrastructure development and recreation.

Enhance evaluation

Improve ethical and professional scientific practice. A number of emerging approaches and methods have the potential to enhance evaluation and hence better inform decisions. These include generalised ecological rules of thumb and precautionary approaches that can be applied without detailed assessment and early warning indicators. Calls for addressing ongoing weaknesses in the quality of science underpinning impact evaluations are not new [33,57]. Regulatory agencies, environmental practitioners, and development proponents could improve industry standards and quality control to ensure appropriate application of effort, technology, and expertise in scoping and assessing probable impacts [38]. Rigorously elicited expert knowledge could also complement insufficient data in evaluating likely impacts [58].

Integrated use of available knowledge, precautions, decision-support tools, and projections. Some enigmatic impacts could be accounted for with estimated uncertainty buffers and additional offset multipliers (e.g., [19]). Impact modelling and spatially explicit estimations that incorporate projected impact trends can aid in reducing uncertainty related to data deficiency and in accounting for probable future impacts, as has been done for Amazonian avifauna extinction risks [59–61].

Decision-support tools, such as structured decision making and value-of-information analyses, can also aid in determining the best use of precaution and preferable courses of action in the face of uncertainty, for instance,

where quarantine measures should be used, or when further research or monitoring is beneficial [62]. Such tools can also determine when resource expenditure on monitoring a cryptic threatened species, versus managing the species without monitoring, or surrendering resources to other conservation needs, is optimal [63]. This approach can be adapted to unknown threats, such as in determining when it is wiser or more cost effective to act on a conservative assumption of impact than expend resources on assessment.

Research to establish baselines and early warning indicators. Long-term ecological studies are crucial for establishing baselines and providing key insights into ecological responses to developments [64], and can be particularly helpful in accounting for cryptic impacts. Such monitoring needs to be targeted, hypothesis-driven, and identify trigger points for management interventions to ensure its effectiveness [65]. Improvements in methods for determining early warning indicators can assist in mitigating potential regime shifts [16].

Address the triple bottom line

Public participation. Improving transparency and public engagement in planning and impact evaluations can also help to include consideration of enigmatic impacts in full-cost accounting. Lack of transparency prevents decision makers from being held publically accountable if they did not sufficiently consider likely impacts of a development, such as cryptic impacts that are overlooked by developers seeking to reduce costs or governments pursuing development agendas [4]. Collaborative governance approaches to dealing with cumulative impacts show promise in delivering improvements, although challenges remain, such as corrupt processes, and the time taken to negotiate partnership agreements and difficulty in implementing unpopular responses [66].

Shift risks from society to the marketplace. Governments could better address the risks of cryptic or low-probability impacts by explicitly placing responsibility for addressing development impacts not accounted for (or inadequately accounted for) in impact evaluations in the hands of developers during project approval. For example, if a species was unwittingly introduced into an area because of a development and became invasive, the developer would be responsible for controlling the invasion and repairing any resulting damage, even if they had abided by all regulations. Responsibility for addressing certain historical impacts or collaborating with other developers to mitigate co-occurring impacts could similarly be worked in to approval or licence conditions.

Mandatory environmental insurance schemes offer one way to enact this shift and could ensure that dedicated funds are available when further impacts emerge. Such schemes can help ensure that development decisions intrinsically take account of the risks of unaccounted impacts occurring, with the onus on the developer to better account for and prevent ecological impacts to merit lower premiums [67].

Concluding remarks

Accounting for and mitigating the full breadth of enigmatic impacts resulting from developments is ambitious but important for preventing the continued degradation of ecosystems and the biodiversity, ecological processes, and services that they support. While this may be difficult to achieve comprehensively, significant advances can be made by improving existing mechanisms and developing new ones, to account for the cumulative, offsite, cryptic, and secondary impacts of developments and their interactions. Potential mechanisms include improved strategic and cumulative assessments, no-development and restricted access zones, addressing historical impacts, improving professional and ethical practice and decision-making processes, and adopting environmental insurance schemes. Ultimately, it is reasonable to expect a fair accounting process whereby the beneficiaries of development are responsible for the full environmental costs of those developments, including costs that are currently borne by the broader society and future generations.

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References

1 ten Kate, K. *et al.* (2004) *Biodiversity Offsets: Views, Experience, and the Business Case*, IUCN
2 Kiesecker, J. *et al.* (2013) *Development by Design: Cooperative Mitigation Planning for Barrick Gold's Kanowna Belle Operations in Western Australia*, The Nature Conservancy
3 Morgan, R.K. (2012) Environmental impact assessment: the state of the art. *Impact Assess. Proj. Appraisal* 30, 5–14
4 Alshuwaikhat, H.M. (2005) Strategic environmental assessment can help solve environmental impact assessment failures in developing countries. *Environ. Impact Assess. Rev.* 25, 307–317
5 Buschke, F.T. and Vanschoenwinkel, B. (2014) Mechanisms for the inclusion of cumulative impacts in conservation decision-making are sensitive to vulnerability and irreplaceability in a stochastically simulated landscape. *J. Nat. Conserv.* 22, 265–271
6 Pope, J. *et al.* (2013) Advancing the theory and practice of impact assessment: setting the research agenda. *Environ. Impact Assess. Rev.* 41, 1–9
7 Gasparatos, A. *et al.* (2008) A critical review of reductionist approaches for assessing the progress towards sustainability. *Environ. Impact Assess. Rev.* 28, 286–311
8 Majer, J. (2009) Saga of the short range endemic. *Aust. J. Entomol.* 48, 265–268
9 Bojórquez-Tapia, L.A. *et al.* (1998) Appraisal of environmental impacts and mitigation measures through mathematical matrices. *J. Environ. Manage.* 53, 91–99
10 Walker, S. *et al.* (2009) Why bartering biodiversity fails. *Conserv. Lett.* 2, 149–157
11 Atkinson, S.F. and Canter, L.W. (2011) Assessing the cumulative effects of projects using geographic information systems. *Environ. Impact Asses.* 31, 457–464
12 Puyravaud, J.P. *et al.* (2010) Cryptic loss of India's native forests. *Science* 329, 32
13 Schneider, R. and Dyer, S. (2006) Death by a thousand cuts: the impacts of in situ oil sands development on Alberta's boreal forest. In *Oil Sands Fever Series* (Holmes, R., ed.), Canadian Parks and Wilderness Society and The Pembina Institute

14 Edgar, G.J. *et al.* (2005) Species extinction in the marine environment: Tasmania as a regional example of overlooked losses in biodiversity. *Conserv. Biol.* 19, 1294–1300
15 Almeida-Gomes, M. *et al.* (2014) Underestimation of extinction threat to stream-dwelling amphibians due to lack of consideration of narrow area of occupancy. *Conserv. Biol.* 28, 616–619
16 Perretti, C.T. and Munch, S.B. (2012) Regime shift indicators fail under noise levels commonly observed in ecological systems. *Ecol. Appl.* 22, 1772–1779
17 Roger, E. *et al.* (2012) Linking habitat suitability and road mortalities across geographic ranges. *Landscape Ecol.* 27, 1167–1181
18 Wickham, J. *et al.* (2013) The overlooked terrestrial impacts of mountaintop mining. *Bioscience* 63, 335–348
19 Maron, M. *et al.* (2012) Faustian bargains? Restoration realities in the context of biodiversity offset policies. *Biol. Conserv.* 155, 141–148
20 Laurance, W.F. *et al.* (2009) Impacts of roads and linear clearings on tropical forests. *Trends Ecol. Evol.* 24, 659–669
21 Osenberg, C.W. *et al.* (1994) Detection of environmental impacts: natural variability, effect size, and power analysis. *Ecol. Appl.* 4, 16–30
22 Ribaudo, M.O. (1986) Consideration of offsite impacts in targeting soil conservation programs. *Land Econ.* 62, 402–411
23 Therivel, R. and Ross, B. (2007) Cumulative effects assessment: does scale matter? *Environ. Impact Assess. Rev.* 27, 365–385
24 Canter, L. and Ross, B. (2010) State of practice of cumulative effects assessment and management: the good, the bad and the ugly. *Impact Assess. Proj. Appraisal* 28, 261–268
25 Kahn, A.E. (1966) The tyranny of small decisions: market failures, imperfections, and the limits of economics. *Kyklos* 19, 23–47
26 Fraser, B. (2014) Deforestation: carving up the Amazon. *Nature* 509, 418–419
27 Laurance, W. (2008) Climate shocks that come out of the blue. *New Sci.* 198, 17
28 Forman, R.T.T. *et al.* (2003) *Road Ecology: Science and Solutions*, Island Press
29 Reed, S.E. and Merenlender, A.M. (2008) Quiet, nonconsumptive recreation reduces protected area effectiveness. *Conserv. Lett.* 1, 146–154
30 Sheppard, C.R.C. (1993) Physical environment of the Gulf relevant to marine pollution: an overview. *Mar. Poll. Bull.* 27, 3–8
31 Khan, M.A.Q. *et al.* (1995) Petroleum hydrocarbons in fish from the Arabian Gulf. *Arch. Environ. Contam. Toxicol.* 29, 517–522
32 Nicholls, R.J. *et al.* (1999) Increasing flood risk and wetland losses due to global sea-level rise: regional and global analyses. *Glob. Environ. Change* 9, S69–S87
33 Treweek, J. (1996) Ecology and environmental impact assessment. *J. Appl. Ecol.* 33, 191–199
34 Longcore, T. and Rich, C. (2004) Ecological light pollution. *Front. Ecol. Environ.* 2, 191–198
35 Tyler, N. *et al.* (2014) Ultraviolet vision and avoidance of power lines in birds and mammals. *Conserv. Biol.* 28, 630–632
36 Houston, D.B. and Dochinger, L.S. (1977) Effect of ambient air pollution on cone, seed and pollen characteristics in eastern white and red pines. *Environ. Pollut.* 12, 1–5
37 Scheffers, B.R. *et al.* (2012) What we know and don't know about Earth's missing biodiversity. *Trends Ecol. Evol.* 27, 501–510
38 Karanovic, T. *et al.* (2013) Two new subterranean ameirids (Crustacea: Copepoda: Harpacticoida) expose weaknesses in the conservation of short-range endemics threatened by mining developments in Western Australia. *Invert. Syst.* 27, 540–566
39 Harvey, M.S. (2002) Short-range endemism amongst the Australian fauna: some examples from non-marine environments. *Invert. Syst.* 16, 555–570
40 Finer, M. and Jenkins, C.N. (2012) Proliferation of hydroelectric dams in the Andean Amazon and implications for Andes-Amazon connectivity. *PLoS ONE* 7, e35126
41 Loss, S.R. *et al.* (2012) Invasions of non-native earthworms related to population declines of ground-nesting songbirds across a regional extent in northern hardwood forests of North America. *Landscape Ecol.* 27, 683–696
42 Barnes, R. *et al.* (1995) A review of the status of forest elephants *Loxodonta africana* in central Africa. *Biol. Conserv.* 71, 125–132
43 Edwards, D.P. *et al.* (2013) Mining and the African environment. *Conserv. Lett.* 7, 302–311
44 Laurance, W.F. *et al.* (2001) The future of the Brazilian Amazon. *Science* 291, 438–439
45 Ahmed, S.E. *et al.* (2013) Temporal patterns of road network development in the Brazilian Amazon. *Reg. Environ. Change* 13, 927–937
46 Valiente-Banuet, A. and Verdú, M. (2013) Human impacts on multiple ecological networks act synergistically to drive ecosystem collapse. *Front. Ecol. Environ.* 11, 408–413
47 Coverdale, T.C. *et al.* (2013) Latent impacts: the role of historical human activity in coastal habitat loss. *Front. Ecol. Environ.* 11, 69–74
48 Brown, C.J. *et al.* (2013) Managing for interactions between local and global stressors of ecosystems. *PLoS ONE* 8, e65765
49 Lindenmayer, D.B. and Possingham, H.P. (2013) No excuse for habitat destruction. *Science* 340, 680
50 Gardner, T.A. *et al.* (2013) Biodiversity offsets and the challenge of achieving no net loss. *Conserv. Biol.* 27, 1254–1264
51 Kiesecker, J.M. *et al.* (2011) Energy by design: making mitigation work for conservation and development. In *Energy Development and Wildlife Conservation in Western North America* (Naugle, D.E., ed.), pp. 157–181, Island Press/Center for Resource Economics
52 Tittler, R. *et al.* (2012) Concentrating anthropogenic disturbance to balance ecological and economic values: applications to forest management. *Ecol. Appl.* 22, 1268–1277
53 Jones-Walters, L. and Čivić, K. (2010) Wilderness and biodiversity. *J. Nat. Conserv.* 18, 338–339
54 Callicott, J.B. and Nelson, M.P., eds (1998) *The Great New Wilderness Debate*, The University of Georgia Press
55 Powers, R.P. *et al.* (2013) Integrating accessibility and intactness into large-area conservation planning in the Canadian boreal forest. *Biol. Conserv.* 167, 371–379
56 Scholes, R. and Biggs, R. (2005) A biodiversity intactness index. *Nature* 434, 45–49
57 Greig, L.A. and Duinker, P.N. (2011) A proposal for further strengthening science in environmental impact assessment in Canada. *Impact Assess. Proj. Appraisal* 29, 159–165
58 Martin, T.G. *et al.* (2012) Eliciting expert knowledge in conservation science. *Conserv. Biol.* 26, 29–38
59 Bird, J.P. *et al.* (2011) Integrating spatially explicit habitat projections into extinction risk assessments: a reassessment of Amazonian avifauna incorporating projected deforestation. *Divers. Distrib.* 18, 273–281
60 Schneider, R.R. *et al.* (2003) Managing the cumulative impacts of land uses in the Western Canadian Sedimentary Basin: a modeling approach. *Conserv. Ecol.* 7, 8
61 Loss, S.R. *et al.* (2012) Direct human-caused mortality of birds: improving quantification of magnitude and assessment of population impact. *Front. Ecol. Environ.* 10, 357–364
62 Moore, J.L. and Runge, M.C. (2012) Combining structured decision making and value of information analyses to identify robust management strategies. *Conserv. Biol.* 26, 810–820
63 Chadès, I. *et al.* (2008) When to stop managing or surveying cryptic threatened species. *Proc. Natl. Acad. Sci. U.S.A.* 105, 13936
64 Lindenmayer, D.B. *et al.* (2012) Value of long-term ecological studies. *Austral. Ecol.* 37, 745–757
65 Lindenmayer, D.B. *et al.* (2013) Counting the books while the library burns: why conservation monitoring programs need a plan for action. *Front. Ecol. Environ.* 11, 549–555
66 Eberhard, R. *et al.* (2013) A collaborative approach to address the cumulative impacts of mine-water discharge: negotiating a cross-sectoral waterway partnership in the Bowen Basin. *Aust. Resour. Policy* 38, 678–687
67 Freeman, P.K. and Kunreuther, H. (2004) Managing environmental risk through insurance. In *The International Yearbook of Environmental and Resource Economics 2003/2004. A Survey of Current Issues* (Folmer, H. and Tietenberg, T., eds), pp. 159–189, Edward Elgar Publishing
68 International Association for Impact Assessment (2009) *What is Impact Assessment?* International Association for Impact Assessment
69 Dyer, S.J. *et al.* (2001) Avoidance of industrial development by woodland caribou. *J. Wildl. Manage.* 61, 531–542

70 Hervieux, D. *et al.* (2013) Widespread declines in woodland caribou (Rangifer tarandus caribou) continue in Alberta. *Can. J. Zool.* 91, 872–882

71 André, M. *et al.* (2011) Low-frequency sounds induce acoustic trauma in cephalopods. *Front. Ecol. Environ.* 9, 489–493

72 Waddell, P. *et al.* (2012) A report on the Gascoyne River catchment following the 2010/11 flood events. In *Resource Management Technical Report 382*. Department of Agriculture and Food

73 Shearer, B. *et al.* (2004) Quantification of the susceptibility of the native flora of the south-west botanical province, Western Australia, to *Phytophthora cinnamomi*. *Aust. J. Bot.* 52, 435–443

74 Harper, G. and Carrion, V. (2011) Introduced rodents in the Galápagos: colonisation, removal and the future. In *Island Invasives: Eradication and Management* (Veitch, C. *et al.*, eds), pp. 63–66, IUCN

75 Commonwealth of Australia (2006) *Background Document for the Threat Abatement Plan to Reduce the Impacts of Tramp Ants on Biodiversity in Australia and its Territories*, Department of the Environment and Heritage

76 Boström-Einarsson, L.E. *et al.* (2014) Habitat degradation modifies the strength of interspecific competition in coral dwelling damselfishes. *Ecology* http://dx.doi.org/10.1890/13-1345.1

77 Cochrane, M.A. and Laurance, W.F. (2008) Synergisms among fire, land use, and climate change in the Amazon. *AMBIO* 37, 522–527

78 Laurance, W.F. *et al.* (2014) Apparent environmental synergism drives the dynamics of Amazonian forest fragments. *Ecology* http://dx.doi.org/10.1890/14-0330.1

79 Fitzsimons, J. *et al.* (2014) Development by Design in Western Australia: overcoming offset obstacles. *Land* 3, 167–187

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22 May 2017

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To whom it may concern

Narrabri Gas Project (SSD 6456; EPBC 2014/7376)
Submission to the NSW Government on the above project

I am writing in response to the Minister for Planning and Environment's call for public comments on Santos' Narrabri Gas Project.

My expertise is in natural resource management, ecology, and environmental impact assessment and regulation (including the coal seam gas mining industry). Below I outline my comments on elements of the proposed project, referring to select sections of the Environmental Impact Statement (EIS), in particular Chapter 15 – Terrestrial Ecology and Appendix J1.

The Pilliga is widely considered highly significant for NSW and Australia's biodiversity, including for numerous threatened species and ecosystems. Indeed, the proponent themselves state in their EIS that the area has "high ecological and landscape value" (Chapter 15, page 15-17). The size of the patch; its position in the landscape (including its relative isolation from other large patches, and hence vital need to be self sustaining); and its biodiversity value, lead me to conclude that the project is very poorly situated. The potential benefits (for example, local employment opportunities) could be considered to be outweighed by the amount of long-term impact (both spatially and temporally) likely to be caused to this high-value habitat.

Indeed, when talking about dollars alone, it is quite possible the costs of: losing the proposed amounts of habitat; of rehabilitating the environment; mitigating and offsetting impacts; reducing ecosystem services; increasing climate change; and negative financial impacts on local towns outweigh the potential financial benefits to government and the community. In order to be more certain, I would suggest undertaking a cost-benefit style analysis to more clearly define the possible cost scenarios of this development, in a more comprehensive manner than is done in the EIS. This could be funded by the proponent, the NSW Government or Australian Government – regardless of who funds the analysis, the appointment of the analyst must be through an independent, Government-run process. I acknowledge not all environmental and social costs and benefits can be quantified in this way. However, there are precedents for a range of ecological and community costs and benefits being measured using these

types of analyses. Such information, assuming it is also made publicly available, would greatly enhance the transparency of the decision and decision-making abilities of the Minister. Another positive is that it would dispel some of the myths and concerns around positive and negative economic impacts of the proposal.

[I note the proponent has provided both a cost-benefit analysis and a review of macroeconomic impacts expected from the project. From a brief review, it appears these cover only a small subset of the matters mentioned above. Careful examination and consideration of the caveats associated with both these assessments, including which costs and benefits were not able to included, should be completed by the Department and the Minister.]

Large-scale coal seam gas mining, for the production of liquefied natural gas, is a comparatively new extractive industry in Australia. Its progress has been marred by controversy and in Victoria the fracking has been banned altogether. There have been numerous government, community and industry investigations into the industry, aimed at catching up on a large knowledge gap that has trailed behind development. These ongoing investigations and concerns indicate the industry is still affected by uncertainty and risk (actual or perceived). In the specific case of environmental impact assessment, this is certainly the case.

On top of these concerns, there are two major environmental issues that must be considered when deciding whether to approve or reject this project. One, that the fossil fuel industry is negatively impacting the Australian environment and livelihoods through its contribution to climate change. Two, halting the removal of native habitat is the single most cost effective and important method for protecting what remains of the Australia's biodiversity. The scientific community could not be more clear on these two matters.

Direct impacts

The proponent has defined both 'direct impact' and 'indirect impact' in section 4.11 of Appendix J1. The proponent should clearly state the reasoning (and referenced literature, if any) behind these definitions.

The matter of calculating direct impacts on the environment is not straightforward for large coal seam gas mining projects, a fact acknowledged by the proponent in the EIS itself. The fact that placement of wells is an iterative process that occurs throughout project development makes it difficult to accurately estimate the amount of habitat likely to be removed or impacted prior to an approval decision. There have been a number of approaches that have attempted to deal with this problem in earlier coal seam gas impact assessments, and all appear to rely on some form of modelling to predict the most likely, or 'worst case' maximum amount of impact that could occur.

The main process the proponent has used to calculate what they term 'direct' impacts of gas fields (i.e. primarily the removal of vegetation) is outlined in Section 4.11 of Appendix J1 and Appendix F3 of Appendix J1. The process is described in detail at Appendix F3, and includes probabilistic estimation of impacts from a range of potential development scenarios. This approach is considered much more appropriate than previous approaches used in coal seam gas impact assessment, yet I note that this area of the environmental impact assessment discipline requires much more policy and research attention.

I recommend the Minister closely review this element of the EIS to ascertain whether the estimate of direct impacts is based on a transparent, repeatable and scientifically justified method. This aspect of the impact assessment is even more important than usual, as there is relatively low ability to reduce impacts through avoidance and mitigation. This exact point is made in the EIS – the location of the project [primarily occurring over intact native vegetation] limits "the ability and effectiveness of avoidance methodologies", page 17, Appendix F3 of Appendix J1. It is also important in this context, to ensure reviewers of the EIS have the relevant expertise to review such matters, including statistical expertise.

Indirect impacts

If my interpretation of the methods used for calculating indirect impacts is correct, my conclusion is that that the process is logically flawed. Using various methods the potential area of impact was calculated (and an assumption made that the habitat had the same values as habitat to be removed). Then it appears a 'formula' has been applied to reduce this amount. First down to 25% for reasons outlined in the following paragraph, and in a different scenario, down to 10% – when mitigation measures are employed (refer to Section 4.11.2 in Appendix J1).

The reasons given for assuming indirect impacts would only affect 25% of the modelled buffer zones are that A) the indirect impacts are unlikely to be linear and B) are likely to be greater at the impact source. Assuming these statements are both true, the amount of area impacted *in some way* has not changed from that initially quantified during modelling, and so any use of a formula to reduce the initial modelled amounts is a significant problem. If the proponent is concerned that the initial modelling of indirect impacts is not accurate, I would suggest trying a new method. The entire process from start to finish must be transparent and unbiased.

Why are mitigation measures assumed to reduce indirect impacts to 10%? This formula assumes A) that mitigation measures will be applied in all circumstances (something the proponent cannot commit to doing in all circumstances, based on comments in the EIS) and B) that they will always be successful (there is no evidence provided, from other similar projects or peer reviewed literature, to support this implicit claim). As an example, Table 15-7 proposes that the indirect impacts of well pad construction will only penetrate 5 m into surrounding habitat (with the application of mitigation measures). Whether this can be achieved is highly questionable, and again, evidence should be provided to support this claim.

Similarly, the decision to apply a 10m indirect impact zone for one area, and 50m zone in another, does not appear to be supported by reference to any peer reviewed literature (e.g. literature regarding impact zones for individual species, species assemblages or ecological communities).

Section 15.3 states that indirect impacts from the operational phase were more heavily weighted in calculations than construction impacts. However, section 15.3 does not provide any transparent information about how these perceived differences in indirect impact types were established.

It is also noted in the EIS that final indirect impacts were calculated to be 181.1 ha (following application of the formula mentioned earlier). Does this include the light impacts of flaring gas wells? If so, how large were the impact zones for these and how frequently (spatially and temporally) were they assumed to occur?

Based on above comments, the indirect impacts listed in table 15-7 appear to be flawed in their calculation. The above concerns should addressed prior to a decision being made by the Minister.

Avoidance and mitigation

Avoidance and mitigation are two steps in the proponent's management of environmental impacts. The overarching approach, as mentioned throughout the EIS, is that environmental values must be avoided first, then mitigated and finally, residual impacts offset. This is in line with government requirements.

However, the methods and parties responsible for selecting sites are not entirely clear. There needs to be more information provided regarding the decision-making process to be employed when determining practicability of an avoidance or mitigation measure versus other constraints or priorities (such as technical or financial priorities).

The Field Development Protocol (Appendix C), which will include an Ecological Scouting Framework, appears to be the primary mechanism for ensuring impacts on biodiversity are avoided or minimised. However, the Protocol does not state anywhere how the proponent will demonstrate that environmental matters have been prioritised over other project priorities/constraints. All language in the EIS, regarding the extent to which environmental impacts will be avoided or minimised is non-binding and apparently based on 'practicability', which is not measurable or defined anywhere in the EIS.

The process of locating gas field infrastructure (wells, pipelines and tracks) appears to be as follows: A concept plan for the location of infrastructure is developed; then adjustments are made based on ecologically sensitive areas and exclusion zones. A series of steps follows, including site inspection and micro-site adjustments based on apparent site-level values. It appears from the process outlined in the Protocol that from the beginning (and apparently prior to implementation of the Ecological Scouting Framework) the proposed infrastructure location has already been identified. It is unclear whether environment has been considered during this initial planning phase, but apparently it's a secondary step (e.g. refer to Figure 5-1, in Appendix C). There is also no clarity around whether the person primarily responsible for implementing the Ecological Scouting Framework has any recourse to *renegotiate* or *reject* the proposed site location.

The above concerns relating to avoidance and mitigation should be addressed in a supplementary EIS or through some other mechanism prior to an approval decision.

Risk

The proponent has provided an Environmental Risk Assessment at Chapter 15, Table 15-22. This does not appear to be an actual risk assessment, as it only tabulates the amount of potential habitat prior to impacts; the hypothetical positive impacts of mitigation and the 'residual risk' (impacts that were not able to be mitigated). This does not actually assess the risk to the environment from the proposed project. For example, it does not outline the potential risk of extinction for each environmental value were the project to be proceed. Nor does it assess the risk that species assumed unlikely to be impacted actually are impacted. Nor does it assess the risk that mitigation measures are unsuccessful, or the risk that they cannot be implemented. These are just a few of a much larger suite of environmental risks apparently not addressed in the EIS. Note:

There is also a Hazard And Risk Assessment provided at Chapter 25 – it does not identify or address any of the aforementioned risks and is not designed to do so.

The Minister and the Department should conduct, or require, a thorough risk analysis to help ascertain whether the potential environmental impacts of the project are significant/acceptable. Due to the potential for uncertainty around environmental impacts, risk should be a top priority in the Minister's decision.

Sincerely

Jessica Miller

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Original Article

Aboriginal engagement and agreement-making with a rapidly developing resource industry: Coal seam gas development in Australia

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ABSTRACT

The onshore development of coal seam gas (CSG) is expanding rapidly in Australia. The industry's interaction with Aboriginal people has entailed 35 Indigenous Land Use Agreements in the State of Queensland in the period 2010–2013. Though the mining sector and, to some extent, conventional oil and gas development, are the source of much of our knowledge about agreement making in extractive industries, CSG extraction presents distinctive challenges. The industry has a distributed footprint on the landscape and multiple megaprojects are creating new forms of infrastructure to extract and handle the gas. This development is occurring during a period of evolution in law and regulation. The issues associated with agreement making and implementation that arise in this context are addressed here as seen from Aboriginal and practitioner viewpoints. Drawing on qualitative interviews, participant observation, applied native title research and indicative legal cases, we address the significance of capability challenges, the need for improved industry understanding of Aboriginal cultural politics, more explicit attention to factionalism among Indigenous groups, and the requirement for greater professional collaboration among all parties. CSG development can be seen to have accelerated the exposure of the resources sector more generally to the complexities of agreements with Indigenous people.

1. Introduction

The coal seam gas (CSG) industry is currently expanding rapidly in the State of Queensland and into northern New South Wales with development anticipated in other parts of Australia. Understanding the industry's impact on Aboriginal people can be seen in the context of the ambivalence among the population generally about the regulation and methods of extraction of this new resource. Additionally, it is important to understand current legislation and legal precedent about Aboriginal rights in relation to land and waters.

CSG is known as an 'unconventional' natural gas (mostly methane) that is trapped, under high pressure, within coal seams. It is called unconventional as its extraction requires many wells across a landscape rather than the few deep wells that are conventionally employed to tap into relatively large gas domes that are thousands of metres below the surface. Coal seams suitable for CSG extraction are usually closer to the surface (e.g., 200–400 m below) and relatively thin (often less than a metre thick), and these seams extend in a variegated pattern over large areas. An area of approximately 40,000 square kilometres in Queensland has CSG leases that are currently being developed (Department of Natural Resources and Mines, 2014).

There is an ongoing programme of well drilling and completion, including the associated activities of construction of roads and pipelines for gas and the saline water that comes with it, water treatment, construction and commissioning of gas compression stations, building of high tension power lines, and well pad and pipe route rehabilitation. Land access negotiations and monitoring activities are extensive. While the physical impact of each well is relatively small (about two hectares during drilling and a half hectare afterward), each gas field has a large dispersed footprint, with numerous interlinked wells geometrically spread across hundreds if not thousands of square kilometres for each proponent (Department of Natural Resources and Mines, 2014; US Department of Energy, 2004). These wells require access roads and pipeline rights of way on farm and grazing land as well as in areas

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of residual native vegetation that have not been cleared for agricultural use in this otherwise intensively farmed region (Williams et al., 2013).

CSG and other forms of onshore, unconventional natural gas are of growing importance as a domestic source of fuel in Australia, Canada and the USA (International Energy Agency, 2012). Three export facilities for CSG (as Liquefied Natural Gas, LNG) are currently under development in north-eastern Australia with activity also occurring in Western Australia. The CSG developments being pursued by four joint venture proponents in Queensland were initially valued at $40 billion, a cost that has now risen to $60 billion, with another $20 billion in investment on hold (Queensland Department of State Development, Infrastructure and Planning, 2013).

While these developments provide important sources of energy and significant economic contributions, they have been highly controversial both within the development region and more broadly (de Rijke, 2013b, p. 415). There is opposition and substantial suspicion about CSG development in rural areas where some residents see a threat to agricultural landscapes and to a rural lifestyle and economy (Everingham et al., 2014). The opposition derives from the industry's significant impacts on communities and livelihoods (Measham and Fleming, 2014), feared environmental and health impacts (Carey, 2012), competition with agriculture for use of the land surface and underground water resources (Nghiem et al., 2011; Hamawand et al., 2013), and localised economic impacts such as the skills shortages and price increases of a boom region (Measham and Fleming, 2014). Such concerns are raised in literature internationally on onshore gas development, whether from coal seams or shale beds, as Hunter and Taylor (2013) have documented in their extensive annotated bibliography.

Supporters of CSG promote the industry's potential for generating regional development through billions of dollars in investment to extract the resource, company commitments to corporate social responsibility (CSR), employment and business opportunities, and the relatively low impact of individual gas wells (compared to large-scale coal mining, for example). These factors are highlighted particularly in areas that have suffered from a declining rural population and the stresses on agriculture of recurring drought (Chen and Randall, 2013; de Rijke, 2013a,b; Mercer et al., 2014; Walton et al., 2013).

In Australia, resource extraction companies must negotiate with Aboriginal parties who hold, or may hold, (native title or cultural heritage) rights and interests in the area of proposed development. These rights would be a result of the Future Act provisions of the Native Title Act (1993, Cth) and various legislative State regimes. The negotiations can potentially lead to agreements between Aboriginal parties and resource extraction companies, often in the form of registered Indigenous Land Use Agreements (ILUAs).[1] Agreements set out the terms that must be fulfilled as resource developments proceed. They may include provisions for monetary payments to the Aboriginal party, cultural heritage management plans as per the relevant legislation (which can include procedures for identifying and managing impacts on sites of significance according to Aboriginal cultural traditions), employment opportunities, and a range of other negotiated initiatives.

In addressing these challenges in the CSG arena, we first outline current knowledge and known issues around Indigenous agreements with companies across the resources sector. The perspectives of CSG industry 'practitioners' (Owen and Kemp, 2014, p. 1) working with Aboriginal parties are reported, followed by discussion of general views among Aboriginal groups about the promise and reality of agreements with CSG proponents. This is an under researched area with what appears to be only one study addressing Indigenous engagement among 439 research projects related to CSG development in Australia across topics ranging from technology and the environment to society and economy (Veitch, 2013).

We consider a number of legal cases to illustrate the issues arising for those seeking to implement the kinds of agreements that have so far been negotiated. This is material indicating the importance of greater understanding in the corporate sector of internal social relations among the Indigenous parties. In concluding, we note that available information indicates a need for clear policies – within government and industry – on dealing with what is a vigorous Aboriginal politics that is mobilised in the context of seeking cultural rights, land rights and economic gains. The legal cases examined suggest that corporate withdrawal from agreement implementation is unlikely to result in sustainable relationships between the parties.

2. Current knowledge and issues relating to Indigenous agreements

Most current knowledge about agreement making in the extractive industries can be traced to experiences in the mining sector (Hamann, 2004; Langton, 2006; McMahon and Remy, 2001; O'Faircheallaigh, 2013; Sawyer and Gomez, 2012). One of the most comprehensive publications (Langton and Longbottom, 2012) has outlined risks of a 'resource curse' involving the reproduction of disadvantage among Aboriginal people amidst economic growth (Langton and Mazel, 2012; O'Faircheallaigh, 2012), the distribution of potential impacts and outcomes (Taylor, 2012), and cases where partnerships have been productive (Doohan et al., 2012). A range of other work has canvassed cultural and environmental issues arising for those Aboriginal communities involved intensively with mining developments (Altman and Martin, 2009). This literature parallels research considering these issues around the world (Gilberthorpe and Hilson, 2014). Langton (2012) has presented an extensive case for the importance of Indigenous engagements with the extractive industries in Australia, while others have challenged her position (Crook, 2013; Frankel, 2013; McClean and Wells, 2013). The governance of agreements, and how such governance contributes to effective implementation, has been examined (Allbrook and Jebb, 2004; Gibson and O'Faircheallaigh, 2010; Langton, 2004; Martin, 2009).

While all of this literature is relevant, there are important differences between CSG, conventional oil and gas extraction, and mining that are relevant to agreements between Indigenous and industry parties. Primarily, these differences relate to the physical dimensions of resource extraction, legislative regimes governing each commodity, and impacts on the landscape. Differences between petroleum and mining corporations, project lifecycles and CSR considerations may be less evident to Indigenous parties, but they can indirectly affect negotiation outcomes (Hilson, 2012, p. 135). In oil and gas operations, there is typically an intensive construction period involving highly specialised engineering, after which there is a much reduced rate of ongoing work. In contrast, mining operations follow intensive construction with a larger ongoing workforce to undertake a diverse range of roles, including low-skilled positions. These differences affect the profile of company needs for land access and ongoing interaction with Indigenous groups as well as timing of opportunities for entry-level employment.

Furthermore, the speed of CSG development is dictated by the promise of increased prices in the currently volatile international

[1] All references to 'agreements' throughout this article refer to ILUAs unless stated otherwise.

and domestic markets for natural gas (Intelligent Energy Systems, 2013, pp. 14–15; US Energy Information Agency, 2014). The speed is also driven by the cost of capital invested for construction and government requirements about how soon a lease needs to be exploited. Such impetus for speed is a particularly significant influence in negotiations with Aboriginal people, who commonly need months, or longer, to arrive at collective positions and decisions.

The implementation of CSG Indigenous agreements in Queensland, Australia, is in its early stages, with the first agreement registered in early 2010. There have been 35 agreements with CSG companies in the study region between 2010 and 2013 (Appendix A), contrasting with a total of 16 mining project agreements registered across the entire State of Queensland between 2010 and July 2014 (three in the CSG area).[2] Amidst these dynamic CSG developments, new issues are emerging as the parties involved navigate implementation, monitoring and evaluation of the agreement outcomes. The relevance of what have been referred to in the resources sector as 'cumulative impacts' (Franks et al., 2010) is significant, derived from a number of technical, social, legal and historical factors:

- the broad geographic spread of CSG projects (across an area roughly 200 km by 200 km plus a 500 km pipeline to the coastal LNG plants) and a large number of agreements with many different Aboriginal groups (Fig. 1);
- the presence of four multi-billion dollar CSG joint ventures means that some Aboriginal groups have agreements with more than one proponent, and companies are working with groups who have more than one agreement to manage[3];
- the legal basis for negotiation as it emerges over time in relation to Indigenous rights (i.e., determination by the Federal Court of Australia) is unresolved for a large portion of the development areas;
- claims to native title rights and interests, and associated cultural heritage custodianship, are in a significant number of cases subject to internal Aboriginal disputes, which impact the implementation of agreements;
- disputes and engagements with the resource industry are informed by the historical, economic and cultural legacies of colonialism in a relatively young post-settler country.

3. CSG and the Native Title Act

Across Australia a substantial number of agreements have been negotiated with Indigenous peoples under the provisions of the Native Title Act. From the early 1990s, the recognition of Indigenous peoples' rights has been based on the concept of 'native title', involving 'traditional' connections to land and waters that have continued substantially since British colonisation. As such, native title rights vary between Indigenous groups and depend on the particular traditional laws and customs acknowledged and observed. Current relations with land and waters must be demonstrated to have their roots in earlier, albeit adapted, customary law.

Additionally, some native title rights can co-exist with other forms of tenure, for example pastoral and mining leases. The statutory process for determining where native title exists and what rights can be conferred where other forms of tenure obtain was first provided by the Native Title Act 1993 (Cth) which applies across all States and Territories. Court decisions and amendments have further refined the process and the conditions for recognition. There are impressive outcomes in some regions enabling traditional access to areas and giving Indigenous groups considerable bargaining position in negotiations over proposed land uses (Blowes and Trigger, 1999).[4] However, there have also been criticisms in public debate about the overall process. The Australian Government Productivity Commission's report on mineral and energy resource exploration reflects complaints by some industry parties about having to deal with both native title and heritage claims.[5] The effectiveness of resulting economic benefits has been challenged (Altman, 2009b; Scullion, 2013), with critical media coverage of efforts to regulate distribution of funds resulting from Indigenous agreements in some cases (Cleary, 2014). Others supportive of Indigenous interests have criticised a legal procedure producing jurisprudence that gradually narrows the recognition space of Indigenous rights and interests (Smith and Morphy, 2007) and there have been concerns that the native title process enforces 'a state-resourced and mandated project of ''traditionalism''' (Martin, 2009, p. 108) that makes successful claims increasingly difficult to achieve in light of significant cultural change within Aboriginal groups.

The Act gives registered native title parties[6] the 'right to negotiate' (RTN) over development on lands that may impact their potential traditional rights. The RTN procedure requires a 3-month advance notification followed by a 6-month negotiation period where the developers and the Aboriginal party must negotiate in 'good faith'. After that time, if there is no agreement, the matter can proceed to a determination via arbitration. A number of scholars (Altman, 2009a; Bartlett, 2004; Corbett and O'Faircheallaigh, 2006; Langton and Palmer, 2003; Ritter, 2002, 2010) have argued that this 'threat of arbitration' after six months of negotiation places pressures on parties to reach an agreement, but that this impetus is significantly biased against native title claimants as determinations via arbitration have overwhelmingly been in the favour of business. Langton and Palmer (2003, pp. 17–18) state that while businesses may see the arbitral procedure as the most expedient path to development, they also expose themselves to the risk of an ongoing poor relationship with native title parties due to the latter's dissatisfaction with an involuntary agreement. An alternative view is that, once an agreement is established, the Indigenous party will over time seek the benefits available and adjust to the project.

A significant development in agreement making was the 1998 amendment to the Act that introduced Indigenous Land Use Agreements as a type of voluntary accommodation between claimants and other parties. Agreements are legally binding and cover the conditions for co-existence of native title and rights of other users in relation to land.

[2] National Native Title Tribunal (2014). Register of Indigenous Land Use Agreements as of 7 July 2014.

[3] In Queensland, the four current projects include: Arrow Energy's Arrow LNG Plant and Surat Gas Project in partnership with Shell; Origin Energy's Australia Pacific LNG Project with ConocoPhillips and Sinopec; QGC's Queensland Curtis Liquefied Natural Gas project involving BG Group and the China National Offshore Oil Corporation; and Santos GLNG (Gladstone Liquefied Natural Gas) led by Santos Ltd in partnership with Petronas Australia Pty Limited.

[4] The Aboriginal Social Justice Commissioner's annual Native Title Reports reflect on both the strengths and weaknesses of the legislative regime. Available from: http://www.humanrights.gov.au/publications/social-justice-and-native-title-report-2013 (accessed 06.05.14).

[5] Available from: http://www.pc.gov.au/projects/inquiry/resource-exploration/report (accessed 06.05.14). Complainants included the Association of Mining and Exploration Companies (AMEC).

[6] The Registration test is applied to native title claims upon lodgement with the National Native Title Tribunal. If a claim satisfies all of the required conditions, it is entered on the Register of Native Title claims, and claimants gain certain procedural rights, including the 'right to negotiate' while their claim is pending.

Agreements might cover::

- native title holders agreeing to a future act or group of future acts
- compensation for loss or impairment of native title
- how native title rights and interests coexist
- access to an area
- extinguishment of native title by surrender to governments
- framework agreements (that define terms and conditions for future act negotiations, decision-making or other activities)
- the exercise of native title rights and interests
- cultural heritage issues, the provision of public works and infrastructure, and employment
- economic opportunities for native title groups.

(National Native Title Tribunal, 2008, p. 7)

The use of Agreements has increased significantly since their introduction, as mining companies (and to a lesser extent, oil and gas companies) and native title parties interact more frequently. Negotiation is regarded as a central part of the 'culture of agreement making' with Indigenous peoples that emerged in Australia over a decade ago (Langton and Palmer, 2003; Neate, 2008; National Native Title Tribunal, 1999). Several reasons are posited for this trend, including reduced cost of negotiation (compared to litigation), the facilitation of sound relationships, better understanding and clarity regarding the Native Title Act and associated processes, and increasing expectations of and commitment to corporate social responsibility (CSR).

4. CSG agreements: key issues

As social and cultural issues in community relations during CSG development in Australia have arisen so recently there is little specific academic literature available on the topic. Some studies are underway (de Rijke, 2013a,b; Lacey and Lamont, 2013; Walton et al., 2013; Willow and Wylie, 2014). Our findings derive from qualitative semi-structured interviews conducted during 2013, interactions with practitioners working in agreement negotiation and/or implementation, a range of applied native title research and related discussions with Aboriginal people across Queensland, and a review of indicative native title legal cases.

The interviews with 'practitioners' encompassed 13 individuals in professional roles related to CSG agreements including direct or indirect employment with CSG companies and Indigenous parties.[7] Ten interviews were conducted individually, and one with a group of three. Seven of the interviewees were employed by CSG companies as 'Indigenous relations' staff. Their responsibilities included managing agreement implementation, community engagement, employment and business development programme design and management, and cultural heritage management. The remaining practitioner interviewees were consultants to CSG companies and Indigenous parties. Three of this group were lawyers, and the three others were specialists in community relations. Two of the consultant group had worked only for Indigenous parties. Four interviewees were female.

Interviews included people working for the four major proponents. Our experience in this sector over recent years suggests that Aboriginal engagement staff in one company often know their counterparts in others, and there is some circulation of practitioners through employment, contracting or consultancy relationships, and at working group meetings in forums and conferences. Multiple proponents have published 'Reconciliation Action Plans' (RAPs) that are meant to integrate a company's initiatives in employment, training, and varied forms of support for Aboriginal groups and individuals. However, collaboration among CSG companies in this arena appears limited.

In terms of knowledge and findings in relation to the perspectives of Aboriginal groups, the authors' jointly draw on substantial academic and applied research experience on native title claims, agreement issues among Aboriginal people, and Indigenous politics prompted by resource development projects.[8] A particularly instructive set of discussions derives from two of the authors' participation in a forum on Aboriginal land, cultural heritage and resource extraction in the CSG region.[9]

4.1. Practitioner views

Practitioners indicated that the rapid development of a new industry means that corporate systems and processes are still developing and that the internal company capacity to engage with Aboriginal communities and implement agreements can be a challenge. The view of one individual working with a major CSG company was that international partner organisations often had lower levels of 'cultural proficiency' in engaging with Indigenous people which sometimes resulted in slow internal responsiveness to significant issues. Such delay can allow dissatisfaction to build within affected Aboriginal families and broader communities.

As professionals seeking optimal outcomes for both company and community parties, a common view among practitioners was that they could benefit from being able to present better arguments for the importance of Indigenous engagement within their own companies. Most indicated that arguments for adhering to voluntary corporate policy commitments are often dismissed because of commercial requirements. In this view, articulation of the business, risk or policy case for Indigenous engagement is seen as a necessary area of improvement, as the costs of supporting Aboriginal employment and business development can be significant in the short term. Failure to engage seriously with such support can also lead to significant costs if companies are required to backtrack and 'make good' on the agreements that they have made (e.g., in response to court rulings). Notwithstanding these

[7] Following Owen and Kemp (2014, p. 1), we conceptualise 'practitioners' as those undertaking 'the stable patterns of decision-making and action and organisational habits, routines and patterns, rather than the normative ideals espoused in corporate policy frameworks'. For further reference, Kemp and Owen (2013) provide a discussion of the dynamics of community relations practice in the mining industry.

[8] David Trigger has carried out applied and academic research with multiple Indigenous groups on native title projects related to resource development negotiations (Blowes and Trigger, 1999; Trigger and Robinson, 2001; Trigger, 2005; Martin et al., 2014). In 2011 he was part of a team engaged to peer review an Indigenous policies document of one of the major companies in the CSG study region. During 2012–2013 he advised claimant and respondent parties on four claims in southwest Queensland adjacent to the study region. Julia Keenan worked for Queensland South Native Title Services for the duration of 2006, engaging with all claim groups in the gas fields region. Between 2009 and 2014, she contributed to two projects undertaken by the Centre for Social Responsibility in Mining (CSRM) at The University of Queensland related to Indigenous engagement with QGC's gas development. She has engaged with CSG practitioners via training conducted by CSRM since 2008. Kim de Rijke has carried out anthropological postdoctoral research on coal seam gas developments in Queensland since 2011. He has undertaken native title research in central Queensland generally since 2005, including for the Gaangalu Nation Aboriginal group within the study region of this paper (de Rijke, 2014). Will Rifkin has worked for two years on social science projects in relation to the CSG industry, including reviews of company initiatives on Indigenous employment and related issues.

[9] David Trigger and Julia Keenan attended the Fitzroy Basin Elders Committee Inc. Symposium, *Our Land, Business & Resources* on 18–19 April 2013 in Rockhampton, Queensland.

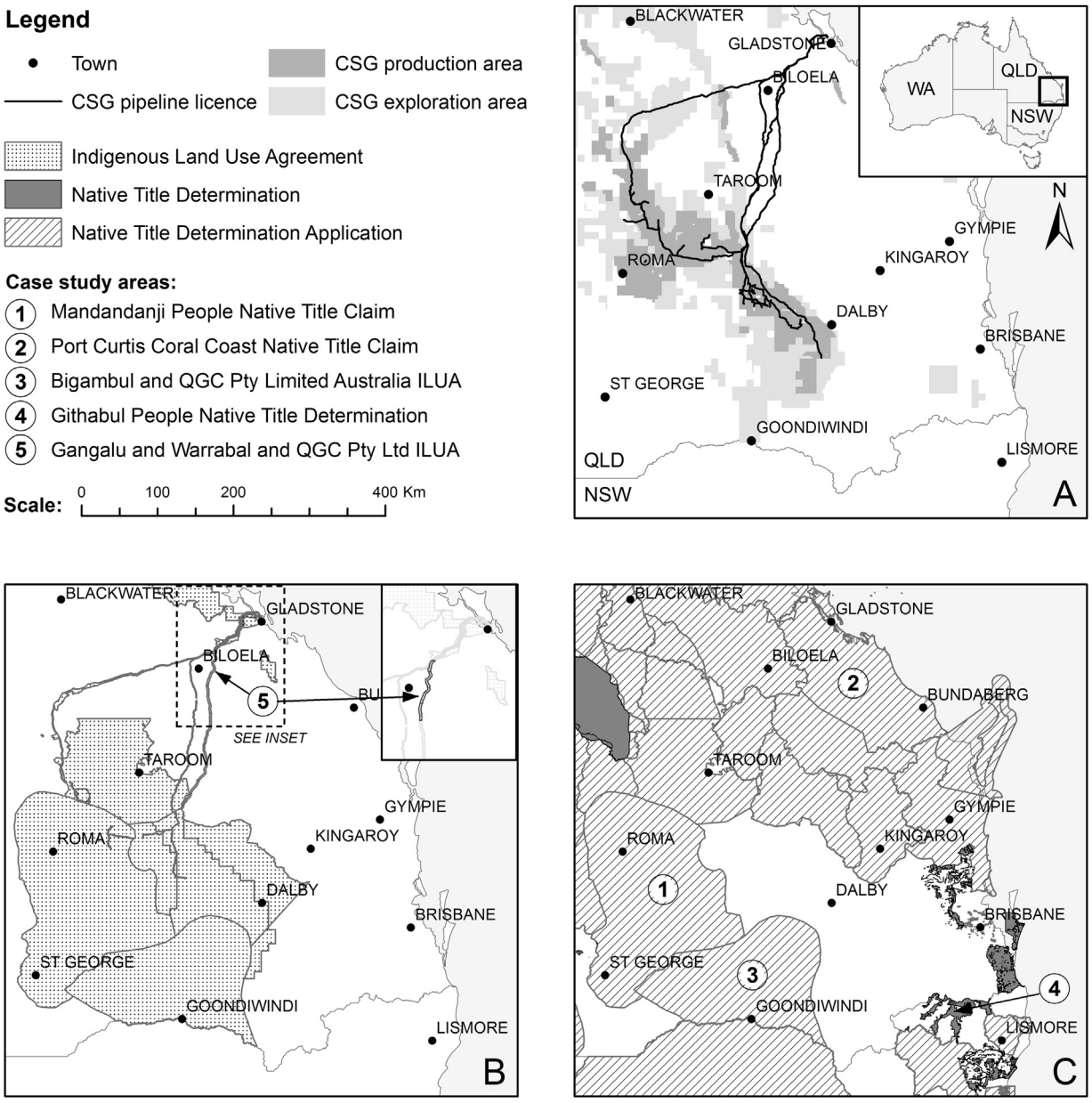

Fig. 1. 'CSG and Aboriginal land interests in the study region of southeast Queensland: Map A – CSG projects; Map B –Indigenous land use agreements; Map C – native title determinations'.

hurdles, we are aware of company practitioners who reported that they had significant levels of support from senior management, which they saw as an opportunity for improving the integration of Indigenous engagement throughout the different functions of the company. There are cases where Indigenous Relations teams are using their company's Reconciliation Action Plans (RAPs) to broaden support for their work within the company.[10] RAPs are an opportunity to engage with a range of internal stakeholders via a working group, as well as an opportunity for senior management to stress the importance of Indigenous relations to the rest of the company (including commitments to promote Indigenous engagement by contractors and sub-contractors).

Most of the practitioners with whom we discussed the matter indicated that agreement governance is an issue encountered day-to-day (e.g., in work with Indigenous subcontractors), with a potential risk for poor outcomes. In this view, agreement governance includes processes and structures for representation, decision making and relationship management to support implementation (Martin, 2009; O'Faircheallaigh, 2002). Governance is critical to the effective implementation of agreements and to creating and maintaining a strong relationship between Aboriginal communities and resource companies (Crooke et al., 2006). Governance challenges relate to Indigenous capacity, forms of representation, transparency, accountability and the consequences for delivering sustainable development outcomes (Doohan et al., 2012; Martin, 2003; O'Faircheallaigh, 2009, 2010; Taylor, 2012).

Governance structures and processes are not uniform within or between companies. The most common arrangement was for each Aboriginal group to have an implementation committee that meets

[10] Reconciliation Action Plans are voluntary plans which outline practical actions that an organisation has committed to taking in order to 'build strong relationships and enhanced respect between Aboriginal and Torres Strait Islander peoples and other Australians' (Reconciliation Australia, n.d.).

three to five times per year with company Indigenous Relations representatives. These meetings generally involve information sharing and advice about upcoming opportunities. At least one of the CSG companies in Queensland has sub-committees for employment and business development. Usually, the Aboriginal committee members are those who together comprise the (native title claim) 'Applicant', i.e. the named representatives of a claim group or signatories to an agreement. A minority of practitioners, acknowledging views arising at times among Aboriginal people, expressed concerns about the degree to which certain committees' members were representative of individual or family interests rather than those of a broad-based 'community'. We can note here the expectation that governance of an agreement needs to reflect a collective set of interests across the Indigenous parties, which may or may not accord with any actual socio-political reality 'on the ground'.

Additional concerns expressed by industry practitioners about representation and governance included:

- apparent 'consultation fatigue' and high turnover on the part of Aboriginal representatives, though interestingly this was not mentioned as a problem for practitioners themselves;
- high turnover of company staff that disrupts working relationships, though reasons for the turnover were not addressed directly;
- challenges of engagement with Aboriginal community members other than those on company–community committees, such concerns relating to both negative undermining of Aboriginal representatives and positive achievement of 'due diligence' as a mechanism for avoiding conflicts or grievances;
- low (available) Aboriginal capacity in areas of administration, planning, financial literacy and community development.

Practitioners reported strong resistance among Aboriginal people to company representation in governance structures involved in managing the financial benefits that flow to an Aboriginal group. They explained this resistance as part of Aboriginal desires for self-determination and a reluctance to being subjected to real or perceived interference by the companies. Such concerns are not surprising given the protest we might envisage if non-Aboriginal recipients of funds arising from land access negotiations encountered the prospect of company oversight on their expenditure. However, this situation raised issues for practitioners about the extent of corporate obligations to promoting accountability and inclusion of the broader Aboriginal community. If nepotism or other forms of selective control over funds arising from an agreement appear to be occurring, company practitioners can be conflicted about how to respond. The uncertainty in the company's position was seen as a potential risk; on one hand, of being 'paternalistic' or interfering in community business, but on the other hand, of being criticised for not ensuring 'acceptable' use of funds. Practitioners also felt that there may be missed opportunities for groups to leverage further investment or cooperation with the company due to a lack of corporate engagement with Aboriginal governance. In their view, corporate input of business development and other skills into Aboriginal investment initiatives could potentially lead to more opportunities for joint projects or programmes for contracting or employment.

Employment, training and business development commitments are significant components of all companies' agreements. In converting these commitments into practice on the ground, practitioners have encountered a range of challenges including:

- supporting long-term unemployed individuals to move into and retain jobs;
- identifying individuals and businesses for training/support;
- developing realistic goals over the life of the project;
- monitoring and evaluation;
- communication of opportunities and outcomes to the broader Aboriginal population of a region as potential beneficiaries of an agreement; and
- addressing Aboriginal community frustrations at perceived lack of progress.

Practitioners further discussed matters related to ensuring that contractors are meeting commitments to Indigenous participation. Companies are able to require their contractors (over a certain size of the contract, often AUS$20 million) to have an Indigenous Participation Plan (IPP). However, it was explained that actual performance varied. Company practitioners reported working with contracting companies on planning and implementing their IPPs, but they noted that they were unable to do so with all contractors (because of time and resource constraints). Those responding to our queries reported that they are usually focussed on contractors with good experience with Indigenous employment, training and business development to improve positive outcomes, rather than trying to hold poor performers to account.

As discussed further in the cases below, the implications of claims to native title are constantly changing. Practitioners rated native title challenges as key to their work. Issues included:

- the implications of working with native title cases yet to be determined through either mediation with the State government (and at times other parties) or litigation;
- interaction with Aboriginal people in relation to cultural heritage (e.g., in identifying the appropriate stakeholders to engage for development of cultural heritage monitoring plans or employing particular individuals to conduct site clearances);
- legal challenges from Aboriginal individuals, families or groups to the representativeness of persons acting as 'applicants' for the claim and/or related issues of claim group composition and membership;
- avenues for accountability and reporting to the appropriate broader Aboriginal group with customary rights to particular claim areas.

There was a view that the current 'legalistic' and financially-driven agreement negotiation processes constrain the generation of arrangements that align with current best practice international community development. These concerns were held in relation to community-led planning, empowerment-based capacity building and long-term strategies. Practitioners explained that they know how to deploy company efforts to support aspects of development to which Aboriginal communities aspire, but they feel hamstrung by near-term financial pressures and legal uncertainties.

In the practitioner view barriers to effective community development from agreements include:

- lack of baseline/needs analysis before negotiation and early implementation;
- working under significant business-related time pressures;
- lack of long-term or strategic planning for implementation over the lifetime of an agreement;
- difficulty of switching between an adversarial approach during negotiation and a post-agreement dialogue focussed on a positive working relationship;
- lack of non-judicial grievance mechanisms, meaning that disputes between Aboriginal parties or Aboriginal and non-Aboriginal parties are being held up in the court system;
- the implications of multiple companies/agreements with a lack of coordination among them.

We can conclude that practitioners recognise hurdles based on company and contractor capabilities as well as capacities, politics and legal concerns within Aboriginal groups.

4.2. Aboriginal perspectives

Issues raised by Aboriginal people in relation to agreements arising from CSG and broader development aspirations are largely centred on links to land (or 'country'), membership of groups of beneficiaries, cultural identity negotiations, representation of collective Aboriginal interests and related governance of groups, and leverage required to negotiate with and extract real outcomes from resource companies. As well as certain internal features of social relations among Aboriginal people, these challenges appear to reflect the scale and speed of CSG development, relative to the time taken for making collective decisions by Aboriginal groups and for resolving native title claims in the courts.

We note diverse views within and across Aboriginal populations about CSG developments. While there is opposition to it as a form of land use, as discussed below, we are aware also that the New South Wales Aboriginal Land Council (NSWALC), in cooperation with a number of local Aboriginal organisations in that State, has been actively involved in CSG exploration and extraction activities for some time (de Rijke, 2013a, p. 2). Similarly diverse responses to this new industry are evident among Indigenous groups across our Queensland study area.

4.2.1. Revitalising links to 'country'

A common aspiration is to strengthen links to traditional 'country' (the term used to refer to the physical and spiritual property of land and waters). The imperative to revitalise such connections is particularly strong where people have, over several generations, moved or been removed by government regulation, as has been the case in large parts of Queensland (Haebich, 2000, pp. 168–181; Kidd, 1997; Trigger, 1983). Strategies for reconnecting to country can include conducting tradition-derived activities such as hunting, fishing, and teaching children cultural information about the bush. Loss of cultural knowledge and identity are seen to be at the root of many of the social problems faced by Indigenous people, particularly youth. While this view remains contested in light of other arguments for the importance of poverty alleviation through participation in the economic mainstream (Langton, 2012; Pearson, 2011), for many Aboriginal people it is clear that the idea of reinforcing direct links to country and 'culture' has the potential to improve community health and social wellbeing.

In this context, for Aboriginal people in parts of Queensland who may live far from their ancestral land or do not have access to it, activities associated with resource development can both ensure oversight of development activities and potentially facilitate access to country (e.g. via engagement in cultural heritage management or governance structures where transport and time are paid for). There is also the socio-political and psychological benefit of being formally recognised as having particular cultural connections, responsibilities, and knowledge of the land as its 'Traditional Owners'.

4.2.2. Economic benefits

There are complaints that Aboriginal people are not able to access business development and employment opportunities as they had expected from the project. CSG impacted Aboriginal people identified a range of barriers to such access, including:

- the rapid development of industry (e.g., a 2-year timeline for pipeline construction) outpaces a group's ability to establish or expand a business;
- a lack of access to contracts/contractors, because contracts are too large for local or fledgling businesses to take on, or sub-contractors – who may work on smaller jobs – are not easily identified;
- an apparent lack of interest from contractors and a lack of requirements for Indigenous business development in major contracts.

Aboriginal people also identified difficulties with accessing employment opportunities in the CSG sector, including:

- balancing work and cultural responsibilities, though the issue of customary obligations tends not to be defined clearly in relation to other possible reasons for 'low value' being attributed to employment in the resources sector (Scambary, 2013, pp. 74, 193–202);
- lack of appropriate formal qualifications;
- but also stereotyping among some employers about lack of relevant skills among Aboriginal people other than for low expertise positions;
- difficulties in accessing employment with contractors because of previous poor experiences and a lack of information about the contractors' contact details;
- limited ability to hold companies and contractors accountable for poor performance and failing to achieve commitments related to Aboriginal employment; and
- frustration with continued training without resulting employment.

Of further relevance to understanding such barriers, though not necessarily addressed publicly among Aboriginal groups, is the question of intergenerational unemployment related to a lack of interest among young people in embracing a routinised work lifestyle (Trigger, 2005).

4.2.3. Marginalisation and lack of agency

Within the agreement making and implementation processes Aboriginal people frequently report a sense of historical and current marginalisation and lack of agency. Marginalisation is seen to be generated by institutional structures (the onus of proof under the Native Title Act, business practices, and government policies) as well as social and cultural forces (perceived racism, discrimination and social disruption, alcohol and drug abuse among Aboriginal people, and related social dysfunction).

Reflecting on recent negotiations with CSG proponents, Aboriginal people have presented a number of further factors understood to limit their negotiating position, including:

- dispersed families and individuals associated with named claim groups and a commensurate lack of experience in formulating a collective negotiating position, with particular difficulties instructing legal representatives;
- historical disputes between and among Aboriginal groups preventing consensus on agreement issues;
- lack of access to legal and financial representation, advice and to information at the same level as the companies;
- lack of leverage due to the possibility of compulsory land acquisition by the State and consequent access by CSG companies; and
- little opportunity to hold companies accountable for their actions or failures.

4.2.4. Agreement making and community divisions

Agreement making and associated processes, while providing a potential avenue for development opportunities, also both respond to and can precipitate a lack of social cohesion in Indigenous

communities. Native title claimants are frequently in dispute with regard to their own group memberships, asserted territorial boundaries, representative roles, governance methods and distribution of economic benefits.

In the CSG sector, and in the context of often partial knowledge of traditional connections to land and waters, there have been a number of disputes in recent years about Aboriginal group representation or negotiations with a resource developer. The conflicts have included challenges to the legitimacy of particular individuals as representatives, the appropriateness of the selection process of such representatives, and the ability of people to represent the interests of the wider group. The development and prioritisation of strategic, broad-based and long-term interests has also been an issue in some cases. There are problems with physical and psychological 'burn out' effects due to the demands of involvement in multiple negotiation processes. Those impacts can be multiplied when a single Aboriginal group must negotiate with more than one CSG company.

The disputes have flow-on effects in communities, and they affect the ability of a group to present a united position in negotiations with resource developers, which is exacerbated by power inequalities. Some Aboriginal people perceive that these internal divisions (often regarded as driven by self-interest or greed) have limited the success of groups in negotiations. Further, in affected towns, divisions may emerge between those Aboriginal people who are considered as Traditional Owners of the area (particularly where native title has been determined), and those who also reside in the town but are ancestrally connected to other places. A number of legal cases are illustrative.

4.3. Indicative legal cases

4.3.1. Mandandanji

On the 25th March 2013, a Federal Court judge ordered that all native title payments to the Mandandanji People in southern Queensland be paid to the Registrar of the Federal Court, although these orders were dismissed in a subsequent judgement on 16th July 2013. The case is notable as the judge raised concerns that money received from gas companies was not benefiting the whole claim group (Weribone on behalf of the *Mandandanji People v State of Queensland* [2013] FCA 255).

This decision was triggered by an internal Aboriginal dispute over the native title claim group description and, thus, contemporary group membership. The dispute was about the inclusion of one identified ancestor in the claim group description and hence the membership assertions of that forebear's descendants. The lack of consensus about the appropriate description of the claim group resulted in two groups' competing applications under the Native Title Act. The court noted that '[t]here is uncertainty in the conclusions available at the present time in the anthropological evidence as to the correct claim group description' (FCA 225, para 51). As the Mandandanji claim was yet to be determined, there had been no legal decision about the correct description of the claim group. There was therefore an understandable concern that the proceeds of agreements were thus potentially not being distributed appropriately to benefit all those with tradition-based rights in the land (FCA 225, para 66).

The judge ordered that the Mandandanji people had to apply to the Registrar of the Court to access some of the $2.3 million held in trust by the group until a determination of native title is made. These orders were later set aside as the judge found a new applicant had been properly appointed, one who was able to 'deal effectively with issues that may concern the various constituents of the claim group' (Weribone on behalf of the *Mandandanji People v State of Queensland (No 4)* [2013] FCA 758, para 6). The judge did comment, however, that he was concerned that there had been an 'apparently disproportionate expenditure on board meetings' (FCA 758, para 11), and that there may have been non-compliance with the earlier orders (FCA 758, para 12). The issue was 'referred to the registrar to investigate whether any proceedings for contempt should be brought with respect to lack of compliance with orders' (FCA 758, para 17).

This case illustrates a number of issues:

- agreements can be made with Indigenous groups while the identity of the native title holding group and its membership has not yet been determined by the relevant legal process;
- payments may be made to claim groups with limited capacity and disputed membership;
- it is unclear what the role is, if any, of the company or other parties, such as government-funded native title representative bodies or the State government, in verifying membership in relation to agreement making and implementation in the CSG sector;
- the role and ability of the court to manage such native title payments has not been resolved (Lovitt et al., 2013);
- there is a need for increased transparency and accountability among all parties;
- the role of the court, land councils, companies, anthropologists, and claimants should be clarified to enable all parties to progress effective resolution of disputes within, or among, relevant Aboriginal groups.

4.3.2. Port Curtis Coral Coast

A court decision in 2001 amalgamated five previous claim groups in coastal southern Queensland into the Port Curtis Coral Coast native title claim group. Against a background of disputation, there were media reports in 2013 that members of the group were planning to initiate a class action against QGC, Santos GLNG, and Asia Pacific LNG for not upholding their agreements. A member of the group said that the companies had damaged cultural heritage sites, failed to pay appropriate compensation, and had not delivered business development or employment opportunities (Rollo, 2013). However, one of the Aboriginal group's registered applicants disagreed with these assertions (Rollo, 2013).

QGC responded to the claims in a media release saying that the company was following the conditions of the cultural heritage management plan agreed with the Port Curtis Coral Coast group as required under the relevant legislation and that no sites had been damaged (QGC, 2013).

The case raises issues as follows:

- there can be differences within claim groups about the perceived impacts/benefits of agreements, which may be based on different views about cultural concerns and/or strategies to seek to leverage funds using the language of heritage regardless of consensus about genuine damage;
- it is important to identify particular locality-specific rights and interests if they are customarily held by different families within claim groups; and
- differences can exist between companies and Indigenous parties in their understandings of 'damage' that is of cultural significance.

4.3.3. Bigambul/Darling Downs

The Court case *QGC Pty Limited v Bygrave [2011] FCA 1457* concerned the registration of Agreements by the National Native

Title Tribunal[11] and the authorisation of those agreements by native title claimants. The delegate of the Native Title Registrar had refused to register an agreement between QGC and the Bigambul People because 'she was not satisfied that all the persons who hold or may hold native title in the land and waters within the Bigambul area had authorised the making of the agreement as required by s 251A of the Act' (FCA 1457, para 5). QGC successfully petitioned the court to overturn this decision.

In this instance, the delegate was aware of a group of Kamilaroi/Gomeroi People who did not authorise the agreement and who she considered 'persons who hold or may hold the common or group rights comprising the native title' (NTA 1993 s 251A). QGC disputed the eligibility of the Kamilaroi/Gomeroi People to authorise an agreement on the basis that they held no registered native title claim in the relevant area. The Federal Court judge found that it is 'fair and just to an existing registered native title claimant by requiring that any other community or group seeking to advance conflicting claims to its claims, has to submit those claims to the discipline of the [registration and authorisation] processes' (FCA 1457, para 118). The judge overturned the delegate's decision.

This judgement was controversial in that previously 'persons who hold or may hold the common or group rights comprising the native title' had not been considered to be restricted to 'registered native title claimants'. The decision thus raises issues concerning:

- uncertainty for proponents and Aboriginal people where there is no registered native title claim in the agreement area, or where a claim is contested; and
- questions about what constitutes best-practice agreement making in a context of uncertainty and dispute about traditional land ownership.

Poignantly, the Federal Government released a Bill to amend the Native Title Act on 28 November 2012[12], which, in response to the uncertainty generated by the *QGC Pty Ltd v Bygrave [2011] FCA 1457* decision, includes the following changes to the authorisation process, giving:

> parties who do not have a registered native title claim (but can establish a *prima facie* case that they may hold native title) a right to take part in the authorisation decision. This will reverse the outcome of the decision in *QGC Pty Ltd v Bygrave [2011] FCA 1457*, which had found that ILUAs can be properly authorised by registered native title claimants only. (Audeyev et al., 2012)

4.3.4. Githabul People

The Githabul native title claim, just across the Queensland border and covering the part of this group's country in northern New South Wales, was determined in 2007. The Federal Court recognised that the Githabul People hold non-exclusive native title rights and interests over 1120 km^2, including nine national parks and thirteen state forests (National Native Title Tribunal, 2007, p. 2). The Githabul People, the Githabul Nation Aboriginal Corporation, and the New South Wales Government also entered into an agreement which set out, among other things, that:

- the Githabul People will be involved in consultation and management of 11 national parks and reserves through a management committee and the employment of at least four Githabul People;
- the Githabul People will be consulted over the management of 13 state forests;
- certain areas that are culturally significant to the Githabul People, including Tooloom Falls, will be protected; and
- 102 ha of Crown lands will be transferred in freehold to the Githabul Nation Aboriginal Corporation (National Native Title Tribunal, 2007, p. 2).

In Githabul country, CSG exploration has been the subject of intensifying dispute since 2012. Githabul opponents have challenged the authority of the Githabul Nation Aboriginal Corporation to allow exploration. Further internal disputes erupted as a result of the application for a number of petroleum special prospecting authorities by the New South Wales Aboriginal Land Council (NSWALC) in 2012. The area covered by these applications includes a portion of the determined Githabul native title claim (Farrow-Smith, 2012)

Some Githabul representatives regard native title and the agreement to be at the heart of this issue. It was reported that:

> Githabul spokeswoman Gloria Williams says the Native Title agreement is being wrongly used to allow coal seam gas interests into the region. 'Through Native Title, this is how they are coming through our country mining the hell out of it,' Ms Williams said. 'Because we signed off on a consent determination agreement ... and when we sign off on a consent determination agreement we are literally giving them consent to come and do what they want,' she said. (Farrow-Smith, 2012).

This statement, however, glosses over underlying factors in the dispute about CSG; namely, intra-Indigenous contestation about representation and authority among Githabul people. In January 2013, Githabul opponents of CSG exploration were said to be 'planning a legal challenge in an international court if necessary against their own to dissolve the Githabul Nation Aboriginal Corporation (GNAC), which they say approved mining on their country without their consent or approval' (Lovejoy, 2013). Arguments against CSG developments included those focused on the cultural maintenance of country (in a spiritual sense) and environmental health, but also concerns related to the possible negative social consequences of financial payments to individuals, including the potential of increased alcohol and drug abuse, violence, road accidents, and reliance on external funding as a new form of passive welfare. Two Aboriginal persons described in the media as Githabul elders were subsequently arrested during a blockade of Metgasco CSG exploration activities (Feain and Brown, 2013).

These reports raise the following issues:

- differences within the claim group about the perceived impacts/benefits of agreements, including the negotiation of conflicting concerns with regard to economic development on the one hand and environmental and cultural integrity of country on the other;
- disagreements about the benefits and risks of substantial individual payments, given possibly self-destructive purposes to which the funds may be put in the social conditions in which recipients may live; and
- ongoing politics of representation and dispute resolution processes within claim groups, occurring both during and following legal processing of the claims.

4.3.5. Gangulu and Warrabal

On 27 February 2012, a Delegate of the National Native Title Tribunal (NNTT) decided not to register the Australia Pacific LNG

[11] The National Native Title Tribunal is an independent agency established to administer the Native Title Act 1993 (Cth). Its role includes keeping a register of native title determinations, claims and Agreements.

[12] This Bill subsequently lapsed in November 2012 with the Australian federal elections, and was reintroduced to the Senate in March 2014 as *Native Title Amendment (Reform) Bill 2014* (2014 Bill), on identical terms to the 2012 Bill.

and Gangulu Parties Agreement. The agreement was to allow the construction of a gas pipeline in an area not covered, at the time the agreement was signed, by a registered native title claim. The Gaangalu [sic] Nation, a regional socio-political grouping encompassing members of constituent descent groups previously identified in discontinued native title proceedings as Gangulu, Ghungalu and Kangoulu had by that time lodged a native title claim inclusive of the area, but it had not yet been subjected to the registration test by the NNTT (though it subsequently passed this test).

The difficulties surrounding the agreement arose out of adverse information submitted by the Warrabal People who asserted native title rights in the area. Nevertheless, it was argued by the company, relying also on material provided by the native title representative body (Queensland South Native Title Services), that the Warrabal had not established a prima facie case to hold native title, and the agreement was therefore made only with the Gangulu party. The Delegate, however, concluded (National Native Title Tribunal, 2012, pp. 29, 43):

> [T]he issues of who holds or may hold native title in the ILUA area was the subject of a genuine dispute between the Gangulu and the Warrabal groups and was also contentious and unclear, such that it was not reasonable to prefer the Gangulu over the Warrabal . . . As I have found, all of the evidence I have reviewed leads me to consider that the Warrabal People were not identified [as a group of persons who hold or may hold native title] and this amounted to a failure by APLNG to make the efforts required of it under s.24CG(3)(b)(i).

Despite the dispute surrounding this particular agreement, the Gangulu and Warrabal had previously entered jointly into an agreement with another company, QGC, for the construction of their gas pipeline (Gangulu and Warrabal and QGC Pty Limited ILUA QI2010/022).

Issues raised in this case include:

- the impact of uncertainty in areas where native title claims are absent or discontinued;
- the role of native title representative bodies, legal practitioners and anthropologists in the provision of relevant evidentiary materials;
- the capacity and adequacy of efforts by proponents to identify those who hold or may hold native title in circumstances of dispute; and
- the potential impact of intensifying intra-Aboriginal disputes on the operation, governance and outcomes of agreements previously jointly authorised by both groups.

The range of concerns, disputes, and unresolved issues illustrated in the legal cases reviewed suggests that development of CSG in eastern Australia is engaging with Aboriginal groups that are internally diverse in terms of articulation of traditional rights in country as well as aspirations for and capacity to manage agreements. Apart from the socially fractured nature of Indigenous social relations in the region, the timeline for exploration and construction in CSG can be seen as compressed relative to the degree of complexity that the Aboriginal groups, companies, the courts and the government must resolve.

5. Conclusions and recommendations

In light of the literature addressing the importance of agreement making between Aboriginal groups and the resources sector in Australia, we have considered the rapidly developing CSG industry in southern Queensland extending into New South Wales. The legislative regime of native title has been focused on owing to its centrality to the context in which negotiations occur. Given the significance of the *relationship* between the key parties in the production and implementation of agreements, we have noted that practitioners are seeking to bring professional standards and best practice to their work engaging with Indigenous community groups and individuals. However, they report concerns with time pressure in the CSG projects for which they work, while coping with organisational silos and changes among personnel and/or their roles.

Practitioners face the challenges of engaging with numerous Aboriginal groups in an arena where other proponents are often negotiating with the same and neighbouring individuals and families. This dynamic is occurring in a shifting regulatory and legal environment. Responses to agreement processes on the part of Aboriginal people indicate concerns about links to country, group membership, cultural identity, representation and governance in groups, as well as about their bargaining position in relation to multiple well-funded resource companies.

In the context of academic and policy studies indicating the opportunities arising from formal recognition of tradition-based Indigenous relations with land, as well as the risks of a 'resource curse' that results in Aboriginal impoverishment amidst rapidly developing megaprojects, the key issues of agreement negotiation and implementation are evident. In concluding this study we present recommendations that follow from our analysis.

Collaboration across a mosaic of agreements: The complexities of competing industry and Indigenous interests, as well as diversity of views within both parties, calls for mapping the mosaic of different agreements to avoid confusion across the relevant CSG development region. What different governance structures and implementation processes are in place and what are the overlaps for the different companies and communities? While acknowledging possible competitive interests between different proponents, and some diversity of commitment within company structures on Indigenous issues, we seek a basis for strategic/aggregated management processes across companies and Indigenous groups.

Recommendation: The parties should embrace opportunities for, and where appropriate facilitate, greater collaboration between different Indigenous groups and companies in addressing the organisational and geographic complexities prompted by CSG development. All parties should focus on retaining knowledge and expertise of agreement implementation over time to ensure deep knowledge of the emergent relationships between Aboriginal people and the industry.

Competence in engaging with Aboriginal groups: In light of the apparent increasingly vigorous internal Indigenous politics focused on CSG development, all parties need improved policies and methods for engaging with the drivers of both collectivism and factionalism among Aboriginal families and individuals. If agreements are to be sustainable over time, they need to be informed by an understanding of both agreed and contesting versions of native title connections and asserted rights over particular areas of land and waters. The cases we have examined illustrate intra-group tensions and disputes and related issues of equity of representation directly relevant to the distribution of financial benefits to flow from CSG agreements. Practitioners in the companies, together with those Aboriginal persons leading negotiations and implementation (with their legal advisors and anthropological experts), require clear joint understandings of how internal disputes are best managed.

Recommendation: The parties should acknowledge directly the issue of tensions and factionalism among Indigenous groups and frame productive ways of ensuring their resolution. This will involve companies achieving greater capacity for understanding

the cultural and kinship bases of emergent and flexible Aboriginal group formation in relation to native title rights and hence agreements. Discussion with Indigenous parties should address the benefits of collaboration and costs of factionalism.

Economic development issues: Given the breadth of concerns and interests articulated among Aboriginal people, and our reportage of practitioners' commitment to broad community development aspirations, it is important for agreements to consider economic benefits in terms of livelihoods rather than narrower financial outcomes (Martin et al., 2014). A focus on livelihoods means that parties require mutual understanding of how sociocultural issues, such as family loyalties and the potential for perceived nepotism, can impact on how agreements are seen to be proceeding. How can the most productive use of funds from agreements be ensured in light of sensitivities about company intrusion into financial management among recipient groups?

Recommendation: The parties should engage in robust discussion about community versus individual enterprises, employment and training. The benefits and costs of greater company involvement in expenditure of funds from agreements should be addressed rigorously and in a politically robust way.

Non-financial outcomes of agreements: There are asserted symbolic significances associated with negotiating and implementing agreements for the Aboriginal parties. Apart from the financial issues to be negotiated, we have reported broad aspirations about achieving recognition of native title rights and the cultural and historical importance of connection to land and waters. The implication is that industry proponents may need to listen at times with empathy to such concerns apart from engaging in the critical legal matter of developing and implementing the technical clauses of an agreement.

Recommendation: The parties should seek to achieve greater understanding on the part of companies of the cultural and historical bases of Aboriginal connection to land and waters. This will include knowledge of traditional group territories, population movements and linked regional bodies of 'law and custom' emergent over time, and the changing nature of rights in country derived from earlier occupation of the landscape.

Governance capacity: The challenges of effective governance capacity building for Indigenous groups prompt the complex question of how this can be supported by CSG companies. Skills and educational achievements can only be successfully facilitated if there is commitment among young people as well those leading agreement making and implementation. Understanding of intergenerational relationships in the Aboriginal groups is necessary. As agreement implementation progresses, demographic changes will include younger people emerging as significant agents for the articulation of Indigenous interests. Flexibility of approach to changing representation is required. This is also the case for the circumstances of persons who may live outside the region but over time assert interests based on traditional connections to the land and waters affected by CSG development.

Recommendation: The parties should focus particularly on youth commitments to opportunities arising from agreements. Recognition of the importance of mutually respectful interpersonal relationships across the parties is critical in relation to younger Aboriginal people engaging with agreement outcomes. Governance of agreements will require flexible modification over time as youth with traditional interests across the CSG region grow to participate in agreement governance.

We conclude that complexity is a signal characteristic of Aboriginal agreements in the CSG arena. It emerges from the contested history of Aboriginal–industry relations in Australia, the political and identity dynamics of Aboriginal groups, and the extensive footprint of onshore natural gas developments, their speed, and their cumulative impacts. Resolution of the issues we have addressed would have implications for other regions where onshore gas is being developed in proximity to, or directly on, the lands of Indigenous peoples.

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Appendix A. Queensland CSG ILUAs, by project

Sources:

Agreements, Treaties and Negotiated Settlements (ATNS) database. Melbourne, Australia: Indigenous Studies Programme, The University of Melbourne. Retrieved 4/7/14, from http://www.atns.net.au/page.asp?PageID=15

National Native Title Register of Indigenous Land Use Agreements. Perth, Australia. Retrieved 21/5/14, from http://www.nntt.gov.au/INDIGENOUS-LAND-USE-AGREEMENTS/SEARCH-REGISTERED-ILUAS/Pages/Search.aspx

1. QGC's Queensland Curtis Liquefied Natural Gas project

1. Djaku-nde & Jangerie Jangerie & Wakka Wakka People and QGC Pty Limited (Balance Area) Indigenous Land Use Agreement (ILUA)

2. Djaku-nde & Jangerie Jangerie & Wakka Wakka Peoples & QGC Pty Limited Indigenous Land Use Agreement (ILUA)

3. Barunggam, Cobble Cobble, Jarowair, Western Wakka Wakka, Yiman and QGC Indigenous Land Use Agreement (ILUA)

4. Gangulu and Warrabal and QGC Pty Limited Indigenous Land Use Agreement (ILUA)

5. Iman People #2 and QGC Pty Limited Indigenous Land Use Agreement (ILUA)

6. Port Curtis Coral Coast & QGC Pty Limited Indigenous Land Use Agreement (ILUA)

7. Mandandanji People and QGC Pty Limited Indigenous Land Use Agreement (ILUA)

8. Bigambul & QGC Pty Ltd Indigenous Land Use Agreement (ILUA)

9. QGC Pty Limited - Jangga Indigenous Land Use Agreement

10. QGC and Wiri Indigenous Land Use Agreement (ILUA)

11 QGC and Barada Barna Indigenous Land Use Agreement (ILUA)

12 QGC, Barada Barna and Wiri Indigenous Land Use Agreement (ILUA)

2 Australia Pacific LNG Pty Ltd, Australia Pacific LNG Gladstone Pipeline Pty Ltd, Australia Pacific LNG (Shared Facilities) Pty Ltd and Australia Pacific LNG Processing Pty Ltd

13. Port Curtis Coral Coast and Australia Pacific LNG Pty Limited Indigenous Land Use Agreement (ILUA)

14. Australia Pacific LNG and Iman People Indigenous Land Use Agreement (ILUA)

15. Australia Pacific LNG Pty Limited Wulli Wulli Djaku-nde and Jangerie Jangerie Indigenous Land Use Agreement (ILUA)

16. APLNG & Mandandanji Indigenous Land Use Agreement (ILUA)

17. APLNG and Area E Native Title Group ILUA

18. APLNG and Gaangalu Nation People ILUA

19. APLNG and Iman People Fairview and Eurombah Creek Projects ILUA

3 Santos GLNG (Gladstone Liquefied Natural Gas) is a project led by Santos Ltd in partnership with Petronas Australia Pty Limited

20. Santos & Petronas & Karingbal People GLNG Indigenous Land Use Agreement (ILUA)

21. Santos Petronas Port Curtis Coral Coast GLNG Indigenous Land Use Agreement (ILUA)

22. Santos, Petronas and Iman People #2 GLNG Indigenous Land Use Agreement

23. Santos Petronas Gangulu GLNG Indigenous Land Use Agreement (ILUA)

24. Santos/Petronas/Bidjara/Karingbal People GLNG Indigenous Land Use Agreement (ILUA)

25. Santos/Petronas/Bidjara GLNG Indigenous Land Use Agreement (ILUA)

26. Santos Petronas Murribinbi Gladstone Liquefied Natural Gas (GLNG) Indigenous Land Use Agreement (ILUA)

4 Arrow Energy

27. Arrow Barada Barna People LNG Project Indigenous Land Use Agreement (ILUA)

28. Arrow Barada Barna People and Wiri People LNG Project Indigenous Land Use Agreement (ILUA)

29. Arrow Wiri LNG Project Indigneous Land Use Agreement (ILUA)

30. Arrow Jangga LNG Project Indigenous Land Use Agreement (ILUA)

31. Arrow Birri LNG Project Indigenous Land Use Agreement (ILUA)

32. Arrow Darumbal LNG Project Indigenous Land Use Agreement (ILUA)

33. Arrow Energy and Port Curtis Coral Coast People Arrow LNG Project Indigenous Land Use Agreement (ILUA)

34. Arrow Energy Western Downs Unclaimed Area Indigenous Land Use Agreement (ILUA)

35. Arrow Energy and Southern Barada People, Kabalbara People, Jetimarala/Yetimarla People, Darumbal People and Darumbal People #2 LNG Project ILUA

References

Allbrook, M., Jebb, M.A., 2004. Implementation and Resourcing of Native Title and Related Agreements. National Native Title Tribunal, Perth.

Altman, J., 2009a. Benefit sharing is no solution to development: experiences from mining on aboriginal land in Australia. In: Wynberg, R., Shroeder, D., Chenells, R. (Eds.), Indigenous Peoples, Consent and Benefit-Sharing: Lessons from the San-Hoodia Case. Springer, Berlin, Germany, pp. 285–302.

Altman, J., 2009b. Contestations over development. In: Altman, J., Martin, D.F. (Eds.), Power, Culture, Economy: Indigenous Australians and Mining. ANU E Press, Canberra, Australia, pp. 1–15.

Altman, J., Martin, D.F., 2009. Power, Culture, Economy: Indigenous Australians and Mining. ANU E Press, Canberra, Australia.

Audeyev, S., Vidler, N., Young, K. (Producer), 2012. The Wind is Shifting in Native Title. Retrieved from http://www.mallesons.com/publications/marketAlerts/2012/Pages/The-wind-is-shifting-in-native-title.aspx.

Bartlett, R., 2004. Native Title in Australia, 2nd ed. Lexis Nexis Butterworths, Chatswood.

Blowes, R., Trigger, D., 1999. Negotiating the Century Mine Agreement: Issues of law, culture and politics. In: Edmunds, M. (Ed.), Regional Agreements in Aboriginal Australia. Australian Institute of Aboriginal & Torres Strait Islander Studies, Canberra, Australia, pp. 85–135.

Carey, M., 2012. Coal seam gas: future bonanza or toxic legacy? Viewpoint 8, 26–31.

Chen, C., Randall, A., 2013. The economic contest between coal seam gas mining and agriculture on prime farmland: it may be closer than we thought. J. Econ. Soc. Policy 15 (3), 1–30.

Cleary, P., 2014. Uneven flow of benefits. Australian Newspaper. Retrieved from http://www.theaustralian.com.au (07.05.14).

Corbett, T., O'Faircheallaigh, C., 2006. Unmasking the politics of native title: the National Native Title Tribunal's application of the NTA's arbitration provisions. UW Aust. Law Rev. 33, 153.

Crook, A., 2013. Marcia Langton Sparks Academic Spat Over Charges of 'Racism'. Retrieved 07.04.14 from http://www.crikey.com.au/2013/02/27/marcia-langton-sparks-academic-spat-over-charges-of-racism/

Crooke, P., Harvey, B., Langton, L., 2006. Implementing and monitoring indigenous land use agreements in the minerals industry: the Western Cape communities co-existence agreement. In: Langton, M. (Ed.), Settling with Indigenous People: Modern Treaty and Agreement Making. Federation Press, Annandale.

de Rijke, K., 2013a. Coal seam gas and social impact assessment: an anthropological contribution to current debates and practices. J. Econ. Soc. Policy 15 (3), 1–28.

de Rijke, K., 2013b. Hydraulically fractured: unconventional gas and anthropology. Anthropol. Today 29 (2), 13–17.

de Rijke, K., 2014. Gaangalu Nation Native Title Determination Application (QUD 400/2012): Connection Report. Report Prepared for D&G Lawyers on Behalf of the Gaangalu Nation. University of Queensland Culture and Heritage Unit, Brisbane.

Department of Natural Resources and Mines, 2014. Queensland's Coal Seam Gas Overview. Retrieved 13.05.14 from http://mines.industry.qld.gov.au/assets/coal-pdf/csg-update-2014.pdf.

Doohan, K., Langton, M., Mazel, O., 2012. From paternalism to partnership. In: Community Futures, Legal Architecture: Foundations for Indigenous Peoples in the Global Mining Boom. Routledge, Oxford, pp. 231–250.

Everingham, J.-A., Collins, N., Rifkin, W., Rodriguez, D., Baumgartl, T., Cavaye, J., Vink, S., 2014. How farmers, graziers, miners, and gas-industry personnel see their potential for coexistence in rural Queensland. SPE Econ. Manage. 6 (3) , http://dx.doi.org/10.2118/167016-PA.

Farrow-Smith, E., 2012. Aboriginal People Reject Native Title Over Coal Seam Gas. Retrieved 07.04.14 from http://www.abc.net.au/news/2012-12-15/githubul-csg/4429486.

Feain, D., Brown, J., 2013. Githabul Elders Arrested at Doubtful Creek CSG Protest. Retrieved 07.04.14, from http://www.northernstar.com.au/news/web-first-arrest-at-doubtful-creek/1743202/

Frankel, B., 2013. Opportunity Lost: Marcia Langton's Boyer lectures, Arena. Retrieved 07.04.14 from http://arena.org.au/opportunity-lost/

Franks, D., Brereton, D., Moran, C., 2010. Managing the cumulative impacts of coal mining on regional communities and environments in Australia. Impact Assess. Project Appraisal 28 (4), 299–312.

Gibson, G., O'Faircheallaigh, C., 2010. IBA Community Toolkit: Negotiation and Implementation of Impact and Benefit Agreements. Walter & Duncan Gordon Foundation.

Gilberthorpe, E., Hilson, G., 2014. Natural Resource Extraction and Indigenous Livelihoods: Development Challenges in an Era of Globalization. Ashgate Publishing, Ltd, London, UK.

Haebich, A., 2000. Broken Circles: Fragmenting Indigenous Families, 1800–2000. Fremantle Arts Centre Press, Freemantle, Australia.

Hamann, R., 2004. Corporate social responsibility, partnerships, and institutional change: the case of mining companies in South Africa. In: Paper Presented at the Natural Resources Forum.

Hamawand, I., Yusaf, T., Hamawand, S., 2013. Coal seam gas and associated water: a review paper. Renew. Sustain. Energy Rev. 22, 550–560.

Hilson, G., 2012. Corporate social responsibility in the extractive industries: experiences from developing countries. Resour. Policy 37 (2), 131–137.

Hunter, T., Taylor, M., 2013. Coal Seam Gas: An Annotated Bibliography. Centre for International Minerals and Energy Law, The University of Queensland, Sustainable Minerals Institute, Centre for Coal Seam Gas, Brisbane, Australia. Retrieved 07.04.14 from http://www.law.uq.edu.au/documents/cimel/Coal-seam-gas-annotated-bibliography-complete.pdf.

International Energy Agency, 2012. Golden Rules for a Golden Age of Gas: World Energy Outlook, Special Report on Unconventional Gas. International Energy Agency, Paris. Retrieved 07.04.14 from https://www.iea.org/publications/freepublications/publication/WEO2012_GoldenRulesReport.pdf.

Intelligent Energy Systems, 2013. Study on the Australian Domestic Gas Market. Australian Department of Industry, and Bureau of Resources and Energy Economics, Canberra, Australia.

