Australia's National Science Agency

HEALTH IMPACTS

GISERA | Gas Industry Social and Environmental Research Alliance

Screening for potential hazards to human health from CSG activities

Scientists from CSIRO and The University of Queensland (UQ) have released results of a five-year research project - *Identification and screening for potential physical hazards to human health from coal seam gas activities at a study site in the Surat Basin, southern Queensland*.

The purpose of this project was to:

- identify potential hazards to human health from CSG activities at a study site in the Surat Basin, Queensland,
- conduct a screening assessment of existing data related to these potential hazards
- determine whether further in-depth assessment of these potential hazards may be needed.

The study site selected for the project takes in the area of the Surat Basin where coal seam gas was first developed, an area of 2,150 square kilometres and including the regional towns of Miles, Chinchilla and Condamine.

In addition to other industries and agricultural activities, the study site contains significant coal seam gas infrastructure including over 2,400 wells, 5,000 km of gas and water gathering lines, four water treatment plants, eight gas processing plants, and 15 compression stations.

The study identified factors associated with CSG activities within the defined study site and appraised their hazard potential to human health.

Factors included chemicals used by industry and naturally occurring (geogenic) chemicals that may be released by industry activities, chemical associated with air emissions and combustion of CSG, and physical factors (noise, light and dust).

This project did not measure or estimate exposure; rather it applied a scientifically rigorous screening process based on best available data to determine whether (or not) a possible pathway exists to potentially affect human health.

A CSG well head.

CSIRO | Australian Government Department of Industry, Science and Resources | NSW Government | Supported by Government of South Australia | Queensland Government | Northern Territory Government | origin | Australia Pacific LNG | QGC | Santos

Key findings

- This five-year human health project focussed on a 2,150 square kilometre study site in the Surat Basin, Queensland.
- Researchers identified chemical and physical 'factors' associated with all CSG activities within the study site and appraised them for their potential hazard to human health.
- 97 unique chemical factors were identified as components of additives used in the drilling of over 2,400 wells and in the hydraulic fracturing of 67 wells. Of these 97 chemical factors:
  - 72 chemical factors were found to have low hazard potential to local communities.
  - 25 chemical factors (in eight groups) were identified as warranting further assessment.
- Based on the available evidence, none of these chemicals represent an acute hazard to human health in the study site.
- CSIRO will undertake further studies to assess these chemical factors.
- CSG combustion products and infrequent, short term releases of fugitive CSG contaminants to air were appraised as known hazards that pose a low hazard potential to human health at the study site.
- Dust emissions from CSG industry activities are known hazards that occasionally exceed air quality standards at the study site.
- Noise levels of continuous sources at the study site, if maintained within the conditions of Environmental Authorities, have been appraised to be below levels that could cause harm.
- Light pollution was considered to have inherently low hazard potential to human health.

About the study site

This project focussed on a specific site in the Surat Basin, Queensland that covers 2,150 square kilometres and includes the regional towns of Miles, Chinchilla and Condamine. In addition to CSG, the primary industry in the region is agriculture.

The study site contains significant coal seam gas infrastructure including over 2,400 wells (67 of which had been hydraulically fractured), 5,000 km of gas and water gathering lines, four water treatment plants, eight gas processing plants, and 15 compression stations.

CSG activities in the study site have been conducted for over 15 years as part of two CSG developments belonging to Australia Pacific LNG (APLNG) and Shell's Queensland Gas Company (QGC). The results of this project are specific to the study site.

Chemical and physical factors

The study's focus was to identify chemical and physical factors associated with all CSG activities within the study site and appraise them for their potential hazard to human health.

A factor is an individual component of CSG activities, or an individual component used in CSG operations, that potentially could be released or emitted to the environment.

These factors included chemicals (chemicals used by industry and naturally occurring chemicals that may be released by industry activities), air emissions including dust, and noise and light.

The study identified CSG factors in five categories:

- Additives (chemicals) used in drilling, hydraulic fracturing, and water treatment,
- Geogenic (naturally occurring) chemicals in produced or treated water and drill cuttings,
- Air emissions from CSG and combustion products, and
- Physical factors – noise, light and dust.

CSIRO scientists monitor air quality at a CSG well in the Surat Basin.

Research results – chemical factors

The appraisal of additives was undertaken by the Queensland Alliance for Environmental Health Sciences (QAEHS) at The University of Queensland. In total, 97 unique chemical factors were identified as components of additives used in the drilling of over 2,400 wells and in the hydraulic fracturing of 64 wells.

