Rural and Remote Health
MEDLINE listed
Impact factor 0.878
The International Electronic Journal of Rural and Remote Health Research, Education, Practice and Policy
ISSN 1445-6354

COMMENTARY

# Health concerns associated with unconventional gas mining in rural Australia

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***Submitted:*** *29 November 2015;* ***Revised:*** *18 August 2016;* ***Accepted:*** *29 August 2016;* ***Published:*** *12 December 2016*

**Haswell M, Bethmont A**

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***Rural and Remote Health*** **16: 3825. (Online) 2016**

**Available: http://www.rrh.org.au**

## ABSTRACT

**Context:** Many governments globally are investigating the benefits and risks associated with unconventional gas mining for shale, tight and coal seam gas (coalbed methane) to determine whether the industry should proceed in their jurisdiction. Most locations likely to be developed are in rural areas, with potential impact on farmers and small communities. Despite significant health concerns, public health knowledge and growing evidence are often overlooked in decision-making. It is difficult to gain a broad but accurate understanding of the health concerns for rural communities because the evidence has grown very recently and rapidly, is complex and largely based in the USA, where the industry is advanced. In 2016, a concerned South Australian beef and lamb farmer in an area targeted for potential unconventional gas development organised visits to homes in developed unconventional gas areas of Pennsylvania and forums with leading researchers and lawyers in Pennsylvania and New York. Guided by priorities identified during this trip, this communication concisely distils the research evidence on these key concerns, highlighting the Australian situation where evidence exists. It summarises key information of particular concern to rural regions, using Australia as an example, to assist rural health professionals to be better prepared to engage in decision-making and address the challenges associated with this new industry.

**Issues:** Discussions with communities and experts, supported by the expanding research from the USA and Australia, revealed increasing health concerns in six key areas. These are absence of a safe solution to the toxic wastewater management problems, air pollution, land and water competition, mental health and psychosocial wellbeing risks, fugitive methane emissions and lack of proven regulatory regimes. Emerging epidemiological studies suggesting interference with foetal development and birth outcomes, and exacerbation of asthma conditions, are particularly concerning to rural families and livestock.

Rural-and-Remote-Health
The International Electronic Journal of Rural and Remote Health Research, Education Practice and Policy

**Lessons learned:** Rural residents in potentially affected areas should be supported to access and interpret the best current evidence regarding the multiple health concerns associated with unconventional gas mining. This knowledge should be part of wider discourse and decision-making processes driving local economic development and national and global energy choices.

**Key words:** Australia, coalbed methane, coal seam gas, fracking, health, mining, pollution, psychosocial impacts, shale gas, unconventional gas.

# Context

In the past 20 years, unconventional gas (UCG) mining has grown from being largely unknown to a 'global phenomenon'[1]. The USA, China, Canada and Australia produce UCG, with countries in Africa, South and Central America, the Middle East and Europe considered 'potential new frontiers'[1].

Governments are examining the benefits and risks of UCG development to determine its future. Communities, particularly those in rural areas where most UCG developments are proposed, are concerned about environmental and health risks.

Research on the health implications of UCG has increased rapidly in the USA, alongside growth in the industry and the number of people (estimated at 15.3 million in 2013[2]) living within a mile of a hydraulically fractured oil or gas well. By 2015, at least 685 peer-reviewed papers on health implications of shale and tight gas mining had been published, with 80% between 2013 and 2015[3]. Few papers examine health concerns associated with coal seam gas (CSG) (coalbed methane) mining, which is occurring in two Australian states (Queensland and New South Wales), but now banned in Victoria[4,5].

Complex and changing messages surround the industry's health implications, challenging rural health professionals to respond. They may struggle with their role as service providers, needing to be cognisant of potential health risks, and as advocates for health protection in the face of uncertainty and technical complexity.

## Issues

This communication offers assistance to rural health professionals facing these challenges. It is informed by the latest research evidence and a US tour organised by a South Australian farmer and attended by 11 Australians, including four South Australian Members of Parliament[6]. Six health concerns and relevance to Australia are highlighted.

### *1. No demonstrated long-term solution for hazardous wastewater management*

Millions of litres of wastewater containing naturally occurring and introduced chemicals are brought to the surface through UCG operations[7-14]. Some pose risks to human and animal health, including volatile organic compounds, heavy metals, naturally occurring radioactive materials and endocrine-disrupting chemicals associated with adverse effects at extremely low concentrations[10-16]. Exacerbated by incomplete assessment and problematic disclosure, health risks from fracking fluids and wastewater remain uncertain.