Kemp, D., Owen, J., 2013. Community relations and mining: core to business but not "core business. Resour. Policy 38, 523–531, http://dx.doi.org/10.1016/j.resourpol.2013.08.003.
Kidd, R., 1997. The Way We Civilise: Aboriginal Affairs, The Untold Story. University of Queensland Press, Brisbane, Australia.
Lacey, J., Lamont, J., 2013. Using social contract to inform social licence to operate: an application in the Australian coal seam gas industry. J. Clean. Prod., http://dx.doi.org/10.1016/j.jclepro.2013.11.047.
Langton, M., 2004. Honour Among Nations: Treaties and Agreements with Indigenous People. Melbourne University Publishing, Melbourne.
Langton, M., 2006. Settling with Indigenous People: Modern Treaty and Agreement-making. Federation Press, Annandale.
Langton, M., 2012. Boyer Lectures 2012: The Quiet Revolution: Indigenous People and the Resources Boom. ABC Books, Sydney.
Langton, M., Longbottom, J., 2012. Foundations for Indigenous Peoples in the Global Mining Boom. Routledge, Oxford.
Langton, M., Mazel, O., 2012. The 'resource curse'compared: Australian Aboriginal participation in the resource extraction industry and distribution of impacts. In: Community Futures, Legal Architecture: Foundations for Indigenous Peoples in the Global Mining Boom. Routledge, Oxford, UK, pp. 23–44.
Langton, M., Palmer, L., 2003. Modern agreement making and Indigenous people in Australia: issues and trends. Aust. Indigenous Law Rep. 8, 1–31.
Lovejoy, H., 2013. International Court Challenge Over CSG Mining. Retrieved 07.04.14 from http://www.echo.net.au/2013/01/international-court-challenge-over-csg-mining/
Lovitt, C., Marchesi, C., Patterson, S. (Producer), 2013. Federal Court Acts to Prevent Misapplication of Native Title Funds in Queensland. Lexology. Retrieved from http://www.lexology.com/library/detail.aspx?g=3acaea96-c114-418d-acaf-37a6485ebdf7.
Martin, D.F., 2003. Rethinking the Design of Indigenous Organisations: the Need for Strategic Engagement. Discussion Paper No. 248/2003. Centre for Aboriginal Economic Policy Research, ANU, Canberra, Australia.
Martin, D.F., 2009. The governance of agreements between Aboriginal people and resource developers: principles for sustainability. In: Altman, J., Martin, D.F. (Eds.), Power, Culture, Economy: Indigenous Australians and Mining. ANU E Press, Canberra.
Martin, D.F., Trigger, D., Parmenter, J., 2014. Mining in aboriginal Australia: economic impacts, sustainable livelihoods and cultural difference at Century Mine, northwest Queensland. In: Gilberthorpe, E., Hilson, G. (Eds.), Natural Resource Extraction and Indigenous Livelihoods: Development Challenges in an Era of Globalisation. Ashgate Publishing, Surrey, UK.
McClean, N., Wells, D., 2013. Indigenous Communities, Conservation and the Resource Boom Chain Reaction #117. Retrieved 07.04.14 from http://www.foe.org.au/chain-reaction/editions/117/marcia-langton.
McMahon, G., Remy, F. (Eds.), 2001. Large Mines and the Community: Socioeconomic and Environmental Effects in Latin America, Canada and Spain. World Bank and International Development Research Centre, Ottawa, Canada.
Measham, T., Fleming, D., 2014. Local economic impacts of an unconventional energy boom: the coal seam gas industry in Australia. Aust. J. Agric. Resour. Econ., http://dx.doi.org/10.1111/1467-8489.12043.
Mercer, A., de Rijke, K., Dressler, W., 2014. Silence in the midst of the boom: coal seam gas, neoliberalizing discourse, and the future of regional Australia. J. Pol. Ecol. 21, 279–302.
National Native Title Tribunal, 1999. Native Title: A Five Year Retrospective 1994–1998: Report on the Operations of the Native Title Act 1993 and the Effectiveness of the National Native Title Tribunal. National Native Title Tribunal, Perth, WA.
National Native Title Tribunal, 2007. Githabul People's Native Title Determination Retrieved 07.04.14, from http://www.nntt.gov.au/news-and-communications/publications/documents/multimedia and determination brochures/determination brochure githabul people november 2007.pdf.
National Native Title Tribunal, 2008. Steps to an Indigenous Land Use Agreement. Retrieved 07.04.14 from http://www.nntt.gov.au/News-and-Communications/Publications/Documents/Booklets/ILUA_steps.pdf.
National Native Title Tribunal, 2012. Indigenous Land Use Agreement (Area Agreement) Non-Certified Application Registration Decision. Australia Pacific LNG & Gangulu Parties ILUA, Queensland, Australia.
National Native Title Tribunal, 2014. Register of Indigenous Land Use Agreements as of 7 July 2014. Retrieved 15.07.14, from http://www.nntt.gov.au/INDIGENOUS-LAND-USE-AGREEMENTS/SEARCH-REGISTERED-ILUAS/Pages/Search.aspx.
Neate, G., 2008. Native title claims: overcoming obstacles to achieve real outcomes. In: Paper Presented at the Native Title Development Conference, Brisbane.
Nghiem, L., Ren, T., Aziz, N., Porter, I., Regmi, G., 2011. Treatment of coal seam gas produced water for beneficial use in Australia: a review of best practices. Desalin. Water Treat. 32 (1–3), 316–323.
O'Faircheallaigh, C., 2002. Implementation: the forgotten dimension of agreement making in Australia and Canada. Indigenous Law Bull. 5 (20), 14–17.
O'Faircheallaigh, C., 2009. Corporate – aboriginal agreements on mineral development: the wider implications of contractual arrangements. In: Paper Presented at the Rethinking Extractive Industries Conference, Toronto.
O'Faircheallaigh, C., 2010. Aboriginal-mining company contractual agreements in Australia and Canada: implications for political autonomy and community development. Can. J. Dev. Stud. 30 (1–2), 69–86.
O'Faircheallaigh, C., 2012. Curse or opportunity? Mineral revenues, rent seeking and development in Aboriginal Australia. In: Communities, Futures, Legal Architectecture: Foundations for Indigenous Peoples in the Global Mining Boom. Routledge, Oxford, pp. 45–58.
O'Faircheallaigh, C., 2013. Community development agreements in the mining industry: an emerging global phenomenon. Commun. Dev. 44 (2), 222–238.
Owen, J.R., Kemp, D., 2014. Mining and community relations: mapping the internal dimensions of practice. Extract. Ind. Soc., http://dx.doi.org/10.1016/j.exis.2013.12.004.
Pearson, N., 2011. Radical Hope: Education and Equality in Australia. Black Inc., Collingwood, Australia.
QGC, 2013. Allegations by Gurang Land Council Baseless. Retrieved from http://www.qgc.com.au/news-media/NewsDetails?Id=3970.
Queensland Department of State Development, Infrastructure and Planning, 2013. CSG to LNG: Opportunities in Queensland. Brisbane, Australia. Retrieved 12.07.14 from http://www.dsdip.qld.gov.au/resources/brochure/invest-qld-csg-lng-opportunties.pdf.
Reconciliation Australia, n.d. About: What is the RAP program? Retrieved 7/4/14, from http://www.reconciliation.org.au/raphub/about/.
Ritter, D., 2002. Sick institution – diagnosing the future act unit of the national native title tribunal. Aust. Indigenous Law Rep. 7 (2), 1–12.
Ritter, D., 2010. The ideological foundations of arguments about native title. Aust. J. Pol. Sci. 45 (2), 191–207.
Rollo, W., 2013. Indigenous Group Plans Class Action Against CSG Industry, ABC Online. Retrieved from http://www.abc.net.au/news/2013-04-05/indigenous-group-plans-class-action-against-csg-industry/4611120/
Sawyer, S., Gomez, E.T., 2012. The Politics of Resource Extraction: Indigenous Peoples, Multinational Corporations and the State. Palgrave Macmillan, Houndmills, UK.
Scambary, B., 2013. My Country, Mine Country: Indigenous People, Mining and Development Contestation in Remote Australia. ANU E Press, Canberra, Australia.
Scullion, N., 2013. Speech to the National Native Title Conference, Alice Springs, 5 June 2013. Retrieved 09.05.14 from http://www.nigelscullion.com/media-hub/indigenous-affairs/speech-national-native-title-conference-alice-springs.
Smith, B., Morphy, F. (Eds.), 2007. The Social Effects of Native Title: Recognition, Translation, Coexistence. Centre for Aboriginal Economic Policy Research, ANU, Canberra, Australia.
Taylor, J., 2012. Measuring indigenous outcomes from mining agreements in Australia. In: Langton, M. (Ed.), Community Futures, Legal Architecture: Foundations for Indigenous Peoples in the Global Mining Boom. Routledge, Oxford, UK, pp. 59–75.
Trigger, D., 1983. Land rights legislation in Queensland: the issue of historical association. In: Peterson, N., Langton, M. (Eds.), Aborigines, Land and Land Association. Australian Institute of Aboriginal Studies, Canberra, Australia.
Trigger, D., 2005. Mining projects in remote aboriginal Australia: sites for the articulation and contesting of economic and cultural futures. In: Austin-Broos, D., Macdonald, G. (Eds.), Culture, Economy & Governance in Aboriginal Australia. University of Sydney Press, Sydney, Australia, pp. 41–61.
Trigger, D., Robinson, M., 2001. Mining, land claims and the negotiation of Indigenous interests: research from the Queensland Gulf Country and Pilbara region of Western Australia. Senri Ethnological Studies 59, 101–116.
US Department of Energy, 2004. Coal Bed Methane Primer: New Source of Natural Gas – Environmental Implications.
US Energy Information Agency, 2014. Short-Term Energy Outlook: Market Prices and Uncertainty Report. Retrieved 12.07.14 from http://www.eia.gov/forecasts/steo/uncertainty/
Veitch, A., 2013. A Preliminary Analysis of Information in the UQ Onshore Gas Research Directory. Report Prepared for Centre for Coal Seam Gas. The University of Queensland, Brisbane, Australia.
Walton, A.M., McCrea, R., Leonard, R., Williams, R., 2013. Resilience in a changing community landscape of coal seam gas: Chinchilla in southern Queensland. J. Econ. Soc. Policy 15 (3), 1–23.
Williams, E., Erskine, P., Schoettker, B., Adams-Hosking, C., McAlpine, C., Seabrook, L., 2013. Scoping Study: The Potential Impacts of Coal Seam Gas on Biodiversity. Report Prepared as a Working Paper for the Centre for Coal Seam Gas. Sustainable Minerals Institute, The University of Queensland, Brisbane, Australia.
Willow, A., Wylie, S., 2014. Politics, ecology, and the new anthropology of energy: exploring the emerging frontiers of hydraulic fracking. J. Pol. Ecol. (21), 222–236.

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Coal Seam Gas and Social Impact Assessment: An Anthropological Contribution to Current Debates and Practices.

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Coal Seam Gas and Social Impact Assessment: An Anthropological Contribution to Current Debates and Practices.

Abstract
Unconventional coal seam gas extraction is expanding rapidly in the renowned agricultural region of the Darling Downs in Queensland, Australia. These developments have given rise to substantial conflict, including the emergence of a national and vocal anti-coal seam gas movement. This paper examines the Darling Downs region and social impact research with regard to coal seam gas developments. It addresses disputes about coal seam gas on the basis of anthropological perspectives with regard to social dynamics and the concept of community, with examples derived from ongoing anthropological fieldwork, including interviews and observations in the area over the past eighteen months. Two specific documents are commented on, including the recent Queensland guideline for social impact assessments (SIA), and the SIA for Arrow Energy's Surat Gas Project. The paper suggests areas of possible improvement and argues that complex social dynamics and the notion of community should be more carefully considered in SIA.

Keywords
Unconventional gas, social impacts, community, conflict, fracking, resource extraction, governance

Cover Page Footnote
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Introduction

Unconventional gas has been extracted in Australia for more than fifteen years, but large-scale developments started to increase rapidly since about 2006. It became a matter of national and international controversy a number of years later, particularly after the release of the American activist documentary *Gasland* in 2010. Current extraction in Australia is largely from coal seams, with plans to extract gas from shale emerging more recently. Coal seam gas (CSG) extraction is most substantial in the relatively arable regions on the eastern seaboard, particularly the Surat and Bowen Basins in Queensland (see Figure 1). Large export facilities and industrial plants to convert the inland CSG into Liquefied Natural Gas (LNG) are under construction on the Queensland coast at Curtis Island near Gladstone. Smaller CSG developments are currently considered in areas such as the Northern Rivers in New South Wales and Gippsland in Victoria, among others. Shale gas exploration is underway in remoter regions such as the Canning Basin in northwest Western Australia, and the Georgina Basin in the Northern Territory.

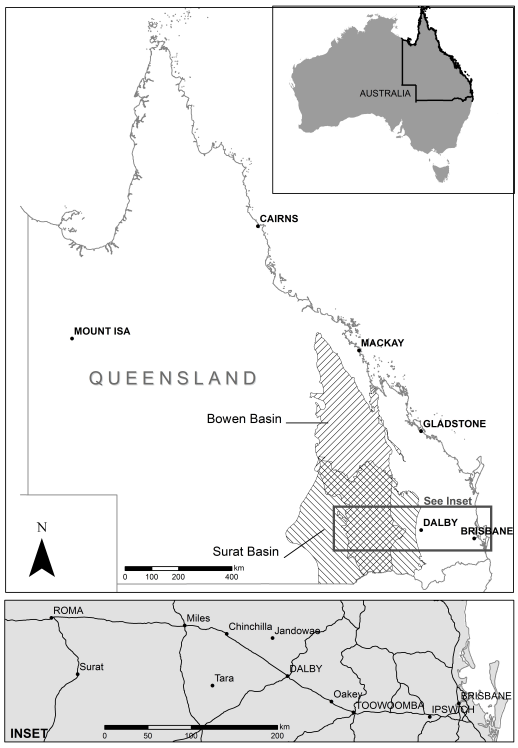

Figure 1: The Surat and Bowen Basins in Queensland.
Source: Whincop and de Rijke (2013).

In light of climate change and the need to reduce carbon dioxide emissions, CSG has been promoted as a 'transitional' source of energy, providing a cheaper and cleaner-burning source of energy than coal and oil. The CSG industry has also been welcomed as a new source of revenue by both the Queensland state government and rural landholders operating in financially challenging times. In 2011, the then-Premier of Queensland announced the arrival of a new 'gas age', characterised by multi-billion dollar investments, many thousands of new jobs and a general sense of future prosperity (Bligh, 2011). Two years later, in March 2013, the Australian Petroleum Production and Exploration Association (APPEA) stated in support of that vision that:

> Queensland's coal seam gas industry now employs more than 27,000 people, has signed 3,500 landholder agreements, and has so far contributed more than $100 million to community projects and causes (APPEA, 2013a).

The CSG industry expansion has undoubtedly brought increased economic activity and investment to resource regions such as the Darling Downs in the Surat Basin. Certain local businesses capable of servicing the gas industry, for example, have grown substantially as a result of these activities, and rural landholders engaged in agricultural pursuits may have obtained an important additional income stream. Additionally, Indigenous Land Use Agreements (ILUAs) may bring economic benefits to disadvantaged Aboriginal groups in extraction and processing areas. Moreover, to maximise the economic benefits for Aboriginal people, the New South Wales Aboriginal Land Council (NSWALC), in cooperation with a number of Local Aboriginal Land Councils in that state, is in the process of becoming actively involved in CSG exploration and extraction activities (NSWALC, 2012; Interview participants, January 17, 2013).

However, CSG has also given rise to substantial contestation, including the emergence of a national and vocal anti-CSG movement. This movement, largely under the umbrella of the Lock the Gate Alliance (LTGA) established in 2010, seeks to mobilise socio-politically diverse and localised groups across the country against CSG, and what it considers as inappropriate forms of mining generally (LTGA, 2013). It voices concerns about unconventional gas that are shared internationally, such as those with regard to controversial hydraulic fracturing technologies and the potential for environmental pollution, the continued use of fossil fuels in light of global climate change, future food production and human health. Local activist agendas oscillate between these concerns and those issues more specific to their region, environment and social dynamics. The intensity of national and international debates surrounding unconventional gas and attendant

technologies underlines the salience of social factors relevant to energy production and resource extraction.

This paper examines social impact research with regard to CSG developments in the eastern Darling Downs region of southern Queensland, an area broadly surrounding the town of Dalby (see Figure 1). It addresses disputes about CSG on the basis of anthropological theories with regard to social dynamics and the concept of community, with examples derived from both desktop research and ongoing fieldwork in the gas field region. The fieldwork examples described in the paper are drawn from in-depth semi-structured interviews with a range of persons largely selected through snowball sampling, including, but not limited to, cattle, crop, and cotton farmers with and without CSG infrastructure on their land, town residents, anti-CSG activists, local entrepreneurs and business representatives, government representatives, Aboriginal people, and residents of the rural residential estates in the region. Snowball sampling involved the selection of informants on the basis of referrals by interviewees, a method particularly useful in researching community networks: "who people know and how they know each other" (Bernard, 1995, pp. 97-98). While some examples are quotes from individuals - each with a particular background and social network - they aptly illustrate the broader range of regional social dynamics this paper aims to highlight. Based on the triangulation of data derived from multiple sources and research methods (e.g. Jick, 1979), including fieldwork data, academic literature, historical data, statistical analyses, as well as media releases and reports, the paper argues that the complexity of social dynamics and the concept of community should be more carefully considered in social impact assessments (SIAs).

The first part of the paper sets out, albeit briefly, some characteristics of the region under consideration. These characteristics inform the second and most substantial part of the paper on SIA theory and current practice. The new Queensland government's SIA guideline, released in July 2013, and the Surat Gas Project SIA by Arrow Energy are used as case studies to comment on research practices and the ways in which social dynamics and the concept of community are engaged. The aim of the paper is thus to offer an anthropological contribution to research on the social aspects surrounding CSG debates in Australia and SIA policies more broadly.

The Darling Downs region of Queensland: Agribusiness, lifestyle and coal seam gas

Land use

The Darling Downs region was named in honour of Governor Darling by the botanist explorer Allan Cunningham in 1827 (Hall, 1925). Cunningham referred to the area with terms such as 'extensive tracts of open country', 'very superior country', and celebrated the 'the range of luxuriant pasturage' (Cunningham, quoted in Hall, 1925, pp. 6-7). These pastures would provide for the thousands of sheep and cattle brought to the Darling Downs by subsequent squatters, who followed some years later as a result of Cunningham's reports. The large stations they established in the 1840s and 1850s at the cost of the Indigenous population have long since been subdivided into smaller grazing and agricultural properties, but their homesteads remained an important part of non-Indigenous cultural heritage (e.g. Hall, 1925; Heritage Consulting Australia Pty Ltd, 2011).

As land use diversified on the Darling Downs, dairying, crops, timber, as well as coal resources were developed. A noteworthy historical development with regard to changing environmental engagements and priorities took place around the small town of Warra, an area of fertile cropping and cotton land where current landholders are strongly opposed to coal mining. This particular area was first developed for agricultural purposes by former railway workers and coal miners who had lost their jobs due to the local coal mine closure in 1919 (Heritage Consulting Australia Pty Ltd, 2011, p. 95). It is in this area that the Lock the Gate Alliance set up its first office.

Coal extraction and agriculture are historically intertwined and important to the economic and social history of the Darling Downs. At least in the earlier parts of the 20th century, these industries were not necessarily seen as incompatible. In his 1925 history of the southern Darling Downs, for example, Hall (1925, p. 4) described the potential of agriculture, but also noted that:

> Some coal beds have been worked successfully for years, but there are many others lying as Nature made them, awaiting the power of Capital to vitalise the energy of man, so as to make the Darling Downs take its proper place as a coal mining area.

Employment

The latest census data by the Australian Bureau of Statistics (ABS) indicate that in the eastern Darling Downs, 20 percent of employed persons over 15 years of age are employed in the industries of agriculture, forestry and fishing, and 4 percent in mining (ABS, 2011a). Despite the much smaller number of people employed in mining, in the Western Downs local government area where CSG is currently extracted, the mining industry nevertheless provided approximately 23 percent of gross regional product, followed at some distance by agriculture, forestry and fishing with 12.2 percent (Advance Western Downs, 2013, p. 2).

Once the dominant form of employment and production, agricultural initiatives on the fertile black soils of the eastern Darling Downs have faced significant challenges and changes since early colonial settlement of the region in the mid-1800s. So-called 'closer settlement' government schemes to radically increase rural population numbers based on an agrarian ideology in the late 1800s and early 1900s for example failed in light of "environmental, technical and economic problems" and the absence of appropriate farming skills among the envisaged "rural yeomanry" (Cameron, 2005, p. 129; Frawley, 2007, p. 378). During that period the wider region became infamous as 'Prickly Pear Land' due to the thick spread of the introduced Prickly Pear (*Opuntia monacantha*), which in vast areas was so impenetrable for humans and livestock it became "a serious biological barrier to the settlement of the Australian inland" (Frawley, 2007, p. 378). Prickly Pear was eventually controlled in the 1920s with the introduction of a South-American moth (*Cactoblastis cactorum*), the larvae of which are Prickly Pear-specific parasites (the Boonarga Cactoblastis Memorial Hall outside the town of Chinchilla is the only memorial hall in Australia built in honour of an insect) (Miller, 2012).

After World War Two, agriculture in the Darling Downs increasingly became a form of 'agribusiness', now characterised by 'broad-acre' farming and advanced technological production methods including GPS-guided tractors, laser-leveled land, sophisticated irrigation infrastructure, genetically modified crops, and properties of approximately 500 hectares (c.f. de Rijke, 2013a). Operating in global competitive markets, these farmers are now properly regarded as business managers: in 2011, 22.9 percent of owner manager enterprises in the agriculture, forestry and fishing sector of the eastern Darling Downs were listed as an incorporated enterprise, with some of these foreign owned (ABS, 2011a; Coffey Environments Pty Ltd, 2012a, p. 13-6).

With regard to the contemporary economic and demographic characteristics of the region, the Australian Bureau of Statistics (ABS), among other sources, provides pertinent data for analysis. Table 1 below, for example, indicates sudden population growth in the eastern Darling Downs region over the period 2006-2011, relatively low unemployment rates, and significant increases in rental prices and mortgage repayments in the region (although regional housing costs are relatively cheaper compared with Australia as a whole). As indicated by the ABS data on country of birth, the region is culturally and linguistically less diverse than Australia as a whole (see also Table 1).

Table 1: Eastern Darling Downs and Australian statistics (ABS, 2011a, 2011b)

Eastern Darling Downs

	Census year			
	2001	***2006***	***2011***	***2011 (Australia)***
Total persons	38,284	38,160	40,241	21,507,717
Unemployment (%)	5.3	4.4	3.8	5.6
Median total personal income ($/week)	344	407	511	577
Median total household income ($/week)	673	837	1,002	1,234
Median mortgage repayment ($/month)	650	893	1,300	1,800
Median rent ($/week)	100	130	195	285
Country of birth = Australia (% of total population)	88.9	88.2	85.3	69.8

While the unemployment rate is relatively low, this does not necessarily mean there is sufficient work for the population. The Darling Downs, in terms of employment, is strongly dependent on agriculture, and fluctuations in the weather, commodity prices and other factors may affect yearly employment rates. The increased mechanisation of agriculture has also had significant negative impacts on local employment opportunities. Trendle (2001) suggested that outmigration - unemployed persons leaving in search of jobs elsewhere and thus no longer included in local employment statistics - might account for the maintenance of relatively high employment rates in such cases.

Non-resident workers

Employment data therefore must be complemented with data on mobility. This topic has received particular attention in mining regions, with concerns raised about the influx of non-resident workers and potential social impacts (e.g. House

of Representatives Standing Committee on Regional Australia, 2013). The *Surat Basin Population Report* (Government Statistician, Queensland Treasury and Trade, 2012) provided pertinent data for the region, focussed on both the Western Downs Regional Council area (WDRC) and the larger Surat Basin in which CSG activities take place:

> The Surat Basin's non-resident worker on-shift population nearly doubled over the year to June 2012 (p.1).
>
> In the same year, non-resident workers on-shift made up 80 percent of full-time equivalent (FTE) population growth for the WDRC area (p.1).
>
> In the year to June 2012, the WDRC area had the largest non-resident worker on-shift population, with 4,175 people or around two-thirds (65%) of the regional total, representing an increase of 108 percent over twelve months (p.3).
>
> Many hotels/motels in the Surat Basin have limited capacity to provide accommodation for visitors other than non-resident industry workers: 400 out of 740 hotel/motel rooms were taken up by non-resident workers in WDRC (p.8).

These figures indicate what some residents qualitatively experience as a negative transition of the rural region and towns to industrial zones and what they refer to as 'mining towns'. In their study of mining developments, non-resident workers and attendant social impacts on rural communities in Queensland, Carrington and Pereira (2011, p. 2) argued that the social license to develop resource extraction projects "is very weak for projects planning to recruit a non-resident workforce in excess of 75 percent".

Large resource extraction developments are commonly accompanied by housing shortages and increased housing costs (c.f. Table 1), as well as increases in industrial traffic, which feature prominently in local concerns. In combination with the arrival of security personnel in the gas fields, publically non-accessible workers' camps, pipeline corridors, compressor stations, concerns about invisible but volatile substances, technologies such as underground hydraulic fracturing and other material transformations, the large increase in non-resident workers and industrial transformations of the landscape may contribute to a sense of alienation among certain residents (cf. de Rijke 2013a; 2013b).

Few empirical data are currently available with regard to local consequences of the arrival of large numbers of young to middle-aged men in the Darling Downs, which may potentially lead to increased levels of anti-social behaviour, crime,

(domestic) violence and personal injury, drug and alcohol abuse, prostitution, and feelings of insecurity among women (e.g. Carrington, McIntosh and Scott, 2010; Carrington, Hogg and McIntosh, 2011; Lockie, Franettovich, Petkova-Timmer, Rolfe and Ivanova, 2009).

Happiness Road and coal seam gas: issues of social differentiation

While much concern has been expressed about the potential impacts of CSG developments on the sensitive black soils of the Darling Downs (e.g. Central Downs Irrigators Ltd, 2012), not all land in the region is exceptional for agricultural purposes. Certain areas of marginal land, commonly referred to by residents and surrounding farmers as 'light country' or 'goanna country', were sold for rural residential developments in the mid-1980s. The resulting residential estates attracted people from cities in Queensland and other states interested in cheap land and a quiet rural lifestyle. These properties are generally timbered bush blocks between 30 and a few hundred acres along unsealed roads with revealing names such as Happiness Road and Lucky Road.

Around 2009, however, dense CSG developments came to an area north of Happiness Road, and the residential estates have been the focus of much CSG dispute in the Darling Downs since this time.

Particularly in the early phase after subdivision, residents of the residential estates, who live largely without secure town water supplies or sewerage, were said to have caused considerable consternation among residents in the nearby township of Tara (Tara residents, personal comments, June 2013). A number of town residents alleged that most early estate residents were from lower socio-economic backgrounds and led alternative lifestyles, contributing to what they regarded as negative publicity and a general sense of decline in the town (Tara residents, personal comments, June 2013). These sentiments have endured at least to some extent to the present day. In 2009 a newspaper reported that the local mayor:

> expressed concern that children were living in 'Third World' conditions on so-called 'lifestyle blocks' near the town of Tara, four hours west of Brisbane. "There is a small minority group there who have socially chosen to live a certain way and it concerns me greatly when children are involved," [he] said (Brisbane Times, 2009).

A number of residents on the residential estates have been vocal opponents of CSG developments, leading to tensions with those in the area who welcome the new job and investment opportunities this industry is seen to offer. For example,

in response to the verbal abuse in town of a CSG worker by an estate resident, an unsigned letter appeared on the public notice board in the main street of Tara (originally in capital letters):

> This is the group of people who are devaluing our homes, our town and our blocks of land. Make no mistake, it is these people who are destroying the value of our town, not the gas and oil companies. This is the group of mainly unemployed drones who whilst having their snouts in the public trough are abusing and threatening honest workers who try to come into our town to spend their wages.

For their part, certain residents of the estates have reported numerous impacts since the CSG developments began, including land devaluation, health impacts, noise, and water contamination. They are acutely aware that their opposition is causing tensions, as one resident explained during an interview:

> I copped a lot of shit here. [Someone's] neighbour attacked me and threatened to shoot me. Trucks were dumping the produced water and drilling waste. I thought it was dust suppression. When I swam in my dam, my skin came off. It is a real industrial zone. … We had hopes and dreams [when we came to live here]. We were demonised as radicals. We're far from radicals. "Freddy" gets $1500 per year [for a CSG well on his land] and I'm copping all the impacts. … We don't want 'us against them' [i.e. the town residents], so we let through local plumbers at [road] blockades.

The CSG industry, in other words, has exacerbated certain prior community tensions, which inform current disputes. Forms of social stratification and power struggles have important historical dimensions. In the 1860s, for example, the Darling Downs was ruled by "an elite oligarchy of aristocratic pastoralists with excellent family connections, considerable wealth, and substantial estates" (Heritage Consulting Australia Pty Ltd, 2011, p. 78). They were referred to with reference to their valuable sheep as the "pure Merinos", and their elaborate homesteads and associated buildings contrasted substantially with the more utilitarian constructions belonging to less powerful landholders in the region (Heritage Consulting Australia Pty Ltd, 2011, p. 78, 80). As I will illustrate further below, related forms of stratification are still relevant to social dynamics in the region today.

Social dynamics and social impact assessment: theory and practice

Power differences and attendant politics among social groups highlight the need for SIAs to carefully consider the concept of community in the dynamic terms of what the anthropologist Silverman (1966, p. 919) called "the cultural rules of hierarchical differentiation" (see also Cashmore and Richardson, 2013; Vicencio, 2001; Walker, 2010). Communities, as de Souza (2007, p. 141) noted, "are always and everywhere in a state of animated tension. Factions, quarrels, status distinctions are as much part of social life as solidarity, mutual regard and unified action".

The notion of community, therefore, is an "unfolding, processual, affair, one which is continually responsive to changing political circumstance rather than being somehow programmed and predictable" (Peace, 1999, p. 159). Importantly then, representations of 'the community' by local residents should be understood as contextual sociopolitical and symbolic acts that suspend internal distinctions (Edwards, 1998, p. 154), mask forms of precariousness (Major and Winters, 2013, p.145), and construct similarity by drawing on "the capacity of symbols to encompass and condense a range of, not necessarily harmonious or congruent meanings" (Jenkins, 1996, p. 104).

For a detailed understanding of social dynamics and the possible impacts on it by CSG developments, SIA researchers ought to carefully consider community representations in light of the variously unfolding relationships among informants (c.f. de Rijke (2012) on the symbolic politics of community and belonging during a recent dam dispute in Queensland). This requires long-term qualitative fieldwork and it may include an analysis of the ways in which some, and not those who are silent or actively silenced, acquired and currently safeguard their 'stake' in the term stakeholder (but see also Metcalf (1998) on the ambivalence of informants).

In the context of the power dynamics involved in development proposals and impact assessments, researchers must also consider the implications of their *own* position, as consultants employed by proponents, government or communities, or as publicly funded academics, among other arrangements (cf. Ballard and Banks, 2003; Chase, 1990; Li, 2009; Negev, 2012). When the current author undertook anthropological fieldwork with regard to CSG disputes in the Northern Rivers region of New South Wales, for example, I was met with severe but anticipated suspicion among certain CSG opponents who distrust the University of Queensland as a result of its Centre for Coal Seam Gas, which receives funds

from the gas industry. Despite my fellowship at the School of Social Science, CSG opponents advocated a moratorium on research participation through national social media networks until my 'bona fides' had been further examined. With regard to contested developments such as CSG, these issues are a normal part of research discussions, and SIA researchers will be subject to similar sentiments while in the field. The implications of the researcher's reception in the field, including impacts on data gathering and the scope of research, however, are rarely addressed in SIA reports.

With the above perspectives and observations in mind, the next section elaborates on some of the main aspects of SIA research and, as case examples, comments on the recently released Queensland SIA guideline and the Surat Gas Project SIA by Arrow Energy Pty Ltd.

Social impact assessment

The general principles of SIA are now well established (e.g. Esteves, Franks and Vanclay, 2012; Vanclay 2003). SIA, ideally, is about:

> creating participatory processes and deliberative spaces to facilitate community discussions about desired futures, the acceptability of likely impacts and proposed benefits, and community input into the SIA process, so that there can be a negotiated agreement with a developer based on free, prior and informed consent. … [T]here should be a specific focus on improving the lives of the worst-off members of society (Esteves et al., 2012, pp. 35, 40).

Esteves et al. (2012, pp. 35-37) also noted a number of pertinent concerns with regard to current SIA practices:

> Compared to the extent of analysis and resources devoted to biophysical issues, SIA usually has a minor role. … The limited capacity of regulators and the limited resources devoted to quality control have a significant impact on the standard of SIAs, with a tendency for proponents to produce assessments that only just pass the minimum expectations of regulators. … Many reports lack adequate details about methods, sources and assumptions. The quality of analysis is another area of variability. Assessments are sometimes little more than a social and economic profile of the impacted communities compiled from secondary data sources. Analysis sometimes lacks identification of the spatial, temporal and stakeholder distribution of impacts and benefits. Integration with environmental, health and cultural heritage issues can be superficial. … The adequacy of public participation continues to be an

> issue. SIAs often do not meet public expectations of being a deliberative process to determine the acceptability of a project. Rather they are seen at best as a process for incremental project improvement, and at worst as being little more than a feeble attempt at project legitimization. Public participation ranges from being the provision of periods for public comment and the supply of information, to being the active involvement of stakeholders in shaping the SIA process and the opening-up of governance processes to include local communities in decision-making about projects.

In the context of governance and community input, proponents may rely strongly on the members of consultative committees to obtain information. In combination with the possibly limited capacity and quality controls of regulators, these committees may constitute, as Lawrence, Richards and Lyons (2013, p. 36) argued in the context of neoliberal agri-environmental governance in Australia, 'an experiment in devolving responsibility, accountability and action [from the state] to the regional level'. Further, as I indicated above, there are questions as to how consultative committees and community workshop participants suspend internal distinctions in their representations of community. SIA researchers interested in the impacts of interventions on communities should always ask questions with regard to those who are *not* around the consultative table.

Noted by Esteves et al. (2012, pp. 37-38), the concept of 'free and prior informed consent', similar to 'the social licence to operate', raises difficult questions: Who has authority to give consent on behalf of 'the community'? How much consent constitutes a licence to operate? What constitutes 'informed' in the context of epistemological diversity? Does consent include the right to veto, or the right to withdraw it subsequently? Who has legitimacy to provide information, and who decides what constitutes pertinent, credible and trustworthy information? What is 'free' in terms of potential power imbalances? While there is increasing engagement with these questions but little international consensus about the answers to them, it may be useful for regulators, proponents, communities, as well as SIA researchers to provide clarity and address them in some way.

SIA should be an iterative process over the entire project life cycle, including the early planning stages. However, given the complexity of social dynamics and the fact that most SIAs are commissioned by technically oriented professionals unfamiliar with the social sciences, there is a view among industry proponents that "the social analyses are often inherently messy, and with uncertain outcomes in terms of implications for the project" (Head of Social Performance, Anglo American, quoted in Esteves et al. 2012, p. 40).

An expression thus often heard is that 'if you can't measure it, you can't manage it'. This expression is indicative of the tension between quantitative and qualitative data, and the desire by some to reduce complex social issues into categories of measurable and manageable indicators. While this desire may be understandable from a managerial point of view, over-simplification may lead to unforeseen social repercussions and possible costly consequences. It may also be an expression of what Roscoe (1995, p. 500) called 'scientism', which

> deploys the term science as though it were a magical talisman guaranteeing the authenticity of whatever half-baked ideas are trotted out under its aegis. Unfortunately, such claims do exercise a sort of magic over the uninitiated - the lay populace and politicians who vote on funding priorities - thereby continually threatening to disenfranchise humanistic inquiry and other forms of inquiry as nonscientific. If I am not mistaken, however, the scientistic boast is hollow: most forms of humanistic inquiry are as scientific as quantum physics; they differ only in their subject matter.

Certain anthropologists have long approached the study of social dynamics through distinctions between 'emic' (insider) and 'etic' (analytical) perspectives (e.g. Harris, 1976). In combination with quantitative analyses, such approaches may produce social insights both nuanced and comprehensive. However, the conciliation of concepts such as causality and social order with concepts such as human agency, ambiguity and creativity remains problematic in SIA. Reductionist portrayals of social life, possibly including simplistic cause-and-effect processes based on statistical correlations between a limited set of narrowly defined variables, have been criticised by anthropologists and others (e.g. Roscoe, 1995). Anthropologists themselves, however, may be criticised as a result of issues associated with the nature of ethnographic fieldwork, which is often conducted by a single person over long periods of time in the field, living among informants, and including various interview techniques and participant observations. These methods, if not adequately explained, may raise questions about 'observational and representational integrity' (Roscoe, 1995, p. 498).

A pertinent question in the context of this debate about methods and approach is what the regulator of development programmes and SIAs actually requires. In Queensland, the Coordinator-General (CG) employed a guideline for social impact management plans (SIMPs) (CG, 2012), but in July 2013 these guidelines were abandoned and replaced with a much more flexible guide to SIA. While not an exhaustive analysis, below I set out some of the main aspects of this recent policy change.

The Queensland SIA guideline

In July 2013, a media statement by the Liberal National Party in Queensland indicated a political agenda to "cut red-tape for major resource projects to proceed in the state" (Seeney, 2013a). It announced modifications to the Queensland SIA policy, which reduce the prescriptive character of the previous guidelines. For example, rather than a broad examination of social impacts, the guide now limits the scope of impact assessments to only those to be considered "high risk impacts and uses outcomes-focused measures, (not prescriptive conditions) to better manage the impacts of projects" (CG, 2013, p.1). Coterminous with "red-tape", SIA has been portrayed as an obstacle to the expansion of the resource industry.

The new guideline aims to "inform" SIA practice (e.g. CG, 2013, p.2) and introduces a number of poorly defined qualifiers to the requirements. Where the previous guideline prescribed that SIMPs should cover the full project life cycle (CG, 2012, p. 2), it now notes that "SIA covers the full lifecycle of the project *to the extent possible*" and that it should be "based on the best data available" (CQ, 2013, p.2, emphasis added). It is not clear who the arbiter of the extent of possibilities and "best data" is in these cases. Furthermore, the requirements to produce a comprehensive SIMP and conduct periodic reviews as part of an iterative process have been entirely removed from the guideline and the approval process.

The guide devolves significant responsibilities from the State to the proponents and impacted communities. With regard to SIA research practices, for example, the guide notes that "the proponent's approach and methodology for identifying and rating social impacts should be acceptable within its organisation and by the communities of interest" (CQ, 2013, p. 10). It is left unclear how organisational or community acceptability should be understood in this context.

The SIA guide requires proponents to address only the important cumulative impacts of multiple projects in a region "where the proportion of the impact of the project can be readily and reasonably forecast and/or separated from the total cumulative impact or opportunity" (CQ, 2013, p.10). However, because cumulative impacts are the result of complex interaction and aggregation, possibly of multiple unrelated projects (e.g. Franks, Brereton and Moran, 2010), they are typically difficult to separate into individual project-specific components. If the guide is applied in such cases, important cumulative impacts on communities are unlikely to be considered in future SIAs.

The previous guide included an attempt to define a broad set of stakeholders including landholders, community groups and community representatives (CG, 2012). The current guide does not explicitly refer to impacted communities in the list of stakeholders, which now includes project proponents, state agencies, local governments and non-government organisations. Impacted communities are presumably regarded as non-government organisations. Moreover, in the description of the potential roles of non-government organisations in the development and implementation of the SIA, the focus is on impacts with regard to "non-government services to the community" (CG, 2012, p. 3). It is unclear how 'services' should be understood in this context.

In summary, the new SIA guideline constitutes a significant reduction in SIA requirements. It is part of a broader agenda to reduce state regulations regarded as 'red tape' obstructions to resource developments. Thus, for environmental impact statements (EIS) of which the SIA is part,

> the terms of reference have been cut from 100 pages to 25 pages of requirements. This huge reduction has been achieved by highlighting the critical matters the proponent should allocate the greatest study effort to in an EIS and by removing overly prescriptive and duplicate requirements (Seeney, 2013a).

Because it is presumably regarded as 'overly prescriptive', the new SIA guideline does not address in detail many of the commonly accepted SIA principles such as iterative processes, impact interactions or the ways in which meaningful community participation may be achieved. It does not entertain or engage with the notions, however difficult, of the social license to operate or free, prior and informed consent, and it does not include a specific focus on those in society who are worst off (c.f. Esteves et al., 2012). The guideline does not require a critical assessment of SIA methods, sources and assumptions, which may encourage, as Esteves et al. (2012) noted, little more than desktop-based social and economic profiling, lacking a more nuanced understanding of interests and potential impact distribution. There are no explicit requirements, as also suggested by Esteves et al. (2012), to integrate environmental, health or cultural heritage issues. Suggestions for the detailed study of community networks, internal socio-political distinctions, interactions with biophysical surroundings, and matters of social significance are also absent.

In thus requiring a minimum engagement with the social dynamics in proposed project areas, the new SIA guideline may have the dual effect of failing to adequately support vulnerable groups throughout the life of projects, *and* failing

to recognise and promote the full variety of community opportunities that may arise from such projects.

In light of the above, I will now examine the Arrow Energy Surat Gas Project SIA and SIMP. This study was produced under the previous guideline which, compared with the current SIA guideline, was more prescriptive and detailed.

Arrow Energy's Surat Gas Project SIA and SIMP

The SIA is part of the much larger EIS prepared by Arrow Energy for its Surat Gas Project, which covers an area of approximately 8,600km² and includes the proposed construction of about 7,500 CSG production wells and associated facilities. The company was provided with terms of reference for the EIS by the Queensland government (Queensland Department of Environment and Resource Management (DERM), 2010).

The social analyses in the Arrow Energy EIS contain a chapter entitled 'Social' (50 pages), the SIMP (as an attachment of 43 pages) and the SIA itself (as an appendix of 199 pages). The SIA was produced by the sub-contracting company URS Australia Pty Ltd (URS) for Arrow Energy's main EIS contractor Coffey Environments Pty Ltd.

The SIA and SIMP documents do not contain the full variety of social aspects related to Arrow Energy's project. Separate chapters and related appendices are provided under headings such as 'landscape and visual amenity', 'non-Indigenous heritage' and 'Indigenous cultural heritage'. Two sub-sections in other chapters provide information on 'the social environment' and socioeconomic cumulative impacts. A substantial 'consultation report' (579 pages) is provided as an appendix by sub-contractor JTA Australia, which was engaged to undertake the overall project community engagement and consultation processes.

While the SIA itself cross-references relevant other sections in the EIS, the various researchers appear not to have integrated their work to an extent that might be more conducive to knowledge and data sharing. For example, the SIA by URS contains a pie-chart pertaining to 'community knowledge' of the project when the consultation process started in 2009. The survey data were provided to URS through 'personal communication' by the major contractor Coffey Environments in 2011. The pie-chart divides the community (although the total number of respondents is unspecified) into three knowledge levels that leave much room for analytical improvement: those who "knew a lot", those who "knew a few things", and those who "knew nothing" (URS, 2011, p. 75).

The section in which this pie-chart was provided, entitled 'Community and Stakeholder Engagement Analysis', provides further information of concern. It implies there had been little success in the alleviation of local concerns through participatory decision-making processes. The SIA indicates that:

> the issues of concern have remained largely unchanged since the consultation process commenced in late 2009, [but] the community has become increasingly informed and aware of the CSG industry and the Arrow Surat Gas Project, through Project consultation activities and through the media. … Despite this increasing awareness, there remains a high level of confusion and misunderstanding amongst stakeholders (URS, 2011, p. 74).

In this context, the SIA and associated documents are notably silent on the 'social licence to operate' and whether the proponent is of the opinion that such a licence has ultimately been obtained.

With regard to the methods employed in the SIA and related social studies, some further comments may be made. Firstly, the SIA does not ground its employed methods in a critical assessment of the broader SIA literature or available international best practice guides. Rather, the methodology chapter simply sums up what was done during the study. Similarly, the suggested impact mitigation strategies are not formulated in the context of the evidence-based literature about the effectiveness of such strategies in other cases. It may be that such assessments provide either weight or alternatives to those actions currently proposed. They may also increase public confidence in the quality of the research programme and its conclusions.

An example where the methods appear at odds with the aim to convey local social significance is found in the chapter and related documents with regard to landscape and visual amenity. The author recognised that "[t]here are no established, measurable technical thresholds for significance of change for landscape and visual impacts" (Coffey Environments, 2012b, p. 18-5). It was further proposed that the study should engage, among other things, the nature of the landscape, including "[i]ts inherent landscape value (its condition, perceptual qualities, cultural importance and any specific values that may apply…)." (Coffey Environments, 2012b, p. 18-5).

The researcher(s) recognised the qualitative dimensions of their research objectives, but appear to have misunderstood qualitative research for subjective judgements on the part of the researcher, rather than the detailed investigation of

social significance, values, and perceptions of change through direct research with the people concerned. They stated that:

> The LVIA [Landscape and Visual Impact assessment] process aims to be objective and describe factually any anticipated changes to landscape resources, views and visual amenity. Potential changes as a result of the project have been defined; however, the significance of these changes requires qualitative (subjective) judgements [sic] to be made. The conclusions to this assessment therefore combine objective measurement and professional interpretation. … [Following desktop analysis] field visits focussed on those aspects of the landscape with potential to be of the greatest sensitivity to project activities and gaining an appreciation of those aspects of the project most likely to affect landscape and/or visual values (AECOM Australia Pty Ltd, 2011, pp. 15, 18).

Rather than a determination of visual values and matters of significance by the researchers, it is more appropriate to undertake detailed fieldwork among local residents and visitors to gain an appreciation of their visual values and opinions about the significance of possible changes to the landscapes with which they interact.

With regard to the methods, notions of community, social significance, and the socio-political distribution of interests among stakeholders, a number of comments may also be made. The SIA states that (URS, 2011, p. 73):

> Stakeholder perceptions have been obtained through qualitative, quantitative and participatory research methods. Stakeholder engagement has included:
>
> • A series of focus groups to identify areas of concern and aspirations relating to the Project;
>
> • A detailed, statistically valid, quantitative telephone survey of the study area and communities of interest to quantify the weight, or level of importance, placed on identified issues or opportunities. The survey also sought to identify perceptions around CSG producers' ability to manage these impacts;
>
> • Meetings and interviews with key stakeholders to understand the existing social baseline in the area and to identify areas of concern and aspirations relating to the Project; and
>
> • Review and interpretation of other independent stakeholder analysis.

The chapter entitled 'Social' includes certain statements about qualitative notions of community recorded during research. It includes statements such as "[R]esidents of the study area value living in cohesive, stable communities, which offer a high standard of living" and "[T]he pace of life, combined with relatively small, stable, close-knit communities, fosters a sense of rural friendliness, which is highly valued by residents" (Coffey Environments, 2012c, pp. 22-11). While I do not doubt that residents may express such views, as indicated in the section above on social dynamics and the concept of community, the SIA could go beyond such statements and interrogate more fully how such views can be understood in the context of (historical) rural socioeconomic change, contemporary social divisions, alliances, and disputes about CSG.

During my own fieldwork with regard to CSG developments, environmental relationships and social networks in the region I found, for example, that farmers may downplay or ridicule the environmental knowledge of 'town people' with regard to envisaged impacts on soils and water. Long-term residents may equally downplay concerns held by more recently arrived residents. More recent farmers and town residents may resent or contest what they perceive as elitist behaviour and claims to social authority by multigenerational and powerful farming families. As an indication of unfolding relationships, certain Aboriginal people attempted to oppose CSG projects but joined contested negotiations later on. I already referred to attenuated social friction resulting from diverging attitudes towards CSG developments, references to alleged 'Third World' living conditions, and the potentially unequal distribution of impacts. And while some farmers in the region have recently joined environmental activists in opposition to CSG, this unusual alliance is subject to ongoing social politics and differences. During interviews, a number of farmers, for example, referred to continuing disagreement with environmentalists about tree-clearing laws and other aspects of environmental regulation. One farmer poignantly referred to a prior period of intense "trench warfare" between local farmers and environmental groups over issues such as the environmental consequences of industrial farming practices in the region and the introduction by farmers of genetically modified cotton. These are indicators of important social dynamics and the factions, quarrels, and status distinctions of everyday social life as referred to by de Souza (2007). SIA researchers must consider these in conjunction with those expressions of social life that focus on small, stable, close-knit communities and a sense of rural friendliness.

The SIA makes little effort to contextualise the statements of stakeholders and appears to take at face value the statements obtained through consultation. Further, the proponent's suggested role of consultative committees, such as the

Arrow Surat Community Reference Group and the Arrow Intensively Farmed Land Committee, may create concerns about governance, as the representative organisation of regional irrigators submitted in response to the EIS (Central Downs Irrigators Ltd, 2012, p. 7):

> DERM [the Queensland Department of Environment and Resource Management] has in the past refused to condition Environmental Authorities issued to Arrow for exploration in ATP683 because they claim that these committees are dealing with the issues. Landholders and the community find this situation totally unacceptable as these committees have limited community acceptance and are wholly resourced and populated by Arrow appointees. The committees TOR [Terms of Reference] also clearly state that the existence of the committee is to facilitate Arrows development of CSG in the region and in no way compels Arrow to deal with issues to the communities satisfaction. We request that the regulator not defer its responsibilities to condition issues to Arrows committees for determination. While effective consultation with landholders is essential, it is not acceptable for this consultation to be a substitute for the Queensland Government conditioning this project to ensure avoidance, mitigation and management.

This submission resonates with the concerns raised also by Lawrence et al. (2013) about contemporary neoliberal governance models that devolve responsibility from the state to the region and consultative committees, a development also apparent in the recently announced modification of Queensland EIS and SIA policies. It also hints at power dynamics and representational contestation within communities. As I argued, SIAs can play an important role in understanding such dynamics, and this is applicable to both Indigenous and non-Indigenous communities.

The Surat Gas Project SIA is limited in its engagement with vulnerability, gender and Indigenous communities. The vulnerable groups identified in the SIA are: low income groups (URS, 2011, p. 50), pensioners, those with disabilities who require particular housing types, and Indigenous people (URS, 2011, p. 127). Little analytical detail is provided with regard to the interaction of various physical and social dimensions contributing to vulnerability and risk (cf. Cartwright, 2013; Checker, 2007), or other categories of persons which may be considered vulnerable under certain conditions, such as young single mothers, those with mental health problems, or those from different (non-Indigenous) cultural backgrounds, among others.

With regard to Indigenous people, the SIA does not consider the interaction of CSG developments with Aboriginal political dynamics and cultural practices. These complex interactions may impact on agreement-making processes, heritage protection activities, and the potential outcomes of agreements. The SIA document contains a rather monolithic representation of 'Indigenous people' divided into a number of language groups and/or native title claim groups. In certain areas, Indigenous Land Use Agreements may be made with Aboriginal parties who claim to hold native title rights and interests in the area. These claims, some of them contested internally and/or by other Aboriginal groups, are yet to be resolved by the Federal Court of Australia. The uncertainties this creates for companies and Aboriginal parties are considerable. While the Indigenous cultural heritage report deals substantially with the legal aspects of agreement making, available data on sites and cultural heritage protection protocols, a thorough engagement with Aboriginal people had not yet occurred. As a result the analysis of the potential social impacts of CSG among Indigenous people remains largely unattended to in the SIA.

Conclusion: policy, politics, and SIA practice

CSG developments are expanding rapidly across the Surat and Bowen Basins in Queensland. These regions are changing as a result, both physically and socio-economically.

In Australia, there have been considerable changes in state and federal CSG policies over the past few years, creating uncertainty for communities as well as development proponents. The overall management of project assessments continues to be a matter of concern. Where individual states that stand to financially benefit significantly from large resource projects are responsible for project assessments, questions may arise about the independence and quality of such assessments. A recent media investigation in Queensland, for example, alleged that political pressure to approve was put on public servants responsible for CSG project assessments, despite their concerns about potential environmental impacts and a perceived lack of detail in the EIS (The Courier Mail, 2013). Companies were also alleged to have unduly influenced sections of assessment reports (The Courier Mail, 2013). A subsequent assessment by the Crime and Misconduct Commission Queensland (CMC), however, found no evidence to substantiate allegations of official misconduct, and concluded that any existing pressure "came from trying to meet deadlines in a department that had to consider a large number of significant projects" (CMC, 2013).

The previous Australian Federal Government shared some assessment concerns and moved to take more control over CSG projects by proposing to include a 'water trigger' in the federal Environment Protection and Biodiversity Conservation Act. This will allow for the federal assessment of those CSG projects potentially impacting nationally important water resources. The move was met with severe criticism from industry and the Queensland state government, concerned about what they perceive as increased "green tape" and desperate "scaremongering" (APPEA, 2013b; Seeney, 2013b). At the time of writing it remains to be seen how the Coalition Government, which won the federal election in September 2013, will operationalise its envisaged "one-stop-shop" model to streamline approval methods covering both Commonwealth and State legislation.

The Queensland government itself has adopted an adaptive management strategy for coal seam developments (cf. Swayne, 2012). This entails, essentially, a learning-by-doing approach to a complex, fast-changing and contested industry. In terms of social management, the new Queensland SIA guide entails a significant reduction of requirements to minimise 'red tape' and to expedite the approval and expansion of resource extraction projects. It introduces reduced regulatory policies of resource extraction based on minimal government involvement characteristic of neoliberal governance models. The public may be left wondering whether such policies will facilitate the approach adopted recently by at least some US shale gas companies in their community and media relations strategies, including the employment of former military counter-insurgency officers and controversial 'psyops' (psychological operations) tactics to deliver outcomes beneficial to industry (Pittsburgh Post-Gazette, 2011).

In conclusion, the new Queensland SIA guideline introduces a significant reduction in regulation and best-practice requirements. While there is an international momentum to engage with difficult but important concepts such as the social license to operate, the regulator has taken to poorly articulated suggestions instead of best-practice and clearly defined requirements.

While not subjected to an exhaustive analysis, the case example of the Surat Gas Project has identified a number of areas where questions emerge about the assumptions, methodological approaches and analytical strengths of the SIA study. It is of some concern for the future quality of SIA reports that this study was conducted under the previous Queensland requirements, which have now been significantly reduced. Those parts of the Surat Gas Project EIS that relate to matters of national environmental significance and hydrogeological impacts recently received strong criticism from the federal government's Independent

Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). The Committee found that, among other issues, "a number of improvements could be made to the survey method", that "further data is required to improve confidence in modeling", and that a "field-based assessment" is required to assess vulnerabilities associated with changes to groundwater hydrology (IESC, 2013, p.2). In terms of the SIA, the assessment of vulnerabilities, social values and differentiation, which is currently limited, may similarly benefit from carefully considered fieldwork in the region.

As a discipline characterised by qualitative and participatory fieldwork methods to understand human diversity and culture, anthropology may enhance the quality of SIA studies. I have advocated a detailed approach to complex social dynamics based on quantitative and qualitative research methods and data triangulation because the possible social impacts by CSG developments, both positive and negative, are best assessed where researchers study the concept of community, including active representations and notable silences, in light of the variously unfolding relationships among residents in the impacted region.

The incentives in the recently announced policy modifications in Queensland, however, work to promote a very different approach; a minimalist study of social characteristics aimed at expediting project approvals. Therefore, the policy challenges for impacted communities are now fundamentally political: how to obtain an appropriate voice in the articulation of those social and approval policies with the potential to dramatically impact the full variety of living conditions in regions of proposed developments.

References

Advance Western Downs. (2013). *Western Downs Regional Economic Brief, February 2013*. Retrieved 26 March, 2013, from http://www.advancewesterndowns.com.au/_literature_140605/Western_Downs_Region_Economic_Brief_March_2013

AECOM Australia Pty Ltd. (2011). *Arrow Energy Surat Gas Project: Landscape and Visual Impact Assessment*. Arrow Energy Surat Gas Project environmental impact statement, Appendix L, prepared for Coffey Environments and Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0009/2313/Appendix20L20-20Landscape20and20Visual20Impact20Assessment.pdf

Australian Bureau of Statistics. (2011a). *Darling Downs – East (30702), Census of Population and Housing: Working Population Profile Based on Place of Work*, Catalogue number 2006.0. Retrieved 26 March, 2013, from

http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/communityprofile/30702

Australian Bureau of Statistics. (2011b). *Australia - 2011 Census QuickStats.* Retrieved 26 March, 2013, from http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/0?opendocument&navpos=220

Australian Petroleum Production and Exploration Association. (2013a). '*Federal regulation of onshore natural gas to drive up prices, cost jobs*', Media release 12 March 2013. Retrieved 26 March, 2013, from http://www.appea.com.au/images/stories/media/130312_epbc.pdf

Australian Petroleum Production and Exploration Association. (2013b). '*Green tape risks stifling valuable major projects*', Media release 25 March 2013. Retrieved 26 March, 2013, from http://www.appea.com.au/images/stories/media/130325%20green%20tape%20report.pdf

Ballard, C., and Banks, G. (2003). Resource wars: the anthropology of mining. *Annual Review of Anthropology,* 32, 287-313.

Bernard, H.R. (1995). *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. Walnut Creek: AltaMira Press.

Bligh, A. (2011). *Premier heralds new 'gas age' for Queensland*. Ministerial Media Statement by the Premier and Minister for Reconstruction, 27 May 2011. Retrieved 26 March, 2013, from http://statements.qld.gov.au/Statement/Id/74946

Brisbane Times. (2009). *No Power. No Sewage. No worries, says Tara*. 5 June 2009, by Scott Casey. Retrieved 26 March, 2013, from http://www.brisbanetimes.com.au/queensland/no-power-no-sewage-no-worries-says-tara-20090604-bx19.html#ixzz2OdMEoIn4

Cameron, D. (2005). Closer settlement in Queensland: The rise and decline of the agrarian dream, 1860s-1960s. In Davison, G. and Brodie, M. (Eds.) *Struggle Country: The rural ideal in twentieth century Australia,* (pp. 129-151). Melbourne: Monash University ePress

Canter, L., and Ross, B. (2010). State of practice of cumulative effects assessment and management: the good, the bad and the ugly. *Impact Assessment and Project Appraisal,* 28(4), 261-268.

Carrington, K. and Pereira, M. (2011). Assessing the social impacts of the resources boom on rural communities. *Rural Society,* 21(1), 2-20.

Carrington, K., Hogg, R. and McIntosh, A. (2011). The resource boom's underbelly: criminological impacts of mining development. *Australian and New Zealand Journal of Criminology,* 44(3), 335-354.

Carrington, K., McIntosh, A. and Scott, J. (2010). Globalization, Frontier Masculinities and Violence. *British Journal of Criminology,* 50(3), 393-413

Cartwright E. (2013). Eco-risk and the case of fracking. In Strauss, S., Rupp, S. and Love, T. (Eds.) *Cultures of Energy: Power, practices, technologies, (*pp. 201-212). Walnut Creek: Left Coast Press.

Cashmore, M. and Richardson, T. (2013). Power and environmental assessment: Introduction to the special issue. *Environmental Impact Assessment Review,* 39, 1-4.

Central Downs Irrigators Ltd. (2012). *Letter to the EIS Coordinator (Surat Gas Project)*, *Statewide Environmental Assessments, [Queensland] Department of Environment and Resource Management*, 12 June 2012. Retrieved 26 March, 2013, from http://www.cdil.com.au/documents/CDILEISSubmission12June12.pdf

Chase, A. (1990). Anthropology and Impact Assessment: Development Pressures and Indigenous Interests in Australia. *Environmental Impact Assessment Review,* 10, 11-23.

Checker, M. (2007). 'But I know it's true': environmental risk assessment, justice, and anthropology. *Human Organization,* 66(2), 112-24.

Coffey Environments Pty Ltd. (2012a). *Surat Gas Project - Environmental Impact Statement, Volume 1, Chapter 13: Agriculture*. Prepared for Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/content/Document/surat-eis/Volume%201/Chapter%2013%20-%20Agriculture.pdf

Coffey Environments Pty Ltd. (2012b). *Surat Gas Project - Environmental Impact Statement, Volume 1, Chapter 18: Landscape and Visual Amenity*. Prepared for Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0003/2865/Chapter201820-20Landscape20and20Visual20Amenity.pdf

Crime and Misconduct Commission Queensland. (2013). *CMC completes assessment of CSG complaints — 19.09.2013*. Media release. Retrieved 23 September, 2013, from http://www.cmc.qld.gov.au/news-and-media/media-releases/cmc-completes-assessment-of-csg-complaints

de Rijke, K. (2012). The Symbolic Politics of Belonging and Community in Peri-urban Environmental Disputes: the Traveston Crossing Dam in Queensland, Australia. *Oceania,* 82(3), 278-293.

de Rijke, K. (2013a). The Agri-Gas Fields of Australia: Black Soil, Food and Unconventional Gas. *Culture, Agriculture, Food and Environment*, 35(1), 41-53.

de Rijke, K. (2013b). Hydraulically fractured: unconventional gas and anthropology. *Anthropology Today,* 29(2), 13-17.

de Souza, A. (2007). 'Our village puts aside politics for the sake of development'. Fluid Communities and Stable Claims. In Baviskar, A. (Ed.) *Waterscapes. The Cultural Politics of a Natural Resource*, (pp. 1-8). Uttaranchal: Permanent Black.

Edwards, J. (1998). The need for a 'bit of history': Place and past in English identity. In Lovell, N. (Ed.) *Locality and Belonging*, (pp. 147-167). London: Routledge.

Esteves, A.M., Franks, D. and Vanclay, F. (2012). Social impact assessment: the state of the art. *Impact Assessment and Project Appraisal*, 30(1), 34-42.

Franks, D.M., Brereton, D. and Moran, C.J. (2010). Managing the cumulative impacts of coal mining on regional communities and environments in Australia. *Impact Assessment and Project Appraisal*, 28(4), 299-312.

Frawley, J. (2007). Prickly pear land: Transnational networks in settler Australia. *Australian Historical Studies*, 38(130), 373-388.

Government Statistician, Queensland Treasury and Trade. (2012). *Surat Basin Population Report, 2012*. Retrieved 26 March, 2013, from http://www.oesr.qld.gov.au/products/publications/surat-basin-pop-report/surat-basin-pop-report-2012.pdf

Hall, T. (1925). *The early history of Warwick district and pioneers of the Darling Downs*. Toowoomba: Robertson & Proven Ltd.

Harris, M. (1976). History and significance of the emic/etic distinction. *Annual Review of Anthropology,* 5, 329-50.

Heggman, G.,and Yarranton, G.A. (2011). Alchemy to reason: Effective use of cumulative effects assessment in resource management. *Environmental Impact Assessment Review,* 31(5), 484-490.

Heritage Consulting Australia Pty Ltd. (2011). *Arrow Energy Surat Gas Project: Non-Indigenous Heritage Report*. Surat Gas Project Environmental Impact Statement, Appendix 20, prepared for Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0011/2702/Appendix20R20-20Non-Indigenous20Heritage20Impact20Assessment.pdf

House of Representatives Standing Committee on Regional Australia. (2013). *Cancer of the bush or salvation for our cities? Fly-in, fly-out and drive-in, drive-out workforce practices in Regional Australia*. Commonwealth of Australia. Retrieved 26 March, 2013, from http://www.aph.gov.au/parliamentary_business/committees/house_of_representatives_committees?url=ra/fifodido/report/fullreport.pdf

IESC. (2013). *Advice to decision maker on coal seam gas project. Proposed action: Arrow Surat Gas Project (EPBC 2010/5344) – Expansion*. Retrieved 18 October, 2013, from http://www.environment.gov.au/coal-seam-gas-mining/pubs/iesc-advice-arrow.pdf

Jenkins, R. (1996). *Social Identity*. London: Routledge.

Jick, T.D. (1979). Mixing qualitative and quantitative methods: triangulation in action. *Administrative Science Quarterly*, 24(4), Qualitative Methodology, 602-611.

Lawrence, G., Richards, C., and Lyons, K. (2013). Food security in Australia in an era of neoliberalism, productivism and climate change. *Journal of Rural Studies,* 29, 30-39.

Li, F. (2009). Documenting accountability: environmental impact assessment in a Peruvian mining project. *PoLAR: Political and Legal Anthropology Review,* 32(2), 218-236.

Lock the Gate Alliance. (2013). *Missions, Principles, Aims*. Retrieved 26 March, 2013, from http://www.lockthegate.org.au/missions_principles_aims

Lockie, S., Franettovich, M., Petkova-Timmer, V., Rolfe, J., and Ivanova, G. (2009). Coal mining and the resource community cycle: A longitudinal assessment of the social impacts of the Coppabella coal mine. *Environmental Impact Assessment Review,* 29, 330-339.

Major, C., and Winters, T. (2013). Community by necessity: security, insecurity, and the flattening of class in Fort McMurray, Alberta. *Canadian Journal of Sociology,* 38(2), 141-165.

Metcalf, P. (1998). The Book in the Coffin: On the Ambivalence of "Informants". *Cultural Anthropology,* 13(3), 326-343.

Miller, S. (2012). *A prickly problem: Dr. Jean White-Haney and the prickly pear*. John Oxley State Library of Queensland Blogs, posted 27 November 2012. Retrieved 13 September, 2013, from http://blogs.slq.qld.gov.au/jol/tag/cactoblastis/

Negev, M. (2012). Knowledge, data and interests: Challenges in participation of diverse stakeholders in HIA. *Environmental Impact Assessment Review, 33*, 48-54.

New South Wales Aboriginal Land Council. (2012). *Statement on behalf of the NSW Aboriginal Land Council by CEO Geoff Scott*. Media release 9 March 2012. Retrieved 4 September, 2013, from http://www.alc.org.au/newsroom/media-releases/statement-on-behalf-of-the-nsw-aboriginal-land-council-by-ceo-geoff-scott.aspx

Peace, A. (1999). Anatomy of a blockade. Towards an ethnography of environmental dispute (Part 2), Rural New South Wales 1996. *The Australian Journal of Anthropology, 10*(2), 144-62.

Pittsburgh Post-Gazette. (2011). *Drillers using counterinsurgency experts: Marcellus industry taking a page from the military to deal with media, resident opposition*. 13 November 2011, by Don Hopey. Retrieved 26 March, 2013, from http://www.post-gazette.com/stories/local/marcellusshale/drillers- using-counterinsurgency-experts-323688/

Queensland Department of Environment and Resource Management. (2010). *Terms of reference for the Arrow Energy Surat Gas Project Environmental Impact Statement (EIS)*. Retrieved 26 March 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0005/2399/Attachment20001-20Final20Terms20of20Reference.pdf

Roscoe, P.B. (1995). The Perils of 'Positivism' in Cultural Anthropology. *American Anthropologist*, 97(3), 492-504.

Seeney, J. (2013a). *Newman Government cuts resources red tape*. Ministerial Media Statement by the Queensland Deputy Premier, Minister for State Development, Infrastructure and Planning, 17 July 2013. Retrieved 18 July, 2013, from http://statements.qld.gov.au/Statement/2013/7/17/newman-government-cuts-resources-red-tape

Seeney, J. (2013b). *Desperate Labor scaremongering over CSG*. Ministerial Media Statement by the Queensland Deputy Premier, Minister for State Development, Infrastructure and Planning, 12 March 2013. Retrieved 26 March, 2013, from http://statements.qld.gov.au/Statement/2013/3/12/desperate-labor-scaremongering-over-csg

Silverman, S.F. (1966). An ethnographic approach to social stratification: prestige in a central Italian community. *American Anthropologist, 68*(4), 899-921.

Swayne. (2012). Regulating coal seam gas in Queensland: lessons in an adaptive environmental management Approach? *Environmental and Planning Law Journal*, 29(2), 163-185.

The Coordinator-General, State of Queensland. (2012). *Social impact assessment: Guideline to preparing a social impact management plan*. Brisbane: Queensland Government. Retrieved 26 March, 2013, from http://www.dlg.qld.gov.au/resources/guideline/cg/social-impact-management-plan-guideline.pdf

The Coordinator-General, State of Queensland. (2013). *Social impact assessment guideline.* Brisbane: Queensland Government. Retrieved 23 July, 2013, from http://www.dsdip.qld.gov.au/resources/guideline/social-impact-assessment-guideline.pdf

The Courier Mail. (2013). *Public servants tasked with approving massive CSG projects were blindsided by demands to approve two in two weeks*, 11 February 2013, by John McCarthy. Retrieved 26 March, 2013, from http://www.couriermail.com.au/news/public-servants-tasked-with-approving-to-massive-csg-projects-were-blindsided-by-demands-to-approve-two-in-two-weeks/story-e6freon6-1226574952587

Trendle, B. (2001). The dispersion and persistence of Queensland regional employment. *Australasian Journal of Regional Studies,* 7(2), 189-208.

URS Australia Pty Ltd. (2011). *Arrow Surat Gas Project Social Impact Assessment*. Arrow Energy Surat Gas Project environmental impact statement, Appendix P, prepared for Coffey Environments. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0012/2460/Appendix20P20-20Social20Impact20Assessment.pdf

Vanclay, F. (2003). International principles for social impact assessment. *Impact Assessment and Project Appraisal*, 21(1), 5-11.

Vicencio, C. (2001). Does "Class Count" in Abanilla? The salience of silence in a local reconfiguration of class. *Journal of the Society for the Anthropology of Europe*, 1(1), 9-15.

Walker, G. (2010). Environmental justice, impact assessment and the politics of knowledge: The implications of assessing the social distribution of environmental outcomes. *Environmental Impact Assessment Review*, 30, 312-318.

Whincop, M., and de Rijke, K. (2013). *The Surat and Bowen Basins in Queensland*. Scale not given.

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Images

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Foreword

The rapid development of coal seam gas (CSG) in Queensland has not been without issues. The spatial dispersion of the gas means the industry coexists with many more neighbours than a typical resource development, and these neighbours are located in some of Queensland's most diverse agricultural lands. The newness of the industry also led to significant concerns about the potential impact of CSG development on water and the environment.

This review provides a timely synthesis of the socioeconomic impacts of CSG development, defined broadly to encompass both headline economic indicators and other factors which influence wellbeing. The review found that the economic impact of CSG development is akin to other natural resource developments, but the socioeconomic impacts differ as a result of the dispersion of the resource and the need for coexistence with landholders.

While this report examines the Queensland experience, there are valuable lessons learnt for other states and territories. These include the need for effective risk-based regulation of CSG development and its potential physical and environmental impacts, and the importance of early and genuine community consultation.

I highly recommend the *Review of the socioeconomic impacts of coal seam gas in Queensland* to anyone seeking to develop a greater understanding of the CSG industry and its impact on communities.

Mark Cully
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October 2015

Contents

ABBREVIATIONS AND ACRONYMS		vi
EXECUTIVE SUMMARY		1
1.	INTRODUCTION	5
1.1	Scope and structure of the review	5
1.2	Coal seam gas	8
1.3	CSG in Queensland	11
1.4	How does CSG differ?	18
1.5	Regulatory and policy frameworks	19
2.	DIRECT ECONOMIC IMPACTS OF CSG	25
2.1	Typical impacts of natural resource development	26
2.2	Employment	27
2.3	Income	31
2.4	Output and consumption	32
2.5	Government revenue	33
2.6	Agricultural productivity	34
3.	COMMUNITY IMPACTS OF CSG	37
3.1	Typical impacts of natural resource development	38
3.2	Distribution of impacts	39
3.3	Demographic and social change	40
3.4	Environmental and physical impacts	42
3.5	Physical and mental health outcomes	45
3.6	Wellbeing	47

3.7	Community engagement	51
4.	INSIGHTS	55
4.1	Cumulative impacts	55
4.2	Distribution of impacts	55
4.3	Role of government	56
4.4	Transitioning to operations phase	57
4.5	Future research priorities	58
4.6	Conclusion	60
REFERENCES		63

List of Figures

Figure 1.1: **Socioeconomic impacts of CSG development in Queensland** 6

Figure 1.2: **Stages of the CSG value chain and the scope of the review** 8

Figure 1.3: **Conventional and unconventional gases** 9

Figure 1.4: **A schematic of a CSG well** 10

Figure 1.5: **CSG production phases** 11

Figure 1.6: **Australia's coal seam gas reserves and infrastructure** 12

Figure 1.7: **Queensland gas reserves and infrastructure** 13

Figure 1.8: **Queensland coal seam gas 2P reserves (proved and probable)** 16

Figure 1.9: **Queensland coal seam gas production** 16

Figure 1.10: **Annual petroleum wells drilled in Queensland** 17

Figure 2.1: **Structure of economic impacts of the resources sector** 25

Figure 2.2: **Unemployment rate in the Western Downs** 28

Box 2.1 Figure 1: **Forecast employment in the upstream CSG industry** 30

Figure 2.3: **Modelled nominal contribution of the coal seam gas sector to Queensland's Gross State Product** 32

Figure 3.1: **Structure of community impacts of the resources sector** 37

Figure 3.2: **Dimensions of community wellbeing** 47

Figure 3.3: **Attitudes towards CSG in the Western Downs** 48

Box 3.1 Figure 1: **Change in female youth in Queensland** 49

Box 3.1 Figure 2: **Attitudes towards CSG in the Western Downs** 50

Figure 3.4: **A model of community acceptance of mining** 51

Abbreviations and acronyms

2P	proven and probable (gas reserves)
APLNG	Australia Pacific LNG
APPEA	Australian Petroleum Production and Exploration Association
BTEX	benzene, toluene, ethylbenzene and xylene
CCA	Conduct and Compensation Agreement
CNOOC	China National Offshore Oil Corporation
CSG	coal seam gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DNRM	Queensland Department of Natural Resources and Mines
EPBC Act	*Environmental Protection and Biodiversity Conservation Act*
EIS	Environmental Impact Statement
fracking	hydraulic fracturing
GFCQ	GasFields Commission Queensland
GISERA	Gas Industry Social and Environmental Research Alliance
GLNG	Gladstone LNG
GSP	Gross State Product
IESC	Independent Expert Scientific Committee on Coal Seam Gas and Large Mining Development
ILUA	Indigenous Land Use Agreement
KOGAS	Korea Gas Corporation
LNG	liquefied natural gas
LGA	local government area
Mtpa	million tonnes per annum
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NPA	National Partnership Agreement on Coal Seam Gas and Large Mining Development
OGIA	Office of Groundwater Impact Assessment
PAA	Priority Agricultural Area
PJ	petajoules
QCLNG	Queensland Curtis LNG

QGSO	Queensland Government Statisticians Office
QRC	Queensland Resources Council
RIRDC	Rural Industries Research and Development Corporation
RPI Act	*Regional Planning Interests Act*
SCA Act	*Strategic Cropping Area Act*
UQ-CCSG	University of Queensland Centre for Coal Seam Gas

Executive Summary

Coal seam gas (CSG) development has expanded relatively rapidly in Queensland, with proven and probable reserves increasing more than tenfold over the last decade. CSG is now the dominant source of Queensland's natural gas production, and it is the basis for a growing liquefied natural gas (LNG) export industry from Gladstone.

CSG development has a dispersed geospatial footprint as a result of the broad distribution of the resource, the technologies and the associated infrastructure required to develop it. As a result of these factors, the development of this industry has had a large effect on local communities, including economic impacts and changes to demographics and social structures with flow-on effects evident in measures of community wellbeing.

This review provides a synthesis of the nature and magnitude of various impacts of CSG development on communities in Queensland. It incorporates a literature review, which covers forecasts of impacts, statistical analyses of census and other data. The literature review was supported by a range of interviews and workshops with industry stakeholders. The analysis presents both economic and broader community impacts, as well as drawing a range of insights and conclusions about the experience of CSG development in the state.

Headline economic impacts of CSG development in Queensland to date are found to be net positive, and are attributable to increases in employment, income, output, consumption and government revenue. These changes are broadly consistent with changes experienced as a result of a typical natural resource development.

Impacts on nearby communities — incorporating the distribution of these economic impacts as well as physical and environmental impacts and demographic and social changes — have been more variable, and also differ more from the impacts of typical resource developments. A large part of this is due to CSG's large spatial distribution, and its development alongside existing land uses. As a result of this, a larger number and range of people experience the positive and negative impacts of the development. There is a strong need for sustainable coexistence between the gas industry and the local landholders and communities.

The rapid development of CSG gave rise to concerns about potential impacts on the environment. The evidence to date shows that there have only been negligible impacts on water and air quality, and work is ongoing in order to continue to assess the potential impacts and reduce uncertainties about potential impacts going forward.

This review acknowledges that CSG development is not completely free from risk. It is important to remember that any new activities, resource development or otherwise, come with their own unique set of risks and challenges. In this circumstance, the Queensland Government assessed the level of risk, and put in place rules and regulations to ensure that the risks and potential impacts of CSG development were appropriately managed.

Demographic and social changes also play a large role in how communities experience CSG development. Migration, including an influx of workers, can have a large impact on the social fabric of a community. In

typical resource development this can lead to ‘boomtown’ effects, where the immigration of male workers can be associated with negative consequences of alcohol consumption and violence. Some of these ‘boomtown’ effects have been seen in Queensland, but studies have shown that CSG development has led to the reversing of rural decline in CSG regions, including through increases in female employment and higher youth education levels.

Economic, environmental, and social changes all culminate in changes to the wellbeing of local communities. Wellbeing is influenced by a large range of factors, including access to opportunities to benefit from CSG development as well as individual experiences and perceptions during exploration, construction and operational phases. These impacts are, as one would expect, distributed unevenly between regions, towns and households. CSIRO has found that wellbeing in CSG regions is currently robust. However, there are concerns for future wellbeing as the sector moves from the construction phase to the operations phase.

The review provides a number of ‘lessons learnt’ for other jurisdictions experiencing development of unconventional natural gas resources, or other developments which may have similar impacts on communities. Firstly, the role of government is essential in ensuring that gas development is beneficial for communities. This includes using risk-based regulation to ensure that the development is sustainable and responsible, and any risks of potential environmental or physical outcomes are monitored, assessed and minimised.

Governments also play a role in supporting coexistence between gas companies and local communities. Regulation of the sector should support coexistence, including through ensuring that landholder’s agreement is sought for access to their property, that landholders are fairly compensated, and that prime agricultural land and water resources are not compromised by development activity. Queensland has supported coexistence both through its regulation of the sector and also the creation of the independent GasFields Commission. The Commission has been highly regarded in its role of supporting coexistence, through provision of independent advice and information and facilitating relationships between rural landholders, local communities and the gas industry.

Another lesson is the importance of community engagement. Building trust in the community is essential for the industry having a social licence to operate. Given the spatial dispersion of CSG development activities and the overlap of multiple CSG projects, the social licence for CSG development needs to hold for the entire industry, with high expectations upheld by companies and contractors alike. Investment by companies into local communities is an important part of this engagement, but also essential is the inclusion of community members into decision making processes through genuine engagement and collaboration.

Governments should also be involved in this engagement. There is a strong need for governments, communities and the gas industry to work closely together to ensure that adverse impacts on community wellbeing are minimised and benefits to community wellbeing occur in the long term.

Further lessons include the importance of considering cumulative impacts of CSG development, and the need to consider how the impacts are distributed. Much of this is the focus of research currently underway into the socioeconomic impacts of CSG development, including by the Gas Industry Social and Environmental Research Alliance (GISERA), a partnership between CSIRO, Australia Pacific LNG (APLNG) and QGC; and the Centre for Coal Seam Gas at the University of Queensland (UQ-CCSG), which has funding from Santos, Arrow Energy, QGC and APLNG.

It is also important to note that studies considered in this review mainly cover the lead up to peak construction in the CSG industry in 2014. Assessment of the decline in business post-construction and into the effects of the CSG industry's operations phase is just beginning. The magnitude, locations, and nature of economic and social impacts will continue to change as the CSG industry develops and transitions from the construction phase to the ongoing production and operational phase. As a result, ongoing research into the socioeconomic impacts of CSG will continue to help improve the understanding of this relatively new industry.


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1. Introduction

Queensland has experienced almost 20 years of CSG development. However, it is only within the last decade that the scale of the industry has increased substantially, due to the establishment of a major LNG industry based on CSG. There is a large body of research and information on the environmental, social and economic effects of unconventional gas activities in Queensland, as well as more broadly in Australia and in other countries. This study addresses a significant need for a high level summary of what is known about the main factors underlying the direct economic and broader socioeconomic and environmental consequences on communities arising from the CSG industry.

Queensland's experience provides an opportunity to review what is known about the state-wide, regional and town-level socioeconomic impacts associated with the development of the CSG industry.

1.1 Scope and structure of the review

In addition to reviewing the socioeconomic impacts, this review provides background information and context on the growth of the CSG industry in Queensland and how the development of CSG differs from other natural resource development such as mining or conventional oil and gas. Chapter 1 provides this context, as well as setting out details of the regulatory and policy frameworks in the Australian Government which relate to CSG development.

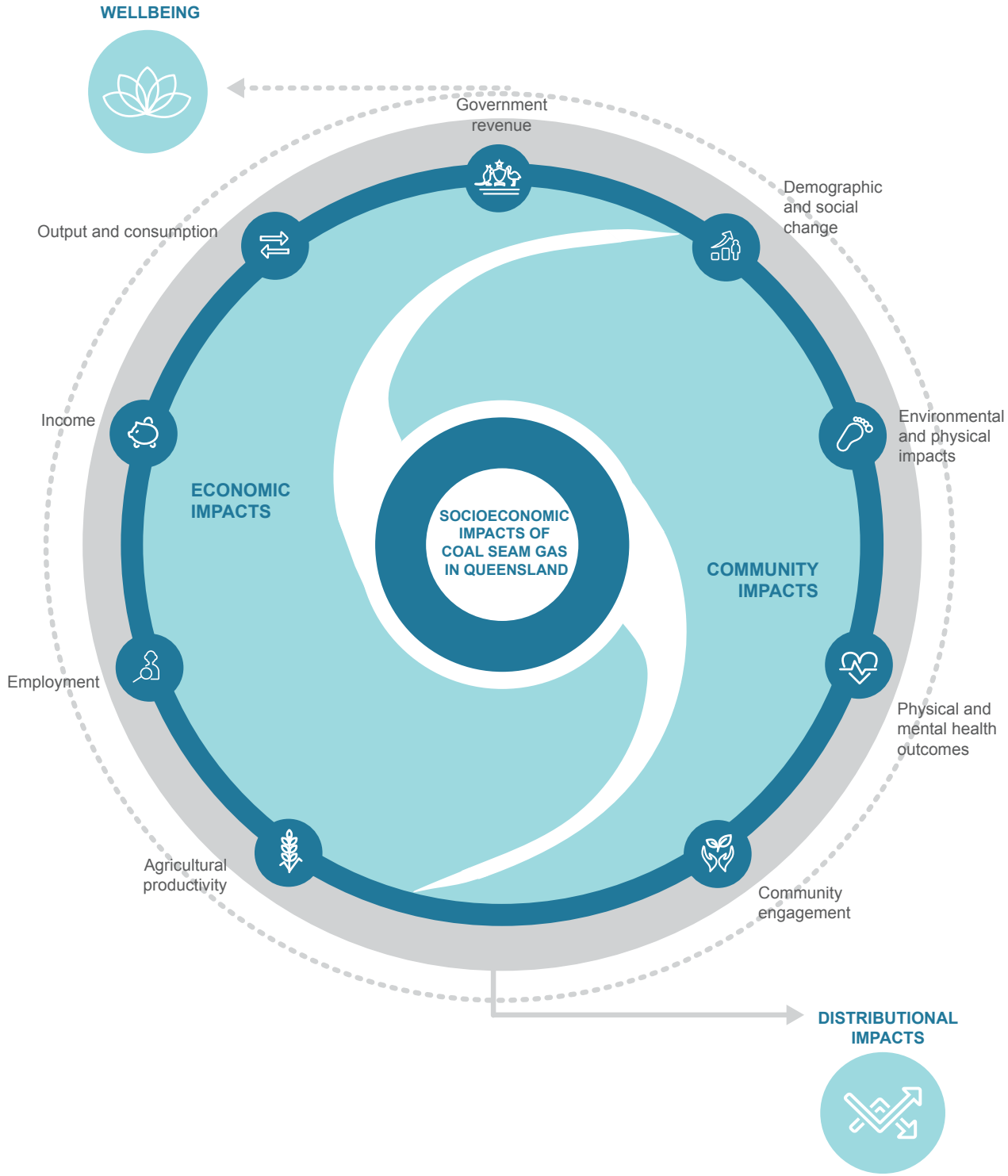
The review adopted a broad definition of socioeconomic impacts. It therefore considers a wide range of aspects of CSG development which are assessed to have potentially significant direct or indirect consequences for a community's economic wellbeing, which are set out in Figure 1.1. The assessment of these impacts is split into two sections covering headline economic impacts, and broader community impacts. Economic impacts of CSG development include changes to employment, income, output and consumption, and government revenue. This part of the review was initially published as a section of the Bureau of Resources and Energy Economics' *Gas Market Report 2014*, and is incorporated as Chapter 2 of this review.

Chapter 3 covers the broader community impacts of CSG development, which include changes to social, demographic, environmental and health outcomes, and findings on wellbeing from interviews and surveys that reflect changes in perceptions and experiences within a community. Community impacts also capture broader factors such as the need for community engagement, which is particularly important given the dispersed footprint of CSG, and the distribution of the economic and broader socioeconomic factors.

The review primarily focusses on economic and broader socioeconomic research on the impacts of CSG development within Queensland. However, where relevant, it also draws upon the literature on impacts of unconventional gas development more generally and the impacts that are more typical of other resource development. This study intentionally does not focus in detail on international experience. The majority of international experience and literature relates to forms of unconventional gas other than CSG, most notably shale gas in the United States. Other unconventional gases, as a result of the differing extraction techniques, can have a range of different impacts on the environment. In addition, different regulatory frameworks in other countries, particularly regarding the ownership of underground resources, can also have a large impact on the economic and community impacts of unconventional gas development. A great deal of care is

therefore required in comparisons between jurisdictions and any generalisations that can be made between experiences in different countries

Figure 1.1: Socioeconomic impacts of CSG development in Queensland



Source: Department of Industry, Innovation and Science (2015)

Literature was identified through an extensive search, drawing upon the annotated bibliography of CSG by Hunter and Taylor.[1] We gave more weight in the review to studies which we assessed to be more rigorous and higher quality. Two of the research organisations undertaking high quality research into the socioeconomic impacts of CSG development are Gas Industry Social and Environmental Research Alliance (GISERA), and the University of Queensland's Centre for Coal Seam Gas (UQ-CCSG). These organisations also helped us identify relevant grey literature to be considered as part of the review.

The review of research was supplemented by a number of meetings with stakeholders in the CSG sector in Queensland to discuss experiences and 'ground-truth' findings from the literature. The stakeholders included:

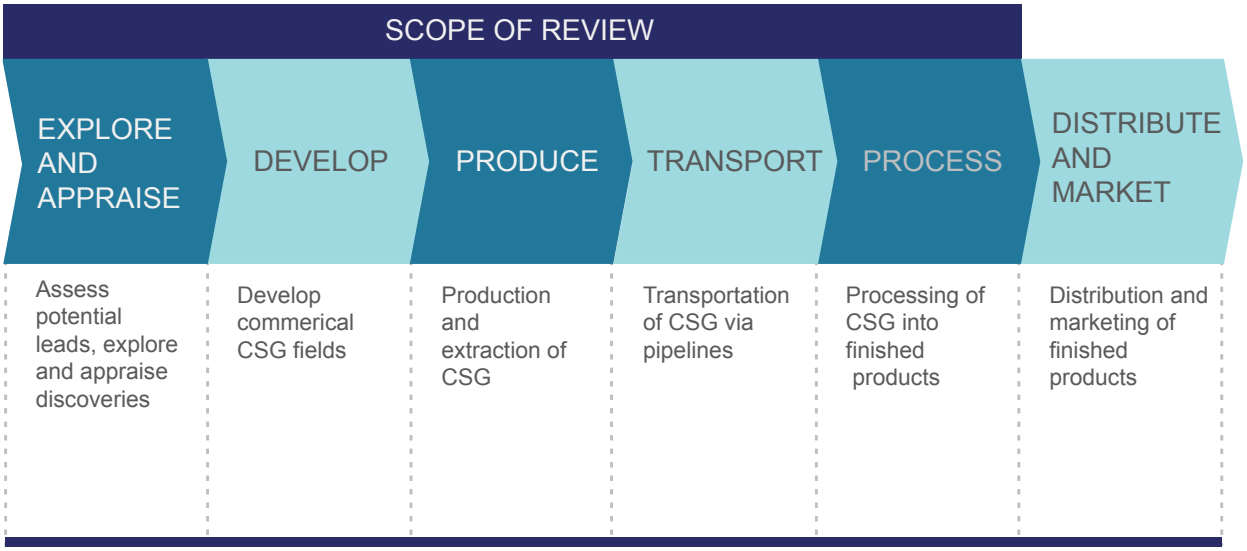
- social science and other researchers, including from the Gas Industry Social and Environmental Research Alliance (GISERA), and the University of Queensland's Centre for Coal Seam Gas (UQ-CCSG)
- Queensland Government representatives, including the Office of Groundwater Impact Assessment (OGIA) and the Department of Natural Resources and Mines (DNRM)
- representatives from the GasFields Commission Queensland (GFCQ)
- industry associations, including the Queensland Resources Council (QRC) and the Australian Petroleum Production and Exploration Association (APPEA)
- representatives from coal seam gas companies and joint ventures operating in Queensland.

We made a conscious decision not to meet with local landholders and community groups. These groups have done extensive consultation with gas companies, governments, and with social science researchers, and there was considered to be a very real risk of research fatigue. Instead, the review has relied on the perspectives of the GasFields Commission and the researchers who have been working very closely with these communities.

This review is limited to the upstream and midstream stages of CSG development, as shown in Figure 1.2. It is often difficult to separate the economic impacts of construction of LNG export facilities from the impact of the upstream CSG development, and to separate the impacts from the various components of the CSG value chain within the upstream stages. Much of the literature does not separate these impacts, and LNG construction activities are incorporated into this study where that is possible.

1 Hunter and Taylor (2013)

Figure 1.2: Stages of the CSG value chain and the scope of the review



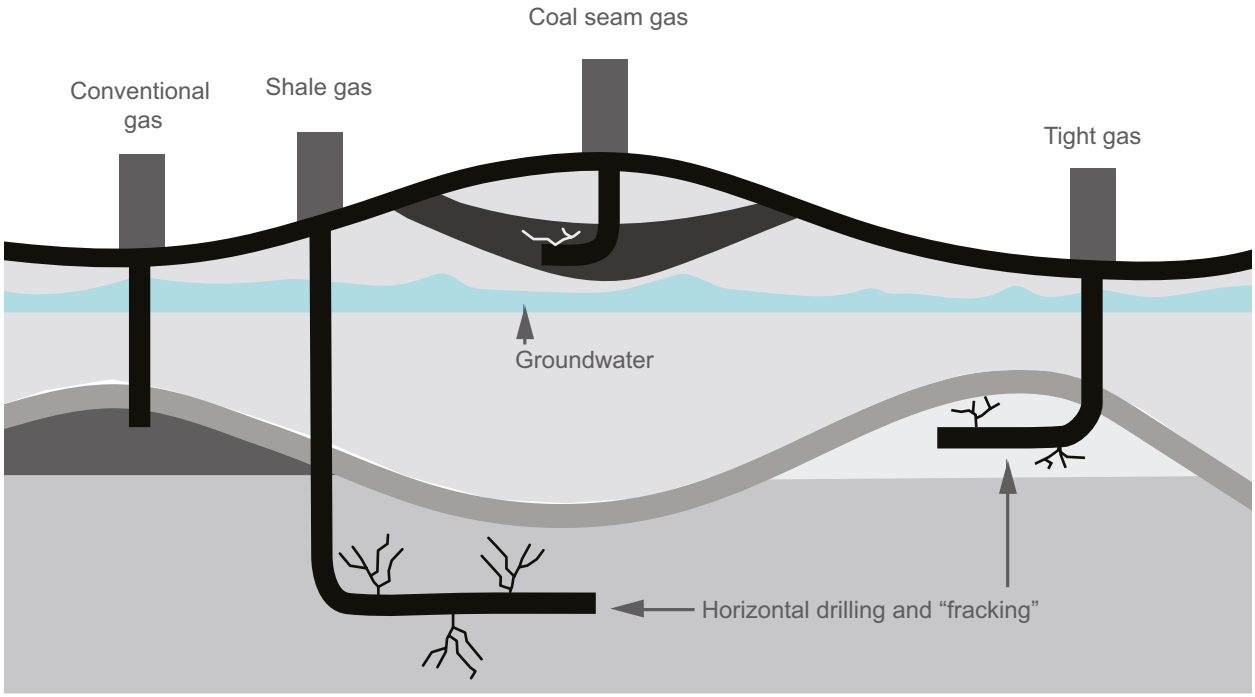
Source: BREE (2014) *Gas Market Report*

1.2 Coal seam gas

CSG is a form of 'unconventional' natural gas contained within coal seams. CSG remains within the source rock (the coal seam) and is held there by water pressure, requiring technological solutions for successful extraction. This is in contrast to conventional extraction of natural gas, where the gas has migrated from a source rock into a reservoir where it is trapped under an impermeable cap-rock, and generally doesn't require pumping for extraction.[2] Figure 1.3 shows a schematic of various types of conventional and unconventional gases.

2 GISERA (2014a)

Figure 1.3: Conventional and unconventional gases



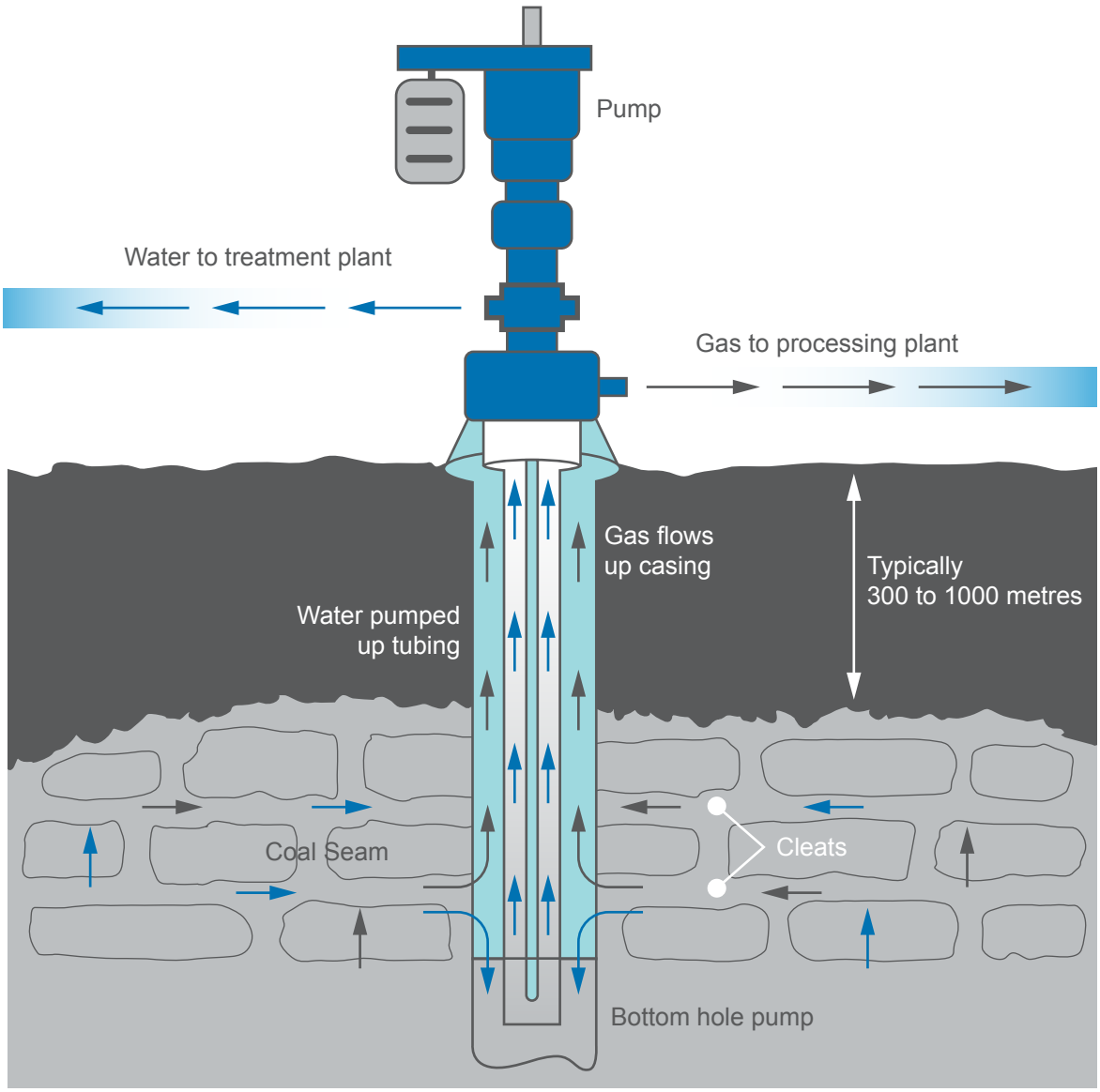
Source: Grattan Institute (2013) *Getting Gas Right: Australia's energy challenge*

CSG extraction requires a larger number of wells than conventional gas production, given CSG remains within the coal seam over a large area and each well can only access a small volume of the gas. However, these wells are generally shallower and cheaper to drill.[3] The CSG wells are depleted of natural gas faster than conventional wells due to relatively low permeability, connectivity and continuity within the coal seams. As a result, to make the development of a CSG field economically viable, wells need to be drilled on a continuing basis to access the gas located in other parts of the coal seam. Figure 1.4 shows a schematic of a CSG well.