Of these 97 chemical factors:

- 72 chemical factors were found to have low hazard potential to local communities.
- 25 chemical factors (in eight groups) were identified as warranting further assessment. Four groups (one group of three chemical factors and three individual chemical factors) were appraised to be chemicals of potential concern (COPCs). Four groups (one group of 16 chemical factors and three individual chemical factors) were identified as having knowledge gaps that prevent a complete appraisal.
  - Based on the available evidence, none of these chemicals represent an acute hazard to human health in the study site.

The chemical factors identified as warranting further assessment are:

- CMIT/MIT (a single chemical factor). A biocide used in drilling additives (5 wells) and hydraulic fracturing fluids (35 wells). Commonly used in Australia as a preservative in cosmetic, cleaning and laundry products and paint. Appraised as a COPC.
- THPS (a single chemical factor). A broad-spectrum biocide and fungicide used in industrial water systems and in drilling and hydraulic fracturing fluids. Appraised as a COPC.
- Nonylphenols (a single chemical factor and its breakdown products). Surfactants used in a drilling additive (97 wells) and hydraulic fracturing additive (5 wells). These chemicals are also used in industrial cleaning, agriculture, plastics, textiles, paper, phenolic resins, plastics additives, detergents, emulsifiers and pesticides. Appraised as a COPC.
- Crystalline silica (three chemical factors). Crystalline silica is the main component of the earth's crust. Quartz sand is used as a proppant in CSG wells and crystalline silica is present as an impurity in mineral-based drilling additives that are widely used in the study site. The respirable form (particles less than 10 micrometres in diameter) has been appraised as a COPC.
- Fluorobenzoic acid tracers (a broad grouping of 16 chemical factors). This group of chemical factors has been used as tracers in hydraulic fracturing fluids for 10 wells in the study site. Limited information exists on toxicity and environmental fate of this group of chemical factors and further research is warranted.
- TTPC (a single chemical factor). An antimicrobial agent used in hydraulic fracturing fluids for 11 wells in the study site. No data are available on environmental behaviour and fate and further research is warranted.
- Glutaraldehyde (a single chemical factor) is used in drilling and well workovers in the study site. Commonly used in domestic, industrial and hospital applications. It readily degrades under aerobic and anaerobic conditions and is susceptible to biodegradation. Uncertainty about the persistence of this chemical factor in shale gas resources raised in recent literature means that further research is warranted.
- Polyacrylamide (a single chemical factor and its breakdown product, acrylamide). Used as a viscosity modifier and friction-reducer in drilling and hydraulic fracturing fluids. Polyacrylamide is also commonly used in water treatment, as a soil conditioner and in other industrial processes. It has inherent low toxicity and, along with its breakdown products, degrades readily in sunlight. A potential breakdown product, acrylamide, has high toxicity. Although considered very low the potential of acrylamide formation warrants further research.

Extension studies to determine microbial degradation of these chemicals in soil and groundwater samples found that four of these chemical factors were rapidly degraded by microbial communities in soils.

CSIRO will undertake further studies to assess these eight groups of chemical factors, and all results will be made public in line with GISERA's established governance model.

Potential exposure pathway

The potential exposure pathway to humans for these chemical factors, with the exception of crystalline silica, is through surface water, infiltration and groundwater.

This potential exposure pathway would require release to surface water (with infiltration) or to groundwater directly, and then human exposure to groundwater containing the chemical.

For crystalline silica, the exposure pathway is via airborne particulate matter. The amount of crystalline silica at individual well sites is not likely to be high enough to create exposure pathways.

A potential exposure pathway was identified where aggregation of this material in sediments from produced water could occur and if these sediments were then exposed to air.

Preliminary analysis

For the seven chemical factors with a potential exposure pathway via surface water, infiltration and groundwater CSIRO completed extension studies to determine microbial degradation of these chemicals in soil and groundwater samples.

Results showed that four groups of chemical factors were rapidly degraded by microbial communities in soils and at a slower rate by microbial communities in groundwater. Three groups of chemical factors were persistent.

CSG combustion

The main products of burning CSG (which is primarily methane) are carbon dioxide (CO_2 and water (H_2O) along with the air pollutants carbon monoxide (CO), nitrogen oxides (NO_x) and volatile organic compounds (VOCs).

These compounds are subject to the National Environment Protection Measures (NEPM) due to their known direct and indirect effects on human health from inhalation. They meet health study criteria for further appraisal.

Based on analysis of emissions and air quality data for the period 2014 – 2018 the CSG industry was the primary source of CO, NOx and VOCs in the study region, however the ambient concentrations of these pollutants measured across the study region were many times lower than their NEPM ambient air quality objectives.

Based on these assessments and using ambient air quality objectives as the assessment criteria, CSG combustion products have been appraised as known hazards that pose a low hazard potential to human health at the study site.