Methods for handling and disposal of large volumes of wastewater remain problematic[11,14,15]. Accidental surface water and aquifer contamination has occurred in Australia[15]. Evaporation ponds are vulnerable to spills and there is no long-term solution for disposing of remaining concentrated chemical and saline mixtures. The adequacy of treatment in removing chemicals of concern at a reasonable cost is uncertain[11,17].

An extensive literature review[3] found that 40 of 58 (69%) peer-reviewed research studies investigating impacts of UCG on water quality contained findings indicating potential,

positive associations, or actual incidence of water contamination.

### *2. Air pollution – an under-recognised significant health risk*

All stages of UCG mining pose potential air pollution risks[7-10,12,13,18-24], including compressor station operations and extensive use of trucks and machinery emitting diesel exhaust, a carcinogen containing fine and ultrafine particles and nitrogen oxides, contributing to ground level ozone[19]. Risk assessments and exposure studies indicate that these pollutants, plus an array of volatile organic compounds, endocrine-disrupting chemicals and hydrogen sulfide emissions, may pose occupational and community health risks[13,18-24]. A community-led study using location- and time-specific sampling detected volatile organic and other compounds above guidelines, raising questions about the sensitivity of standard air quality testing and health risks associated with frequent short-term exposures to pollutant levels exceeding guidelines[22-24].

Potential impacts of air pollutants on developing foetuses and children are particularly concerning[12,16,25-28]. Four studies reported significant negative outcomes among infants of mothers with the highest exposure potential based on temporal changes (pre- vs post-drilling), spatial distance from and/or density of wells, or UCG activity levels. These outcomes include reduced average birth weight[25,26], increased prevalence of low birth weight[25], preterm births[27], high-risk pregnancies[27] and birth defects[28].

Adults may also face risks. In addition to suggestions from community symptom surveys[29], a large study found significant increases in cardiovascular and neurological patient hospitalisations in postcodes with greater densities of wells introduced between 2007 and 2011[30]. Exposure to UCG activities is also associated with increases in mild, moderate and severe exacerbations of existing asthma conditions[31]. During drilling, hydraulic fracturing and production phases, the odds of hospitalisation and requiring new corticosteroid prescriptions increased by between 74% and three- to fourfold, respectively, after control of potential confounders.

These studies identified known air pollutants and psychosocial stressors as plausible causative contributors[25-31].

There have been few Australian studies. Unpublished accounts and a household survey near CSG activities recorded symptoms such as burning eyes, headaches, bleeding noses and difficulty breathing, especially among children[32]. A compilation of information by Queensland Health did not find associations between reported symptoms and air monitoring data[33], although authors recommended improved air quality measurements to assess temporal and spatial variation during CSG operations. Another Queensland study found greater increases in all-age hospital admission rates for neoplasms and blood/immune diseases from 1995 to 2011 in a CSG area compared to coal mining and rural areas, after adjusting for sociodemographic characteristics[34].

Overall, the peer-reviewed literature indicates concerning air quality and public health impacts, with 40 of 46 (87%) air quality studies finding elevated air pollutant emissions and/or atmospheric concentrations and 26 of 31 (84%) public health studies finding public health hazards, elevated risks or adverse health outcomes[3].

### *3. Competition for water and land between gas companies and farmers*

While the link between food safety and security and UCG has received less research interest, it is a critical concern for farmers for whom livestock health and water rights are paramount, especially with increased droughts predicted in Australia and globally[35]. These concerns were highlighted in exceptionally drought-stricken California in 2015 where some crops were irrigated with unconventional oil wastewater[36]. The long-term safety of treated water in farming remains uncertain, as toxins may transfer into food chains[37] and increased soil salinity may reduce productivity[11].

Negotiations between water and energy sectors face conflicting views and complexity, increasing with climate change and population growth[38]. Prospects for successful coexistence between farming and UCG are further challenged by roads and mining infrastructure on agricultural land, pollution risks, livestock disturbance and economic uncertainties surrounding UCG[36-39].

### *4. Risks to mental health and social and emotional wellbeing*

Some Pennsylvanian residents spoke of loss of social cohesion due to nearby UCG operations, polarising families and communities into winners and losers and those for and against. Disturbances from lights, noise, privacy invasion, anxiety about health, loss or contamination of water supply and falling property values enhanced distress among those living near wells.

In contrast, discussions with other residents and public relations firm Energy InDepth suggested the industry brings roads and neighbourhood improvements, reduced property taxes, increased business, training and research opportunities, jobs for local residents and increased self-worth. Production work often involves skilled fly-in, fly-out rotations with on-site accommodation.

Similar upbeat accounts emerged during the construction phase of CSG mining in the Darling Downs, Australia. However, research has found uneven impacts on residents and uncertainty in how communities will cope with the post-construction phase[40,41]. A survey by Australia's Commonwealth Scientific and Industrial Research Organisation of 390 residents found that 48.5% felt their community was 'only just coping', 'not coping' or 'resisting' the industry. While 51.5% felt their community was adapting, just 11.4% of this group saw the change as 'into something different but better'[41].