This requirement gives CSG development some characteristics consistent with mining, in that there is the need for continuing capital investment over time, which creates a greater sensitivity to changes in gas prices and a greater delivery risk. As such, CSG development can be seen as more risky than the development of conventional oil and gas.

3 Ibid

Figure 1.4: A schematic of a CSG well

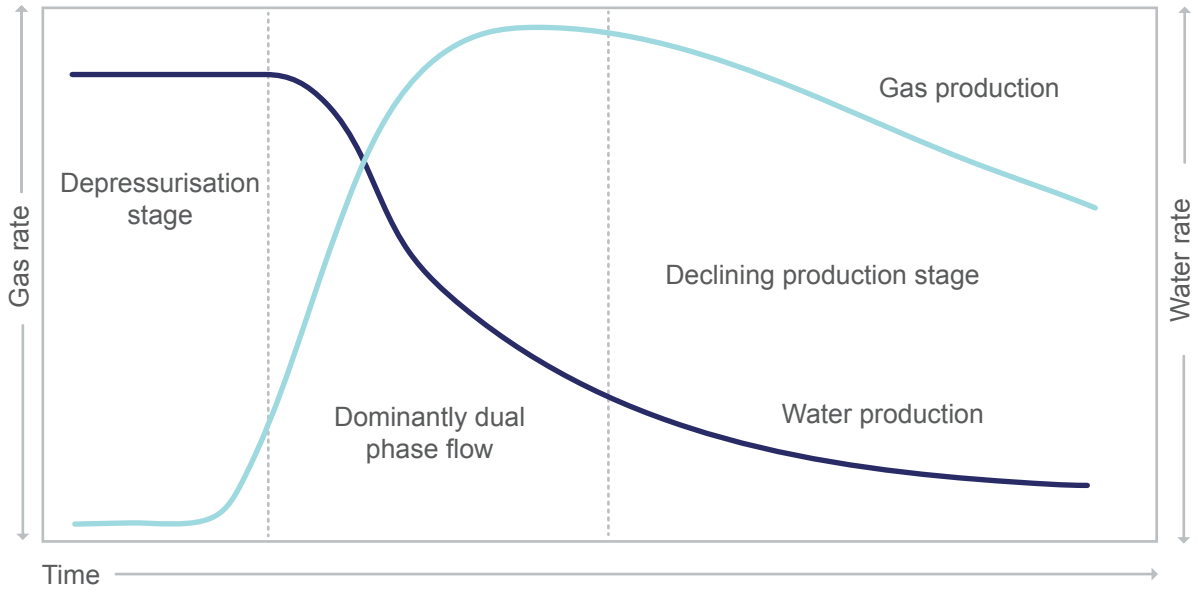


Source: GISERA (2014) *What is coal seam gas?*

CSG is held within the coal seam by water pressure, and the extraction of the gas requires the extraction of water from the coal seam to reduce the pressure and allow the gas to be released, as shown in Figure 1.5. In Australia, this 'associated water' is treated to remove salts and other chemical constituents. What results is called 'produced water', which can then be re-used or disposed of.[4] In other jurisdictions overseas and in conventional oil and gas operations, suitably treated produced water is often reinjected — after the hydrocarbons have been separated.

4 CSIRO (2015)

Figure 1.5: CSG production phases



Source: Queensland Water Commission (2012) *Underground Water Impact Report for the Surat Cumulative Management Area*

Depending on the characteristics of the coal seam, extraction can require further stimulation to increase gas flow, such as hydraulic fracturing, or fracking. Hydraulic fracturing involves pumping water, containing a proppant (such as sand) and chemical additives, at high pressure into the coal seam to either create or open up existing fractures within the coal. These fractures, which are kept open by the proppant, both increase the surface area for gas desorption and allow the gas to flow more freely through the well and to the surface.[5]

1.3 CSG in Queensland

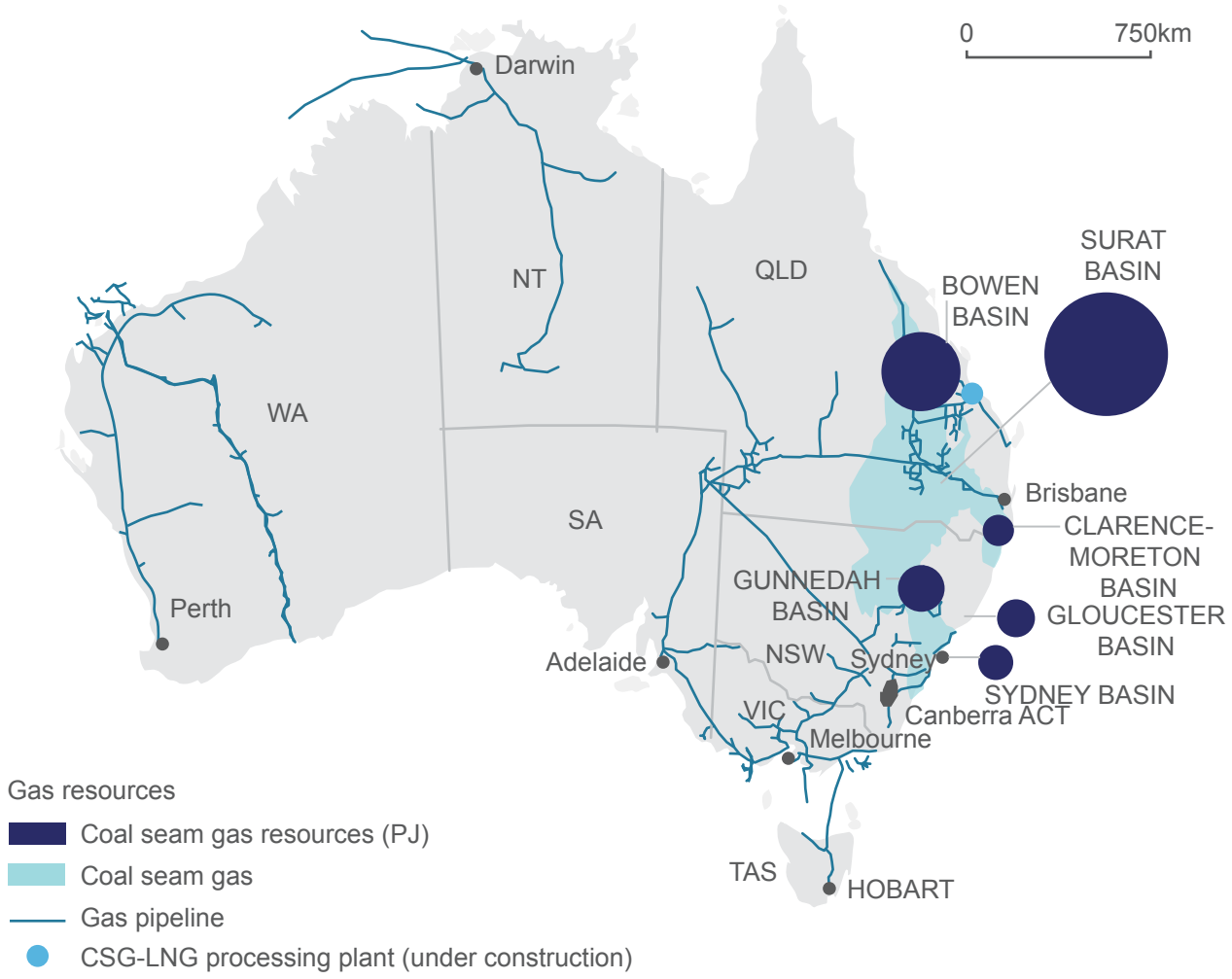
Australia's proved and probable (2P) reserves of CSG are significant, and most recently estimated to be around 45,000 petajoules (PJ).[6] The distribution of reserves is along the east coast as shown in Figure 1.6. Over 90 per cent of Australia's CSG reserves (around 42,000PJ) are located in Queensland's Bowen and Surat basins,[7] while smaller reserves are located in the Clarence-Moreton, Gunnedah, Gloucester and Sydney basins in New South Wales. Figure 1.7 shows the Queensland reserves in more detail.

5 Ibid

6 Geoscience Australia and the Bureau of Resources and Energy Economics (2014)

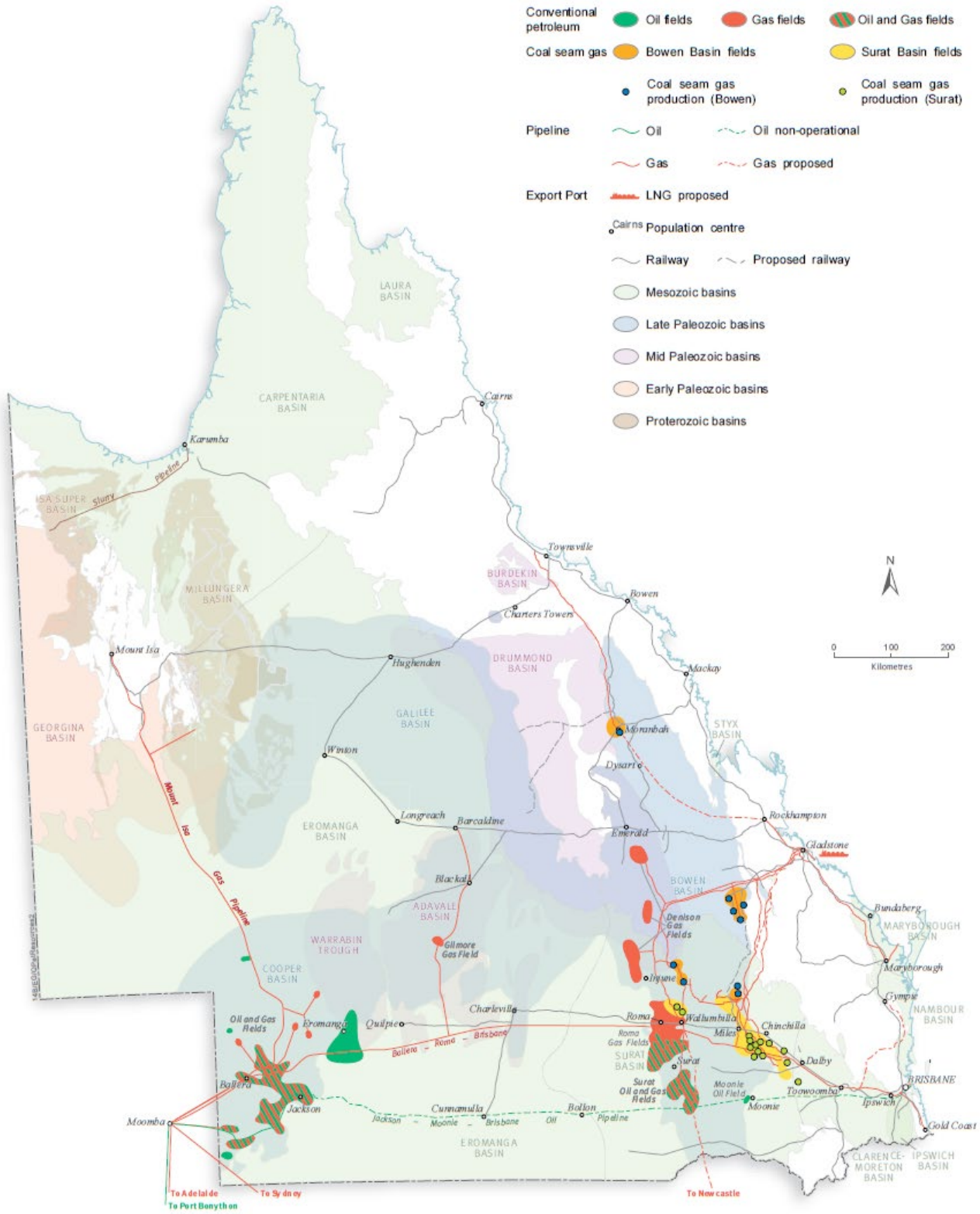
7 DNRM (2015a)

Figure 1.6: Australia's coal seam gas reserves and infrastructure



Source: Geoscience Australia and BREE (2014) *Australian Energy Resource Assessment 2014*

Figure 1.7: Queensland gas reserves and infrastructure



Source: DNRM (2015a), *Queensland's petroleum and coal seam gas 2013–14*

The Bowen and Surat basins have quite different demographic profiles, based on the definitions of these regions by KPMG in its 2013 analysis of census data.[8] The Bowen Basin comprises the Isaac, Central Highlands, Woorabinda and Banana Local Government Areas (LGAs), and the townships of Moranbah, Emerald and Biloela, with a total population of over 85,000 in June 2014.[9] There has been a long history of coal mining in the Bowen Basin prior to CSG development, with mining the largest employer in both 2006 and 2011.[10] Other important industries for employment in the Bowen Basin include agriculture, retail trade and construction.

The Surat Basin comprises the Toowoomba, Western Downs and Maranoa LGAs, including the major township of Toowoomba and townships of Dalby and Roma, with a population of over 200,000 in 2014.[11] Largest employers by industry are health care, retail trade, agriculture and education. The resources sector, including both mining and gas production, represented just 1 per cent of the working population in 2006, and grew by 170 per cent to reach 3 per cent of the population by 2011. This largely relates to a 273 per cent growth in oil and gas employment through the rapid development of CSG in the region.[12] The resources sector is now estimated to be the largest contributor to the Gross Regional Product of the Western Downs LGA, growing by an average of around 16 per cent per annum over the last five years.[13]

Both regions are home to a range of agricultural industries, including livestock and irrigated and dryland cropping. The Surat Basin in particular, where much of Queensland's CSG activity is now occurring, contains some of Queensland's most diverse agricultural lands, including sheep and beef production, horticulture, and broadacre cropping.[14] Coexistence between CSG and agriculture remains a key focus area for research, including at UQ-CCSG and GISERA.

CSG exploration commenced in Queensland in the late 1970s. The growth of CSG in these regions commenced at a time when conventional gas resources supplying gas to the state were starting to deplete. As LNG prices increased in the mid to late 2000s, opportunities emerged to utilise Queensland's CSG reserves for LNG export. This encouraged a wave of exploration activity as a number of gas producers sought to discover and develop CSG reserves. From a large range of proposals under consideration, three LNG projects proceeded to final investment decision. Of these three, two are currently under construction, and one recently started operations.

The three projects will have a combined capacity of over 25 Mtpa, slightly larger than the total export capacity of the LNG projects currently operating in Western and Northern Australia, and will use more than double the amount of gas annually consumed in the eastern Australian gas market. The three projects will be the first CSG to LNG projects in the world. They are:

- Queensland Curtis LNG (QCLNG) – operated by BG Group in a venture with China National Offshore Oil Corporation (CNOOC) and Tokyo Gas; QCLNG will have a capacity of 8.5 Mtpa from two trains, which commenced operations in December 2014 and July 2015 respectively;

- Gladstone LNG (GLNG) – operated by Santos in partnership with Petronas, Total and Korea Gas Corporation (KOGAS); GLNG will have a capacity of 7.8 Mtpa from two trains, and it is scheduled for first gas in the third quarter of 2015; and

8 KPMG (2013)
9 QGSO (2014a)
10 KPMG (2013)
11 QGSO (2014b)
12 Ibid
13 Western Downs Regional Council (2015)
14 Queensland Government (2011)

- Australia Pacific LNG (APLNG) – operated by Origin Energy (upstream) and ConocoPhillips (downstream) in a venture with Sinopec; APLNG will have a capacity of 9 Mtpa from two trains, with first gas expected in the last quarter of 2015.

The Queensland Government also encouraged gas exploration, including through the Queensland Gas Scheme, which was introduced in 2005 to boost the industry and reduce greenhouse gas emissions. It required electricity retailers to procure a certain percentage of their electricity from gas-powered generation.[15] The scheme was closed at the end of 2013, at which time gas-powered generation had exceeded the target of 15 per cent and reached almost 20 per cent of Queensland's electricity generation, up from only 2.4 per cent of generation when the scheme was introduced in 2005.[16]

As a result of these factors, Queensland's CSG reserves have grown substantially since December 2004, when 2P reserves (proven and probable) were around 3,650 PJ. Over the nine years to 2014, 2P reserves have increased more than tenfold, predominantly in the Surat Basin (Figure 1.8).

Figure 1.9 shows the rapid growth in CSG production. Commercial production from CSG commenced in 1996 from the Dawson River area near Moura in the Bowen Basin, and the Fairview area near Injune in 1998.[17] Commercial production of CSG from the Surat Basin started in 2006 from the Kogan North area near Dalby and the Berwyndale South area near Chinchilla.[18]

In the late nineties, CSG accounted for only three per cent of Queensland's gas, but with 285 PJ of production in 2013–14 it is now the dominant source of Queensland's gas, at almost 90 per cent.[19]

15 Queensland Government (2014a)

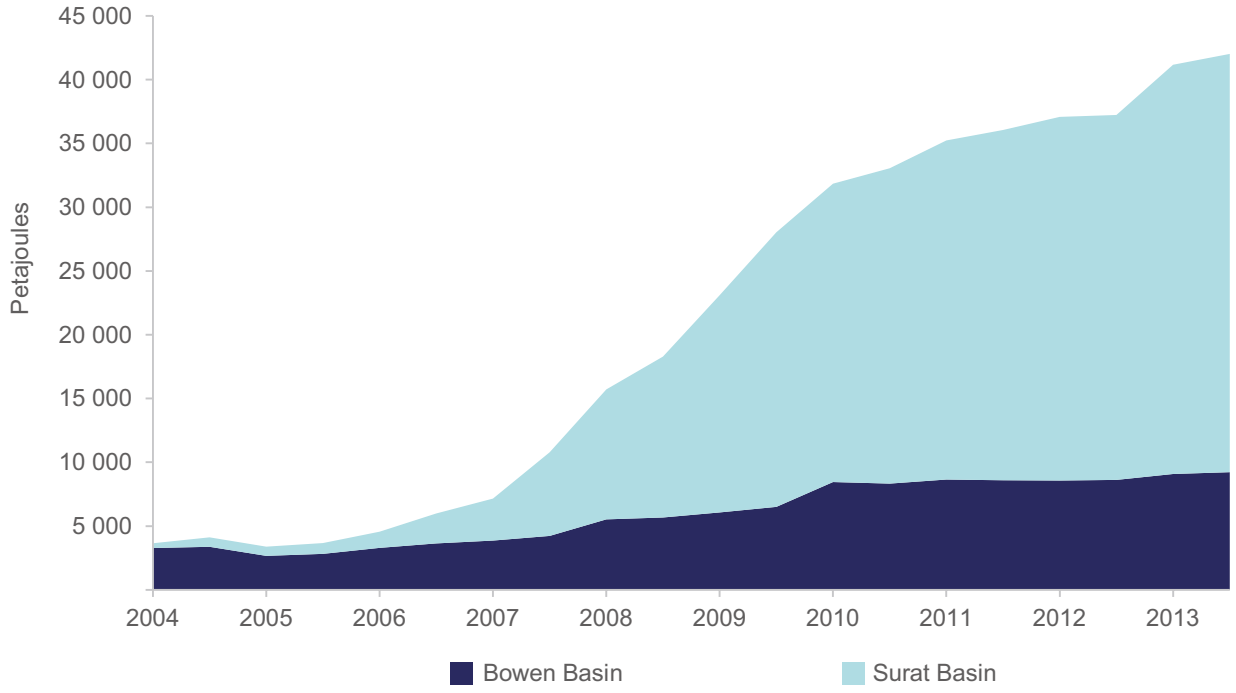
16 Queensland Government (2014b)

17 DNRM (2015a)

18 Ibid

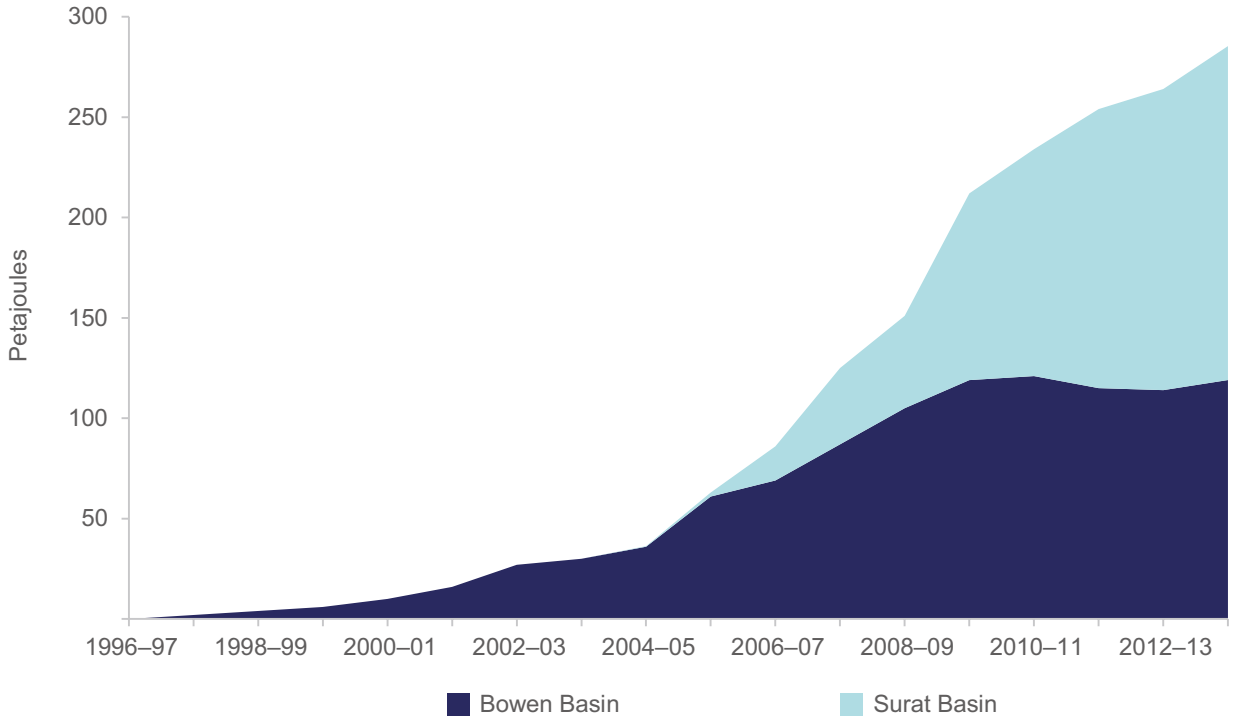
19 Ibid

Figure 1.8: Queensland coal seam gas 2P reserves (proved and probable)



Source: Queensland Government (2015a) *Coal seam gas production and reserve statistics*

Figure 1.9: Queensland coal seam gas production

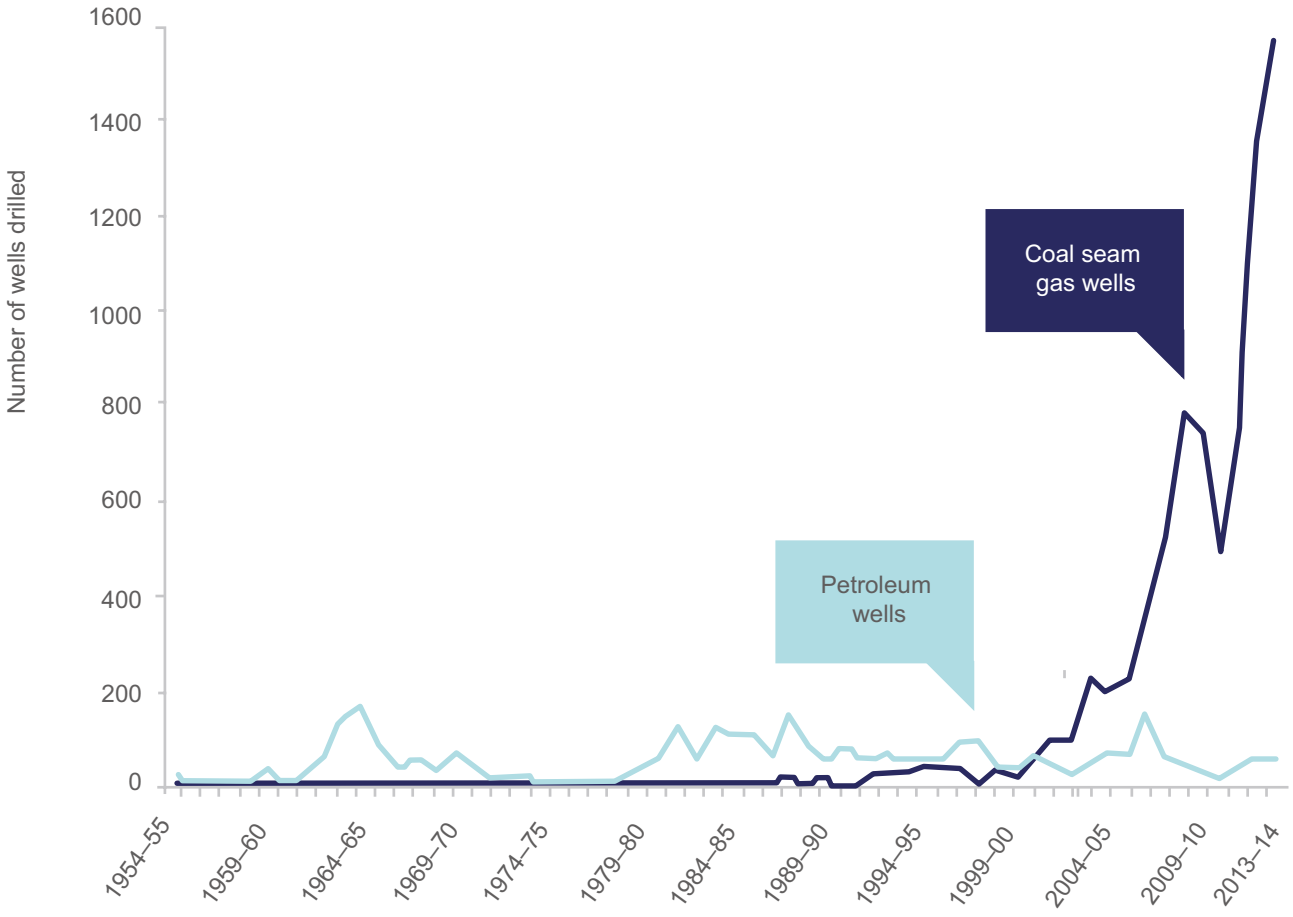


Source: Queensland Government (2015a) *Coal seam gas production and reserve statistics*

This growth in exploration and development has been accompanied by an increased physical presence and impact on the landscape. The number of CSG wells drilled per annum has increased rapidly over the period, from around 200 wells in 2005–06 to around 1,600 wells in 2013–14, as shown in Figure 1.10.[20] This activity is expected to decrease once production has been ramped up for the three LNG projects, and plateau at a lower level.

CSG activities are expected to continue in Queensland for at least several decades, with more than thirty thousand CSG wells expected to be drilled. The impact on the landscape will vary over time as additional exploration and appraisal activity is undertaken and as wells are developed and move into the production phase. In the long term, CSG proponents are required to decommission old wells and remediate CSG wells, ensuring the protection of the groundwater resources and isolation of geological formations, as well as ensuring that surface infrastructure is removed.[21]

Figure 1.10: Annual petroleum wells drilled in Queensland



Source: DNRM (2015a) *Queensland's petroleum and coal seam gas 2013–14*

20 Ibid

21 DNRM (2013)

1.4 How does CSG differ?

There are a number of key differences in the context and technology of development of CSG compared to other resource developments in Queensland. These differences, which primarily relate to the speed of development and the geospatial dispersion of the resource, contribute to differences in the socioeconomic impacts on communities and regions.

'Newness' and rapid development

Although exploration and production of CSG in Queensland started in the 1990s, it was not until the mid 2000s that the pace of development increased and the focus expanded from the Bowen Basin to encompass the Surat Basin. As a result, there was an increase in the area affected by this activity and the associated number of wells and the volume of production. The speed and scale of CSG development and its 'newness' focused attention in local towns and regions on the physical and environmental effects of CSG activities. In some cases, these effects and the related uncertainties are reported to have culminated in increased levels of stress and anxiety for some members of the regional communities.

In addition, although many communities in the Bowen Basin were accustomed to other resource development in the region, CSG development in the Surat Basin affected many communities that had not previously been exposed to significant mineral or petroleum resource development. The adjustment required by residents, businesses, and local government services in a number of these towns to CSG development was therefore quite large.

Geospatial dispersion

CSG development differs considerably from traditional resource development (including conventional gas development) due to the spatial dispersion of the CSG resource and associated activities required for extraction, processing and transport. While modest in total size compared to agriculture, CSG has a dispersed development footprint, not just because the resource occurs across a large subsurface area, but also due to a relatively large scale of the CSG industry's operations, which necessitate a range of infrastructure including gas wells, access roads, pipelines, processing plants and dams.

A complicating factor is that communities and regions are often affected by the cumulative impacts of CSG development from two or three different companies given the existence of multiple projects run by different proponents in the same region.

Land access, land use and community engagement are issues for all resource developments. However, in contrast to coal mining, which takes land out of use by others, existing land uses continue to cohabit over a large area where CSG activities occur. That is, CSG wells are being drilled on active farms and grazing properties. The overlap of activities exposes a larger number of people to the social and economic impacts of the resource development. The 'coexistence' between the CSG industry and communities increases the need for community engagement activities. Given the large number of people who can be directly impacted and the nature of the development, coexistence needs to be maintained for the duration of CSG activities.

The overlap also means that compensation is required for a large number of landholders, rather than simply purchasing an area of land to be mined. Compensation payments can assist with the distributional impacts of CSG development, given that financial benefits are provided to affected landowners. There are more than 5,000 Conduct and Compensation Agreements (CCAs) signed in Queensland in gasfield and pipeline areas.[22]

22 APPEA (2015)

The geospatial footprint of CSG development in Queensland has overlapped with populated areas with pre-existing land uses and industries, including agricultural uses of grazing, cropping and irrigated cultivation. It has been increasingly important for the CSG industry to have a deep understanding of key issues in relation to developing and managing sustainable coexistence with the agricultural industry. Consistent with this goal, the industry is supporting significant research in this area, GISERA and UQ-CCSG.

1.5 Regulatory and policy frameworks

Successful coexistence between CSG and existing landholders and communities is essential for achieving and maintaining a social licence to operate for the industry as a whole. The Australian Government regulatory and policy regime works in concert with state and territory governments, which have primary responsibility for the regulation of CSG in their jurisdiction to ensure responsible development.

The development of the Australian and Queensland governments' policy and regulatory frameworks has been influenced by the National Partnership Agreement on Coal Seam Gas and Large Mining Development (the NPA).[23] The NPA was signed by the Australian, Queensland, New South Wales, Victorian and South Australian governments in February 2012. The purpose of the NPA is to create a more consistent national approach to strengthen the regulation of CSG and large coal mining development by ensuring that future decisions are informed by substantially improved science and independent expert advice. Although the NPA expired in June 2014, arrangements put in place ensure that its objectives and outcomes have enduring effect.

Under the NPA, responsibilities of the Australian Government included establishing the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC), and funding bioregional assessments and other priority research (discussed further below). Responsibilities of state governments included ensuring that processes were put in place to ensure coal seam gas (and coal mining) developments likely to have a significant impact on water resources are referred to the IESC for advice, and that this advice is taken into account in a transparent manner.

Australian Government

The Domestic Gas Strategy sets out the contributions made by the Australian Government to ensure the responsible development of CSG and other unconventional gases, including:

- Improving gas markets to enable better access and price discovery for all market participants, through the Council of Australian Governments (COAG) Energy Council and the Office of the Chief Economist.

- Understanding and responding to potential social impacts to build confidence that community needs and expectations will be considered, including through this study and the work of GISERA.

- Understanding and communicating the science to build confidence in the community that risks and environmental impacts can be managed, through the bioregional assessment of cumulative impacts on water resources, the work of the IESC, and the research done by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS), the Department of Environment, Geoscience Australia, GISERA and CSIRO.

- Attracting investment and encouraging steady and predictable supply through better regulation, including the development of a one-stop shop for environmental approvals and the development of international best practice standards.

23 COAG (2012)

- Tailoring production technologies for Australia to ensure we are making the best of our resources by developing a 'National Strategic Research Initiative for Onshore Gas'.

- Establishing an Oil, Gas and Energy Resources Industry Growth Centre to accelerate advancements within the industry.

- Improving access to geoscientific precompetitive data from Geoscience Australia to understand our resources and attract investment.

- Demonstrating the macroeconomic benefits to build community confidence.

- Learning from mistakes and successes of other jurisdictions through sharing knowledge between states and from international experience.[24]

The Australian Government plays a role in regulating the environmental impacts of CSG development through the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act focuses on the protection of matters of national environmental significance. Matters of national environmental significance include 'a water resource, in relation to coal seam gas development and large coal mining development' (known as the 'water trigger') as well as places of world and national heritage, wetlands of international importance and listed threatened species and ecological communities.

The water trigger ensures coal seam gas developments that are likely to have a significant impact on water resources are comprehensively assessed at a national level. As a result of the introduction of the water trigger, the Australian Government Environment Minister can set appropriate conditions as part of the project approval to ensure that any impacts on a water resource are acceptable.

To support regulation under the EPBC Act, the Australian Government is also leading efforts to improve understanding of the water-related impacts of coal seam gas (and large coal mining) development. This includes:

- Providing secretariat and technical support to the IESC, which provides expert scientific advice to Australian government regulators on the water-related impacts of coal seam gas and large coal mining development proposals.

- Managing the Australian Government's programme of targeted bioregional assessments to assess the potential impacts of coal seam gas and large coal mining developments on water resources and water-related assets.

- Managing the Australian Government's research programme to identify and address critical gaps in scientific understanding of the water-related impacts of coal seam gas and large coal mining developments.

The Australian Government also works in partnership with state and territory governments through the COAG Energy Council to develop best practice regulations for CSG. The National Harmonised Regulatory Framework for Natural Gas from Coal Seams is a suite of leading practices with a focus on four key areas of operations: well integrity; water management and monitoring; hydraulic fracturing; and chemical use.[25]

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24 Department of Industry and Science (2015)

25 Standing Council on Energy and Resources (2013)

The Australian Government has also developed the following coexistence principles for the development of coal seam gas, which were featured in the Domestic Gas Strategy[26] and the Agricultural Competitiveness White Paper:[27]

- Access to agricultural land should only be done with the farmer's agreement and farmers should be fairly compensated.
- There must be no long term damage to water resources used for agriculture and local communities.
- Prime agricultural land and quality water resources must not be compromised for future generations.

Queensland Government

In response to the scale, speed, the potential risks and inherent uncertainties of CSG development, the Queensland Government put in place an 'adaptive management' process for imposing appropriate regulation on the industry that allowed for flexibility in dealing with unforeseen outcomes or risks and addressed community and environmental concerns.[28] This ensures that the potential risks of adverse physical outcomes from CSG development are identified and appropriately managed. In addition to the standard legislation that applies to the gas industry with regard to exploration and production activities, safety, water and environmental impacts, a range of regulatory instruments were introduced specific to the CSG industry with regard to water management, gas gathering, construction and abandonment of wells, and emissions detection and reporting.

The Queensland Government created the GFCQ in 2013 to manage and improve sustainable coexistence among rural landholders, regional communities and the onshore gas industry. As an independent statutory organisation, the GFCQ has played a critical role as a key reference point for both CSG and the agricultural industry. It not only facilitates relationships between landholders and CSG companies, but also provides impartial advice, information and tools throughout negotiations about land access and compensation. The GFCQ is also responsible for reviewing the effectiveness of legislation and regulation and for making recommendations to government and industry.[29]

The previous Queensland government also created a 'Royalties for Regions' program in order to channel resource royalties toward regional infrastructure projects. This program has been superseded by the 'Building our Regions' program, with $200 million available over two years as a 'targeted infrastructure' program.[30]

The Queensland regulatory framework is consistent with the Australian Government principles of supporting coexistence, the key components of which are outlined below.

26 Department of Industry and Science (2015)

27 Australian Government (2015)

28 Queensland Government (2015b)

29 GFCQ (nd)

30 DoSD (2015)

Land access

A major component of the coexistence between CSG and communities is land access. The Queensland Government's land access laws have been updated to ensure that:

- landholders are fairly compensated for activities on their land
- resource companies minimise the impact on existing land and business operations.[31]

The Queensland Government's land access regulatory framework sets out consistent legislation and processes relating to land access and compensation, including obligations for each party and expectations for CCAs between resource companies and landholders.[32] The Land Access Code was established in 2010 under the *Petroleum and Gas (Production and Safety) Act 2004*, which aims to promote co-operation and improved relationships between the agriculture and resources/CSG sectors.

The Queensland Government has also been working closely with other organisations to promote improved stakeholder relationships and ensure that quality information and education on land access rules and CCA negotiations is provided to communities. There are checklists and guidelines on CCA negotiations and compensation arrangements available from peak body and Government organisations, including AgForce, Basin Sustainability Alliance, GFCQ, and the Queensland Government. All of these factors have positively contributed to completion of a significant number of negotiations between landholders and CSG companies, reflected in substantial increase in signed CCAs, from around 1,800 in July 2011 to 5,107 in March 2015.[33]

As a further innovation, the Queensland Government also established the CSG Compliance Unit within the DNRM to increase the resource available to landholders. The aim of the Unit is to engage and respond to landholders' concerns, to monitor compliance of CSG activities with government requirements, and to coordinate groundwater monitoring by the landholders themselves through 'CSG Net'.[34]

Water resources

The protection of water resources is a key issue for the successful coexistence of agriculture and CSG, given the importance of ongoing access to safe water for the maintenance of agricultural livelihoods. The Queensland Government has put in place a range of measures to address water management issues, including controlling the water quality and prohibiting the use of potentially harmful chemicals, such as benzene, toluene, ethylbenzene and xylene (BTEX) in hydraulic fracturing fluids.[35]

The OGIA was established under the *Water Act 2000* to oversee the groundwater impacts of the CSG industry.[36] A cumulative management area has been declared over the Surat Basin. As a result, gas companies are mandated to report water production and monitoring data and OGIA prepares an Underground Water Impact Report (UWIR), which is updated every two years. The UWIR includes a cumulative assessment of groundwater impacts of CSG extraction activities and an overview of integrated regional management arrangements. Any necessary 'make good' arrangements, including the provision of water to landholders whose bore levels drop by 5 metres or more following initiation of CSG development, remain the responsibility of the companies.

31 Queensland Government (2010)
32 Ibid
33 APPEA (2015), Queensland Government (2013)
34 DNRM (2015c)
35 Ibid
36 DNRM (2015d)

In addition to OGIA's public reports and forecasts, and landholder groundwater engagement through CSG Net, the Queensland Government have also created an online data map, the 'CSG Globe', to enable the public to view activity and water data related to the industry.[37] CSG Globe plots on a Google Earth map the location of and data from bores that are required to be registered with the Queensland Government.

Resource protection

The Queensland Government's regulatory framework identifies and protects areas that are considered to be 'of regional interest' to ensure a balance between protecting 'priority land uses' (such as farming on highly fertile land) and supporting diverse economic development. The *Strategic Cropping Land Act* (SCL Act) was introduced in 2011, which was replaced by the *Regional Planning Interests Act* (RPI Act) and associated guidelines in 2014.[38]

The RPI Act defines Priority Agricultural Areas (PAAs), which are strategically significant and high value agricultural areas within a region. PAAs include the major dryland and irrigated cropping areas of the Darling Downs. Proposed activity must not result in a material impact on a priority agricultural land use. Strategic Cropping Areas (SCAs) are areas defined as being of regional interest under the RPI Act, which incorporate all the former protections for land previously identified under the SCL Act. In order for CSG to be approved in SCAs, the activity needs to demonstrate to have an impact for less than 50 years except under exceptional circumstances. The RPI Act also provides protection for Priority Living Areas and Strategic Environmental Areas.

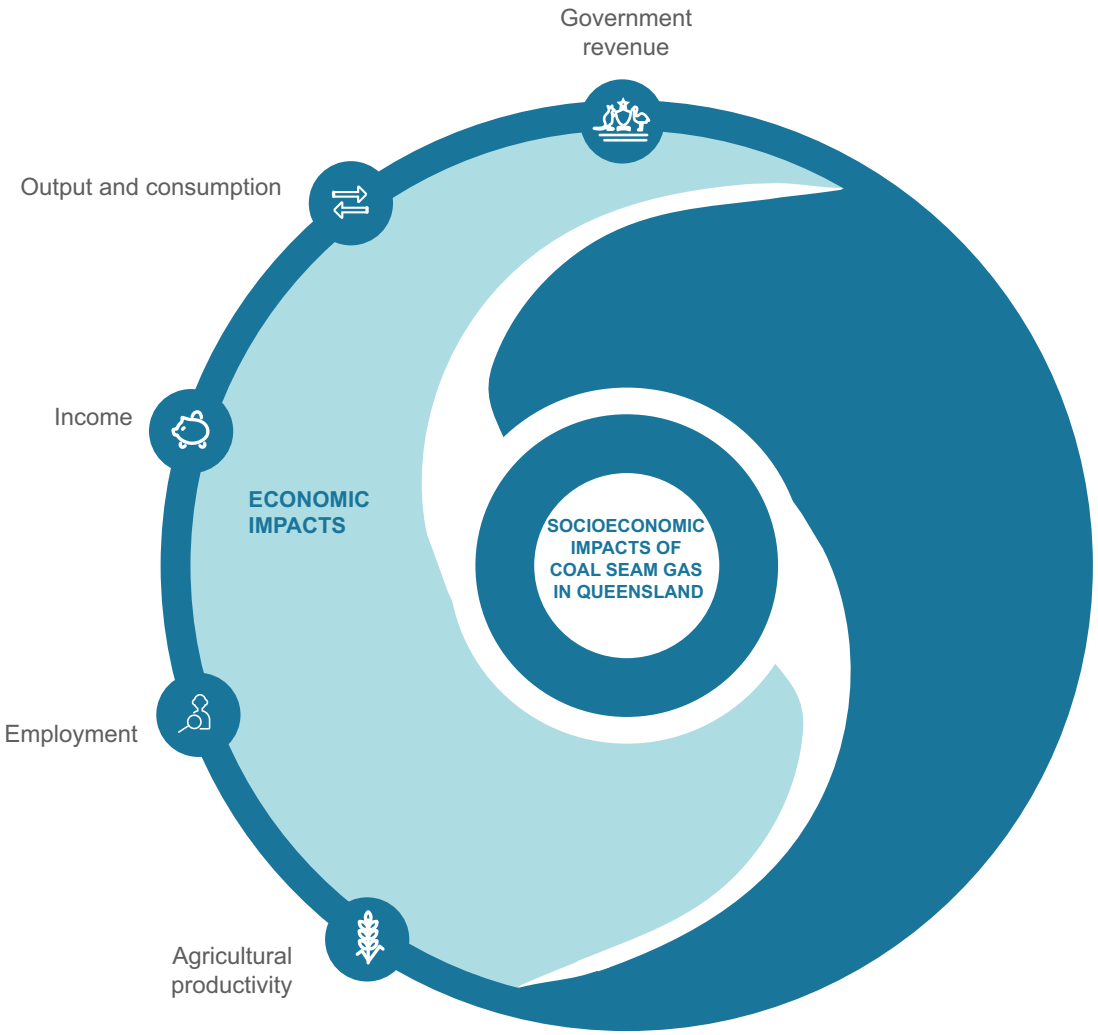
37 Queensland Government (2015c)

38 DILGP (2015), DNRM (2015b)

2. Direct economic impacts of CSG

This chapter assesses the direct economic impacts of CSG development in Queensland. It finds that the headline economic impacts are consistent with those of a typical natural resource development, with increases in employment, income, labour, output, consumption, and government revenue as shown in Figure 2.1.

Figure 2.1: Structure of economic impacts of the resources sector



Source: Department of Industry, Innovation and Science (2015)

Given the overlap of CSG development with agricultural activities, the chapter also considers the impact of CSG development on agricultural productivity. There are a large range of factors which have the potential to reduce productivity, including time spent in negotiations, land use, and competition for labour. However, these can be offset by positive factors, including compensation and access to treated water.

2.1 Typical impacts of natural resource development

The typical economic impacts of natural resource development set an important context for considering the impacts of CSG development. Given this array of impacts, it is easy to recognise that resource development has both positive and negative economic consequences.

Common in the resources literature is the idea of a 'resources curse', in which the economies of countries with significant natural resources often grow more slowly than those without. The decline in economic growth is attributed a number of factors including to the resource development crowding out other forms of industrial development, as the workforce and skill sets are tailored to the one industry. The existence of a resource curse is not universally accepted but for those who subscribe to it at a national level, it is often seen as more of an issue for developing and non-democratic countries. Hajkowicz et al found no evidence of a resource curse at a local government level in Australia's mining regions,[39] but Fleming et al did find some adverse effect in eastern regions.[40]

The key change caused by any resource development is effectively a labour demand shock. The labour demand generated as a result of resource development increases employment and salaries in the region, contributing to economic growth. Fleming et al found that a doubling of the number of miners in a region is expected to lead to 2 per cent growth in family income in that region.[41] The demand for labour generally cannot be filled by the local population. As a result, the regional population increases, although some of this increase can be temporary, non-resident workers.

The ways in which changes in employment impact on the economy can vary. Job spillovers (or multipliers) are created through employment opportunities that develop in other sectors, while crowding out of local employment results from people moving from other industries into the resource development sector. How these changes to employment flow through the economy has a major impact on whether the development results in long-term positive or negative economic outcomes. If job spillovers outweigh crowding out, medium term employment growth can be favourable, whereas if job spillovers are negligible, non-mining sectors will be negatively affected, with employment growth reduced in the medium term.[42]

Resource development also has consumption effects. There is increased spending from the resource sector itself to direct business suppliers, which will flow through to indirect effects on other suppliers.[43] In addition, increased disposable income of workers in the region leads to increased demand, consumption and investment. Although a larger share of consumption effects are estimated to flow through to capital cities and regional centres, a portion will generally stay in the region. In addition, resource development will lead to increased government revenue, both directly from the project and from the economic growth more broadly. However, the rise in government revenue from royalties would only start once the resource project begins operations and sales, after an initial construction boom.

39 Hajkowicz et al (2011)

40 Fleming et al (2015)

41 Ibid

42 Fleming and Measham (2014)

43 Rolfe et al (2011)

Although one can determine a general pattern of impacts of natural resource developments, it is important to note that these impacts vary considerably as a result of the initial state of the hosting community, as well as external factors regarding the resource itself, the broader community, and the communities' existing industries or commodities. Regional factors include the type of economic activities, existing skillsets, the nature of the housing market, and the integration of the regional economy into the national economy. In agricultural areas, rainfall patterns can be a critical issue. External factors include the type and location of the resource, the life cycle of its extraction, and the price volatility of the commodity.[44] Given the spatial dispersion of the CSG industry, these factors can also impact on how different communities have experienced CSG development.

The economic impacts of CSG, although varying between regions and towns, are broadly consistent with the economic impacts of typical resource developments. The rest of this chapter considers the impacts of CSG development against the following metrics:

- employment, both in terms of direct employment by CSG companies and indirect impacts on broader employment in the state
- household income, including the combined income for people sharing a household
- increases to output and consumption through changes to Queensland's Gross State Product (GSP)
- increased royalties and other government revenues.

2.2 Employment

Prior to the commencement of LNG project construction, CSG development in Queensland was projected to have a large impact on employment, leading to strong employment growth, both in terms of direct employment and indirect effects.

Consistent with predictions, a range of studies find strong evidence that the growth of the CSG industry has provided increases in both direct and indirect employment, particularly in the construction and professional services sectors.[45] However, these empirical studies have generally covered periods only leading up to 'peak construction' for the CSG industry, which occurred during 2014. More recent research at UQ-CCSG indicates that employment in the CSG industry began to fall, in line with project plans, from this point.[46]

Economic data from the Queensland Government Statistician's Office (QGSO) shows a strong growth in employment in the CSG resource regions. [47] Although this growth cannot be attributed purely to the growth in the CSG sector, the unemployment rate in the Surat Basin decreased from 5.9 to 3.1 per cent between the 2001 and 2011 census, and in the Bowen Basin from 4.3 to 2.2 per cent over the same period.

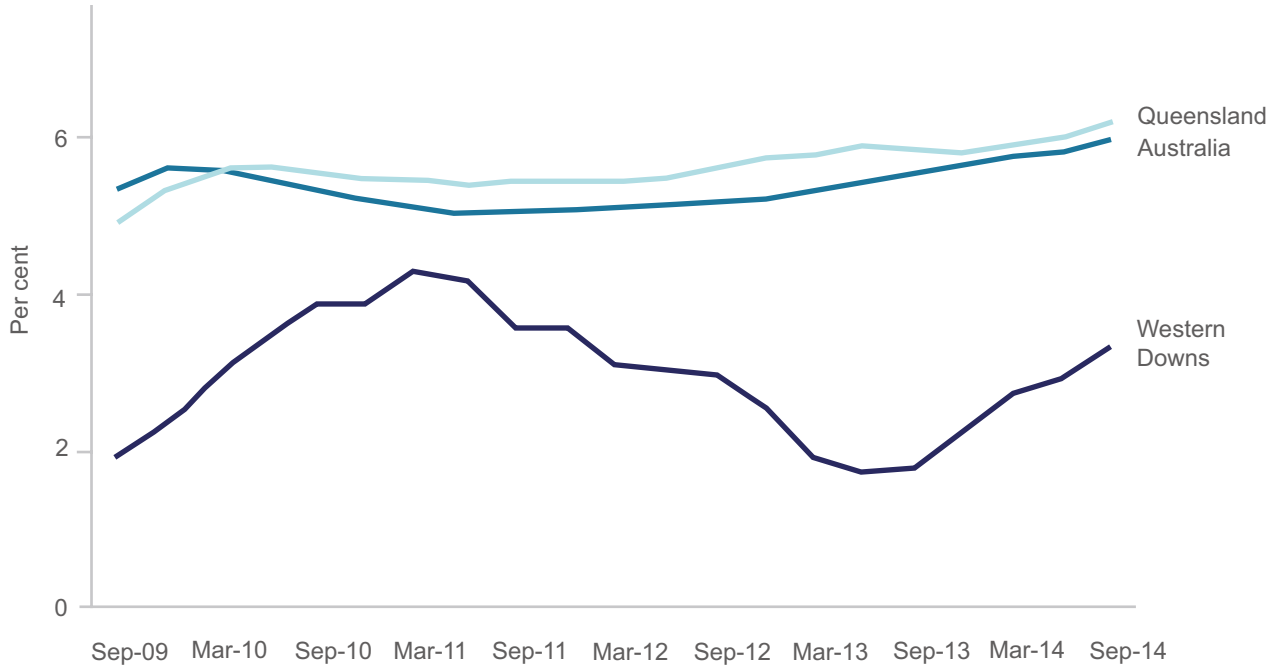
44 Fleming and Measham (2013)

45 Fleming and Measham (2015a)

46 Will Rifkin, UQ, personal communication

47 QGSO (2015)

Figure 2.2: Unemployment rate in the Western Downs



Source: Western Downs Regional Council (2015) *Western Downs Economic Annual*

Figure 2.2 shows the change in unemployment in the Western Downs region, which was 3.3 per cent in the September quarter of 2013, significantly lower than the rates for Queensland and Australia.[48]

Unemployment figures for agricultural areas need to be viewed carefully, as there is often an amount of unpaid work on farms provided by family members. As a result, there may be people who are active in the workforce who are not counted as 'participating' in the measured workforce. Nonetheless, the peaks and troughs in unemployment in relation to resource development show strong changes in levels of employment. For individual towns, the UQ-CCSG town-by-town profiles for the heart of the CSG region show unemployment dropping during peak construction in the CSG industry in 2013.[49]

The growth in employment as CSG development increased was even stronger when considering purely the change in mining sector employment. Over the same period, mining employment grew by 121.6 per cent in the Bowen Basin (from 20.8 to 31.8 per cent of the workforce), and by 574.5 per cent in the Surat Basin (from a lower base – from 1.3 to 7.2 per cent of the workforce), although this data encompasses the broader mining sector and not just CSG.[50] KPMG analysis of the census found that the percentage of people working in the oil and gas sector in the Surat increased by 273 per cent between the 2006 and 2011 census.[51]

An analysis of census data between 2001 and 2011 by Fleming and Measham found that employment in the mining/resources sector showed higher growth in areas with CSG development compared to the rest of Queensland, as has non-mining employment in some areas.[52] Employment in the Surat Basin grew more

48 Western Downs Regional Council (2015)

49 Rifkin et al (2015)

50 QGSO (2015)

51 KPMG (2013)

52 Fleming and Measham (2015a)

than in the Bowen, signalling that the positive employment effects were stronger in areas such as the Surat Basin that did not have a history of mining.[53]

From a closer examination of the Surat Basin, there was mixed evidence of spillover effects of employment into other industries. The expected positive job multipliers across a broad range were evident only in the construction and professional services industries, with 1.4 new construction sector jobs and 0.4 new professional services jobs for each additional CSG job, but no impact on jobs in retail trade or other local services.[54]

The growth in employment in the CSG industry occurred during a period of large resources investment in Australia. Over the period 2003 to 2014, more than $400 billion of resource projects were initiated in Australia, around half of this investment in the development of LNG projects, predominantly onshore in Queensland or on the northwest shelf and in Darwin. This large peak of investment activity led to high levels of employment and competition for skilled labour.

There is evidence that some of the employment in the CSG sector has been drawn from other industries, as the growth in employment in CSG has been associated with a reduction in agricultural employment. However, the latter decline could also be attributed to drought, increased mechanisation, and a trend toward consolidation of farm ownership. Fleming and Measham found evidence that agricultural jobs have been affected negatively: 1.8 agricultural jobs lost correlating with every CSG job created.[55] Those shifts could be direct moves into mining jobs or could be due to high labour costs encouraging a move toward less labour-intensive agriculture. Farming communities can experience limited availability and increasing cost of rural labour as a result of competition between CSG companies, especially at peak times such as planting and harvest.[56]

Contrary to expectations, there was no significant loss of jobs in the manufacturing sector as a result of the growth of CSG in the period covered by the data. Local businesses owners have reported skills shortages, difficulties in hiring and retaining suitable staff for service industries, such as food, accommodation, and certain trades such as electricians.[57] They attribute that to attractive wages in the resources sector and a significant spike in weekly rents in towns central to the CSG development.

With moderating consumption growth and lower commodity prices, resources companies now have a renewed focus on reducing costs and improving productivity. A casualty of this could be employment numbers, combined with the fact that employment requirements change as projects move from the construction phase to the production phase.

53 Fleming and Measham (2015a)

54 Fleming and Measham (2015a)

55 Ibid

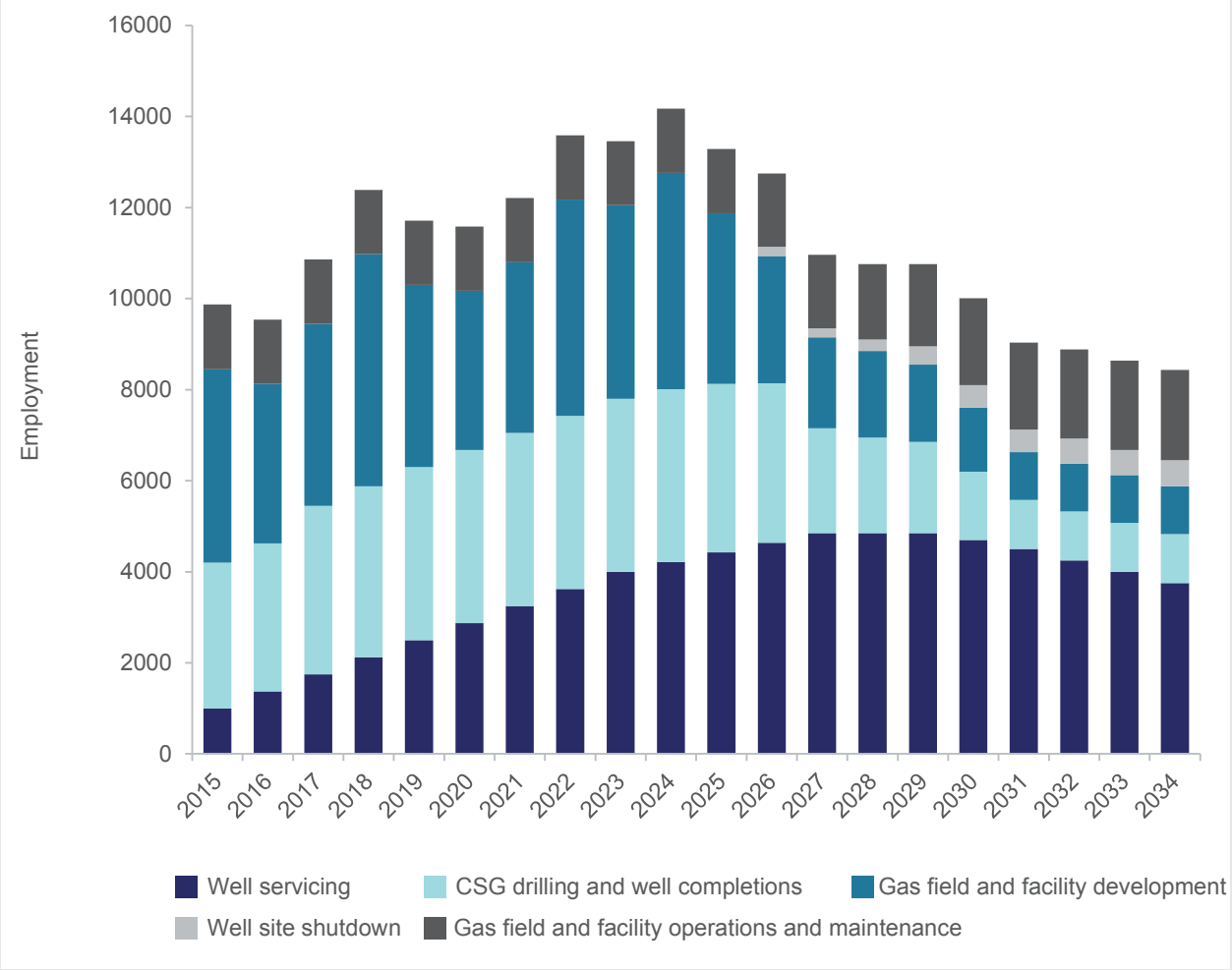
56 Cavaye J and Kelly L (2015), Hossain et al (2008)

57 Rifkin et al (2015)

Box 2.1: Employment in the upstream CSG industry

Although employment for LNG project construction is now tapering, Energy Skills Queensland forecast that the upstream CSG workforce would not peak until 2024 (based on a scenario of 45,000 wells and six LNG trains). Upstream activities consist of CSG well drilling, well servicing, well shutdown, and gas field and facility development, operations and maintenance, and the balance between the roles changes over time, with well servicing becoming the largest employer after drilling and gas field development pass their peaks, as shown in the figure below.

Box 2.1 Figure 1: Forecast employment in the upstream CSG industry



Source: Department of Industry, Innovation and Science (2015), based on Energy Skills Queensland (2013) *Queensland CSG to LNG Industry Workforce Plan*

2.3 Income

The CSG sector, like other resource sectors, tends to pay higher wages than many other jobs in regional economies. While wage increases are good for workers (both those directly employed by CSG companies and those in other industries where increased demand pushes wages up), there is concern for other regional businesses who can struggle to compete with the resources industry for labour.

The growth of the CSG industry in Queensland has led to increases in the number of high income residents in CSG regions.[58] Fleming and Measham's investigation of economic outcomes related to the CSG industry across southern Queensland found that between 2001 and 2011, areas with CSG development showed higher income growth than those without. Over this period, family income grew by 12 to 15 per cent more in areas impacted by CSG than the rest of Queensland.[59] Analysis of business income in certain towns showed a five-fold increase in one year.[60]

It is not clear the extent to which income growth can be attributed strictly to increased wages from the resource industry or whether it can also be attributed to non existent on-farm wages (such as a family member working unpaid on the farm), or artificially low declared income for a small business owner (through reinvesting profit in the business) being replaced by full-time paid employment in the sector.

Although it is difficult to identify precise figures for agricultural income, the data suggest that CSG development was associated with income growth, but also that the growth was not restricted to workers residing temporarily in CSG regions (and declaring their income in other regions). The income growth could therefore be seen to be of potential benefit to the region (additional if it was spent in the region), as the income effect applied to locally-residing families as well as non-resident workers.

Compensation payments negotiated as part of land access arrangements, including both up-front and ongoing components, can be an important income source for farmers. They can not only buffer against the variable nature of agriculture income, including through periods of drought, but also provide greater certainty in financing agricultural businesses. There is a question about the extent to which lending institutions recognise this income stream in providing loans to enable expanding farm businesses.[61]

Offsetting this increase in household income is a potential increase in the cost of living. The costs of services and some goods may increase as a result of increasing demand and pressures on labour costs for businesses. The Rural Industries Research and Development Corporation (RIRDC) reported a substantial increase in the cost of fencing (from $200 per day to $600), mainly due to shortages in good quality skilled labour.[62] These factors together can create distributional issues, which are considered further in the following section.

The distribution of income and other impacts of CSG development will be considered further in section 3.2.

58 KPMG (2013)

59 Fleming and Measham (2015a)

60 Katherine Witt, UQ, personal communication (based on analysis of ATO data)

61 Lisa Kelly, UQ, personal communication

62 RIRDC (2013)

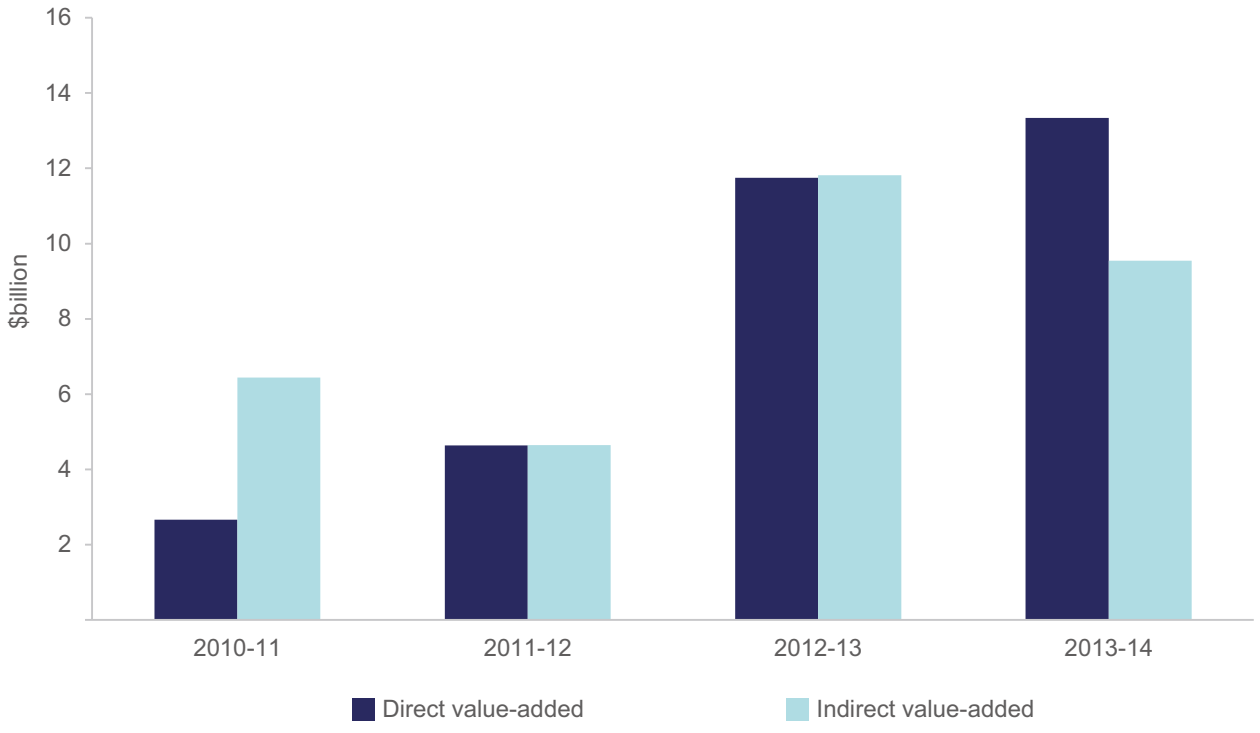
2.4 Output and consumption

Forecasts of the impact of CSG development on Queensland's GSP were consistently positive, both in terms of direct effects and indirect effects of the flow-on impacts of the CSG industry to other sectors. Much of the GSP growth was forecast to come from industries that supply the oil and gas sector and whose output is non-tradable, including construction, other mining, transport and hospitality. Offsetting the benefits to some extent were industries forecast to suffer losses as a result of the growth in CSG, including tradable sectors where there is competition from international suppliers, such as manufacturing and agriculture. ACIL Tasman forecast that the cumulative impact of a six-train LNG export industry on Queensland's GSP would peak at around $25 billion in 2035.[63]

A review of the Lawrence Consulting analysis of data collected by the Queensland Resource Council since 2010–11 illustrates that the forecast growth in the contribution of the CSG sector to Queensland's GSP has commenced. In 2013–14, direct value added (including salaries to direct full-time employees, purchases of goods and services and community contributions), was $13.3 billion and second round value added (supply chain and consumption effects) from the CSG sector was $9.5 billion, providing a total contribution to GSP of $22.9 billion,[64] as shown in Figure 2.3.

The Queensland Government expects that state GSP will strengthen by 4.5 per cent in 2015–16 and 2016–17, as a result of the surge in LNG exports.[65]

Figure 2.3: **Modelled nominal contribution of the coal seam gas sector to Queensland's Gross State Product**



Source: Lawrence Consulting (2014) *Economic contribution of the Minerals and Energy Sector to the Queensland Economy*

63 ACIL Tasman (2012)

64 Queensland Resources Council (2014)

65 Queensland Government (2015d)

2.5 Government revenue

State and Commonwealth government revenue are both expected to see a boost from increased CSG production and have positive flow on effects throughout the regional and state economy. The average annual cumulative impact of six trains, from the CSG and LNG activities, were estimated in 2012 at around $900 million each year to the Queensland Government. That figure consists of royalties, taxes, excise and charges. Another $2.4 billion each year was forecast to go to the Australian Government in company and personal income taxes.[66]

This figure is likely to be smaller given the reduction in oil prices since 2012, however CSG development is still expected to drive increases in government revenue. At this stage, the Queensland Government has collected a small increase in royalties and other Queensland Government revenue from the growing CSG production for the domestic gas market. This is consistent with the expectation in the 2014–15 State Budget that the growth in government revenue as a result of CSG exports would be strongest in 2015–16. The 2015–16 Budget acknowledges that lower LNG prices, driven by lower oil prices, are reducing Queensland's CSG royalty revenue.[67]

Queensland's economic growth is still supported by LNG exports. Any flow through impacts on communities from increased CSG revenue will take some time, although the Queensland Government has already committed to invest royalty earnings into infrastructure projects for communities through the Royalties for Regions program which has been superseded by the new government's Building our Regions program.[68]

66 ACIL Tasman (2012)

67 Queensland Government (2015d)

68 DoSD (2015)

2.6 Agricultural productivity

There is a range of aspects of CSG development that can impact on the productivity and profitability of agricultural activities. A key component is the reduced access to productive agricultural land as a result of CSG operations, which may have broad implications for operations/production, management, and long-term development of agricultural businesses. While concerns around land access have reduced over time,[69] agricultural communities have raised concerns about reduced farm profitability as a result of possible additional costs and time and efficiency and productivity loss arising from the CSG infrastructure.

Research is being undertaken at the UQ-CCSG to investigate the relationship between CSG development and farm profitability by developing quantifiable measures of productivity and profitability.[70] The research covers an extensive range of potentially significant impacts of CSG development on agricultural business, including farm operations and production, biosecurity, farm economics and management, and social and human issues. Ongoing monitoring and evaluation of the potential impacts and long-term implications on the agriculture sector will be particularly important given the current shift to an operational stage for CSG activities in some areas.

With respect to CSG and farm operations and production, CSG infrastructure can potentially change cultivation, cropping and irrigation patterns due to soil compaction and disturbance, changes to controlled traffic lines, alteration of surface water flow and erosion, and disruption to the overland flow of surface water to irrigation storage.[71] These factors, and subsequent changes in farming practices, can potentially increase production costs and reduce efficiency, productivity and profitability. CSG companies have responded by developing a framework of minimising CSG impacts on farm operations, such as reducing the need to place wells in cultivated portions of agricultural land and careful configuration of CSG infrastructure, including the use of directional drilling.

Many of the impacts explored in previous sections can also have impacts on agricultural productivity, including change to regional employment. Although CSG development in a region can increase labour costs and reduce availability, the development also provides off-farm employment opportunities and subsequently additional income to the agriculture communities. The local content code of practice endorsed by the Queensland Government can encourage the upgrade of skills in agricultural communities.[72]

Community impacts explored in the following section, including water management, biosecurity and other environmental changes can also impact on agricultural productivity. Compensation agreements with affected landholders are designed to ensure that they are compensated for any physical impacts, as well as for impacts on the productivity and profitability of the land. There is also a range of potential benefits from CSG development to the agriculture industry, including irrigation, infrastructure, community support funding and employment opportunities.

Irrigation and grazing with treated co-produced CSG water can substantially benefit the agricultural businesses in Queensland where drought has been a serious issue, as well as further opening up the possibility of growing high value crops.[73]

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69 Jim Cavaye, UQ, personal communication

70 Cavaye and Kelly (2015)

71 RIRDC (2013)

72 RIRDC (2013)

73 Cavaye and Kelly (2015)

Improvement in both on and off farm infrastructure and associated farm management and operations is another potential benefit from coexistence with the CSG industry. Such benefits include improved roads, gates and grids, upgrading of road networks and sealing of local roads, and improved telecommunication.[74] In addition to improved infrastructure, the community support funding offered by the CSG industry can provide improved services at a community level. The improvements in both infrastructure and services, however, require adequate planning and provision of social infrastructure, such as police, teachers and medical practitioners. The community investment requires qualified local partners to follow through with implementation, and anecdotal evidence indicates that can be a challenge.[75]

Both the positive and negative impacts are likely to be most pronounced during the construction phase of CSG projects. In terms of direct impacts on farm operations, it has been estimated that each CSG well could require about 1 hectare of land for approximately one year initially, gradually decreasing for the rest of the well's economic life of approximately 20 years.[76]

The spatial impact coincides in time with the maximum level of activity during the construction and development stage. As such, physical and environmental impacts, such as transport nuisance, as well as economic impacts, such as labour demand, is expected to peak at the same time. Nevertheless, given the long-term nature of CSG operations, there will be ongoing impacts on the affected agricultural businesses and communities. However, as technologies and CSG development practices improve, the size of the footprint per well is likely to continue to reduce.

74 Cavaye et al (2015)

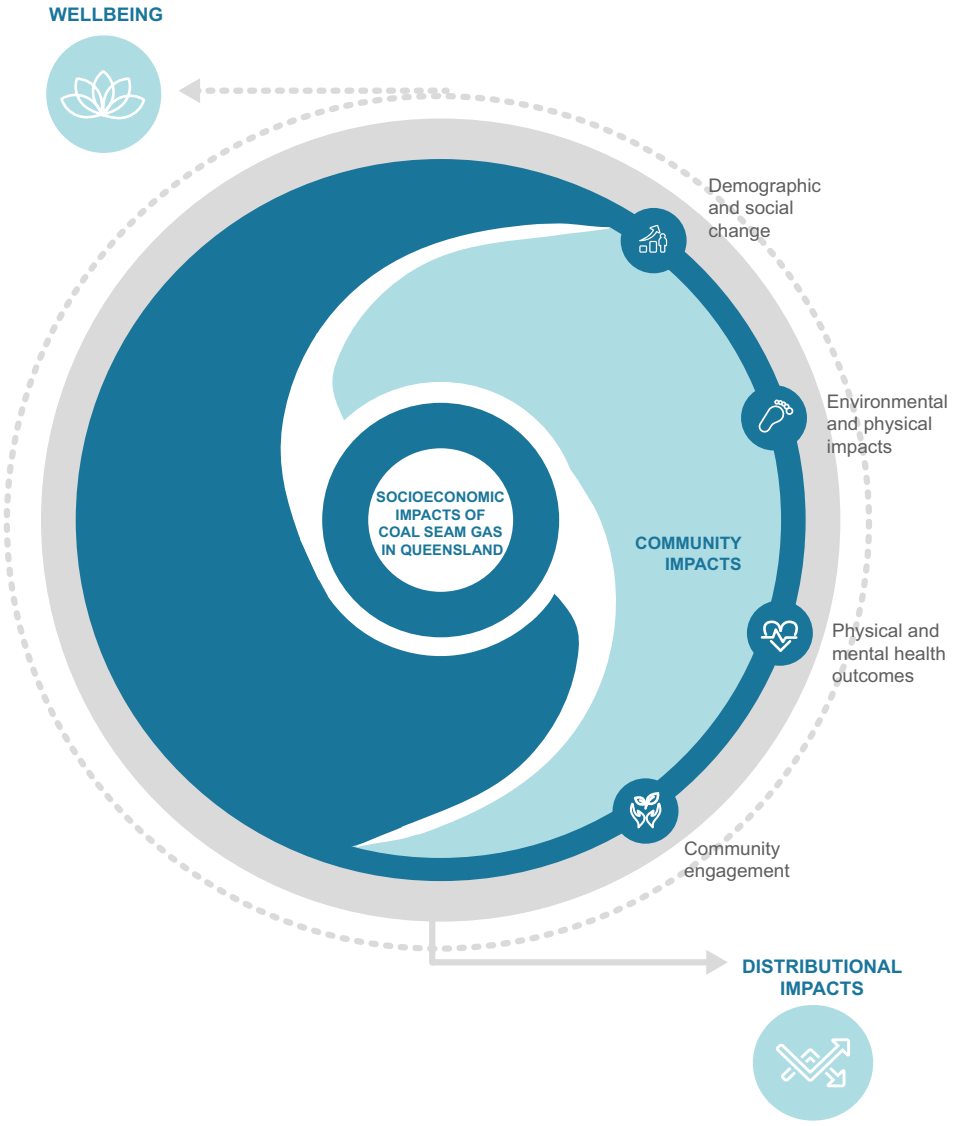
75 Will Rifkin, UQ, personal communication

76 Queensland Department of Environment and Heritage Protection (2012)

3. Community impacts of CSG

The headline direct economic indicators demonstrate only a small fraction of the potential impacts of CSG on regional communities. Broader community impacts as shown in Figure 3.1 may, in the long run, have a greater influence on welfare than changes to employment and income.

Figure 3.1: Structure of community impacts of the resources sector



Source: Department of Industry and Science (2015)

This chapter draws on relevant literature and ongoing research to explore how socioeconomic indicators have changed with the development of CSG in Queensland, and how communities have experienced these changes. It also considers how the economic and the community effects are distributed among and within communities. The distribution of impacts is very important, but the study finds that income inequality has increased less in CSG regions than elsewhere.

Community impacts include demographic and social change, environmental and physical impacts and health outcomes. Demographic and social changes can be mixed, with population changes leading to decreased housing affordability and negative social impacts, but supporting a reversal of rural decline in some regions. Environmental and physical impacts have caused concern for a number of residents, but the review finds that actual impacts have been minimal, and continued work is being done to ensure risks are managed appropriately.

Given the broad definition of community impacts used in this review, this chapter also reviews the literature on the importance of early and genuine community engagement, and on how CSG development has contributed to changes in wellbeing in local communities. Wellbeing is found to be currently robust, but with concerns for the future as CSG development moves from the construction to the operations phase.

To set the context, we first set out community impacts of natural resource development that are recognised as typical.

3.1 Typical impacts of natural resource development

Economic impacts of a natural resource development can have significant effects on broader socioeconomic aspects of a town or region. These effects follow through the distribution of costs and benefits attributable to the activity and the way that the changes interact with the broader economy of the hosting region.

Hajkowicz et al examined the relationship between socioeconomic wellbeing (measured through quality of life indicators) and the gross value of minerals production from Australian regions.[77] The study found no evidence of systematic negative associations between quality of life and minerals production for mining regions across Australia. Mining activity was significantly positively correlated at a regional level with socioeconomic indicators, such as communication access, education level and housing affordability. It was also positively correlated with the more traditional economic indicators of improved employment and income. In aggregate across local government areas, those with more mining activities were assessed to perform better on social welfare indicators; however it was noted that this assessment may overlook income inequality and intra-regional and demographic-specific trends.

The construction peak of a large mining or infrastructure project can put pressures on housing affordability and rent, due to the need to accommodate a large temporary workforce. Although this problem should be minimised by the provision of temporary accommodation by project proponents, workers in other sectors boosted by the development (such as hospitality) need housing, and increased demand will push up prices. Such rises create difficulties for renters in the community who do not benefit from increased wages in the resources sector, which can range from dishwashers and hotel cleaners to teachers, police officers, and state government staff. Lower income households are pressured by increases in the cost of living in the region due to increased demand for goods and services, potentially leading to the outmigration of these households, something that has been reported in the Darling Downs.[78]

77 Hajkowicz et al (2011)

78 Rifkin et al (2015)

Any resources boom will lead to a range of demographic and social changes in the hosting community. A common regional trend as a result of mining is known as the 'boomtown effect', which includes social disruption resulting from large scale immigration of males into a region, and has been associated historically with negative outcomes of alcoholism, drug abuse and violence.[79]

3.2 Distribution of impacts

The first part of the study identified that although CSG has a net positive economic benefit to Australia, Queensland and affected regions, the distribution of these benefits and costs are very different. Both benefits and costs can be unevenly distributed between regions, given that many goods and services may be procured from regional centres or capital cities rather than hosting regions. Additionally, many workers reside outside the resource region and can take a large part of their incomes back to their place of residence. It is also evident that investors in new housing developments and businesses come from outside the region during the peak construction period.[80]

Distribution effects can be a concern within communities amongst those involved in the industry and those outside it. For example, compensation payments flow to a minority of the population, and job opportunities are only available to those with skills sets appropriate to resource industry employment. The bottom line is that some individuals and groups are able to capture more of the financial benefits through employment and business opportunities, whereas others may bear more of the costs.

Income inequality could be a problem in areas impacted by a natural resources boom, given the mining sector generally pays higher wages than other regional industries. However, any concern over growing inequality in resource regions may be misplaced. An analysis of census data by Fleming and Measham has found that income inequality, measured by the Gini coefficient, has increased on average less in mining regions than non-mining regions between 2001 and 2011.[81] The study showed that income inequality increased by an average of 8.7 per cent in non-mining regions, but by around 4.8 per cent in mining regions. Growth in inequality in the Bowen and Surat Basins was even smaller, 1.3 per cent and 3.3 per cent respectively; although it is worth noting the last census was prior to the peak of the CSG construction phase. Additionally, any measure of income in an agricultural region can be confounded by the income reporting strategies of farm businesses and small businesses, as discussed earlier.

Some literature suggests that wealth inequalities are the cause of social hardship and that geographically concentrated, or 'point' resources, lead to worse outcomes.[82] As such, resources that are concentrated in a small location, such as an underground mine, lead to poorer institutional structures, given access to the resource is very limited and few people are able to benefit from its development. Given that CSG is a regionally dispersed resource, one would expect a broader range of stakeholders to benefit from the resource extraction, including through landholder compensation. However, another contributing factor that can reduce growth in inequality could be the outmigration of lower income residents from CSG regions, due, for example, to higher rents and other aspects of localised inflation.

Distributional effects are important to consider across the spectrum of socioeconomic impacts of CSG development and not just in terms of income. Some landholders benefit more from compensation agreements purely due to geography, some businesses are better placed to capture opportunities from CSG development, and others will only see the costs of increased wages in order to maintain staff. Other

79 Fleming and Measham (2013), Carrington et al (2013)

80 Rifkin et al (2015)

81 Fleming and Measham (2015b)

82 Hajkowicz et al (2011)

impacts explored in this section, including physical and health impacts and changes to wellbeing, will also be distributed differently between individuals and communities.

3.3 Demographic and social change

Population change

Project proponents did not envisage a large increase in permanent populations in the areas affected by CSG and LNG developments. They anticipated instead that the parts of the workforce requirements not met by local residents lead to commuting into the region by 'non-resident workers', who would be accommodated in work camps.

Actual observations of changes to population are consistent with these forecasts. Data from the QGSO show that growth in the resident population (excluding workers who commute to and from the region) of the Bowen Basin has grown by an average rate of 1.6 per cent per year between 2001 and 2013, and by 1.2 per cent per year in the Surat Basin.[83] These figures are lower than the population growth across the whole of Queensland of 2.2 per cent per year over the same period. However, the growth in the Bowen and Surat basins has sped up relatively in the past few years, at 2.3 and 1.5 per cent per year, respectively. These figures are relative to a growth rate of 2.0 per cent per year across Queensland as a whole.

Regional figures can mask town-by-town differences. The CSG hub of Chinchilla saw a rise in its district population of 13 per cent between 2001 and 2013 from 6,000 to 6,800, while the district of the nearby town of Miles had its population increase negligibly during the same period, staying around 1,200.[84]

Rolfe found that positive impacts of resource projects on economic growth in the Surat Basin are very sensitive to the extent that the existing workforce can be utilised and the level of non-resident workforce based outside the region. If workers commute, the positive impacts will be much smaller.[85] Like many other large resource development projects, the scale and nature of these projects makes it impractical to use an entirely resident workforce, and some combination of both is required.

Although an increase in regional population can be seen as economically beneficial, it can also have negative impacts, including on housing affordability and social capital, which will be considered in more detail below.

Housing affordability

Increases in population, combined with increases in income and consumption can have a large impact on housing affordability, particularly during the peak of the construction period. Both rents and house prices increased in the Western Downs towns during the construction phase. In 2013, housing rents in Miles were roughly $200 higher than the Queensland median, and median house prices peaked around 2013.[86] This University of Queensland study also found that the size of the town made a large difference to the scale of the impact, with smaller towns experiencing much higher pressures on affordability than larger towns, as the size of the non-resident workforce accommodated and working nearby was much greater in proportion to the population of the town centre.

83 Rifkin et al (2015)

84 Rifkin et al (2015)

85 Rolfe (2013)

86 Witt et al (2014)

This pressure is likely continue, as worker accommodation villages are being located closer to gas fields rather than in town centres.[87] As at June 2014, around 95 per cent of non-resident workers are housed in these villages rather than other forms of accommodation, including hotels and caravan parks.[88]

Across the Western Downs, rents and prices have now dropped significantly, with some residents noting that housing is now returning to 'affordable' levels, with some concerns that rental vacancies are now too low.[89] Resolving the pressure on housing is clearly a matter of balance when a temporary workforce is involved. Communities will be keen to maximise the benefits that can accrue from resident workers rather than non-resident workers. This shift, though, will increase pressure on the existing stock of housing and require new residences to be built. However, once the workforce peaks and employment opportunities are reduced, excess housing supply can also cause problems, as noted by local real estate agents.[90]

Rural decline

An advantage of an increased population is that it can help to combat rural decline, which is being experienced in many rural communities across Australia, including those in which CSG has been subsequently developed. Rural decline can result from the loss of rural youth, reductions in human capital (the skill sets in the population), and an increase in rural poverty.[91] A range of demographic changes experienced in CSG communities have contributed to the mitigation and potential reversing of rural decline, at least during the CSG exploration, development, and construction phases.

Change in the gender balance can be a very important component of demographic change from resource development, given that the influx of male labour can lead to social disruption. However, compared to similar regions where gas development had not occurred, regions with CSG development have experienced a growing youth share of the population, leading up toward the peak in CSG production, with equal increases in male and female youth.[92] Female employment was found to have increased in CSG regions, in the construction, mining, and accommodation/food services sectors. However, anecdotal evidence suggests that retention of youth in the region has declined as CSG jobs have evaporated following peak construction in 2014.[93]

Education is another important aspect of this change. There is evidence in CSG areas of education levels higher at younger ages than the broader population, including completion of secondary school, university degrees and advanced technical training.[94] These changes in education and gender patterns were part of a broader positive impact of CSG activity on areas subject to rural decline.

It is important to note that higher mean levels of education may result from migration and are likely not to be merely due to long-term residents gaining higher qualifications. In fact, CSG development has resulted in older residents selling their homes for higher prices and moving to the coast, and there are reports that residents with lower socioeconomic status have moved to avoid high rents.[95] Both shifts suggest that those who may have lower education levels are leaving the area.

87 QGSO (2014a)
88 Ibid
89 Witt et al (2014)
90 Ibid
91 Measham and Fleming (2014a)
92 Ibid
93 Will Rifkin, UQ, personal communication
94 Measham and Fleming (2014a), QGSO (2015), KPMG (2013)
95 Witt et al (2014)

Such migration plays a role in the ability of CSG activity, partially as a result of its large spatial footprint, in mitigating and reversing rural decline. There has been at least a temporary growth in the youth share of population, including a growing female youth share, as well as a reduction in the number of poor people in some specific CSG regions. These changes represent a key divergence in the social impact between CSG development and other mining booms.

Social impacts

Although the 'boomtown' impact for the construction phase of CSG development in Queensland has differences compared to traditional resource development, it does not mean that CSG and the associated demographic changes have had no social impact. A study funded by the UQ-CCSG found that the movement of people in and out of the Western Downs region can be seen to lead to a decline in 'social capital' through a reduction in social bonds and networks.[96]

Some boomtown social impacts have been experienced in the region, including impacts on crime and safety. Since 2011, there has been an increase in reported offences in the Western Downs, primarily good order offences and traffic offences, but also drug offences and theft.[97] Actions have been taken to mitigate the increase in offenses, including changing police strategies, community responses, such as implementing a local liquor accord, and company responses, such as computerised vehicle monitoring.[98]

Despite these social issues, a CSIRO survey on wellbeing in the Western Downs found that community spirit was one of the most positively perceived aspects of wellbeing. Survey respondents reported that they felt that they could rely on others in the community to help, they could work together, and that relationships within the community were friendly.[99] Community spirit was also found to have a strong contribution to the overall sense of wellbeing. Changes to wellbeing will be considered further in section 3.6.

3.4 Environmental and physical impacts

As CSG development increased and expanded into new regions, local communities were often uncertain about how CSG activities in their region would affect them, their properties, and future generations. There are a number of potential physical impacts of CSG that can impact on individuals and communities, including water, air quality, and human health, as well as concerns about geological and transport impacts and broader environmental impacts. This section considers these key impacts, and the current status of work on how they are understood and managed.

Water management

Given the overlap of CSG development with a range of other land uses, particularly agriculture, one of the key concerns of local communities was the actual and forecast or potential impacts of CSG development, including:

- groundwater issues, including the impacts of water pressure changes on freshwater aquifers and the replacement of extracted water

- pollution issues, such as the disposal of the extracted water (including salt and other chemicals from coal seams) and the management and disposal of fracking fluids.

96 Rifkin et al (2015)

97 Ibid

98 Ibid

99 Walton et al (2014)

A CSIRO study on wellbeing in the Western Downs in 2014 found that the management of underground water quality was one of the biggest concerns in the community.[100] Community members who responded more positively about CSG development in their area reported that they felt that the natural environment (including water quality and sustainability of local farming land) was being managed well.

Many of the concerns about both groundwater and pollution relate to the use of hydraulic fracturing, or 'fracking' to help extract the gas from the coal seam. Hydraulic fracturing in Australia is currently used in 9 per cent of CSG wells though it may eventually be used in 30 to 40 per cent of wells.[101] Numerous in-depth reviews by experts in other countries have found that, subject to the implementation of appropriate controls and standards, the use of hydraulic fracturing does not pose a significant risk to the environment.[102]

In Queensland between 2010 and March 2015, 6,734 wells were drilled. No sub-surface equipment leaks have been reported to the Petroleum and Gas Inspectorate.[103]

Air quality

Well-head and other equipment leaks are inherently limited in size and duration. However, there is the potential for fugitive emissions from CSG wells as well as other infrastructure. In contrast to shale-gas developments in the US where volatile hydrocarbons may be emitted, in CSG such leaks are predominantly methane, a non-toxic gas which is flammable in air between well-known upper and lower limits.

Queensland has adopted stringent reporting standards based on those normally used in more sensitive urban environments, leading to a very conservative approach to reporting leaks. As at the end of 2014, there were 3,500 producing gas wells. From 2010 to the end of 2014, there were 199 'reportable' leaks notified to the petroleum and gas inspectorate, all of which were subsequently fixed, and there were no reports of sub surface leakage.[104]

These experiences are in line with a scientific study undertaken by CSIRO of 43 wells in Queensland and New South Wales.[105] The study found that emissions were generally very low, especially when compared to the volume of gas produced. The sources of emissions were found to be equipment leaks, venting, pneumatic device operation and engine exhaust (areas that are often easy to repair), with none showing evidence of sub surface methane migration outside the well casing.

The rates of emissions found in the study were much lower than those reported for US unconventional gas production. The report noted that emissions may vary over time, and in cases of maintenance and repairs, there may be higher emissions of limited duration. CSIRO is currently in the process of undertaking further work on the level of emissions in the Surat Basin, including from water infrastructure and other potential sources. Furthermore, research recently undertaken by UQ-CCSG shows evidence of a variety non-fugitive, natural background and anthropogenically stimulated methane and other hydrocarbon sources.[106] That is, gas has been historically emitted in the region via a range of other avenues.

100 Ibid
101 APPEA (2015)
102 Andrew Garnett, UQ, personal communication
103 Ibid
104 GFCQ (2015)
105 Day et al (2014)
106 Underschultz et al (2015)

Geological impacts

Geological impacts from CSG development have thus far been minimal, in terms of both induced seismicity and subsidence. The key cause of concern is again the use of hydraulic fracturing. However, the potential for induced seismicity as a result of CSG development in Queensland is small, given the shallow depths at which CSG extraction occurs.[107]

While the fields are not yet at full production, and some minor subsidence might reasonably be expected over a long period of time, there is no confirmed subsidence as a result of CSG development in Australia,[108] and the maximum predicted is 280mm.[109] Nevertheless, particularly in the Surat Basin, companies pursuing CSG development are developing extensive monitoring networks including tiltmeters, extensometers, InSAR analysis, and geodetic survey monitoring.[110] Furthermore, the Queensland Government regulation requires an evaluation and sets trigger levels for the potential for subsidence in the groundwater impact assessments undertaken by project proponents.

Transport impacts

CSG activity generates a large number of truck and vehicle movements associated with the transport of workers and drilling infrastructure, which can lead to concerns within the community regarding road safety, particularly in towns and near schools. It can also contribute to degradation of infrastructure and the spreading of weeds.

Biosecurity can be an area of concern for agriculture producers, especially organic certified producers. A number of these impacts are managed through regulation, such as the requirement to wash vehicles to minimise the spread of weeds. Other impacts are minimised through company contributions to road infrastructure and changes to driving practices.

Traffic offences have increased in a number of towns in the Western Downs region,[111] although it is unclear how much of this increase is a result of the increased number of vehicles on the road, poor driving behaviour, or from changes to policing strategies. For example, towns such as Miles changed their policing strategy as a result of expectations of CSG impacts.[112] Traffic infractions are being attributed by local residents and police to contractors rather than company staff, which may reflect the effectiveness of extensive computer monitoring of CSG company vehicles.[113]

107 Gibson and Sandiford (2013)
108 Andrew Garnett, UQ, personal communication
109 Australian Government (2014b)
110 Andrew Garnett, UQ, personal communication
111 Witt et al (2014)
112 Ibid
113 Rifkin et al (2015)

Overall risks and impacts

Like any other industry, including agriculture, mining and forestry, CSG faces uncertainties, risks and challenges. However, the rapid development of CSG led to a level of uncertainty around these potential adverse physical effects on communities and future generations. As the CSG industry continues to grow and the industry and the regulation adapts, these uncertainties and risks will continue to be minimised. The NSW Chief Scientist and Engineer found that the industry is 'not significantly more likely to be more damaging or dangerous than other extractive industries'.[114]

Consistent with economic impacts, the physical and environmental impacts associated with CSG development change through the value chain. The peak of socioeconomic impacts coincides with the peak of construction and associated activities in the development phase. As wells in an area move into the production phase, the physical and environmental impacts of the development in that locality are likely to change.

Considering the cumulative nature of physical and environmental impacts is important. This includes not just taking into account the multiple CSG projects being developed at the same time over a similar area but also other developments and existing land uses, and their impact on various factors, including water use.

Companies are now required to address cumulative impacts of projects in their Environmental Impact Statements (EIS, with a social impact assessment being a component); however, they may not be best placed to understand the full details and consequences of other proponents' projects. The Australian Government's programme of bioregional assessments will also increase knowledge about regional and cumulative impacts of coal resource development, including coal seam gas, in the bioregions being assessed.[115]

3.5 Physical and mental health outcomes

Many reports and commentators have noted concerns about potential health impacts of CSG development as a result of the physical impacts listed above, including water quality, air quality and noise pollution. Adverse health impacts would have a negative economic impact on individuals and communities, and they would also have a large impact on perceptions of CSG as an industry. However, there are very few studies that demonstrate a correlation between CSG activities and adverse health outcomes, much less a causal relationship.

A recent literature review by Werner et al found the strength of epidemiological evidence to be 'tenuous', with only seven highly relevant studies providing evidence about direct associations between environmental health hazards related to unconventional natural gas activities (not just CSG) and health outcomes.[116] The review recommended that further research be undertaken to credibly assess the extent of the risk posed to the public.

Focussing specifically on CSG, the Queensland Department of Health found no clear link between CSG activities in Tara and reported health complaints. This finding is based on an assessment of both clinical and environmental monitoring data. In terms of air quality, data was insufficient to assess the impact in the region. Low frequency noise was found to exist at levels that could be annoying, although levels were below relevant

114 NSW Government Chief Scientist and Engineer (2014), p. 8

115 More information is available at bioregionalassessments.gov.au.

116 Werner et al (2015)

regulatory thresholds. The review also found evidence of solastalgia, or distress caused by environmental change and a perceived lack of control over these changes.[117]

Solastalgia and other potential mental health impacts may be an important aspect of the health impacts of CSG development, and have been explored in a number of studies. CSG activities, and concerns about their on- and off-farm effects, can be a significant source of stress for farmers.[118]

The levels of stress experienced by some landholders may not be reflected across communities more broadly, potentially as a result of community engagement by the CSG industry, the GFCQ, and organisations such as the farming peak body AgForce, as well as improvements in understanding and processes. A recent survey by CSIRO on perceptions of community wellbeing across the Western Downs found that health, including physical and mental health, was one of the dimensions of wellbeing that was most positively perceived by participants.[119]

It has long been known that uncertainty about impacts of any significant change can play a role in the level of stress and anxiety experienced in the community.[120] CSG development in a region can represent a significant change. In a study of potential harms from CSG activities, Fibbens et al found that the impacts of CSG could differ from the typical impacts of large mining or infrastructure projects, as there was uncertainty about the extent and timing of the impact over the different stages of the CSG development activities.[121] Given the CSG industry needs to work closely with local residents including farmers to gain access to their land, this uncertainty regarding short and long term impacts can lead to challenges for the CSG and agricultural industries in achieving successful coexistence.