Fugitive emissions

For this appraisal, data supplied by industry for 132 CSG samples collected in the Surat Basin were analysed by CSIRO scientists for over 100 chemicals. Data from previous GISERA and CSIRO studies were also used.

Results showed that:

- CSG contains approximately 97% methane, 2% nitrogen, and less than 1% CO_2, O_2, argon, helium, ethane, and propane. These gasses are not considered toxic at ambient concentrations and were considered to be of inherently low hazard potential to human health at the study site.
- Trace amounts of potential air pollutants were found and include hydrocarbons (C_4–C_8), BTEX (benzene, toluene, ethylbenzene and xylene), hydrogen sulphide, radon, and mercury. These pollutants are known hazards and meet the health impact assessment criteria for further appraisal.

The hazard potential for these pollutants was assessed based on their calculated concentration in air as a result of a leak from a point source.

The levels of CSG contaminants released to air were well below their respective ambient air quality objectives as set out in the National Environment Protection (Air Toxics) Measures, the Queensland Environment Protection Policy (Air), and the Australian Radiation Protection and Nuclear Safety Agency guidelines for households and workplaces.

Based on this assessment, infrequent, short term release events of fugitive CSG contaminants to air have been appraised as known hazards that pose a low hazard potential to human health at the study site.

Research results - physical factors

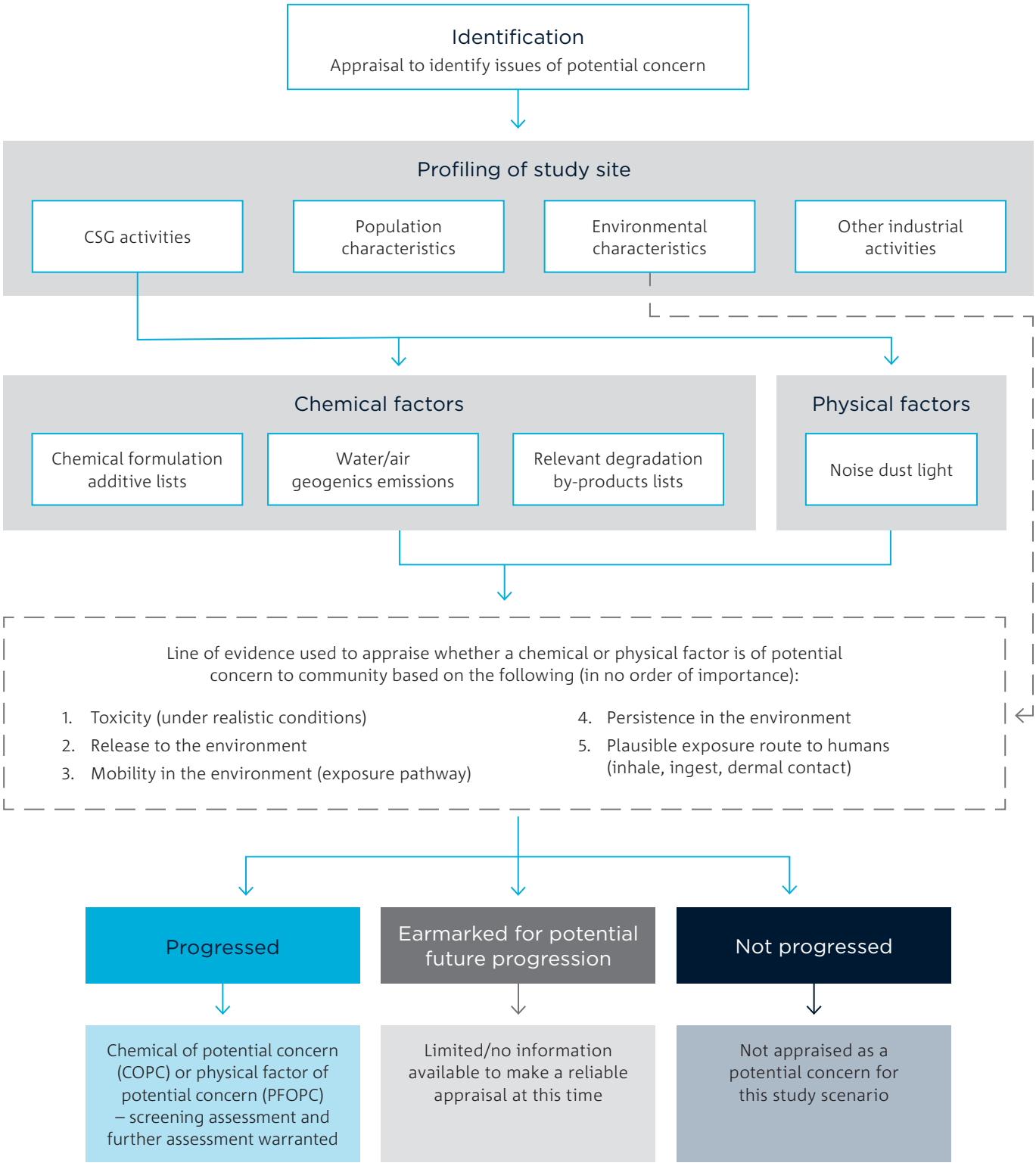
Dust

Infrequent occurrences of high levels of airborne particulate matter were the most common cause of observed exceedances of National and Queensland state air quality objectives reported in monitoring studies in the Surat Basin.