The New South Wales Parliament Legislative Council Inquiry into Coal Seam Gas found widespread concern about CSG developments from rural, urban and indigenous communities. Some inquiry participants were concerned about poor behaviour by CSG companies and contractors, the pace of development and fear of loss of land and livelihood[42].

In southern Queensland, 239 landholders, community and service representatives attending workshops linked psychosocial, health service, housing and financial stressors and negative mental health impacts with coal and UCG mining[43]. Participants urged greater protection of mental health and increased health and psychological services in mining areas. Augmenting the Edinburgh Farming Distress Inventory[44] to include stressors linked to CSG mining, Morgan et al[45] demonstrated that mining concerns contributed to overall stress burdens and odds of experiencing depression and anxiety, felt most severely by farmers directly affected by mining activities.

The suicide of an Australian farmer in 2015 who, according to a family statement, resisted pressure and experienced the consequences of UCG and underground coal gasification on his farmland for more than 10 years[46] adds gravity to the findings of these studies[41,43,45]. This death stimulated a national Senate Select Committee Inquiry on Unconventional Gas Mining but, after an interim report[5], the Inquiry was suspended due to the 2016 Australian election.

The employment and economic benefits of UCG are often assumed to be substantial, but some research has contested this. For example, Chen and Randall[39] modelled long-term economic net benefits in Australia and found that, under some plausible scenarios, the economic benefits from agriculture alone exceeded those from CSG. Costs to health and community wellbeing and other externalities were not included in the modelling.

### *5. High levels and potency of fugitive methane emissions promoting climate change*

Initially UCG was welcomed as a potential contributor to global greenhouse gas emission reduction and a positive step in responding to climate change. However, research suggests that as much as 3.6 and 7.9% of methane produced at shale-

gas wells escapes to the atmosphere, with 'super-emitting' wells of great concern[47]. Methane is 85 times more potent in trapping heat than carbon dioxide over 20 years, a critical period for emission reductions[48]. In December 2015, a blowout of a UCG well connected to an underground storage facility at Aliso Canyon in California released more than 100 000 tonnes of methane, plus other volatile organic compounds of direct health concern[49]. UCG mining thus contributes to global warming through major incidents, fugitive emissions and competition with renewable energies; hence, continued development may accelerate the severe health impacts of climate change[47-52].

### *6. Regulation will not eliminate risk and impact*

Much talk is devoted to promises of regulatory regimes to fully protect water, prevent well failures and blowouts and reduce greenhouse gas emissions associated with UCG. However, there is little demonstration of actual, long-term cumulative safety through regulation. A referenced compilation of scientific, medical and media findings in the USA argues that regulations have not prevented significant harms, and that some harms are not preventable through regulatory opportunities[7]. Even if theoretically possible, the capacity of regulatory agencies to handle the burden of adequately monitoring and responding to many hazardous chemical, social, mental and physical health risks posed by large numbers of producing and depleted wells is uncertain.

## Lessons learned

Many rural residents in Australia and other countries are concerned about UCG mining. Discussions with communities and experts, supported by expanding research, revealed evidence of an absence of safe solutions to toxic wastewater and air pollution, land and water competition, mental health and psychosocial wellbeing risks, climate impacts and unproven regulatory regimes. Emerging studies suggesting interference with foetal development are particularly concerning to rural families and livestock.

Many health organisations in the USA and Australia argue that UCG mining has progressed in advance of demonstrated safety to people and the environment. The upward trend in health research publications, with most indicating potential risk or associated negative outcomes[3], has enhanced, not alleviated, human health concerns.

This research is an essential contribution towards understanding potential environmental health impacts associated with UCG. Fully understanding these impacts requires comprehensive assessments and detailed epidemiological studies with substantial numbers of people living near wells for sufficient time. Such studies are only just emerging, many with concerning findings. Although gaps remain, allowing the industry to expand whilst overlooking growing evidence of risk seems inconsistent with basic principles of environmental health protection. We urge governments in Australia and elsewhere to protect rural populations from these multiple potential, even if uncertain, risks.

While it is too late for a precautionary approach for millions of people living close to these operations, doctors and public health professionals can support rural residents and decision makers to avoid, limit and/or address these potential harms by ensuring the latest evidence is taken seriously in discourse and decision-making in local, national and global energy choices.

## Acknowledgements

We thank members of the Unconventional Gas Group of the Doctors for the Environment Australia for sharing knowledge and publications on unconventional gas and Mr David Smith of Kalangadoo, South Australia, for organising the US Fracking Fact Finding Tour.

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