117 Queensland Health (2013)

118 Morgan et al (2015)

119 Walton et al (2014)

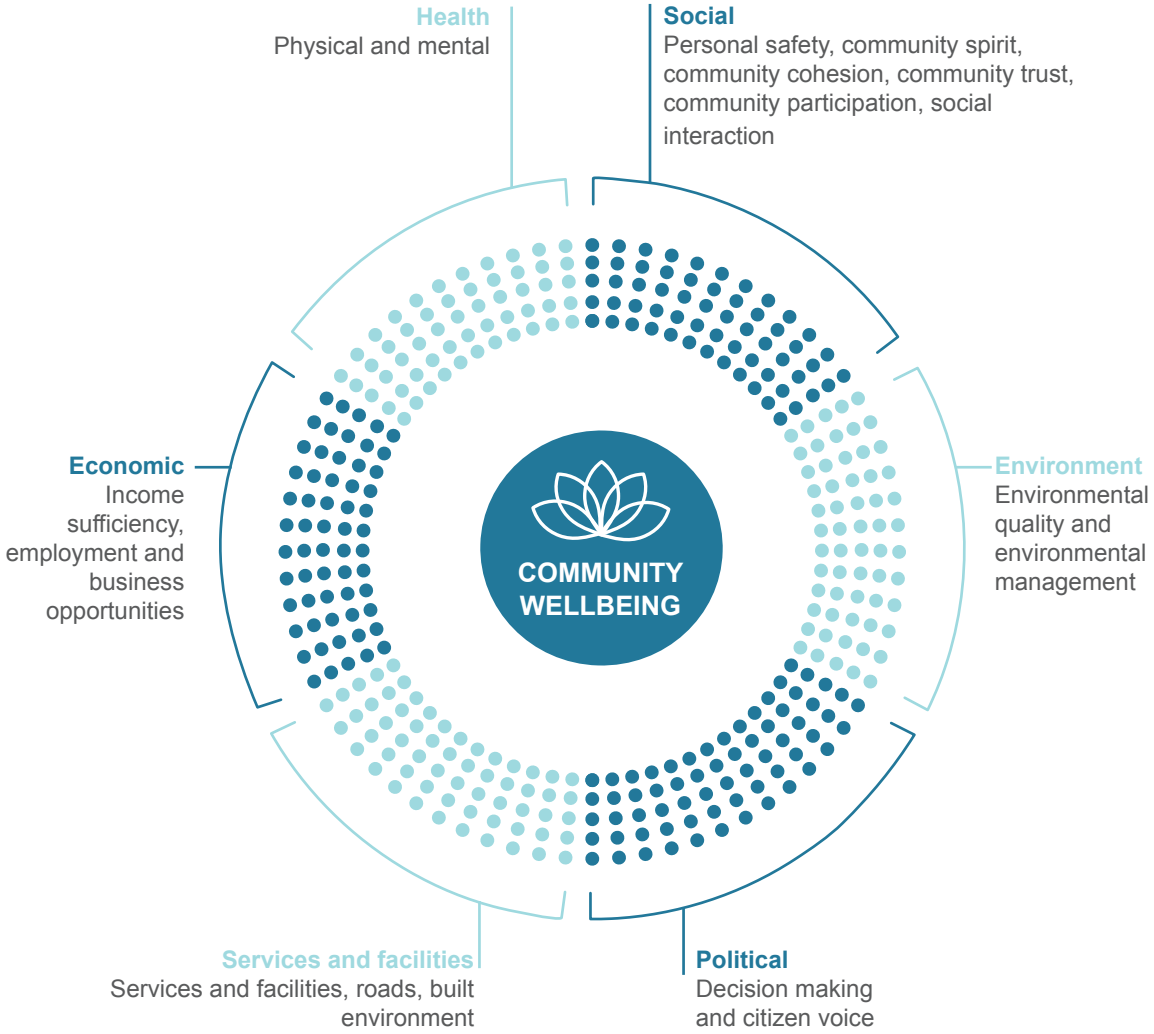
120 Colson (1973)

121 Fibbens and Mak (2014)

3.6 Wellbeing

The level of wellbeing experienced by community residents reflects the economic impacts of CSG as well as many of the community factors considered in this section. These include health outcomes, social and environmental impacts. In a survey of community wellbeing and responses to change in the Western Downs region, Walton et al divided aspects of wellbeing into six dimensions, as set out in Figure 3.2.[122]

Figure 3.2: Dimensions of community wellbeing



Source: Walton et al (2014) *CSIRO survey of community wellbeing and responding to change*

This depiction of wellbeing also incorporates political impacts and adequacy of services and facilities. Political impacts, incorporating decision making and political voice, were negatively perceived, indicating that community members in the Western Downs were concerned with how decisions were made. Perceptions of services and facilities were mixed, with moderate responses on services and facilities and the built environment, but negative perceptions regarding roads. Although the quality of road infrastructure may have increased in many areas, residents were still concerned about the condition, safety and the volume of traffic on roads.[123]

122 Walton et al (2014)

123 Ibid

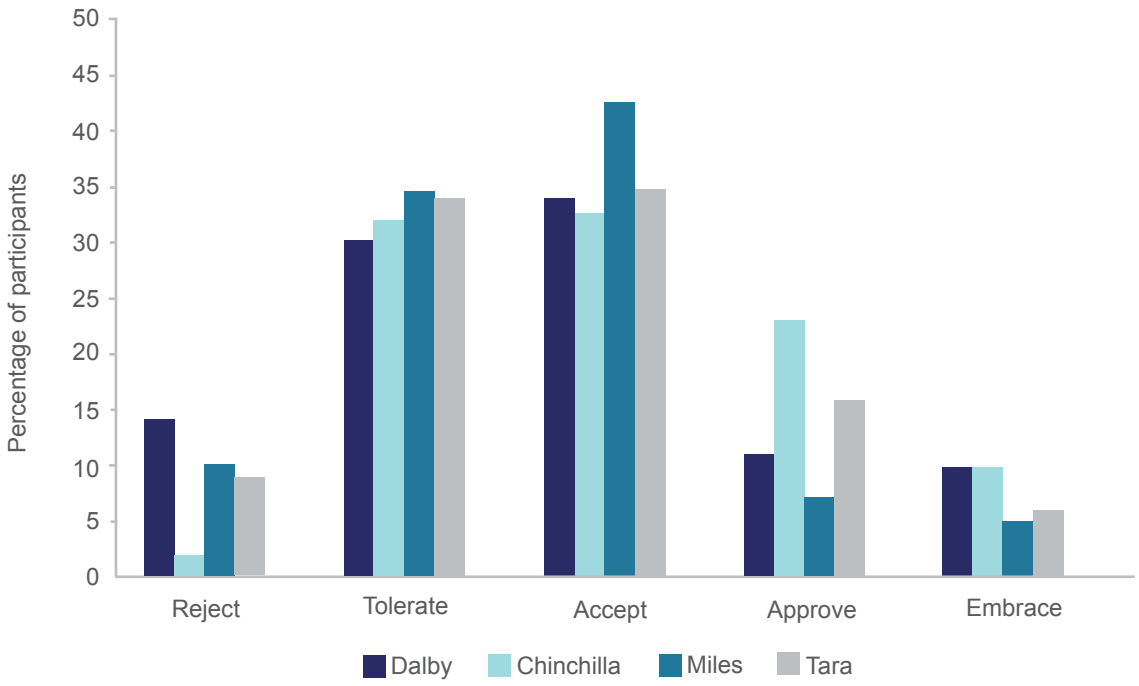
The survey found that the most important dimensions contributing to an overall sense of community wellbeing in the Western Downs region were: services and facilities; community spirit and cohesion; personal safety; and environmental quality. It also found that wellbeing is currently robust in Western Downs communities, but there are concerns of a downward trajectory in wellbeing as the construction peak passes, with communities expecting their wellbeing to be reduced in the future.[124]

That result corresponds with recent anecdotal evidence and public forums, where business owners have expressed concern, frustration, and distress at the strong downturn in business following the end of the peak construction period for CSG.[125] This anecdotal evidence indicates that some businesses are closing and owners leaving the area without settling their accounts with local suppliers who are remaining in the area.

Walton et al provide a number of suggestions on investments to be made into wellbeing and resilience, based on key areas of dissatisfaction in the Western Downs – improvements to roads, further community participation in decision making, and management of the environment over the long term.[126] Working together within a community to resolve these issues has benefits for wellbeing, for resilience, and for perceptions of the CSG industry.

The perception of the CSG industry and its social licence to operate are very important for wellbeing and for the ongoing success of the industry. Walton et al found mixed attitudes toward CSG development in the Western Downs region, as shown in Figure 3.3.[127] Over 80 per cent of participants had moderate attitudes toward CSG, tolerating, accepting or approving CSG, while less than 10 per cent had extreme views in either direction – rejecting or embracing CSG.

Figure 3.3: Attitudes towards CSG in the Western Downs



Source: Walton et al (2014) *CSIRO survey of community wellbeing and responding to change*

124 Ibid

125 Will Rifkin, UQ, personal communication

126 Walton et al (2014)

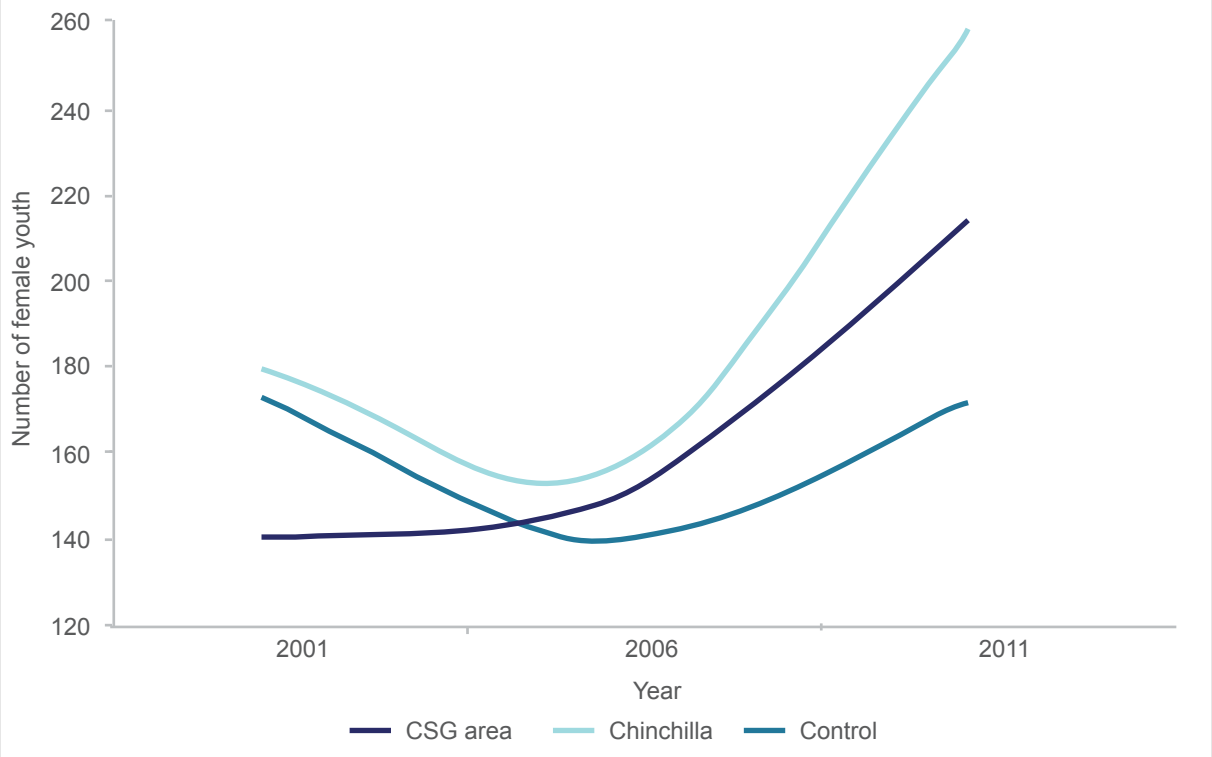
127 Ibid

Box 3.1: A case study: Chinchilla

The town of Chinchilla has experienced a significant change as a result of CSG development, with the population growing almost 20 per cent between 2008 and 2012. This brought about increasing diversity in the town, but also a reduction in connectivity, which has been missed.[128]

Chinchilla has been an example of where CSG development has mitigated rural decline, with the population of young people increasing by about 46 per cent between 2006 and 2011.[129] This occurred across both males and females, contrary to typical male migration in typical resource 'boom towns', as shown below (where control represents other comparable rural Queensland regions). Some 'boom town' social issues emerged, with increases in good order offences, and initial reports of women initially feeling unsafe.[130]

Box 3.1 Figure 1: Change in female youth in Queensland



Source: Measham TG and Fleming DA (2014b) *How coal seam gas is changing the face of rural Queensland*

128 Witt et al (2014)

129 Measham and Fleming (2014b)

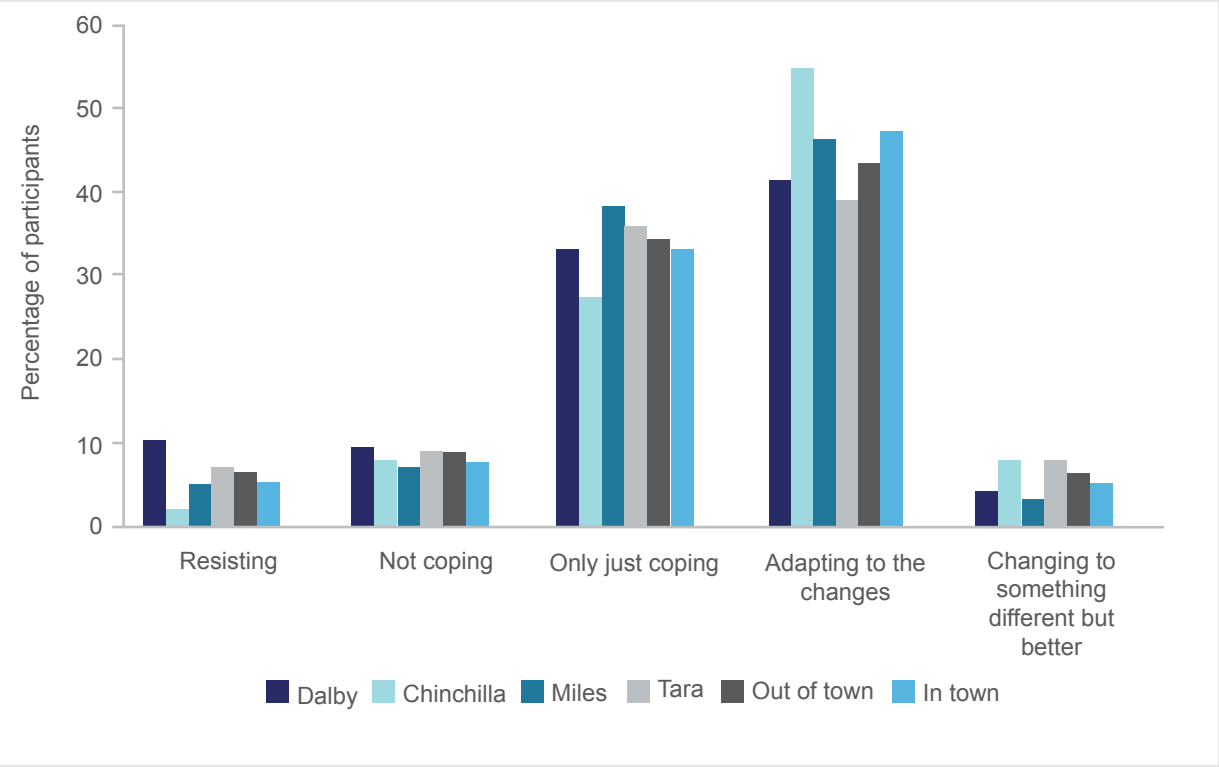
130 Witt et al (2014)

Poverty reduction in CSG regions has been concentrated particularly in Chinchilla, although this does need to be balanced against higher housing costs.[131] House prices and rents in Chinchilla, which were traditionally lower than Queensland's median, both grew rapidly as a result of CSG development, with rent higher than the state median in 2013.[132]

Walton et al found that overall wellbeing in Chinchilla was relatively high.[133] Dimensions of wellbeing which were higher than other towns in the Western Downs were perceptions of community spirit, income sufficiency, community cohesion, services and facilities, and employment and business opportunities. Chinchilla reported dissatisfaction with levels of environmental management, decision making, and roads.

Within the region, residents of Chinchilla had the most positive attitudes towards CSG (as shown in Figure 3.3), and most positive perceptions of the way their community was responding to CSG development, with only 2 per cent resisting, and over 60 per cent with favourable perceptions, as shown below.[134]

Box 3.1 Figure 2: Attitudes towards CSG in the Western Downs



Source: Walton et al (2014) *CSIRO survey of community wellbeing and responding to change*

131 Measham and Fleming (2014b)

132 Witt et al (2014)

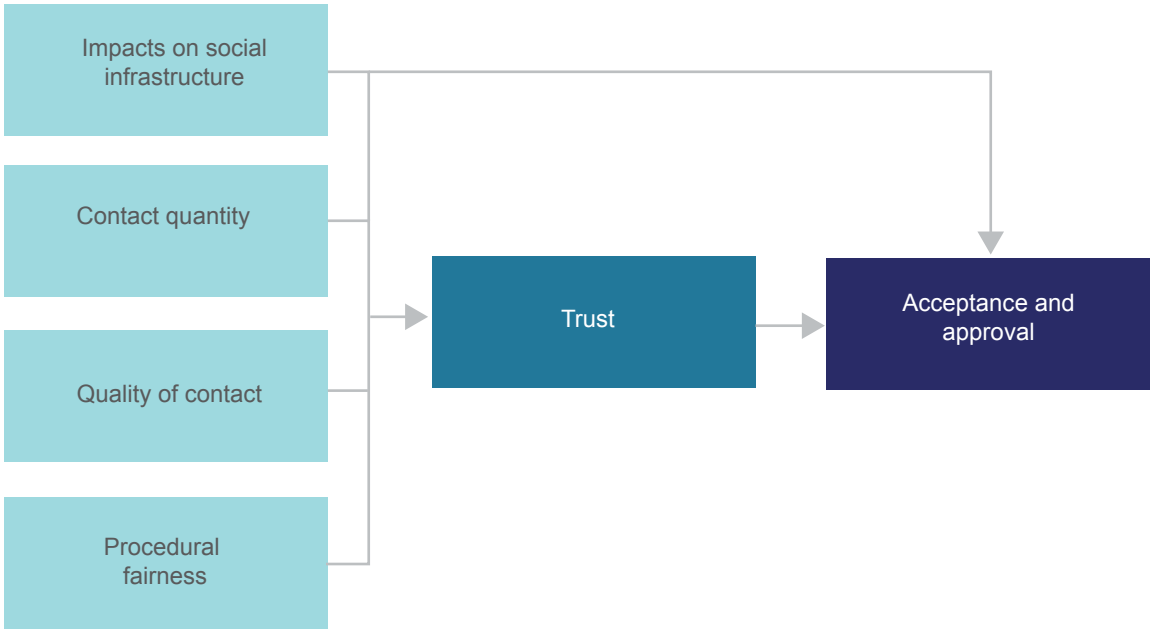
133 Walton et al (2014)

134 Walton et al (2014)

3.7 Community engagement

Given the scale and the overlap of CSG activities by multiple companies, studies have found that the social licence to operate for CSG development needs to hold for the entire industry rather than for individual operators.[135] Building and maintaining landholder/community trust is essential for a social licence to operate and a key factor in building mutually-beneficial coexistence between the CSG industry and the agriculture sector.[136] Moffatt and Zhang developed a model of social licence to operate, with trust as the central element.[137] Impacts on social infrastructure, including employment, training, and physical infrastructure, are very important for trust and community acceptance. Other factors influencing the level of trust are contact quantity and quality, and procedural fairness. Moffatt and Zhang's model is set out in Figure 3.4.

Figure 3.4: A model of community acceptance of mining



Source: Moffatt and Zhang (2014) *The paths to social licence to operate*

Research findings on the level of trust in CSG companies tend to vary. CSIRO's research on community wellbeing (undertaken in February 2014) showed a low level of trust for CSG companies.[138] However, the overall picture of trust appears to be more nuanced when considering different types and drivers of trust within different stakeholder groups. An interview study of a broad range of CSG stakeholders (including community, regulators and employees), conducted by UQ Business School between May and October 2014, found that most participants had moderate to high levels of trust that companies would conduct their operations competently and effectively (though levels varied across companies).[139] However, at that time, only around half of the participants had moderate to high trust that the CSG operations would have an overall beneficial impact.

135 Paragreen and Woodley (2013)

136 Gillespie and Bond (2015), Williams and Walton (2013)

137 Moffat and Zhang (2014)

138 Walton et al (2014)

139 Gillespie and Bond (2015)

Broader sampling and deeper analyses is needed to better understand drivers and distribution of feelings of trust. Given the long-term nature of the operational stage of CSG in Queensland, these findings emphasise the importance of ongoing monitoring and assessment of CSG activities. That result suggests a need to promote long-term sustainability and coexistence with the agricultural sector.

Early engagement is one of the major factors building landholder and community trust, with consequences for the social licence to operate.[140] There are incentives for companies to undertake early engagement and build sustainable relationships with communities in order to reduce the costs of conflict. Davis and Franks found that many extractive companies don't identify and aggregate the full costs of conflict with local communities. The study concluded that in terms of investment into communities – the more that can be done early, the better.[141] Moffatt and Zhang identified that the divergence of impacts between expectations and reality as a major factor in community acceptance, stressing the importance of early engagement to clearly explain likely impacts of the project well in advance.[142]

The quality of the relationship and ongoing engagement with communities are also crucial for maintaining and enhancing this trust.[143] An important factor for driving quality engagement can be a deep understanding of and responding to diverse perspectives and concerns held in agricultural communities. Moffatt and Zhang found that social investments are important, but more helpful for community acceptance is the inclusion of community members into decision making processes through genuine engagement and collaboration.[144]

An important aspect of community engagement is the negotiation of compensation agreements. These negotiations, which can be lengthy, complex and require significant legal input, can cause anxiety and stress especially for time-poor farmers. Farmers may have to spend up to 500 hours negotiating with CSG company representatives to reach a CCA for a single property, with over a quarter of the time spent during the first six months of interaction.[145] Ongoing reviews of compensation agreements can be an additional factor in causing stress.

With significantly more experience in successful CCA negotiations over the years, these burdens are reported to have been substantially reduced for both CSG companies and landholders. For instance, CSG industry representatives note an improved understanding of agricultural land uses, and as a result, they see that they can better plan and design resource activities to minimise potential negative impacts on the agriculture industry. For landholders, the differences between exploration and production activities and their impacts are better understood.[146]

Nevertheless, perceived lack of fairness and transparency associated with compensation agreements may still be areas of concerns for landholders. The confidential nature of the CCA negotiated at an individual level can create community perception that the outcome is a result of negotiation skills instead of the true value of the economic loss. Additionally, time spent in negotiations, and the associated productivity loss, are generally not included in compensation.[147]

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140 Queensland Government (2012), RIRDC (2013)

141 Davis and Franks (2014)

142 Moffat and Zhang (2014)

143 Department of Industry and Science (2015)

144 Moffat and Zhang (2014)

145 RIRDC (2013)

146 Queensland Government (2013)

147 Cavaye and Kelly (2015)

Williams and Walton note that inclusive engagement strategies need to incorporate the fact that values, expectations and aspirations are diverse within each community.[148] Engagement needs to ensure that all community members have an opportunity to be involved, including marginalised community members, not just those most vocal or those already significantly engaged in community activities.

Other potential factors that contribute to quality engagement can be provision of more detailed information on resource development activities, as well as thorough planning and consultation on work programs with agricultural communities.[149] Other important elements include open and effective communication, as well as focusing on building long-term relationships based on shared values and visions. Such measures would not only help communities to assess the potential impacts of CSG activities, but they could also help to create a mutually beneficial coexistence.

Box 3.2: Engagement with Aboriginal and Torres Strait Islander peoples

Another important aspect of land access and community engagement for any natural resource development is the engagement with Indigenous Australians. A study by Trigger et al, looking at both Indigenous Australian and practitioner viewpoints, found that the geospatial dispersion of CSG development and the rapid development of the sector created additional challenges for the negotiation of Indigenous Land Use Agreements (ILUAs).[150]

Trigger et al noted that there have been 35 ILUAs negotiated for CSG development in Queensland, which necessitated the rapid development of corporate systems, processes and cultural proficiency in engagement with Indigenous Australians. The study found that access to economic benefits through employment, training and business development commitments are an important component of ILUAs, as is a commitment to youth opportunity.[151]

A review of QGC's Indigenous employment, training and business development initiatives by UQ's Centre for Social Responsibility in Mining found that QGC had achieved a significant increase in employment of Indigenous Australians, up from 63 jobs in 2011 to 251 in 2013.[152] It noted that a methodological limitation of the study was that only a small proportion of traditional owner groups participated in the research. The study also found that it will be necessary to observe outcomes as the work continues to mature in order to fully judge the effectiveness of the initiatives.

148 Williams and Walton (2013)

149 Queensland Government (2012)

150 Trigger et al (2014)

151 Ibid

152 Arbelaez-Ruiz et al (2014)

4. Insights

This chapter distils from the literature review, as well as our own experience and analysis of key issues, a range of insights on CSG development in Queensland and the lessons learned. These insights are likely to be relevant to other jurisdictions.

4.1 Cumulative impacts

It is important for each company to consider the impact of its own project on the environment and the community. Given that there are a number of overlapping large projects, it is also important to have a comprehensive understanding of the cumulative impacts of CSG development across environmental, economic, social and other indicators.

In advance of the CSG industry's expansion, there was a lack of robust sensitivity analysis of the cumulative economy wide effects of the CSG industry and associated LNG projects. Each of the LNG project proponents used computable general equilibrium modelling to assess the impact of their project, and some of the project proponents included sensitivities in their analysis in relation to price assumptions, cost assumptions, and greenhouse gas emission policies and associated permit prices.[153] Other analyses noted some of the risks to their forecasts, including potential downside risks on CSG reserves or production rates. In addition to these studies, an independent analysis of the cumulative impacts of multiple CSG-LNG projects would have been informative for planning and regulatory purposes.

The consideration of cumulative impacts is now an important feature of the Australian and Queensland governments' regulatory frameworks. The EISs undertaken by proponents are required to consider the cumulative effects of developments in a region, and Queensland has created a number of institutions whose role is to consider and minimise the cumulative impacts of CSG development in the state. Additionally, the University of Queensland has developed a methodology, in consultation with the four major CSG proponents, the state and local governments, and community representatives, for assessment and ongoing monitoring of cumulative socioeconomic impacts at the town and regional levels.[154]

4.2 Distribution of impacts

Impacts on economic welfare can vary significantly between regions, between community groups, and between individual households. In particular, communities in the Bowen Basin have had more experience in adapting to previous mining experiences, which has not been the case in the Surat Basin region, making their adaption to CSG development more challenging for local communities.

As with any economic shock, CSG development affects the distribution of income and other economic costs and benefits within the community. The economic and community impacts of CSG development are not always jointly beneficial. Economic impacts can be experienced differently by different members of the community depending on individual circumstances, location (of households and industry) and their capacity to adapt. Individual circumstances play a large role in determining whether individuals are able to capture the benefits of the CSG development and their acceptance of CSG in their community.

153 QGC (2009), Santos (2009). APLNG (2010)

154 Rifkin et al (2015)

The effects of CSG development on a community are not static but rather change over time. That is a result of the nature and scale of the activities changing as the CSG process moves through the value chain. Effects of CSG activities tend to peak as the CSG value chain progresses from exploration into development, and then it tapers off once the gas pipeline network is mostly in place and the initial tranche of wells moves fully into production. Key factors contributing to the extent and duration of associated impacts in a particular area are the intensity and amount of drilling activity required each year to deliver the contracted gas.

Both economic and community impacts will change as the CSG industry moves further beyond the construction peak for the three LNG projects. However, the activity and the impact on communities will not reduce to nothing. Given the nature of CSG development, continued work will be required to explore, appraise and develop new CSG wells over the coming two or more decades. This continual work ensures that the production workforce will be required, but it will be a smaller regional workforce providing economic benefits to local communities. The adjustment of communities to the operations phase requires impacts being absorbed and minimised.

The change in impacts over time is also a result of companies gaining experience with the activities involved in CSG development. As a result, they develop significant capabilities in the relevant technologies, including water management. The experiences arising from CSG activities provide regulators with the opportunities to learn, adapt, and respond in ways that satisfy both commercial objectives and community expectations.

4.3 Role of government

Considering the regulatory and policy frameworks set out in section 1.5, the role of government in CSG development is very important. Governments need to provide appropriate regulation to balance the need to encourage investment whilst ensuring best practice, sustainable and environmentally responsible resource extraction. Developing such regulation can be particularly challenging in an emerging industry, where unforeseen problems can emerge that are outside the regulatory framework, and which warrant the attention of governments.

The Australian Government's role in the development of the CSG industry has included its regulatory role under the water trigger provisions of the EPBC Act. By undertaking these roles, the Australian Government has both improved the scientific knowledge underpinning regulatory decisions and strengthened the regulation of the water-related impacts of CSG development.

An important feature of Queensland's regulatory and monitoring framework has been the creation of strong institutions. In particular, the GFCQ has played a useful role in managing and improving sustainable coexistence, including in terms of providing information and tools for land access agreements. OGIA has also been essential to assure landholders and communities that potential groundwater impacts are being assessed and managed at a cumulative level. Both of these institutions are highly regarded and seen as effective by community, industry, and academia alike in their respective roles given their legislated independence and certainty in their roles and ongoing funding.

These institutions have also been well regarded in terms of their provision of information. Another useful institution in this space has been GISERA, the research alliance between CSIRO, APLNG and QGC, involved in researching the environmental, social and economic impacts of the natural gas industry. The CSG industry has also engaged significantly in supporting independent research in leading institutions, such as the UQ-CCSG with UQ, Santos, Arrow Energy, QGC and APLNG. The UQ-CCSG is engaged in researching socioeconomic impacts, agricultural coexistence and ground water impacts.

The strength of institutions is important in terms of ensuring positive impacts of CSG development through government allocation of the future revenue from the growth of the LNG sector. Sustainable government spending decisions can help to mitigate distributional effects and other potential costs to communities in these resource corridors.

It is important that Queensland's regulatory framework be frequently reviewed to ensure that regulatory requirements are risk based and that an appropriate balance between objective-based and prescriptive requirements are in place to engender efficiency and innovation. There are a number of formal reviews of CSG regulation from which to draw for best practice recommendations. The Queensland Competition Authority made a series of recommendations to reduce duplication and unnecessarily prescriptive regulation.[155] Other examples include suggestions of the Productivity Commission to develop a register of land access agreements to increase the transparency of compensation outcomes and to develop a uniform voluntary code of practice for community engagement in the gas industry.[156]

In addition to regulation and information provision, various levels of government play an important role in the planning process, with respect to the provision of housing, water, other infrastructure and town planning. With respect to CSG, much of the development occurred in regions with small communities and insufficient infrastructure to be able to support CSG activities and the associated large increases in temporary and ongoing population.

There were definitely challenges in responding to the planning demands of a fast growing industry. In Queensland, a number of regions were experiencing rural decline, and local regional councils that had gone through significant disruptions through an amalgamation process. These events were also occurring during a period of extended drought that was having severe impacts on the local agricultural industry. Particularly in this context, it can be very difficult to accurately forecast industry impacts and infrastructure needs. Therefore, it is important that governments work closely with communities and companies to better understand how parties can work together and enhance the value that can be obtained by the community.

The important lesson here is having in place high quality planning institutions and mechanisms by which coordinated decisions are made initially and then adaptively as development progresses. It is essential that these institutions foster productive three-way discussions among communities, companies and governments to ensure that planning and implementation processes are as successful as possible. Lessons from Queensland's experience, such as captured in the UQ Cumulative Impacts Tool Kit developed by Rifkin et al, will be useful for other jurisdictions where there are multiple large projects occurring.[157]

4.4 Transitioning to operations phase

The realisation of economic benefits is a key factor that has influenced the perception of the industry by local communities. Linking in with the negative impact of uncertainty on stress and wellbeing, areas where CSG is progressing and where economic benefits have been realised have more positive perspectives on CSG than areas in which there is still uncertainty regarding whether and when CSG development will occur.

These economic benefits are maximised when CSG activity reaches its peak. They reduce as CSG development moves into the production phase of the value chain. Although many of these economic benefits are maintained through the operational phase, there are reductions in employment and business opportunities for local communities. It will be important that this transition is managed well by relevant stakeholders. Research work currently underway, including by GISERA and UQ-CCSG, to model and assess

155 Queensland Competition Authority (2014)

156 Productivity Commission (2015)

157 Rifkin et al (2015)

these impacts from the scale of individual businesses through to regional and state levels, will be helpful in this regard.

It is also important to note that this transition will be occurring as the oil and gas industry is adjusting to the current low international price environment, a time when there are huge pressures to increase productivity and reduce costs. Social licence to operate, through best practice activities and continued community engagement, will be very important to ensure continued net benefits to communities, the region, and the state. Although there may not be as much funding available to be allocated to these activities, a very important factor is the quality rather than the dollar value of the spend, including the quality of engagement with communities and stakeholders.

4.5 Future research priorities

Research is continuing into the economic, socioeconomic, physical and environmental impacts of CSG. The review has identified a number of key areas for future study.

Looking ahead

Given the current transition from the construction phase to the operation phase, continued work on how this transition will be experienced by regions, communities and individuals is useful. GISERA has commenced a study to consider the likely impact of the transition to the operation phase of the CSG industry in Queensland, to help with preparation for likely economic effects. The project will utilise both economic modelling to forecast these effects, and interviews with local businesses to understand how they are experiencing the change and how they can respond positively and remain resilient.

In addition, a team from UQ-CCSG is analysing how small to medium sized enterprises are responding to the shift, and identifying effective strategies. Another team from the UQ-CCSG is extending the effort to monitor indicators of cumulative socioeconomic impacts during this transition. The monitoring will be undertaken until 2017 and covers a greater proportion of the industry footprint – extending beyond the Western Downs to Maranoa, Toowoomba, and the newer developments in the Bowen Basin.

Ongoing monitoring of the impacts through transition, and comparison to forecasts, will be helpful to provide lessons learned for other communities facing such a transition.

Water

The Department of the Environment is supporting targeted bioregional assessments to assess the potential impacts of coal seam gas and large coal mining developments on water resources and water-related assets, as well as managing the Australian Government's research programme to identify and address critical gaps in scientific understanding of the water-related impacts of coal seam gas and large coal mining developments.

The UQ-CCSG is working with OGIA to address fundamental challenges in ground water impact prediction and monitoring. This focus includes fundamental geological and mathematical research needed to improve the impact of connectivity, as well as new ground water field measurements (recharge rates and in-field movements) and better estimating methods. These efforts are oriented to improve predictive modelling and visualisation focussing on improved understanding of Great Artesian Basin dynamics and risks. UQ-CCSG is also investigating alternative uses for brines and salt residues.

Well integrity and emissions

Further work is also being undertaken into well integrity and emissions, including GISERA's ongoing research comprehensively examining sources and fluxes of emissions to the atmosphere, both natural and anthropogenic. UQ-CCSG is working on materials to replace and improve on the performance of than conventional cements when wells are decommissioned. These materials could also be used to remediate legacy bores in the context of unofficial estimates of more than 10,000 coal exploration wells in the region.

Workforce composition and housing

There were concerns within communities during the construction phase regarding the appropriate balance of workforce composition between resident workers and non-resident workers (fly-in-fly-out or other arrangements). The balance between the two needs to take into account the size of the workforce, the skills and capabilities in the region, the level of existing infrastructure and the infrastructure required, the costs of the workforce as well as the costs of the infrastructure, and the long-term impact on the wellbeing of the community.

Further study into an optimal balance in workforce composition could be beneficial in addressing and alleviating these concerns and optimising the balance. Organisations such as Energy Skills Queensland, with members from industry, training organisations and the Government have in the past helped to identify in various stages of CSG projects where skills gaps are likely to exist and what training will be required. A role for such organisations in the future could be to assist workers to transition from their roles in the construction phase to other projects or opportunities.

It is important that all relevant parties are aware of the scale and type of workforce involved in these projects. Communities, governments and companies need to work together to ensure that all relevant parties have a clear understanding of the scale of the permanent and temporary workforce, and to ensure that housing is managed as well as possible to accommodate workers in an appropriate balance of permanent and temporary housing.

Land value

A better understanding is needed of the impact of CSG on land values, including how this impacts on the ability of farmers to gain financing to improve their businesses. Land values are a key indicator of wellbeing and perceptions – if there is a significant change in a region, a comparison of local land values against a control region will illustrate how that change is perceived and valued within the region, controlling for external factors, such as drought. Unfortunately such tracking and comparison is difficult to assess given the range of factors at play, including short-term housing demand throughout the construction period, and the fact that the market for larger properties is much less liquid, with larger properties bought and sold less frequently. These parameters make farm to farm (and region to region) comparison difficult.

The Queensland Valuer General found that land values increased over recent years in the Western Downs as construction peaked, but that the property market in these areas has since slowed somewhat.[158] Once the construction peak has passed and further data can be collected, consideration of long term changes in land values in CSG areas compared with similar regions without CSG development would be a useful indicator of changes in community wellbeing and perceptions.

More work on this issue is warranted. Consideration of impacts on migration would also be useful, including the extent to which CSG growth and the associated wage and population increase has led to the outmigration of low income residents from CSG areas. As well as land value, further analysis of the impacts on housing affordability would also be useful, including impacts on rental prices and the distribution of these effects within a community.

4.6 Conclusion

There is a broad range of research and live experiences relating to CSG development, which illustrate the various ways in which CSG can impact on the net benefit of the hosting regions. The direct economic impacts of CSG development appear to be consistent with other resource developments, leading to increases in employment, output, income, government revenue and regional populations.

Other factors including demographic and social change, and real and perceived physical and environmental impacts, also play a large role in how communities experience CSG development and how that experience, and their perception of it, changes over time. These community impacts can have a material impact on the net benefit of the CSG industry to Queensland and the regions and communities within it, and how the benefits are distributed between — and experienced by — individual households. CSG, as a dispersed resource that was developed rapidly in Queensland, has a socioeconomic impact that differs clearly from other resource development.

CSG has a larger number of neighbours than a typical mining development, and its ongoing development overlaps with other land uses. As a result, additional effort is required for coexistence with a large number of landholders, and more members of the community are exposed to potential negative impacts of the development. Conversely, it also means that a large number of stakeholders are able to realise economic benefits from the development through employment and business opportunities and landholder compensation.

To ensure these benefits are able to be realised, it is essential that companies engage with communities early, and in a genuine and consultative way. Various levels of government also need to be closely engaged in the engagement process to inform their planning processes, and also to ensure the regulatory framework is clear, appropriate and understood.

158 DNRM (2015d)

Regulatory adaptation and innovation has an important role. The impact of the CSG industry has changed over time, as processes and regulations have improved. There have been changes through the different stages of the value chain, with the peak of both economic and socioeconomic impacts coinciding with the peak of drilling and other activities in the development phase. The impacts of the CSG industry will continue to change as the sector transitions into the ongoing, operational phase from the peak activity in 2014 during development and construction.

Ongoing research into both the cumulative and the distributional effects of the CSG industry over time is bringing together the economic and social impacts of the development of the industry and how they change over time. Results of such research will provide a greater depth of understanding of the impacts of these developments. It is important that the quantitative data on economic indicators be integrated with the qualitative analysis on how the development of the CSG sector is experienced by communities, households, and individuals. It would also ensure that government, industry and the community have the information available to best manage the overall impacts of the CSG industry.

References

ACIL Tasman (2012) *Economic significance of Coal Seam Gas in Queensland*, viewed 4 September 2015, http://www.acilallen.com.au/projects/1/economic-analysis/56/economic-significance-of-coal-seam-gas-in-queensland

AgForce (2015) *Landholders and CSG*, viewed 11 September 2015, http://www.agforceqld.org.au/index.php?tgtPage=&page_id=291

APLNG, see Australia Pacific LNG

APPEA, see Australian Petroleum Production and Exploration Association

Arbelaez-Ruiz D, Parmenter J and Barclay M (2014) *Documenting and Reviewing QGC's Indigenous Employment, Training and Business Development Initiatives,* Centre for Social Responsibility in Mining, University of Queensland, Brisbane

Australia Pacific LNG (2010) *Australia Pacific LNG Environmental Impact Statement*, viewed 14 September 2015, http://www.aplng.com.au/environment/our-environmental-impact-statement

Australia Pacific LNG (ND) *Finding the best use of coal seam gas water*, viewed 11 September 2015, http://aplng.com.au/pdf/factsheets/Finding_the_best_use_for_coal_seam_gas_water.pdf

Australian Government (2015) *Agricultural Competitiveness White Paper*, viewed 4 September 2015, Australian Government, Canberra

Australian Government (2014a), *Background review: Hydraulic fracturing ('fraccing') techniques, including reporting requirements and governance arrangements*, Australian Government, Canberra

Australian Government (2014b) *Background review: Subsidence from coal seam gas extraction in Australia*, Australian Government, Canberra

Australian Government Rural Industries Research and Development Corporation (2013) *Principles for negotiating appropriate co-existence arrangements for agricultural landholders*, Australian Government, Canberra

Australian Petroleum Production and Exploration Association (2015) *Industry statistics*, viewed 6 September 2015, http://www.appea.com.au/industry-in-depth/industry-statistics/

Bureau of Resources and Energy Economics (2014) *Gas Market Report 2014*, Australian Government, Canberra

Carrington K, McIntosh AF, Hogg RG and Scott J (2013) Rural masculinities and the internalisation of violence in agricultural communities, *International Journal of Rural Criminology*, 2(1), pp. 3–24

Cavaye J and Kelly L (2015) *Working Paper: Agriculture and Coal Seam Gas Development in Queensland*, School of Agriculture and Food Sciences, University of Queensland Centre for Goal Seam Gas, Brisbane

Cavaye J, Rifkin W, Cameron D, Kelly L, Baldwin S, Martin M, Everingham J, Baumgartl T and Vink S (2015) *Working paper on measures of agricultural business impacts from coal seam gas development in southern Queensland*, School of Agriculture and Food Science and Centre for Social Responsibility in Mining, University of Queensland Centre for Coal Seam Gas, Brisbane

COAG, see Council of Australian Governments

Colson E (1973) Tranquility for the decision-maker, *Cultural Illness and Health*, 9, pp. 89–96

Council of Australian Governments (2012) *National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development*, viewed 4 September 2015, https://www.ehp.qld.gov.au/management/impact-assessment/pdf/partnership-agreement.pdf

Davis R and Franks D (2014) Costs of Company-Community Conflict in the Extractive Sector, *Corporate Social Responsibility Report No. 66*, Cambridge, Harvard Kennedy School

Day S, Dell'Amico M, Fry R, and Javanmard Tousi H (2014) *Field Measurements of Fugitive Emissions from Equipment and Well Casings in Australian Coal Seam Gas Production Facilities*, CSIRO, Australia

Department of Industry and Science (2015) *Domestic Gas Strategy: Australian Government Policy and Actions*, Australian Government, Canberra

DILGP, see Queensland Department of Infrastructure, Local Government and Planning

DNRM, see Queensland Department of Natural Resources and Mines

DoSD, see Queensland Department of State Development

Energy Skills Queensland (2013) *Queensland CSG to LNG Industry Workforce Plan*, viewed 4 September 2015, http://www.energyskillsqld.com.au/

Fibbens M and Mak M (2014) *Compensation for coal seam gas occupation: assessing the harms*, viewed 7 September 2015, http://www.prres.net/papers/Fibbens_Compensation_CSG_Occupation.pdf

Fleming M and Measham T (2015a) Local economic impacts of an unconventional energy boom: the coal seam gas industry in Australia, *The Australian Journal of Agricultural and Resource Economics*, 59(1), pp. 78–94

Fleming D and Measham T (2015b) Income Inequality across Australian Regions during the Mining Boom: 2001-11, *Australian Geographer*, 46(2) pp. 201–214

Fleming D and Measham T (2014) Local job multipliers of mining, *Resources Policy*, 41, pp. 9–15

Fleming D and Measham T (2013) *Disentangling the Natural Resources Curse: National and Regional Socioeconomic Impacts of Resource Windfalls*, viewed 4 September 2015, http://ageconsearch.umn.edu/bitstream/150526/2/Fleming%20and%20Measham__AAEApaper.pdf

Fleming D, Measham T and Paredes D (2015) Understanding the Resource Curse (or Blessing) across National and Regional Scales: Theory, Empirical Challenges and an Application, *Australian Journal of Agricultural and Resource Economics*, in press, DOI: 10.1111/1467-8489.12118

GasFields Commission Queensland (2015) *Onshore Gas Well Integrity in Queensland*, Australia, Technical Communication 4, GasFields Commission, Brisbane.

GasFields Commission Queensland (ND) *About us*, viewed 4 September 2015, http://www.gasfieldscommissionqld.org.au/gasfields/about-us/

Geoscience Australia and the Bureau of Resources and Energy Economics (2014) *Australian Energy Resource Assessment*, viewed 4 September 2015, http://www.ga.gov.au/scientific-topics/energy/resources/australian-energy-resource-assessment

GFCQ, see GasFields Commission Queensland

Gas Industry Social and Environmental Research Alliance (2014a) *What is coal seam gas?*, viewed 8 September 2015, http://www.gisera.org.au/publications/factsheets/what-is-csg.pdf

Gas Industry Social and Environmental Research Alliance (2014b) *Hydraulic fracturing in coal seams*, viewed 8 September 2015, http://www.gisera.org.au/publications/factsheets/hydraulic-fracturing.pdf

Gillespie N and Bond C (2015) *Drivers of Trust in the CSG Sector, Working paper*, UQ Business School, University of Queensland Centre for Coal Seam Gas, Brisbane

Gibson G and Sandiford M (2013) *Seismicity and induced earthquakes: a background paper to the Office of the NSW Chief Scientist and Engineer (OCSE) providing information and a discussion about induced seismicity, microseismic monitoring and natural seismic impacts, in relation to CSG activities*, Melbourne Energy Institute, Australia

GISERA, see Gas Industry Social and Environmental Research Alliance

Grattan Institute (2013) *Getting gas right: Australia's energy challenge*, viewed 4 September 2015, http://grattan.edu.au/

Hajkowicz SA, Heyenga S and Moffat K (2011) The relationship between mining and socio-economic well being in Australia's regions, *Resources Policy*, 36, pp. 30–38

Hossain D, Eley R, Coutts J and Gorman D (2008) The mental health of landholders in southern Queensland: issues and support, *Australian Journal of Rural Health* 16, pp. 343–348

Hunter T and Taylor M (2013) *Coal Seam Gas: An annotated bibliography*, Centre for International Minerals and Energy Law, University of Queensland Centre for Coal Seam Gas, Brisbane

Huth NI, Cocks B, Dalgliesh N, Poulton PL, Marinoni O, and Navarro G (2014) *Farmer's perceptions of coexistence between agriculture and large scale coal seam gas development*, GISERA working paper, CSIRO, Brisbane

Ivanova G (2014) The mining industry in Queensland, Australia: Some regional development issues, *Resources Policy*, 38, 101–114

KPMG (2013) *Minerals Council of Australia: Analysis of the Changing Resident Demographic Profile of Australia's Mining Communities*, viewed 4 September 2015, http://www.minerals.org.au/file_upload/files/reports/MCA-13-ResidentialProfile0131-MYR.pdf

Lawrence Consulting (2014) *Economic contribution of the Minerals and Energy Sector to the Queensland Economy 2013–14*, Queensland Resources Council, Brisbane

Measham TG and Fleming DA (2014a) Impacts of unconventional gas development on rural community decline, *Journal of Rural Studies*, 36, pp. 376–385

Measham TG and Fleming DA (2014b) How coal seam gas is changing the face of rural Queensland, *theconversation.com*, 15 January 2014, viewed 7 September 2015, http://theconversation.com/how-coal-seam-gas-is-changing-the-face-of-rural-queensland-21064

Measham TG and Fleming DA (2013) *Lessons from development of resource extraction industries in rural areas*, a literature review report to the Gas Industry Social and Environmental Research Alliance, CSIRO, Canberra

Moffat K and Zhang A (2014) The paths to social licence to operate: An intergrative model explaining community acceptance of mining, *Resources Policy*, 39, pp. 61–70

Morgan MI, Hine DW, Bhullar N and Bartik W (2015) *Stressed: Coal Seam Gas Extraction and Farmers' Mental Health*, manuscript submitted for publication

NSW Government Chief Scientist and Engineer (2014) *Final report of the Independent Review of Coal Seam Gas Activities in NSW*, New South Wales Government, Sydney

Paragreen N, and Woodley A (2013) Social licence to operate and the coal seam gas industry: What can be learnt from already established mining operations?, *Rural Society*, 23(1), pp. 46–59

Productivity Commission (2015) *Examining barriers to more efficient gas markets*, Commission Research Paper, Productivity Commission, Canberra

QGC (2009) *QCLNG Environmental Impact Statement*, viewed 14 September 2015, http://www.qgc.com.au/environment/environmental-impact-management/qclng-environmental-impact-statement-(eis).aspx

Queensland Competition Authority (2014) *Coal Seam Gas Review*, Queensland Competition Authority, Brisbane

Queensland Competition Authority (2014) Coal Seam Gas Review, Queensland Competition Authority, Brisbane

Queensland Department of Agriculture, Fisheries and Forestry (2012) *Resource activities and organic farming, guidelines for organic producers and resource development companies in Queensland*, Queensland Government, Brisbane

Queensland Department of Agriculture, Fisheries and Forestry (2014) *State of Queensland agriculture report*, Queensland Government, Brisbane

Queensland Department of Environment and Heritage Protection (2012) *Draft terms of reference for the future gas supply area project environmental impact statement (EIS): proposed by Santos Limited*, viewed 4 September 2015, https://www.ehp.qld.gov.au/management/impact-assessment/eis-processes/documents/future-gas-draft-tor.pdf

Queensland Department of Infrastructure, Local Government and Planning (2015) *Regional Planning Interests Act*, viewed 4 September 2015, http://www.dilgp.qld.gov.au/

Queensland Department of Natural Resources and Mines (2015a) *Queensland's petroleum and coal seam gas 2013–14*, viewed 4 September 2015, https://www.business.qld.gov.au/invest/investing-queenslands-industries/mining/resources-potential/petroleum-gas

Queensland Department of Natural Resources and Mines (2015b) *Strategic Cropping Land*, viewed 4 September 2015, https://www.dnrm.qld.gov.au/land/accessing-using-land/strategic-cropping-land

Queensland Department of Natural Resources and Mines (2015c) C*SG Water Management*, viewed 4 September 2015, https://www.dnrm.qld.gov.au/mining/coal-seam-gas/water

Queensland Department of Natural Resources and Mines (2015d) *Valuer-General's 2015 Property Market Movement Report*, Queensland Government, Brisbane

Queensland Department of Natural Resources and Mines (2013) *Code of Practice for constructing and abandoning coal seam gas wells and associated bores in Queensland*, Queensland Government, Brisbane

Queensland Department of State Development (2015) *Building our regions*, viewed 24 August 2015, http://www.statedevelopment.qld.gov.au/regional-development/building-our-regions.html

Queensland Government (2015a) *Coal seam gas production and reserve statistics*, viewed 4 September 2015, https://data.qld.gov.au/dataset/activity/coal-seam-gas-production-and-reserve-statistics

Queensland Government (2015b) *Environmental assessments and conditions*, viewed 4 September 2015, https://www.business.qld.gov.au/industry/csg-lng-industry/water-environmental-management-csg/environmental-assessments-conditions

Queensland Government (2015c) *Using the Coal Seam Gas Globe*, viewed 4 September 2015, https://www.business.qld.gov.au/business/support-tools-grants/services/mapping-data-imagery/queensland-globe/coal-seam-gas

Queensland Government (2015d) *Budget Strategy and Outlook 2015–16*, Queensland Government, Brisbane

Queensland Government (2014a) *Queensland Gas Scheme*, viewed 4 September 2015, https://www.business.qld.gov.au/industry/energy/gas/queensland-gas-scheme

Queensland Government (2014b) Business and industry portal: Gas industry, viewed 4 September 2015, https://www.business.qld.gov.au/industry/energy/gas.

Queensland Government (2013) Land access Implementation Committee Report, Queensland Government, Brisbane

Queensland Government (2012) *Land Access Framework — 12-month review, Report of the Land Access Review Panel*, Queensland Government, Brisbane

Queensland Government (2011) *Surat Basin Regional Planning Framework: A framework for a prosperous and sustainable community*, Queensland Government, Brisbane

Queensland Government (2010) *Guide to Queensland's new land access laws*, Queensland Government, Brisbane

Queensland Government Statistician's Office (2015) *Queensland Regional Profiles*, viewed 4 July 2015, http://statistics.qgso.qld.gov.au/qld-regional-profiles

Queensland Government Statistician's Office (2014a) *Surat Basin Population Report 2014*, Queensland Government, Brisbane

Queensland Government Statistician's Office (2014b) *Bowen Basin Population Report 2014*, Queensland Government, Brisbane

Queensland Government Statistician's Office (2014c) *Population growth*, Queensland, March quarter 2014, Queensland Government, Brisbane

Queensland Health (2013) *Coal seam gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data*, Queensland Government, Brisbane

Queensland Resources Council (2014) *Economic report*, viewed 4 September 2015, https://www.qrc.org.au/01_cms/details.asp?ID=3473

Rifkin W, Witt K, Everingham JA and Uhlmann V (2015) *Cumulative Socioeconomic Impacts of CSG Development in the Western Downs*, Preliminary Draft Report, Sustainable Minerals Institute Centre for Social Responsibility in Mining, University of Queensland Centre of Coal Seam Gas, Brisbane

RIRDC, see Australian Government Rural Industries Research and Development Corporation

Rolfe J (2013) Predicting the economic and demographic impacts of long distance commuting in the resources sector: A Surat basin case study, *Resources Policy*, 38, pp. 723–732

Rolfe J, Gregg D, Ivanova G, Lawrence R and Rynne D (2011) The Economic Contribution of the Resources Sector by Regional Areas in Queensland, *Economic Analysis and Policy*, 41 (1), pp. 15–36

Santos (2009) *Gladstone LNG Environmental Impact Statement*, viewed 14 September 2015, http://www.santosglng.com/resource-library/glng-eis.aspx

Standing Council on Energy and Resources (2013) The National Harmonised Regulatory Framework for Natural Gas from Coal Seams, Australian Government, Canberra

Trigger D, Keenan J, de Rijke K, and Rifkin W (2014) Aboriginal engagement and agreement-making with a rapidly developing resource industry: Coal seam gas development in Australia, *The Extractive Industries and Society*, 1(2), pp. 176–188

Underschultz J, Pasini P and Grigorescu M (2015) *Applying hydrocarbon systems analysis and basin hydrodynamics to Onshore Gas in Australia*, First EAGE/TNO Workshop on Basin Hydrodynamic Systems in Relation to their Contained Fluids, 6–8 May 2015, Utrecht ,The Netherlands

Werner A, Vink S, Watt K and Jagals P (2015) Environmental health impacts of unconventional natural gas development: A review of the current strength of evidence, *Science of the Total Environment*, 505, pp. 1127–1141

Walton A, McCrea R and Leonard R (2014) *CSIRO survey of Community Wellbeing and responding to change: Western Downs region in Queensland*, CSIRO Technical report, CSIRO, Australia

Western Downs Regional Council (2015) *Western Downs Economic Annual*, Western Downs Regional Council, Dalby

Williams R and Walton A (2013) *The social licence to operate and coal seam gas development: A literature review*, Report to the gas industry social and environmental research alliance (GISERA), CSIRO, Canberra

Witt K, Uhlmann V, May K, Johnson S and Rifkin W (2014) *Interim Data Reports: Possible indicators of impact of CSG development on Chinchilla, Dalby and Miles and district communities, Cumulative Socioeconomic Impacts of CSG Development in the Western Downs Project*, Centre for Social Responsibility in Mining, University of Queensland, Centre for Coal Seam Gas, Brisbane

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Original research article

Change, opportunity and grief: Understanding the complex social-ecological impacts of Liquefied Natural Gas development in the Australian coastal zone

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ABSTRACT

Recent rapid growth in the natural gas industry has led to concerns about the potential impacts of development on local communities, and the capacity of current governance arrangements to manage those impacts. Although a growing body of research explores the impacts of 'boomtown' mining and energy development in inland communities, comparatively little work has examined the impacts of natural gas development on communities in the coastal zone. Coastal communities are part of complex social-ecological systems that are increasingly a focal point for Liquefied Natural Gas (LNG) development. Drawing on in-depth interviews and grey literature, this paper examines the direct, indirect and cumulative social-ecological impacts of LNG development in a coastal community in Australia, an emerging hub for the global gas industry. The research finds that the impacts of coastal LNG development share similarities with conventional mining, but also present new challenges for the governance of the industry.

1. Introduction

In recent years, the unprecedented development of unconventional gas resources, in combination with domestic concerns over energy security and the growth of key export markets in Asia and Europe, has prompted the expansion of Liquefied Natural Gas (LNG) infrastructure in many parts of the globe [1–3]. Twenty-four countries currently export gas or have plans to do so, and a further 45 countries import gas products, or are planning to build import facilities (Fig. 1).

LNG is a liquefied form of natural gas, usually methane (CH_4). In the past, it has been exclusively generated from conventional gas sources (reservoirs), but the liquefaction process is increasingly used to export unconventional fuels such as shale gas, coal seam gas and tight gas. Because LNG is used for export products, gas liquefaction infrastructure is generally located in coastal zones where access to shipping is readily available. As a result, LNG development is occurring in coastal zones throughout the world including in the Gulf of Mexico and the Great Barrier Reef World Heritage Area in Australia. These zones are complex social-ecological systems (SES) [4,5], home to many human communities as well as critically important ecosystems [6–9]. As gas developments proliferate in these and other areas, it is increasingly important that our understanding of their impacts and our ability to sustainably manage those impacts keeps pace with this rapidly developing sector.

1.1. Impacts of energy and mining development at the local scale

Energy and mining development is often characterised by cyclical periods of economic and demographic 'boom' and 'bust' that can bring localised economic growth and employment opportunities, but can also affect the socio-economic wellbeing of local communities [3,27–44]. Socio-economic impacts are defined in the literature as the effects of development as perceived and experienced by local residents [18–20,40,45]. In the context of mining and energy development, impacts can include social dislocation among the (often transient) workforce, rising costs of living and disparities in local incomes between the industry and other sectors, population health impacts, overburdening of essential services, increases in crime, and declining social capital and civic participation within the local community [29,31,34,35,39–43,46–53]. The impacts of development may be distributed unevenly across social groups: for example, women and low-income earners are known to experience specific financial, health and safety impacts associated with mining development [32,54]. Impacts may also manifest differently across the lifecycle of a development, even occurring before the

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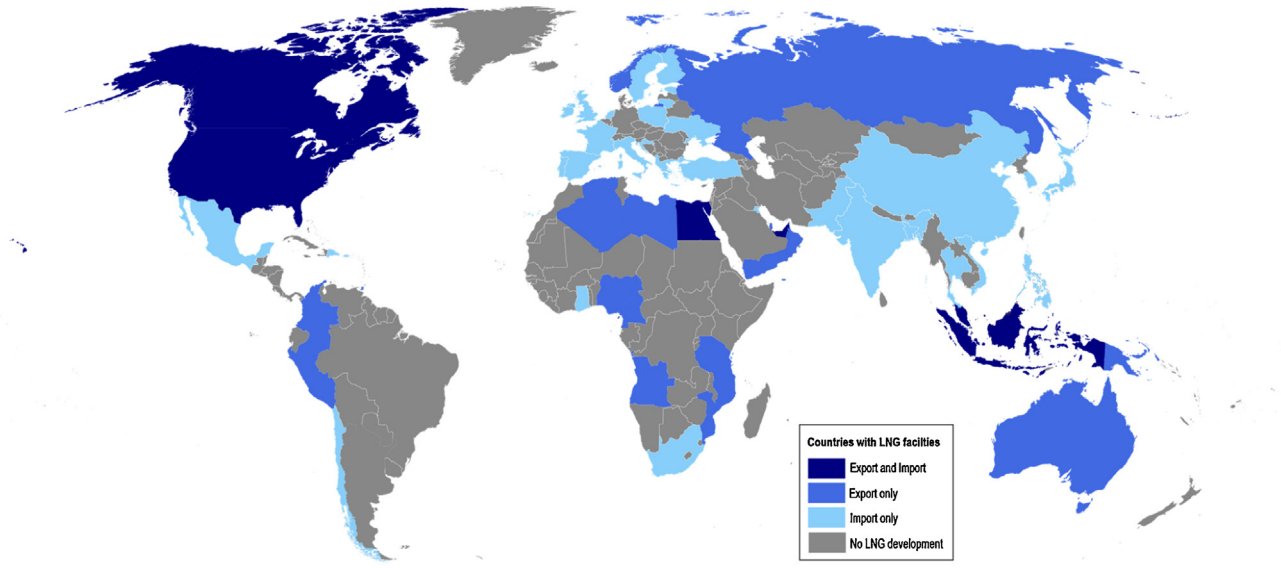

Fig. 1. Global map of countries with LNG import and/or export facilities, current as of October 2015 [26].

development commences as communities begin to anticipate coming changes [45].

In recent decades, the expansion of energy and mining developments, coupled with changes in the way that developments are resourced and operated, has substantially altered interactions between the industry and local communities, and consequently the impacts of these activities [34]. Mining and energy developments are increasingly staffed by a FIFO (Fly-In-Fly-Out) or DIDO (Drive-In-Drive-Out) workforce, housed mainly in camps, who work extended block rosters of up to three weeks at a time [40]. This work pattern can lead to large, transient and male-dominated workforces in regional and remote areas, often with low populations and few services [34]. Research has suggested that the beneficial impacts of mining for the local employment market may be less than anticipated due to the need for specialised labour which is often brought in from outside the local community [55,56]. In addition to direct socio-economic impacts, mining and energy development is associated with substantial environmental change which can indirectly affect local communities [3,18,20,38]. Coastal and marine environments make vital contributions to ecosystem services and declining ecosystem health in these environments is known to impact on human wellbeing [6,57,58].

1.2. Understanding complex impacts: a role for integrated social-ecological research

Over several decades, a growing body of social sciences research has explored the impacts of mining development on communities near production sites. As a result, understanding of the localised socio-economic impacts of mining is well developed. However, there remain several critical gaps in our understanding of the impacts of new developments, such as LNG facilities. Most studies of resource development focus on social impacts within communities near the inland production site (mine or gas field), while the majority of research into coastal port development examines environmental or livelihood impacts. Moreover, although analytical approaches that explicitly recognise socio-ecological interdependencies are becoming increasingly common across a range of research areas and disciplines, including integrated coastal zone management (ICZM) [10–15], these approaches have not featured as strongly in the energy literature. The practice of impact assessment – a key mechanism for assessing and mitigating the impacts of development – also treats social and environmental impacts separately. Thus, while previous research has yielded critical insights on the impacts of energy development at the source, there is an urgent need for qualitative research that explores the complex human and environmental dimensions of energy development along the entire production chain – including in the coastal zone – and for integration of these learnings into regulation and management practice [16].

1.3. Purpose of this paper

This paper applies a social-ecological lens to understanding the impacts of three co-located gas liquefaction plants in Gladstone, a small industrial city located in north-eastern Australia, adjacent to the Great Barrier Reef. Using empirical, mixed-methods data, the paper provides a broad overview of the socio-economic impacts of LNG development in Gladstone during the early stages of the recent LNG boom (2010–2014), focusing on the following key areas: impacts linked to demographic change, rising costs of living, impacts on social capital and community safety, socio-economic impacts related to changes in the local environment, and impacts on government service delivery. In structuring its analysis, the paper draws on two SES frameworks: an early impact assessment framework developed by Slootweg et al. [17–20] and the Driver-Pressure-State-Welfare-Response (DPSWR) framework, a policy framework designed to model changes in social-ecological systems [21–23]. DPSWR is a recent iteration of the DPSIR (Driver-Pressure-State-Impact-Response) framework, a widely used policy framework which traces the environmental and social impacts of change, with a focus on impact pathways and governance responses [12,24]. Both frameworks conceive of impacts as the result of social and biophysical change processes caused by the interaction between a driver (in this case, LNG development), and external factors [19–21,25]. The paper compares and contrasts the impacts of LNG and conventional inland mining, to draw out key lessons for researchers and decision makers seeking to understand and manage this new industry.

2. Case study

Australia is currently the world's third largest gas producer, and is expected to become the largest gas exporter in the world by 2020

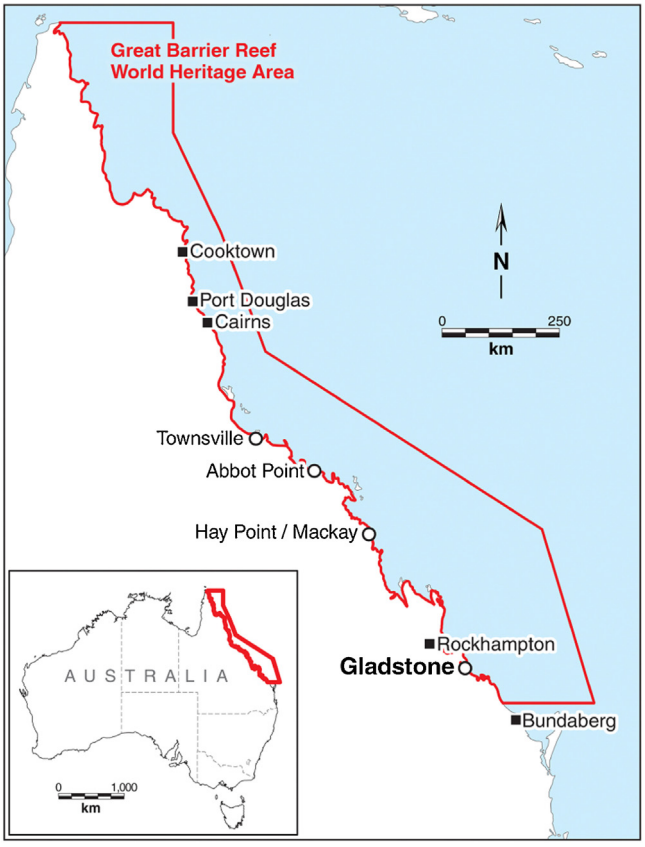

Fig. 2. Map showing location of Gladstone in the Great Barrier Reef World Heritage Area [Adapted from Ref. [8]].

[59,60]. The recent development of unconventional gas resources has driven rapid growth in the Australian gas industry, and gas liquefaction facilities are now under construction or operational in several locations across northern Australia. This research focuses on Gladstone, a small industrial city located on the north-eastern coast of Australia (see Fig. 2). Gladstone is home to a large multi-commodity port, an alumina refinery and smelter, coal export terminals, a cement works and a power station in addition to three gas liquefaction plants constructed since late 2010. The city of Gladstone and surrounding coastal region is also a gateway to tourism on the Great Barrier Reef and supports a small commercial fishing industry and a recreational fishing community, although fishing in the region was affected by flooding in 2011.

Since 2010, the Port of Gladstone has undergone extensive expansion to facilitate the export of LNG and coal, including dredging involving the removal of 22 million cubic metres of sediment from the seabed to create shipping channels and swing basins for LNG tankers. Coal Seam Gas (CSG), mined more than 400 km inland, is transported via pipeline to three liquefaction facilities located on an island within the port, where the gas is cooled and loaded onto tankers for export. Gladstone is one of several industrial ports undergoing current or planned expansion in the Great Barrier Reef. Concerns have been expressed about the environmental impacts and governance of port expansion to accommodate LNG and mining exports through the Great Barrier Reef. A recent UNESCO monitoring mission noted that the "scale and pace of [port] development proposals [in the Reef] appear beyond the capacity for independent, quality and transparent decision making" [61].

The migration of a large LNG workforce to Gladstone between 2010 and 2014 was a key driver of change in the local community during that period. Formal estimates suggest that 13 000 workers were employed in construction of the three Gladstone LNG plants, an increase from earlier projections in response to accelerated construction schedules, an easing of skills shortages and the demand for more workers with specialised skills as the projects transitioned from civil construction works to structural and mechanical phases during 2013–2014 [63]. The population of the Gladstone Region at the time of the 2011 census was approximately 60 000 persons and half of these (approximately 32 000) resided permanently in the city of Gladstone [64,65]. Publicly available data on the size and composition of the LNG workforce are scarce, however at the end of June 2014 there were 6655 non-resident workers in Gladstone (12% of the Gladstone city population), most of whom were engaged in the construction of LNG facilities, a coal export terminal and associated infrastructure [66]. A population increase was observed across most age groups throughout the boom, particularly pronounced amongst younger age groups, and the ratio of males to females in the Region was heavily skewed towards males. At the last census in 2011, the sex ratio in Gladstone was 111 males for every 100 females, substantially higher than the state of Queensland as a whole, where there were approximately 98 males for every 100 females [64].

The experiences of residents in Australian LNG towns such as Gladstone can provide important early insights into the future of coastal communities in Australia and elsewhere, as LNG begins to expand at an unprecedented scale across the globe. Gladstone provides an opportunity to examine the cumulative effects of LNG development in a critically important environmental setting, and to further develop understandings of the human dimensions of energy development, identified as a critical gap in the energy literature [16].

3. Methods

This research used government statistical records and qualitative data from semi-structured interviews with 33 residents of the Gladstone Region to provide a synthesis and overview of community experiences of socio-economic impacts in Gladstone during the early phases of the LNG boom (2010–2014).

3.1. Data collection and analytical approach

Where possible, demographic and economic data collected through the Australian census 2011 [64] and long-term statistical records held by the Queensland Government, the state in which Gladstone is located [66,67] was used to provide context to local residents' perceptions of the impacts of LNG development in Gladstone. These data provide a broad understanding of demographic and economic changes in the Gladstone Local Government Area (LGA, comprising the City of Gladstone and surrounding rural and coastal areas totalling approximately 10,500 square kilometres).

A qualitative, semi-structured interviewing approach was also used to elicit local community views about the socio-economic impacts of the Gladstone LNG developments. Qualitative methods allow researchers to explore development through local perspectives, and add depth to quantitative data [68,69]. In a semi-structured interview process, the researcher works from an interview guide or schedule containing a list of questions that can be flexibly altered or reordered during the interview. Semi-structured interviewing allows researchers to preserve the flow of the interview, and facilitates the in-depth exploration of respondent experiences while also remaining focused on the main research topic [69–71]. In this research project, interview questions included contextual and demographic questions about each respondent's organisational or community role, how long they had worked in the role and how long they had lived in the community. Respondents were also asked to identify key changes that

they had observed in the Gladstone community before and since the LNG plants began construction, and to comment on their personal experiences of the LNG boom. Lastly, respondents were asked to comment on the adequacy and effectiveness of governance and management arrangements for LNG, with a focus on the impact assessment process.

Interviews were conducted between August and October 2014. A key objective of the research was to explore a wide range of perspectives on LNG development within Gladstone. For this reason, interview respondents (n) were selected from diverse stakeholder groups: local businesses (4), LNG/port industry (6), government, including local and state agencies (8), Environmental non-government organisations (4), non-government organisations providing social services (9) and community representatives without a specific affiliation (2). Government representatives included both elected officials and appointed staff with a wide range of social, economic and environmental policy and management responsibilities within the local and state governments. There was a high degree of diversity amongst non-government organisations in the sample, including three organisations dedicated to providing social support, advocacy and employment for Indigenous Australians, several counselling services (alcohol, drugs, domestic violence and harassment) and a support service for recent migrants. Local businesses include real estate agencies, local engineering firms and boating operators.

Interview participants were recruited through their workplaces and through informal networks using a snowball sampling technique [72]. Sampling began with contacts known to the author. During interviews, respondents were asked to nominate other potential respondents who could provide insight into the diversity of local experiences of LNG. Interviews were recorded except by interviewee request, and notes were taken during all interviews. Interviewing continued until a saturation point was reached, whereby no additional themes or insights emerged during interviews. This is an accepted method of ensuring that interview data is representative of the key issues and themes [73–75].

An iterative, phenomenological approach was used to analyse interview data [76–78]. This approach uses interpretive epistemological traditions to explore the subjective or lived experience of informants [76,77]. Data analysis involved coding and sorting passages of text from interview transcripts into thematic categories corresponding to the key impacts and governance mechanisms identified through the research. Data analysis was conducted in two phases over several months. In phase one, an initial coding structure was established to reflect the key analytical concepts. This was then revised in the second phase, as new concepts and issues emerged during data analysis. This is an established methodology for qualitative analysis and has been used previously to analyse experiential data from mining towns [see for example Refs. [27,79]].

In this paper, a notation system is used to identify individual respondents and protect respondent confidentiality. Respondents are identified by gender, age and employment sector. For example, [M, 55–64, local business] refers to a male aged between 55 and 64 years, employed in a local business in the Gladstone Region. (F, 35–44, government) indicates that the respondent is a female, aged 35–44 years, employed in a government agency.

4. Results and discussion

The research reveals a number of key insights about the impacts of LNG development in Gladstone, and the change processes that underpinned those impacts. For brevity the paper focuses on the following four key areas, which were substantial areas of concern and interest for the community in Gladstone, and which also provide opportunities to compare and contrast LNG development with conventional mining and energy development:

1. Impacts on housing prices and the cost of living.
2. Impacts on social capital and community safety.
3. Impacts on amenity and recreation in the coastal zone.
4. Impacts on government service delivery and infrastructure.

4.1. Housing prices and cost of living

The economic benefits of Gladstone's LNG boom were substantial for some sectors of the community. The regional employment rate increased during peak construction times (Fig. 3), and some local businesses (particularly harbour engineering and transport firms) also reported benefiting from industry contacts [M, 55–64, local business; F, 55–64, local business]. New businesses were established to fill needs created by the industry for services such as relocation and transport for workers and materials. Homeowners who sold property at peak prices were also amongst the beneficiaries of the boom. Many respondents noted that high housing prices prompted a wave of early retirees who left the Region for areas where retirement care infrastructure is better developed.

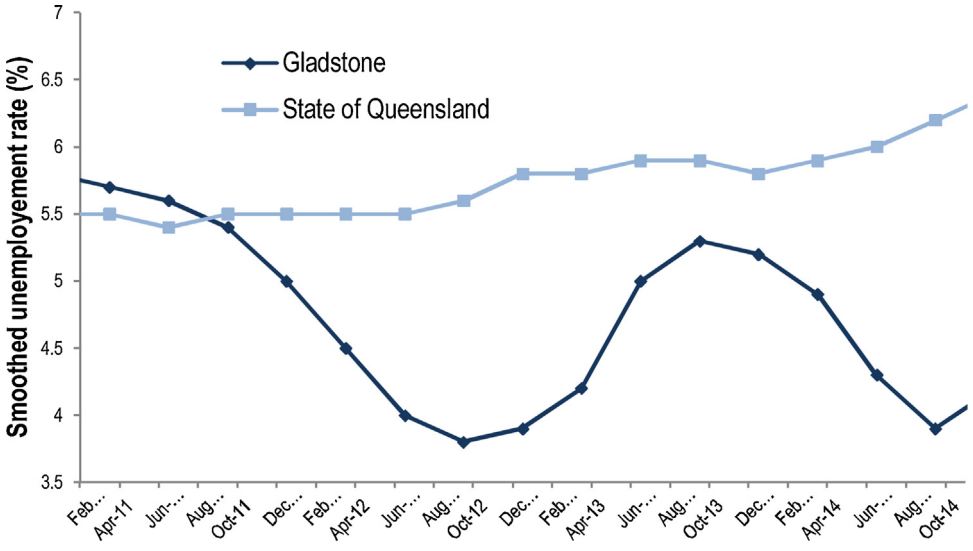

Fig. 3. Smoothed unemployment rate per capita Gladstone Local Government Area and Queensland, 2010–2014 [67].

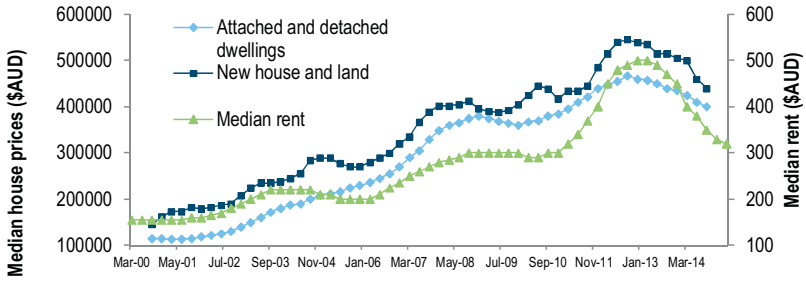

Fig. 4. Cost of housing, Gladstone Local Government Area, 2000–2014 [67].

However, the LNG boom in Gladstone was also associated with increased costs of living, a housing shortage and a rapid boom and bust cycle in the local housing market (Fig. 4). Housing prices in Gladstone doubled during 2011, but by January 2014 had dropped to 25% below peak prices. The short-term increase in housing costs was more pronounced in the rental market [67]. Interview data suggest that a major contributing factor to this increase in rental costs was the practice by companies of reserving large numbers of motel rooms for use as temporary housing by LNG workers and contractors, effectively reducing the supply of available rental accommodation in Gladstone [67].

The increased cost of housing, food, petroleum and other goods and services affected many local residents, particularly low-income earners or those working outside the LNG industry. The interview data showed many respondents experienced difficulties meeting the rising housing cost associated with the LNG boom; some low-income residents received housing subsidies [80], while others relocated to more affordable areas within or outside the Gladstone Region. The housing boom was followed by a precipitous decline in house prices when housing camps were built for the LNG workforce, increasing workforce accommodation capacity from 80 beds to more than 8000 beds between June 2011 and June 2013 [66]. This action alleviated pressure on rental housing in the town, at the same time as local authorities released additional land for housing development. The subsequent weakening in the local housing market resulted in substantial financial losses for local residents and property investors (F, 25–34, real estate).

4.2. Impacts of LNG on social capital and public safety in Gladstone

Social capital refers to the capacity that is created through social bonds between members of a community. These bonds are important to community life because they can promote civic engagement, increase the resilience of communities in the face of rapid change and enhance general feelings of community cohesion and wellbeing [5,81–83]. Interview responses suggested that some aspects of the Gladstone LNG boom have strengthened social capital amongst Gladstone residents, while other change processes have weakened social ties amongst the local community. The LNG industry has invested in local community organisations through structured grants programmes and ad hoc donations and incoming industry families were perceived by interview respondents to have contributed to increased cultural diversity in Gladstone. Both of these benefits were valued by local residents and were perceived to improve the sense of community and social connection – both indicators of social capital – in the town. However, respondents also observed that the rapid demographic and economic shifts associated with LNG had eroded social capital within the local community, through the disruption of established social networks. One resident reflected a common view that:

> "Often what was said was 'I could go shopping prior to LNG and you just about knew everybody. Now you know nobody.' That's exactly how it's expressed to me repeatedly. That should change once the construction workers are gone but it won't settle back to what it was because there are a lot of new people here because the older ones left. " [F, 55–64, government].

The out-migration of older residents affected local families through the loss of grandparents who played important family roles and provided childcare, and affected the community-at-large through the loss of volunteers for community services. Although some of the shortfall in volunteers was filled by new residents- particularly female spouses of LNG workers- this has not been the case for all volunteer associations. As one resident commented:

> "Some of the management staff. . .have brought their wives and families with them. Our churches have seen an increase in wives who participate in weekly activities. [However] I belong to a committee and am desperate for volunteers. [The wives] are reluctant to commit because their spouse wants them to be free and flexible for his leave" (F, 45–54, local business).

Respondents perceived that LNG workers did not share local values and behavioural norms. In particular, a number of residents felt that FIFO workers lacked strong attachment to the local community, and as such were more likely to exhibit antisocial behaviour and less likely to participate in community activities. The LNG boom in Gladstone was associated with an increase in some types of crime, and with increased fear of crime amongst local residents. Arrests for disorderly, offensive, threatening, or violent behaviour ("good order offences") reached a 10-year peak in August 2012 (see Fig. 5). Drug offences also increased markedly during the construction boom, reaching a 10-year high in August 2013 [84]. Additional police were deployed to manage crime, with funding from the LNG industry.

Many respondents commented that they were concerned about the perceived increase in crime and antisocial behaviour during the LNG boom. Some local residents reported feeling less safe or comfortable in public spaces than before the LNG boom, in some cases changing their behaviour to avoid areas they felt were unsafe or uncomfortable spaces after dark. Women were more likely than men to report feeling unsafe when walking at night. In interviews, many female respondents reported feelings of unease, discomfort and marginalisation in public spaces during the LNG boom.

Respondents expressed the view that LNG workers did not share local values and behavioural norms. In particular, a number of residents felt that FIFO workers lacked strong attachment to the local community, and as such were more likely to exhibit antisocial behaviour and less likely to participate in community activities. Some residents expressed concerns about the future of Gladstone after the boom was over. "[O]ur city was flooded with [construction] workers who appeared to 'use' our city and its services; they come as Fly-In Fly-Out workers and their families stay elsewhere...I fear that once LNG construction is complete, the city social structure will be a wasteland- with less small businesses, less volunteers and less family support (sic). Who will be left behind? I don't believe it will be me, if I have a choice" [F; 45–54].

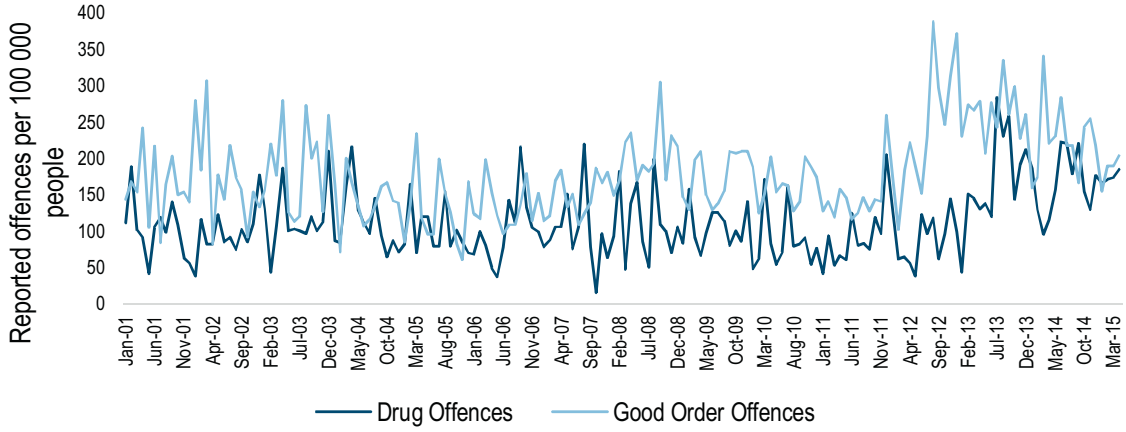

Fig. 5. Reported criminal offences per 100 000 people, Gladstone, 2001–2015 [84].

4.3. Impacts on environmental health and social amenity

The construction of LNG in Gladstone Harbour was also perceived by local residents to have affected the marine environment and, as a consequence, coastal lifestyles. A high level of community concern was expressed about the impacts of channel dredging on harbour ecosystems [85]. Dredging operations, which occurred contemporaneously with major flood events in the local region, were associated with elevated turbidity and impacts on marine life, in particular seagrasses and marine turtles [86,87]. In their own words, a number of informants expressed the view that Gladstone Harbour had been "sacrificed" for economic benefit. The cultural importance of coastal lifestyles is underscored by high levels of private boat ownership within the Gladstone Region [88]. Lifestyles, pleasant weather and access to recreational opportunities were described as being important to Gladstone residents. There are many ecological attributes and values that are highly specific to coastal and marine environments within the Great Barrier Reef World Heritage Area [8,9,89,90] which are critical to understanding the interactions between people and the environment in the Gladstone Region.

The interview data also highlighted community concerns about maritime safety and a loss of access to important sites in the Gladstone Harbour. Many informants felt that access to recreational sites in the harbour had been reduced as a result of construction, and as a consequence of increasing vessel traffic in the harbour, which increased five-fold between 2010–2011 and 2011–2012 [91]. With the unprecedented increase in commercial shipping traffic during LNG construction, recreational boating and fishing was perceived to be more dangerous for smaller, recreational craft. In combination with changes in amenity of the environment, this affected self-reported community use of the harbour.

4.4. Understanding indirect and cumulative impacts

While the LNG boom in Gladstone affected the local community in a number of direct ways, it also had indirect and cumulative impacts on the local community. In many instances, these indirect impacts were the result of interactions between multiple direct impacts and external change processes, policies and management actions. For example, a lack of childcare availability in Gladstone resulted from a range of intersecting factors including the loss of grandparents for reasons that include high housing costs and a lack of retirement facilities in the region, coupled with increased demand for childcare services due to the large number of incoming families. In a highly industrialised town such as Gladstone, LNG development also occurred simultaneously with other developments such as a coal terminal and other pre-existing industry operations, thereby exacerbating pre-existing impacts of FIFO and shift work amongst the community.

In some instances, impacts were the result of third parties taking advantage of new economic opportunities created by the boom. For example, problem gambling, an endemic problem within the community, was perceived to have been exacerbated during the LNG boom. Respondents working in community services identified alcohol and gambling as the main addictive behaviours present amongst the LNG workforce (including FIFO workers). These respondents reported observing a sizeable increase in referrals for gambling addiction, both amongst the LNG workforce and in the general community. In mid-2011, individual poker machines within the Gladstone Region were the second-most profitable in the state, taking AUD$5472 per machine, on average, during August 2011 [92,93]. One interviewee working in social services expressed the view that the relocation of poker machines into Gladstone at the height of the boom had contributed to increased referrals amongst the LNG workforce and general community, but that those not working in LNG were particularly affected because they did not have the disposable income to support a gambling habit (F, 45–54, social services).

In other cases, external policy decisions had combined with LNG-related change processes to produce unforeseen impacts. The increased demand for government services provides an illustration of this. Many government and community-based organisations, including medical, emergency, counselling and support services faced higher demand for services during the peak of construction. Previous policy decisions in areas such as medical service delivery, coupled with failures in communication between industry, state and local government, and the compression of timeframes for construction meant that community infrastructure was underprepared to cope with rapid population growth. Earlier health services reforms aimed at centralising services to larger regional centres meant that local medical services came under pressure as the population grew. Overburdening of local hospitals and clinics in Gladstone was compounded by a pre-existing lack of private medical practitioners and a state-wide policy to centralise hospital services. These issues were identified in impact assessments [94,95]. Police, ambulance services, parole services and the maritime safety authority (professions with capped salaries) also struggled to attract staff during the height of housing shortages, with some organisations renting accommodation for visiting workers. Parole services reported a large increase in demand for services as a large number of parolees moved into the Region for work (F, 45–54, government). The rapid influx of LNG construction staff to Gladstone and satellite areas has led to a marked increase

in air and vehicle traffic in Gladstone. Although local authorities took steps to spread car parking around the city, to relieve congestion and provide a long-term benefit to the community, in general, public infrastructure failed to keep pace with the sharp increase in demand associated with the LNG boom. Lastly, some impacts resulted from policy or responses directly aimed at alleviating impacts. For example, the steep rise and decline of property prices in Gladstone was caused primarily by the lack of adequate workforce accommodation during the early phases of construction, and exacerbated by the release of new land to meet housing demand.

4.5. Comparing the impacts of LNG and conventional mining

In many ways, the socio-economic impacts of LNG development in Gladstone mirror the effects of inland resource developments on communities in Australia and elsewhere. Demographic boom and bust cycles play a key role in determining the magnitude and nature of social and economic impacts in resource boomtowns [42,44,62]. Local communities are generally expected to benefit from industry spending, but this is not the case for all groups within resource boomtowns. Although "boomtown development represents often unprecedented job- and wealth-creation opportunities, especially in economically underdeveloped areas, it also represents clear potential opportunity *costs* in the likelihood of social stresses, increased inequality, and strains on local infrastructure, to say nothing of the possibility of an eventual bust" [28]. Burdens on infrastructure and services during boom periods in mining communities are well documented [40,42,49], as are the negative effects of resource booms on housing availability, cost of living, community functioning and security [34,42]. Local governments are often unprepared and inadequately resourced to manage the impacts of boomtown development [62]. FIFO workers are often perceived to possess values and behavioural norms that undermine community social capital in mining towns, and concern and fear increases [39].

As in mining, some sections of the population, such as those on low incomes and women, are likely to report feeling vulnerable to specific impacts of the gas boom: including increases in living costs and reduced availability of low-cost housing and childcare. Some groups, particularly younger women, felt that their access and level of comfort in public spaces has been reduced as a consequence of the influx of a largely male construction workforce. Women were substantially more likely than men to report feeling unsafe or uncomfortable as a result of the large numbers of male workers residing in Gladstone, a finding consistent with previous qualitative work on the effects of mining booms in Australia and elsewhere [31,32,49,79,96].

Impacts of LNG operations on the workforce, such as increased levels of family stress, alcohol and drug misuse, also appear to mirror those reported in mining. For some industry workers and families, the work schedules required in LNG exacerbated feelings of social dislocation associated with FIFO work or regional migration away from home and extended family networks. As one respondent commented: "The detriment is that these 12-hour shifts . . .you've got no capacity for. . . your family" [M; 35–44, ports].

While the findings suggest that there are many similarities between LNG and other forms of mining, several key characteristics of the Gladstone LNG industry in Gladstone differentiate it from inland mining or offshore drilling projects. Because LNG plants are located in coastal environments, some impacts are highly specific to habitats and communities in the coastal zone. The impacts of LNG development on Gladstone Harbour and the associated reduction in social and recreational amenity highlight the highly specific and localised nature of these impacts.

Secondly, LNG projects are characterised by an intensive construction phase, followed by an extended – and markedly less labour intensive – operational phase. The LNG boom, and its associated impacts and benefits, is therefore truncated when compared to mines, which often require large workforces over extended periods. The experience of Gladstone is further differentiated from mining by the speed and scale of LNG development in the Region. The co location of three LNG plants in the Gladstone region, and the subsequent size of the LNG workforce and scale of development has also led to cumulative socio-economic impacts which may not occur as a result of single developments. In comparing LNG to previous industrial booms in Gladstone, one respondent said:

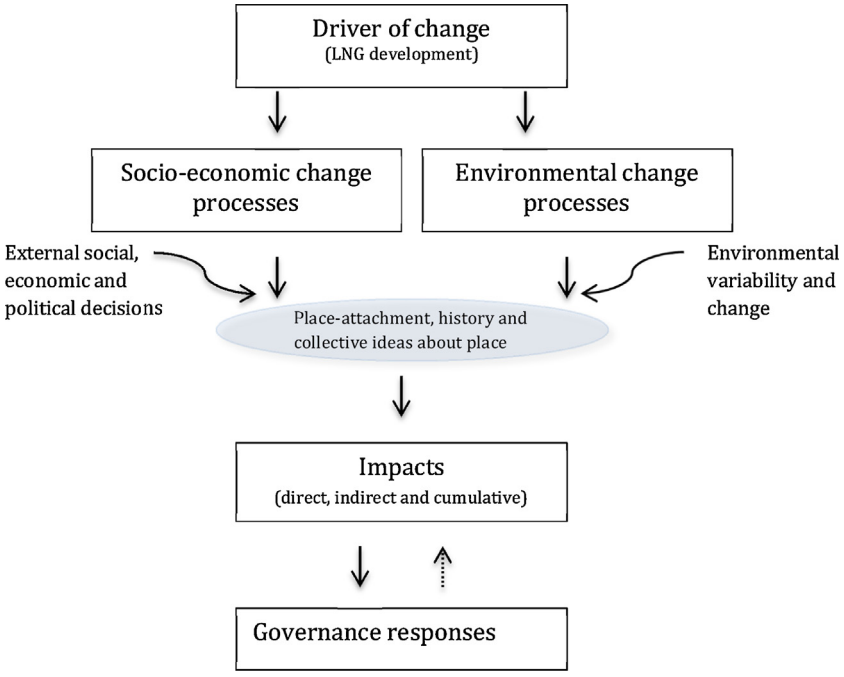

Fig. 6. Impacts and governance of LNG: a social-ecological perspective.

Table 1
Impacts and governance of LNG development in Gladstone, Australia.

Pressures and change processes	Proximate impacts	Cumulative and cascading impacts	External factors, variability and change	Governance responses
Rapid increase in size of local population	Increase in housing prices, decrease in housing availability	Housing price 'boom' and 'bust'	Small regional city, lack of housing to accommodate large LNG workforce	Release of additional land for housing development by local authorities
Change in local demographic profile	Increased demand for medical services	Lack of doctors, parole workers and emergency services	Reallocation of hospital resources to large regional centres	Industry constructs workforce housing
Outmigration of low income earners and retired residents	Increase in commercial shipping traffic in Gladstone Harbour	Decline in perceived social capital	Salary capping for government employees	Employers paying to house employees
FIFO work practices	Environmental impacts (e.g., water quality changes)	Disruption of established social networks	Strong local identities and local/outsider dichotomy	Industry invests in local organisations
		Social dislocation among LNG workforce	Lack of retirement facilities in local area	
		Effects on amenity and recreational use of harbour	Impacts of 2011 flood event on commercial and recreational fishing in Gladstone Harbour	

> "I have lived in the Gladstone area on and off since 1975. Boom periods as a result of new industry [are] well known. . .but LNG is different...The size of this project has had a huge impact on our community" [F, 45–54].

While there are similarities across the sector, each mining and energy project occurs within unique political, social, economic and biophysical contexts, and involves global, regional and local-scale processes that shape and mediate local experiences of impact. Community perceptions of impacts are shaped by a range of factors, such as the speed of development, the size and structure of the local community, as well as previous experiences with industrial development, local values and normative expectations [27,28,34]. In every community, the physical features of the local environment interact with collective meanings about how the place was formed, its nature and purpose [97]. Complex place-attachments are formed by local residents, both with the biophysical environment of a place, and with the memories and experiences that are associated with the place [98,99]. As such, while boomtown development may change the social, economic and physical landscape of a place, it can also challenge the collective identities of local residents, and their understandings and expectations of life in the local community, and unearth or compound existing social divisions [27,39]. Amongst those who viewed the changes associated with LNG development as a significant departure from the pre-existing character of Gladstone as a small coastal town, there was "a lot of grief from, especially really older people about how it [has] changed." [F, 55–64, community services]. Other respondents, both newer and longer-term residents, viewed industry as an integral part of the character of the town, and some respondents believed that previous industrial booms in Gladstone, although smaller in scale, had contributed to the formation of a collective memory and consequently a resilience to the impacts of the LNG boom.