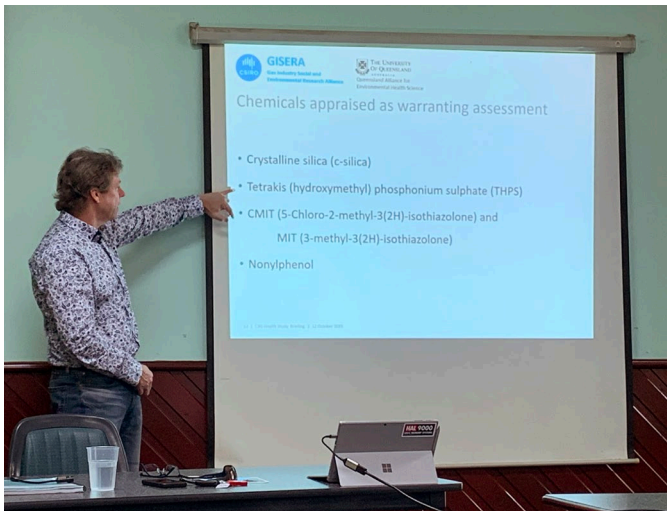
In most cases these events were attributable to soil dust from CSG industry activities including vehicle movements and construction activities, (Lawson et al., 2018 a,b,c, Dunne et al., 2020) with additional contributions from smoke and other rural activities that re-entrain dust.

Based on these assessments, dust emissions from the CSG industry are known hazards that occasionally exceed air quality standards at the study site.

A CSG well site undergoing hydraulic fracturing operations.



Hazard Identification process applied for the current study (Rigby et al., 2021).



Presenting study findings to the Local Stakeholder Reference Group in Chinchilla.

Noise and light

CSG activities generate noise and light through the operation of plant and equipment and flares. These noise and light sources may be transient and of short duration (drilling or hydraulic fracturing activities, operation of flares), or continuous (water treatment and gas processing facilities).

The noise levels of continuous sources at the Surat Basin study site, if maintained within the conditions of Environmental Authorities, have been appraised to be below levels that could cause harm.

Light pollution was considered to have inherently low hazard potential to human health, from a physical perspective.

The nuisance value or impacts on social stress of noise and light emissions were out of scope for this study.

Local Stakeholder Reference Group

The research team recognised the importance of having community and local stakeholder involvement throughout the project so that local perspectives could be integrated into the project design, planning, and decision making.

A Local Stakeholder Reference Group (LSRG) was therefore established for the project. The main purpose of the group was to bring community perspectives, values and local knowledge into the research process.

Group members comprised those local stakeholders interested in health in relation to CSG development at the local level.

All eleven members were residents from the local government region and included landowners, local business owners, a local indigenous group, and a representative each from the regional health sector and the local regional council.

Limitations of the study

This study was specifically designed to determine whether any of the factors identified as potential hazards warrant further assessment on impacts to human health at the study site.

This study relied on industry and government data that was collected in a variety of ways, and were not collected specifically for health study purposes. Data collected by industry and government primarily reflects operational management and environmental protection data requirements. These limitations are most evident in the quality of data for drilling additives and their composition.

While regulatory requirements make the reporting of detailed composition data from hydraulic fracturing fluids mandatory, there are no such requirements for well drilling additives in the study area.

Next steps

CSIRO's GISERA has approved two new related research projects to provide a comprehensive analysis of the eight groups of chemical factors identified as warranting further assessment.

Based on the available evidence, none of these chemicals represent an acute hazard to human health in the study site.

The *Exposure assessment of identified chemicals used in CSG activities* research project will assess the seven chemical factors that have a potential exposure pathway via surface water, infiltration and ground water. This research will involve a comprehensive field sampling campaign.

The *Analysis of Dust Near CSG Sites to Assess Potential for Respirable Crystalline Silica* will assess the potential contribution of silica dust from CSG activities. This research will involve a comprehensive field sampling campaign that will also include areas that have no CSG development.

Both projects will take 18 to 24 months to complete and are expected to start in early 2023.

More information

Read the final report

Learn about the project

Find out more about other GISERA projects in Queensland

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