In short, the specific social, economic and ecological characteristics of the Gladstone region, coupled with an industry-wide move towards FIFO work practices, the unprecedented scale and speed at which LNG development was pursued in Gladstone, the lack of adequate workforce housing in the early stages of the LNG boom, and the interaction of LNG-related change with other policy and management decisions strongly influenced the range and severity of impacts experienced by the local community. Pre-existing social dynamics and historical legacies of development in Gladstone may have exacerbated the community's experience of certain impacts, and mitigated others. Fig. 6 and Table 1 (below) summarise the findings presented above, through a social-ecological systems lens which sees impacts as being driven by the interaction between LNG development, external socio-economic and environmental factors, and governance responses which may mitigate some impacts but exacerbate others.

5. Conclusions

In Gladstone, as in other mining boom towns, increased living costs and an erosion of social amenity and community safety have emerged as counterweights to the economic benefits that flow from energy development to local businesses and the regional economy. Some local non-profit organisations have benefited from a boost in funding and resources, and the boom has promoted cultural diversity in the region. Nevertheless, there appears to be a disjunct between the scales at which impacts and benefits are experienced, with economic benefits flowing to the state of Queensland and the nation through increased tax revenue through the sale of gas to overseas markets. At the same time, notwithstanding benefits to local business and industry employees, detrimental impacts appear to have been concentrated at the local community level.

That LNG and mining exhibit similar impacts is not unexpected, given similarities in working practices across the mining and energy sectors. Experiences in other resource developments offer important lessons for those tasked with managing LNG and those living alongside these developments. However, LNG developments have unique characteristics that set them apart from conventional mining. Specifically, the speed of construction and unprecedented scale of the LNG projects in Gladstone appear to have contributed substantially to the scale of detrimental impacts experienced by local residents. The size of the LNG workforce – more than a third of the prior population – has been an important driver of social change, as have the working arrangements for construction employees – in particular FIFO work arrangements. In comparison with mining, the LNG boom is particularly short lived, and much of the construction workforce is expected to relocate once the plants are built. With their exit, the socio-economic impacts associated with the boom may dissipate, together with the benefits of the boom for the local economy.

The experiences of communities like Gladstone show that LNG developments in coastal environments bring a range of impacts and challenges. The consistency of social and economic impacts across different social and geographic contexts suggests a universality of impacts and experiences that provide valuable lessons for both regulators and communities in terms of managing the impacts and effects of gas developments at the local scale. At the same time, the novel features of LNG development present new challenges for effective governance of the industry.

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References

[1] BP p.l.c., BP Statistical Review of World Energy, London, UK, 2015.
[2] E. Stephenson, A. Doukas, K. Shaw, Greenwashing gas: might a 'transition fuel' label legitimize carbon-intensive natural gas development? Energy Policy 46 (2012) 452–459.
[3] R.C. Stedman, et al., Environmental reviews and case studies: Marcellus Shale gas development and New boomtown research: views of New York and Pennsylvania residents, Environ. Pract. 14 (04) (2012) 382–393.
[4] F. Berkes, C. Folke (Eds.), Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience, Cambridge University Press, New York, 1998.
[5] W.N. Adger, et al., Social-ecological resilience to coastal disasters, Science 309 (5737) (2005) 1036–1039.
[6] E.B. Barbier, et al., The value of estuarine and coastal ecosystem services, Ecol. Monogr. 81 (2) (2011) 169–193.
[7] J.-Y. Ko, J.W. Day, A review of ecological impacts of oil and gas development on coastal ecosystems in the Mississippi Delta, Ocean Coast. Manag. 47 (11–12) (2004) 597–623.
[8] Great Barrier Reef Marine Park Authority, Great Barrier Reef Outlook Report 2014. Townsville, Queensland, 2014.
[9] R. Lawrence, et al., The Great Barrier Reef—Finding the Right Balance, Melbourne University Press, Melbourne, 2002.
[10] J.M. Anderies, M.A. Janssen, E. Ostrom, A framework to analyze the robustness of social-ecological systems from an institutional perspective, Ecol. Soc. 9 (1) (2004) 18.
[11] J. Liu, et al., Complexity of coupled human and natural systems, Science 317 (5844) (2007) 1513–1516.
[12] C.R. Binder, et al., Comparison of frameworks for analyzing social-ecological systems, Ecol. Soc. 18 (4) (2013) 26.
[13] E. Ostrom, A general framework for analyzing sustainability of, Proc. R. Soc. London Ser. B (2007).
[14] E. Ostrom, M. Cox, Moving beyond panaceas: a multi-tiered diagnostic approach for social-ecological analysis, Environ. Conserv. 37 (04) (2010) 451–463.
[15] F. Vanclay, The potential application of social impact assessment in integrated coastal zone management, Ocean Coast. Manag. 68 (0) (2012) 149–156.
[16] B.K. Sovacool, What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda, Energy Soc. Sci. Res. 1 (2014) 1–29.
[17] R. Slootweg, A. Kolhoff, A generic approach to integrate biodiversity considerations in screening and scoping for EIA, Environ. Impact Assess. Rev. 23 (6) (2003) 657–681.
[18] R. Slootweg, F. Vanclay, M. van Schooten, Function evaluation as a framework for the integration of social and environmental impact assessment, Impact Assess. Project Appraisal 19 (1) (2001) 19–28.
[19] R. Slootweg, F. Vanclay, M. Van Schooten, Integrating environmental and social impact assessment. In: H.A. Becker and F. Vanclay (Eds.) (2003). .
[20] M. Van Schooten, F. Vanclay, R. Slootweg, Conceptualizing social change processes and social impacts, in: H.A. Becker, F. Vanclay (Eds.), The International Handbook of Social Impact Assessment: Conceptual and Methodological Advances, 74, Edward Elgar, Cheltenham, UK, 2003, p. 91.
[21] P. Cooper, Socio-ecological accounting: DPSWR, a modified DPSIR framework, and its application to marine ecosystems, Ecol. Econ. 94 (2013) 106–115.
[22] R. Ramachandran, et al., Improving science and policy in managing land-based sources of pollution, Environ. Dev. 11 (2014) 4–18.
[23] L. Mee, et al., Sustaining Europe's seas as coupled social-ecological systems, Ecol. Soc. 20 (1) (2015) 1.
[24] E.R. Carr, et al., Applying DPSIR to sustainable development, Int. J. Sustain. Dev. World Ecol. 14 (6) (2007) 543–555.
[25] J.P. Atkins, et al., Management of the marine environment: integrating ecosystem services and societal benefits with the DPSIR framework in a systems approach, Mar. Pollut. Bull. 62 (2) (2011) 215–226.
[26] Global LNG Info.com, World's LNG Liquefaction Plants and Regasification Terminals As of October 2015. 2015 [1 November 2015].
[27] K. de Rijke, Coal Seam gas and social impact assessment: an anthropological contribution to current debates and practices, J. Econ. Soc. Policy 15 (3) (2013).
[28] K.A. Schafft, Y. Borlu, L. Glenna, The relationship between Marcellus Shale gas development in Pennsylvania and local perceptions of risk and opportunity, Rural Sociol. 78 (2) (2013) 143–166.
[29] K.A. Schafft, et al., Local Impacts of unconventional gas development within Pennsylvania's Marcellus Shale Region: gauging boomtown development through the perspectives of educational administrators, Soc. Nat. Resour. 27 (4) (2014) 389–404.
[30] B.J. Wynveen, A thematic analysis of local respondents' perceptions of Barnett Shale energy development, J. Rural Soc. Sci. 26 (1) (2011) 8–31.
[31] K. Carrington, M. Pereira, Assessing the social impacts of the resources boom on rural communities, Rural Soc. 21 (1) (2011) 2–20.
[32] S. Lozeva, D. Marinova, Negotiating gender: experience from Western Australian mining industry, J. Econ. Soc. Policy 13 (2) (2010).
[33] S. Lockie, et al., Coal mining and the resource community cycle: a longitudinal assessment of the social impacts of the Coppabella coal mine, Environ. Impact Assess. Rev. 29 (5) (2009) 330–339.
[34] V. Petkova, et al., Mining developments and social impacts on communities: Bowen Basin case studies, Rural Soc. 19 (3) (2009) 211–228.
[35] S. Lockie, et al., Assessing the social impacts of extensive resource use activities, J. Environ. Plan. Manag. 52 (4) (2009) 437–455.
[36] P. Kirsch, et al., Health impacts extend from the life of a mine to the life of a community—knowledge gaps, in: Paper Presented at Life-of-Mine Conference, Brisbane Queensland, 10–12 July 2012, 2012.
[37] S.A. Hajkowicz, S. Heyenga, K. Moffat, The relationship between mining and socio-economic well being in Australia's regions, Resour. Policy 36 (1) (2011) 30–38.
[38] K.J. Brasier, et al., Residents' perceptions of community and environmental impacts from development of natural gas in the Marcellus Shale: a comparison of Pennysylvania and New York cases, J. Rural Soc. Sci. 26 (1) (2011) 32–61.
[39] J. Scott, K. Carrington, A. McIntosh, Established-outsider relations and fear of crime in mining towns, Sociol. Ruralis 52 (2) (2012) 147–169.
[40] G. Ivanova, et al., Assessing social and economic impacts associated with changes in the coal mining industry in the Bowen Basin: Queensland, Australia, Manag. Environ. Qual. 18 (2) (2007) 211–228.
[41] J. Rolfe, et al., Lessons from the social and economic impacts of the mining boom in the Bowen Basin 2004–2006, Australas. J. Reg. Stud. 13 (2) (2007) 134–153.
[42] J. Rolfe, et al., Lessons from the social and economic impacts of the mining boom in the Bowen Basin 2004–2006, 2007.
[43] M. Lawrie, M. Tonts, P. Plummer, Boomtowns, resource dependence and socio-economic well-being, Aust. Geogr. 42 (2) (2011) 139–164.
[44] S.L. Perry, Development, land use, and collective trauma: the Marcellus Shale gas boom in rural Pennsylvania, Cult. Agric. Food Environ. 34 (1) (2012) 81–92.
[45] F. Vanclay, International principles for social impact assessment, Impact Assess. Project Appraisal 21 (1) (2003) 5–12.
[46] A.M. Torkington, S. Larkins, T.S. Gupta, The psychosocial impacts of fly-in fly-out and drive-in drive-out mining on mining employees: a qualitative study, Aust. J. Rural Health 19 (3) (2011) 135–141.
[47] S. Petrova, D. Marinova, Using 'soft' and 'hard' social impact indicators to understand societal change caused by mining: a Western Australia case study, Impact Assess. Project Appraisal (2014) 1–12 (ahead-of-print).
[48] S. Petrova, D. Marinova, Social impacts of mining: changes within the local social landscape, Rural Soc. 22 (2) (2013) 153–165.
[49] J.A. Shandro, et al., Perspectives on community health issues and the mining boom–bust cycle, Resour. Policy 36 (2) (2011) 178–186.
[50] F. Solomon, E. Katz, R. Lovel, Social dimensions of mining: research, policy and practice challenges for the minerals industry in Australia, Resour. Policy 33 (3) (2008) 142–149.
[51] M. Sibbell, Living FIFO: The Experiences and Psychosocial Wellbeing of Western Australian Fly-in/Fly-out Employees and Partners, Edith Cowan University, Perth, 2010.
[52] G. Halseth, We came for the work: situating employment migration in BC's small, resource-based, communities, Can. Geogr. Géogr. Can. 43 (4) (1999) 363–381.
[53] M. Tonts, P. Plummer, M. Lawrie, Socio-economic wellbeing in Australian mining towns: a comparative analysis, J. Rural Stud. 28 (3) (2012) 288–301.
[54] P. Kirsch, D. Viswanathan, R. Labouchardiere, J. Shandro, P. Jagals, Health impacts extend from the life of a mine to the life of a community—knowledge gaps, in: Life-of-Mine Conference, Brisbane, Queensland, 2012.
[55] D. Black, T. McKinnish, S. Sanders, The economic impact of the coal boom and bust, Econ. J. 115 (503) (2005) 449–476.
[56] J. Marchand, Local labor market impacts of energy boom-bust-boom in Western Canada, J. Urban Econ. 71 (1) (2012) 165–174.
[57] E.B. Barbier, et al., Coastal ecosystem-based management with nonlinear ecological functions and values, Science 319 (5861) (2008) 321–323.
[58] N. Stoeckl, et al., The economic value of ecosystem services in the Great Barrier Reef: our state of knowledge, Ann. N. Y. Acad. Sci. 1219 (1) (2011) 113–133.
[59] D. Spedding, Australia's Liquefied Natural Gas (LNG) export, 2003–2004 to 2013–2004 and beyond, Australian Government Department of Foreign Affairs and Trade, Canberra, 2015.
[60] D. Ledesma, J. Henderson, N. Palmer, The future of Australian LNG exports: will domestic challenges limit the development of future LNG export capacity? in: OIES Paper: NG 90, Oxford Institute for Energy Studies, Oxford, UK, 2014.
[61] F. Douvere, T. Badman, Mission Report: Reactive Monitoring Mission to the Great Barrier Reef (Australia), 6th to 14th March 2012, United Nations

Educational, Scientific and Cultural Organization/International Union for Conservation of Nature (UNESCO-IUCN), Paris, France, 2012.
[62] J. Jacquet, Energy Boomtowns & Natural Gas: Implications for Marcellus Shale Local Governments & Rural Communities, in NERCRD Rural Development Paper No. 43. 2009, 63 pp.
[63] Bechtel, The experiences and challenges of building LNG plants in Australia. GasFields Commission Queensland (2014) CSG–LNG Projects Update—as at end of June Quarter 2014, 2014.
[64] Australian Bureau of Statistics, Gladstone (R) (LGA) Estimated Resident Population—at 30 June. 2011.
[65] Gladstone Area Promotion and Development Ltd., Gladstone Region Socio Economic Profile: 2011 Census Snapshot. Gladstone, Queensland, 2011.
[66] Queensland Government Statistician's Office, Q.T.a.T., Gladstone Region Population Report. Brisbane, 2014.
[67] Queensland Government Statistician's Office, Queensland Regional Database. Brisbane, Queensland, 2015.
[68] J.W. Creswell, V.L. Plano Clark, Designing and Conducting Mixed Methods Research, Sage Publications, Thousand Oaks, 2007.
[69] C. Gross, Fairness and Justice in Environmental Decision Making: Water Under the Bridge, Routledge, Abingdon, Oxon, 2014.
[70] T. Wengraf, Qualitative Research Interviewing: Biographic Narrative and Semi-Structured Methods, Sage, London, 2001.
[71] K. Dunn, 'Doing' Qualitative Research in Human Geography. Qualitative Research Methods in Human Geography, I. Hay (Ed.), Oxford University Press, Don Mills, Ont., 2010, pp. 99–137.
[72] J. Ritchie, J. Lewis, G. Elam, Designing and Selecting Samples. Qualitative Research Practice: A Guide for Social Science Students and Researchers, J. Ritchie, J. Lewis (Eds.), 2003, Sage, London, pp. 77–108.
[73] G. Guest, A. Bunce, L. Johnson, How many interviews are enough? An experiment with data saturation and variability Field Methods 18 (1) (2006) 59–82.
[74] M. Mason, Sample Size and Saturation in PhD Studies Using Qualitative Interviews, 2010.
[75] J. Corbin, A. Strauss, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, Sage Publications, 2014.
[76] J.W. Creswell, Qualitative Enquiry and Research Design: Choosing Among Five Traditions, Sage Publications, Thousand Oaks, 1998.
[77] J.W. Creswell, D.L. Miller, Determining validity in qualitative inquiry, Theory Pract. 39 (3) (2000) 124–130.
[78] D. Layder, Sociological Practice: Linking Theory and Social Research, Sage, 1998.
[79] R. Mayes, B. Pini, Women and mining in contemporary australia: an exploratory study, in: The Australian Sociological Association 2011 Conference, Local Lives/Global Networks, University of Newcastle, 2011.
[80] J. Rolfe, D. Akbar, P. Chapman, Gladstone Housing Need Analysis, Centre for Environmental Management, CQ University, Rockhampton, Queensland, 2012.
[81] R.D. Putnam, Bowling Alone: The Collapse and Revival of American Community, Simon & Schuster, New York, 2000.
[82] L.L. Newman, A. Dale, Network structure, diversity, and proactive resilience building: a response to Tompkins and Adger, Ecol. Soc. 10 (1) (2005) r2.
[83] E.L. Tompkins, W.N. Adger, Does adaptive management of natural resources enhance resilience to climate change? Ecol. Soc. 9 (2) (2004) 10.
[84] Queensland Police Service, Recorded Offences for Gladstone. Brisbane, Queensland, 2015.
[85] Australian Government Department of Environment, Independent Review of the Port of Gladstone—Report on Findings, Australian Government, Canberra, 2013.
[86] C. Petus, M. Devlin, Using Satellite Maps to Document the Extent of Sediment Plumes Associated With Dredging Activity in Gladstone Port's Western Basin, Queensland in Rep. 2012, James Cook University, Townsville, Queensland, 2012, pp. 1–46.
[87] J. Brodie, et al., Links between water quality and marine turtle health, in: TropWATER Report 14/05, James Cook University, Townsville, Queensland, 2014.
[88] Maritime Safety Queensland, Queensland's Recreational and Light Commercial Marine Industry. Brisbane, Queensland, 2012.
[89] C. Pocock, Sense matters: aesthetic values of the Great Barrier Reef, Int. J. Herit. Stud. 8 (4) (2010) 365–381.
[90] R.G. Coles, et al., The Great Barrier Reef World Heritage Area seagrasses: managing this iconic Australian ecosystem resource for the future, Estuar. Coast. Shelf Sci. 153 (2015) A1–A12.
[91] Gladstone Ports Corporation, Gladstone Ports Corporation – Annual Report 2011–2012. Gladstone, Queensland, 2012.
[92] A. McDonald, Queensland's most profitable poker machines in state's most disadvantaged suburbs, in The Courier Mail. 2011.
[93] Queensland Government Office of Liquor and Gaming, Gaming Machine Data by Local Government Areas: Monthly gaming machine data for all Local Government Areas in Queensland—From July 2004–2015: Brisbane, Queensland.
[94] Worley Parsons, Australia Pacific LNG Project Volume 5: Attachment 42: Social Baseline Assessment—Gas Fields, Pipeline and LNG Facility 2009, Report prepared for Australia Pacific LNG.
[95] URS Australia, Santos GLNG Social Impact Assessment: Final. Brisbane, Australia, 2009.
[96] S. Sharma, S. Rees, Consideration of the determinants of women's mental health in remote Australian mining towns, Aust. J. Rural Health 15 (2007) 1–7.
[97] R.C. Stedman, Is it really just a social construction? The contribution of the physical environment to sense of place, Soc. Nat. Resour. 16 (8) (2003).
[98] B.B. Brown, D.D. Perkins, Disruptions in place attachment, in: I. Altman, S. Low (Eds.), Place Attachment, Plenum, New York, 1992.
[99] P. Devine-Wright, Rethinking NIMBYism: the role of place attachment and place identity in explaining place-protective action, J. Community Appl. Soc. Psychol. 19 (6) (2009) 426–441.

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Unconventional gas developments and the politics of risk and knowledge in Australia

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ABSTRACT

Australia could become the world's largest liquefied natural gas (LNG) exporter by 2021. Especially the unconventional coal seam gas (CSG) reserves in the state of Queensland are developed at an unprecedented scale and pace. This rapid growth has intensified land use competition and, combined with concerns over associated extraction techniques such as hydraulic fracturing ('fracking'), the CSG industry has prompted heated debates about its impacts. In this paper we present findings from our ethnographic fieldwork within Queensland's gas fields and demonstrate how various actors respond differently to questions of risk and existing levels of knowledge. Highlighting this contingent nature of risk and knowledge, we caution against reductionist scientific understandings that suggest imaginary boundaries between knowledgeable experts and uninformed citizens. Rather, we argue for an anthropological perspective that allows to carefully think through the ways in which contentious subterranean resources such as CSG become known and how risks are socio-politically negotiated. This focus on the underlying politics of risk and knowledge is highly relevant to public debates over unconventional hydrocarbon developments and can address a central issue for the energy production in industrialized societies: the challenges of environmental change and the resulting socio-political negotiations of knowledge in the contemporary 'risk society'.

1. Introduction

The development of unconventional natural gas resources in Australia has been heralded by proponents as part of a 'global gas revolution', which could see Australia becoming the world's largest liquefied natural gas (LNG) exporter by 2021 [11,p. 87]. To supply this emerging industry along Australia's eastern seaboard, abundant coal seam gas (coal bed methane) reserves in the state of Queensland in the country's north-east are currently developed at an unprecedented scale and pace. The demand for unconventional gas may ultimately lead to the drilling of up to 40,000 gas wells in Queensland alone [12]. This rapid growth and the socio-cultural changes it produces in predominantly regional and rural areas have further intensified land use competition between agricultural and extractive industries, while also affecting non-agricultural landholders and regional residents more generally. In combination with controversies about associated extraction techniques such as hydraulic fracturing ('fracking'), the expansion of the coal seam gas (CSG) industry has prompted heated national debates about extractive industries and regional development, energy production, and related environmental, social, and economic impacts.

Since 2012, we have undertaken ongoing ethnographic fieldwork with the broad variety of persons involved in these debates about CSG developments in the agricultural region of southern Queensland known as the Darling Downs (see Fig. 1 below). As anthropologists concerned with social diversity, our approach is to study the societal implications of energy and unconventional gas developments 'up, down and sideways' [48,p. 317]. Among our interlocutors are therefore local landholders with and without gas infrastructure on their properties, regional town residents, Indigenous people, government and interest group representatives, anti-CSG activists, as well as urban residents, a variety of scientists and gas industry professionals. These ideal-type categories of persons may, however, overlap. While the intricacies of our interlocutors' social worlds are outside the scope of this paper, we present relevant case material from our research that is particularly illustrative of the diverse positions and engagements with the politics of risk and knowledge considered here. This case material was

Abbreviations: CMA, Cumulative Management Area; CSG, coal seam gas; EPA, (U.S.) Environmental Protection Agency; IAA, Immediately Affected Area; LNG, liquefied natural gas; OGIA, Office of Groundwater Impact Assessment.

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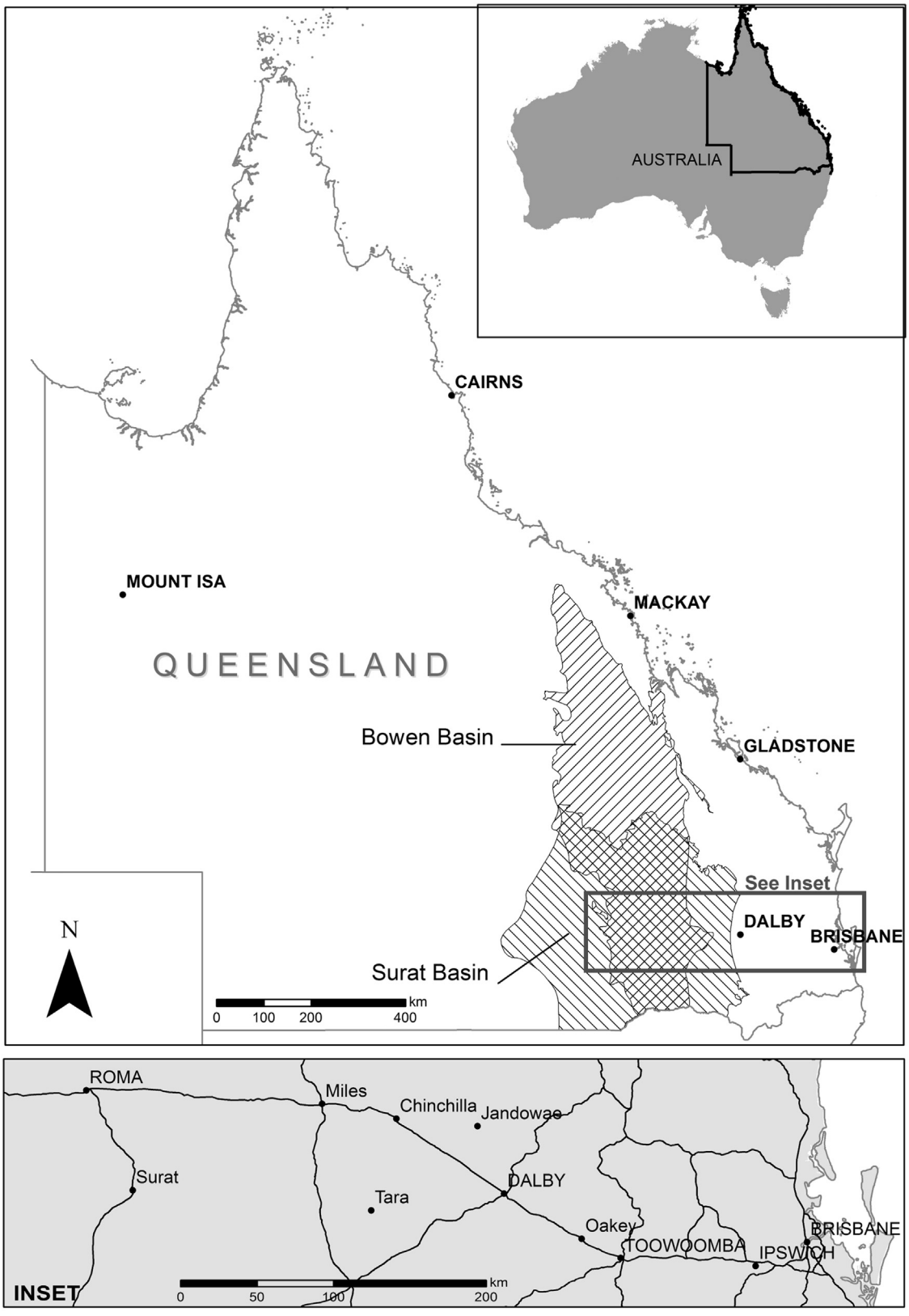

Fig. 1. The Surat and Bowen Basins and our study region of the Darling Downs (Inset), Australia.
(Source: de Rijke [13])

obtained by utilizing a range of research methods including (semi-structured) interviews, participant-observations, archival research, and textual analyses of a broad variety of publically available documents.

A notable conclusion arising from our work is that various local residents in the gas fields and representatives from broader interest groups express significant uncertainty, anxiety and concern about lacking knowledge regarding potential impacts and risks

posed by CSG developments. While some proponents may suggest that these concerns are due to public misinformation and ignorance of existing technical expertise and scientific knowledge, we also found similar concerns among CSG-related professionals and scientists. A number of academics have also cautioned against potential qualitative and quantitative cumulative impacts of CSG extraction, arguing that impacts on, for example, groundwater resources pose "overwhelming unknowns . . . far beyond anything yet experienced" [52,p. 156]. Further, systematic reviews of studies focusing on the environmental health impacts of CSG extraction are yet to demonstrate conclusive evidence, leaving many questions unanswered (e.g. Ref. [74]). Including industry professionals and scientists into our research, we found that uncertainties and concerns about unknowns are not defined along imaginary boundaries between knowledgeable experts and misinformed citizens. We therefore question the usefulness of contrasting lay and expert knowledge in such risk debates and focus on the entanglements of different modalities of knowledge in the actual lived encounters with CSG.

In doing so, we suggest an anthropological perspective that goes 'beyond risk' [53] to more carefully think through the entangled and often hybrid ways in which contentious subterranean resources such as CSG become known in the first place (e.g. Ref. [54]) and, crucially, how unknowns are socio-politically negotiated among diverse sectors of society. In doing so we stress the need to resist reductionist scientific conceptions of these processes (see e.g. Roscoe's 'scientism' [55]). Instead, crucial questions about the cultural politics of risk and knowledge must be asked. Such an approach is highly relevant to public debates and the anthropological literature on unconventional gas, as well as emerging research into unknowns and ignorance in their own right (e.g. Refs. [17,28,41]). As de Rijke [14,p. 17] noted, "[a]nthropology, with its commitment to understanding local individuals and groups in their holistic cultural contexts is well suited to contribute to these debates surrounding gas extraction and energy" (cf. Refs. [58,68]). We argue that focusing on the cultural politics of knowledge and risk in unconventional hydrocarbon debates addresses a central issue for industrialized societies: envisioned energy futures, the management of environmental change, and the growing need for insights into the socio-political negotiation of knowledge to manage these challenges in the contemporary 'risk society' [7].

This article first provides an overview of the developing CSG industry in Queensland. This overview serves to identify those aspects of the industry important to current societal risk debates. We follow this overview with a brief evaluation of the social scientific literature on risk and knowledge relevant to our approach. After setting out the details of our research methods, we then provide an analysis of the research data. Based on our analysis, we conclude that risk debates about unconventional gas developments are driven by the negotiation of concepts that are inherently sociocultural. This article thus brings to the fore the importance of social scientific analyses in understanding the variety of responses to new energy initiatives.

2. The coal seam gas industry in Queensland, Australia

Approximately 7000 unconventional gas wells have been drilled in Queensland over the past decade [10,p. 43]. The targeted geological formations are largely coal seams (also called coal beds) in the Surat and Bowen Basins of southern and central Queensland. Over the next decades, up to 40,000 gas wells may be drilled in these regions to support the LNG export facilities established on Curtis Island near Gladstone. Similar to the unconventional gas developments in the United States and Europe, the coal seam gas industry has been subject to intense opposition. This opposition has resulted in the emergence of an unusual national activist movement called 'Lock the Gate', which integrates progressive environmental and conservative agricultural concerns in its aim to halt unconventional gas and coal mine developments in regions deemed inappropriate for such initiatives. This includes the Darling Downs region in southern Queensland known predominantly for its agricultural qualities despite the longstanding socioeconomic importance of the oil, gas and coal mining industries in the region.

The rapid development of the coal seam gas industry in the Darling Downs since 2009 has created intense debates about the potential negative impacts on groundwater resources important to the agricultural industry, social impacts including human health concerns, as well as concern about the fragmentation of landscapes, fugitive gas emissions, power relationships and governance, and rural socioeconomic futures more broadly (e.g. [15,pp. 44–48]. A major factor in the emergence of these concerns is the geographic footprint and material organization of unconventional gas developments. While each gas well has a relatively small footprint of about 1 ha or less, the collective footprint of thousands of wells, gathering lines, pipelines, tracks, compressor stations, water treatment facilities and so on, is significant. In comparison to extractive developments such as coal mines, these developments lack clearly defined boundaries and spread across the regional landscape as productive gas-bearing coal seams are explored, developed and connected to locations for processing and export.

Additional to these issues, concerns emanating as a result of earlier shale gas developments in the United States have influenced Australian responses. In particular, the release of the activist documentary film *Gasland* contributed to international concern about unconventional gas developments generally, and the technology of hydraulic fracturing in particular. Because our expertise lies outside the fields of natural science such as engineering and hydrology, we cannot comment on the accuracy of the various concerns depicted. However, as anthropologists who conduct qualitative research in this area, we are well-placed to elicit the social and cultural aspects which can be seen to drive the emergence of such unprecedented opposition to new hydrocarbon developments.

Firstly, we note how the term 'fracking', colloquially used in reference to the technology of hydraulic fracturing, has effectively conjured up notions of the extreme. Similar to other hydrocarbons that require significant energy input to extract them, such as the oil contained in Canadian tar sands, unconventional gas developments have been labeled among some as a form of 'extreme energy' (e.g. Ref. [63]). While hydraulic fracturing technologies have been employed in the oil and gas industry for decades, the term 'fracking' has only recently gained societal traction in public debates. A number of factors are important to this development. The emergence of the notion of 'extreme energy', in combination with increased concern about the implications of global climate change and related energy futures, is one factor. Further, the term is fundamentally perceived as the fracturing of boundaries thought stable both physically and culturally (e.g. Ref. [23]). In her classic outline of purity and danger as eminent cultural categories, the anthropologist Douglas [18] provided an effective framework for understanding how social conflict arises in settings where developments are perceived to potentially result in 'matter out of place'. The perceived threat that fracking might cause matter to cross subterranean boundaries and potentially enter the domain inhabited by humans at the surface is fundamental to the unprecedented reactions to this technology.

In many discussions, the term fracking has clearly come to represent the entire industry even though the industry itself is heterogeneous, fracking technologies have been used for decades without significant societal debates, and fracking itself is but a part of various extraction technologies (cf. Refs. [23,76]). Further, in the Australian coal seam gas industry, fracking is used infrequently as the coal seams are more porous than shale, and gas flows readily to

the well as the coal seams are depressurized [11,p. 43]. However, the uptake of fracking in international societal debates brings to the fore the powerful character of cultural categories that associate danger with potential boundary crossings and matter out of place. Coupled with the diffuse geographic boundaries of surface developments, associated debates about impacts, intensifying concerns about global climate change and the need to reduce reliance on fossil fuels, fracking has brought to the debate a sense of societal doom previously absent from oil and gas conflict. In this context we situate our discussions of risks and unconventional gas in Australia.

3. Risk, knowledge and unconventional gas

3.1. The ontology of risk

Risk has become omnipresent in the rhetoric of the corporate world, private planning, and many popular pastimes. Viewed from a social scientific perspective, we regard risk as an essentially modern phenomenon that addresses "not *actual* but rather *potential* dangers" [3,p. 8—original emphasis]. It is, however, not merely the assessment of those dangers, but especially the attempts to actively manage them that embeds risk deeply in late modern societies. Risk therefore refers first and foremost to societal negotiations rather than the mere product of calculative rationalizations of potential impacts' likelihood and severity. As such, risks form part of a culturally biased normative system as "a joint product of knowledge about the future and consent about the most desired prospects" [19,p. 5]. Risk may hence be understood in the logic of anticipation as "a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself" ([5,p. 21]; [7,p. 9]; also [27,p. 22]). As we will argue, the concept of induced risk is productive in understanding societal debates about the potential impacts from CSG and other natural resource developments.

Giddens [27,pp. 26–29] elaborates on Beck's thoughts by introducing the distinction between external ('natural') risks, which more or less affect all societies, and manufactured risks, which are predominantly created by human applications of techno-scientific capabilities. In late industrial and highly technological societies, a shift has occurred because "[o]nce the source of safety, science and technology had become the source of risk" [19,p. 10]. For Beck, this shift is typified by the emergence of novel societal relations: the risk society. The key transition relates to prior concerns with the distribution of 'goods', while risk society is driven by the distribution of 'bads', that is risks [20,p. 8]. As noted, however, risks are not objective calculations, but "characterize [. . .] a peculiar, intermediate state between security and destruction, where the *perception* of threatening risks determines thought and action" [6,p. 135—original emphasis]. Fundamentally, then, it is "cultural perception and definition that constitutes risk" (*ibid.*). Similar to Marx's relations of production, the concept of relations of definition is important for Beck to emphasize the contested nature of risk [1,p. 4]. That is, since "the ontology of risk as such does not grant privilege to any specific form of knowledge" (*ibid.*), it becomes important to understand the cultural politics of risk definition.

We therefore argue for a perspective that investigates the socially negotiated processes of risk and knowledge. To do so, we understand knowledge, similarly to risk, not as a static object, but rather as part of ongoing socio-cultural practices of sense-making. This viewpoint entails a deflational concept of knowledge that marks a "shift from thinking about a putative object that a concept could describe to thinking about the practices in which the concept is used" ([56,p. 199]; [57,p. 69]; [60]). Here, knowledge is not regarded as an external static possession, but forms as a 'capacity to act' [67] part of the ongoing (cognitive) acting and being of knowing individuals, who experience and (co-) construct their life worlds (e.g. Ref. [43]).

In the first place, however, members of risk societies face a lack of certainty, especially in light of often multiple and conflicting knowledge claims. As Beck argues, "[l]iving in world risk society means living with ineradicable non-knowing [. . . and] living in the milieu of manufactured non-knowing means seeking unknown answers to questions that nobody can clearly formulate" [7,p. 115]. This is especially evident in contestation about the role of scientific knowledge during contemporary environmental controversies. While the "connection between the language of risk and that of science is intimate" [77,p. 129], science's inability to deliver certainty leads to risks being raised above scientific debates and into the public sphere ([31,p. 62]; [36,p. 34]). As Yearley notes, however, "official agencies are commonly left with no alternative but to demand 'more and better' science; yet there are few grounds for thinking that further steps down the same path will resolve the problems" ([77,p. 138]; also Evensen [22]). We therefore argue that these unsettled debates, clearly emerging also in the context of unconventional hydrocarbon developments, demand a careful, empirically-grounded investigation of the politics of risk, knowledge, and uncertainty.

3.2. Anthropology and coal seam gas

We find the need for in-depth social scientific investigation has so far not been met sufficiently in relation to unconventional gas developments generally, and Australian coal seam gas developments especially. We agree with Willow and Wylie [75,p. 223] that "[w]hile actual and potential environmental degradation resulting from fracking has received a significant amount of scholarly attention [. . .,] sociocultural consequences have been comparatively overlooked". Where these have been investigated, researchers have largely relied on quantitative rather than qualitative enquiries (*ibid.*). In Australia, much exploratory social scientific research on CSG has focused on understanding public perception (e.g. Refs. [35,37]), but some in-depth qualitative work has been published (e.g. Refs. [13–15,24,25,42,46,62,70,72]). This gap in existing social scientific research is problematic, especially because "gas comes with many unknowns" [29,p. 55] that are subsequently enrolled in broad societal debates and "conflicting visions and experiences of rural life", specifically in extractive regions [64,p. 262]. Some of these unknowns of CSG developments, at least initially, "are overwhelming and pertain not just to the projections of impacts but also to methods of trying to discover and validate ways of assessing potential impacts" [52,p. 156]. These concerns, however, emerge not merely around potential impacts on the physical environment, such as groundwater, but span a large spectrum from socio-cultural, to psychological, and health-related issues [15,pp. 44–48]. For example, Cartwright argues that the potential health implications of fracking – what she terms eco-risk- "are terrifyingly complex" and that our "ability to make visible/diagnose/quantify are far behind the questions that we are faced with in this situation . . . [,w]e just don't know" [9,p. 206]. These complex risks and uncertainties remain with some members of the population we engaged with in Australia.

4. Research methods

We address the questions raised above on the basis of ongoing ethnographic fieldwork conducted since 2012 with a broad variety of persons involved in debates about the operational and proposed gas fields along Australia's eastern seaboard. Our primary geographic focus has been the Western Darling Downs region in the southern part of the state of Queensland and the Northern Rivers

region in the northern part of New South Wales (see Fig. 1 above). While a large-scale CSG industry has been established in the Surat and Bowen Basins of the State of Queensland, the State of New South Wales has only been subject to exploratory activity and a state-wide moratorium on new CSG licences currently limits further developments. To investigate the debates in these regions' gas fields we bring together focused [32], theoretically informed [51], and multi-sited [44] ethnographic approaches.

Among our interlocutors are local landholders with and without gas infrastructure on their properties, town residents, Indigenous people, government, industry and interest group representatives, anti-CSG activists, a variety of natural scientists, gas industry professionals, as well as residents of the urban centres of Toowoomba and Brisbane. As such, we draw on findings from the iterative analysis of approximately 100 semi-structured interviews, participant observations, informal conversations, archival research, and textual analyses of a variety of publicly available documents. While not the main focus, we further include a significant amount of secondary data such as social media videos, blogs, and discussion groups in our analysis. We also keep systematic records of media accounts that emerge in relation the CSG developments in Australia and, to a degree, unconventional hydrocarbon developments internationally.

5. Findings

5.1. Embodied practice, uncertainty and knowledge

Since we do not regard risk exclusively in quantifiable terms but as culturally negotiated normative considerations, debates about risk and uncertainty emerge through, and are informed by, various ways of knowing. We address different forms of risk knowledges and encountered uncertainties by exploring indicative responses from local residents, scientists, and industry representatives. In doing so, we focus especially on how actors come to know CSG and its risks.[1]

Local landholders and residents living in close geographic proximity to CSG developments and infrastructure are immediately confronted with the (potential) impacts of CSG and thus the need to make sense of associated risks. We found that phenomenological or embodied understandings of CSG, through direct sensory experience or via associated environmental changes, play an important part in how actors come to know CSG and its risks. This becomes especially important in light of the 'immateriality' of gas (e.g. Ref. [14,p. 17]), which constrains direct sense-making. Landholders often perceive impacts through the embodied practices of their everyday lives. For example, a woman who lives on a rural property just outside the Immediately Affected Area (IAA)[2] of groundwater impacts has regularly inspected her property's water bore for years. With CSG wells now drilled nearby, she can identify changes in water pressure when the nearby gas wells are operating and when activity is restricted. This led her to question the accuracy of the modelled groundwater impacts, noting her farm was located outside the IAA declared by the State. For other residents, impact knowledge goes beyond engagements with water pressure, and may include a sense of all-encompassing embodied change, varying from agricultural production and domestic activities to new concerns about the composition of air in the region. As a small-scale farmer noted:

> My story is: I moved here seven years ago and spend everything on my house, my farm. I have pigs, I have choocks [i.e. chickens] – everything was really good. Come Christmas time, this Christmas just past, [a gas company] went and drilled a well nearby and, boom, our bore went bad. [. . .] Now the water in my bore is no good to even water crops, so I can't grow crops or grass to feed the animals. . . . This is unbelievable. Just on the top of our bore . . . all the meters, even [the company's meters] read 50 per cent gas coming out the top, methane gas. Now, we can't do anything about it because we don't know what to do, because they told me not to close the bore because it can blow up. So I just leave it open, so everybody else, my next door neighbour, can breathe it in. . . . It comes straight out. . . . We used to bath in it, but we don't bath in it anymore. . . . I don't know what to do. I'm ready to sell and leave.

Some local residents are therefore confronted with uncertainties about the human health impacts of CSG extraction. One landholder explained the bodily experience of CSG and resulting uncertainty in an open letter:

> So I watched my children and my husband (and myself) continue to get sick, the rashes and blood noses started, then the smell wafted in and we had to ask ourselves 'is it the gas', and so the journey began.

Especially among local residents, sense-making of CSG and its risks involves direct and indirect phenomenological experiences – knowing through everyday embodied practices – and coming to terms with the immediacy of new lived uncertainties. However, these uncertainties are not exclusive to local residents but can, albeit in different forms, also be observed among (often external) scientists who investigate the impacts of CSG.

Leaving aside the more fundamental debate about definitions of scientific knowledge, we draw here on responses from natural scientists employed within academia and as independent consultants working on different aspect of CSG developments. One noticeable finding is that among some of these actors, too, knowledge about potential, especially long-term, impacts and risks remains unsettled. For example, many interlocutors working on future groundwater-related impacts noted the heavy reliance on scientific modelling conducted by the State. While usually emphasizing the high and improving quality of the modelling, concerns were frequently raised about the scale of the modelled geographic area, the complexity of hydrogeological and ecological systems, the ambiguities of the modelling process, and the need to understand modelling output as conceptual working tools that are subject to review and improvements over time. One senior academic groundwater scientist explained in response to a question about the exact impacts of CSG developments for local farmers and residents:

> [T]hat's the million dollar question. I still don't think we know definitely and perhaps we never will, but at least the way I see the structure now . . . I think you'll see some very good studies.

However, the scientist noted the political nature of hydrological modelling and scientific research, and referred to the difficulties of obtaining adequate data in the first place.

> [T]he companies are taking water quality samples, levels, doing all sorts of tests for their own commodity, and also trying to

[1] We describe these differentiations in the Weberian sense of ideal types, which is not to say that ways of knowing do not overlap and form complex entanglements in the lived encounters with CSG. Our intention is therefore not to ascribe these responses solely to any one (in itself idealized) actor group and to dissociate these from one another, but rather to draw attention to the existing diverse forms of knowledge emerging in relation to CSG.

[2] The IAA is a modelled geographic area in which bores are predicted to be impacted by groundwater drawdown within the first three years of CSG developments. The impact modelling was conducted by the Queensland State Government in the Brisbane-based Office of Groundwater Impact Assessment (OGIA) and is associated with the declaration of a Cumulative Management Area (CMA) that spans parts of the Surat and Bowen Basins. Landholders with affected bores in the IAA are entitled to so-called Make Good agreements with the tenement-holding CSG company.

understand their risks, and nobody has that data. Well, the companies have that data and keep that data and they will not release it.

These statements resonate with the account of an independent hydrogeologist who stressed the need to separate modelling from magic[3]:

No, I don't think we've already caught up [with the industry's scale and pace]. But I think they are still working on this. . . . Farmers have got to really take models in blind faith. Because they are never going to understand them. And half the people in the department never understood them . . .. And people didn't realize you've got to update these things. The model isn't magical.

While this account suggests that improvements of the existing model and, crucially, of the public's understanding of the models' output may increase existing knowledge and reduce uncertainties, a senior natural resource management consultant and agricultural scientist was more pessimistic:

There is a fellow at [a university] who has done a significant review of the groundwater models, and [it] basically says there are seven models and none of them agree. But we knew that.

During interviews, scientists frequently emphasized that ambiguities remain and, more fundamentally, that scientific research, knowledge gaps, and uncertainties are inseparable (cf. Ref. [4]). Scientific knowledge, in their view, is ultimately unlikely to provide answers that conclude current risk debates and the public's demand for certainty.

The resulting tension is not merely rooted in the nature of scientific enquiry, but also related to the characteristics of subterranean resource and unconventional gas developments. That is, locating and extracting commercial quantities of oil and gas is inherently imbued with uncertainties, and this is especially so in the case of unconventional gas developments and its subsequent conversion to LNG, which, at the Queensland scale and pace, is a world-wide novelty (e.g. Ref. [34,pp. 42,49 & 57]).[4] How, then, do CSG industry professionals engage with questions related to knowledge, uncertainty, and risk?

Among industry representatives we found such a diversity of concerns and responses that we may speak of different cultures of knowledge and risk, even within companies. For example, a company environmental ecologist described concerns with the company's reservoir engineers' approaches to environmental impacts, but noted that, ultimately, both were secondary to the company's economist who was said to make the important decisions mainly based on cost calculations. For CSG industry professionals, uncertainties, risks, and indeterminacies are omnipresent in their daily work practices and communications. On a macro-level, risks are of course also apparent in the repercussions of the collapse of oil and gas prices throughout 2015, which may lead to some corporate regret about the A$70 billion investment decisions made some years ago. However, for the present purpose we focus primarily on the micro-level and the practices around CSG developments. On the work floor, uncertainties often lead to a tendency to normalize risk and potential unknowns as part of the extraction process. For instance, an experienced groundwater specialist previously employed in a senior company position described the inevitable risks within the industry:

Obviously risk management from a localized event, they [i.e. incidents] are going to happen. You drill 5,000 holes in the ground, something is going to go wrong. It has to, the law of averages is against you. They are human beings doing this. You've got a lot of uncertainties.

While accidents do of course occur in any industry, our intention is to highlight the embeddedness of these uncertainties among industry representatives. This is also evident in the procedures to locate and prove underground gas reserves. Leaving aside the systematic exploratory process of moving from so-called 'found' resources, to 'probable', to 'proven' reserves,[5] a revealing dynamic of uncertainty occurs around the location of so-called 'sweet spots' and 'hit or miss' rhetoric. For example, during a bus tour of one major gas processing facility in the Darling Downs, the leading technical officer noted how wells have their own 'identities', which is to say that some wells produce more gas than others and/or at higher levels for longer periods of time. For the technical officer this was due to some hitting a better spot – the colloquial 'sweet spot' – but the production level of wells did not appear to be easily predictable even within the same gas field.[6]

His account of 'sweet spots' and unpredictable well production and depletion rates resonates strongly with the perspective of a drilling and hydraulic fracturing expert who described the process of well construction. He noted that "there's still a lot of uncertainty about the geological model, but [now] you have more precision in your data stream. . . . [A]s we gain more knowledge, we have more precision". During drilling itself, he explained, uncertainty about the underground geology was not unusual. This means that going back and forth in different directions with the drill head in an attempt to follow the coal seam is a normal procedure. The embeddedness of risk and inexact subterranean knowledge in drilling is even more apparent in some aspects of the subsequent hydraulic fracturing process. Referring to the 'stimulation' of an unlined laterally drilled coal seam gas well, the expert described such fracking operations as a 'spray and pray' process as only limited knowledge and control was available to determine underground effects. Another subterranean uncertainty well-known among drillers is the so-called 'thief zone'. This porous subterranean zone may be hit during the drilling process, leading to an unexpected rapid loss of drilling mud. As for 'sweet spots', however, locating these zones with certainty is difficult.

In summary, during our research among industry professionals we encountered an almost omnipresent engagement with limited knowledge, uncertainty, and risk. However, compared to the concerned responses from, for example, local residents and landholders, these are dealt with by industry professionals as a normal and integral part of the industry's practice. In the following section we examine how these differences play out within the context of wider public risk debates.

5.2. Reading science: pure and polluted

Our findings and analysis of publicly available documents, including media, government and industry reports, reveals that 'science' is used to argue for and against the industry. The different responses to a draft study of hydraulic fracturing and drinking water impacts by the American Environmental Protection Agency

[3] cf. Biersack [8,p. 80] for a contrasting view of geologists and mining technicians held by the Paiela people of Highland Papua New Guinea as the 'shamans of Paiela modernity'.

[4] For example, contrary to the number cited above, at the time of writing, revised forecasts halved estimates to 20,000 wells in Queensland [50,p. 14]. This significant discrepancy in predicted well numbers, however, adds further uncertainties for many residents, as expressed by landholders during a consultation meeting in March 2016.

[5] Explained by a driller.

[6] de Rijke et al. [16] have similarly described knowledge of the peculiarities of subterranean water resources at the farm level among irrigators in the same region.

(EPA) in 2015 provide a good illustration of the ways in which science is read by different stakeholders. For example, the American proponent website 'Energy from Shale', concluded in a headline that:

> Following a five-year information gathering period, the EPA confirmed what industry experts already knew: Safe hydraulic fracking doesn't threaten our drinking water. The EPA's study results disprove the scaremongering tactics utilized by fracking opponents. The main takeaway from the study can be summarized by a single quote, found in the EPA's draft report: "We did not find evidence that these mechanisms have led to widespread, systemic impacts on drinking water resources in the United States."

Opponents, however, read the report differently. An American environmental news website, for example, opened its review of the study with the statement that:

> Last week, the U.S. Environmental Protection Agency (EPA) released 1000-plus draft pages of its "Hydraulic Fracturing Drinking Water Assessment." The report took almost five years to produce and essentially tells us (in great detail) what we already knew: Fracking and drinking water are a bad combination. On top of that, the EPA finally admitted that water resources have already been contaminated by fracking: "We found specific instances where one or more mechanisms led to impacts on drinking water resources, including contamination of drinking water wells".[7]

In early 2016, the EPA's own Science Advisory Board, after a review of the draft study, was considering a more nuanced evaluation. A University of California engineering professor and board member, for example, reportedly suggested changes to the conclusion about widespread, systemic impacts, and:

> faulted the document for trying "to draw a global and permanent conclusion about the safety or impacts of hydraulic fracturing at the national level" given the "uncertainties and data limitations described in the report".[8]

We hence observe three very different readings of the same study: the first ignored certain details and highlighted the general conclusion, the second highlighted certain details and ignored the general conclusion, and the third advocated for a better articulation of the relationship between general conclusion and details. The risks associated with uncertainty, thus, are interpreted differently among diverse sectors of society, in this case leaving the scientists in between gas industry proponents and opponents with diagonally opposed readings of the same document.

Perhaps reflecting an acceptance that a focus on science itself is politically ineffective in such cases, proponents may also describe threats to the industry as a risk to national energy security and economic development (e.g. Ref. [46]). For example, in a media release entitled 'Activists campaign against energy security and jobs', the Australian Petroleum Production & Exploration Association – Australia's oil and gas lobby group – claimed that opposition to unconventional gas developments 'is really a campaign against the energy that powers our homes, Australian jobs and investment in our economy'. Among other issues, opponents of unconventional gas developments, however, maintain a strong focus on existing scientific uncertainty and argue for the application of the precautionary principle to halt the industry. Consequently, Australian regulators have found it difficult to act decisively in these circumstances (e.g. Refs. [13,69]). We therefore agree with Williams et al. [73,p. 12] who concluded their study of public perceptions of fracking in the UK with the observation that:

> the fracking problem is not just about the existence of objective risks, nor just about the public's ability to understand them, but also about the institutional ability and willingness to recognise, encounter and accommodate diverse and polyvalent public views, and that broader consideration of possible uncertainties and areas of ignorance, and broader, more plural, deliberation around innovation choices and the social desirability of fracking are justified, necessary and rational.

We have argued that these 'diverse and polyvalent public views' are fundamentally related to the interplay of different ways of knowing and ongoing sociocultural practices of sense-making. On the one hand, we observe a focus on scientific knowledge as pure, universal and reflective of truth, leading to arguments that more science will settle the debate. On the other hand, we find views of science as inherently incomplete and therefore insufficiently reliable for decision-making purposes. This view has gained particular societal traction since the emergence of a phenomenon now commonly referred to as 'frackademia': the asserted usurpation of academic research and intellectual rigour in service of the unconventional hydrocarbon industry (e.g. Ref. [61]). Indeed, diminishing public research funding and a concomitant increase in requests for funding from industry has led to considerable concern about research integrity in Australia generally (e.g. Refs. [38,39]). Leaving aside some of the fundamental questions about the relation between funding and integrity, we argue that in the context of CSG such dynamics have contributed substantially to a public view of science and scientific institutions as potentially 'polluted'.[9] As noted above, the potent sociocultural categories of purity, danger and pollution are important to the unconventional gas and risk debates. The emergence of 'frackademia', in combination with an industry-supportive Australian political economy of 'adaptive management' and the celebration of 'the new gas age' [46], has thus exacerbated tensions to which science itself has no answers. Nevertheless, science remains a central concern in current Australian debates.

Throughout our fieldwork it has become apparent that the debate about CSG has to some degree been 'scientized' (cf. Ref. [59]) with frequent calls for 'science over emotions' by a variety of actors. We therefore agree with Evensen [22] who observes scientized discourses around the regulation of shale gas[10] developments in the United States that, he argues, are characterized by a 'cryptonormativism', or the "tendency of political figures [and actors *per se*] to cloak normative statements with science as a way of justifying their positions" (515). Constructing and stating the 'mere facts' of scientific enquiry suggest a de-politicized and independent claim that is untainted by individual political motivations and agendas and, therefore, more legitimate. Put differently, by referring to the output of distant centres of calculation [33], actors frequently attempt to utilize evidence that is framed as the product of de-politicized, 'placeless expertise' (e.g. Ref. [53]), conforming with the modern discourse of science as pure, value-free, and a 'culture of no culture' (e.g. Refs. [26,45,47]). However, as we have described above, 'pure' and 'polluted' science are inextricably linked sociocultural

[7] http://ecowatch.com/2015/06/15/brune-epa-fracking-report/ (accessed 11.01.16).

[8] http://www.bloomberg.com/news/articles/2016-01-07/the-u-s-epa-called-fracking-safe-now-its-scientists-disagree (accessed 11.01.16).

[9] See Espig and de Rijke [21] for challenges of researching CSG debates, including an anecdote of local reactions as a result of activist perceptions of academic institutions as polluted.

[10] Shale gas is another form of unconventional gas, but similar to CSG in the controversies its development sparks.

categories ultimately to be negotiated in the broader context of large resource projects and desired futures.

6. Conclusion

In the debates about unconventional gas developments we have observed certain attempts to draw imaginary lines between experts and lay persons to establish legitimacy. These attempts to create authority and legitimize knowledge claims are, of course, intrinsically related to societal power and efforts to influence decision making processes, especially in circumstances of unsettled science and risk debates (e.g. Aitken [2] on wind power planning controversies; Lysaght and Kerridge [40] on stem cell research; Tuckwell [71] on environmental contest in mining developments; and, more generally, Stehr [66]). As we have noted, however, the ontology of risk itself grants no privilege to any specific form of knowledge, such as science over more experiential forms of knowledge. Such privileges are socially and politically negotiated among diverse sectors of society.

The (perceived) risks and uncertainties associated with modelling and subterranean peculiarities faced by scientists, industry professionals and other 'external' experts are, with the exception of on-the-ground drillers, less embodied and physically immediate than those faced by the residents and local landholders in the Queensland gas fields. For example, expert scientists often readily acknowledge the limitations of their models and scientific studies, but also defend them for their value in understanding complex natural processes (e.g. Ref. [4]). However, these uncertainties may lead non-experts who are not accustomed to them to either dismiss those models and scientific projections as 'guess work', with others taking them at face value as established 'facts'. Without necessarily dichotomizing the experts' 'abstracted' experiences of CSG with the 'lived' realities of non-experts – especially local residents and landholders – (cf. Ref. [49]), we nonetheless argue that the latter are confronted daily and unavoidably with uncertainties that impact their immediate surroundings, domestic activities and personal bodies. While differences in knowing risks and dealing with uncertainties therefore clearly exist, both 'external' professionals and 'local' persons confront these in complex and entangled ways, which ultimately undermines the boundaries and levels of legitimate participation some may wish to draw between so-called expert and lay actors.

The differences among various categories of persons in the process of knowing and experiencing risk also contribute to varying levels of demanded certainty about potential impacts. We found that landholders and residents in close geographic proximity to CSG activity generally request a higher level of certainty than 'external' industry professionals and scientists. This demand, however, often stands in contrast to those professionals and scientists' limited ability to satisfactorily deliver such guarantees. Consequently, and perhaps unsurprisingly, unknowns and uncertainties about CSG developments are less readily accepted and normalized by local landholders. However, given the propinquity of some CSG activity to the everyday life-spaces of these residents, combined with the immateriality of gas and perceptions of fracking as potentially leading to 'matter out of place', our findings highlight that risk and knowledge cannot be regarded merely as objective categories and issues best left to knowledgeable 'experts'. Rather, we argue that both concepts must be understood as socio-culturally informed practices of sense-making by those involved. The role of risk and knowledge in resource contests are thus continuously negotiated and, following Douglas [18] and Douglas and Wildavsky [19], subject to cultural sentiments regarding purity and danger, and discursive exchanges over acceptable and desired futures.

Our findings and analyses raise some important issues for unconventional energy developments in contemporary societies. Firstly, negotiating induced risks and existing levels of knowledge of potential impacts forms an intrinsic part of these projects and cannot be avoided by resorting to 'expert' authorities. In fact, our research indicates that ignoring or disregarding lived experiences and expertise as 'lay' frequently reinforces existing power imbalances and spurs controversy. Secondly, an appropriate response to the contingent and processual nature of these negotiations requires a consideration of political dimensions. That is, public and institutional frameworks may productively allow for the articulation and meaningful incorporation of varying accounts. To be clear, creating such spaces will only be fruitful if the authority, legitimacy, and validity of various positions are not solely judged against notions of 'pure' and 'polluted' knowledge. While the emergence of 'frackademia' may limit the public role of some scientific institutions in risk debates, presupposing a form of 'pure' science would also be inconsistent with the view held by a significant number of scientists for whom uncertainty is omnipresent. We therefore, thirdly, caution against a scientization of these discursive exchanges and negotiations, and advocate a critical engagement with the politics of risk and knowledge inherent within them. That is, the management of energy resource projects and other initiatives of significant societal import would be assisted by thorough qualitative research on who regards what at risk, how that is so, and who, and on what basis, is subsequently considered able to legitimately participate in the decision making process (cf. Ref. [65]).

With global energy needs and especially the demand for natural gas predicted to significantly increase over the next two decades [30], unconventional hydrocarbon reserves and extractive fracking technologies may become increasingly important not just in North American and Australia. Given the intense public opposition to these developments in recent years, it is important to understand the social dynamics that occurred in areas with operational projects and the debates that emerged around them. The data on risk and knowledge debates obtained from a variety of actors in the CSG development areas of Queensland, as well as our analysis of publicly available documents regarding such studies as the American EPA fracking and drinking water assessment, provide critical insights into the social complexities and intricacies of relevance to unconventional gas developments generally. Such understandings may contribute to an appreciation and institutional incorporation of the politics of risk and knowledge inherent within new and globally significant energy debates.

References

[1] B. Adam, L. van Loon, Introduction: repositioning risk—the challenges for social theory, in: B. Adam, U. Beck, L. van Loon (Eds.), The Risk Society and Beyond: Critical Issues in Social Theory, SAGE Publications, London, Thousand Oaks & New Delhi, 2000, pp. 1–31.
[2] M. Aitken, Wind power planning controversies and the construction of 'expert' and 'lay' knowledges, Sci. Cult. 18 (1) (2009) 47–64.
[3] J. Arnoldi, Risk: An Introduction, Polity Press, Cambridge & Maiden, 2009.
[4] J. Barnes, Uncertainty in the signal: modelling Egypt's water futures, J. R. Anthropol. Inst. 22 (S1) (2016) 46–66.
[5] U. Beck, Risk Society: Towards a New Modernity, SAGE Publications, London, Newbury Park & New Delhi, 1992.
[6] U. Beck, World Risk Society, Polity Press, Cambridge & Malden, 1999.
[7] U. Beck, World at Risk, Polity Press, Cambridge & Malden, 2009.
[8] A. Biersack, The Mount Kare python and his gold: totemism and ecology in the Papua New Guinea Highlands, Am. Anthropol. 101 (1999) 68–87.
[9] E. Cartwright, Eco-risk and the case of fracking, in: S. Strauss, S. Rupp, T. Love (Eds.), Cultures of Energy: Power, Practices, Technologies, Left Coast Press, Walnut Creek, 2013, pp. 201–212.
[10] Commonwealth of Australia, Review of the Socioeconomic Impacts of Coal Seam Gas in Queensland, Office of the Chief Economist; Department of Industry, Innovation and Science; Australian Government, Canberra, 2015.
[11] P. Cook, V. Beck, D. Brereton, R. Clark, B. Fisher, S. Kentish, J. Toomey, J. Williams, Engineering Energy: Unconventional Gas Production—A Study of

Shale Gas in Australia, Australian Council of Learned Academies (ACOLA), Melbourne, 2013.
[12] GISERA, Coal Seam Gas Developments—Predicting Impacts, Gas Industry Social & Environmental Research Alliance (GISERA), Australia, 2014.
[13] K. de Rijke, Coal seam gas and social impact assessment: an anthropological contribution to current debates and practices, J. Econ. Soc. Policy 15 (3) (2013), Article 3.
[14] K. de Rijke, Hydraulically fractured: unconventional gas and anthropology, Anthropol. Today 29 (2) (2013) 13–17.
[15] K. de Rijke, The agri-gas fields of Australia: black soil, food, and unconventional gas, Cult. Agric. Food Environ. 35 (1) (2013) 41–53.
[16] K. de Rijke, P. Munro, M. Melo Zurita, The Great Artesian Basin: a contested resource environment of subterranean water and coal seam gas in Australia, Soc. Nat. Resour. 29 (6) (2016) 696–710.
[17] R. Dilley, G. Kirsch (Eds.), Regimes of Ignorance: Anthropological Perspectives on the Production and Reproduction of Non-Knowledge, Berghahn Books, New York & Oxford, 2015.
[18] M. Douglas, Purity and Danger: An Analysis of the Concepts of Danger and Taboo, Routledge, London, 1966.
[19] M. Douglas, A. Wildavsky, Risk and Culture, University of California Press, Berkeley & Los Angeles, 1982.
[20] R.V. Ericson, K.D. Haggerty, Policing the Risk Society, University of Toronto Press, Toronto & Buffalo, 1997.
[21] M. Espig, K. de Rijke, Navigating coal seam gas fields: ethnographic challenges in Queensland, Australia, Pract. Anthropol. 38 (3) (2016), forthcoming, summer.
[22] D. Evensen, Policy decisions on shale gas development ('fracking'): the insufficiency of science and necessity of moral thought, Environ. Values 24 (2015) 511–534.
[23] D. Evensen, J.B. Jacquet, C.E. Clarke, R.C. Stedman, What's the 'fracking' problem? One word can not say it all, Extr. Ind. Soc. 1 (2) (2014) 130–136.
[24] J. Everingham, N. Collins, D. Rodriguez, J. Cavaye, S. Vink, W. Rifkin, T. Baumgartl, Energy Resources from the Food Bowl: An Uneasy Coexistence. Identifying and Managing Cumulative Impacts of Mining and Agriculture, CSRM, The University of Queensland, Brisbane, 2013.
[25] J.A. Everingham, V. Devenin, N. Collins, The beast doesn't stop: the resource boom and changes in the social space of the Darling Downs, Rural Soc. 24 (1) (2015) 42–64.
[26] S. Franklin, Science as culture, cultures of science, Ann. Rev. Anthropol. 24 (1995) 163–184.
[27] A. Giddens, Runaway World: How Globalisation is Reshaping Our Lives, Profile Books, London, 2002.
[28] Routledge International Handbook of Ignorance Studies, in: M. Gross, L. McGoey (Eds.), Routledge, Abingdon & New York, 2015.
[29] A. Hudgins, Fracking's future in a coal mining past: subjectivity undermined, Cult. Agric. Food Environ. 35 (1) (2013) 54–59.
[30] International Energy Agency, World Energy Outlook 2013 Factsheet: How Will Global Energy Markets Evolve to 2035? International Energy Agency, Paris, 2013.
[31] A. Irwin, Sociology and the Environment, Routledge, London & New York, 2001.
[32] H. Knoblauch, Focused ethnography Forum: Qual. Soc. Res. 6 (3) (2005), Art. 44.
[33] B. Latour, Science in Action: How to Follow Scientists and Engineers Through Society, Harvard University Press, Cambridge, 1987.
[34] D. Ledesma, J. Henderson, N. Palmer, The Future of Australian LNG Exports, Oxford Institute for Energy Studies, Oxford, 2014.
[35] D.J. Lloyd, H. Luke, W.E. Boyd, Community perspectives of natural resource extraction: coal-seam gas mining and social identity in Eastern Australia, Coolabah 10 (2013) 144–164.
[36] S. Lockie, Social nature: the environmental challenge to mainstream social theory, in: R. White (Ed.), Controversies in Environmental Sociology, Cambridge University Press, Cambridge, 2004, pp. 26–42.
[37] H. Luke, K.A. den Exter, W.E. Boyd, D.J. Lloyd, B. Roche, Developing the lismore CSG poll—a university/local government collaboration, J. Econ. Soc. Policy 15 (3) (2013), Art. 6.
[38] K. Lyons, 'Partner or Perish'? The convergence of public and private interests pose new questions for controversial university science research, Chain Reaction (June) (2014), Magazine of Friends of the Earth Australia.
[39] K. Lyons, C. Richards, Mining the integrity out of Australian universities? Arena (124) (2013) 7–9.
[40] T. Lysaght, I. Kerridge, Rhetoric, power and legitimacy: a critical analysis of the public policy disputes surrounding stem cell research in Australia (2005–6), Public Underst. Sci. 21 (2) (2012) 195–210.
[41] J. Mair, A.H. Kelly, C. High, Introduction: making ignorance and ethnographic object, in: C. High, A.H. Kelly, J. Mair (Eds.), The Anthropology of Ignorance: An Ethnographic Approach, Palgrave Macmillan, New York & Basingstoke, 2012, pp. 1–32.
[42] M. Makki, Coal Seam Gas Development and Community Conflict: A Comparative Study of Community Responses to Coal Seam Gas Development in Chinchilla and Tara, Queensland. Doctoral Thesis, University of Queensland, School of Communication and Arts, 2015.
[43] T.H.J. Marchand, Making knowledge: explorations of the indissoluble relation between minds, bodies, and environment, J. R. Anthropol. Inst. 16 (s1) (2010) 1–21.
[44] G.E. Marcus, Ethnography in/of the world system: the emergence of multi-sited ethnography, Ann. Rev. Anthropol. 24 (1) (1995) 95–117.
[45] E.D. McCarthy, Knowledge as Culture: the New Sociology of Knowledge, Routledge, New York, 1996.
[46] A. Mercer, K. de Rijke, W. Dressler, Silences in the boom: coal seam gas, neoliberalizing discourse, and the future of regional Australia, J. Polit. Ecol. 21 (2014) 279–302.
[47] Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge, in: L. Nader (Ed.), Routledge, New York & London, 1996.
[48] L. Nader, The Energy Reader, Wiley Blackwell, Oxford, 2010.
[49] J. O'Reilly, Sensing the ice: field science, models, and expert intimacy with knowledge, J. Royal Anthropol. Inst. 22 (S1) (2016) 27–45.
[50] OGIA, Underground Water Impact Report for the Surat Cumulative Management Area—Consultation Draft, The Office of Groundwater Impact Assessment, Department of Natural Resources and Mines; State of Queensland, Brisbane, 2016.
[51] S. Pink, J. Morgan, Short-term ethnography: intense routes to knowing, Symb. Interact. 36 (3) (2013) 351–361.
[52] A. Randall, Coal seam gas—toward a risk management framework for a novel intervention, Environ. Plan. Law J. 29 (2) (2012) 152–162.
[53] J. Reno, Beyond risk: emplacement and the production of environmental evidence, Am. Ethnol. 38 (3) (2011) 516–530.
[54] T. Richardson, G. Weszkalnys, Resource materialities, Anthropol. Q. 87 (1) (2014) 5–30.
[55] P.B. Roscoe, The perils of 'Positivism' in cultural anthropology, Am. Anthropol. 97 (3) (1995) 492–504.
[56] J. Rouse, Engaging Science: How to Understand Its Practices Philosophically, Cornell University Press, Ithaca & London, 1996.
[57] J. Rouse, Vampires: social constructivism, realism, and other philosophical undead, Hist. Theory 41 (1) (2002) 60–78.
[58] S.E. Ryan, C. Hebdon, J. Dafoe, Energy research and the contributions of the social sciences: a contemporary examination, Energy Res. Soc. Sci. 3 (2014) 186–197.
[59] D. Sarewitz, How science makes environmental controversies worse, Environ. Sci. Policy 7 (2004) 385–403.
[60] T.R. Schatzki, K. Knorr Cetina, E. von Savigny (Eds.), The Practice Turn in Contemporary Theory, Routledge, London & New York, 2001.
[61] J. Schneider, Frackademia, divestment, and the limits of academic freedom, in: Paper Presented at the Conference on Communication and the Environment, International Environmental Communication Association, Boulder, Co. June 13, 2015.
[62] M. Sherval, K. Hardiman, Competing perceptions of the rural idyll: responses to threats from coal seam gas development in Gloucester, NSW, Australia, Aust. Geogr. 45 (2) (2014) 185–203.
[63] D. Short, J. Elliot, K. Norder, E. Lloyd-Davies, J. Morley, Extreme energy, 'fracking' and human rights: a new field for human rights impact assessments? Int. J. Hum. Rights 19 (6) (2015) 697–736.
[64] J. Simonelli, Home rule and natural gas development in New York: civil fracking rights, J. Polit. Ecol. 21 (1) (2014) 258–278.
[65] B.K. Sovacool, S.E. Ryan, P.C. Stern, K. Janda, G. Rochlin, D. Spreng, M.J. Pasqualetti, H. Wilhite, L. Lutzenhiser, Integrating social science in energy research, Energy Res. Soc. Sci. 6 (2015) 95–99.
[66] N. Stehr, Knowledge, democracy and power, Cent. Eur. J. Public Policy 4 (1) (2010) 14–35.
[67] N. Stehr, Knowledge and non-knowledge science, Technol. Innov. Stud. 8 (1) (2012) 3–13.
[68] S. Strauss, S. Rupp, T. Love (Eds.), Cultures of Energy: Power, Practices, Technologies, Left Coast Press, Walnut Creek, 2013.
[69] N. Swayne, Regulating coal seam gas in Queensland: lessons in an adaptive environmental management approach? Environ. Plan. Law J. 29 (2) (2012) 163–185.
[70] D. Trigger, J. Keenan, K. de Rijke, W. Rifkin, Aboriginal engagement and agreement-making with a rapidly developing resource industry: coal seam gas development in Australia, Extr. Ind. Soc. 1 (2) (2014) 176–188.
[71] E. Tuckwell, Science in dispute: debating the authority of knowledge in an environmental contestation, Oceania 82 (3) (2012) 308–322.
[72] A. Walton, R. McCrea, R. Leonard, R. Williams, Resilience in a changing community landscape of coal seam gas: Chinchilla in Southern Queensland, J. Econ. Soc. Policy 15 (3) (2013), Art. 3.
[73] L. Williams, P. Macnaghten, R. Davies, S. Curtis, Framing 'fracking': exploring public perceptions of hydraulic fracturing in the United Kingdom, Public Underst. Sci. (2015) 1–17, Published online before print 13 July 2015.
[74] A.K. Werner, S. Vink, K. Watt, P. Jagals, Environmental health impacts of unconventional natural gas development: a review of the current strength of evidence, Sci. Total Environ. 505 (2015) 1127–1141.
[75] A.J. Willow, S. Wylie, Politics, ecology: and the new anthropology of energy: exploring the emerging frontiers of hydraulic fracking, J. Polit. Ecol. 21 (2014) 222–236.
[76] K. Wolske, A. Hoffman, Public perceptions of high-volume hydraulic fracturing and deep shale gas development Graham Sustainability Institute Integrated Assessment Report Series, vol. 2, University of Michigan, Ann Arbor, 2013, Report 8.
[77] S. Yearley, Making Sense of Science: Understanding the Social Study of Science, SAGE Publications, London, Thousand Oaks & New Delhi, 2005.

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Coal Seam Gas and Social Impact Assessment: An Anthropological Contribution to Current Debates and Practices.

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Coal Seam Gas and Social Impact Assessment: An Anthropological Contribution to Current Debates and Practices.

Abstract
Unconventional coal seam gas extraction is expanding rapidly in the renowned agricultural region of the Darling Downs in Queensland, Australia. These developments have given rise to substantial conflict, including the emergence of a national and vocal anti-coal seam gas movement. This paper examines the Darling Downs region and social impact research with regard to coal seam gas developments. It addresses disputes about coal seam gas on the basis of anthropological perspectives with regard to social dynamics and the concept of community, with examples derived from ongoing anthropological fieldwork, including interviews and observations in the area over the past eighteen months. Two specific documents are commented on, including the recent Queensland guideline for social impact assessments (SIA), and the SIA for Arrow Energy's Surat Gas Project. The paper suggests areas of possible improvement and argues that complex social dynamics and the notion of community should be more carefully considered in SIA.

Keywords
Unconventional gas, social impacts, community, conflict, fracking, resource extraction, governance

Cover Page Footnote
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Introduction

Unconventional gas has been extracted in Australia for more than fifteen years, but large-scale developments started to increase rapidly since about 2006. It became a matter of national and international controversy a number of years later, particularly after the release of the American activist documentary *Gasland* in 2010. Current extraction in Australia is largely from coal seams, with plans to extract gas from shale emerging more recently. Coal seam gas (CSG) extraction is most substantial in the relatively arable regions on the eastern seaboard, particularly the Surat and Bowen Basins in Queensland (see Figure 1). Large export facilities and industrial plants to convert the inland CSG into Liquefied Natural Gas (LNG) are under construction on the Queensland coast at Curtis Island near Gladstone. Smaller CSG developments are currently considered in areas such as the Northern Rivers in New South Wales and Gippsland in Victoria, among others. Shale gas exploration is underway in remoter regions such as the Canning Basin in northwest Western Australia, and the Georgina Basin in the Northern Territory.

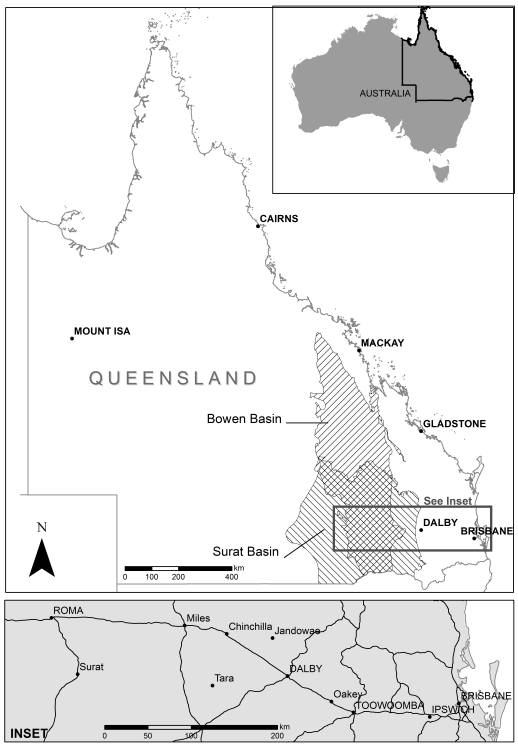

Figure 1: The Surat and Bowen Basins in Queensland.
Source: Whincop and de Rijke (2013).

In light of climate change and the need to reduce carbon dioxide emissions, CSG has been promoted as a 'transitional' source of energy, providing a cheaper and cleaner-burning source of energy than coal and oil. The CSG industry has also been welcomed as a new source of revenue by both the Queensland state government and rural landholders operating in financially challenging times. In 2011, the then-Premier of Queensland announced the arrival of a new 'gas age', characterised by multi-billion dollar investments, many thousands of new jobs and a general sense of future prosperity (Bligh, 2011). Two years later, in March 2013, the Australian Petroleum Production and Exploration Association (APPEA) stated in support of that vision that:

> Queensland's coal seam gas industry now employs more than 27,000 people, has signed 3,500 landholder agreements, and has so far contributed more than $100 million to community projects and causes (APPEA, 2013a).

The CSG industry expansion has undoubtedly brought increased economic activity and investment to resource regions such as the Darling Downs in the Surat Basin. Certain local businesses capable of servicing the gas industry, for example, have grown substantially as a result of these activities, and rural landholders engaged in agricultural pursuits may have obtained an important additional income stream. Additionally, Indigenous Land Use Agreements (ILUAs) may bring economic benefits to disadvantaged Aboriginal groups in extraction and processing areas. Moreover, to maximise the economic benefits for Aboriginal people, the New South Wales Aboriginal Land Council (NSWALC), in cooperation with a number of Local Aboriginal Land Councils in that state, is in the process of becoming actively involved in CSG exploration and extraction activities (NSWALC, 2012; Interview participants, January 17, 2013).

However, CSG has also given rise to substantial contestation, including the emergence of a national and vocal anti-CSG movement. This movement, largely under the umbrella of the Lock the Gate Alliance (LTGA) established in 2010, seeks to mobilise socio-politically diverse and localised groups across the country against CSG, and what it considers as inappropriate forms of mining generally (LTGA, 2013). It voices concerns about unconventional gas that are shared internationally, such as those with regard to controversial hydraulic fracturing technologies and the potential for environmental pollution, the continued use of fossil fuels in light of global climate change, future food production and human health. Local activist agendas oscillate between these concerns and those issues more specific to their region, environment and social dynamics. The intensity of national and international debates surrounding unconventional gas and attendant

technologies underlines the salience of social factors relevant to energy production and resource extraction.

This paper examines social impact research with regard to CSG developments in the eastern Darling Downs region of southern Queensland, an area broadly surrounding the town of Dalby (see Figure 1). It addresses disputes about CSG on the basis of anthropological theories with regard to social dynamics and the concept of community, with examples derived from both desktop research and ongoing fieldwork in the gas field region. The fieldwork examples described in the paper are drawn from in-depth semi-structured interviews with a range of persons largely selected through snowball sampling, including, but not limited to, cattle, crop, and cotton farmers with and without CSG infrastructure on their land, town residents, anti-CSG activists, local entrepreneurs and business representatives, government representatives, Aboriginal people, and residents of the rural residential estates in the region. Snowball sampling involved the selection of informants on the basis of referrals by interviewees, a method particularly useful in researching community networks: "who people know and how they know each other" (Bernard, 1995, pp. 97-98). While some examples are quotes from individuals - each with a particular background and social network - they aptly illustrate the broader range of regional social dynamics this paper aims to highlight. Based on the triangulation of data derived from multiple sources and research methods (e.g. Jick, 1979), including fieldwork data, academic literature, historical data, statistical analyses, as well as media releases and reports, the paper argues that the complexity of social dynamics and the concept of community should be more carefully considered in social impact assessments (SIAs).

The first part of the paper sets out, albeit briefly, some characteristics of the region under consideration. These characteristics inform the second and most substantial part of the paper on SIA theory and current practice. The new Queensland government's SIA guideline, released in July 2013, and the Surat Gas Project SIA by Arrow Energy are used as case studies to comment on research practices and the ways in which social dynamics and the concept of community are engaged. The aim of the paper is thus to offer an anthropological contribution to research on the social aspects surrounding CSG debates in Australia and SIA policies more broadly.

The Darling Downs region of Queensland: Agribusiness, lifestyle and coal seam gas

Land use

The Darling Downs region was named in honour of Governor Darling by the botanist explorer Allan Cunningham in 1827 (Hall, 1925). Cunningham referred to the area with terms such as 'extensive tracts of open country', 'very superior country', and celebrated the 'the range of luxuriant pasturage' (Cunningham, quoted in Hall, 1925, pp. 6-7). These pastures would provide for the thousands of sheep and cattle brought to the Darling Downs by subsequent squatters, who followed some years later as a result of Cunningham's reports. The large stations they established in the 1840s and 1850s at the cost of the Indigenous population have long since been subdivided into smaller grazing and agricultural properties, but their homesteads remained an important part of non-Indigenous cultural heritage (e.g. Hall, 1925; Heritage Consulting Australia Pty Ltd, 2011).

As land use diversified on the Darling Downs, dairying, crops, timber, as well as coal resources were developed. A noteworthy historical development with regard to changing environmental engagements and priorities took place around the small town of Warra, an area of fertile cropping and cotton land where current landholders are strongly opposed to coal mining. This particular area was first developed for agricultural purposes by former railway workers and coal miners who had lost their jobs due to the local coal mine closure in 1919 (Heritage Consulting Australia Pty Ltd, 2011, p. 95). It is in this area that the Lock the Gate Alliance set up its first office.

Coal extraction and agriculture are historically intertwined and important to the economic and social history of the Darling Downs. At least in the earlier parts of the 20th century, these industries were not necessarily seen as incompatible. In his 1925 history of the southern Darling Downs, for example, Hall (1925, p. 4) described the potential of agriculture, but also noted that:

> Some coal beds have been worked successfully for years, but there are many others lying as Nature made them, awaiting the power of Capital to vitalise the energy of man, so as to make the Darling Downs take its proper place as a coal mining area.

Employment

The latest census data by the Australian Bureau of Statistics (ABS) indicate that in the eastern Darling Downs, 20 percent of employed persons over 15 years of age are employed in the industries of agriculture, forestry and fishing, and 4 percent in mining (ABS, 2011a). Despite the much smaller number of people employed in mining, in the Western Downs local government area where CSG is currently extracted, the mining industry nevertheless provided approximately 23 percent of gross regional product, followed at some distance by agriculture, forestry and fishing with 12.2 percent (Advance Western Downs, 2013, p. 2).

Once the dominant form of employment and production, agricultural initiatives on the fertile black soils of the eastern Darling Downs have faced significant challenges and changes since early colonial settlement of the region in the mid-1800s. So-called 'closer settlement' government schemes to radically increase rural population numbers based on an agrarian ideology in the late 1800s and early 1900s for example failed in light of "environmental, technical and economic problems" and the absence of appropriate farming skills among the envisaged "rural yeomanry" (Cameron, 2005, p. 129; Frawley, 2007, p. 378). During that period the wider region became infamous as 'Prickly Pear Land' due to the thick spread of the introduced Prickly Pear (*Opuntia monacantha*), which in vast areas was so impenetrable for humans and livestock it became "a serious biological barrier to the settlement of the Australian inland" (Frawley, 2007, p. 378). Prickly Pear was eventually controlled in the 1920s with the introduction of a South-American moth (*Cactoblastis cactorum*), the larvae of which are Prickly Pear-specific parasites (the Boonarga Cactoblastis Memorial Hall outside the town of Chinchilla is the only memorial hall in Australia built in honour of an insect) (Miller, 2012).

After World War Two, agriculture in the Darling Downs increasingly became a form of 'agribusiness', now characterised by 'broad-acre' farming and advanced technological production methods including GPS-guided tractors, laser-leveled land, sophisticated irrigation infrastructure, genetically modified crops, and properties of approximately 500 hectares (c.f. de Rijke, 2013a). Operating in global competitive markets, these farmers are now properly regarded as business managers: in 2011, 22.9 percent of owner manager enterprises in the agriculture, forestry and fishing sector of the eastern Darling Downs were listed as an incorporated enterprise, with some of these foreign owned (ABS, 2011a; Coffey Environments Pty Ltd, 2012a, p. 13-6).

With regard to the contemporary economic and demographic characteristics of the region, the Australian Bureau of Statistics (ABS), among other sources, provides pertinent data for analysis. Table 1 below, for example, indicates sudden population growth in the eastern Darling Downs region over the period 2006-2011, relatively low unemployment rates, and significant increases in rental prices and mortgage repayments in the region (although regional housing costs are relatively cheaper compared with Australia as a whole). As indicated by the ABS data on country of birth, the region is culturally and linguistically less diverse than Australia as a whole (see also Table 1).

Table 1: Eastern Darling Downs and Australian statistics (ABS, 2011a, 2011b)

Eastern Darling Downs

	Census year			
	2001	***2006***	***2011***	***2011 (Australia)***
Total persons	38,284	38,160	40,241	21,507,717
Unemployment (%)	5.3	4.4	3.8	5.6
Median total personal income ($/week)	344	407	511	577
Median total household income ($/week)	673	837	1,002	1,234
Median mortgage repayment ($/month)	650	893	1,300	1,800
Median rent ($/week)	100	130	195	285
Country of birth = Australia (% of total population)	88.9	88.2	85.3	69.8

While the unemployment rate is relatively low, this does not necessarily mean there is sufficient work for the population. The Darling Downs, in terms of employment, is strongly dependent on agriculture, and fluctuations in the weather, commodity prices and other factors may affect yearly employment rates. The increased mechanisation of agriculture has also had significant negative impacts on local employment opportunities. Trendle (2001) suggested that outmigration - unemployed persons leaving in search of jobs elsewhere and thus no longer included in local employment statistics - might account for the maintenance of relatively high employment rates in such cases.

Non-resident workers

Employment data therefore must be complemented with data on mobility. This topic has received particular attention in mining regions, with concerns raised about the influx of non-resident workers and potential social impacts (e.g. House

of Representatives Standing Committee on Regional Australia, 2013). The *Surat Basin Population Report* (Government Statistician, Queensland Treasury and Trade, 2012) provided pertinent data for the region, focussed on both the Western Downs Regional Council area (WDRC) and the larger Surat Basin in which CSG activities take place:

> The Surat Basin's non-resident worker on-shift population nearly doubled over the year to June 2012 (p.1).
>
> In the same year, non-resident workers on-shift made up 80 percent of full-time equivalent (FTE) population growth for the WDRC area (p.1).
>
> In the year to June 2012, the WDRC area had the largest non-resident worker on-shift population, with 4,175 people or around two-thirds (65%) of the regional total, representing an increase of 108 percent over twelve months (p.3).
>
> Many hotels/motels in the Surat Basin have limited capacity to provide accommodation for visitors other than non-resident industry workers: 400 out of 740 hotel/motel rooms were taken up by non-resident workers in WDRC (p.8).

These figures indicate what some residents qualitatively experience as a negative transition of the rural region and towns to industrial zones and what they refer to as 'mining towns'. In their study of mining developments, non-resident workers and attendant social impacts on rural communities in Queensland, Carrington and Pereira (2011, p. 2) argued that the social license to develop resource extraction projects "is very weak for projects planning to recruit a non-resident workforce in excess of 75 percent".

Large resource extraction developments are commonly accompanied by housing shortages and increased housing costs (c.f. Table 1), as well as increases in industrial traffic, which feature prominently in local concerns. In combination with the arrival of security personnel in the gas fields, publically non-accessible workers' camps, pipeline corridors, compressor stations, concerns about invisible but volatile substances, technologies such as underground hydraulic fracturing and other material transformations, the large increase in non-resident workers and industrial transformations of the landscape may contribute to a sense of alienation among certain residents (cf. de Rijke 2013a; 2013b).

Few empirical data are currently available with regard to local consequences of the arrival of large numbers of young to middle-aged men in the Darling Downs, which may potentially lead to increased levels of anti-social behaviour, crime,

(domestic) violence and personal injury, drug and alcohol abuse, prostitution, and feelings of insecurity among women (e.g. Carrington, McIntosh and Scott, 2010; Carrington, Hogg and McIntosh, 2011; Lockie, Franettovich, Petkova-Timmer, Rolfe and Ivanova, 2009).

Happiness Road and coal seam gas: issues of social differentiation

While much concern has been expressed about the potential impacts of CSG developments on the sensitive black soils of the Darling Downs (e.g. Central Downs Irrigators Ltd, 2012), not all land in the region is exceptional for agricultural purposes. Certain areas of marginal land, commonly referred to by residents and surrounding farmers as 'light country' or 'goanna country', were sold for rural residential developments in the mid-1980s. The resulting residential estates attracted people from cities in Queensland and other states interested in cheap land and a quiet rural lifestyle. These properties are generally timbered bush blocks between 30 and a few hundred acres along unsealed roads with revealing names such as Happiness Road and Lucky Road.

Around 2009, however, dense CSG developments came to an area north of Happiness Road, and the residential estates have been the focus of much CSG dispute in the Darling Downs since this time.

Particularly in the early phase after subdivision, residents of the residential estates, who live largely without secure town water supplies or sewerage, were said to have caused considerable consternation among residents in the nearby township of Tara (Tara residents, personal comments, June 2013). A number of town residents alleged that most early estate residents were from lower socio-economic backgrounds and led alternative lifestyles, contributing to what they regarded as negative publicity and a general sense of decline in the town (Tara residents, personal comments, June 2013). These sentiments have endured at least to some extent to the present day. In 2009 a newspaper reported that the local mayor:

> expressed concern that children were living in 'Third World' conditions on so-called 'lifestyle blocks' near the town of Tara, four hours west of Brisbane. "There is a small minority group there who have socially chosen to live a certain way and it concerns me greatly when children are involved," [he] said (Brisbane Times, 2009).

A number of residents on the residential estates have been vocal opponents of CSG developments, leading to tensions with those in the area who welcome the new job and investment opportunities this industry is seen to offer. For example,

in response to the verbal abuse in town of a CSG worker by an estate resident, an unsigned letter appeared on the public notice board in the main street of Tara (originally in capital letters):

> This is the group of people who are devaluing our homes, our town and our blocks of land. Make no mistake, it is these people who are destroying the value of our town, not the gas and oil companies. This is the group of mainly unemployed drones who whilst having their snouts in the public trough are abusing and threatening honest workers who try to come into our town to spend their wages.

For their part, certain residents of the estates have reported numerous impacts since the CSG developments began, including land devaluation, health impacts, noise, and water contamination. They are acutely aware that their opposition is causing tensions, as one resident explained during an interview:

> I copped a lot of shit here. [Someone's] neighbour attacked me and threatened to shoot me. Trucks were dumping the produced water and drilling waste. I thought it was dust suppression. When I swam in my dam, my skin came off. It is a real industrial zone. … We had hopes and dreams [when we came to live here]. We were demonised as radicals. We're far from radicals. "Freddy" gets $1500 per year [for a CSG well on his land] and I'm copping all the impacts. … We don't want 'us against them' [i.e. the town residents], so we let through local plumbers at [road] blockades.

The CSG industry, in other words, has exacerbated certain prior community tensions, which inform current disputes. Forms of social stratification and power struggles have important historical dimensions. In the 1860s, for example, the Darling Downs was ruled by "an elite oligarchy of aristocratic pastoralists with excellent family connections, considerable wealth, and substantial estates" (Heritage Consulting Australia Pty Ltd, 2011, p. 78). They were referred to with reference to their valuable sheep as the "pure Merinos", and their elaborate homesteads and associated buildings contrasted substantially with the more utilitarian constructions belonging to less powerful landholders in the region (Heritage Consulting Australia Pty Ltd, 2011, p. 78, 80). As I will illustrate further below, related forms of stratification are still relevant to social dynamics in the region today.

Social dynamics and social impact assessment: theory and practice

Power differences and attendant politics among social groups highlight the need for SIAs to carefully consider the concept of community in the dynamic terms of what the anthropologist Silverman (1966, p. 919) called "the cultural rules of hierarchical differentiation" (see also Cashmore and Richardson, 2013; Vicencio, 2001; Walker, 2010). Communities, as de Souza (2007, p. 141) noted, "are always and everywhere in a state of animated tension. Factions, quarrels, status distinctions are as much part of social life as solidarity, mutual regard and unified action".

The notion of community, therefore, is an "unfolding, processual, affair, one which is continually responsive to changing political circumstance rather than being somehow programmed and predictable" (Peace, 1999, p. 159). Importantly then, representations of 'the community' by local residents should be understood as contextual sociopolitical and symbolic acts that suspend internal distinctions (Edwards, 1998, p. 154), mask forms of precariousness (Major and Winters, 2013, p.145), and construct similarity by drawing on "the capacity of symbols to encompass and condense a range of, not necessarily harmonious or congruent meanings" (Jenkins, 1996, p. 104).

For a detailed understanding of social dynamics and the possible impacts on it by CSG developments, SIA researchers ought to carefully consider community representations in light of the variously unfolding relationships among informants (c.f. de Rijke (2012) on the symbolic politics of community and belonging during a recent dam dispute in Queensland). This requires long-term qualitative fieldwork and it may include an analysis of the ways in which some, and not those who are silent or actively silenced, acquired and currently safeguard their 'stake' in the term stakeholder (but see also Metcalf (1998) on the ambivalence of informants).

In the context of the power dynamics involved in development proposals and impact assessments, researchers must also consider the implications of their *own* position, as consultants employed by proponents, government or communities, or as publicly funded academics, among other arrangements (cf. Ballard and Banks, 2003; Chase, 1990; Li, 2009; Negev, 2012). When the current author undertook anthropological fieldwork with regard to CSG disputes in the Northern Rivers region of New South Wales, for example, I was met with severe but anticipated suspicion among certain CSG opponents who distrust the University of Queensland as a result of its Centre for Coal Seam Gas, which receives funds

from the gas industry. Despite my fellowship at the School of Social Science, CSG opponents advocated a moratorium on research participation through national social media networks until my 'bona fides' had been further examined. With regard to contested developments such as CSG, these issues are a normal part of research discussions, and SIA researchers will be subject to similar sentiments while in the field. The implications of the researcher's reception in the field, including impacts on data gathering and the scope of research, however, are rarely addressed in SIA reports.

With the above perspectives and observations in mind, the next section elaborates on some of the main aspects of SIA research and, as case examples, comments on the recently released Queensland SIA guideline and the Surat Gas Project SIA by Arrow Energy Pty Ltd.

Social impact assessment

The general principles of SIA are now well established (e.g. Esteves, Franks and Vanclay, 2012; Vanclay 2003). SIA, ideally, is about:

> creating participatory processes and deliberative spaces to facilitate community discussions about desired futures, the acceptability of likely impacts and proposed benefits, and community input into the SIA process, so that there can be a negotiated agreement with a developer based on free, prior and informed consent. … [T]here should be a specific focus on improving the lives of the worst-off members of society (Esteves et al., 2012, pp. 35, 40).

Esteves et al. (2012, pp. 35-37) also noted a number of pertinent concerns with regard to current SIA practices:

> Compared to the extent of analysis and resources devoted to biophysical issues, SIA usually has a minor role. … The limited capacity of regulators and the limited resources devoted to quality control have a significant impact on the standard of SIAs, with a tendency for proponents to produce assessments that only just pass the minimum expectations of regulators. … Many reports lack adequate details about methods, sources and assumptions. The quality of analysis is another area of variability. Assessments are sometimes little more than a social and economic profile of the impacted communities compiled from secondary data sources. Analysis sometimes lacks identification of the spatial, temporal and stakeholder distribution of impacts and benefits. Integration with environmental, health and cultural heritage issues can be superficial. … The adequacy of public participation continues to be an

> issue. SIAs often do not meet public expectations of being a deliberative process to determine the acceptability of a project. Rather they are seen at best as a process for incremental project improvement, and at worst as being little more than a feeble attempt at project legitimization. Public participation ranges from being the provision of periods for public comment and the supply of information, to being the active involvement of stakeholders in shaping the SIA process and the opening-up of governance processes to include local communities in decision-making about projects.

In the context of governance and community input, proponents may rely strongly on the members of consultative committees to obtain information. In combination with the possibly limited capacity and quality controls of regulators, these committees may constitute, as Lawrence, Richards and Lyons (2013, p. 36) argued in the context of neoliberal agri-environmental governance in Australia, 'an experiment in devolving responsibility, accountability and action [from the state] to the regional level'. Further, as I indicated above, there are questions as to how consultative committees and community workshop participants suspend internal distinctions in their representations of community. SIA researchers interested in the impacts of interventions on communities should always ask questions with regard to those who are *not* around the consultative table.

Noted by Esteves et al. (2012, pp. 37-38), the concept of 'free and prior informed consent', similar to 'the social licence to operate', raises difficult questions: Who has authority to give consent on behalf of 'the community'? How much consent constitutes a licence to operate? What constitutes 'informed' in the context of epistemological diversity? Does consent include the right to veto, or the right to withdraw it subsequently? Who has legitimacy to provide information, and who decides what constitutes pertinent, credible and trustworthy information? What is 'free' in terms of potential power imbalances? While there is increasing engagement with these questions but little international consensus about the answers to them, it may be useful for regulators, proponents, communities, as well as SIA researchers to provide clarity and address them in some way.

SIA should be an iterative process over the entire project life cycle, including the early planning stages. However, given the complexity of social dynamics and the fact that most SIAs are commissioned by technically oriented professionals unfamiliar with the social sciences, there is a view among industry proponents that "the social analyses are often inherently messy, and with uncertain outcomes in terms of implications for the project" (Head of Social Performance, Anglo American, quoted in Esteves et al. 2012, p. 40).

An expression thus often heard is that 'if you can't measure it, you can't manage it'. This expression is indicative of the tension between quantitative and qualitative data, and the desire by some to reduce complex social issues into categories of measurable and manageable indicators. While this desire may be understandable from a managerial point of view, over-simplification may lead to unforeseen social repercussions and possible costly consequences. It may also be an expression of what Roscoe (1995, p. 500) called 'scientism', which

> deploys the term science as though it were a magical talisman guaranteeing the authenticity of whatever half-baked ideas are trotted out under its aegis. Unfortunately, such claims do exercise a sort of magic over the uninitiated - the lay populace and politicians who vote on funding priorities - thereby continually threatening to disenfranchise humanistic inquiry and other forms of inquiry as nonscientific. If I am not mistaken, however, the scientistic boast is hollow: most forms of humanistic inquiry are as scientific as quantum physics; they differ only in their subject matter.

Certain anthropologists have long approached the study of social dynamics through distinctions between 'emic' (insider) and 'etic' (analytical) perspectives (e.g. Harris, 1976). In combination with quantitative analyses, such approaches may produce social insights both nuanced and comprehensive. However, the conciliation of concepts such as causality and social order with concepts such as human agency, ambiguity and creativity remains problematic in SIA. Reductionist portrayals of social life, possibly including simplistic cause-and-effect processes based on statistical correlations between a limited set of narrowly defined variables, have been criticised by anthropologists and others (e.g. Roscoe, 1995). Anthropologists themselves, however, may be criticised as a result of issues associated with the nature of ethnographic fieldwork, which is often conducted by a single person over long periods of time in the field, living among informants, and including various interview techniques and participant observations. These methods, if not adequately explained, may raise questions about 'observational and representational integrity' (Roscoe, 1995, p. 498).

A pertinent question in the context of this debate about methods and approach is what the regulator of development programmes and SIAs actually requires. In Queensland, the Coordinator-General (CG) employed a guideline for social impact management plans (SIMPs) (CG, 2012), but in July 2013 these guidelines were abandoned and replaced with a much more flexible guide to SIA. While not an exhaustive analysis, below I set out some of the main aspects of this recent policy change.

The Queensland SIA guideline

In July 2013, a media statement by the Liberal National Party in Queensland indicated a political agenda to "cut red-tape for major resource projects to proceed in the state" (Seeney, 2013a). It announced modifications to the Queensland SIA policy, which reduce the prescriptive character of the previous guidelines. For example, rather than a broad examination of social impacts, the guide now limits the scope of impact assessments to only those to be considered "high risk impacts and uses outcomes-focused measures, (not prescriptive conditions) to better manage the impacts of projects" (CG, 2013, p.1). Coterminous with "red-tape", SIA has been portrayed as an obstacle to the expansion of the resource industry.

The new guideline aims to "inform" SIA practice (e.g. CG, 2013, p.2) and introduces a number of poorly defined qualifiers to the requirements. Where the previous guideline prescribed that SIMPs should cover the full project life cycle (CG, 2012, p. 2), it now notes that "SIA covers the full lifecycle of the project *to the extent possible*" and that it should be "based on the best data available" (CQ, 2013, p.2, emphasis added). It is not clear who the arbiter of the extent of possibilities and "best data" is in these cases. Furthermore, the requirements to produce a comprehensive SIMP and conduct periodic reviews as part of an iterative process have been entirely removed from the guideline and the approval process.

The guide devolves significant responsibilities from the State to the proponents and impacted communities. With regard to SIA research practices, for example, the guide notes that "the proponent's approach and methodology for identifying and rating social impacts should be acceptable within its organisation and by the communities of interest" (CQ, 2013, p. 10). It is left unclear how organisational or community acceptability should be understood in this context.

The SIA guide requires proponents to address only the important cumulative impacts of multiple projects in a region "where the proportion of the impact of the project can be readily and reasonably forecast and/or separated from the total cumulative impact or opportunity" (CQ, 2013, p.10). However, because cumulative impacts are the result of complex interaction and aggregation, possibly of multiple unrelated projects (e.g. Franks, Brereton and Moran, 2010), they are typically difficult to separate into individual project-specific components. If the guide is applied in such cases, important cumulative impacts on communities are unlikely to be considered in future SIAs.

The previous guide included an attempt to define a broad set of stakeholders including landholders, community groups and community representatives (CG, 2012). The current guide does not explicitly refer to impacted communities in the list of stakeholders, which now includes project proponents, state agencies, local governments and non-government organisations. Impacted communities are presumably regarded as non-government organisations. Moreover, in the description of the potential roles of non-government organisations in the development and implementation of the SIA, the focus is on impacts with regard to "non-government services to the community" (CG, 2012, p. 3). It is unclear how 'services' should be understood in this context.

In summary, the new SIA guideline constitutes a significant reduction in SIA requirements. It is part of a broader agenda to reduce state regulations regarded as 'red tape' obstructions to resource developments. Thus, for environmental impact statements (EIS) of which the SIA is part,

> the terms of reference have been cut from 100 pages to 25 pages of requirements. This huge reduction has been achieved by highlighting the critical matters the proponent should allocate the greatest study effort to in an EIS and by removing overly prescriptive and duplicate requirements (Seeney, 2013a).

Because it is presumably regarded as 'overly prescriptive', the new SIA guideline does not address in detail many of the commonly accepted SIA principles such as iterative processes, impact interactions or the ways in which meaningful community participation may be achieved. It does not entertain or engage with the notions, however difficult, of the social license to operate or free, prior and informed consent, and it does not include a specific focus on those in society who are worst off (c.f. Esteves et al., 2012). The guideline does not require a critical assessment of SIA methods, sources and assumptions, which may encourage, as Esteves et al. (2012) noted, little more than desktop-based social and economic profiling, lacking a more nuanced understanding of interests and potential impact distribution. There are no explicit requirements, as also suggested by Esteves et al. (2012), to integrate environmental, health or cultural heritage issues. Suggestions for the detailed study of community networks, internal socio-political distinctions, interactions with biophysical surroundings, and matters of social significance are also absent.

In thus requiring a minimum engagement with the social dynamics in proposed project areas, the new SIA guideline may have the dual effect of failing to adequately support vulnerable groups throughout the life of projects, *and* failing

to recognise and promote the full variety of community opportunities that may arise from such projects.

In light of the above, I will now examine the Arrow Energy Surat Gas Project SIA and SIMP. This study was produced under the previous guideline which, compared with the current SIA guideline, was more prescriptive and detailed.

Arrow Energy's Surat Gas Project SIA and SIMP

The SIA is part of the much larger EIS prepared by Arrow Energy for its Surat Gas Project, which covers an area of approximately 8,600km² and includes the proposed construction of about 7,500 CSG production wells and associated facilities. The company was provided with terms of reference for the EIS by the Queensland government (Queensland Department of Environment and Resource Management (DERM), 2010).

The social analyses in the Arrow Energy EIS contain a chapter entitled 'Social' (50 pages), the SIMP (as an attachment of 43 pages) and the SIA itself (as an appendix of 199 pages). The SIA was produced by the sub-contracting company URS Australia Pty Ltd (URS) for Arrow Energy's main EIS contractor Coffey Environments Pty Ltd.

The SIA and SIMP documents do not contain the full variety of social aspects related to Arrow Energy's project. Separate chapters and related appendices are provided under headings such as 'landscape and visual amenity', 'non-Indigenous heritage' and 'Indigenous cultural heritage'. Two sub-sections in other chapters provide information on 'the social environment' and socioeconomic cumulative impacts. A substantial 'consultation report' (579 pages) is provided as an appendix by sub-contractor JTA Australia, which was engaged to undertake the overall project community engagement and consultation processes.

While the SIA itself cross-references relevant other sections in the EIS, the various researchers appear not to have integrated their work to an extent that might be more conducive to knowledge and data sharing. For example, the SIA by URS contains a pie-chart pertaining to 'community knowledge' of the project when the consultation process started in 2009. The survey data were provided to URS through 'personal communication' by the major contractor Coffey Environments in 2011. The pie-chart divides the community (although the total number of respondents is unspecified) into three knowledge levels that leave much room for analytical improvement: those who "knew a lot", those who "knew a few things", and those who "knew nothing" (URS, 2011, p. 75).

The section in which this pie-chart was provided, entitled 'Community and Stakeholder Engagement Analysis', provides further information of concern. It implies there had been little success in the alleviation of local concerns through participatory decision-making processes. The SIA indicates that:

> the issues of concern have remained largely unchanged since the consultation process commenced in late 2009, [but] the community has become increasingly informed and aware of the CSG industry and the Arrow Surat Gas Project, through Project consultation activities and through the media. … Despite this increasing awareness, there remains a high level of confusion and misunderstanding amongst stakeholders (URS, 2011, p. 74).

In this context, the SIA and associated documents are notably silent on the 'social licence to operate' and whether the proponent is of the opinion that such a licence has ultimately been obtained.

With regard to the methods employed in the SIA and related social studies, some further comments may be made. Firstly, the SIA does not ground its employed methods in a critical assessment of the broader SIA literature or available international best practice guides. Rather, the methodology chapter simply sums up what was done during the study. Similarly, the suggested impact mitigation strategies are not formulated in the context of the evidence-based literature about the effectiveness of such strategies in other cases. It may be that such assessments provide either weight or alternatives to those actions currently proposed. They may also increase public confidence in the quality of the research programme and its conclusions.

An example where the methods appear at odds with the aim to convey local social significance is found in the chapter and related documents with regard to landscape and visual amenity. The author recognised that "[t]here are no established, measurable technical thresholds for significance of change for landscape and visual impacts" (Coffey Environments, 2012b, p. 18-5). It was further proposed that the study should engage, among other things, the nature of the landscape, including "[i]ts inherent landscape value (its condition, perceptual qualities, cultural importance and any specific values that may apply…)." (Coffey Environments, 2012b, p. 18-5).

The researcher(s) recognised the qualitative dimensions of their research objectives, but appear to have misunderstood qualitative research for subjective judgements on the part of the researcher, rather than the detailed investigation of

social significance, values, and perceptions of change through direct research with the people concerned. They stated that:

> The LVIA [Landscape and Visual Impact assessment] process aims to be objective and describe factually any anticipated changes to landscape resources, views and visual amenity. Potential changes as a result of the project have been defined; however, the significance of these changes requires qualitative (subjective) judgements [sic] to be made. The conclusions to this assessment therefore combine objective measurement and professional interpretation. … [Following desktop analysis] field visits focussed on those aspects of the landscape with potential to be of the greatest sensitivity to project activities and gaining an appreciation of those aspects of the project most likely to affect landscape and/or visual values (AECOM Australia Pty Ltd, 2011, pp. 15, 18).

Rather than a determination of visual values and matters of significance by the researchers, it is more appropriate to undertake detailed fieldwork among local residents and visitors to gain an appreciation of their visual values and opinions about the significance of possible changes to the landscapes with which they interact.

With regard to the methods, notions of community, social significance, and the socio-political distribution of interests among stakeholders, a number of comments may also be made. The SIA states that (URS, 2011, p. 73):

> Stakeholder perceptions have been obtained through qualitative, quantitative and participatory research methods. Stakeholder engagement has included:
>
> • A series of focus groups to identify areas of concern and aspirations relating to the Project;
>
> • A detailed, statistically valid, quantitative telephone survey of the study area and communities of interest to quantify the weight, or level of importance, placed on identified issues or opportunities. The survey also sought to identify perceptions around CSG producers' ability to manage these impacts;
>
> • Meetings and interviews with key stakeholders to understand the existing social baseline in the area and to identify areas of concern and aspirations relating to the Project; and
>
> • Review and interpretation of other independent stakeholder analysis.

The chapter entitled 'Social' includes certain statements about qualitative notions of community recorded during research. It includes statements such as "[R]esidents of the study area value living in cohesive, stable communities, which offer a high standard of living" and "[T]he pace of life, combined with relatively small, stable, close-knit communities, fosters a sense of rural friendliness, which is highly valued by residents" (Coffey Environments, 2012c, pp. 22-11). While I do not doubt that residents may express such views, as indicated in the section above on social dynamics and the concept of community, the SIA could go beyond such statements and interrogate more fully how such views can be understood in the context of (historical) rural socioeconomic change, contemporary social divisions, alliances, and disputes about CSG.

During my own fieldwork with regard to CSG developments, environmental relationships and social networks in the region I found, for example, that farmers may downplay or ridicule the environmental knowledge of 'town people' with regard to envisaged impacts on soils and water. Long-term residents may equally downplay concerns held by more recently arrived residents. More recent farmers and town residents may resent or contest what they perceive as elitist behaviour and claims to social authority by multigenerational and powerful farming families. As an indication of unfolding relationships, certain Aboriginal people attempted to oppose CSG projects but joined contested negotiations later on. I already referred to attenuated social friction resulting from diverging attitudes towards CSG developments, references to alleged 'Third World' living conditions, and the potentially unequal distribution of impacts. And while some farmers in the region have recently joined environmental activists in opposition to CSG, this unusual alliance is subject to ongoing social politics and differences. During interviews, a number of farmers, for example, referred to continuing disagreement with environmentalists about tree-clearing laws and other aspects of environmental regulation. One farmer poignantly referred to a prior period of intense "trench warfare" between local farmers and environmental groups over issues such as the environmental consequences of industrial farming practices in the region and the introduction by farmers of genetically modified cotton. These are indicators of important social dynamics and the factions, quarrels, and status distinctions of everyday social life as referred to by de Souza (2007). SIA researchers must consider these in conjunction with those expressions of social life that focus on small, stable, close-knit communities and a sense of rural friendliness.

The SIA makes little effort to contextualise the statements of stakeholders and appears to take at face value the statements obtained through consultation. Further, the proponent's suggested role of consultative committees, such as the

Arrow Surat Community Reference Group and the Arrow Intensively Farmed Land Committee, may create concerns about governance, as the representative organisation of regional irrigators submitted in response to the EIS (Central Downs Irrigators Ltd, 2012, p. 7):

> DERM [the Queensland Department of Environment and Resource Management] has in the past refused to condition Environmental Authorities issued to Arrow for exploration in ATP683 because they claim that these committees are dealing with the issues. Landholders and the community find this situation totally unacceptable as these committees have limited community acceptance and are wholly resourced and populated by Arrow appointees. The committees TOR [Terms of Reference] also clearly state that the existence of the committee is to facilitate Arrows development of CSG in the region and in no way compels Arrow to deal with issues to the communities satisfaction. We request that the regulator not defer its responsibilities to condition issues to Arrows committees for determination. While effective consultation with landholders is essential, it is not acceptable for this consultation to be a substitute for the Queensland Government conditioning this project to ensure avoidance, mitigation and management.

This submission resonates with the concerns raised also by Lawrence et al. (2013) about contemporary neoliberal governance models that devolve responsibility from the state to the region and consultative committees, a development also apparent in the recently announced modification of Queensland EIS and SIA policies. It also hints at power dynamics and representational contestation within communities. As I argued, SIAs can play an important role in understanding such dynamics, and this is applicable to both Indigenous and non-Indigenous communities.

The Surat Gas Project SIA is limited in its engagement with vulnerability, gender and Indigenous communities. The vulnerable groups identified in the SIA are: low income groups (URS, 2011, p. 50), pensioners, those with disabilities who require particular housing types, and Indigenous people (URS, 2011, p. 127). Little analytical detail is provided with regard to the interaction of various physical and social dimensions contributing to vulnerability and risk (cf. Cartwright, 2013; Checker, 2007), or other categories of persons which may be considered vulnerable under certain conditions, such as young single mothers, those with mental health problems, or those from different (non-Indigenous) cultural backgrounds, among others.

With regard to Indigenous people, the SIA does not consider the interaction of CSG developments with Aboriginal political dynamics and cultural practices. These complex interactions may impact on agreement-making processes, heritage protection activities, and the potential outcomes of agreements. The SIA document contains a rather monolithic representation of 'Indigenous people' divided into a number of language groups and/or native title claim groups. In certain areas, Indigenous Land Use Agreements may be made with Aboriginal parties who claim to hold native title rights and interests in the area. These claims, some of them contested internally and/or by other Aboriginal groups, are yet to be resolved by the Federal Court of Australia. The uncertainties this creates for companies and Aboriginal parties are considerable. While the Indigenous cultural heritage report deals substantially with the legal aspects of agreement making, available data on sites and cultural heritage protection protocols, a thorough engagement with Aboriginal people had not yet occurred. As a result the analysis of the potential social impacts of CSG among Indigenous people remains largely unattended to in the SIA.

Conclusion: policy, politics, and SIA practice

CSG developments are expanding rapidly across the Surat and Bowen Basins in Queensland. These regions are changing as a result, both physically and socio-economically.

In Australia, there have been considerable changes in state and federal CSG policies over the past few years, creating uncertainty for communities as well as development proponents. The overall management of project assessments continues to be a matter of concern. Where individual states that stand to financially benefit significantly from large resource projects are responsible for project assessments, questions may arise about the independence and quality of such assessments. A recent media investigation in Queensland, for example, alleged that political pressure to approve was put on public servants responsible for CSG project assessments, despite their concerns about potential environmental impacts and a perceived lack of detail in the EIS (The Courier Mail, 2013). Companies were also alleged to have unduly influenced sections of assessment reports (The Courier Mail, 2013). A subsequent assessment by the Crime and Misconduct Commission Queensland (CMC), however, found no evidence to substantiate allegations of official misconduct, and concluded that any existing pressure "came from trying to meet deadlines in a department that had to consider a large number of significant projects" (CMC, 2013).

The previous Australian Federal Government shared some assessment concerns and moved to take more control over CSG projects by proposing to include a 'water trigger' in the federal Environment Protection and Biodiversity Conservation Act. This will allow for the federal assessment of those CSG projects potentially impacting nationally important water resources. The move was met with severe criticism from industry and the Queensland state government, concerned about what they perceive as increased "green tape" and desperate "scaremongering" (APPEA, 2013b; Seeney, 2013b). At the time of writing it remains to be seen how the Coalition Government, which won the federal election in September 2013, will operationalise its envisaged "one-stop-shop" model to streamline approval methods covering both Commonwealth and State legislation.

The Queensland government itself has adopted an adaptive management strategy for coal seam developments (cf. Swayne, 2012). This entails, essentially, a learning-by-doing approach to a complex, fast-changing and contested industry. In terms of social management, the new Queensland SIA guide entails a significant reduction of requirements to minimise 'red tape' and to expedite the approval and expansion of resource extraction projects. It introduces reduced regulatory policies of resource extraction based on minimal government involvement characteristic of neoliberal governance models. The public may be left wondering whether such policies will facilitate the approach adopted recently by at least some US shale gas companies in their community and media relations strategies, including the employment of former military counter-insurgency officers and controversial 'psyops' (psychological operations) tactics to deliver outcomes beneficial to industry (Pittsburgh Post-Gazette, 2011).

In conclusion, the new Queensland SIA guideline introduces a significant reduction in regulation and best-practice requirements. While there is an international momentum to engage with difficult but important concepts such as the social license to operate, the regulator has taken to poorly articulated suggestions instead of best-practice and clearly defined requirements.

While not subjected to an exhaustive analysis, the case example of the Surat Gas Project has identified a number of areas where questions emerge about the assumptions, methodological approaches and analytical strengths of the SIA study. It is of some concern for the future quality of SIA reports that this study was conducted under the previous Queensland requirements, which have now been significantly reduced. Those parts of the Surat Gas Project EIS that relate to matters of national environmental significance and hydrogeological impacts recently received strong criticism from the federal government's Independent

Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). The Committee found that, among other issues, "a number of improvements could be made to the survey method", that "further data is required to improve confidence in modeling", and that a "field-based assessment" is required to assess vulnerabilities associated with changes to groundwater hydrology (IESC, 2013, p.2). In terms of the SIA, the assessment of vulnerabilities, social values and differentiation, which is currently limited, may similarly benefit from carefully considered fieldwork in the region.

As a discipline characterised by qualitative and participatory fieldwork methods to understand human diversity and culture, anthropology may enhance the quality of SIA studies. I have advocated a detailed approach to complex social dynamics based on quantitative and qualitative research methods and data triangulation because the possible social impacts by CSG developments, both positive and negative, are best assessed where researchers study the concept of community, including active representations and notable silences, in light of the variously unfolding relationships among residents in the impacted region.

The incentives in the recently announced policy modifications in Queensland, however, work to promote a very different approach; a minimalist study of social characteristics aimed at expediting project approvals. Therefore, the policy challenges for impacted communities are now fundamentally political: how to obtain an appropriate voice in the articulation of those social and approval policies with the potential to dramatically impact the full variety of living conditions in regions of proposed developments.

References

Advance Western Downs. (2013). *Western Downs Regional Economic Brief, February 2013*. Retrieved 26 March, 2013, from http://www.advancewesterndowns.com.au/_literature_140605/Western_Downs_Region_Economic_Brief_March_2013

AECOM Australia Pty Ltd. (2011). *Arrow Energy Surat Gas Project: Landscape and Visual Impact Assessment*. Arrow Energy Surat Gas Project environmental impact statement, Appendix L, prepared for Coffey Environments and Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0009/2313/Appendix20L20-20Landscape20and20Visual20Impact20Assessment.pdf

Australian Bureau of Statistics. (2011a). *Darling Downs – East (30702), Census of Population and Housing: Working Population Profile Based on Place of Work*, Catalogue number 2006.0. Retrieved 26 March, 2013, from

http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/communityprofile/30702

Australian Bureau of Statistics. (2011b). *Australia - 2011 Census QuickStats.* Retrieved 26 March, 2013, from http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/0?opendocument&navpos=220

Australian Petroleum Production and Exploration Association. (2013a). '*Federal regulation of onshore natural gas to drive up prices, cost jobs*', Media release 12 March 2013. Retrieved 26 March, 2013, from http://www.appea.com.au/images/stories/media/130312_epbc.pdf

Australian Petroleum Production and Exploration Association. (2013b). '*Green tape risks stifling valuable major projects*', Media release 25 March 2013. Retrieved 26 March, 2013, from http://www.appea.com.au/images/stories/media/130325%20green%20tape%20report.pdf

Ballard, C., and Banks, G. (2003). Resource wars: the anthropology of mining. *Annual Review of Anthropology,* 32, 287-313.

Bernard, H.R. (1995). *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. Walnut Creek: AltaMira Press.

Bligh, A. (2011). *Premier heralds new 'gas age' for Queensland*. Ministerial Media Statement by the Premier and Minister for Reconstruction, 27 May 2011. Retrieved 26 March, 2013, from http://statements.qld.gov.au/Statement/Id/74946

Brisbane Times. (2009). *No Power. No Sewage. No worries, says Tara*. 5 June 2009, by Scott Casey. Retrieved 26 March, 2013, from http://www.brisbanetimes.com.au/queensland/no-power-no-sewage-no-worries-says-tara-20090604-bx19.html#ixzz2OdMEoIn4

Cameron, D. (2005). Closer settlement in Queensland: The rise and decline of the agrarian dream, 1860s-1960s. In Davison, G. and Brodie, M. (Eds.) *Struggle Country: The rural ideal in twentieth century Australia,* (pp. 129-151). Melbourne: Monash University ePress

Canter, L., and Ross, B. (2010). State of practice of cumulative effects assessment and management: the good, the bad and the ugly. *Impact Assessment and Project Appraisal,* 28(4), 261-268.

Carrington, K. and Pereira, M. (2011). Assessing the social impacts of the resources boom on rural communities. *Rural Society,* 21(1), 2-20.

Carrington, K., Hogg, R. and McIntosh, A. (2011). The resource boom's underbelly: criminological impacts of mining development. *Australian and New Zealand Journal of Criminology,* 44(3), 335-354.

Carrington, K., McIntosh, A. and Scott, J. (2010). Globalization, Frontier Masculinities and Violence. *British Journal of Criminology,* 50(3), 393-413

Cartwright E. (2013). Eco-risk and the case of fracking. In Strauss, S., Rupp, S. and Love, T. (Eds.) *Cultures of Energy: Power, practices, technologies, (*pp. 201-212). Walnut Creek: Left Coast Press.

Cashmore, M. and Richardson, T. (2013). Power and environmental assessment: Introduction to the special issue. *Environmental Impact Assessment Review,* 39, 1-4.

Central Downs Irrigators Ltd. (2012). *Letter to the EIS Coordinator (Surat Gas Project)*, *Statewide Environmental Assessments, [Queensland] Department of Environment and Resource Management*, 12 June 2012. Retrieved 26 March, 2013, from http://www.cdil.com.au/documents/CDILEISSubmission12June12.pdf

Chase, A. (1990). Anthropology and Impact Assessment: Development Pressures and Indigenous Interests in Australia. *Environmental Impact Assessment Review,* 10, 11-23.

Checker, M. (2007). 'But I know it's true': environmental risk assessment, justice, and anthropology. *Human Organization,* 66(2), 112-24.

Coffey Environments Pty Ltd. (2012a). *Surat Gas Project - Environmental Impact Statement, Volume 1, Chapter 13: Agriculture*. Prepared for Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/content/Document/surat-eis/Volume%201/Chapter%2013%20-%20Agriculture.pdf

Coffey Environments Pty Ltd. (2012b). *Surat Gas Project - Environmental Impact Statement, Volume 1, Chapter 18: Landscape and Visual Amenity*. Prepared for Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0003/2865/Chapter201820-20Landscape20and20Visual20Amenity.pdf

Crime and Misconduct Commission Queensland. (2013). *CMC completes assessment of CSG complaints — 19.09.2013*. Media release. Retrieved 23 September, 2013, from http://www.cmc.qld.gov.au/news-and-media/media-releases/cmc-completes-assessment-of-csg-complaints

de Rijke, K. (2012). The Symbolic Politics of Belonging and Community in Peri-urban Environmental Disputes: the Traveston Crossing Dam in Queensland, Australia. *Oceania,* 82(3), 278-293.

de Rijke, K. (2013a). The Agri-Gas Fields of Australia: Black Soil, Food and Unconventional Gas. *Culture, Agriculture, Food and Environment*, 35(1), 41-53.

de Rijke, K. (2013b). Hydraulically fractured: unconventional gas and anthropology. *Anthropology Today,* 29(2), 13-17.

de Souza, A. (2007). 'Our village puts aside politics for the sake of development'. Fluid Communities and Stable Claims. In Baviskar, A. (Ed.) *Waterscapes. The Cultural Politics of a Natural Resource*, (pp. 1-8). Uttaranchal: Permanent Black.

Edwards, J. (1998). The need for a 'bit of history': Place and past in English identity. In Lovell, N. (Ed.) *Locality and Belonging*, (pp. 147-167). London: Routledge.

Esteves, A.M., Franks, D. and Vanclay, F. (2012). Social impact assessment: the state of the art. *Impact Assessment and Project Appraisal*, 30(1), 34-42.

Franks, D.M., Brereton, D. and Moran, C.J. (2010). Managing the cumulative impacts of coal mining on regional communities and environments in Australia. *Impact Assessment and Project Appraisal*, 28(4), 299-312.

Frawley, J. (2007). Prickly pear land: Transnational networks in settler Australia. *Australian Historical Studies*, 38(130), 373-388.

Government Statistician, Queensland Treasury and Trade. (2012). *Surat Basin Population Report, 2012*. Retrieved 26 March, 2013, from http://www.oesr.qld.gov.au/products/publications/surat-basin-pop-report/surat-basin-pop-report-2012.pdf

Hall, T. (1925). *The early history of Warwick district and pioneers of the Darling Downs*. Toowoomba: Robertson & Proven Ltd.

Harris, M. (1976). History and significance of the emic/etic distinction. *Annual Review of Anthropology,* 5, 329-50.

Heggman, G.,and Yarranton, G.A. (2011). Alchemy to reason: Effective use of cumulative effects assessment in resource management. *Environmental Impact Assessment Review,* 31(5), 484-490.

Heritage Consulting Australia Pty Ltd. (2011). *Arrow Energy Surat Gas Project: Non-Indigenous Heritage Report*. Surat Gas Project Environmental Impact Statement, Appendix 20, prepared for Arrow Energy Pty Ltd. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0011/2702/Appendix20R20-20Non-Indigenous20Heritage20Impact20Assessment.pdf

House of Representatives Standing Committee on Regional Australia. (2013). *Cancer of the bush or salvation for our cities? Fly-in, fly-out and drive-in, drive-out workforce practices in Regional Australia*. Commonwealth of Australia. Retrieved 26 March, 2013, from http://www.aph.gov.au/parliamentary_business/committees/house_of_representatives_committees?url=ra/fifodido/report/fullreport.pdf

IESC. (2013). *Advice to decision maker on coal seam gas project. Proposed action: Arrow Surat Gas Project (EPBC 2010/5344) – Expansion*. Retrieved 18 October, 2013, from http://www.environment.gov.au/coal-seam-gas-mining/pubs/iesc-advice-arrow.pdf

Jenkins, R. (1996). *Social Identity*. London: Routledge.

Jick, T.D. (1979). Mixing qualitative and quantitative methods: triangulation in action. *Administrative Science Quarterly*, 24(4), Qualitative Methodology, 602-611.

Lawrence, G., Richards, C., and Lyons, K. (2013). Food security in Australia in an era of neoliberalism, productivism and climate change. *Journal of Rural Studies,* 29, 30-39.

Li, F. (2009). Documenting accountability: environmental impact assessment in a Peruvian mining project. *PoLAR: Political and Legal Anthropology Review,* 32(2), 218-236.

Lock the Gate Alliance. (2013). *Missions, Principles, Aims*. Retrieved 26 March, 2013, from http://www.lockthegate.org.au/missions_principles_aims

Lockie, S., Franettovich, M., Petkova-Timmer, V., Rolfe, J., and Ivanova, G. (2009). Coal mining and the resource community cycle: A longitudinal assessment of the social impacts of the Coppabella coal mine. *Environmental Impact Assessment Review,* 29, 330-339.

Major, C., and Winters, T. (2013). Community by necessity: security, insecurity, and the flattening of class in Fort McMurray, Alberta. *Canadian Journal of Sociology,* 38(2), 141-165.

Metcalf, P. (1998). The Book in the Coffin: On the Ambivalence of "Informants". *Cultural Anthropology,* 13(3), 326-343.

Miller, S. (2012). *A prickly problem: Dr. Jean White-Haney and the prickly pear*. John Oxley State Library of Queensland Blogs, posted 27 November 2012. Retrieved 13 September, 2013, from http://blogs.slq.qld.gov.au/jol/tag/cactoblastis/

Negev, M. (2012). Knowledge, data and interests: Challenges in participation of diverse stakeholders in HIA. *Environmental Impact Assessment Review, 33*, 48-54.

New South Wales Aboriginal Land Council. (2012). *Statement on behalf of the NSW Aboriginal Land Council by CEO Geoff Scott*. Media release 9 March 2012. Retrieved 4 September, 2013, from http://www.alc.org.au/newsroom/media-releases/statement-on-behalf-of-the-nsw-aboriginal-land-council-by-ceo-geoff-scott.aspx

Peace, A. (1999). Anatomy of a blockade. Towards an ethnography of environmental dispute (Part 2), Rural New South Wales 1996. *The Australian Journal of Anthropology, 10*(2), 144-62.

Pittsburgh Post-Gazette. (2011). *Drillers using counterinsurgency experts: Marcellus industry taking a page from the military to deal with media, resident opposition*. 13 November 2011, by Don Hopey. Retrieved 26 March, 2013, from http://www.post-gazette.com/stories/local/marcellusshale/drillers- using-counterinsurgency-experts-323688/

Queensland Department of Environment and Resource Management. (2010). *Terms of reference for the Arrow Energy Surat Gas Project Environmental Impact Statement (EIS)*. Retrieved 26 March 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0005/2399/Attachment20001-20Final20Terms20of20Reference.pdf

Roscoe, P.B. (1995). The Perils of 'Positivism' in Cultural Anthropology. *American Anthropologist*, 97(3), 492-504.

Seeney, J. (2013a). *Newman Government cuts resources red tape*. Ministerial Media Statement by the Queensland Deputy Premier, Minister for State Development, Infrastructure and Planning, 17 July 2013. Retrieved 18 July, 2013, from http://statements.qld.gov.au/Statement/2013/7/17/newman-government-cuts-resources-red-tape

Seeney, J. (2013b). *Desperate Labor scaremongering over CSG*. Ministerial Media Statement by the Queensland Deputy Premier, Minister for State Development, Infrastructure and Planning, 12 March 2013. Retrieved 26 March, 2013, from http://statements.qld.gov.au/Statement/2013/3/12/desperate-labor-scaremongering-over-csg

Silverman, S.F. (1966). An ethnographic approach to social stratification: prestige in a central Italian community. *American Anthropologist, 68*(4), 899-921.

Swayne. (2012). Regulating coal seam gas in Queensland: lessons in an adaptive environmental management Approach? *Environmental and Planning Law Journal*, 29(2), 163-185.

The Coordinator-General, State of Queensland. (2012). *Social impact assessment: Guideline to preparing a social impact management plan*. Brisbane: Queensland Government. Retrieved 26 March, 2013, from http://www.dlg.qld.gov.au/resources/guideline/cg/social-impact-management-plan-guideline.pdf

The Coordinator-General, State of Queensland. (2013). *Social impact assessment guideline.* Brisbane: Queensland Government. Retrieved 23 July, 2013, from http://www.dsdip.qld.gov.au/resources/guideline/social-impact-assessment-guideline.pdf

The Courier Mail. (2013). *Public servants tasked with approving massive CSG projects were blindsided by demands to approve two in two weeks*, 11 February 2013, by John McCarthy. Retrieved 26 March, 2013, from http://www.couriermail.com.au/news/public-servants-tasked-with-approving-to-massive-csg-projects-were-blindsided-by-demands-to-approve-two-in-two-weeks/story-e6freon6-1226574952587

Trendle, B. (2001). The dispersion and persistence of Queensland regional employment. *Australasian Journal of Regional Studies,* 7(2), 189-208.

URS Australia Pty Ltd. (2011). *Arrow Surat Gas Project Social Impact Assessment*. Arrow Energy Surat Gas Project environmental impact statement, Appendix P, prepared for Coffey Environments. Retrieved 26 March, 2013, from http://www.arrowenergy.com.au/__data/assets/pdf_file/0012/2460/Appendix20P20-20Social20Impact20Assessment.pdf

Vanclay, F. (2003). International principles for social impact assessment. *Impact Assessment and Project Appraisal*, 21(1), 5-11.

Vicencio, C. (2001). Does "Class Count" in Abanilla? The salience of silence in a local reconfiguration of class. *Journal of the Society for the Anthropology of Europe*, 1(1), 9-15.

Walker, G. (2010). Environmental justice, impact assessment and the politics of knowledge: The implications of assessing the social distribution of environmental outcomes. *Environmental Impact Assessment Review*, 30, 312-318.

Whincop, M., and de Rijke, K. (2013). *The Surat and Bowen Basins in Queensland*. Scale not given.

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Local economic impacts of an unconventional energy boom: the coal seam gas industry in Australia*

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Complementing the scarce economic literature about local impacts of energy extraction booms, this paper empirically investigates economic outcomes related to the new coal seam gas (CSG) industry located across southern Queensland. This Australian state has seen an unprecedented inflow of investments into the extraction of this previously unexploited unconventional natural gas over the last decade. We analyse census data to study income and employment effects associated with the CSG boom, exploiting the quasi-experimental conditions provided by CSG extraction areas (treatment regions) and regions without this development (control regions). Findings show that treatment regions have higher income growth than control areas during 2001–2011 for families residing locally and for individuals present on census night. Employment in the mining sector also shows higher growth as has non-mining employment in some areas. We include comparisons between CSG areas with no major mining history (the Surat basin) and CSG areas where mining was important before the CSG boom (the Bowen basin), to better understand boom effects in areas with different initial mining industry importance in their economies. Local job multipliers are also analysed for Surat basin CSG areas, where positive impacts (job spillovers) are restricted to construction and professional services jobs, while agricultural jobs have decreased.

Key words: Australia, coal seam gas, mining, resource boom, unconventional natural gas.

1. Introduction

As the world economy is in a phase of large and increasing demand for energy and new technology has eased the costs of extraction and transportation of natural resources, different regions across the globe are experiencing new investments targeting the extraction of fossil fuels. This energy scenario has converted previously uneconomic reservoirs into new potential sources of

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profit, transforming regions that were not related to fossil fuel extraction to the locus of large investments in drilling and mine openings. These new sources of wealth are commonly seen by markets and regional planners as employment generators and income boosters that can improve the living standards of a region. However, resource windfalls are not always translated to positive outcomes for communities hosting the resource extraction industry, as most of the generated income can flow out of the region as non-resident workers spend part of their incomes elsewhere, and employment numbers can be negatively affected in non-mining sectors. The so-called 'resource curse' is an outcome generally associated with national effects, but that can also occur in local areas (James and Aadland 2011).

Compared to the growing body of literature focusing on the economic impacts of resource windfalls at national levels, fewer studies have evaluated its potential impacts within countries. This is an important gap considering that, empirically, economic evaluations of resource booms can be much more reliable and informative than multinational studies (van der Ploeg 2011). Considering this point and improving empirical identification strategies by using the quasi-experimental conditions provided by resource endowments, recent economic studies have paid more attention to understanding the local consequences of resource booms. Starting with Black *et al.* (2005), who analyse local economic impacts of the coal boom and bust in the US, a handful of studies have provided evidence about economic effects associated with resource extraction booms at local levels (Marchand 2012; Weber 2012; Caselli and Michaels 2013). Our study follows this quasi-experimental literature and complements it by providing an analysis of impacts associated with a current boom of a newly exploited unconventional natural gas in Australia: coal seam gas (CSG), also known as coal bed-methane.

The CSG boom in Australia has occurred principally across southern Queensland, a region that during the last decade has seen an unprecedented inflow of investments into the extraction of this fossil fuel. Empirically exploiting the quasi-experimental conditions of the CSG development across the region, and using 2001 and 2011 census data at statistical local areas (SLAs) level (subregions within the state), we evaluate the boom by analysing how income and employment indicators behave between treatment regions (areas where CSG wells have been largely dug) and control regions (areas with no CSG development). In addition, considering the location of the CSG industry across the state (clustered over two basins: the Surat and Bowen basins), we also provide insights into the differential effect of the boom on areas where mining was not a common feature in the past (the Surat basin) versus regions with a mining industry that was well established before the CSG boom started (the Bowen basin). By focusing on these basins, we provide new evidence that complements previous studies analysing the impacts of resource extraction industries across these regions (Rolfe *et al.* 2011; Rolfe 2013).

2. Energy boom, local impacts and the CSG case

As a result of global economic and population growth, prices of non-renewable resources such as fossil fuels have risen during last decades. This scenario, together with a reduction in transportation costs (spurred by gas liquefaction technology and the use of large vessels for intercontinental trade) and new technologies for extraction (translated into more efficient drilling and extraction processes) has seen unexploited reservoirs of traditional and unconventional fossil fuels converted to profitable sources of energy. Under these conditions, unconventional natural gas sources such as shale gas, tight-gas and CSG have become new and increasingly important resources within the energy industry.

As unconventional gas becomes profitable to exploit, regions that traditionally were not part of the energy industry locus are becoming strategic areas of production. This new source of wealth for richly endowed regions has raised questions about the real benefits and costs that resource extraction can bring. Past experience has shown that resource windfalls can bring important benefits in terms of employment, income and trading gains (Gregory 2012); however, economic outcomes are not always beneficial for nations or to the communities hosting the resource extraction industry, as consequences of the so-called natural resources curse and other unintended socioeconomic outcomes (van der Ploeg 2011).

The economic impacts of a resource extraction boom can create social concerns at national and regional scales. Nationally, concerns can relate to international corporations that export resource extraction-based profits overseas. Regionally, concerns often arise about the capacity of regions to retain resources (either the resource itself or the revenues generated by it) that are otherwise likely to flow to capital cities or other non-extractive regions of the country. Abstracting from the potential environmental externalities that can disrupt the functioning of local communities, common economic outcomes to evaluate in resource extraction regions are local jobs creation, both within the resource sector and in non-mining sectors (Marchand 2012), personal income (Weber 2012) and housing affordability (Hajkowicz *et al.* 2011).

Theory suggests that the main direct local impact of a resource boom is a sharp increase in the demand for labour to cover the expanding extractive sector, which will tend to rapidly increase local wages (Corden and Neary 1982). These potential employment and income effects are also likely to generate spillovers into other sectors as the additional income now available in local economies will tend to increase the consumption of non-tradables (local goods), generating employment in these sectors. By contrast, during a resource boom, adverse employment effects are likely in the local tradable sectors, namely manufacturing and agriculture, as potentially higher wages paid by mining can produce a migration of labour from these sectors to the extraction industry (Marchand 2012). Additional income effects, besides

potential higher wages paid by the extraction firms, can be generated by the inflow of financial assets generated by these firms as local taxes and as payments for landowners' compensation. This last source is more likely to happen in the case of natural gas and oil, where wells are distributed across space and therefore across multiple private land sites. Although other socioeconomic consequences of resource windfalls, such as housing affordability, are likely to arise in local areas, we focus this study on testing these primary economic outcomes – income and employment – by employing ex-post econometric models that avoid the assumptions of ex-ante input–output models and allow us to observe changes over time (Kilkenny and Partridge 2009; Weber 2012).

2.1. Empirical evidence of resource windfalls' local impacts

The empirical economic literature includes many studies examining the economic impacts of natural resource windfalls at the national level, commonly employing multicountry samples in econometric models attempting to explain the occurrence, causes and potential consequences of the natural resource curse – see Frankel (2010) and van der Ploeg (2011) for surveys of this literature. In contrast, the availability of ex-post studies evaluating local impacts of resource booms is much less abundant. This is an important gap in the literature, as it has been stated that to better understand the real economic effects of natural resource windfalls 'The road forward might be to exploit variation within a country where variables that might confound the relationship between resources and macroeconomic outcomes do not vary and the danger of spurious correlation is minimized' (van der Ploeg 2011, p. 381). Thus, the main advantage of within-country studies is that they do not present the common confounding factors of cross-country models, such as openness to trade and institutional/political differences.

Although less problematic than cross-country models, the empirical identification of resource boom impacts remains a challenge in local-level studies. Providing a novel approach to address this issue, Black *et al*. (2005) use the quasi-experimental conditions of the coal industry in the US to evaluate the impacts of the coal boom and bust of the 1970s and 1980s across US counties. Based on the percentage of earnings of local economies coming from the coal industry, these authors find that the coal boom translated into more jobs and income for local dwellers, while the bust decreased economic growth. Using a similar approach, Marchand (2012) analyses local effects of the energy price boom (and bust) in provinces of Western Canada, also finding higher income growth and employment levels in areas hosting the energy industry versus comparable provinces elsewhere in Canada during the boom.

Also using quasi-experimental frameworks, Caselli and Michaels (2013) find for Brazilian municipalities that once oil was discovered and extraction had started, the services sector of the local economy expanded and household

income increased by 10 per cent (Caselli and Michaels 2013). Analysing a different fossil fuel commodity, Weber (2012) studied the natural gas boom in the US, observing how expansion of gas production affected employment, income and poverty across counties in the states of Wyoming, Texas and Colorado between 1998 and 2008. He found that the natural gas boom produced a mild income effect across counties hosting the industry, which appeared to be more focused on households in the upper half of the income distribution. On employment, Weber (2012) found that for each extra million dollars generated by the gas industry, there were 2.35 more jobs generated in the average production county.

To contribute to this literature and shed some light on a current resource boom, we employ a quasi-experimental approach to study the CSG development in Australia. We differ from these previous studies in two points. First, we analyse a previously unexploited unconventional natural gas (CSG). Second, we compare the impacts of CSG development on a region that has a history of mining (the Bowen basin) with that of a region in which little mining has previously occurred (the Surat basin).

2.2. Australia and the CSG industry in Queensland

Mining has historically played a major role in the Australian economy and continues to do so (Schandl *et al*. 2008). Mining exports have grown from around a third to around a half of all Australian exports (by value) over recent decades (Reeson *et al*. 2012). The mining boom from the early 2000s to the time of writing has raised concerns amongst policy analysts over how the boom has affected the nation, beyond the profit margins of individual companies and their shareholders (Richardson and Denniss 2011). Debates over the two/three speed economy effect (Corden 2012) and distributing royalties to regions are examples of public concern over the need to carefully manage resource endowments to ensure a wider distribution of economic benefits (Measham *et al*. 2013). Accordingly, the new booming CSG industry in Queensland offers many opportunities and challenges.

In Australia, Queensland possesses around 95 per cent of the country's total economic demonstrated resources (EDR) of CSG. This reservoir was reported to be 15.1 trillion cubic feet in 2008 (Geoscience Australia (GA) and Australian Bureau of Agricultural and Resource Economics (ABARE) 2010). Despite this large reservoir, CSG has only recently become part of the resource extraction portfolio in Queensland. As a consequence of high international prices and better technologies, commencing in early 2000s, the CSG industry started operating in different areas of the state, but especially in the Surat and Bowen basins (Figure 1). The Surat basin encompasses more than 60 per cent, and the Bowen basin around 35 per cent of Australia's total CSG EDR known by 2008 (GA and ABARE 2010). This CSG boom has meant the development of over 4000 wells in Queensland to 2011, but the boom is far from over. As of 2008, only around 1 per cent of the total

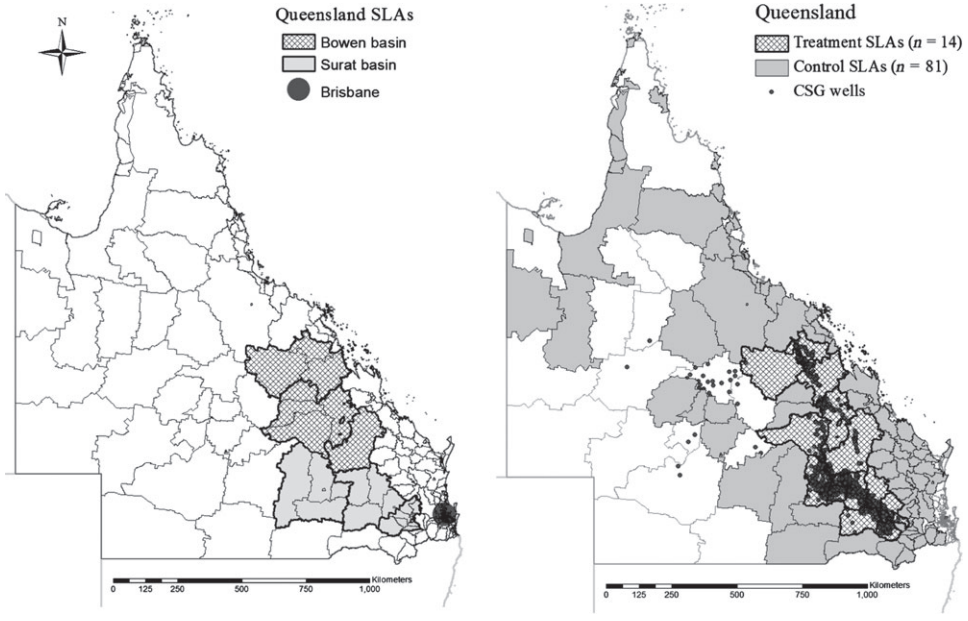

Figure 1 Queensland statistical local areas (SLAs) and location of Bowen and Surat basins, control and treatment groups, and coal seam gas (CSG) wells to 2012. The Bowen basin is defined by the LGAs of Banana, Central Highlands, Isaac and Woorabinda. The Surat basin is defined by the local government areas of Maranoa, Toowoomba and Western Downs (bolded borders). Source: Own elaboration with data from Australian Bureau of Statistics (2012) and Department of Natural Resources and Mines of the Queensland Government (2012).

reservoir had been exploited (GA and ABARE 2010) and new evidence has suggested that the CSG EDR can even double previous estimates (GA 2012).

The enormous growth in CSG development observed since the mid-2000s can be considered an important boom for both the Surat and Bowen basins, and is worth analysing in detail. For our analysis, we consider regions where the CSG industry is located as 'treatment areas' receiving this exogenous shock (CSG boom) and contrast their economic outcomes to comparable regions of Queensland not participating in the CSG boom. In addition, as mentioned, one important attribute of our case study is the differences that the Surat basin has compared with the Bowen basin in terms of mining history. Given their contexts, we can evaluate the economic impacts of the boom over areas that had no major mining activity, namely the Surat basin, to areas with a large mining presence before the boom, which is the case of the Bowen basin.

3. Methods

To evaluate local economic impacts associated with CSG development in southern Queensland, we exploit the empirical quasi-experimental conditions that this energy extraction development presents. This boom can be considered a quasi-experiment for evaluation purposes because of three main

Table 1 Descriptive statistics and coal seam gas (CSG) wells across groups and for the whole state

	Treatment SLAs on Surat Basin (n = 8) Mean (SD)	Treatment SLAs on Bowen Basin (n = 6) Mean (SD)	Control group SLAs (n = 81) Mean (SD)	All Queensland
Median per capita income, 2001 ($, weekly)	355.1 (97.9)	516.2 (115.9)	312.3 (82.2)	359
Median family income, 2001 ($, weekly)	746.3 (122.1)	1205.5 (246.2)	727.1 (182.7)	871
Share of agriculture in total employment, 2001	0.394 (0.105)	0.193 (0.117)	0.212 (0.142)	0.049
Share of manufacturing in total employment, 2001	0.058 (0.042)	0.033 (0.018)	0.076 (0.043)	0.105
Share of mining in total employment, 2001	0.015 (0.015)	0.249 (0.149)	0.023 (0.055)	0.012
Total mining employment, 2001	19.9 (15.3)	842.8 (538.4)	72.4 (257.9)	19,286
Number of CSG wells to 2011†	2976	1765	160	4934

†Data derived using ArcGIS 9.1. CSG wells include exploratory, appraisal and extraction wells. The 160 CSG wells in the control group are scattered across 21 different statistical local areas (SLAs). ($) Australian Dollars in nominal values. Source: Own calculations with data from Department of Natural Resources and Mines of the Queensland Government (2012) and Office of Economic and Statistical Research (2012).

(nonendogenous) characteristics: it is happening over natural CSG reservoirs, it has been triggered by external (mostly non-Australian) demand and it has been exploited by investments by companies that are not based in the area of extraction (non-local investments). Given these characteristics, we claim that the treatment effect of the CSG boom can be captured by identifying regions with a high number of extraction points (CSG wells). We approach this idea by identifying the location of CSG wells, based on geospatial data available from the Department of Natural Resources and Mines of the Queensland Government (2012), across SLAs of Queensland.[1] SLAs are subregions of local government areas (LGAs) in Australia and, for this study, we use SLA 2011 boundaries, for which census time series data are available for 2001, 2006 and 2011 (Office of Economic and Statistical Research (OESR) 2012). Figure 1(a) shows the distribution of the SLAs across the state and Figure 1(b) shows the location of CSG wells established between 2001 and 2011.

Table 1 records, in numbers, the CSG wells shown in Figure 1(b). The various wells in Queensland are scattered across 43 different SLAs. As mentioned, to select our treatment region, we focused on SLAs encompassing the large majority of the CSG-related wells in our data. From the 43 SLAs with wells, the upper third (14 SLAs) include 96 per cent of the total wells in the state. We select these 14 SLAs as our treatment group. Given that CSG development has been most rapid since the mid-2000s, we can infer the

[1] These wells include exploration, appraisal and extraction wells.

economic impacts by comparing changes in indicators for the period 2001 to 2011 between this treatment group and a control group (CG).

To create the CG, we selected Queensland SLAs based on one main criterion: population density in 2001 (the base year). This is a variable that is more informative than total population considering that SLA sizes vary across space. Among the 475 SLAs in Queensland, population density in 2001 varied from 0.004 to 5483.762 persons per square kilometre. In our treatment group, population density varies from 0.109 (d_1) to 3.896 (d_2), so we decided to trim our CG to SLAs in the 2001 population density range of $\frac{1}{2}d_1 \leq \text{CG} \leq 2d_2$.[2] With this approach, we remove sparsely habited and highly dense SLAs from our analysis sample. Our CG is then formed by 81 SLAs, which including the treatment SLAs gives us a cross-sectional sample of 95 SLAs (sample 1 in Table 2) containing 15 per cent of the state's total population in 2001.[3]

3.1. Variables and models

We evaluate the boom potential impacts on economic indicators considering data availability from the Australian censuses. Thus, we focus our attention on understanding changes in median total personal income, median total family income and mining and non-mining employment between 2001 and 2011, with statistics reported in Table 1 for 2001. We also include state-level values for comparison purposes in Table 1. We chose 2001 as the starting point because most of the CSG development in Australia started during the mid-2000s, so economic consequences in the extraction regions should be observable looking at changes between 2001 and 2011 (at least changes occurring in the medium-term). We hypothesise that the CSG boom will have positive and significant effects on each of these indicators.

Our empirical strategy includes covariates that may affect the changes in income and employment indicators across space. By controlling for potential endogeneity in the covariates by using beginning of the period levels, we use a model given by:

$$\ln(y_{2011,i}) - \ln(y_{2001,i}) = \alpha + \beta T_i + \theta' \mathbf{X}_{2001,i} + \varphi d_i + e_i, \qquad (1)$$

where i denotes an SLA and e is an idiosyncratic error term. T is our binary treatment variable receiving the value of 1 if the SLA belongs to one of the 14 treatment SLAs, and 0 otherwise. y is our outcome of interest (either income

[2] We also excluded SLAs corresponding to islands from our analysis: Torres Strait SLAs, Mornington and Moreton Island. Alternative results using different criteria to select our CGs (robustness check) are available in the online Supporting Information.

[3] The trim actually gave us 77 SLAs, but to reach exactly the 15 per cent of Queensland population in 2001, we included four extra SLAs in our sample: the next two ranked SLAs in both the top and bottom limits of our population density range. A list of all SLAs included in our control and treatment groups is available on the online Supporting Information.

Table 2 Differential growth in income and employment between treatment and control groups

Indicator	Sample 1: SLAs trimmed by population density	Sample 2: sample 1 excluding Bowen basin SLAs	Sample 3: sample 2 excluding Mining-Boom SLAs
Median per capita income growth (2001–2011)	0.237 (0.074)***	0.163 (0.093)*	0.185 (0.087)**
Median family income growth (2001–2011)	0.152 (0.049)***	0.110 (0.064)*	0.124 (0.060)**
Mining employment growth (2001–2011)	0.313 (0.173)*	0.437 (0.157)***	0.449 (0.185)**
Local goods sector employment growth (2001–2011)	0.321 (0.129)**	0.330 (0.169)*	0.293 (0.175)
Observations	95	86	48

Notes: *$P < 0.10$; **$P < 0.05$; ***$P < 0.01$. Values are OLS estimations for treatment effects (coefficient β in equation (1)). Results can be directly interpreted as the per cent difference, between treatment and control group, in the respective indicator's growth rate. All regressions control for 2001 levels of population density, median per capita income, percentage of people with university degree, shares of agricultural and manufacturing employment, and the distance (kilometre) of the respective statistical local area (SLA) to Brisbane (complete set of results provided in online Supporting Information). Robust clustered standard errors at local government area levels are in parentheses. Local goods sector includes employment in the Australian Bureau of Statistics categories of construction, professional services, retail trade, accommodation, rental agencies, transport and 'other services'.

or employment levels) and **X** a set of control variables given by 2001 levels of the median per capita income, population density and the proportion of the population with university degrees. We also include in **X** the share of employment in the agricultural and manufacturing sectors (see Table 1 for summary statistics). The covariates in **X** are included to control for initial levels of income, agglomeration effects, human capital and the importance of agriculture and manufacturing across local economies, respectively. d is the distance (in kilometres) of the respective SLA to Brisbane, the capital and largest city in Queensland.[4] We include d to control for the spillover and agglomeration effects that the Brisbane economy spatially produces over the rest of the state.

At the end, our primary interest lies in the direction (sign) and significance to be obtained for β, which will signal the associated CSG boom effect. Thus, the estimated coefficient will show the difference *treatment – control* in terms of the analysed dependent variables. In other words, it will measure the differential growth that the treatment (CSG boom) SLAs have on their income and employment 2001–2011 change, compared to the change in these indicators across control (non-CSG boom) SLAs.

[4] The distance is measured from the geographic centroid of each SLA polygon to the polygon of the LGA of Brisbane.

3.2. Local employment multipliers from the CSG boom

We are also interested in evaluating the potential positive and/or negative employment local multiplier (spillover) effects of the CSG boom. The resource curse literature claims that one negative effect of resource extraction booms is the migration of labour from the traded sector (local manufacturing and agriculture) to the resource extraction industry. On the other hand, positive spillover effects are expected in employment in non-tradable goods (local goods) sectors. Demands for local goods increase because of the new mine businesses coming to local areas, as well as new miners. To analyse this point, we employ an estimation by following the specification provided by Moretti (2010), which captures the number of jobs in different sectors created by new tradable goods sector employment – in our case, mining. Thus, we apply the following estimation,

$$\ln(Es_{2011,i,s}) - \ln(Es_{2001,i,s}) = \alpha + \psi\big(\ln(Em_{2011,i}) - \ln(Em_{2001,i,s})\big) + e_i, \quad (2)$$

where Es is total non-mining employment in a particular sector s, and Em is total mining employment.[5] The coefficients to be obtained from the different regressions (one regression for each sector) will indicate the elasticity of the respective sectoral job growth to changes in mining employment in the same region, from which we can calculate the respective new jobs added by each additional mining job created (Moretti 2010). Also following Moretti (2010), we employ a two-stage least square (2SLS) specification to estimate these elasticities, but based on an instrumental variable (IV) identifying the treatment areas as in Black *et al.* (2005) and Marchand (2012). This IV procedure is done to empirically isolate the change in mining employment associated with the treatment, that is, the CSG industry development. Thus, to capture the treatment effect in (2), we use the number of CSG wells located across SLAs as the IV.

3.3. Considering the resource extraction baseline: Bowen versus Surat basins

It is important to make two distinctions about the basins where the CSG development has been taking place. The Bowen basin is an area where other types of mining, including the extraction of conventional energy resources, have been a common feature for decades. As seen in Table 1, in 2001, the share of employment in the mining industry across the Bowen treatment SLAs was 0.23, which clearly signals dependence on resource extraction in the local economy. On the other hand, the percentage of mining employment was only around 1 per cent in the treatment SLAs belonging to the Surat basin, an area in which mining industry activity has been limited before the CSG boom.

[5] We used $(Es(m) + 1)$ across all observations to avoid problems when transforming data to logarithms.

Considering these 'resource extraction' initial conditions, it is worth analysing whether the CSG boom has been associated with fewer or more effects across the Surat and Bowen basins. We empirically check this in alternative regressions that exclude Bowen basin SLAs from our sample. Thus, we removed six and three Bowen basin SLAs from our treatment and CGs, respectively, obtaining a set of 86 SLAs (sample 2 in Table 2).

3.4. Other resource boom regions

An important issue to consider when analysing a particular resource boom, such as that involving CSG, is the potential increase in other resource extraction industries across the CG. The main idea of our quasi-experimental approach is to evaluate CSG boom effects by comparing treatment areas to areas without this energy resource that could act as counterfactuals, which may show us what would have occurred in the CSG areas in the absence of the boom. So, to better distinguish the potential CSG boom effect in local economies, it is important to consider counterfactuals not showing a similar boom, even if they come from different types of mining.

In recent years, the state of Queensland, as well as the rest of Australia, has experienced a considerable mining boom. According to census data, people working directly for the mining industry in Queensland increased 174 per cent (135 per cent in Australia) between 2001 and 2011 (Australian Bureau of Statistics 2012). To consider SLAs that have not experienced important mining boom economic effects, we provide alternative estimations for a sample, trimming our comparison group by excluding SLAs where the growth in mining employment has been higher than the state total change between 2001 and 2011 (>170 per cent). We denote these removed regions as Mining-Boom SLAs, and their exclusion leaves us with a subsample of 48 SLAs (sample 3 in Table 2).[6]

All results provided in the following section are estimated using clustered standard errors to control for the potential spatial autocorrelation within functional economic regions. In our case, we define these functional regions by LGAs, which are subregions that nest all SLAs across the state. There are 48, 44 and 32 LGAs in samples 1, 2 and 3, respectively.

4. Results

We report in Table 2 results for the coefficient β in equation (1); a complete set of results is provided in online Supporting Information. Results show the differential growth that the CSG boom areas (treatment) are experiencing in contrast to comparable areas where the CSG boom has not taken place

[6] Important to have in consideration is that, given the nature of our data, some of these excluded SLAs are not necessarily hosting mines, but are places where miners were residing at Census night.

(control). This 'treatment effect' is reported for median total personal and family income and for mining and non-tradable (local goods) sectoral employment. Thus, the values reported are equal to the differential growth on the 2001 to 2011 change in these indicators between treatment and CGs, other things being equal.

The first two rows in Table 2 report the income effect related to the CSG boom. Evidence shows that between 2001 and 2011 the median personal (family) income in the treatment areas has increased 24 per cent (15 per cent) more than in the control SLAs of sample 1. Interestingly, the differential effect is somewhat less pronounced (in magnitude and significance) when we consider only Surat basin SLAs in our treatment group.

Our results for employment show that mining employment has grown 31 per cent more in the average treatment SLAs compared to the comparison group. In this case, the effect over the Surat basin is more pronounced (in magnitude and statistical significance), where mining employment has grown around 45 per cent more than in comparable rural areas of Queensland. Looking at the growth in non-mining employment, our results show that treatment SLAs reported a 32 per cent higher increase in non-mining employment compared to the CG. However, these results are less statistically significant when the Bowen basin is removed from the analysis, and indistinguishable from zero when removing Mining-Boom SLAs from the CG (sample 3).

This last result would suggest that the CSG development in the Surat basin area has not produced gains in terms of employment in non-mining sectors, compared to similar regions of Queensland. Taking into account that the Surat basin is where the CSG boom has been more pronounced (considering the number of wells and the growth in mining employment in the area), to further analyse this statistically insignificant effect, we break down the local goods sector into construction, professional services, retail trade, accommodation and food services and other services, and estimate local job multipliers for each of these sectors (as described in Section 3.2) for sample 3.

Table 3 reports the 2SLS results of CSG employment spillovers for sample 3. For the case of local goods employment, only two sectors show statistically significant elasticities at the 10 per cent level: construction and professional services. The elasticity reported for construction indicates that a 10 per cent increase in the number of mining jobs in an SLA is associated with an 8.3 per cent increase in construction employment. Since on average (over the sample) there were 1.7 construction jobs for each mining job in 2001, the estimated elasticity implies that for each additional CSG job in a given SLA, 1.4 jobs are created in the construction sector in the same SLA. In the case of professional services, there were only 0.6 jobs in this sector for each mining job in 2001, which translates that for each new CSG job in an SLA, 0.4 new professional services jobs were created in the SLA. Elasticities for retail trade, hospitality and other services are statistically indistinguishable from zero.

Table 3 Coal seam gas (CSG) employment spillovers over different sectors

	Elasticity	Additional job for each new CSG job
Local goods sector		
Construction	0.832 (0.426)*	1.414
Professional services	0.704 (0.259)**	0.422
Retail trade	0.011 (0.140)	0.024
Accommodation and food services	0.375 (0.263)	0.471
Other services	−0.385 (0.247)	−0.890
Tradable goods sector		
Manufacturing	0.068 (0.199)	0.160
Agriculture	−0.314 (0.182)*	−1.790

Notes: *$P < 0.10$; **$P < 0.05$. Elasticity values are two-stage least square estimations for coefficient β in equation (2). The number of CSG wells in an statistical local area is used as instrument for the log change of mining employment. Values are estimated using sample 3 ($n = 48$). F-stat first-stage = 10.74. Robust clustered standard errors at Local Government Area levels are in parentheses. Other services sector includes employment in the Australian Bureau of Statistics categories of rental agencies, transport and 'other services'.

In the last two rows of Table 3, we include manufacturing and agriculture (tradable goods sector) estimations to evaluate potential migration of labour from these sectors to the labour-demanding CSG industry. While the results do not show a statistically significant effect of job spillovers in the manufacturing sector, there is evidence of an out-flow of agricultural labour, although the result is barely significant at the 10 per cent level (P-value = 0.093). Considering that, on average, there were 5.7 agricultural jobs per each mining job in 2001, the negative estimated elasticity implies that for each additional CSG job in a given SLA, around 1.8 jobs were lost in the agriculture sector in the same SLA.

5. Discussion of results

The results demonstrate that the CSG boom is associated with higher income growth in areas hosting the industry, compared to non-CSG regions. One important issue to consider when interpreting these results, though, is that the 2001–2011 Australian census time series data are only available based on place of enumeration. Therefore, in the case of personal income, results may overestimate the CSG boom income effect at the local level, as mining workers residing temporarily in CSG areas may pull the median upward. Several studies have considered this issue, whereby local residents are potentially excluded from income benefits due to the high number of non-resident workers who take their income back to their normal place of residence (Rolfe *et al.* 2007; Measham *et al.* 2013). However, income effects are also significant for families residing in the region. This is an important consideration, given that the family income indicator does not consider families with members residing outside of the household surveyed (OESR

2012), so the associated income effect from the CSG development is indeed showing higher growth for families residing locally.

One interesting point in the income effect results is that the effect is higher in magnitude in sample 1 (for both personal and family incomes), which can be explained by higher income increases in the Bowen basin SLAs. Considering that the Bowen basin hosts other types of mining on a substantial scale, especially compared to the relative lack of mining in the Surat basin (Table 1), this last effect could be the result of expansions of other mining activities in the area that can be increasing income beyond the CSG effect.

When looking at mining employment effects, the results are in line with expectations. However, again, it is important to note the differences in magnitude and significance of the effect between the Bowen and Surat basins. After excluding the Bowen basin SLAs from the sample, the differential growth increases noticeably, suggesting that Surat basin SLAs have grown more in terms of mining employment. This result clearly signals that the initial condition of the Surat basin has allowed the industry to grow more rapidly than in the Bowen basin, which is also encouraged by more reservoirs concentrated in the Surat area. In this regard, the Surat basin faces more challenges in terms of accommodating this rapidly growing number of workers, many of whom come from other areas of the state and country.

On the other hand, Table 2 shows that non-mining employment has increased in the average CSG SLA by 32 per cent, compared to the CG. However, in this case, the result of sample 3 shows that job spillovers into non-mining employment is not statistically significant. This result is at least intriguing, considering that the same sample shows the highest growth in mining employment. However, after breaking non-mining employment in different sectors, it can be noticed that local multipliers are taking effect for construction and professional services sectors, as shown in Table 3. Thus, our evidence suggests that the CSG boom is at least generating more construction employment and jobs related to the provision of technical services such as electricians and mechanics. Interestingly, even considering the growing number of miners working in the area, retail trade and other local services jobs do not show strong growth in the studied Surat basin SLAs, compared to the control SLAs in sample 3.

Also regarding job multipliers across local economies, one important theme in the literature is migration out of manufacturing employment. However, results found for sample 3 show no effect on this sector (statistically non-significant multiplier). On the other hand, although statistically not strong, there is some evidence suggesting that agricultural jobs have been negatively affected by the CSG boom. This last result shows how people employed in agriculture, between 2001 and 2011, have either migrated out of the area or reallocated into the CSG industry or into the construction and professional services sectors. In addition, this negative spillover can also be explained by a transition to more mechanised agriculture in the area, as

higher labour costs and higher income levels generated by the CSG boom might trigger technological change towards less labour intensive agriculture. More research is encouraged on this issue, especially considering the overlapping of CSG production in agricultural land across Queensland.

6. Conclusions

The growth in CSG development in southern Queensland has been occurring very quickly, and is likely to continue. Better understanding of the current impacts is a key issue in addressing benefits and potential conflicts in the areas affected. Based on the analysis of the quasi-experimental conditions presented by CSG development, this study identifies income and employment (in mining and non-mining activities) effects associated with the CSG boom. In the average SLA hosting the CSG industry, family income grew by 12–15 per cent more than in comparable areas of Queensland during the decade 2001–2011. Employment in the mining sector has also grown faster across the CSG region. However, local job multipliers into other non-mining areas are less consistent across space. Looking in detail at the Surat basin, where most CSG wells have been placed, results suggest that only positive job spillovers from the CSG industry to the construction and professional services sectors have occurred, while the agricultural sector has seen a reduction in jobs.

Overall, the analysis demonstrates that the CSG regions of the Surat and Bowen basins show benefits in terms of income and employment compared to non-CSG regions. However, further research is needed to provide a fuller picture of the extent to which these regions experience overall advantage from their CSG endowments. Future studies could consider how incomes are distributed between households, how higher incomes may be offset by increased housing costs and other local socioeconomic challenges likely to arise as consequences of natural resource booms.

References

Australian Bureau of Statistics (2012). Census DataPacks, ABS, Canberra. Available from URL: https://www.censusdata.abs.gov.au/datapacks [accessed Oct 2012].

Black, D., McKinnish, T. and Sanders, S. (2005). The economic impact of the coal boom and bust, *The Economic Journal* 115, 449–476.

Caselli, F. and Michaels, G. (2013). Do oil windfalls improve living standards? Evidence from Brazil, *American Economic Journal: Applied Economics* 5, 208–238.

Corden, W.M. (2012). Dutch disease in Australia: Policy options for a three-speed economy, *Australian Economic Review* 45, 290–304.

Corden, W.M. and Neary, J.P. (1982). Booming sector and de-industrialisation in a small open economy, *Economic Journal* 92, 825–848.

Department of Natural Resources and Mines of the Queensland Government (DNRM) (2012). Queensland geospatial data. Available from URL: https://webgis.dme.qld.gov.au/webgis/webqmin/viewer.htm [accessed Oct 2012].

Frankel, J.A. (2010). The Natural Resource Curse: A Survey. HKS Working Paper No. RWP10-005. Available at: http://www.ssrn.com/abstract = 1565588 [accessed 10 July 2013].

Geoscience Australia (GA) (2012). *Australian Gas Resource Assessment 2012*. GA Catalogue number 74032. Canberra, Australian Government.

Geoscience Australia (GA) and Australian Bureau of Agricultural and Resource Economics (ABARE) (2010). *Australian Energy Resource Assessment*. GA Catalogue number 70142. Canberra, Australian Government.

Gregory, R.G. (2012). Living standards, terms of trade and foreign ownership: reflections on the Australian mining boom, *Australian Journal of Agricultural and Resource Economics* 56 (2), 171–200.

Hajkowicz, S.A., Heyenga, S. and Moffat, K. (2011). The relationship between mining and socio-economic well being in Australia's regions, *Resources Policy* 36, 30–38.

James, A. and Aadland, D. (2011). The curse of natural resources: An empirical investigation of U.S. counties, *Resource and Energy Economics* 33, 440–453.

Kilkenny, M. and Partridge, M. (2009). Export sectors and rural development, *American Journal of Agricultural Economics* 91, 910–929.

Marchand, J. (2012). Local labor market impacts of energy boom–bust–boom in Western Canada, *Journal of Urban Economics* 71, 165–174.

Measham, T., Haslam, F., Moffat, K. and Franks, D. (2013). An expanded role for the mining sector in Australian society? *Rural Society* 22, 184–194.

Moretti, E. (2010). Local multipliers, *American Economic Review* 100, 373–377.

Office of Economic and Statistical Research (OESR) (2012). Queensland Regional Database. Available from URL: http://qrsis.oesr.qld.gov.au/pls/qis_public/qis1110w$.startup [accessed Oct 2012].

van der Ploeg, F. (2011). Natural resources: curse or blessing? *Journal of Economic Literature* 49, 366–420.

Reeson, A., Measham, T. and Hosking, K. (2012). Mining activity, income inequality and gender in regional Australia, *Australian Journal of Agricultural and Resource Economics* 56, 302–313.

Richardson, D. and Denniss, R. (2011). *Mining the Truth*. Institute Paper No. 7. The Australia Institute, Canberra. Available at: http://www.tai.org.au/node/1777 [accessed 10 July 2013].

Rolfe, J. (2013). Predicting the economic and demographic impacts of long distance commuting in the resources sector: a Surat basin case study. *Resources Policy* 38, 723–732.

Rolfe, J., Miles, B., Lockie, S. and Ivanova, G. (2007). Lessons from the social and economic impacts of the mining boom in the Bowen basin 2004–2006, *Australasian Journal of Regional Studies* 13, 134–153.

Rolfe, J., Gregg, D., Ivanova, G., Lawrence, R. and Rynne, D. (2011). The economic contribution of the resources sector by regional areas in Queensland, *Economic Analysis and Policy* 41, 15–36.

Schandl, H., Poldy, F., Turner, G., Measham, T., Walker, D. and Eisenmenger, N. (2008). Australia's resource use trajectories, *Journal of Industrial Ecology* 12, 669–685.

Weber, J.G. (2012). The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming, *Energy Economics* 34, 1580–1588.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Data S1. The STATA do file (.do) that provides in detail all the code needed to replicate estimates presented in tables across the paper and the Supporting Information tables.

Data S2. A STATA data file (.dta) that contains all the raw data used in the study.

Table S1. List of the 14 treatment SLAs, divided by basins.

Table S2. List of the 81 SLAs used as control group (sample 1).

Table S3. Full set of results, income and employment growth models, 2001 to 2011 (complement of Table 2 in paper).

Tables S4 to S39. Robustness check: tables of results for model (1) considering different samples based on alternative methods to select the control groups.

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PROTECTING HERITAGE ON AUSTRALIA'S COASTS: A ROLE FOR STRATEGIC ENVIRONMENTAL ASSESSMENT?

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This article examines two experiences with strategic environmental assessment (SEA) in Australia, one complete the other in progress. The first applied SEA to a plan for a liquefied natural gas hub precinct on the National Heritage listed Kimberley coast of Western Australia, and the second applies SEA to a coastal management, planning and development framework for the World Heritage listed Great Barrier Reef on the coast of Queensland. Both cases illustrate the approach of the Australian governments to SEA, highlighting the benefits of the approach yet certain flaws in application and process. The research consists of an extensive evaluation of the relevant legislation, its application and reform, together with a thorough literature review. Results highlight concerns in relation to the objective of SEA in Australia, its initiation and timing, consideration of alternatives, and governance. Conclusions are that SEA in Australia will be enhanced if the purpose is more explicitly focused on environmental protection, if SEA is applied early to a reasonable range of alternative sites, and if the Australian Government continues to play an active role in relation to matters of national environmental significance.

Keywords: Strategic environmental assessment; national heritage; world heritage; Kimberley; Great Barrier Reef; Australia.

Introduction

Strategic environmental assessment (SEA) evaluates the environmental effects of policies, plans and programs (or "strategic proposals"), in part to streamline the assessment of the environmental effects of projects, typically evaluated by

environmental impact assessment (EIA). Alternatives and cumulative effects are better considered in SEA, and avoidance of duplication and improved governance may also result (Fischer, 2007; Fundingsland Tetlow and Hanusch, 2012).

In Australia in relation to the national SEA process, most commonly known as "strategic assessment", a recent Senate Report suggested that "while strategic impact assessments appear to be supported in theory, the evidence suggests they may be controversial in practice" (Senate Standing Committee, 2009, para 3.5.3). Governance concerns about fast track environmental approvals may be a major reason, illustrated by the controversy over the defunct proposal for a Pulp Mill in northern Tasmania, which was not however subject to an SEA (Stokes, 2012; Baxter, 2009; Godden and Peel, 2010, 100). Lessons from high profile SEAs complete and underway in the Kimberley and Great Barrier Reef (GBR) where National and World Heritage listed sites are present, and which have also greatly concerned environmental groups (Collins, 2013), are considered in this article.

The call for SEA to be applied to Australia's coastal heritage was made by the present author in this journal in 2002 (Marsden, 2002a, 54), with particular emphasis on the GBR, and with reference to SEA in a coastal context broadly in addition to the role of the World Heritage Convention (Marsden, 2012; 2013a). Ironically, prior to the 2006 amendments to Australia's national legislative framework for SEA, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which were designed to increase the application of SEA, two SEAs were commenced which were of relevance to both areas considered here (Hawke, 2009, 164; Ashe and Marsden, 2011, 25, 29). These SEAs related to offshore oil and gas exploration, an area of emerging application for SEA globally (Elvin and Fraser, 2012; Bankes *et al.*, 2012; Fidler and Noble, 2012), and to the conduct of major military training exercises (in the GBR).

The article reviews Australian experience of SEA in the coastal zone where heritage listed sites are the focus, in particular the SEA of a plan for a liquefied natural gas (LNG) hub precinct considered for James Price Point on the Kimberley coast of Western Australia (WA), and an SEA of a Queensland (Qld) coastal management, planning and development framework applicable to the GBR. The purpose is not to make direct comparisons between these two SEAs, which although subject to the same federal legislation, were initiated for entirely different reasons. The objective, and indeed the basis for the review, is to draw conclusions about the state of SEA in Australia in relation to major resource developments impacting the coastal zone. The approach taken is an examination of the purpose of SEA and the initiation and timing of the SEAs, a critique of the consideration of alternatives (in particular with reference to the Kimberley study), and analysis of

the appropriateness of the decision-making process of the Australian federal government in relation to the relevant state government process.

The first of these geographical areas, the West Kimberley, was listed as a National Heritage site under the EPBC Act, (Shearing, 2012) during the SEA undertaken, and the second is one of Australia's longest established World Heritage sites listed under the World Heritage Convention.[1] The listing of each is important because it triggers the involvement of the Australian government. By way of explaining the context to a reader unfamiliar with the process in Australia, the article begins by providing an overview of SEA in Australia at the federal level, including historical background and applications, purpose and approaches, the findings of an independent review and the Australian Government response to them. A summary of the SEAs undertaken for the Kimberley and GBR follows, with a discussion section analysing the purpose of each, initiation and timing, consideration of alternatives, and decision-making process. Some concluding comments follow at the end.

SEA in Australia

Historical background and applications

After an extensive review of the *Environment Protection (Impact of Proposals) Act* 1974 two decades ago, which considered international experiences with SEA (Court *et al.*, 1994), a new federal statute, the EPBC Act, came into force repealing the old, with Part 10 formally introducing SEA to the Australian national regulatory landscape for the first time in accordance with endorsed policy (ANZECC, 1991). Before then, while informally applied nationally to certain types of strategic proposal (Marsden, 1997), and to some extent in WA (Sippe, 1994), there was no systematic regulation (James, 1995).

In the first decade of experience with the EPBC Act, the overwhelming majority of SEA applications were in the fisheries sector, mainly because a specific provision of the Act required such assessments to be carried out (Marsden, 2002b; Early, 2008; Stoeglehner *et al.*, 2010). While these assessments appear to have been largely successful (Senate Standing Committee, 2009, para 3.5.2), the failure of the general provision enabling SEA to be used (Marsden, 1999) resulted in legislative reform in 2006 to try and encourage proponents to refer strategic proposals to the Commonwealth for assessment (Ashe and Marsden, 2011, 21).

From 2008–2009, these reforms were responsible for initiation of a number of assessments including in relation to a plan for the LNG hub precinct in WA

[1] *Convention Concerning the Protection of the World Cultural and Natural Heritage*, opened for signature 16 November 1972, 11 ILM 1358 (entered into force 17 December 1975) ("*The Convention*"). See generally Francioni and Lenzerini (2008).

(Commonwealth of Australia and State of Western Australia, 2009). Another twelve SEAs have either concluded or are in progress across Australia since this time, each initiated by an agreement between the national government and proponent, the latter typically a state government or a private company. Seven of these concern land use planning matters (Marsden, 2013b), and three relate to the resources industry, including the comprehensive SEA of the GBR WHA begun in 2012 (Commonwealth of Australia and State of Queensland, 2012).

Purpose and approach

It is important to understand the purpose of SEA in an Australian context if comparisons with other experiences are to be validly made. In Australia, while the definition of SEA set out at the start of the introduction to this article is generally also applicable, there are some differences in purpose and approach which have been apparent for some time. In relation to the objective of SEA, the EPBC Act does not make this explicit, which is very different to legislation elsewhere.[2] The link between SEA and EIA through tiering is consequently rather different for example to European understandings, and the proposals subject to the procedure are also different. Most significantly however, is the purpose of SEA as understood in the Australian context.

While the purpose is overwhelmingly to streamline the evaluation of individual project proposals linked with the strategic proposal, this does not mean that a related EIA is limited to matters not already assessed in the SEA, rather that there will be no subsequent EIA at all. This is because under the EPBC Act, the Australian Environment Minister "may approve the taking of an action or class of actions in accordance with an endorsed policy, plan or program".[3] Unfortunately the language is clumsy, as it states that "an assessment be made of the impacts of actions under the policy, plan or program"[4] This does not mean an EIA will be carried out however, as the "impacts of actions under" the policy, plan or program are not the impacts from a project proposal but impacts of the policy, plan or program, which are assessed in the SEA.

[2] See for example the EU SEA Directive, Article 1, where the objective is "to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development". The objective of the EPBC Act is however set out generally in s3, which, in including social and economic factors, is broader than the focus on environmental protection elsewhere.

[3] EPBC Act, s146B.

[4] EPBC Act, s146(1).

Potentially significant environmental effects upon what are known as "matters of national environmental significance" (MNES), or "protected matters", are the trigger for the assessment and approvals process under the EPBC Act and hence involvement of the Australian Government in SEA and, where it is carried out under other provisions in the EPBC Act, EIA (Early, 2008). Examples of MNES include World Heritage and National Heritage listed areas, including the GBR in Qld and the West Kimberley in WA. If the Australian Government agrees with a proponent to conduct an SEA,[5] while this may be assessed and approved by a state government under relevant state legislation, (even if it is also the proponent), where MNES are at issue, an approval by the Australian Government will additionally be needed.

While the legislation does not make clear the purpose of an SEA, the Australian Government states the following advantages of SEA on its website, which are indicative of its purpose[6]:

- clear "goal posts" or requirements for protection of MNES are set up-front, at the planning stage
- greater certainty to local communities and developers over future development
- reduced administrative burden for strategic assessment partners and government through:
    - a substantial reduction in the number of environmental assessments required for an area
    - the avoidance of potentially duplicative and separate environmental assessments by different types of government (such as Australian, state, territory or local governments)
- capacity to achieve better environmental outcomes and address cumulative impacts at the landscape level
- coordinated establishment and management of offsets
- flexible timeframes to better meet planning processes.

Findings of the independent review of the EPBC Act

An independent review into the operation of the EPBC Act was concluded in 2009 on the tenth anniversary of the statute. Known as the "Hawke Report", it notes that "A recurring theme in public comments throughout the Review has

[5] EPBC Act, s146.

[6] http://www.environment.gov.au/epbc/assessments/strategic.html, See also Australian Government (undated) and (2012).

been the Act's perceived failure to manage adequately the cumulative impacts of actions or threatening processes (including climate change) at a landscape or ecosystem scale." (paras 1.33–1.34). This is also noted later in Chapter 7, concerned with individual project approvals (paras 7.28–7.31). Furthermore, it concludes that the public would like greater assurance of the quality of "landscape-scale assessments", which are considered to include SEAs (para 10). Other submissions in relation to SEAs emphasised the need for "robust and strict criteria", raised concerns about Ministerial discretion, conditions and their enforcement (para 10.37–10.45).

The Council of Australian Governments (COAG), which comprises the Australian, state and local governments, made a submission to the independent review in relation to SEA, agreeing that SEA should be used "as a means of harmonising environmental regulation across the federation" (Hawke Report, para 3.12), and also agreed:

> "…to the identification of opportunities for strategic assessments under the *Environment Protection and Biodiversity Conservation Act* 1999 to avoid unnecessary delays in development approval processes. Strategic assessments are conducted over an entire region and provide a mechanism to approve classes of development which have been assessed under this process, rather than conducting individual assessments and approvals. Strategic assessments provide certainty for development proponents and reduce duplication, while providing greater protection for the environment." (para 2.19)

Numerous recommendations were made by the Hawke Report in regard to improving the SEA framework in Australia (Marsden, 2013c). Briefly, these include expanding the role of SEAs and bioregional plans and strengthening the process for each (Recommendation 6.1), and applying SEA to water management plans (Recommendation 9; paras 4.54, 4.78, 4.79). The process should begin early in the formulation of the strategic proposal, alternatives must be addressed, and it must be well supported by information and public participation (paras 3.13, 3.39). Mandatory content requirements are also recommended by the Hawke Report (Recommendation 6(2)(b)), including enhanced provision for public engagement.

Australian Government response to the findings

The Australian Government responded to the Hawke Report in 2011. Commitments have been made to shift from individual project approvals to strategic

approaches and for streamlined assessment and approval processes (Australian Government Response, 2011, 3).[7] It agrees in substance to Recommendation 6(2) of the Hawke Report for amendment of the EPBC Act in relation to SEA. The specific recommendations to specify mandatory required information for SEAs (Government Response 19), to enhance provision for public engagement (Government Response 20) and to assess the performance of accredited systems (Government Response 20), are all accepted and will be significant reforms if implemented. Other responses agree in part to Recommendations 44 and 45, measures to increase public participation and transparency (Government Responses 80, 82 and 83). Certain recommendations, such as for a call-in power for state strategic proposals with potential for significant impact upon MNES, have not however been accepted (Shearing, 2012, 79–80).

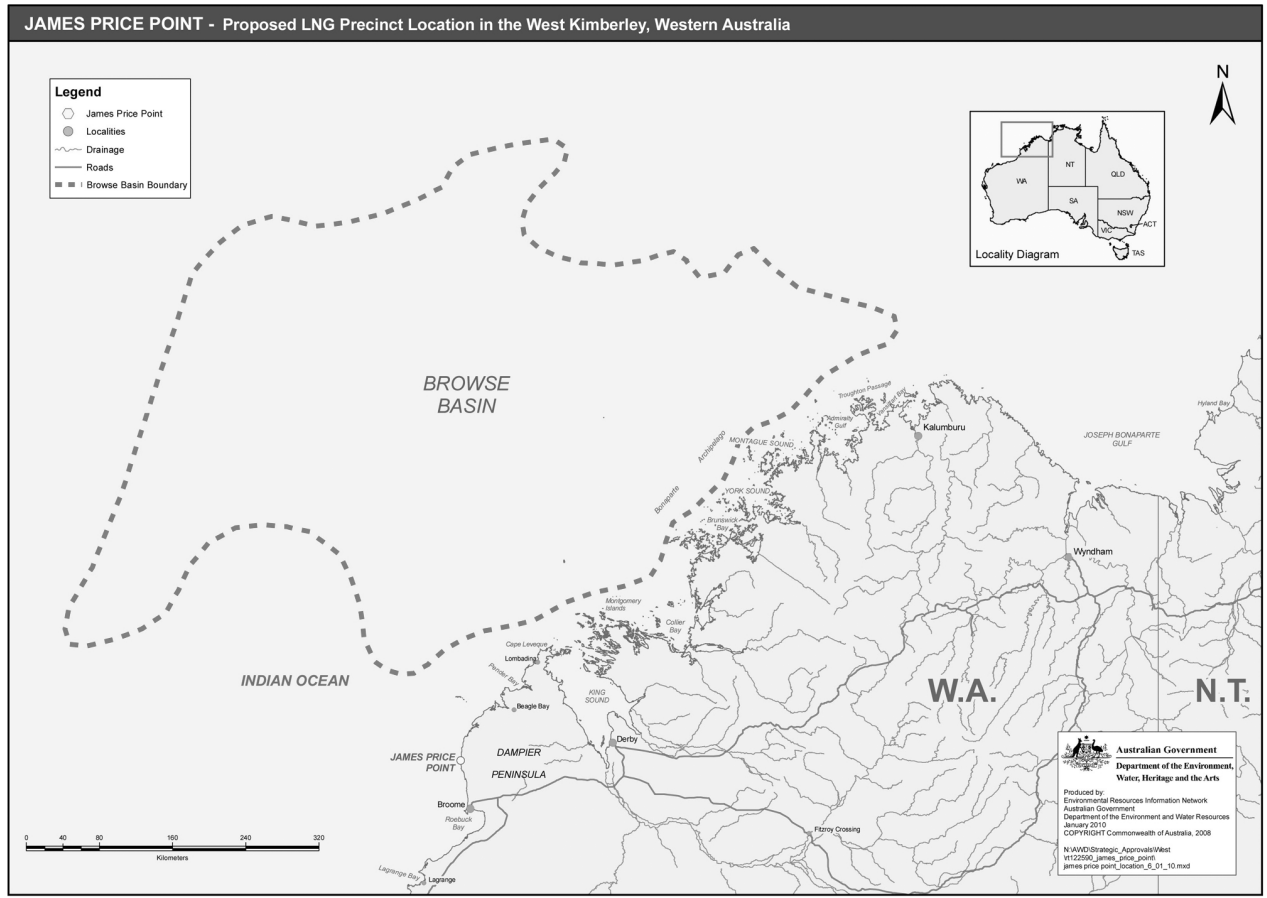
SEA of Australia's Heritage Listed Coasts

SEA of the James Price Point LNG precinct

On 6 February 2008, the Australian Government signed an agreement with the WA Government for the latter to undertake an SEA of the impacts of actions under a plan for the Browse Basin LNG precinct in accordance with WA legislation, the *Environmental Protection Act* 1986. This legislation contains provisions for SEA in WA whether or not assessments are required under the EPBC Act (where MNES are involved). The WA legislation allows proponents to make voluntary referrals of strategic proposals to the Environmental Protection Authority (EPA), the key advisory body to the Government, the advantage of which is that subsequent project proposals already identified ("derived proposals") will not need separate assessment (Marsden and Ashe, 2006, 209; Beckwith, 2012). This is very similar to the approach of the EPBC Act discussed earlier as the SEA avoids the need for an EIA entirely rather than limits the matters considered within it.

The SEA was intended to prevent piecemeal development and avoid cumulative impacts on the Kimberley coastline (Map 1). The draft terms of reference (ToR) for the SEA report were released for public comment between 23 February and 25 March 2008, following which the ToR were finalised. A selection process of more than 40 Kimberley sites was undertaken by the WA Government in 2008 to identify a potential location for the precinct with indigenous communities, environmental scientists, marine experts, the public, environment groups and industry

[7] With respect to the Kimberley case study, a similar earlier review carried out on the WA legislation contained similar findings (Environmental Protection Authority, 2009); these may have influenced the Australian Government findings.



Map. 1.

consulted. It was guided by agreed criteria released for public comment at the same time as the draft ToR for the SEA report. Four short listed sites were thereafter released for public comment (Government of Western Australia, undated). In addition to the Kimberley site assessment process, the SEA also required an analysis of feasible alternative locations for the precinct outside the Kimberley. An independent preliminary report was commissioned by the Australian Government for this, which examined alternative locations along the Pilbara coast of WA (to the south of the Kimberley), along the Northern Territory coast (to the east of the Kimberley), and also offshore structures (Department of the Environment, Water, Heritage and the Arts, 2009). This was provided to the WA Government.

Despite potential for offshore floating facilities and development in the Pilbara, James Price Point was chosen by the WA Government as the preferred site for the SEA, apparently because it avoided the most environmentally and culturally significant areas of coast. This was contrary to the advice of the EPA, which did not believe it was the best site (Environmental Protection Authority, 2008). From 2009 to 2010, the WA Government therefore began several studies at James Price Point and the surrounding area to inform the environmental, heritage and social aspects to be included in the SEA report and plan for the precinct (Department of State Development, 2010; Worley Parsons, 2010).[8] Potential impacts upon MNES were an important part of the process, significantly because the West Kimberley was added to the National Heritage List on 31 August 2011, in recognition of its outstanding Aboriginal, historic, aesthetic and natural heritage values. These included the dinosaur footprints in the intertidal zone at James Price Point which therefore had to be fully assessed.

Following consideration by the WA EPA (Government of Western Australia, 2012), the WA Environment Minister formally approved the Browse Basin LNG precinct on 19 November 2012. If the requirements of the SEA agreement between the Australian and WA Governments had been satisfied the Australian Environment Minister would have been in a position to make a decision under the EPBC Act. Before this occurred however the principal proponent, Woodside, decided to withdraw its application, citing changed financial circumstances. Scoping issues, site selection and governance issues were all raised as concerns during the process, which are examined in the discussion section below, together with alternative processes that could have been applied to a proposal in an area of such sensitivity.

[8] Full documentation can be accessed via the government website at: http://www.dsd.wa.gov.au/7901.aspx

SEA of the impacts of development on the GBR WHA

The qualities of the GBR WHA were recognised in 1981 when it was inscribed on the World Heritage List (Map 2). On 16 February 2012 however, following the outcome of the Reactive Monitoring Mission by the World Heritage Committee (UNESCO, 2012), which was particularly concerned about coastal development impacting the Reef (Shearing, 2012, 73), the Australian and Qld Governments agreed to undertake a comprehensive SEA of the GBR WHA and adjacent coastal zone.

On 30 August 2012 the Australian Environment Minister approved the ToR for the SEA, which takes into account the public comments, the Committee's decision of 6 July 2012, the Mission report, and consultations with the GBR Marine Park Authority, (which exercises federal legislative responsibilities for the area),[9] and the Qld Government, with its own applicable state legislation affecting the area.[10] Neither legislation has comparable provisions for SEA however, and both the Authority and Qld Government will undertake the SEA in accordance with the EPBC Act requirements. There will be further opportunities for the public to comment, including on the draft SEA reports. The Australian Environment Minister will be provided with the comments received when considering endorsement of the SEA, if satisfied that it adequately addresses the impacts, the recommended modifications to the plan have been made, and the criteria have been satisfied.[11]

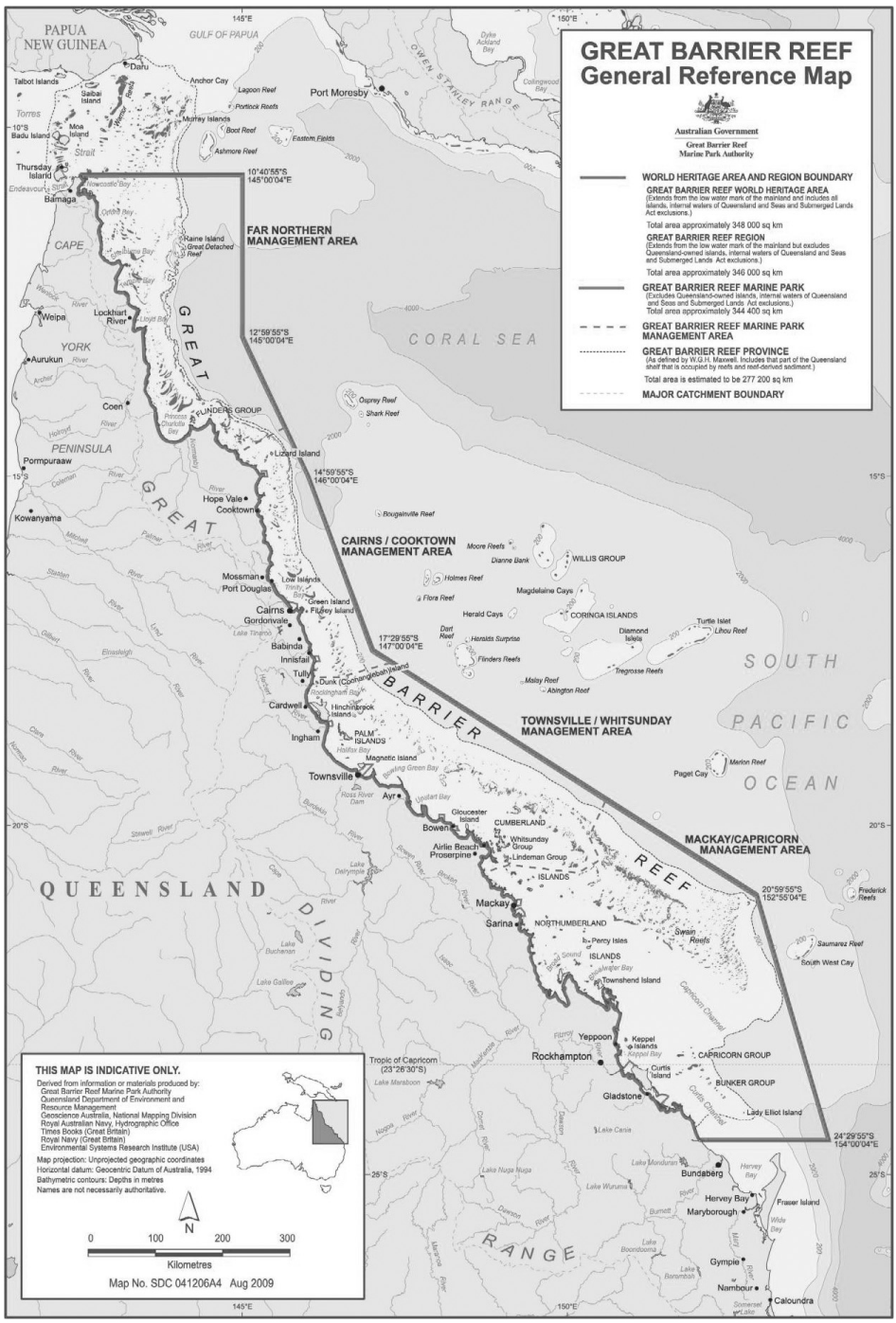
The comprehensive SEA will help identify, plan for and manage existing and emerging risks to ensure ongoing protection and management of the unique environmental values of the GBR WHA and adjacent coastal zone, which indicates a very different purpose and character of this SEA from the Kimberley SEA, as it is focused on both present and future issues. This will be achieved by investigating the adequacy of the existing management arrangements, and assessing current and future development policies and planning in the GBR WHA and the adjacent coastal zone and analysing likely direct, indirect and cumulative impacts.

The SEA has two key components: marine and coastal. The Authority will lead the marine component and the Qld Government will lead the coastal, the latter importantly examining coastal planning including urban, industrial and port development. Overall it will examine whether the appropriate planning processes and management arrangements are in place to ensure development occurs

[9] Full details are available on a designated website at: http://www.gbrmpa.gov.au/outlook-for-the-reef/strategic-assessment/about-the-marine-strategic-assessment

[10] Full details are available on a designated website at: http://www.dsdip.qld.gov.au/gbr-strategic-assessment/

[11] EPBC Act, s146(2)(f).



Map. 2.

sustainably and does not impact unacceptably on MNES. In February 2012 the Qld Government and Authority sought public comment on the draft ToR for the SEA with the public comment period closing on 30 April 2012.

As part of the Australian Government's response to the 2012 decision of the World Heritage Committee regarding the ongoing protection and management of the GBR WHA, the Australian Government has furthermore committed to an Independent Review of the Port of Gladstone. This may result in findings that are relevant to other ports adjoining the GBR, such as the Port of Townsville, discussed below. The outcomes of the review are expected to inform the comprehensive SEA.[12]

Discussion

From the foregoing it is clear that the Kimberley and GBR SEAs are very different in their purpose and nature. The former has primarily evaluated the significant environmental effects anticipated from the actions under a plan for the LNG precinct, and the latter is an evaluation of current and future development policies and plans impacting or with potential to impact upon the GBR. The Kimberley SEA was clearly determined within a pro-development context given the determination of the WA Government to extract and process LNG, and because of the opportunities of the legislation to avoid project assessments. The GBR SEA is entirely different, and is being progressed in response to Australia's obligations under the World Heritage Convention to protect the GBR WHA, which requires an appraisal of strategic proposals currently impacting or likely to impact upon it. While any direct comparison will therefore be ineffective, the case studies nonetheless highlight good and bad approaches to SEA, in particular concerning the overall purpose of an SEA, its initiation and timing, consideration of alternatives, and governance arrangements, especially the allocation of decision-making responsibilities.

Regarding the James Price Point development on the Kimberley coast, as mentioned the key proponent withdrew their proposal in 2013 on the basis of changed economic circumstances (Stewart, 2013; Phillips, 2013), which has effectively pre-empted any final decision by the Australian Environment Minister. Despite this, it is fair to say that the SEA process was dogged by controversy throughout, with scoping, site selection and governance issues raised frequently by opponents. In relation to scoping, key environmental effects on marine mammals

[12] A dedicated website is also available in relation to this. See: http://www.environment.gov.au/coasts/gbr/gladstone/index.html

and heritage were downplayed (Government of Western Australia, 2012), ignored (Mailer and Collins, 2012), or addressed late in the process by the respective governments, such as the National Heritage listing of the East Kimberley (Boyd, 2011).

In relation to site selection, a reluctance to seriously consider alternative sites or technologies at the outset appears misguided, as since the principal proponent has withdrawn a key partner had apparently favoured the offshore option (Freeman, 2012). Although since around 40 alternative sites were reviewed by the WA Government for the hub precinct it would have constituted an expensive and time consuming process for the SEA to look at all of these in detail, it would have been reasonable to expect that the alternative locations identified by the Australian Government — including the offshore processing option — were examined fully. Arguably a reasonableness test should be applied to identifying alternative locations, using criteria subject to public scrutiny and input. Similarly, a risk-based approach for reviewing potential impacts and their mitigation and management would have contributed to the evaluation this SEA.

To meet global best practice, the SEA of the proposed LNG facility for the Browse Basin should at a minimum have been applied to the full range of these possible alternative sites identified beyond the Kimberley coast, not after the selected site at James Price Point was chosen. This would have allowed consideration while other options were on the table and full consultation on this basis. The reason why the WA Government pursued so vigorously the onshore hub at James Price Point arguably had less to do with avoiding the most environmentally and culturally significant areas of coast but more to do with restricting significant developments to one precinct on the Kimberley coast, finding a site relatively close to existing infrastructure (in the regional city of Broome) to manage costs for State-funded services, and to ensure that gas was processed onshore to maximise benefits to WA. This is because gas royalties from the offshore Browse Basin would be collected by the Australian Government, not the WA Government, whereas onshore processing, while still producing royalties for the Australian Government, would at least allow the WA Government to receive some benefits including the opportunities of value-adding industries to leverage off the LNG plant.

In relation to governance, the decision to recommend the plan and SEA to the WA Government for approval was made by the EPA Chairman alone when four of the five members of the board were unable to be involved in the decision making process because of a conflict of interest. The legitimacy of this has been questioned (Moodie, 2012), although since the WA and Australian Governments were the decision-makers, safeguards were in place. The decision of the Australian

Environment Minister in relation to the assessment of MNES remains particularly significant however because responsibility for these matters falls on the Australian Government, primarily due to international treaty obligations underlying most of them.

In regard to the social impacts of development of the hub precinct, the dominant issue was who from the indigenous people of the area benefitted and by how much. This led to a divided indigenous community with some in favour and others opposed. Significant blame for this could be levelled at the proponent or WA Government. Beckwith (2012) has considered the social impacts of development of the hub precinct in depth and hence this contribution does not repeat what is said there. What can be said is that the social effects of strategic proposals are of course a key part of SEA given the driver of sustainable development, what in Australia is termed "Ecologically Sustainable Development" (ESD). Social effects and ESD are furthermore to be considered by the Australian Environment Minister in decision-making under the legislation. When the Minister decides whether to endorse the policy, plan or program therefore, the Minister must consider all MNES,[13] economic and social matters,[14] and take into account the principles of ESD.[15]

In relation to the GBR, the SEA should also have been commenced before a reasonable range of options were foreclosed and certainly long before the relevant Qld resource development and associated infrastructure in Gladstone harbour had began operation. In both this case, and indeed in the Kimberley case, economics appear to have won out long before the environment was considered appropriately and interested communities had their say, which is neither consistent with sustainable development or importantly, the precautionary principle informing it. In relation to decision making, it provides further support for Australian Government approval of both proposals given the legislative requirements for decision making in the EPBC Act outlined above, which will no doubt be scrutinised extensively in the future by interested and concerned stakeholders, and possibly subjected to judicial challenges if inappropriately applied. The Australian Government has been challenged on several occasions in relation to this legislation already. National Heritage listing of the Tarkine wilderness in Tasmania is an example of this, where politicisation of Ministerial decision making has been subject to recent comment (Macintosh and Wilkinson, 2012). Neither the federal, WA nor Qld

[13] EPBC Act, s146F(1)(a); ss 146G-M.
[14] EPBC Act, s146F(1)(b).
[15] EPBC Act, s146F(2).

Governments are immune to this, and hence the importance of accountability in applying SEA processes.

An amendment to the EPBC Act currently before the Australian Senate, the *Environment Protection and Biodiversity Conservation Amendment (Great Barrier Reef) Bill* 2013 (Cth), is designed to amend the EPBC Act to prohibit developments within and outside existing port areas along the GBR coastline, and if approved will introduce a moratorium on developments impacting on the GBR WHA until the SEA is completed and deemed adequate by the World Heritage Committee. It will also prohibit approval of any developments that do not deliver a net benefit to the GBR WHA. The site visit by representatives of the international Committee was, and indeed remains, a major embarrassment to Australia, and if Australia is to avoid having the GBR WHA listed on the 'in danger' list of the World Heritage Convention, the SEA in preparation must fully address and engage with the concerns of the Committee. Whether this happens given that the Qld Government appears intent on deregulation and has already made changes to state law that reduce coastal protections (Hoobin, 2012), must be subject to significant doubt.

In addition, and despite the prospect of a moratorium at Gladstone Port, another proposal which may be considered in the future concerns the export of uranium from the Port of Townsville to the north, and also bordered by the GBR WHA (Clarke, 2013). The Convention advisory body has already expressed its opposition to this, despite the Qld and Australian Governments stating they could not rule out assessing the merits of any proposal for the export of the ore from the Ben Lomond Uranium Mine, which is to the west of Townsville. The Australian Government recently provided an update to the Committee on the GBR WHA SEA, yet the potential of this proposal was not referenced in the report (Australian Government, 2013). However it will undoubtedly be taken into account in deciding whether to list the GBR WHA as "in danger". Overall however, it would appear that the pressures of industry on the respective governments may be extremely difficult to resist given a looming deregulation agenda (Hepworth, 2013), which has also recently resulted in a major overhaul of the environmental assessment legislation of another major resource economy and competitor, Canada (Gibson, 2012; Heelan, 2012).

Given the levels of concern expressed during and since the SEAs began, both of the cases in the Kimberley and GBR would have been extremely suitable candidates for the establishment of a Commission of Inquiry, perhaps along the lines of the former Australian Resource Assessment Commission (Stewart and McColl, 1994, 12; Richardson and Boer, 1995, 90). Unlike other SEAs carried out in Australia under the EPBC Act, particularly relating to land use planning proposals,

both have been extremely controversial in environmental impact and governance, suggesting a body independent of government would have been, or be, better placed to contend with the matters to be determined. Although this option is no longer available following the revoking of the enabling legislation, the EPBC Act contains provisions for inquiry mechanisms to be used in relation to EIA, which do not appear to have been invoked to date. The Government Response accepting "greater use of public inquiries and joint assessment panels for major projects" also suggests that this option may be utilised in the future (Recommendation 4.9) if the reform agenda for EIA and SEA is not derailed.

Conclusion

The Kimberley and GBR SEA experiences highlight the challenges of protecting the environment in the context of increased demands for greater resource exploitation. In both cases analysed in this article, planning frameworks for development to provide infrastructure to enable mining operations have been or are being essentially reviewed in the light of this. Yet Australian governments appear little closer to reconciling environmental protection with economic development today than they have ever been, with environmental values often completely ignored or severely compromised in the face of the economic imperative (Phillips, 2012).

SEA is an central part of the process of sustainable development, providing information to stakeholders and decision-makers. While the application of SEA in both cases demonstrates commitment on the part of Australian governments to attempt to integrate environmental and other considerations in process and decision-making, and legislative review and reform highlight a wish to continue, and potentially enhance, existing assessment and approval processes, whether they are able to meet or overcome the failings identified above must be in doubt. The article has shown that the purpose of SEA in Australia is, despite the theory, primarily to fast track decision-making processes to avoid the application of EIA. While an SEA comprehensively carried out in advance of any strategic proposal may be best placed to ensure environmental protection is not compromised by economic development, neither of the two cases considered here demonstrate that.

While the Kimberley proposal was a plan for a significant energy hub, it was initiated too late, once the site location had been chosen and the political commitment made to exploit the resource. Although "strategic" in applying to a plan and in being a significant resource undertaking for WA and Australia, in other ways it was simply a very large project in need of evaluation. Similarly the assessment of the current and future development policies of the Australian and

Qld Governments in relation to the GBR WHA is also being carried out too late, in this case because development has already begun and has compromised the status of the area. In the GBR WHA case however the scale and cumulative nature of mining, port and coastal development are undoubtedly strategic in this sense as well as in applying to strategic proposals. Whatever the differences, in both cases it appears that the full advantages of an ex ante evaluation have been undermined by being commenced largely ex post.

SEA in Australia will only be enhanced if the legislated purpose is more explicitly focused on environmental protection, if it is applied earlier to a reasonable range of alternative sites, and if the Australian Government continues to play an active role in relation to MNES. In relation to the latter, the key challenge in the Australian context is to maintain momentum for reform at a time of continuing uncertainty in the global economy when overseas resource competitors have chosen instead to scale back environmental assessment processes and domestic pressures for this applied by the business sector and state governments (demonstrated through the COAG deliberations) are increasing. The strong prospect of a change of national government in September 2013 with a renewed focus on the deregulation agenda is additionally and in particular likely to mean that the reforms to the EPBC Act outlined will not be implemented, the legislation for a moratorium on development impacting the GBR WHA will not be passed, and the other suggestions for reform made in this article have little prospect of being taken up.

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References

Ashe, J and S Marsden (2011). SEA in Australia. In Sadler, B, R, Aschemann, J, Dusik, TB Fischer, MR Partidario and R Verheem (eds.), *Handbook of Strategic Environmental Assessment.* London: Earthscan, pp. 21–35.

Australian and New Zealand Environment and Conservation Council (1991). A National Approach to Environmental Impact Assessment in Australia.

Australian Government, Department of Sustainability, Environment, Water, Population and Communities (2011). Australian Government Response to the Report of the

Independent Review of the Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia ("Government Response").

Australian Government, Department of Sustainability, Environment, Water, Population and Communities (undated). Strategic Assessments: Policy Statement for EPBC Act Referrals.

Australian Government, Department of Sustainability, Environment, Water, Population and Communities (2012). A Guide to Undertaking Strategic Assessments: Environment Protection and Biodiversity Conservation Act 1999, Commonwealth of Australia.

Australian Government (2013). State Party Report on the State of Conservation of the Great Barrier Reef World Heritage Area (Australia) 2013, Property ID N154, in response to decision of the World Heritage Committee (WHC) WHC 36 COM 7B.8, Australian Government, February 2013, Commonwealth of Australia.

Bankes, N, M Doelle and L Porta (2012). Using strategic environmental assessments to guide oil and gas exploration decisions in the Beaufort Sea: Lessons learned from Atlantic Canada. Canadian Institute of Resources Law Occasional Paper, 39(1).

Baxter, TI (2009). (Dis)Integrated assessment: the pulping of an integrated assessment process. *Proceedings of the Conference of the Australia New Zealand Society for Ecological Economics*, 27–30 October 2009, Darwin Convention Centre, Darwin, pp. 1–19

Beckwith, J (2012). A social impact perspective on the Browse LNG precinct strategic assessment in Western Australia. *Impact Assessment and Project Appraisal*, 30(3), 189–194.

Boyd, D (2011). Dinosaur footprints or environmental footprints? *ABC Environment*, 14 April 2011.

Clarke, S (2013). Potential uranium port sparks fears for Barrier Reef. *ABC News*, 23 April 2013.

Collins, B (2013). Woodside and protesters on collision course at James Price Point. *ABC Kimberley*, 20 March 2013.

Commonwealth of Australia and the State of Queensland (2012). Section 146(1) Agreement — Strategic Assessment of Impacts of Actions on the Values of the Great Barrier Reef World Heritage Area, and other Relevant Matters of National Environmental Significance, under the Queensland Coastal Management, Planning and Development Framework.

Commonwealth of Australia and the State of Western Australia (2008). Section 146(1) Agreement Relating to the Assessment of the Impacts of Actions under the Plan for the Browse Basin Common-User Liquefied Natural Gas Hub Precinct and Associated Activities.

Court, JD, CJ Wright and AC Guthrie (1994). Assessment of Cumulative Impacts and Strategic Assessment in Environmental Impact Assessment. Commonwealth of Australia.

Department of the Environment, Water, Heritage and the Arts (2009). Comparative Analysis of the Feasibility of Alternative Locations for the Development of a Liquefied Natural Gas Precinct.

Department of State Development, Government of Western Australia (2010). Browse Liquefied Natural Gas Precinct Strategic Assessment Report, December 2010.

Early, G (2008). Australia's national environmental legislation and human/wildlife interactions. *Journal of International Wildlife Law and Policy*, 11(2), 101–155.

Elvin, SS and GS Fraser (2012). Advancing a national strategic environmental assessment for the Canadian offshore oil and gas industry with special emphasis on cumulative effects. *Journal of Environmental Assessment Policy and Management*, 14(3), 1250015.

Environmental Protection Authority (2008). Kimberley LNG Precinct Review of potential sites for a proposed multi-user liquefied natural gas processing precinct in the Kimberley Region, Advice of the EPA to the Minister for Planning (as the Minister for Environment's delegate) under section 16(e) of the EP Act 1986, Report 1306, EPA Perth.

Environmental Protection Authority (2009). Review of Environmental Impact Assessment Process in Western Australia, Environmental Protection Authority, Perth, March 2009.

Fidler, C and BF Noble (2012). Advancing strategic environmental assessment in Canada's western Arctic: Implementation opportunities and challenges. *Journal of Environmental Assessment Policy and Management*, 15(1), 1350007.

Fischer, TB (2007). *Theory and Practice of Strategic Environmental Assessment*. London: Earthscan.

Francioni, F and F Lenzerini (eds.) (2008). *The 1972 World Heritage Convention: A Commentary*. Oxford: Oxford University Press.

Freeman, W (2012). Alternatives ignored in WA gas hub. *ABC Environment*, 17 July 2012.

Fundingsland Tetlow, M and M Hanusch (2012). Strategic environmental assessment: the state of the art. *Impact Assessment and Project Appraisal*, 30(1), 15–24.

Gibson, RB (2012). In full retreat: The Canadian government's new environmental assessment law undoes decades of progress. *Impact Assessment and Project Appraisal*, 30(3), 179–160.

Godden, L and J Peel (2010). *Environmental Law: Scientific, Policy and Regulatory Dimensions*, Melbourne: Oxford University Press.

Government of Western Australia, Department of State Development (undated). Browse LNG Precinct Public Information Booklet. Government of Western Australia (2012). Report and Recommendations of the Environmental Protection Authority, Browse Liquefied Natural Gas Precinct, Report 1444, July 2012.

Hawke, A (2009). Report of the Independent Review of the Environment Protection and Biodiversity Conservation Act 1999, Commonwealth of Australia ('Hawke Report').

Heelan, B (2013). The difference a year makes: changes to Canadian federal environmental assessment law in 2012. *Environmental Law Centre*, 28 February 2013

Hepworth, A (2013). "Emotive" rhetoric on the Reef threatens development: Business. *The Australian*, 2 April 2013.

Hoobin, S (2012). The Great Barrier Reef at risk. *ABC Environment*, 19 October 2012.

James, D (1995). Environmental impact assessment: Improving processes and techniques. *Australian Journal of Environmental Management*, 2(2), 78–89.

Macintosh, AK and DL Wilkinson (2012). Best practice heritage protection: Australia's National Heritage regime and the Tarkine. *Journal of Environmental Law*, 24(1), 75–101.

Mailer, R and B Collins (2012). New dolphin for James Price Point suggests inadequate environmental impact assessment: Scientist. *ABC Kimberley*, 8 June 2012.

Marsden, S (1997). Applying EIA to legislative proposals: Practical solutions to advance ESD in Commonwealth and state policy-making. *Environmental and Planning Law Journal*, 14(3), 159–173.

Marsden, S (1999). SEA in Australia: An evaluation of s146 of the EPBC Act 1999 *Griffith Law Review*, 8(2), 394–410.

Marsden, S (2002a). An international overview of SEA, with reference to World Heritage Areas globally and in Australian coastal zones. *Journal of Environmental Assessment Policy and Management*, 4(1), 31–66.

Marsden, S (2002b). Strategic environmental assessment and fisheries management in Australia: How effective is the Commonwealth legal framework? In Marsden, S and S Dovers (eds.), *Strategic Environmental Assessment in Australasia*. Sydney: Federation Press, pp. 47–70.

Marsden, S and Ashe, J (2006). Strategic environmental assessment legislation in Australian states and territories. *Australiasian Journal of Environmental Management*, 13(4), 205–215.

Marsden, S (2012). Coordinating strategic environmental assessments of marine and terrestrial plans: Australian experience in the sub-Antarctic. In Warner, R and S Marsden (eds.), *Transboundary Environmental Governance: Inland, Coastal and Marine Perspectives*. Farnham: Ashgate, pp. 203–221.

Marsden, S (2013a). Protecting sub-Antarctica via the World Heritage Convention: Recommendations for improved domestic and transboundary governance in Australasia. *Macquarie Journal of International and Comparative Environmental Law*, in press July.

Marsden, S (2013b). Strategic environmental assessment in Australian land use planning. *Environmental and Planning Law Journal*, in press September.

Marsden, S (2013c). A global critique of national environmental law reform for strategic environmental assessment. *University of Tasmania Law Review*, forthcoming.

Moodie, C (2012). EPA green lights controversial LNG project. *ABC News*, July 16 2012.

Phillips, S (2012). What price for James Price Point? *ABC Environment*, 8 October 2012.

Phillips, S (2013). Cheap, fracked gas killed the Kimberley gas hub. *ABC News*, 12 April 2013.

Richardson, BJ and BW Boer (1995). Federal public inquiries and environmental assessment. (1995) *Australian Journal of Environmental Management*, 2(2), 90–103.

Senate Standing Committee of Environment, Communications and the Arts (2009). The Operation of the Environment Protection and Biodiversity Conservation Act: First Report ('Senate Report').

Shearing, S (2012). Reforming Australia's National Heritage law framework. *Macquarie Journal of International and Comparative Environmental Law*, 8(1), 71–95.

Sippe, R (1994). *Policy and Environmental Assessment in Western Australia: Objectives, Options Operations and Outcomes*, paper prepared for the International Workshop on Policy EA and Strategic EA, (The Hague, 12–16 December 1994), 1.

Stewart, D and G McColl (1994). The Resource Assessment Commission: An inside assessment'. *Australian Journal of Environmental Management*, 1, 12–23.

Stewart, J (2013). Woodside shelves James Price gas hub. *ABC Lateline*, 12 April 2013.

Stoeglehner, G, A Morrison-Saunders and G Early (2010). Comparing legislative mechanisms for SEA screening and decision-making: Austrian and Australian experiences. *Journal of Environmental Assessment Planning and Management*, 12(4), 1–25.

Stokes, MD (2011). 'Legal Issues arising from the Pulp Mill Permit issued under the Pulp Mill Assessment Act 2007 (Tasmania)', *University of Tasmania Law Review*, 30(2), 75–106.

UNESCO, Convention Concerning the Protection of the World Cultural and Natural Heritage, World Heritage Committee, 36th Session, Saint Petersburg, Russian Federation 24 June-6 July 2012, *Mission Report Great Barrier Reef (Australia) (N 154)*, 6–14 March 2012.

Worley Parsons Resources and Energy (2010). Department of State Development Browse LNG Precinct Master Plan Report.

Review

CellPress

Under the radar: mitigating enigmatic ecological impacts

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Identifying the deleterious ecological effects of developments, such as roads, mining, and urban expansion, is essential for informing development decisions and identifying appropriate mitigation actions. However, there are many types of ecological impacts that slip 'under the radar' of conventional impact evaluations and undermine the potential for successful impact mitigation (including offsets). These 'enigmatic' impacts include those that are small but act cumulatively; those outside of the area directly considered in the evaluation; those not detectable with the methods, paradigms, or spatiotemporal scales used to detect them; those facilitated, but not directly caused, by development; and synergistic impact interactions. Here, we propose a framework for conceptualising enigmatic impacts and discuss ways to address them.

The problem of enigmatic ecological impacts

There is increasing recognition of the need to find ways to reduce the environmental impact of human development (e.g., [1–5]). This has led to a proliferation of approaches to evaluate, manage, mitigate, and offset the ecological impacts of developments. Evaluations of ecological impact, such as environmental impact assessments, biodiversity offset calculations, and conservation or land-use plans, are generally intended to account for the full range of foreseeable ecological impacts of proposed developments. However, despite the popularity of impact evaluations (see Glossary) and some substantial improvements over time, their effectiveness remains questionable [6].

In particular, impact evaluations tend to reduce complex impacts of human activity to simple, user-friendly metrics to streamline integration of economic and environmental concerns in decision making [7]. They are usually limited in scope to impacts on a predetermined subset of environmental values [4,8]. Impact evaluations are also limited by the knowledge and tools available for identifying impacts, the skills, interests, and motivations of the people conducting, approving, and auditing evaluations, and political dynamics [9–11]. Furthermore, data are often lacking for uncommon and localised species. Although some ecological impacts are simple and immediately apparent, others are subtle yet potentially far-reaching. Examples of the disparity between the full extent of impacts resulting from a development, and the impacts that have been accounted, are mounting [8,12–18]. Accounting for enigmatic impacts is not the only challenge inherent in mitigating development impacts (e.g., [3,10,19]), but addressing it is crucial: oversights in accounting for impacts undermine the ability of mitigation strategies to achieve their objectives (e.g., [12,18]).

Here, we provide a framework for conceptualising what we refer to as 'enigmatic' ecological impacts: impacts that are easily and often overlooked in impact evaluations. This framework can inform decisions regarding planning objectives, acceptable developments, offset requirements, and regional environmental mitigation strategies. We also explore ways in which the challenges of mitigating these impacts may be met.

Four categories of enigmatic impact

Our framework identifies four categories of impact that are often overlooked or inadequately addressed in impact evaluations: (i) cumulative; (ii) offsite; (iii) cryptic; and (iv) secondary impacts. Interactions between multiple impacts

Glossary

Ecological impact: : the effects or consequences of a current or proposed action on ecosystems, processes, and ecological values and services; that is, the difference between what would happen with the action and what would happen without it [68].
Enigmatic impact: : any one of a large range of ecological impacts that is not systematically accounted for in impact evaluations. We define four categories of enigmatic impact: (i) cumulative impacts: the combined effects of individually acceptable or negligible impacts that become significant at regional scales or over longer temporal scales; (ii) offsite impacts: impacts that occur away from the immediate locality of the disturbance or study area and may permeate far into apparently undisturbed areas; (iii) cryptic impacts: impacts that escape detection using existing methods, resources, or technology, under existing scientific paradigms, within assessment time frames, or at the spatial and temporal scales used in the evaluation; and (iv) secondary impacts: impacts that are not directly caused by the development in question, but are facilitated by it.
Impact evaluation: : any process, policy, or document that includes an evaluation of ecological impacts of development for the purposes of informing decisions or plans, or otherwise mitigating those impacts. This includes, but is not limited to, environmental impact statements and assessments, strategic assessments, applications for clearing permits or similar, works or project approvals, biodiversity offset or biobanking strategies and calculations, and conservation or land-use plans that include sustainable environmental management or biodiversity conservation (or similar) in their objectives.

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may also be overlooked. These categories, named after the reasons for which the impacts are excluded from impact evaluations, act as a checklist for scoping the various 'enigmatic' impacts that could result from a development or series of developments. As such, the categories are not mutually exclusive: an impact may be overlooked for multiple reasons.

Exactly which category an impact belongs to depends on the environmental, social, legislative, scientific, and technological context in which they occur, as illustrated by examples throughout this paper. Some will 'slip under the radar' in certain contexts but not in others. The first and fourth categories are adopted from existing literature and policies (e.g., [6,20]), and the second and third categories are reformulated from concepts elsewhere (e.g., [12,21,22]): the four categories have not previously been synthesised in a single paper.

Cumulative impacts: death by a thousand cuts

'Cumulative impacts' refer to the sum of individual impacts that alone are considered negligible, but accumulate over space and/or time and are so numerous that they are

Box 1. Cumulative and offsite impacts of oil sands development in Canada

Oil sand extraction from naturally occurring bitumen under the boreal forests of western Canada exemplifies the issue of cumulative impacts across a landscape [13]. The boreal forests of North America represent a quarter of the remaining intact forests worldwide, but are becoming increasingly impacted by seismic lines and infrastructure corridors associated with the expansion of *in situ* energy production. The amount of vegetation cleared appears small (conventional seismic lines are 5–8 m wide), but the cumulative disturbance footprint of drill pads and other infrastructure is large, estimated to reach 296 000 ha over the next 40 years [13] (Figure IA). Other impacts include: depletion of freshwater resources; damage to aquatic ecosystems; acidification of land and water; contamination events; production and desalination wastes and byproducts and accidental spills; and the loss of fens and wetlands by conversion to upland landscapes [13].

However, these impacts do not end at the edge of the disturbance footprint (Figure IB). Studies have shown that the threatened woodland caribou (Figure IC) tends to avoid areas less than 1 km from roads and wells. Roads further fragment caribou habitat by acting as semipermeable barriers to movement [13,69]. This is concerning given that woodland caribou populations are declining rapidly, with an approximate halving of populations every 8 years. Projected density of artificial edges caused by oil extraction may increase from 1.8 km/km^2 up to 8.0 km/km^2, with a decline in habitat availability from 43% to 6% of the land base over the next 20 years [13,70].

A suite of other species has also been found to avoid infrastructure in the boreal forests of Canada, including the yellow bellied sapsucker, lynx, marten, fisher, wolverine, boreal chickadee, brown creeper, rose-breasted grosbeak, red-breasted nuthatch, and various warblers [13]. According to Schneider and Dyer [13], 'it is the regional cumulative impact of multiple developments, not the impact at any specific site, that is of greatest concern'.

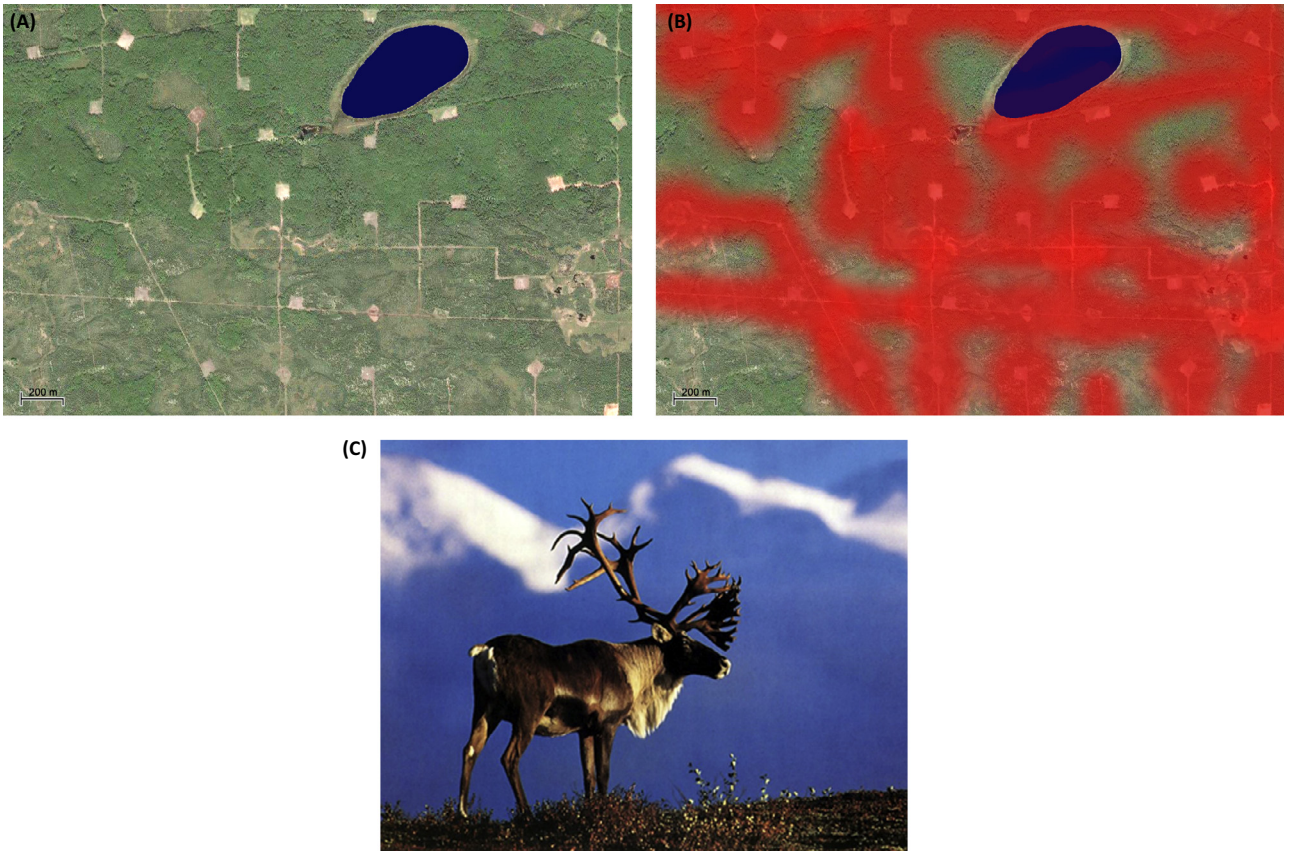

Figure I. Enigmatic impacts from oil sand extraction in Alberta, Canada. Satellite view of roads and well pads showing disturbance footprint **(A)**, satellite view of roads and well pads showing wildlife avoidance zones in red **(B)**, woodland caribou, threatened by multiple impacts of development **(C)**. Reproduced, with permission, from R. Schneider (A, B) and J. Bennett, Sierra Club Canada Foundation (C).

significant when considered in totality [23,24]. A common example of cumulative impacts is many small instances of habitat loss. Individual areas cleared for development, such as housing, drill pads, or roads, may be small but in sum could be unacceptable (Box 1). This concept was originally coined in economics as the 'tyranny of small decisions' [25] or 'death by a thousand cuts' [13].

Cumulative impacts are often overlooked because impact evaluations are often limited by laws that focus exclusively on project-by-project evaluations or impacts deemed to be 'significant', and/or 'reasonably foreseeable' [3,4,23,24]. The emerging fields of strategic and cumulative impact assessments attempt to address these issues, but in their present form are ineffectual or not applied widely [3,23].

Two concerns regarding cumulative impacts are that they can push natural systems over ecological thresholds and their consequences may not be merely additive [5]. Nonlinear relations (such as between remnant habitat area and species richness), feedback mechanisms (such as degraded habitat being less resilient to climate change), space–time lags, and critical tipping points mean that the accumulation of numerous small impacts can be catastrophic [5,23,26]. For example, Florida Bay changed abruptly from a clear-water system with seagrasses and manatees to a 'dead' system with murky water dominated by plankton blooms. The change was unexpected but was probably a threshold response to long-term pollution from septic systems for a long period preceding [27].

Offsite impacts: out of 'site', out of mind

Offsite impacts are those impacts that are difficult to account for in impact evaluations because they are outside the immediate location of the disturbance (the development footprint). Some offsite impacts are considered in impact evaluations (often as so-called 'indirect' impacts) but there are countless impacts that are not included because they are offsite or outside the designated project area or relevant jurisdiction.

Offsite impacts include effects that may occur at great distances from the development such as air, water, light, or noise pollution; or contamination of ecosystems with dust, salt, excess nutrients, or other toxins. They also include alterations to habitat quality away from the disturbance footprint or survey area, such as changed microclimates, altered foraging potential and susceptibility to predation near edges, barriers to wildlife movement and water flow, and changes in animal behaviour with flow-on effects for ecosystems [26,28]. Such changes have been identified even when disturbances are as minor as quiet, nonconsumptive recreation, which is a land use typically thought to be compatible with biodiversity protection [29].

The ecological impacts of hydrocarbons from the extraction, processing, transport, and use of crude oil in the Arabian Gulf exemplify offsite impacts. Hydrocarbons and other pollutants reach the waters of the Gulf by adsorbing to dust carried by wind to the marine environment or via ballast discharge, dredging, infilling, and spills [30,31]. Hydrocarbons can remain dissolved or suspended in water and ingested or absorbed by marine organisms and are often concentrated via food chains, with toxic and carcinogenic effects. However, these impacts are difficult to account for in impact evaluations relating to crude oil activities because of geographic and political separation between the contaminant source and sink [30,31].

More broadly, increasing flood risk to island nations and coastal areas from sea-level rise is an offsite impact of developments that produce greenhouse gases [32]. Many offsite impacts are also cryptic and are covered further later.

Cryptic impacts: the arsenic in the tea

Cryptic impacts elude detection and may be overlooked because of inherent limitations of impact evaluations, but they can be substantial. Reliable detection may be compromised by limited assessment time frames, spatial scales, statistical power, practitioner skill, technology and resources, and the practicalities of survey design [33]. Often only impacts on specific taxonomic groups, ecological communities, or environmental features are evaluated [4,8,12,18].

Cryptic impacts include: noise and light pollution effects on animal communication, movement, foraging, reproductive behaviour and success, visual capabilities, community structure, and predator–prey interactions [34,35]; air pollution impacts on ovule and pollen viability [36]; fragmentation of populations and loss of genetic connectivity [28]; and unwitting disease and invasive species introductions (further examples in Box 2). Furthermore, statistical noise frequently masks trends in ecological data to the extent that early-warning indicators fail to give sufficient warning of potential regime shifts, particularly where data are sparse [16].

Impacts of development on restricted-range endemics are often cryptic, with many species undescribed, poorly surveyed, and/or hard to find, owing to their cryptic nature [37–39]. In Western Australia, where restricted-range endemism is widespread, the Environmental Protection Authority has legislative responsibility to ensure that proposals do not threaten the viability of these species, but many impacts on such species remain unnoticed [38,39].

In 2009, a mining operation in the Great Western Woodlands of southwestern Australia was approved because the restricted-range ameirid copepod (i.e., a small invertebrate that inhabits underground water) found there was thought to occur elsewhere as well [38]. However, the rapid timelines imposed precluded detailed morphological or molecular determination of conspecificity. Subsequent examination found that the two populations belonged to different genera, with the initial population misidentified because of convergent morphology [38]. Consequently, the ameirid is threatened with extinction by dehydration of its habitat.

Secondary impacts: Pandora's box

Secondary impacts are not directly caused by developments but are facilitated by them, yet are generally not considered the legal responsibility of development proponents in impact evaluations. For example, secondary impacts of a hydroelectric dam include the (unintended) impacts of activities facilitated by the road network required for its construction and maintenance [40].

Box 2. Cryptic impact examples

Low-frequency effects on cephalopods

Low-frequency underwater noise produces substantial alterations of the structures responsible for regulating balance and position in cephalopods, such as cuttlefish (Figure IA). This work has shown that the type of noise that is produced by shipping, offshore industrial construction, resource exploitation activities, and naval manoeuvres in marine environments worldwide threatens the survival of these organisms. Little is known about flow-on effects for marine ecosystems worldwide, although they may be substantial [71].

Combining native forests and exotic tree plantations for forest survey

Exotic tree plantations (Figure IB) were lumped together with native forests through automatic analyses of satellite imagery by the Forest Survey of India. This resulted in misleading reports that forests in India expanded by 5% in the decade preceding 2009, when native forests are in fact estimated to have declined by 3.5% per year, driven primarily by forest cutting for fuel wood [12]. These rapid declines in an area that encompasses parts of three recognised biodiversity hotspots were obscured by inappropriate use and interpretation of analytical methods.

Effects of linear infrastructure on water movement and dependent vegetation

Roads can have cryptic impacts on landscapes by interrupting overland flow, upon which vegetation depends (Figure IC). The top half of Figure IC shows the upslope area with annual wind grass (*Aristida contorta*) cover. The lower half of the image shows the effect of water starvation by the road: water from upslope is directed along the road and into creek lines and no longer flows overland [72].

Introduction of microscopic pathogens

Phytophthora cinnamomi is an invasive plant pathogen almost invisible to the naked eye that is practically impossible to eradicate once introduced. This pathogen was inadvertently introduced to Australia and became widespread before it was discovered and its impacts understood. With devastating ecological impacts globally, it is listed as one of the key threatening processes in Australia [73]. Other examples of cryptic invasions include the destructive invasion by non-native earthworms in northern America [41], and devastation caused by invasive rodents on islands, tramp ants, and numerous weeds [20,74,75].

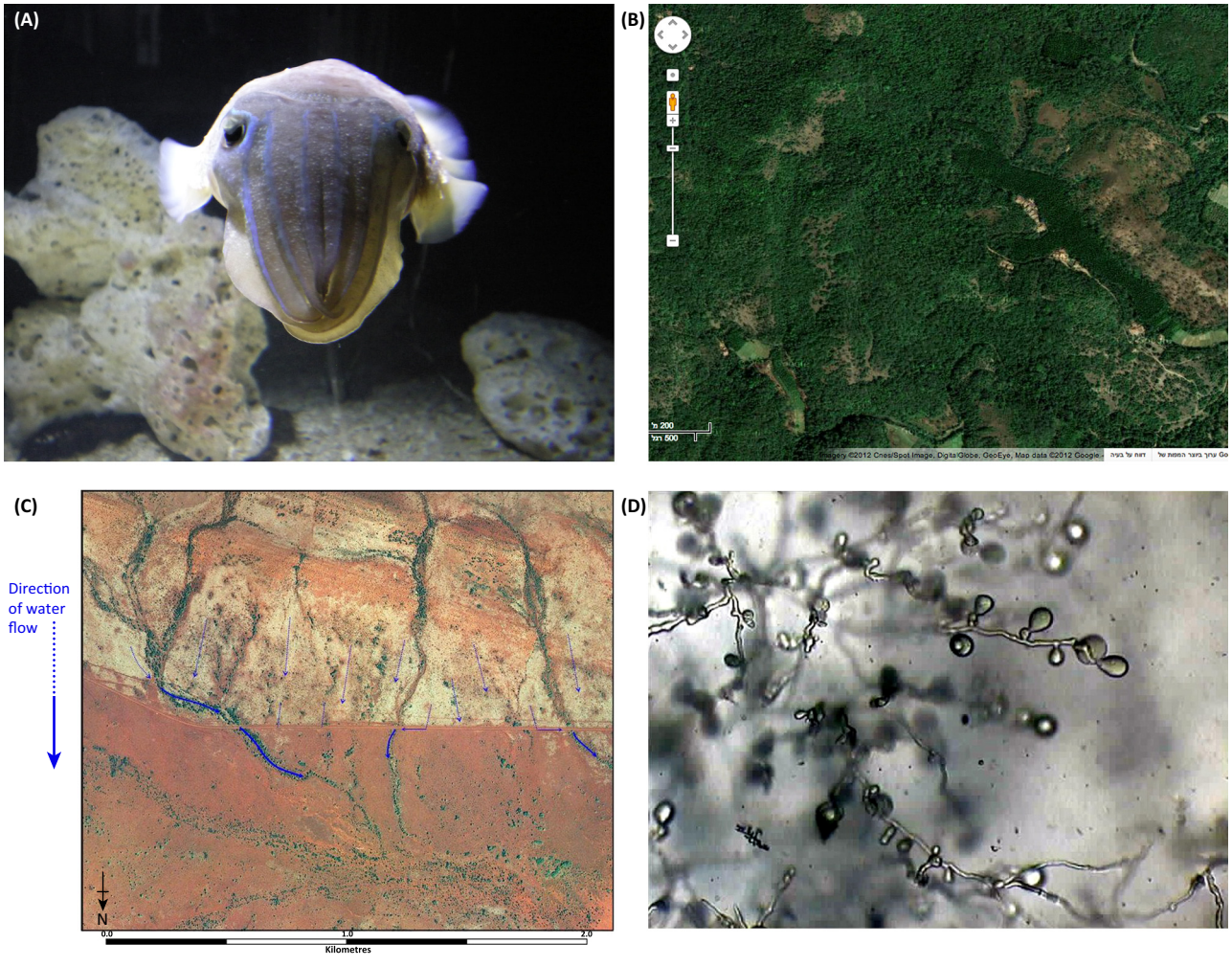

Figure I. Examples of cryptic impacts described in the literature. A cephalopod, whose survival can be threatened by industrial noise in marine environments **(A)**, a landscape of mixed native forests and exotic plantations in India **(B)**, a landscape in which annual wind grass has been severely impacted by a road diverting overland water flow **(C)**, and hyphal swellings of the invasive plant pathogen *Phytophthora cinnamomi* under a light microscope **(D)**. Reproduced, with permission, from Gbaddorf (A) and P.J. Waddell (C).

Indeed, secondary impacts are frequently associated with increased access to relatively undisturbed areas through such road networks. Such accessibility can attract poachers, loggers, miners, graziers, arsonists, land speculators, recreationalists, and even researchers. These uses almost inevitably result in further impacts that can extend far beyond the initial impacts of a development both in space and time, such as introductions of invasive organisms with major ramifications for ecosystems (e.g., [41]). Thus, secondary impacts are also called 'human invasions', or the 'Pandora's box effect' [20,26].

For example, numbers of forest elephants in Central Africa have been reduced by an estimated 40% by illegal poaching for ivory. Intense poaching is a result of a combination of issues, including poverty, weak regulatory powers, and corruption, but access to elephant habitat via new roads is a demonstrated key factor determining poaching rates [42]. Despite providing much-needed economic benefits to human populations, road expansion is associated with increasing threats and local extinctions worldwide [42,43].

Other examples of secondary impacts include the growing contributions of human-ignited fires, 'spontaneous colonisation', uncontrolled logging, mining, and slash-and-burn farming to deforestation in the Amazon basin, that are secondary consequences of an aggressive development strategy of the Brazilian Government [26,44,45]. The strategy includes US$40 billion worth of new and upgraded highways, roads, hydroelectric reservoirs, and power lines, and has been predicted to cause deforestation and severe degradation of up to 500 000 and 2.37 million ha of forest per year respectively, with the majority of impacts above and beyond the direct impacts of the developments [44].

Impact synergies

For every pair of impacts, there are possible synergies that exacerbate environmental damage. The combined effect of the two impacts could be greater than their sum, or one phenomenon might facilitate another. For example, the synergistic effects of multiple species extinctions on ecosystem function are often greater than the additive effect of each extinction, were it to occur in isolation; also, forest fragmentation can facilitate fires [44,46]. It is difficult to predict interactions between different threats and stressors on multiple temporal and spatial scales, and how often they create problematic synergies [47,48]. Nevertheless, history shows that synergistic phenomena can have substantial ecological impacts [48], as outlined in some examples in Box 3.

Challenges and opportunities

Evaluating impacts is the first step to mitigating them. Some impacts are overlooked because they are difficult to detect, quantify, and attribute. In other cases, ignoring them may simply be convenient or politically expedient from a development perspective (e.g., [12,49]).

The difficulty of accounting for enigmatic impacts is not the only hurdle to achieving credible impact evaluations. The effectiveness of many impact evaluations can be undermined by a suite of political and economic constraints including corruption, poor governance, attitudes of governments and regulatory agencies, and persistent weaknesses in rigorous scientific input and meaningful public participation [6,33,43,49].

Quantifying all the enigmatic impacts and their interactions for each development is unlikely given constraints of money and knowledge. However, given the imperatives of conservation and development, governments and proponents need to develop approaches to prevent enigmatic impacts where possible, manage the more predictable impacts, and build mechanisms to account for and mitigate the remainder in a more generic sense. Examples of such mechanisms are presented in Box 4. This process should follow the mitigation hierarchy of (i) avoid, (ii) minimise, (iii) restore, and (iv) offset, with reconsideration of approval for developments that are expected to have large enigmatic impacts [6,50].

Strategic and large-scale evaluation and planning

Developments in regional land-use planning, cumulative and strategic assessments, strategic offsets, and integrated resource management have the greatest potential for mitigating impacts that are inadequately accounted for in project-level evaluations. Such approaches can respond proactively rather than react to developments and provide a much needed mechanism for addressing cumulative impacts [4]. They can also help to ensure that evaluations are designed in ways that maximise their power to detect enigmatic impacts, such as allowing sufficient survey time

Box 3. Impact synergies in space and time

Possibly the most overlooked impacts lie beyond the full extent of individual impacts: in their interactions. Interactions may be antagonistic, additive, or synergistic; that is, the combined effect may be less than, equal to, or greater than the sum of their isolated effects, respectively [48]. Synergistic impacts may also result when one impact facilitates another. Interactions between impacts that are separated by long time periods or operate over different spatial scales are perhaps the most likely to be overlooked.

Coverdale *et al.* [47] investigated a latent, historical synergistic interaction between mosquito ditching that occurred on Cape Cod, Massachusetts, during the 1930s, and recent predator depletion caused by recreational fishing in developed areas. Historical construction of ditches to drain flooded mosquito breeding habitats expanded existing low-marsh cord grass (*Spartina alterniflora*) into areas formerly dominated by high marsh, but this had little effect for decades. Recently, however, recreational fishing reduced predator abundances, such that native herbivorous crab (*Sesarma reticulatum*) populations exploded, causing herbivore-driven saltmarsh die-offs where low-marsh cord grass existed. The synergistic interaction between these impacts resulted in amplified die-off events, despite the historical impact having been dormant for decades.

Local and global impact synergies can also present significant challenges for impact evaluation. For example, global warming can cause direct physiological stress to seagrasses, and excessive local nutrient inputs can cause increased growth of phytoplankton and epiphytes, but the two in combination can have more deleterious impacts on seagrass meadows than their individual impacts combined [48].

Other examples of impact synergies include interactions between habitat degradation and dominance hierarchies of reef fish that substantially alter the mechanisms that structure reef fish communities [76]. In the Amazon basin, increased fire incidence, decreased carbon storage, and changes in forest dynamics caused by logging and fragmentation of forests are amplified by changes in the climate, with potential for dangerous feedback between impacts [26,77,78].

Box 4. Addressing enigmatic impacts in practice

The Nature Conservancy's Development by Design: cooperative mitigation of offsite impacts

The Nature Conservancy was recently commissioned by global gold miner Barrick Gold to develop a cooperative mitigation plan for their Kanowna Belle operations in Western Australia [2,79]. The objective of the plan was to implement Barrick's corporate goal of no net loss of biodiversity.

The Nature Conservancy used the science-based Development by Design mitigation planning process to develop a plan for mitigation and offsetting that included a number of elements designed to account for commonly overlooked impacts. These comprised the inclusion of a 1-km buffer zone around mine footprints and roads in the calculation of impacts for offsetting purposes (to account for 'indirect impacts'; Figure I), a consideration of risks inherent in achieving successful offset outcomes, and a disturbance index based on the cumulative density of mapped disturbance features to inform offset options and priorities.

Environmental risk management and liability insurance for cryptic impacts

If combined with laws that place responsibility for environmental impacts on development proponents, environmental liability insurance can act as a decentralised means of ensuring high regulatory compliance that could reduce oversights in addressing cryptic impacts. Insurance is an effective risk management mechanism because of its capacity to segregate and spread risk effectively, allow for the monitoring and control of behaviour, and encourage loss reduction measures [67]. Importantly, insurance schemes have a lower regulatory burden than most other forms of enforcement.

Although insurance has been used extensively for managing environmental risks to humans from natural disasters, it has only rarely been used to manage the risks of environmental calamities caused by human activities. Section 112(r) of the 1990 US Clean Air Act Amendments provides one example: it offers an opportunity to utilise insurance coupled with third-party inspections to encourage firms to reduce their risks of pollution events from accidents and disasters [67]. At present, impacts that are covered by insurance firms are restricted to human loss of life and injury, and environmental and social impacts remain negative externalities. There clearly is potential to include these other impacts into the insurance equation.

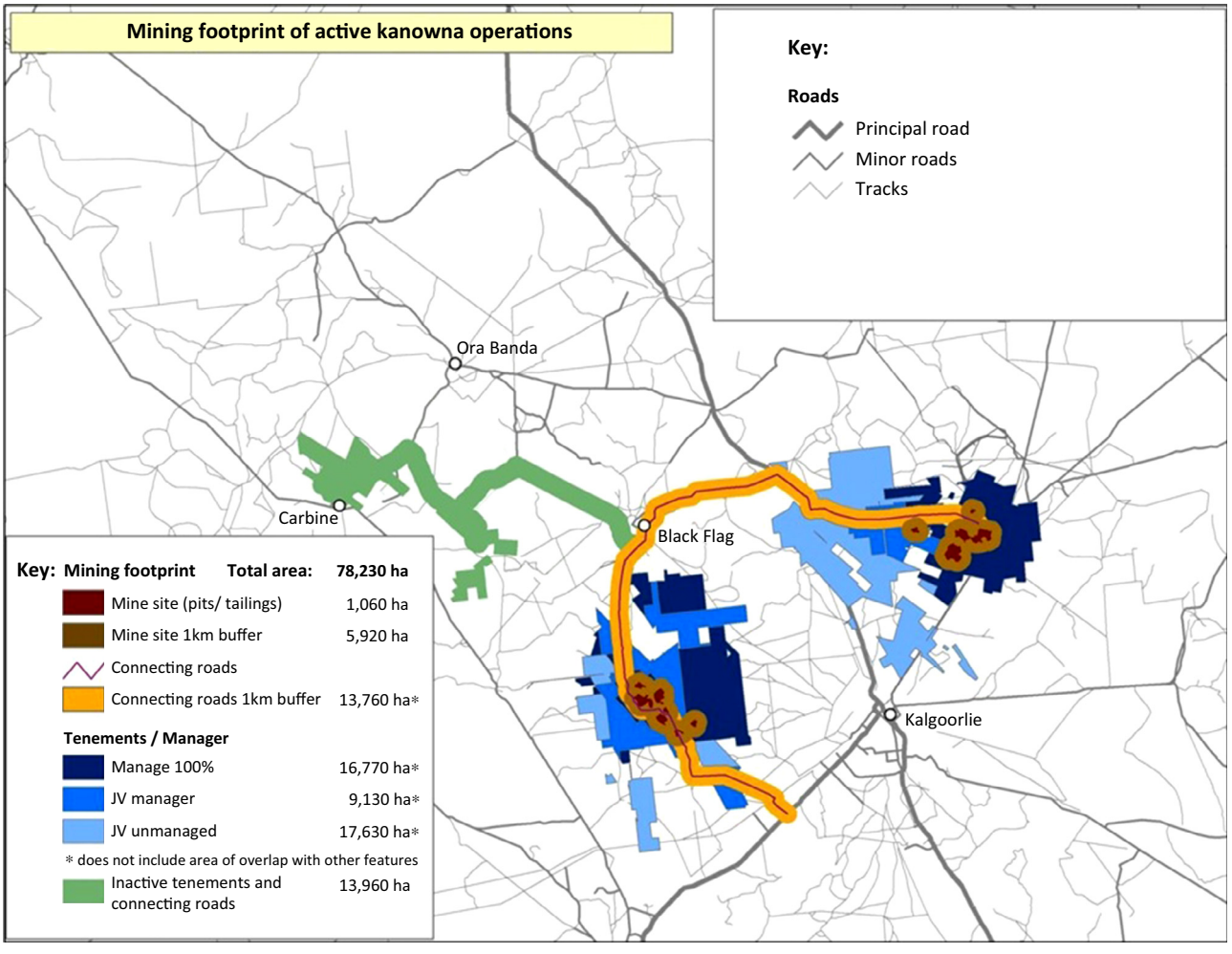

Figure I. An example of an offset calculation in which offset impacts have been taken into account with buffers around disturbed areas in a cooperative mitigation plan developed by the Nature Conservancy for Barrick Gold's Kanowna operations. Reproduced, with permission, from J. Kiesecker, The Nature Conservancy.

frames, considering regional implications beyond individual projects, identifying ancillary impacts, and predicting secondary impacts [3,4,18,44].

However, many such approaches are severely limited, not widely implemented, and are 'underdeveloped' [3,5,6,23]. For example, in the Appalachian region of the USA the impacts of mountaintop mining are only considered for aquatic ecosystems, and severe terrestrial impacts are systematically overlooked [18]. Similarly, fewer impacts would evade consideration if evaluations were broadened from assessing impacts defined as 'significant'.

Trade-offs associated with expanding the scope of impact evaluations could include increased difficulty in decision making regarding approval and prioritising mitigation actions. However, a more realistic picture of probable impacts can only serve to better inform such decisions, and numerous impacts could be grouped or weighted to ensure straightforward yet robust outcomes.

While strategic assessments can facilitate more comprehensive evaluation of enigmatic impacts, other strategic approaches can help to mitigate those impacts. For example, the benefits of offsetting numerous, small developments may be questionable when compensatory activities are implemented separately for individual impacts, but strategic offset funds can provide consolidated sources of funding for offset activities while reducing overall costs. Such approaches would require simple rules for calculating offset requirements and could target regional environmental priorities. Importantly, they can also address cumulative impacts that are commonly too small to offset because the transaction costs of implementing the offset are higher than the cost of implementing the compensatory activity.

Manage, concentrate, and protect

Many enigmatic impacts could be reduced substantially by concentrating developments in areas that are already disturbed, incorporating buffer zones into land-use planning processes and impact evaluations, and establishing no-development zones (or protected areas) in relatively undisturbed areas [51,52]. Roads and developments that penetrate into previously inaccessible areas are disproportionately associated with secondary (and other enigmatic) impacts and could be avoided as a priority [20,26]. Limits on linear infrastructure density could be imposed in other areas. Infrastructure can be shared and consolidated where possible, and investment made into overcoming the barriers to sharing; a strategy also likely to generate cost savings [51,52]. The probable benefits of linear disturbances such as roads and firebreaks that are to be used for 'public good' purposes, such as fire management or ecological monitoring, should be assessed against possible deleterious impacts.

Conserve wilderness or intactness. Other planning policies can complement efforts to concentrate developments and establish no-development zones. Wilderness conservation policies, such as the US Wilderness Act of 1964 [53], effectively prevent countless enigmatic impacts by restricting development in relatively undisturbed areas and represent cost-effective means for long-term biodiversity conservation [54]. However, wilderness is a much debated concept and is embedded in policy only in certain parts of the world [54]. Intactness indices offer a proxy for identifying areas that are less likely to be impacted by enigmatic impacts and may provide an alternative tool for avoiding them [55,56].

Address historical impacts and mitigate co-occurring impacts. Deleterious interactions between multiple impacts, including historical disturbances and global changes, need to be addressed by the societies that have benefited from these developments and by industries that further impact those ecosystems. Where little is known about managing such synergisms, developers can at least minimise their occurrence by measures such as actively rehabilitating disturbed areas, managing species invasions, and facilitating faunal movement across linear infrastructure.

Access management. Secondary impacts can be reduced by restricting public and commercial access along designated-purpose roads, addressing off-road access, and rehabilitating linear infrastructure corridors immediately after project completion. This approach may be difficult to implement in areas where the rule of law is limited and appropriate substitutes may need to be developed, such as creating alternatives to poaching or logging for income generation. Access management may also need to be balanced with community demands for infrastructure development and recreation.

Enhance evaluation

Improve ethical and professional scientific practice. A number of emerging approaches and methods have the potential to enhance evaluation and hence better inform decisions. These include generalised ecological rules of thumb and precautionary approaches that can be applied without detailed assessment and early warning indicators. Calls for addressing ongoing weaknesses in the quality of science underpinning impact evaluations are not new [33,57]. Regulatory agencies, environmental practitioners, and development proponents could improve industry standards and quality control to ensure appropriate application of effort, technology, and expertise in scoping and assessing probable impacts [38]. Rigorously elicited expert knowledge could also complement insufficient data in evaluating likely impacts [58].

Integrated use of available knowledge, precautions, decision-support tools, and projections. Some enigmatic impacts could be accounted for with estimated uncertainty buffers and additional offset multipliers (e.g., [19]). Impact modelling and spatially explicit estimations that incorporate projected impact trends can aid in reducing uncertainty related to data deficiency and in accounting for probable future impacts, as has been done for Amazonian avifauna extinction risks [59–61].

Decision-support tools, such as structured decision making and value-of-information analyses, can also aid in determining the best use of precaution and preferable courses of action in the face of uncertainty, for instance,

where quarantine measures should be used, or when further research or monitoring is beneficial [62]. Such tools can also determine when resource expenditure on monitoring a cryptic threatened species, versus managing the species without monitoring, or surrendering resources to other conservation needs, is optimal [63]. This approach can be adapted to unknown threats, such as in determining when it is wiser or more cost effective to act on a conservative assumption of impact than expend resources on assessment.

Research to establish baselines and early warning indicators. Long-term ecological studies are crucial for establishing baselines and providing key insights into ecological responses to developments [64], and can be particularly helpful in accounting for cryptic impacts. Such monitoring needs to be targeted, hypothesis-driven, and identify trigger points for management interventions to ensure its effectiveness [65]. Improvements in methods for determining early warning indicators can assist in mitigating potential regime shifts [16].

Address the triple bottom line

Public participation. Improving transparency and public engagement in planning and impact evaluations can also help to include consideration of enigmatic impacts in full-cost accounting. Lack of transparency prevents decision makers from being held publically accountable if they did not sufficiently consider likely impacts of a development, such as cryptic impacts that are overlooked by developers seeking to reduce costs or governments pursuing development agendas [4]. Collaborative governance approaches to dealing with cumulative impacts show promise in delivering improvements, although challenges remain, such as corrupt processes, and the time taken to negotiate partnership agreements and difficulty in implementing unpopular responses [66].

Shift risks from society to the marketplace. Governments could better address the risks of cryptic or low-probability impacts by explicitly placing responsibility for addressing development impacts not accounted for (or inadequately accounted for) in impact evaluations in the hands of developers during project approval. For example, if a species was unwittingly introduced into an area because of a development and became invasive, the developer would be responsible for controlling the invasion and repairing any resulting damage, even if they had abided by all regulations. Responsibility for addressing certain historical impacts or collaborating with other developers to mitigate co-occurring impacts could similarly be worked in to approval or licence conditions.

Mandatory environmental insurance schemes offer one way to enact this shift and could ensure that dedicated funds are available when further impacts emerge. Such schemes can help ensure that development decisions intrinsically take account of the risks of unaccounted impacts occurring, with the onus on the developer to better account for and prevent ecological impacts to merit lower premiums [67].

Concluding remarks

Accounting for and mitigating the full breadth of enigmatic impacts resulting from developments is ambitious but important for preventing the continued degradation of ecosystems and the biodiversity, ecological processes, and services that they support. While this may be difficult to achieve comprehensively, significant advances can be made by improving existing mechanisms and developing new ones, to account for the cumulative, offsite, cryptic, and secondary impacts of developments and their interactions. Potential mechanisms include improved strategic and cumulative assessments, no-development and restricted access zones, addressing historical impacts, improving professional and ethical practice and decision-making processes, and adopting environmental insurance schemes. Ultimately, it is reasonable to expect a fair accounting process whereby the beneficiaries of development are responsible for the full environmental costs of those developments, including costs that are currently borne by the broader society and future generations.

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References

1 ten Kate, K. *et al.* (2004) *Biodiversity Offsets: Views, Experience, and the Business Case*, IUCN
2 Kiesecker, J. *et al.* (2013) *Development by Design: Cooperative Mitigation Planning for Barrick Gold's Kanowna Belle Operations in Western Australia*, The Nature Conservancy
3 Morgan, R.K. (2012) Environmental impact assessment: the state of the art. *Impact Assess. Proj. Appraisal* 30, 5–14
4 Alshuwaikhat, H.M. (2005) Strategic environmental assessment can help solve environmental impact assessment failures in developing countries. *Environ. Impact Assess. Rev.* 25, 307–317
5 Buschke, F.T. and Vanschoenwinkel, B. (2014) Mechanisms for the inclusion of cumulative impacts in conservation decision-making are sensitive to vulnerability and irreplaceability in a stochastically simulated landscape. *J. Nat. Conserv.* 22, 265–271
6 Pope, J. *et al.* (2013) Advancing the theory and practice of impact assessment: setting the research agenda. *Environ. Impact Assess. Rev.* 41, 1–9
7 Gasparatos, A. *et al.* (2008) A critical review of reductionist approaches for assessing the progress towards sustainability. *Environ. Impact Assess. Rev.* 28, 286–311
8 Majer, J. (2009) Saga of the short range endemic. *Aust. J. Entomol.* 48, 265–268
9 Bojórquez-Tapia, L.A. *et al.* (1998) Appraisal of environmental impacts and mitigation measures through mathematical matrices. *J. Environ. Manage.* 53, 91–99
10 Walker, S. *et al.* (2009) Why bartering biodiversity fails. *Conserv. Lett.* 2, 149–157
11 Atkinson, S.F. and Canter, L.W. (2011) Assessing the cumulative effects of projects using geographic information systems. *Environ. Impact Asses.* 31, 457–464
12 Puyravaud, J.P. *et al.* (2010) Cryptic loss of India's native forests. *Science* 329, 32
13 Schneider, R. and Dyer, S. (2006) Death by a thousand cuts: the impacts of in situ oil sands development on Alberta's boreal forest. In *Oil Sands Fever Series* (Holmes, R., ed.), Canadian Parks and Wilderness Society and The Pembina Institute

14 Edgar, G.J. *et al.* (2005) Species extinction in the marine environment: Tasmania as a regional example of overlooked losses in biodiversity. *Conserv. Biol.* 19, 1294–1300
15 Almeida-Gomes, M. *et al.* (2014) Underestimation of extinction threat to stream-dwelling amphibians due to lack of consideration of narrow area of occupancy. *Conserv. Biol.* 28, 616–619
16 Perretti, C.T. and Munch, S.B. (2012) Regime shift indicators fail under noise levels commonly observed in ecological systems. *Ecol. Appl.* 22, 1772–1779
17 Roger, E. *et al.* (2012) Linking habitat suitability and road mortalities across geographic ranges. *Landscape Ecol.* 27, 1167–1181
18 Wickham, J. *et al.* (2013) The overlooked terrestrial impacts of mountaintop mining. *Bioscience* 63, 335–348
19 Maron, M. *et al.* (2012) Faustian bargains? Restoration realities in the context of biodiversity offset policies. *Biol. Conserv.* 155, 141–148
20 Laurance, W.F. *et al.* (2009) Impacts of roads and linear clearings on tropical forests. *Trends Ecol. Evol.* 24, 659–669
21 Osenberg, C.W. *et al.* (1994) Detection of environmental impacts: natural variability, effect size, and power analysis. *Ecol. Appl.* 4, 16–30
22 Ribaudo, M.O. (1986) Consideration of offsite impacts in targeting soil conservation programs. *Land Econ.* 62, 402–411
23 Therivel, R. and Ross, B. (2007) Cumulative effects assessment: does scale matter? *Environ. Impact Assess. Rev.* 27, 365–385
24 Canter, L. and Ross, B. (2010) State of practice of cumulative effects assessment and management: the good, the bad and the ugly. *Impact Assess. Proj. Appraisal* 28, 261–268
25 Kahn, A.E. (1966) The tyranny of small decisions: market failures, imperfections, and the limits of economics. *Kyklos* 19, 23–47
26 Fraser, B. (2014) Deforestation: carving up the Amazon. *Nature* 509, 418–419
27 Laurance, W. (2008) Climate shocks that come out of the blue. *New Sci.* 198, 17
28 Forman, R.T.T. *et al.* (2003) *Road Ecology: Science and Solutions*, Island Press
29 Reed, S.E. and Merenlender, A.M. (2008) Quiet, nonconsumptive recreation reduces protected area effectiveness. *Conserv. Lett.* 1, 146–154
30 Sheppard, C.R.C. (1993) Physical environment of the Gulf relevant to marine pollution: an overview. *Mar. Poll. Bull.* 27, 3–8
31 Khan, M.A.Q. *et al.* (1995) Petroleum hydrocarbons in fish from the Arabian Gulf. *Arch. Environ. Contam. Toxicol.* 29, 517–522
32 Nicholls, R.J. *et al.* (1999) Increasing flood risk and wetland losses due to global sea-level rise: regional and global analyses. *Glob. Environ. Change* 9, S69–S87
33 Treweek, J. (1996) Ecology and environmental impact assessment. *J. Appl. Ecol.* 33, 191–199
34 Longcore, T. and Rich, C. (2004) Ecological light pollution. *Front. Ecol. Environ.* 2, 191–198
35 Tyler, N. *et al.* (2014) Ultraviolet vision and avoidance of power lines in birds and mammals. *Conserv. Biol.* 28, 630–632
36 Houston, D.B. and Dochinger, L.S. (1977) Effect of ambient air pollution on cone, seed and pollen characteristics in eastern white and red pines. *Environ. Pollut.* 12, 1–5
37 Scheffers, B.R. *et al.* (2012) What we know and don't know about Earth's missing biodiversity. *Trends Ecol. Evol.* 27, 501–510
38 Karanovic, T. *et al.* (2013) Two new subterranean ameirids (Crustacea: Copepoda: Harpacticoida) expose weaknesses in the conservation of short-range endemics threatened by mining developments in Western Australia. *Invert. Syst.* 27, 540–566
39 Harvey, M.S. (2002) Short-range endemism amongst the Australian fauna: some examples from non-marine environments. *Invert. Syst.* 16, 555–570
40 Finer, M. and Jenkins, C.N. (2012) Proliferation of hydroelectric dams in the Andean Amazon and implications for Andes-Amazon connectivity. *PLoS ONE* 7, e35126
41 Loss, S.R. *et al.* (2012) Invasions of non-native earthworms related to population declines of ground-nesting songbirds across a regional extent in northern hardwood forests of North America. *Landscape Ecol.* 27, 683–696
42 Barnes, R. *et al.* (1995) A review of the status of forest elephants *Loxodonta africana* in central Africa. *Biol. Conserv.* 71, 125–132
43 Edwards, D.P. *et al.* (2013) Mining and the African environment. *Conserv. Lett.* 7, 302–311
44 Laurance, W.F. *et al.* (2001) The future of the Brazilian Amazon. *Science* 291, 438–439
45 Ahmed, S.E. *et al.* (2013) Temporal patterns of road network development in the Brazilian Amazon. *Reg. Environ. Change* 13, 927–937
46 Valiente-Banuet, A. and Verdú, M. (2013) Human impacts on multiple ecological networks act synergistically to drive ecosystem collapse. *Front. Ecol. Environ.* 11, 408–413
47 Coverdale, T.C. *et al.* (2013) Latent impacts: the role of historical human activity in coastal habitat loss. *Front. Ecol. Environ.* 11, 69–74
48 Brown, C.J. *et al.* (2013) Managing for interactions between local and global stressors of ecosystems. *PLoS ONE* 8, e65765
49 Lindenmayer, D.B. and Possingham, H.P. (2013) No excuse for habitat destruction. *Science* 340, 680
50 Gardner, T.A. *et al.* (2013) Biodiversity offsets and the challenge of achieving no net loss. *Conserv. Biol.* 27, 1254–1264
51 Kiesecker, J.M. *et al.* (2011) Energy by design: making mitigation work for conservation and development. In *Energy Development and Wildlife Conservation in Western North America* (Naugle, D.E., ed.), pp. 157–181, Island Press/Center for Resource Economics
52 Tittler, R. *et al.* (2012) Concentrating anthropogenic disturbance to balance ecological and economic values: applications to forest management. *Ecol. Appl.* 22, 1268–1277
53 Jones-Walters, L. and Čivić, K. (2010) Wilderness and biodiversity. *J. Nat. Conserv.* 18, 338–339
54 Callicott, J.B. and Nelson, M.P., eds (1998) *The Great New Wilderness Debate*, The University of Georgia Press
55 Powers, R.P. *et al.* (2013) Integrating accessibility and intactness into large-area conservation planning in the Canadian boreal forest. *Biol. Conserv.* 167, 371–379
56 Scholes, R. and Biggs, R. (2005) A biodiversity intactness index. *Nature* 434, 45–49
57 Greig, L.A. and Duinker, P.N. (2011) A proposal for further strengthening science in environmental impact assessment in Canada. *Impact Assess. Proj. Appraisal* 29, 159–165
58 Martin, T.G. *et al.* (2012) Eliciting expert knowledge in conservation science. *Conserv. Biol.* 26, 29–38
59 Bird, J.P. *et al.* (2011) Integrating spatially explicit habitat projections into extinction risk assessments: a reassessment of Amazonian avifauna incorporating projected deforestation. *Divers. Distrib.* 18, 273–281
60 Schneider, R.R. *et al.* (2003) Managing the cumulative impacts of land uses in the Western Canadian Sedimentary Basin: a modeling approach. *Conserv. Ecol.* 7, 8
61 Loss, S.R. *et al.* (2012) Direct human-caused mortality of birds: improving quantification of magnitude and assessment of population impact. *Front. Ecol. Environ.* 10, 357–364
62 Moore, J.L. and Runge, M.C. (2012) Combining structured decision making and value of information analyses to identify robust management strategies. *Conserv. Biol.* 26, 810–820
63 Chadès, I. *et al.* (2008) When to stop managing or surveying cryptic threatened species. *Proc. Natl. Acad. Sci. U.S.A.* 105, 13936
64 Lindenmayer, D.B. *et al.* (2012) Value of long-term ecological studies. *Austral. Ecol.* 37, 745–757
65 Lindenmayer, D.B. *et al.* (2013) Counting the books while the library burns: why conservation monitoring programs need a plan for action. *Front. Ecol. Environ.* 11, 549–555
66 Eberhard, R. *et al.* (2013) A collaborative approach to address the cumulative impacts of mine-water discharge: negotiating a cross-sectoral waterway partnership in the Bowen Basin. *Aust. Resour. Policy* 38, 678–687
67 Freeman, P.K. and Kunreuther, H. (2004) Managing environmental risk through insurance. In *The International Yearbook of Environmental and Resource Economics 2003/2004. A Survey of Current Issues* (Folmer, H. and Tietenberg, T., eds), pp. 159–189, Edward Elgar Publishing
68 International Association for Impact Assessment (2009) *What is Impact Assessment?* International Association for Impact Assessment
69 Dyer, S.J. *et al.* (2001) Avoidance of industrial development by woodland caribou. *J. Wildl. Manage.* 61, 531–542

70 Hervieux, D. *et al.* (2013) Widespread declines in woodland caribou (Rangifer tarandus caribou) continue in Alberta. *Can. J. Zool.* 91, 872–882

71 André, M. *et al.* (2011) Low-frequency sounds induce acoustic trauma in cephalopods. *Front. Ecol. Environ.* 9, 489–493

72 Waddell, P. *et al.* (2012) A report on the Gascoyne River catchment following the 2010/11 flood events. In *Resource Management Technical Report 382*. Department of Agriculture and Food

73 Shearer, B. *et al.* (2004) Quantification of the susceptibility of the native flora of the south-west botanical province, Western Australia, to *Phytophthora cinnamomi*. *Aust. J. Bot.* 52, 435–443

74 Harper, G. and Carrion, V. (2011) Introduced rodents in the Galápagos: colonisation, removal and the future. In *Island Invasives: Eradication and Management* (Veitch, C. *et al.*, eds), pp. 63–66, IUCN

75 Commonwealth of Australia (2006) *Background Document for the Threat Abatement Plan to Reduce the Impacts of Tramp Ants on Biodiversity in Australia and its Territories*, Department of the Environment and Heritage

76 Boström-Einarsson, L.E. *et al.* (2014) Habitat degradation modifies the strength of interspecific competition in coral dwelling damselfishes. *Ecology* http://dx.doi.org/10.1890/13-1345.1

77 Cochrane, M.A. and Laurance, W.F. (2008) Synergisms among fire, land use, and climate change in the Amazon. *AMBIO* 37, 522–527

78 Laurance, W.F. *et al.* (2014) Apparent environmental synergism drives the dynamics of Amazonian forest fragments. *Ecology* http://dx.doi.org/10.1890/14-0330.1

79 Fitzsimons, J. *et al.* (2014) Development by Design in Western Australia: overcoming offset obstacles. *Land* 3, 167–187

NSW GOVERNMENT | Chief Scientist & Engineer

Final Report of the Independent Review of Coal Seam Gas Activities in NSW

September 2014

www.chiefscientist.nsw.gov.au/coal-seam-gas-review

NSW GOVERNMENT | Chief Scientist & Engineer

The Hon Michael Baird MP
Premier
Minister for Infrastructure
Minister for Western Sydney
Parliament House
SYDNEY NSW 2000

Dear Premier,

Final Report – Independent Review of Coal Seam Gas Activities in NSW

In February 2013 your predecessor wrote requesting I undertake an independent review of coal seam gas activities in NSW. I now submit the final report of that Review.

This report presents the Review's findings and recommendations. Detailed support for the outcomes of the Review is provided in the accompanying reports and information papers released as part of the Review.

In presenting this final report I wish again to acknowledge the assistance of many people – the experts who advised the Review; those who took the time to write submissions or talk to my team; colleagues from government departments in NSW and other jurisdictions; colleagues in industry, research organisations, learned academies and professional associations; and the CSG review team itself which worked hard to make sense of a complex and contentious issue.

Yours sincerely,

Mary O'Kane
Chief Scientist & Engineer
30 September 2014

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EXECUTIVE SUMMARY

This report is the final and overarching report of the independent review of coal seam gas activities in NSW (the Review) undertaken by the Chief Scientist and Engineer. It presents the main findings and recommendations of the Review along with a summary of Government decisions regarding CSG over the time of the Review and a description of the Review process.

The Review was commissioned on 21 February 2013 by the former Premier, in a climate of community unease about CSG extraction.

The initial report of the Review was released in July 2013. In June 2014 the Review released reports on related matters referred to it by Government (cumulative impacts of activities in the Sydney Water Catchment, and placement of monitoring equipment for NSW water resources). At that time it also released a report on whether adequate financial mechanisms are in place to deal with possible environmental impacts from CSG and related operations.

With the release of this final report, the Review is also releasing reports on regulatory compliance and managing risk.

In preparing these reports, the Review drew on information from a large number of experts from around the world in a range of fields. It also consulted extensively with community groups, industry and government agencies.

Having considered all the information from these sources and noting the rapid evolution of technological developments applicable to CSG from a wide range of disciplines, the Review concluded that the technical challenges and risks posed by the CSG industry can in general be managed through:

- careful designation of areas appropriate in geological and land-use terms for CSG extraction
- high standards of engineering and professionalism in CSG companies
- creation of a State Whole-of-Environment Data Repository so that data from CSG industry operations can be interrogated as needed and in the context of the wider environment
- comprehensive monitoring of CSG operations with ongoing automatic scrutiny of the resulting data
- a well-trained and certified workforce, and
- application of new technological developments as they become available.

All of this needs to take place within a clear, revised, legislative framework which is supported by an effective and transparent reporting and compliance regime and by drawing on appropriate expert advice.

Of course, as the technologies involved are applied in new regions where the detailed hydrogeology is not yet fully characterised, there could be unexpected events, learnings, or even accidents. This is common for new applications in the extractive industries and underlines the need for Government and industry to approach these issues with eyes wide open, a full appreciation of the risks, complete transparency, rigorous compliance, and a commitment to addressing any problems promptly with rapid emergency response and effective remediation. It also highlights the need to record and capitalise on the data and knowledge gained from CSG extraction activities in new regions and to take advantage of new technology developments which, if harnessed appropriately, can make CSG production increasingly safer and more efficient over time.

Contents

Executive Summary ..... **iv**

1 About the Review **1**
1.1 THE REVIEW AND ITS REPORTS 1
1.2 PROCESS OF THE REVIEW 1
1.3 HOW THIS REPORT IS STRUCTURED 4

2 Developments in Government and related entities since the Review started **5**

3 Findings **7**

4 Recommendations **12**

Appendices **16**
APPENDIX 1 TERMS OF REFERENCE 16
APPENDIX 2 REPORTS AND BACKGROUND PAPERS WRITTEN AND/OR COMMISSIONED BY THE NSW CHIEF SCIENTIST & ENGINEER DURING THE INDEPENDENT REVIEW OF COAL SEAM GAS ACTIVITIES IN NSW 17

1 ABOUT THE REVIEW

1.1 THE REVIEW AND ITS REPORTS

The independent review of coal seam gas activities in NSW (the Review) undertaken by the Chief Scientist & Engineer began in late February 2013. The Terms of Reference for the Review are at Appendix 1. This report is the final and overarching report of the Review.

Over the past 19 months, the Review has examined the coal seam gas (CSG) industry, the potential environmental, human health and social impacts of CSG extraction, and the legislative and regulatory framework within which CSG operations occur in NSW.

The Initial Report of the Review (CSE Initial Report) was released in July 2013. It provided an overview of the issues and made five recommendations. Since then, the Review has released and is releasing reports on major topics identified through the Review, including:

- insurance and related financial coverage to manage environmental impacts (CSE Insurance)
- compliance systems and processes (CSE Compliance)
- risks to human and environmental health (CSE Risks).

The Review has also provided advice on other related matters requested by Ministers, specifically:

- the placement of monitoring equipment for water resources (CSE Monitoring)
- measuring cumulative impacts of activities which impact ground and surface water in the Sydney Water Catchment (CSE Catchment).

A full list of all the reports released by the Review is given at Appendix 2. All are available on the Chief Scientist & Engineer's website (http://www.chiefscientist.nsw.gov.au/coal-seam-gas-review).

In addition, the Review team is releasing information papers on fracture stimulation, abandoned wells and on managing the physical interface between the CSG industry and other activities. As well, more than 20 background information papers by experts were commissioned on a range of topics, with more than one paper for more controversial topics. These background papers are also available on the website.

1.2 PROCESS OF THE REVIEW

Overall the process of the Review was developed in the knowledge that the issues to be examined were contentious, complex, technical and wide ranging. For this reason it was clear that the Review needed to canvass many different opinions and experts covering a range of perspectives and fields, but it had to do this in a way that maintained a level of independence and avoidance (or awareness) of organisations' conflicts of interests.

The Chief Scientist & Engineer established a team within the Office of the Chief Scientist & Engineer (the Review team) to support and facilitate the Review work. The size of the task required the team to grow from the small team already in place in the Office. The fact that the Review team included individuals with a diverse range of academic and professional backgrounds, including computer engineering, chemical engineering, mechanical engineering, petroleum engineering, hydrogeology, medicine, agriculture, chemistry, environmental science, high-tech equipment compliance systems, public policy and communication, brought a range of perspectives to the issues involved. While the Review team members were not CSG experts, their range of experience meant the Review was able

to formulate detailed technical queries and undertake informed analysis and interpretation of relevant issues and information, drawing on experts advising the Review as necessary.

Throughout the Review the team has pursued the philosophy of operating as transparently as possible, publishing all submissions received apart from those marked 'confidential' on the website of the Chief Scientist & Engineer, talking to the media on request and publishing commissioned papers on the website. Those working on the Review, either in the team or as commissioned experts, were asked to declare all real and possible conflicts of interest with a register established and decisions about how to handle conflicts being determined on a case-by-case basis with decisions formally recorded.

The range and complexity of the issues meant that a great many individuals and organisations needed to be canvassed, ranging from independent impartial experts, to key players in the CSG landscape; from those deeply supportive, to others fighting to prevent the industry's further development.

To address the terms of reference and understand the complexities of the issues, the Review team conducted substantial literature searches (CSE Initial Report §1.4.1) and read widely in the peer-reviewed literature as well as the 'grey literature' reports from organisations, industry and associations. During the course of the Review, a range of material was developed and released by other Australian bodies including the Commonwealth (particularly through the IESC processes), the Queensland Government, CSIRO and other organisations. This was taken into account by the Review.

Consultation was undertaken widely with independent academic experts, government agencies, natural gas industry and service companies, industry bodies, wider industry, community activist groups and the broader community to understand the key issues from a range of perspectives. These consultations were done through public submissions, background technical information papers, formal meetings, visits, workshops, interviews and information requests.

Technical assistance and expertise was drawn particularly from universities, publicly funded research organisations, the learned academies and technical consulting firms. Such assistance included commissioned papers, occasional advice on formulating issues, assistance with identifying experts, peer review of the Review reports, and participation in meetings.

A series of background technical information papers was commissioned on a range of issues related to the CSG industry. Independent experts, who had minimal or no actual, potential or perceived conflicts of interest, were engaged to write the papers. The rationale, process and development for the papers is discussed in the Initial Report §1.4.2. More than 20 background papers have been developed and are available on the website (http://www.chiefscientist.nsw.gov.au/coal-seam-gas-review/csg-background-papers).

The Review inspected CSG exploration and related water-management activities at Narrabri and Gloucester and inspected CSG production and related activities at Camden. It also inspected the Apex Energy CSG exploration site in the Sydney Catchment.

A call for public submissions to the Review was made to enable the Review to understand the issues and concerns from various perspectives (CSE Initial Report §1.4.5). Submissions were welcomed throughout the entire Review and provided considerable insight into specific issues. A total of 266 submissions was received. The submissions are available on the website (http://www.chiefscientist.nsw.gov.au/coal-seam-gas-review/public-submissions).

Consultations involving community members and local councils were held across the State in Camden, Campbelltown, Gloucester, Sydney Catchment, Taree, Gunnedah, Narrabri (including the Pilliga) and the Liverpool Plains.

The team also consulted with government agencies in NSW, across Australia, and overseas.

Consultations with NSW Government agencies formed an important part of the Review, and were used to provide information on the current regulatory system, how the system has operated previously, and what reforms have been put in place more recently. The Review had many face-to-face meetings and teleconferences over the period with agencies, and also surveyed relevant agencies to identify data holdings and systems. The Review sought formal advice on specific issues as required. The Review team also worked closely with the Land and Water Commissioner, drawing on his ongoing consultations across the State on CSG.

The team met with relevant officers from Queensland, Western Australian and South Australian agencies to understand the processes and issues being dealt with in those states. Discussions were held with various Commonwealth Government agencies and agencies from overseas including from Canada, New Zealand, USA and UK. The government agencies associated with resource and environmental management in these other jurisdictions were consulted through meetings, phone discussions and email, with some of these agencies also assisting the Review by providing peer review of report sections, in particular as they related to their jurisdictions.

Various stakeholders from the CSG industry, including companies providing services to the CSG industry, community groups, industry bodies and associations, including from the wider business sector, were invited to meetings with the Review team to discuss key issues and concerns – including those raised in submissions. The Review team met many of these organisations multiple times, including meeting with peak bodies and key stakeholders in the final few weeks of the Review to ensure that the team kept abreast of any new issues that may have arisen.

The Review also ran several workshops aimed at resolving some of the more difficult issues. To understand the complexities associated with cumulative impacts in the Sydney Water Catchment, the Review held two workshops where it brought together top-level experts in relevant fields (see CSE Catchment §1.3.3). To inform the work on CSG risks, four workshops were held. These were a novel way of bringing together stakeholders (many expert) from industry, research organisations, government and the community so participants could hear, debate, consider and, in some cases, resolve opposing viewpoints. Attendees at these workshops were selected for their knowledge, expertise and interest in the issues related to CSG and related activities. Government officials, researchers, and representatives from extractive industries, peak bodies, learned academies and community groups took part, providing a diverse range of backgrounds, expertise and views. Further to this a series of targeted meetings was held with expert practitioners from individual government agencies, research organisations and industry to delve further into specific issues in particular the risks and technical controls available to manage CSG (see CSE Risks §1.2.1).

By far the most complex and time-consuming task the Review undertook was the Compliance Study and its investigation of the processes and systems for ensuring compliance with legislative instruments, regulations and conditions applying to CSG extraction in NSW. The approach to reviewing compliance activity was informed by consultation, public submissions, well inspections, site visits and extensive interaction with the various agencies responsible for compliance with the legislation and regulations pertaining to CSG extraction (see CSE Compliance §1.2), but was challenged by difficulties

in obtaining data to demonstrate compliance, and indeed it ended up being the rate-limiting step for the Review.

1.3 HOW THIS REPORT IS STRUCTURED

This final report provides the overall findings and recommendations of the Review. The individual reports, listed at Appendix 2, provide the detail, evidence and rationale behind various findings and recommendations.

The main findings of the Review are in Chapter 3 and its recommendations are in Chapter 4. As much has happened in Government regarding CSG over the course of the Review, these developments are summarised in Chapter 2 to provide contemporary context for the findings and recommendations.

2 DEVELOPMENTS IN GOVERNMENT AND RELATED ENTITIES SINCE THE REVIEW STARTED

During the course of the Review, a number of regulatory, administrative and process changes have been brought in by NSW Government as well as Commonwealth and local entities to address issues related to CSG.

Legislative reform has included a range of amendments to the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (SEPP), which brought about initiatives such as the Gateway Process, Strategic Agricultural Land mapping, residential CSG exclusion zones and their 2km buffers, as well as Critical Industry Clusters in the Upper Hunter, and clarified the State Significant Development criteria for CSG exploration wells. Further changes to the SEPP were also introduced to stipulate criteria to protect water resources, habitat and amenity; to ensure that decisions around approvals balance economic (resource) and environment issues; and to require the consent authority to consider biodiversity mitigation and offsets.

The *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (General) Regulation 2009* were amended, positioning the Environment Protection Authority (EPA) to be the lead regulator for environmental and human health impacts of CSG; and introducing a risks-based approach to environmental licensing.

Soon to be completed are a review of the *Petroleum (Onshore) Act 1991* and the introduction of a new title instrument that aims to ensure that activity approvals and conditions travel with the petroleum title. The Codes of Practice for Fracture Stimulation Activities and Well Integrity are also being reviewed, while Codes for Safety Management Systems and Emergency Response are being developed.

During the period of the Review, the Commonwealth Government has also introduced legislative changes that impact NSW CSG industry, in particular the introduction of the 'water trigger' under the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999*, requiring the CSG-related proposals that are likely to impact significant water resources to be referred to the Commonwealth. Later amendments devolved the Environmental Impact Assessment authority from the Commonwealth to NSW, with the Commonwealth accrediting the NSW processes.

Several changes have also been made to the administrative arrangements in NSW Government agencies for dealing with CSG. These have included the establishment of the Office of Coal Seam Gas in NSW Trade & Investment; the establishment of the position of Land and Water Commissioner; and a review followed by a restructure of the Division of Resources and Energy (DRE) in NSW Trade & Investment, following the appointment of a new Deputy Secretary. Furthermore, the responsibility for collecting minerals royalties (including for petroleum) has been transferred from DRE in NSW Trade & Investment to the Office of State Revenue in the Treasury and Finance cluster of NSW Government, effective from July 2014.

Efforts have also been made to streamline and coordinate processes across regulators, including through a Memorandum of Understanding (MOU) and the establishment of a cross-agency working group on CSG. In addition, several agencies have taken steps to improve regulatory capability and capacity through recruiting staff, purchasing additional

instrumentation and developing materials to improve officers' knowledge of the CSG industry.

On exploration licence issues, the NSW Government has:

- put a hold on CSG exploration and extraction in the Sydney Water Catchment Special Areas
- put a 6 month freeze on new petroleum exploration licence applications, which was extended by a further 12 months to September 2015
- undertaken to audit existing petroleum exploration licences
- designated the Santos Narrabri Gas Project and AGL's Gloucester Gas Project as Strategic Energy Projects
- signed an MOU with Santos to streamline the assessment process for the Narrabri Gas Project
- renewed AGL's Gloucester petroleum exploration licence and granted an activity approval to fracture stimulate four wells.

Initiatives that relate to land access have been introduced by Government and other entities, such as a review of the process for arbitrating land access arrangements for exploration commissioned by NSW Government followed by the announcement in August 2014 that all recommendations of that review were endorsed and will be implemented progressively. A voluntary Code of Practice for Land Access was developed by DRE. An MOU was executed by NSW Farmers, Cotton Australia, NSW Irrigators Council, AGL, and Santos agreeing common principles of access to private agricultural landholders' property.

Other broader initiatives that affect CSG extraction include:

- an Energy Security Summit that examined emerging issues of gas supply for NSW
- the release of the Water Monitoring Framework developed by the NSW Office of Water, which includes a Groundwater Baseline Project commissioned by the Land and Water Commissioner
- an announcement by the Minister for Natural Resources, Lands and Water of a scheme to credit the return of groundwater to the water sources from which it was extracted
- development by the NSW Office of Water of Guidelines to assist proponents to develop Groundwater Monitoring and Modelling Plans
- release of a framework by the NSW Office of Water that describes the assessment criteria for the Aquifer Interference Policy to aid the development of a project proposal or Environmental Impact Statement.

Other developments, not directly related to CSG, that could impact the industry include:

- the release in October 2013 of the Independent Commission Against Corruption's report *Reducing the opportunities and incentives for corruption in the state's management of coal resources,* that makes a range of relevant recommendations on managing the coal mining industry in NSW
- a number of agency amalgamations and restructures including the formation of Bulk Water NSW from the Sydney Catchment Authority and State Water, and the creation of the new Department of Planning and Environment.

3 FINDINGS

This chapter presents the high-level findings of the Review. The evidence and reasoning supporting these findings is provided in the various detailed reports of the Review, listed at Appendix 2.

Stakeholders have significant concerns

- Land is a key issue and one that strikes an emotional chord due to the strong affinity Australians have with their land and its central role in the livelihood of rural communities. There is a perceived lack of support for rights of landowners in terms of access to their land. Lack of consultation, inadequate compensation, property value decreases, and potential legacy issues are also cited as major issues by landowners as are the negative impacts on amenity and a lack of adequate benefits for their neighbours and their communities.
- Water is another key issue. Primary producers and others fear that CSG developments will negatively impact prime agricultural land by depleting aquifers and contaminating groundwater reserves. They argue that it could result in reduced food production.
- Other major concerns, especially from community groups, are short- and long-term negative environmental impacts (and who will pay to remediate land); managing produced water and associated by-products such as salts; possible impacts on human and animal health; the distributed nature of the industry (giving rise to concerns including malfunctioning unattended wells and heavy traffic on minor roads); and the cost to the taxpayer of regulating the industry.
- Certain processes such as fracture stimulation ('fracking') and, to a lesser extent, horizontal drilling, are of particular concern in the context of CSG although the use of these techniques in other industries (underground water access in the case of fracture stimulation and infrastructure provision in the case of horizontal drilling) is more accepted.
- There is concern about lack of adequate and respectful consultation. Stakeholders cited the failure of industry proponents and government agencies at all levels to engage, provide information, communicate and address community concerns before proceeding with development. On the issue of consultation and adequate information provision, the Review notes that getting the balance right between overall benefit to society and impact on individuals is a recurrent challenge for governments especially for issues as divisive as CSG. While the Review found that consultation and information provision could be significantly improved, it is clear that there are many in the community whose level of concern is such that they are likely to remain opposed to CSG production in NSW under any conditions.
- A large number of those who expressed their opposition to CSG to the Review also made it clear that they were not opposed to CSG *per se* but were opposed to CSG production in heavily populated areas and in areas of intensive agricultural production.
- Local councils, especially rural councils, are concerned that they are not receiving adequate funds to cover rapid infrastructure upgrades (such as upgrades to local roads and other amenities) necessary to deal with the CSG industry coming to a rural locality.
- The CSG industry is concerned that it is being adversely affected financially by what it perceives to be an uncertain, often changing, and increasingly tough regulatory regime in NSW.
- There is a perception in some parts of the community that CSG extraction is potentially more damaging and dangerous than other extractive industries. This perception was heightened following the release of the American movie *Gasland* in 2010. The Review examined this issue in detail and concluded that while the CSG industry has several

aspects that need careful attention, as do almost all industries, it is not significantly more likely to be more damaging or dangerous than other extractive industries.

- Many perceive the CSG industry to be a new industry that is being fast-tracked without adequate attention to significant concerns. CSG production has been happening at significant levels in North America (where coal seam gas is generally referred to as coal bed methane) for two decades and in NSW for 13 years (at Camden by Sydney Gas, later AGL). CSG from NSW sources currently accounts for 5% of the NSW gas supply. In the 1990s the Government introduced measures such as a five-year royalty holiday (followed by a five-year incremental sliding scale of royalties from 6% up to 10%) to encourage the petroleum industry. This benefit was removed at the end of 2012. Some of the companies that began exploring during this time were responsible for incidents that led to increased concerns about the industry generally.
- Complex and opaque legislation and complex regulatory processes. This concern was raised repeatedly by community, the CSG industry and government agencies. It can lead to considerable administrative burden for those needing to comply, those assessing compliance and those trying to understand the legislative and regulatory regime from the community for the purpose of investigating concerns. This complexity can also lead to gaps, overlaps, contradictions and wasted time in inefficient oversight. The Review agrees that the legislation and regulatory processes need to be addressed.
- Inconsistent legislation. Many industry and community groups have alerted the Review to varying legislative and regulatory regimes for things similar to those relating to CSG extraction. Legislation and regulation covering the construction of wells and production of gas from coal seams as part of coal mining activities is less stringent than that for CSG production. Similarly a 2km buffer zone approach has been introduced for CSG extraction, but no such zone is in place for conventional gas or other types of unconventional gas extraction.

Lack of trust

- CSG companies are viewed as untrustworthy by some members of the community in both urban and rural areas. This lack of trust seems to stem particularly from some CSG exploration companies: being perceived to be in violation of land access regulations; being perceived by some to bully vulnerable landholders; not managing sub-contractors appropriately; engaging in questionable environmental practices; and not reporting accidents to the regulator quickly enough.
- Despite the limited extent of CSG development across NSW, Government is perceived by some as favouring the CSG industry for allowing it to proceed in areas where there has been considerable community opposition. Government is also perceived by some as not managing regulatory compliance effectively and not supporting compliance activities with sufficient penalties where CSG companies have infringed regulations.
- Government and industry information about CSG is perceived by some as lacking independence and, accordingly, is not trusted.
- Among groups trying to understand CSG impacts there is concern about lack of access to raw data, and especially baseline data associated with a locality, before CSG exploration and production commences. While the Government open data access provisions of recent years go some way to addressing this concern, the fact that most companies are not releasing this data in raw form (and are not required by Government to release it) leads to increased suspicion.
- There is considerable social tension and animosity between some neighbours in some local communities where CSG operations are proceeding or proposed. On the one hand there are those who are concerned about potential negative impacts of CSG extraction and see those who want its introduction as ‘selling out’ to CSG companies. On the other hand, landowners and community members who are in favour of CSG often feel that the debate has been ‘hijacked’ by environmental activists who are ‘using’ the community for their own ends.

There can be benefits to individuals, industry and communities

- Industry, particularly the manufacturing industry, believes having increased amounts of locally produced gas helps deal with concerns about rising gas prices and possible future shortages. This is a particular issue for several companies that have long-term gas purchase contracts expiring. As well as raising concerns about price, several industry and government figures have also expressed concern about potential gas shortages, in the light of the high-value contracts for the export of gas from the new LNG plants at Gladstone. The impending increase in export capacity is anticipated to lead to greater demand for CSG production and to cause Australian east coast gas prices to rise to meet the export price.
- With effective consultation addressing stakeholder concerns and appropriate levels of compensation, CSG development can provide new revenue streams for landholders and their communities. With appropriate support arrangements in place, landholders can make money from CSG production on their land. While local councils have to ensure their communities can cope with the industry influx, industry activity can bring benefits to communities, especially to rural communities, in terms of increased employment, rents and servicing opportunities.

CSG extraction and related technologies are mature and Australia is well equipped to manage their application

- Unconventional gas production is now a major industry especially in North America where, on balance, it is generally highly valued because of the energy security it provides. On the back of this, there is now considerable investment and experience in the development and refinement of technologies to maximise production while minimising adverse impacts. In Australia related technologies have now been extensively deployed successfully for some years (including at Camden in NSW). The independent petroleum engineering, geological and geophysical experts advising the Review consider that such technologies (including fracture stimulation and horizontal drilling technologies), with appropriate safeguards, are suitable for use in many parts of the sedimentary basins in NSW, noting that drilling in any new location is, to an extent, a learning-by-doing activity as there will always be local geological attributes specific to an individual resource development. These activities can and should be guided by companies investing in geophysics and other characterisation techniques to inform the best drilling and extraction approaches to take.
- There is a long history of working in the subsurface in Australia for the extraction of resources such as minerals, coal, gas, oil, water and, to a lesser extent, geothermal heat. This has led to a good understanding by Australian governments of what is needed to regulate subsurface activities for the purposes of safety, health, minimising environmental impact and protecting high-priority resources such as water. As a consequence Australia has built up high-quality expertise and knowledge of subsurface activities. In the public sector it has government agencies such as Geoscience Australia and State resources departments; research-intensive Earth Science and Mining Engineering departments in universities; publicly funded research agencies such as CSIRO and ANSTO; various collaborative research centres; and relevant national collaborative research infrastructure. In the private sector Australian resources companies have reputations as leading in the applications of world best practice. With Australia heavily invested in resources development, most of the global resources industry service companies have a major presence here. Australia also has a well-educated workforce.
- Australia has a strong track record in water technology innovation and management. Water is a key issue for Australia so we have developed significant capabilities in water management. This includes water treatment, operations and infrastructure for water and fluids management, management of byproducts such as salts, waste disposal,

remediation and rehabilitation. These activities are backed by considerable research and science expertise especially in government agencies, universities, CSIRO, the Bureau of Meteorology and various Cooperative Research Centres. This means that Australia is in a good position to rise to the challenge of managing the various water issues associated with CSG production.

There are things we need to know more about

- While Australia has a long history of working in the subsurface, there is still considerable uncertainty associated with the development of any new resource province. Currently CSG activities tend to be considered mainly at a site-specific level. A better understanding of the industry impacts at scale and over time is needed. To enable better planning decisions and better management of cumulative impacts, it will be necessary that industry collects and provides to Government significantly more data than at present including data from a wider range of sources. With a diverse range of resources, including coal, CSG and underground water, hosted in our sedimentary basins, there is a need to understand better how the different resources and their development regimes interact. More detailed knowledge of the structure and composition (especially regarding hydrogeology) of the sedimentary basins is needed to enhance productivity for the CSG industry through more precise resource characterisation and better subsurface and surface environmental management.
- There is a need to understand better the nature of risk of pollution or other potential short- or long-term environmental damage from CSG and related operations, and the capacity and cost of mitigation and/or remediation and whether there are adequate financial mechanisms in place to deal with these issues. This requires an investigation of insurance and environmental risk coverage, security deposits, and the possibility of establishing an environmental rehabilitation fund. Doing this is essential to ensure that the costs and impacts from this industry are not a burden for the community.
- Legacy issues, including better understanding of inappropriately abandoned wells, need attention.

Risks can be managed

- Management of potential risks associated with CSG, as with other industries, requires effective controls; high levels of industry professionalism; systems to predict, assess, monitor and act on risks at appropriate threshold conditions; legislation; regulation; research; and commitment to rapid remediation, continuous improvement and specialist training. The Review studied the risks associated with the CSG industry in depth and concludes that – provided drilling is allowed only in areas where the geology and hydrogeology can be characterised adequately, and provided that appropriate engineering and scientific solutions are in place to manage the storage, transport, reuse or disposal of produced water and salts – the risks associated with CSG exploration and production can be managed. That said, current risk management needs improvement to reach best practice.
- In particularly sensitive areas, such as in and near drinking water catchments, risk management needs to be of a high order with particularly stringent requirements on companies operating there in terms of management, data provision, insurance cover, and incident-response times.

New knowledge and technologies are becoming available but need to be harnessed to make CSG extraction safer and more productive

- Rapid advances in knowledge and technologies in a wide range of fields (especially in information and communication technologies; numerical modelling; geology, geophysics and petroleum engineering; and new materials) are occurring and can be harnessed to improve CSG production efficiency and to minimise adverse impacts. Some of the most notable recent developments include:

    - data technologies especially in the area of big data, data analytics and data fusion. These technologies use very large amounts of data from diverse sources to enable better understanding of complex earth systems with an improved grasp of the uncertainties in modelling for purposes such as characterising CSG resources and predicting groundwater impacts. For these powerful technologies to be effective, significantly more data from a wider range of sources need to be collected
    - visualisation technologies that allow for detailed inspection of data. These include using 3D and movie techniques which are often particularly useful in allowing experts from a wide range of disciplines to inspect and analyse large amounts of complex data easily and quickly. They are also used for training and testing responses to hazardous situations
    - sensor and monitoring technologies – both in-line and remote monitoring technologies – are becoming very cheap and are increasingly integrated with onboard signal processing and communications technologies. This means that the very large amounts of surveillance data they produce can be preprocessed locally then rapidly sent to a central data repository
    - artificial intelligence techniques that allow for intelligent, real-time interrogation of monitoring data with alerts when anomalies are detected
    - developments in petroleum engineering that allow for better matching of combinations of appropriate technologies for particular geological situations
    - developments in new materials.
- In order to speed the beneficial uptake of new technology developments for an industry as contentious as CSG, the Review concludes that Government needs access to such expertise on a permanent basis, such as by creation of a standing committee comprising top experts from relevant disciplines, to advise it when to act on new technology developments as they become available.

There are no guarantees

- All industries have risks and, like any other, it is inevitable that the CSG industry will have some unintended consequences, including as the result of accidents, human error, and natural disasters. Industry, Government and the community need to work together to plan adequately to mitigate such risks, and be prepared to respond to problems if they occur.

4 RECOMMENDATIONS

The final recommendations of the Review are presented below, grouped according to themes. Some of the recommendations have been modified, simplified or combined, compared with the form in which they were first presented in previously released reports of the Review; however their intent has not changed.

Intent, communication, transparency and fairness

Recommendation 1

That Government make clear its intent to establish a world-class regime for extraction of CSG. This could be articulated in a clear public statement that covers:

- the rationale/need for CSG extraction
- a clear signal to industry that high performance is mandatory, compliance will be rigorously enforced and transgressions punished
- a fair system for managing land access and compensation
- a mechanism for developing a clear, easy-to-navigate legislative and regulatory framework that evolves over time to incorporate new technology developments
- mechanisms for working closely and continuously with the community, industry, and research organisations on this issue.

Recommendation 2

That Government ensure clear and open communication on CSG matters is maintained at all times. This includes:

- simplicity and clarity in legislative and regulatory requirements
- ensuring openness about CSG processes in line with an open access approach; publishing all relevant approval requirements, decisions and responses, and compliance and enforcement outcomes on appropriate government websites and making CSG data from companies, Government and research organisations available through a centralised Government data repository
- measurable outcomes to track performance against commitments to reform.

Recommendation 3

That Government investigate as a priority a range of practical measures for implementation (or extension of current measures) to allow affected communities to have strengthened protections and benefits including fair and appropriate:

- land access arrangements, including land valuation and compensation for landholders
- compensation for other local residents impacted (above threshold levels) by extraction activities
- funding (derived from the fees and levies paid by CSG companies) for local councils to enable them to fund, in a transparent manner, infrastructure and repairs required as a consequence of the CSG industry.

Recommendation 4

That the full cost to Government of the regulation and support of the CSG industry be covered by the fees, levies, royalties and taxes paid by industry, and an annual statement be made by Government on this matter as part of the Budget process.

Legislative and regulatory reform and appropriate financial arrangements

Recommendation 5

That Government use its planning powers and capability to designate those areas of the State in which CSG activity is permitted to occur, drawing on appropriate external expertise as necessary.

Recommendation 6
That Government move to a single Act for all onshore subsurface resources (excluding water) in the State, constructed to allow for updating as technology advances. This will require a review of all major Acts applying to the resources sector.

Recommendation 7
That Government separate the process for allocation of rights to exploit subsurface resources (excluding water) from the regulation of the activities required to give effect to that exploitation (i.e. exploration and production activities); and that it establish a single independent regulator. The regulator will require high levels of scientific and engineering expertise, including geological and geotechnical ability, environmental and water knowledge and information, and ICT capability including data, monitoring and modelling expertise; and will be required to consult – and publish details of its consultations – with other arms of Government and external agencies, as necessary. The regulator will also require appropriate compliance monitoring and enforcement capability.

Recommendation 8
That Government move towards a target and outcome-focused regulatory system, with three key elements:

- regularly reviewed environmental impact and safety targets optimised to encourage uptake of new technologies and innovation
- appropriate and proportionate penalties for non-compliance
- automatic monitoring processes that can provide data (sent to and held in the openly accessible Whole-of-Environment Data Repository) which will help detect cumulative impacts at project, regional and sedimentary basin scales which can be used to inform the targets and the planning process.

Recommendation 9
That Government consider a robust and comprehensive policy of appropriate insurance and environmental risk coverage of the CSG industry to ensure financial protection short and long term. Government should examine the potential adoption of a three-layered policy of security deposits, enhanced insurance coverage, and an environmental rehabilitation fund.

Managing risk by harnessing data and expertise

Recommendation 10
That Government commission the design and establishment of a Whole-of-Environment Data Repository for all State environment data including all data collected according to legislative and regulatory requirements associated with water management, gas extraction, mining, manufacturing, and chemical processing activities. This repository, as a minimum, would have the characteristics that it:

- is accessible by all under open data provisions
- has excellent curatorial and search systems
- houses long-term data sets collected as part of compliance activities
- can accept citizen data input
- can be searched in real time
- is spatially enabled
- is able to hold data in many diverse formats including text, graphics, sound, photographs, video, satellite, mapping, electronic monitoring data, etc., with appropriate metadata
- is the repository of all research results pertaining to environmental matters in NSW along with full details of the related experimental design and any resulting scientific publications and comments
- is the repository of historical resources data with appropriate metadata

Various legislative amendments or other incentives will be needed to direct all environment data to the Repository.

Recommendation 11

That Government develop a centralised Risk Management and Prediction Tool for extractive industries in NSW. This would include a risk register, a database of event histories, and an archive of Trigger Action Response Plans. The tool would be updated annually based on Government and company reporting and would include information on risk management and control approaches and draw on data from the Whole-of-Environment Data Repository for the State. The risk tool would be reviewed and commented on by relevant expert and regulatory bodies. The risk tool would be used to assist with:

- assessing new proposals
- assessing compliance
- improving prediction capability for consequences of incidents in risk assessments
- improving prediction capability of risk likelihoods
- informing project design amendments to decrease risk levels (such as undertaken in the Dam Safety Committee)
- informing the calculation of cumulative impacts
- flagging issues or risks that require a higher level of regulatory protection such as inclusion in legislation.

Recommendation 12

That Government establish a standing expert advisory body on CSG (possibly extended to all the extractive industries). This body should comprise experts from relevant disciplines, particularly ICT and the earth and environmental sciences and engineering, but drawing as needed on expertise from the biological sciences, medicine and the social sciences. The prime functions of this expert body would be to advise Government:

- on the overall impact of CSG in NSW through a published Annual Statement which would draw on a detailed analysis of the data held in the Whole-of-Environment Data Repository to assess impacts, particularly cumulative impacts, at project, regional and sedimentary basin scales
- on processes for characterising and modelling the sedimentary basins of NSW
- on updating and refining the Risk Management and Prediction Tool
- on the implications of CSG impacts in NSW for planning where CSG activity is permitted to occur in the State
- on new science and technology developments relevant to managing CSG and when and whether these developments are sufficiently mature to be incorporated into its legislative and regulatory system
- on specific research that needs to be commissioned regarding CSG matters
- on how best to work with research and public sector bodies across Australia and internationally and with the private sector on joint research and harmonised approaches to data collection, modelling and scale issues such as subsidence
- on whether or not other unconventional gas extraction (shale gas, tight gas) industries should be allowed to proceed in NSW and, if so, under what conditions.

Recommendation 13

That Government establish a formal mechanism consisting of five parallel but interacting steps. The five steps are given below.

- Companies or organisations seeking to mine, extract CSG or irrigate as part of their initial and ongoing approvals processes should, in concert with the regulator, identify impacts to water resources, their pathways, their consequence and their likelihood, as well as the baseline conditions and their risk trigger thresholds before activities start. These analyses and systems should be incorporated in project management plans to meet regulator-agreed targets. Appropriate monitoring and characterisation

systems would be developed as part of these project management plans and then installed. The monitors would measure baseline conditions and detect changes to these, as well as providing data on impacts and triggered risk thresholds.

- Data from the monitors should be deposited (either automatically or in as close to real time as possible) in the State Whole-of-Environment Data Repository by all the extractive industries. Increasingly automated tools to interrogate data in the Repository should be developed, and these used to search data for discontinuities and compliance alerts.
- As a separate process, the expert advisory body would examine on a frequent basis all data relevant to a region or a sedimentary basin. This data would come from a range of sources (the companies' monitoring data along with triangulation/cross-validation data such as that from satellites, reports from local councils, seismic data, subsidence maps, information from cores, etc.). The expert body would use this data review to check for any factors signalling problems in that region and, if any are found, recommend to Government the appropriate action to be taken with regard to the relevant parties.
- In a parallel process, the Government should commission, construct and maintain a variety of models of each region and in particular one that seeks to address cumulative impacts. These models should feed into the land use planning process and the activity approvals processes, and should assist in target setting for new projects.
- Government, working with other appropriate Australian governments, should commission formal scientific characterisation of sedimentary basins starting with the East Coast basins, and concentrating initially on integration of groundwater with the geological, geophysical and hydrological context. Viewing these integrated systems in models and in interpretation could be described as a 'Glass Earth' approach to understanding the dynamics of activities and impacts in the basins.

Training and certification

Recommendation 14

That Government ensure that all CSG industry personnel, including subcontractors working in operational roles, be subject to ongoing mandatory training and certification requirements. Similarly, public sector staff working in compliance, inspections and audits should be given suitable training and, where appropriate, accreditation.

Legacy and consistency matters

Recommendation 15

That Government develop a plan to manage legacy matters associated with CSG. This would need to cover abandoned wells, past incomplete compliance checking, and the collection of data that was not yet supplied as required under licences and regulations. There will also need to be a formal mechanism to transition existing projects to any new regulatory system.

Recommendation 16

That Government consider whether there needs to be alignment of legislation and regulation governing extraction of methane as part of coal mining and the application of buffer zones for gas production other than CSG with the relevant legislation and regulation provisions governing CSG production.

APPENDICES

APPENDIX 1 TERMS OF REFERENCE

Review of coal seam gas activities in NSW

At the request of the NSW Government, the NSW Chief Scientist & Engineer will conduct a review of coal seam gas (CSG) related activities in NSW, with a focus on the impacts of these activities on human health and the environment.

The Chief Scientist & Engineer is to:

1. undertake a comprehensive study of industry compliance involving site visits and well inspections. The Chief Scientist's work will be informed by compliance audits undertaken by regulatory officers, such as the Environment Protection Authority and other government agencies
2. identify and assess any gaps in the identification and management of risk arising from coal seam gas exploration, assessment and production, particularly as they relate to human health, the environment and water catchments
3. identify best practice in relation to the management of CSG or similar unconventional gas projects in close proximity to residential properties and urban areas and consider appropriate ways to manage the interface between residences and CSG activity
4. explain how the characteristics of the NSW coal seam gas industry compare with the industry nationally and internationally
5. inspect and monitor current drilling activities including water extraction, hydraulic fracturing and aquifer protection techniques
6. produce a series of information papers on specific elements of CSG operation and impact, to inform policy development and to assist with public understanding. Topics should include:
    - operational processes
    - NSW geology
    - water management
    - horizontal drilling
    - hydraulic fracturing (fraccing)
    - fugitive emissions
    - health impacts
    - wells and bores
    - subsidence.

The NSW Chief Scientist & Engineer will provide an initial report to the Premier and the Minister for Resources and Energy on her findings and observations by July 2013.

APPENDIX 2 REPORTS AND BACKGROUND PAPERS WRITTEN AND/OR COMMISSIONED BY THE NSW CHIEF SCIENTIST & ENGINEER DURING THE INDEPENDENT REVIEW OF COAL SEAM GAS ACTIVITIES IN NSW

Reports written by the NSW Chief Scientist & Engineer for the Independent Review of Coal Seam Gas Activities in NSW

Available at http://www.chiefscientist.nsw.gov.au/reports

- Initial Report on the Independent Review of Coal Seam Gas Activities in NSW
- Environmental risk & responsibility and insurance arrangements for the NSW CSG industry
- On measuring the cumulative impacts of activities which impact ground and surface water in the Sydney Water Catchment
- Placement of monitoring equipment for water resources in NSW
- Study of regulatory compliance systems and processes for coal seam gas
- Managing environmental and human health risks from coal seam gas activities
- Final Report of the Independent Review of Coal Seam Gas Activities in NSW

Information papers written by the NSW Chief Scientist & Engineer for the Independent Review of Coal Seam Gas Activities in NSW

- Information paper: On managing the interface between coal seam gas activities and other land uses (Setbacks)
- Information paper: Fracture stimulation activities
- Information paper: Abandoned wells

Reports commissioned by the NSW Chief Scientist & Engineer for the Independent Review of Coal Seam Gas Activities in NSW

Available at http://www.chiefscientist.nsw.gov.au/coal-seam-gas-review/csg-background-papers

	Topic	Expert name and organisation	Title of paper
1	Baseline human health	Dr Pavla Vaneckova & Assoc Professor Hilary Bambrick: University of Western Sydney – Centre for Health Research	Approaches to baseline studies of human health in relation to industries with potential environmental impact
2	CSG processes	Professor Peter Cook: PJC International, National Centre for Groundwater Research and Training, Flinders University	Life Cycle of Coal Seam Gas Projects: Technologies and Potential Impacts
3	Community concerns	Dr Melanie Taylor, Ms Natalie Sandy & Professor Beverley Raphael: University of Western Sydney - School of Medicine, Disaster Response and Resilience Research Group	Background paper on community concerns in relation to coal seam gas
4	Data management	Dr Ian Gibson, Intersect Australia	NSW Coal Seam Gas: Data Background Paper
5	Gas dispersion modelling	Professor Peter Rayner & Dr Steven Utembe: University of Melbourne - School of Earth Sciences	Modelling the Airborne Dispersion of Pollutants from Coal Seam Gas Extraction
6	Geology	Dr Craig O'Neill and Dr Cara Danis: Macquarie University - Department of Earth and Planetary Science	The Geology of NSW: The geological characteristics and history of NSW with a focus on coal seam gas (CSG) resources
7	Geology	Professor Colin Ward and Assoc. Professor Bryce Kelly: University of New South Wales - School of Biological, Earth and Environmental Sciences	Background Paper on New South Wales Geology: With a focus on basins containing coal seam gas resources
8	Groundwater	Mr Doug Anderson, Ms Priom Rahman, Ms Erica Davey, Mr Brett Miller, Dr William Glamore: University of New South Wales - Water Research Library	Background Paper on Groundwater Resources in Relation to Coal Seam Gas Production
9	Horizontal drilling	Professor John Carter: Advanced Geomechanics	Background Paper on Horizontal Drilling
10	Legislation and regulation	Ms Sue Graebner, Independent consultant	Legislative framework for CSG exploration and production. Released as appendix to CSE report, "Study of

			regulatory compliance systems and processes for coal seam gas"
11	Methane	Dr Linda Stalker: CSIRO	Methane origins and behaviour
12	Produced water	Assoc Professor Damian Gore and Dr Peter Davies: Macquarie University - Department of Environment & Geography	Macquarie University Background paper on produced water and solids in relation to coal seam gas production
13	Produced water	Dr Stuart Khan and Ms Geena Kordek	Coal Seam Gas: Produced Water and Solids,
14	Risk, insurance & management	Mr Bernard Evans: Hicksons Lawyers	Paper 1 - Insurance and Environmental Securities; Attachment: Environmental risks arising from CSG operations
15	Risk, insurance & management	Mr Tony Abbott: Piper Alderman	Insurance and Environmental Securities; Attachment: Risk Model Evaluation
16	Sedimentary basins	Assoc Professor Tim Rawling & Professor Mike Sandiford: University of Melbourne - Melbourne Energy Institute	Multi basin usage/cumulative impact,
17	Seismicity	Professor Mike Sandiford and Mr Gary Gibson: The University of Melbourne - Melbourne Energy Institute	Seismicity and Induced Earthquakes
18	Seismicity	Dr Barry Drummond: Independent consultant, formerly with Geoscience Australia	Background Paper on Seismicity
19	Subsidence causes	Dr Jubert A Pineda and Professor Daichao Sheng: The University of Newcastle - ARC Centre of Excellence for Geotechnical Science and Engineering	Subsidence: An overview of causes, risks and future developments for Coal Seam Gas production
20	Subsidence monitoring	Dr Simon McClusky and Dr Paul Tregoning: The Australian National University - School of Earth Sciences	Background paper on subsidence monitoring and measurement with a focus on coal seam gas (CSG) activities
21	Subsidence monitoring	Cooperative Research Centre for Spatial Information	Subsidence monitoring in relation to coal seam gas production
22	Water treatment	Emeritus Professor Chris Fell: Fell Consulting Pty Ltd	Water treatment and coal seam gas

Other reports written by or commissioned by the NSW Chief Scientist & Engineer prior to the Independent Review of Coal Seam Gas Activities in NSW

- Hydraulic fracturing for coal seam gas (CSG) stimulation in NSW, by Dr Rob Jeffrey: CSIRO
- CSE draft letter on the likelihood of hydraulic fracturing

Geographical Research

Unconventional Gas in Australia: Towards a Legal Geography

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Abstract
Recent commentary on future research directions for legal geography highlights the need for studies that are historically grounded and focused on human–environment interactions in rural settings. As a current, controversial land use in Australia, unconventional gas (UG) development provides an ideal lens through which researchers can investigate these themes. Utilising emerging international literature and current Australian examples, this paper surveys major trends in the Australian literature relating to UG, before exploring some of the ways in which Australian legal geographers might contribute constructively to community debates around this resource. Seeking to encourage further analysis, this paper contributes to this developing literature by focusing on two key areas: the various legal actors involved in UG development in Australia (including their regulatory choices, spatial interpretations, expertise, and influence) and the implications for legal geography where attempts are made to establish 'social licence' through contractual arrangements between industry and individual landholders. This article also delves into the place of Indigenous Australians in relation to UG extraction and the questions this resource raises about land use conflicts in Australia more generally – offering suggestions for comparative international studies and further critique at the domestic level.

KEY WORDS *unconventional gas; legal geography; law; geography; Australia*

Introduction

Legal geography is an increasingly dynamic research area, 'less a "field", than braided lines of inquiry that have emerged out of the confluence of various intellectual interests' since the 1980s (Braverman *et al*., 2014, 1). Arguably not finding its voice as a disciplinary endeavour until 1994, with the publication of Nicholas Blomley's seminal *Law, Space and the Geographies of Power* (Delaney, 2014), Blomley called for studies that evaluate 'the manner in which legal practice serves to produce space yet, in turn, is shaped by a sociospatial context' (1994, 51). In a recent survey of Australian perspectives on the subject, Bartel *et al*. (2013, 349) concluded that legal geography's 'greatest impact is where its focus reveals the importance of scale, time and connection in specific local contexts' and that by 'situating law in space, that is within its physical conditions and limits, legal geography encourages place-based knowledge to form law's basis'. By making this claim, Bartel *et al*. (2013) extend legal geography's ambitions from that of a sociological critique of the law (e.g., Delaney *et al*., 2001), to advocate for a reconfigured 'relation between society and the natural world itself' (Graham, 2011, 16).

With scholarly interest in unconventional gas (UG) growing across the physical and social sciences (Lave and Lutz, 2014), an attempt is made

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to selectively assess the extant Australian literature on this contested land use from a legal geography perspective, identifying ways in which this discipline might contribute to the public debate surrounding this resource. Sources of methane, 'unconventional natural gas' comprises three types: shale gas (SG), coal seam gas (CSG) (also known as coal-bed methane and linked with underground coal seams), and tight gas. All three forms are present within Australia, although their accessibility and commercial readiness vary, with shale and tight gas located within rock formations that pose extraction difficulties (Williams *et al*., 2012; Measham and Fleming, 2014). Arguing that legal geography offers many insights into UG development in Australia and drawing on possible international comparisons, the following topics are considered: Conduct and Compensation Agreements in Queensland, litigation mechanisms, the multi-faceted place of lawyers and judges, legal precedent as a protest strategy for anti-CSG activism, the role of local government in approving protest camps, and finally questions of compensation. Legal geography might also be a fruitful lens for studying other contentious land uses. In setting out their aims for *The Expanding Spaces of Law: A Timely Legal Geography*, Braverman *et al*. (2014) contend that silences and gaps abound within the literature of this field. Two are particularly pertinent for this review: the tendency for legal geography writings to exclude the rural from their investigations and to avoid historically grounded analysis in favour of exploring the connections between contemporary urban spaces and the law. This urban focus does of course have merit in a UG context, such as explaining setback distance ordinances for SG drilling in urban counties of Texas (Fry, 2013). However, as much of Australia's UG expansion is occurring in rural localities, a focus on this aspect of the sector's legal geography would be beneficial for researchers.

Summing up the efforts of legal geography for their own critique of SG regulation in Pennsylvania, Andrews and McCarthy argue that researchers have 'paid far too little attention to the environment as both an object of governance and a terrain of struggle with respect to the law'(2014, 7). Although their absence has been noted in the wider legal geography literature (Delaney, 2001), issues relating to the environment and the place of the law within it have intrigued Australian historical geographers (e.g., Stratford, 1993; Stubbs, 2001; Holmes, 2014). More recently, a legal geography slant has proved attractive to those investigating siting disputes through an environmental justice lens (e.g., Jessup, 2013). Other socio-legal arenas may assist in informing that research direction in the future (e.g., analysis of the Commonwealth's 2007 Northern Territory Emergency Response, see Keenan [2013] and Crabtree [2013]).

This paper seeks to contribute to this growing research effort, reviewing some of the ways in which legal geography may aid in developing a richer understanding of the UG sector in Australia. This includes the manner in which this industry is disputed by pressure groups on a national scale, focusing on two areas in the emerging literature. The first is through studying the types of legal actors involved, their choices, geographical interpretations, and the influence of their expertise upon regulatory decisions. The second area for focus are the attempts made by companies to achieve a community 'social licence' via contractual agreements with individual landholders, considering also protest strategies employed by social movements to counter such efforts. Other issues are noted, including lobbying efforts to alter the physical extent of regulatory measures for UG and the emerging role of Indigenous people in the development of this industry. Drawing on recent international commentary and using current examples to demonstrate the applicability of this analysis in an Australian context, this paper argues that the opportunities and risks posed by UG development provide an ideal setting for researchers to test various themes in the legal geography literature in greater depth.

Law, geography, and unconventional gas

Mining and UG extraction has engaged the interest of legal geography scholars for some years, with research in the United States examining the historical interconnection between mining law and geography (Matthews, 1997), the present-day competition between mining and Indigenous cultural heritage legislation (Benson, 2012), the power of property law as a source of social disorder in the Appalachian coalfields (Haas, 2008a; 2008b), and the politics of a particular statute and the constitution of expert committees reaching planning decisions (Hudgins and Poole, 2014; Simonelli, 2014). Andrews and McCarthy (2014) recently combined the analytical tools of legal geography and political ecology to investigate Pennsylvania's Act 13 and its role in facilitating mineral extraction from the Marcellus Shale in

the United States by preventing local government control over zoning arrangements for natural gas, noting that law is a powerful instrument of State authority, with significant capacity to shape the social and legal spaces that extractive industries operate in. Australia has yet to be served by similar studies. Much of the popular literature devoted to both coal and UG development in Australia is focused on the individual experiences of landholders, with a particular emphasis on the efforts of various communities to negotiate (successfully or otherwise) with governments and private corporations (e.g., Cleary, 2012; Manning, 2012; Munro, 2012; Pearse *et al*., 2013). Although the stories revealed are often compilations of news reports and all too frequently utilised for explanatory power rather than critical analysis, there are still numerous glimpses into issues that are a legal geographer's stock and trade: the interconnections between space, society, and power.

The above popular accounts are regularly cited within the Australian academic literature (e.g., Sherval and Hardiman, 2014). Similarly to the work of popular authors, academic commentators frequently utilise the near-constant media outpourings surrounding both coal and UG extraction in Australia (e.g., Galloway, 2012; McManus and Connor, 2013). However, the intended audience of a specialist journal may obviously be quite distinct from a journalist's readership. As an example, the anti-CSG organisation Lock the Gate has figured prominently in much of the Australian literature, yet their organisational materials are only gradually becoming the subject of critical discourse analysis, highlighting the extent to which this social movement distinguishes itself from not only CSG companies, but also the 'growth first' message of the Queensland Government (Mercer *et al*., 2014). Australian commentators have also shown an interest in gauging community perceptions of natural resource extraction and their capacity to influence social identity (e.g., the linking of concerns about land rights with cultural understandings of the landscape, see Lloyd *et al*., 2013). Others have sought to critique the legal infrastructure of both SG and CSG in Australia, with some international comparisons being made (e.g., Hunter, 2011; 2014; Swayne, 2012).

One means of expanding the range of legal geographies displayed in UG disputes is to explore how other disciplines have interpreted the social impact of mineral extraction, such as the prevention of criminal activity in mining camps, currently a key focus for criminologists (e.g., Carrington *et al*., 2011). Although not without data collection obstacles, the distribution of assault offences, or the dynamics of private security contractors acting in a policing function are questions for legal geographers to consider. Doing so may contribute to broader Australian and US studies concerning the clout (or otherwise) of physically distant law enforcement agencies in rural settings (Millner, 2011; Pruitt, 2014).

Distance between land uses is clearly an important part of the UG literature (e.g., Fry, 2013), but the concept of scale is also particularly relevant as a gauge of social licence for extractive industries at local and regional levels. In Australia, Lacey and Lamont (2014) have pondered the spatial nature of over 4000 Landholder Access Agreements between landholders and CSG operators in Queensland (*Petroleum (Production and Safety) Act 2004* (Qld), ss 533–534), questioning whether or not these contractual arrangements – which are functionally akin to an easement (Christensen *et al*., 2012) – are truly reflective of a broader social licence to operate. Even where an Agreement is successfully negotiated, community doubts may linger, because these documents are more akin to one-off business deals than a broader social contract (Manning, 2012; Lacey and Lamont, 2014). In addition to negotiation dynamics (Liss, 2011), these agreements with CSG operators expose social and cultural issues in community relationships with CSG operators. The extent to which these are resolved in legally binding contracts is only beginning to be explored by researchers (Trigger *et al*., 2014), presenting a knowledge vacuum in the literature for legal geographers.

Judicial interpretations of time and geography may also be relevant in discussions between landholders and CSG companies: particularly where it serves as grounds for judicial review of government decision making. In 2011, QCLNG Pipeline Pty Ltd was engaged in negotiations with the landholder Michael Baker to install a CSG pipeline across a portion of his property at Eidsvold in the North Burnett region of Queensland. This was part of QCLNG's larger endeavour to construct a CSG pipeline from the Surat Basin to the industrial port of Gladstone in central Queensland. QCLNG's failure to provide Baker with an appropriately scaled map of the property that would be used for the pipeline was found to be a denial of procedural fairness.

Procedural fairness is a fundamental concept of administrative law and revolves around the idea that a person who might be adversely affected by an administrative decision must be given a fair hearing before a decision is made. In this case, procedural fairness referred to Baker being given sufficient information by QCLNG to be able to participate meaningfully in the decision-making process and also being permitted a reasonable opportunity to respond to QCLNG's pipeline application before a decision was made by the Queensland Department of Natural Resources and Mines. Because Baker lacked a sufficiently precise map of QCLNG's pipeline route through his property and was not given accurate information in sufficient time to respond to QCLNG's application to the Department, Justice Dalton concluded Baker did not receive procedural fairness, ruling that the Department's decision to grant QCLNG access in that particular location was void (*Baker v Minister for Employment, Skills and Mining & Another*, 2012). In this instance, judicial understandings of time and space converged with legal consequences for the parties. Although only one judgement, it demonstrates that litigation case studies are an important way for UG researchers to analyse both the temporal and spatial elements of this industry, by investigating legal interpretations of geographical concepts, such as scale (Valverde, 2014). This approach could widen the current focus of the Australian UG literature beyond case notes aimed at legal professionals (e.g., Geritz *et al*., 2012) and reach an audience critiquing other aspects of the sector (including public participation and information-sharing).

As shown above, the manner in which land use agreements are enacted by stakeholders or contested between them is a subject of ongoing deliberation. Recent judicial findings from the Queensland Court of Appeal sought to clarify the types of remedies available to landholders who are not able to successfully negotiate a Conduct and Compensation Agreement with CSG companies. In *Australia Pacific LNG Pty Ltd v Golden* (2013), Justice Muir ruled that accessing alternative dispute resolution remedies to secure a Conduct and Compensation Agreement, in this case through arbitration, was not possible without both parties consenting to use this form of negotiation (Hough, 2014; Plumb and Shute, 2014). As legal spaces are founded upon 'contested social practices and material realities', litigation has a crucial role to play in the process of maintaining and reworking of space (Jepson, 2012, 616). Landscapes are in many ways legal performances, with law acting as a fusing agent between place and identity (Howe, 2008). Litigation is an integral component of this performance, and further research is warranted given the extent of these agreements with landholders.

Benson (2014) builds on this idea by suggesting that the internal 'rules of engagement' surrounding formal litigation (e.g., standing) are in themselves another facet of 'everyday' legal geography, veiled though they may be in procedural 'neutrality'. There are certainly many ways in which standing can be analysed in Australia, particularly given its range of applications in recent decades (Douglas, 2006). As an important filtering mechanism in the litigation process, standing is a rule that may involve 'sacrificing the rule of law, and the protection of individual and corporate interests at the expense of collective interests' (Douglas, 2006, 22). An absence of standing could also limit community objections to SG development in Tasmania (Ryan, 2014). Given this tension, analysis of standing rules from a geographical standpoint could assist in discerning the possibilities of a distinctly 'Australian legal geography' (Bartel *et al*., 2013). Accepting that the 'everyday' aspects of litigation are an underutilised component of the legal geography literature (Benson, 2014, 218), these 'rules of engagement' can be seen through the prism of UG disputes in Australia. For example, the New South Wales Office of Coal Seam Gas recently decided to suspend their approval for the company Metgasco to drill an exploration well at Bentley near Casino in the Northern Rivers region of the state, 'on the basis that the company was not in compliance with its community consultation obligations' (New South Wales Office of Coal Seam Gas, 2014). Metgasco has responded in turn by seeking judicial review of the suspension (Metgasco, 2014a; 2014b), therefore there may be an opportunity to combine the growing literature around the importance of community engagement in CSG developments with legal analysis of conditions attached to an exploration licence (ABC News, 2014d).

Another example could be an examination of the rule of evidence known as 'discovery'. Although a seemingly benign mechanism for ensuring that all parties exchange relevant documentation prior to the closing of litigation proceedings, when the rule's adversarial context is acknowledged, it may also assume contested meanings. The instrument of discovery may be both a step towards answering questions of

possible contamination of water bores near the Pilliga State Forest in the public interest for the people of New South Wales (the view of the NSW Environmental Defenders Office), or serve, according to the company Santos, as an irrelevant data-gathering exercise for potential litigation in the future (EDO NSW, 2014; Herbert, 2014a). Differing interpretations are of course at the heart of the law's operation, with lawyers serving as both translators and creators of legal language and everyday discourse (Sugarman, 1994).

Beyond land access concerns, the impact of CSG operations on the real estate market in New South Wales has attracted media (ABC News, 2014a) and academic commentary (Fibbens *et al*., 2013; 2014). Speaking on the Hunter Valley real estate market recently, the State Valuer General, Phillip Weston, stressed the challenges of determining the causes behind property sale delays, on account of both coal and CSG development in the region. Weston acknowledged that the immature nature of the CSG industry in NSW also made this type of research difficult but confirmed that: 'There seems to be some anecdotal evidence from property professionals there has been some changes in terms of the length of time it's taking for properties to sell' (ABC News, 2014a). For Fibbens *et al*. (2013; 2014), there remain ongoing questions surrounding the compensation regime of the *Petroleum (Onshore) Act 1991* (NSW) as raised by CSG extraction. The occupation of land by CSG operators is not equated with acquisition of freehold title, but a company's operations require access arrangements between themselves and landholders that 'tie up land for the term of occupation', an inherently uncertain length of time, ranging from 20 to 40 years on some estimates and subject to the economic viability of the resource itself (Fibbens *et al*., 2013, 5).

Drawing on compensation and valuation theory, Fibbens *et al*. (2013) argue that the New South Wales legislative framework for mining operates on a preconceived notion that all exploration activities are temporary (*Petroleum* (*Onshore*) *Act 1991* (NSW), s 107), thereby affecting the manner in which compensation is considered. They find the legislation wanting on several grounds, including loss of business goodwill and special value (land having value to an owner due to some 'attribute or use made of the land') (Fibbens *et al*., 2013, 7, 11–12). Given media coverage of CSG exploration and its possible influence on tourism numbers (Schweinsberg and Wearing, 2013), could negative publicity prompt a law reform argument for loss of business goodwill (Fibbens *et al*., 2014)? Other openings for discussion are raised around the impacts of access agreements and CSG infrastructure, with potential for qualitative and quantitative studies into the affects of CSG development on property values (Fibbens *et al*., 2013).

Internationally, SG development presents its own series of 'what if?' scenarios for US valuers (Lipscomb *et al*., 2012). Despite cross-fertilisation potential, Kedar (2014) has described the dearth of comparative research outputs from legal geographers as a significant challenge for the field. Attempts at a comparative approach are clearly not without difficulties. For example, a US study of landowner coalitions seeking to collectively bargain with natural gas companies to draw up legally binding leases seems unlikely to find an Australian equivalent (Jacquet and Stedman, 2011), because mineral subsurface rights in the United States, unlike the situation in Australia, are primarily held by private landholders. The global distribution of legal geography researchers presents another challenge, with scholarly efforts largely confined to precedent-focused common law countries – leading to a methodology bias against code-based civil law traditions (Villanueva, 2013, 36; Kedar, 2014). However, the use of moratoria by state governments in both the United States and Australia to prevent and postpone UG development is one fruitful comparative pathway, with only limited critique of moratoria in New York State (Simonelli, 2014) and mixed media coverage in Australia (e.g., King *et al*., 2013; McGauran, 2013; Carter, 2014). Any comparative research would need to acknowledge differing political contexts, with some countries more wary of UG development than others (Becker and Werner, 2014). Comparing Australian and Indonesian legislative responses to a growing UG industry is another possibility (for an Indonesian perspective, see Godfrey *et al*., 2010). It is also worth pointing out that geographers have already shown some of the potential rewards for posing comparative questions, for example, through the relevance of competing cartographic interpretations for offshore oil and gas negotiations between Australia and East Timor (Nevins, 2004). Aside from international comparisons, additional insights into the Australian legal geography of UG would be gained from key professionals, such as town planners and legal practitioners.

Legal practitioner perspectives

Socio-legal researchers have long recognised that lawyers occupy a privileged, multifaceted position in society, as both officers of the legal system and an all-important link between the courts and the wider population (Ingleby and Johnstone, 1995). Their capacity to engage across these arenas can be seen in the realms of policy reform, legislative drafting, and litigation advocacy – often with blurred distinctions (Tomasic, 1978). Geographers have recognised that law is 'too important to be left to the lawyers' (Friedman, 1986, 780), but researchers have remained reluctant to engage systematically with the profession. Nonetheless, legal professionals exert considerable influence as 'constituents of landscape' (Martin and Scherr, 2005, 379). In wider socio-legal research, members of the legal profession have offered their voices to substantiate research questions in the past. Occasionally this has taken on a geographical component, as seen in Smith's (2006) study of Australian criminal defence lawyers and their motivations for representing the unpopular. Others have considered the impact of geography as a factor in the transplantation of legal precedent among Australia's state courts (Smyth and Mishra, 2011). These studies could well be considered cases of legal geography in all but name, as many authors would not see themselves as legal or geography practitioners (Blomley, 2003a).

Although the perspectives of legal practitioners can be seen in a variety of sources relating to UG in Australia, from interviews with the media (Locke, 2014), Parliamentary inquiries (De Rijke, 2013a), legal determinations (Plumb and Shute, 2014) and professional journals (Christie, 2012), as a group, legal practitioners are not generally seen as influential actors in directing the outcome of land-use disputes. This is despite their often central place in attempting to resolve contested legal and political claims (Martin *et al*., 2010). They can do this by deploying arguments and language against judges in order to persuade and create physical effects upon the world (Delaney, 2010).

Despite this recognition, Deborah Martin *et al*. have correctly identified that both lawyers and 'the practice of the law' are generally missing from the growing output of the legal geography project (Martin *et al*., 2010, 176). Viewing lawyers and judges as 'nomospheric technicians' (Delaney, 2010, 158, 159) is one means of analysing legal professionals and their litigation/adjudication strategies through a legal geography framework. The 'nomosphere' is derived from *nomos*, Greek for law, and refers to 'the cultural–material environs that are constituted by the reciprocal materialization of "the legal", and the legal signification of the "socio-spatial" ' (Delaney, 2010, 25). 'Nomospheric technicians' are actors within the nomosphere, namely lawyers and judges, who advance their goals by various tactical means (Delaney, 2010; Benson, 2014). This term is an element of Delaney's wider nomospheric investigations research and a response to Nicholas Blomley's earlier call for researchers to create a conceptual language 'that allows us to think beyond binary categories such as "space" and "law" ' (Blomley, 2003b, 29–30). For Delaney, the 'nomosphere' amounts to 'the cultural-material environs that are constituted by reciprocal materialization of "the legal" and the legal signification of the "sociospatial", and the practical, performative engagements through which such constitutive moments happen and unfold' (2010, 25). Applying his concept to legal professionals, or 'technicians' of the nomosphere, Delaney links the actions of these key actors with changes in geographical space:

> [W]hat nomospheric technicians do can be thought of as a kind of fabrication process, where raw materials are brought together and worked on, and which results in the construction of nomospheric *world-models*. These . . . representations are fabricated in order to be presented in ritual, institutional settings to other nomospheric technicians (judges). The job of judging essentially entails the assessment of the relative merits of contending world-models according to a range of criteria. Judges disqualify one, and validate another . . . These arguments as world-models are not offered [by lawyers] for the purposes of contemplation or admiration. They are designed to have cognitive and affective effects on judges and practical effects in the world. They are pragmatically fabricated *in order to* persuade–to cause an empowered state actor to see the world in a particular way [and act accordingly]. (2010, 159–160. Emphasis in original.)

As a new development in the literature, it may be some time before the potential of legal practitioners as a research source is fully realised. Although acknowledging that Martin's challenge should be responded to, possibly through the lens of Delaney's world-making nomosphere, there is even greater scope to include individuals from all

levels of legal practice in this analysis, not just lawyers: from law students to judges, legal academics, in-house company counsel, and bureaucrats. This is illustrated by the public unease associated with CSG development and competing community narratives of place in rural centres (e.g., Sherval and Hardiman, 2014). As noted above, the perspectives of individuals involved in the legal process are to be found in many places, from media coverage of self-represented litigants recalling their experiences in the Queensland Land Court (Calderwood, 2014), popular texts on coal development in Australia (Manning, 2012, 10; Munro, 2012), industry journals containing commentary on the latest regulatory developments (Plumb, 2013; Brockett, 2014; Hoare *et al*., 2014), speeches, policy submissions, and scholarly articles by judges and barristers (e.g., Christie, 2012). Then there are the more obvious contributions of legal judgments and draft legislation. Geographers and legal commentators have themselves utilised the power of interviews for their own research, enriching their analysis beyond purely regulatory matters in the process (Sherval and Graham, 2013). Keeping an open mind as to the all-encompassing impact of legal relations is beneficial to the researcher, as clearly lawyers are not the only professional group responding to the challenges of UG, with many other active participants, such as town planners, bureaucrats, land valuation experts, and police.

Beyond individual actors, legal structures are bound more generally to community understandings of a nation's cultural heritage. Australia's legal history and the contemporary conditions of Indigenous Australians are not necessarily new ground for legal geographers (Bartel *et al*., 2013), but integrating these issues into the broader context of extractive industries in Australia is another potential area for researchers to explore.

Legal history and contemporary Indigenous perspectives

Political campaigns surrounding contested land uses are not a new phenomenon in Australia. As the latest resource to court controversy, the exploitation of UG offers historically minded legal geographers the opportunity to reflect more critically upon competition between private property interests. Although CSG development in particular has been credited with altering previously held community beliefs about State ownership of mineral resources (Organ, 2014), this 'modern property law conundrum' (Weir and Hunter, 2012) has an historical twist:

> Ironically, the exercise by miners of CSG rights is in direct contrast to the mining industry's widely publicised untruthful objections to native title following the *Mabo* and *Wik* decisions [in 1992 and 1996 respectively]. Aggressive national campaigns were run at the time, warning freehold landowners of the threat that native title posed to the maintenance and exercise of private property rights. Native title, that most fragile of all property rights, was never contemplated as being in competition with freehold title in spite of the miners' claims. In contrast, CSG rights directly and explicitly collide with what . . . [Blackstone called] 'the highest and most extensive interest that a man [*sic*] can have' in land. (Galloway, 2012, 79)

Indigenous Australians have certainly featured strongly in critiques of the mining industry (e.g., Cleary, 2012; Pearse *et al*., 2013). They may also have a significant role to play in discussions around UG in Australia, depending on drilling locations. A future example of this may potentially be seen at Mount Mulligan (Nguddaboolgan), 100 kilometres west of Cairns (Figure 1). An impressive natural landmark of sandstone cliffs, coal deposits beneath the mountain supported a mining community from 1914 to 1958. Entering a new phase as a cattle property (Bell, 1978), it now serves as an eco-tourism operation following a recent purchase at auction (North Queensland Lock the Gate Alliance Affiliate Group, email 13 October 2014). Mount Mulligan is also entrenched in North Queensland folklore as the scene of Queensland's worst land disaster, a massive coal dust explosion on 19 September 1921 that resulted in the deaths of all 75 men and boys working underground (Bell, 1978; 1996; 2013). Significant for its Indigenous prehistory, archaeological evidence of human habitation in rock shelters of the mountain date to 37 000 years (Bell, 1996).

From 1991, Mount Mulligan was owned by the Western Yalangi Aboriginal Corporation and leased to the Queensland Department of Environment and Heritage as the Kuku Djugan Nurrabullgin National Park (Bell, 1996). In August 2012, the Djugan people were granted native title interests over the site by the Federal Court, permitting them exclusive use of approximately 149 915 hectares in and around the mountain (*Archer on Behalf of the Djungan People #1*

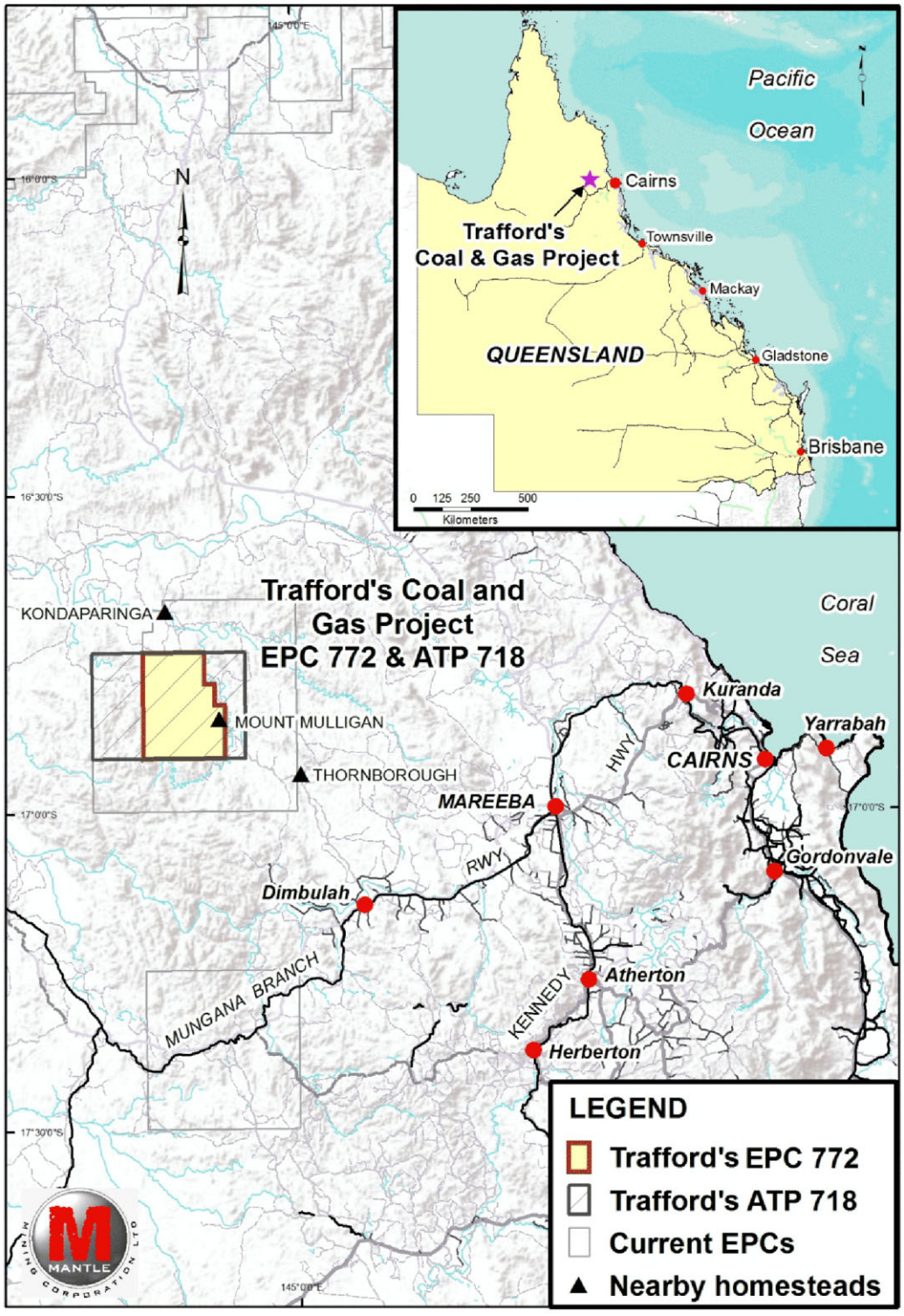

Figure 1 Map of Trafford Project. *Source*: Mantle Mining Corporation (2014a, 7).

v State of Queensland, 2012; Queensland Government, 2012). The area is once again generating interest due to a coal exploration licence being granted to Mantle Mining Corporation, a Perth-based company, in 2008. The area may also be the subject of future CSG exploration, with Mantle Mining's application presently under consideration with the State Government (Nancarrow, 2014). The company's initial 4-year coal exploration permit was recently extended by the State Government to 4 December 2015 and relates to a 5500 sq km area surrounding Mount Mulligan. Initially, an Indigenous Land Use Agreement was executed with the Djungan people, who formed a Coordinating Committee to work with Mantle Mining to progress exploration plans and manage Indigenous cultural heritage (Mantle Mining Corporation, 2012; 2014a; 2014b). This Committee had a leading role in finalising a Conduct and Compensation Agreement that was entered into by the Djungan people and Mantle Mining in November 2013 (Mantle Mining Corporation, 2013).

In a place alive with legends and cultural heritage – dealing with both the disaster (Bell, 1979–1980) and the origins of the mountain itself in Indigenous oral tradition – the extension of Mantle Mining's coal exploration licence and potential for CSG operations has caused some consternation. Traditional owners held a public meeting at Mareeba on 28 May 2014, to discuss the company's intended operation – expressing concern at the potential for contamination of underground aquifers and urging Mantle Mining to negotiate with them to secure an access agreement (Cluff, 2014; Reghenzani and Vlasic, 2014). With presentations from visiting residents of Chinchilla, solicitors from the North Queensland EDO, Federal and State politicians and key members of Lock the Gate, further discussion is planned (Nancarrow, 2014; North Queensland Lock the Gate Alliance Affiliate Group, email 9 June 2014). Whether this represents the type of contractual agreement versus social licence conundrum suggested above by Lacey and Lamont (2014) remains to be seen.

This brief overview hints at how sites such as Mount Mulligan present possibilities for researchers examining UG development in a local Australian context. As landscapes are partly influenced by community perceptions of the law, the manner in which the UG industry is implemented may vary between localities, notwithstanding the legislative intent of central government (Jones, 2006). Legal analysts concerned with access to justice challenges for rural and remote Australian communities have acknowledged the wider role of geography in determining both the choice and costs associated with obtaining legal counsel and environmental experts (e.g., Millner, 2011). However, this 'tyranny of distance' and resources remains an underexplored area from a UG standpoint. Researchers may choose to consider this further, with rural areas arguably distanced – both physically and socially – from the 'force of the state' as a source of legal order (Pruitt, 2014, 190). Consequently, negotiations across multiple scales and jurisdictions are commonplace.

Scale and spillover

The spatial and categorical obsessions of both law and property have been recognised by legal geographers for some time (e.g., Dorsett and McVeigh, 2002; Blomley, 2005). Extractive industries are also notable for their ability to affect regions in a spatially uneven manner, with the law serving as an instrument in this process of social construction (Haas, 2008b). If the notion of jurisdiction is understood to be 'law's territory' (Ford, 1999), then the use of legal authorities as a protest strategy against coal and CSG development by Lock the Gate, for example, presents another research question for legal geographers (Figure 2). Illustrating this most clearly, the High Court's decision in *Plenty v Dillon* involved the failure of two police

Figure 2 Invoking boundaries as a protest strategy. *Source*: Lock the Gate Alliance (2014).

officers to provide a search warrant to Plenty before entering their premises. The High Court's finding of trespass against the police, in the absence of lawful authority to enter on to Plenty's property, seems far removed from Lock the Gate's efforts to halt mining operators who have been granted licences by the State (1991, 635). However, this has not prevented the symbolic use of the Court's decision on signs by anti-CSG protestors; combining a physical barrier with a jurisdictional challenge. Social spaces and boundaries are of course 'saturated' in legal meanings and often subject to 'divergent interpretations' (Delaney *et al*., 2001, xviii). The symbolic politics of property is a theme to be found across the world and is not limited to extractive industries (e.g., Blomley, 1998; Brower *et al*., 2009). In addition to being a ubiquitous presence in the world (as Austin Sarat famously observed: 'law is all over', quoted in Delaney, 2003, 67), law is also a tool through which protest action can be mobilised for particular ends.

The extent of law's reach in society makes it an attractive weapon for protest groups, yet its deployment remains contingent upon geographical context (Akinwumi, 2012). Interpretation and prioritisation of different geographical scales can be relevant for framing community dissent and ultimately the legal basis for development approvals (Jessup, 2013). Jurisdictional choices by regulators can also be a source of dispute, as farmers in the Pilliga Forest region of New South Wales recently discovered, after the CSG operator Santos was fined $1500 by the NSW Environmental Protection Agency for failing to prevent a uranium spill into a local aquifer – a leakage found by Santos itself and reported accordingly. Although the regulator also imposed a pollution reduction programme upon Santos, forcing the company to improve monitoring and remediation infrastructure at the site, for some observers this was not a sufficient penalty, leading to questions about its regulatory approach: '[F]armers and environmental groups say the EPA has failed its charter. They say if Santos had been forced to go before the Land and Environment Court, it could have been liable to penalties of up to a million dollars' (Cornwall, 2014).

It is stressed that the law's geographical impact can be shaped by any number of stakeholder perspectives, not just those who protest the existence of the UG industry. The spatial extent of the sector has been noted widely in the literature, both within Australia and overseas (e.g., Stedman *et al*., 2012; Measham and Fleming, 2014). Less attention has been directed to stakeholder efforts to mould the State's regulatory response to this expansion. For example, alleged lobbying by the resource company Santos to modify the geographical range of a then draft New South Wales Strategic Regional Land Use Policy (released in 2012) suggests there is more to be said about how regulatory choices regarding the industry are made and what influences may underpin them (Lamacraft, 2014).

Landholders have demanded the legal right to refuse entry to CSG operators at a Parliamentary level (Galloway, 2012) but seem to have had more success with their argument when particular companies have declared that they will not seek to establish themselves where they are deemed unwanted (e.g., the land access agreement reached between Santos, AGL, the NSW Irrigators Council and Cotton Australia in March 2014: Herbert, 2014b, see also the subsequent discussions between Dairy Connect and AGL at Gloucester in New South Wales, ABC News, 2014c). These industry arrangements can of course be seen as an effort to construct a social licence to operate and avoid reputational damage to a company's image (Tuck, 2012), but the protest strategy itself has not (as yet) resulted in formal legal change by government. The spatial presence of protests against CSG development can also be found in the local government approvals for protest camps – as demonstrated by the non-renewal of a permit to expand a protest camp at Bentley, New South Wales. As explained by the Richmond Valley Council, existing uses of the landscape and public health concerns were key considerations: '[Their] application . . . has been opposed by people who have a fairly strong influence, such as the police . . . R[oads and] M[aritime] S[ervices] and our planners themselves . . . It unfortunately is not of an appropriate quality and the proposed use will not be approved' (ABC News, 2014b).

The above shows that in defining the boundaries and uses of landscapes, some specialist groups have considerable power. For example, despite the fact that local government in Australia is generally perceived to be excluded from decision-making processes around UG (De Rijke, 2013b), their role may be of increasing relevance given the use of referendum-style polling on CSG developments in local government areas (Luke *et al*., 2014) and attempts by some councils to 'lock the gate' to CSG operators

(Robertson, 2014). UG extraction raises jurisdictional questions that traverse far more than compensation, land access, and environmental harms – partly because of its relatively short commercial existence in Australia (Keogh, 2013). It therefore has the potential to create new legal frontiers.

Conclusion

As shown above, there are many ways in which legal geography might contribute to the ongoing public debate in Australian around UG extraction. Researchers may choose to approach this challenge by studying the types of legal actors involved, their choices, spatial interpretations, arguments, and the influence of their expertise upon regulatory decisions. Alternatively, ongoing CSG development presents opportunities for companies attempting to achieve community social licence via contractual agreements with individual landholders, and for the use of boundaries as a protest strategy to counter such efforts. The physical extent of regulatory measures may also be influenced by lobbying from any number of interested parties, including Indigenous people. In the search for extractive models, further analysis of the comparative type undertaken by Hunter (2014) is warranted to assess whether Australia's regulatory regimes are appropriate for the minimisation of social, economic, and environmental costs. This is no easy task where energy law and policy is concerned. With both 'unique and universal truths' surrounding issues of compensation, litigation processes, land valuation and Indigenous perspectives (Bartel *et al*., 2013, 348), Australian commentators are encouraged to compare these questions while addressing their domestic circumstances. Perhaps most importantly, the controversy of UG extraction invites wider questions about resource use and the linkages between space, power, and society as a whole.

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REFERENCES

ABC News, 2014a: More research needed on impact of CSG land sales, 13 May 2014. Retrieved: 15 May 2014 from <http://www.abc.net.au/news/2014-05-13/more-research-needed-on-impact-of-csg-on-land-sales/5448480>.

ABC News, 2014b: Council to withdraw approval for anti-CSG protest camp, 23 April 2014. Retrieved: 25 April 2014 from <http://www.abc.net.au/news/2014-04-23/protest-camp/5407434>.

ABC News, 2014c: Dairy farmers and gas industry giant sign new cooperation agreement, 29 May 2014. Retrieved: 30 May 2014 from <http://www.abc.net.au/news/2014-05-29/dairy-farmers-and-gas-industry-giant-sign-new-cooperation-agree/5485554>.

ABC News, 2014d: Metgasco says it was assured of government support prior to gas drilling licence suspension, 24 July 2014. Retrieved: 25 July 2014 from <http://www.abc.net.au/news/2014-07-24/metgasco/5620618>.

Akinwumi, A., 2012: Powers of reach: legal mobilization in a post-apartheid redress campaign. *Social and Legal Studies* 22, 25–41.

Andrews, E. and McCarthy, J., 2014: Scale, shale, and the state: political ecologies and legal geographies of shale gas development in Pennsylvania. *Journal of Environmental Studies and Sciences* 4, 7–16.

Archer on Behalf of the Djungan People #1 v State of Queensland, 2012: Federal Court of Australia 801, 2 August 2012. Retrieved: 30 May 2014 from <http://www.austlii.edu.au/au/cases/cth/FCA/2012/801.html>.

Australia Pacific LNG Pty Ltd v Golden and Others, 2013: Queensland Court of Appeal 366, 9 December 2013. Retrieved: 10 May 2014 from <http://archive.sclqld.org.au/qjudgment/2013/QCA13-366.pdf>.

Baker v Minister for Employment, Skills and Mining & Another, 2012: Queensland Supreme Court 160, 22 June 2012. Retrieved: 15 October 2014 from <http://www.sclqld.org.au/caselaw/QSC/2012/160>.

Bartel, R., Graham, N., Jackson, S., Prior, J.H., Robinson, D.F., Sherval, M. and Williams, S., 2013: Legal geography: an Australian perspective. *Geographical Research* 51, 339–353.

Becker, V. and Werner, A., 2014: One step forward, one step back: shale gas in Denmark and Sweden. *Journal of European Management and Public Affairs Studies* 1, 23–30.

Bell, P., 1978: *The Mount Mulligan Disaster*. History Department James Cook University of North Queensland, Townsville.

Bell, P., 1979–1980: 'If you take something from mother earth, she will retaliate': legends from the Mt. Mulligan Coal Mine Disaster. *Royal Historical Society of Queensland: Historical Papers* 11, 89–102.

Bell, P., 1996: *'If Anything, Too Safe': The Mount Mulligan Coalmine Disaster of 1921*. Department of History and Politics James Cook University of North Queensland, Townsville.

Bell, P., 2013: *Alas It Seems Cruel: The Mount Mulligan Coal Mine Disaster of 1921*. Boolarong Press, Brisbane.

Benson, M., 2012: Mining sacred space: law's enactment of competing ontologies in the American West. *Environment and Planning A* 44, 1443–1458.

Benson, M.H., 2014: Rules of engagement: the spatiality of judicial review. In Braverman, I., Blomley, N., Delaney, D. and Kedar, A. (eds) *The Expanding Spaces of Law: A Timely Legal Geography*. Stanford University Press, Stanford, 215–238.

Blomley, N., 1994: *Law, Space and the Geographies of Power*. The Guilford Press, New York.

Blomley, N., 1998: Landscapes of property. *Law and Society Review* 32, 567–612.

Blomley, N., 2003a: Law, property, and the geography of violence: the frontier, the survey and the grid. *Annals*

of the Association of American Geographers 93, 121–141.

Blomley, N., 2003b: From 'what?' to 'so what?': law and geography in retrospect. In Holder, J. and Harrison, C. (eds) *Law and Geography: Current Legal Issues 2002 Volume 5*. Oxford University Press, Oxford, 17–33.

Blomley, N., 2005: Flowers in the bathtub: boundary crossings at the public-private divide. *Geoforum* 36, 281–296.

Braverman, I., Blomley, N., Delaney, D. and Kedar, A., 2014: Introduction: expanding the spaces of law. In Braverman, I., Blomley, N., Delaney, D. and Kedar, A. (eds) *The Expanding Spaces of Law: A Timely Legal Geography*. Stanford University Press, Stanford, 1–29.

Brockett, R., 2014: Moving forward with unconventional gas. *Water: Journal of the Australian Water Association* 41, 46–50.

Brower, A., Page, J., Kennedy, A. and Martin, P., 2009: The cowboy, the southern man, and the man from snowy river: the symbolic politics of property in Australia, The United States, and New Zealand. *Georgetown International Environmental Law Review* 21, 455–493.

Calderwood, K., 2014: Milestone for self-represented landholder in court. *ABC Rural*, 30 April 2014. Retrieved: 30 April 2014 from <http://www.abc.net.au/news/2014-04-08/alpha-coal-project/5378530>.

Carrington, K., Hogg, R. and McIntosh, A., 2011: The resource boom's underbelly: criminological impacts of mining developments. *Australian and New Zealand Journal of Criminology* 44, 335–354.

Carter, J., 2014: Onshore gas fears for farmers. *ABC Rural*, 12 June 2014. Retrieved: 12 June from <http://www.abc.net.au/news/2014-06-12/onshore-gas-fears-for-farmers/5518690>.

Christensen, S., O'Connor, P., Duncan, W.D. and Phillips, A., 2012: Regulation of land access for resource development: a coal seam gas case study from Queensland. *Australian Property Law Journal* 21, 110–146.

Christie, E., 2012: Coal seam gas development, environmental legislation and power, towards a pathway for conflict resolution and environmental justice. *Queensland Lawyer* 32, 225–247.

Cleary, P., 2012: *Mine-Field: The Dark Side of Australia's Resources Rush*. Black Inc, Collingwood.

Cluff, R., 2014: Indigenous group fears CSG impact on mount mulligan water. *ABC Indigenous*, 28 May 2014. Retrieved: 30 May 2014 from <http://www.abc.net.au/news/2014-05-28/indigenous-group-fears-csg-impact-on-mount/5483102>.

Cornwall, D., 2014: Coal seam gas in NSW unites farmers and green groups. *ABC PM*, 10 March 2014. Retrieved: 10 March 2014 from <http://www.abc.net.au/pm/content/2014/s3960379.htm>.

Crabtree, L., 2013: Decolonising property: exploring ethics, land, and time, through interventions in contemporary Australia. *Environment and Planning D* 31, 99–115.

Delaney, D., 2001: Making nature/marking humans: law as a site of (cultural) production. *Annals of the Association of American Geographers* 91, 487–503.

Delaney, D., 2003: Beyond the word: law as a thing of this world. In Holder, J. and Harrison, C. (eds) *Law and Geography: Current Legal Issues 2002 Volume 5*. Oxford University Press, Oxford, 67–83.

Delaney, D., 2010: *The Spatial, the Legal and the Pragmatics of World-Making*. Routledge, New York.

Delaney, D., 2014: Legal geography I: constitutivities, complexities, and contingencies. *Progress in Human Geography*. doi: 10.1177/0309132514527035.

Delaney, D., Ford, R. and Blomley, N., 2001: Preface: where is law? In Blomley, N., Delaney, D. and Ford, R.T. (eds) *The Legal Geographies Reader: Law, Power, and Space*. Blackwell, Oxford, xiii–xxii.

Dorsett, S. and McVeigh, S., 2002: Just so: 'the law which governs Australia is Australian law'. *Law and Critique* 13, 289–309.

Douglas, R., 2006: Uses of standing rules 1980–2006. *Australian Journal of Administrative Law* 14, 22–37.

EDO NSW, 2014: Farmers Seek Court Order for Santos Water Monitoring Data, 26 May 2014. Retrieved: 26 May 2014 from <http://www.edonsw.org.au/farmers_seek_court_order_for_santos_water_monitoring_data>.

Fibbens, M., Mak, M. and Williams, A., 2013: Coal seam gas extraction: does landholder compensation match the mischief?, paper presented at the *19th Pacific Rim Real Estate Society Conference*, 13–16 January 2013, RMIT University, Melbourne, Australia, 1–14. Retrieved: 29 March 2014 from <http://www.prres.net/papers/Fibbens_Coal_seam_gas_extraction.pdf>.

Fibbens, M., Mak, M. and Williams, A., 2014: Compensation for coal seam gas occupation: assessing the harms, paper presented at the *20th Pacific Rim Real Estate Society Conference*, 19–22 January 2014, Lincoln University, Christchurch, New Zealand, 1–12. Retrieved: 29 March 2014 from <http://www.prres.net/papers/Fibbens_Compensation_CSG_Occupation.pdf>.

Ford, R., 1999: Law's territory (a history of jurisdiction). *Michigan Law Review* 97, 843–930.

Friedman, L.M., 1986: The law and society movement. *Stanford Law Review* 38, 763–780.

Fry, M., 2013: Urban gas drilling and distance ordinances in the Texas Barnett Shale. *Energy Policy* 62, 79–89.

Galloway, K., 2012: Landowners' vs miners' property interests: the unsustainability of property as dominion. *Alternative Law Journal* 37, 77–81.

Geritz, M., Aro, T. and Nielsen, T., 2012: Near enough not good enough with Land Owners, 19 July 2012. Retrieved: 26 November 2014 from <http://www.claytonutz.com/publications/edition/19_july_2012/20120719/near_enough_not_good_enough_when_consulting_with_land_owners.page>.

Godfrey, P., Ee, T. and Hewitt, T., 2010: Coal bed methane development in Indonesia: golden opportunity or impossible dream?, *Journal of Energy and Natural Resources Law* 28, 233–264.

Graham, N., 2011: *Lawscape: Property, Environment, Law*. Routledge, Oxford.

Haas, J., 2008a: Law and property in the mountains: a political economy of resource land in the Appalachian coalfields, PhD thesis, Ohio State University, Columbus. Retrieved: 16 July 2014 from <https://etd.ohiolink.edu/rws_etd/document/get/osu1204466619/inline>.

Haas, J., 2008b: Law of regions: mining legislation and the construction of East and West. In Goodman, M.K., Boykoff, M.T. and Evered, K.T. (eds) *Contentious Geographies: Environmental Knowledge, Meaning, Scale*. Ashgate, London, 187–199.

Herbert, L., 2014a: Santos claims legal action is a 'data crawl'. *ABC Rural*, 26 May 2014. Retrieved: 26 May 2014 from <http://www.abc.net.au/news/2014-05-26/santos-responds-farmer-claims-water-contamination/5477226>.

Herbert, L., 2014b: Santos and AGL sign land access deal with farmers. *ABC Rural*, 28 March 2014. Retrieved: 1 April 2014 from <http://www.abc.net.au/news/2014-03-28/santos-agl-agreement/5352090>.

Hoare, R., Shannon, N., Studdart, J. and Finn, W., 2014: The impact of CSG on our water resources: what does the future hold?, *Water: Journal of the Australian Water Association* 41, 32–34.

Holmes, J., 2014: Explorations in Australian legal geography: the evolution of lease tenures as policy instruments. *Geographical Research* 52, 411–429.

Hough, C., 2014: Queensland Grazier Wins Landmark CSG decision. *ABC Rural*, 12 February 2014. Retrieved: 12 February 2014 from <http://www.abc.net.au/news/2014-02-12/csg-law/5255628>.

Howe, N., 2008: Thou shalt not misinterpret: landscape as legal performance. *Annals of the Association of American Geographers* 98, 435–460.

Hudgins, A. and Poole, A., 2014: Framing fracking: private property, common resources and regimes of governance. *Journal of Political Ecology* 21, 303–319.

Hunter, T., 2011: Shale gas resources in Western Australia: an assessment of the legal framework for the extraction of onshore shale gas. *eLaw Journal: Murdoch University Electronic Law Journal* 18, 29–52. Retrieved: 29 May 2014 from <https://elaw.murdoch.edu.au/index.php/elawmurdoch/article/viewFile/99/50>.

Hunter, T., 2014: The role of regulatory frameworks and state regulation in optimising the extraction of petroleum resources: a study of Australia and Norway. *The Extractive Industries and Society* 1, 48–58.

Ingleby, R. and Johnstone, R., 1995: Invocation and enforcement of legal rules. In Hunter, R., Ingleby, R. and Johnstone, R. (eds) *Thinking About Law: Perspectives on the History, Philosophy and Sociology of Law*. Allen and Unwin, Sydney, 157–173.

Jacquet, J. and Stedman, R., 2011: Natural gas landowner coalitions in New York State: emerging benefits of collective natural resource management. *Journal of Rural Social Sciences* 26, 62–91.

Jepson, W., 2012: Claiming space, claiming water: contested legal geographies of water in South Texas. *Annals of the Association of American Geographers* 102, 614–631.

Jessup, B., 2013: Environmental justice as spatial and scalar justice: a regional waste facility or a local rubbish dump out of place?, *McGill International Journal of Sustainable Development Law and Policy* 9, 71–107.

Jones, M., 2006: Landscape, law and justice – concepts and issues. *Norsk Geografisk Tidsskrift – Norwegian Journal of Geography* 60, 1–14.

Kedar, A., 2014: Expanding legal geographies: a call for a critical comparative approach. In Braverman, I., Blomley, N., Delaney, D. and Kedar, A. (eds) *The Expanding Spaces of Law: A Timely Legal Geography*. Stanford University Press, Stanford, 95–119.

Keenan, S., 2013: Property as governance: time, space and belonging in Australia's northern territory intervention. *The Modern Law Review* 76, 464–493.

Keogh, L., 2013: The first four wells: unconventional gas in Australia. *M/C Journal: A Journal of Media and Culture* 16. Retrieved: 16 May 2014 from <http://journal.media-culture.org.au/index.php/mcjournal/article/viewArticle/617>.

King, J., Bell, L. and Bernard, J., 2013: Don't kill the golden goose before it lays an egg – time to review restrictions on the unconventional gas sector. *Corrs Chambers Westgarth Lawyers*, 5 August 2013. Retrieved: 8 June 2014 from <http://www.corrs.com.au/thinking/insights/dont-kill-the-golden-goose-before-it-lays-an-egg-time-to-review-restrictions-on-the-unconventional-gas-sector/>.

Lacey, J. and Lamont, J., 2014: Using social contract to inform social licence to operate: an application in the Australian Coal Seam Gas Industry. *Journal of Cleaner Production* 84, 831–839.

Lamacraft, T., 2014: Santos lobbied for 'no go' area reduction. *ABC News*, 17 July 2014. Retrieved: 24 July 2014 from <http://www.abc.net.au/news/2014-07-17/santos-lobbied-for-22no-go22-area-reduction/5605030>.

Lave, R. and Lutz, B., 2014: Hydraulic fracturing: a critical physical geography review. *Geography Compass* 8, 739–754.

Lipscomb, C., Wang, Y. and Kilpatrick, S., 2012: Unconventional gas development and real estate valuation issues. *The Review of Regional Studies* 42, 161–175.

Liss, J., 2011: Negotiating the Marcellus: the role of information in building trust in extractive deals. *Negotiation Journal* 27, 419–446.

Lloyd, D., Luke, H. and Boyd, W.E., 2013: Community perspectives of natural resource extraction: coal seam gas mining and social identity in Eastern Australia. *Coolabah* 10, 144–164.

Lock the Gate Alliance, 2014: Lock your gate. Retrieved: 20 May 2014 from <http://www.lockthegate.org.au/lock_your_gate>.

Locke, S., 2014: Legal advice about CSG contamination of food not disclosed. *ABC Rural*, 26 March 2014. Retrieved: 26 March 2014 from <http://www.abc.net.au/news/2014-03-26/beef-contamination-legal-advice/5346640>.

Luke, H., Lloyd, D., Boyd, W. and Den Exter, K., 2014: Unconventional gas development: why a regional community said no: a report of findings from the 2012 Lismore City council election poll and exit poll survey (New South Wales). *Geographical Research* 52, 263–279.

Manning, P., 2012: *What the Frack?: Everything You Need to Know About Coal Seam Gas*. University of New South Wales Press, Sydney.

Mantle Mining Corporation, 2012: ASX Release: Mt Mulligan ILUA authorised, 20 July 2012. Retrieved: 29 May 2014 from <http://www.mantlemining.com/wp-content/uploads/announcements/1129001.pdf>.

Mantle Mining Corporation, 2013: Positive progress achieved at Mount Mulligan, 13 November 2013. Retrieved: 30 May 2014 from <http://www.mantlemining.com/wp-content/uploads/2013/11/1276782.pdf>.

Mantle Mining Corporation, 2014a: December 2013 Quarterly Activities Report, 24 January 2014. Retrieved: 30 May from <http://www.mantlemining.com/wp-content/uploads/2014/01/140124-Quarterly-Activities-Report.pdf>.

Mantle Mining Corporation, 2014b: Trafford. Retrieved: 29 May 2014 from <http://www.mantlemining.com/project/trafford/>.

Martin, D. and Scherr, A., 2005: Lawyering landscapes: lawyers as constituents of landscape. *Landscape Research* 30, 379–393.

Martin, D., Scherr, A. and City, C., 2010: Making law, making space: lawyers and the production of space. *Progress in Human Geography* 34, 175–192.

Matthews, O.P., 1997: Geography, law, and mineral development. In Thompson, G.L., Shelley, F.M. and Wije, C. (eds) *Geography, Environment, and American Law*. Colorado University Press, Niwot, 104–119.

McGauran, C., 2013: Victorian Moratorium on Fracking Extended Until Mid 2015. *ABC Rural*, 21 November 2013. Retrieved: 5 June 2014 from <http://www.abc.net.au/news/2013-11-21/nrn-fracking-moratorium-extended/5107780>.

McManus, P. and Connor, L., 2013: What's mine is mine(d): contests of marginalisation of rural life in the Upper Hunter Valley, NSW. *Rural Society* 22, 166–183.

Measham, T.G. and Fleming, D.A., 2014: Impacts of unconventional gas development on rural community decline. *Journal of Rural Studies* 36, 376–385.

Mercer, A., De Rijke, K. and Dressler, W., 2014: Silences in the boom: coal seam gas, neoliberalizing discourse, and the future of regional Australia. *Journal of Political Ecology* 21, 279–302.

Metasgco, 2014a: Metgasco Initiates Legal Action, 3 June 2014. Retrieved: 4 June 2014 from <http://www.metgasco.com.au/asx-announcements/metgasco-initiates-legal-action>.

Metgasco, 2014b: Supreme Court Action Update, 22 October 2014. Retrieved: 24 October 2014 from <http://www.metgasco.com.au/asx-announcements/supreme-court-action-update>.

Millner, F., 2011: Access to environmental justice. *Deakin Law Review* 16, 189–207.

Munro, S., 2012: *Rich Land, Wasteland*. Macmillan, Sydney.

Nancarrow, K., 2014: Western Yalanji Chairman Seeks Convincing About Mount Mulligan CSG Benefits, 3 November 2014. Retrieved: 3 November 2014 from <http://www.abc.net.au/news/2014-11-03/indigenous-corp-chairman-seeks-convincing-about/5862092>.

Nevins, J., 2004: Contesting the boundaries of international justice: state countermapping and offshore resource struggles between east timor and Australia. *Economic Geography* 80, 1–22.

New South Wales Office of Coal Seam Gas, 2014: Statements on Megasco PEL 16, 26 June 2014. Retrieved: 20 November 2014 from <http://www.resourcesandenergy.nsw.gov.au/landholders-and-community/coal-seam-gas/community/statement-on-metgasco>.

North Queensland Lock the Gate Alliance Affiliate Group, email 13 October 2014.

North Queensland Lock the Gate Alliance Affiliate Group, email 9 June 2014.

Organ, M., 2014: New tactics see coal seam gas protests gain the upper hand. *The Conversation*, 28 May 2014. Retrieved: 10 June 2014 from <http://theconversation.com/new-tactics-see-coal-seam-gas-protests-gain-the-upper-hand-26645>.

Pearse, G., McKnight, D. and Burton, B., 2013: *Big Coal: Australia's Dirtiest Habit*. University of New South Wales Press, Sydney.

Petroleum (Onshore) Act, 1991: (NSW).

Petroleum (Production and Safety) Act, 2004: (Qld).

Plenty v Dillon, 1991: 171 Commonwealth Law Reports 635.

Plumb, J., 2013: Taking on legal challenges for resource exploration in Queensland, February 2013. *Gas Today*. Retrieved: 15 March 2014 from <http://gastoday.com.au/news/taking_on_legal_challenges_for_resource_exploration_in_queensland/080305>.

Plumb, J. and Shute, A., 2014: Negotiated access to land in Queensland – is this the end of ADR?, *Carter Newell Lawyers*, January 2014. Retrieved: 14 May 2014 from <http://www.carternewell.com/page/Publications/2014/Negotiated_access_to_land_in_Queensland_is_this_the_end_of_ADR/>.

Pruitt, L.R., 2014: The rural lawscape: space tames law tames space. In Braverman, I., Blomley, N., Delaney, D. and Kedar, A. (eds) *The Expanding Spaces of Law: A Timely Legal Geography*. Stanford University Press, Stanford, 190–214.

Queensland Government, 2012: Djungan People's Native Title Rights Recognised, 2 August 2012. Retrieved: 10 June 2014 from <http://statements.qld.gov.au/Statement/Id/80044>.

Reghenzani, K. and Vlasic, K., 2014: Coal seam gas protest at Mareeba over exploration on site of mining disaster. *The Cairns Post*, 29 May 2014. Retrieved: 1 June 2014 from <http://www.cairnspost.com.au/news/coal-seam-gas-protest-at-mareeba-over-exploration-on-site-of-mining-disaster/story-fnjpvlcp-1226935955114>.

de Rijke, K., 2013a: The agri-gas fields of Australia: black soil, food, and unconventional gas. *Culture, Agriculture, Food and Environment* 35, 41–53.

de Rijke, K., 2013b: Hydraulically fractured: unconventional gas and anthropology. *Anthropology Today* 29, 13–17.

Robertson, B., 2014: Douglas shire council locks the gate against fracking. *Newsport: Douglas Shire's Online Newspaper*, 4 November 2014. Retrieved: 4 November 2014 from <http://www.tourismportdouglas.com.au/Douglas-Shire-Council-locks-the-gate-aga.12019.0.html>.

Ryan, J., 2014: Shale gas fracking under review in Tasmania. *ABC News*, 1 December 2014. Retrieved: 1 December 2014 from <http://www.abc.net.au/news/2014-11-30/shale-gas-fracking-under-review-in-tasmania/5929076>.

Schweinsberg, S. and Wearing, S., 2013: Coal seam gas and its impacts on destination image assessment: an investigation into wine tourism in the Hunter Valley, NSW. In Fountain, J. and Moore, K. (eds) *Proceedings of the 23rd Council of Australasian University Tourism and Hospitality Education Conference 2013: Tourism and Global Change – On the Edge of Something Big*. Lincoln University, 11–14 February 2013, Christchurch, New Zealand, 717–722.

Sherval, M. and Graham, N., 2013: Missing the connection: how SRLU policy fragments landscapes and communities in NSW. *Alternative Law Journal* 38, 176–180.

Sherval, M. and Hardiman, K., 2014: Competing perceptions of the rural idyll: responses to threats from coal seam gas development in Gloucester, NSW, Australia. *Australian Geographer* 45, 185–203.

Simonelli, J., 2014: Home rule and natural gas development in New York: civil *fracking* rights. *Journal of Political Ecology* 21, 258–278.

Smith, A., 2006: Defending the unpopular down-under. *Melbourne University Law Review* 30, 495–553.

Smyth, R. and Mishra, V., 2011: The transmission of legal precedent across the Australian state supreme courts over the twentieth century. *Law and Society Review* 45, 139–170.

Stedman, R., Jacquet, J., Filteau, M., Willits, F., Brasier, K. and McLaughlin, D., 2012: Marcellus shale gas development and new boomtown research: views of New York and Pennsylvania residents. *Environmental Practice* 14, 382–393.

Stratford, E., 1993: Ideology, environment and legislation: South Australian attitudes to vegetation. *Australian Geographical Studies* 31, 14–25.

Stubbs, B.J., 2001: From 'useless brutes' to national treasures: a century of evolving attitudes towards native fauna in New South Wales, 1860s to 1960s. *Environment and History* 7, 23–56.

Sugarman, D., 1994: Blurred boundaries: the overlapping worlds of law, business and politics. In Cain, M. and Harrington, C.B. (eds) *Lawyers in a Postmodern World: Translation and Transgression*. New York University Press, New York, 105–123.

Swayne, N., 2012: Regulating coal seam gas in Queensland: lessons in an adaptive environmental management approach. *Environmental and Planning Law Journal* 29, 163–185.

Tomasic, R., 1978: Towards a typology of lawyer roles. In Tomasic, R. (ed.) *Understanding Lawyers: Perspectives on the Legal Profession in Australia*. Law Foundation of New South Wales and Allen & Unwin, Sydney, 75–100.

Trigger, D., Keenan, J., de Rijke, K. and Rifkin, W., 2014: Aboriginal engagement and agreement-making with a rapidly developing resource industry: coal seam gas development in Australia. *The Extractive Industries and Society* 1, 176–188.

Tuck, J., 2012: *Mobility or immobility: reputation and property rights in the mining industry*, University of Ballarat Business School Working Paper Series: 003 – 2012, 1–13. Retrieved: 12 April 2014 from <http://www.ballarat.edu.au/__data/assets/pdf_file/0019/75025/Mobility-or-Immobility-Reputation-and-Property-Rights-in-the-Mining-Industry.pdf>.

Valverde, M., 2014: Time thickens takes on flesh': spatiotemporal dynamics in law. In Braverman, I., Blomley, N., Delaney, D. and Kedar, A. (eds) *The Expanding Spaces of Law: A Timely Legal Geography*. Stanford University Press, Stanford, 53–76.

Villanueva, J., 2013: The territorialization of the 'republican law': judicial presence in Seine-Saint Denis, France, PhD thesis, Syracuse University, New York. Retrieved: 11 June 2014 from <http://surface.syr.edu/geo_etd/79/>.

Weir, M. and Hunter, T., 2012: Property rights and coal seam gas extraction: the modern property law conundrum. *Property Law Review* 2, 71–83.

Williams, J., Stubbs, T. and Milligan, A., 2012: *An Analysis of Coal Seam Production and Natural Resource Management in Australia: A Report Prepared for The Australian Council of Environmental Deans and Directors*. John Williams Scientific Services Pty Ltd, Canberra, 1–111. Retrieved: 6 August 2014 from <http://aie.org.au/AIE/Documents/Oil_Gas_121114.pdf>.