GROUND AND SURFACE WATERS

GISERA | Gas Industry Social and Environmental Research Alliance

Baseline studies and microbial degradation experiments of chemicals used in coal seam gas activities in Narrabri

CSIRO scientists have completed a project to establish baseline data and investigate microbial degradation of chemicals used in coal seam gas (CSG) activities in the soils, groundwater and surface waters of the Narrabri region of New South Wales.

Key points

- This project was established to gather microbial and chemical baseline data from aquifers, surface waters and soil in in the Narrabri Gas Project area.
- Researchers collected samples from around 52 sites across the region in November 2022 and June 2023.
- The study provides the most comprehensive baseline data set to date, including the first insights into fungal diversity in non-cropping soils and surface water.
- Researchers also assessed the ability of microbial communities to degrade chemicals commonly used in CSG activities.
- The project builds on previous CSIRO research into microbial communities in South Australia and the Northern Territory.
- Most chemicals tested degraded completely in groundwaters, surface waters and soils of the region.

Banner image: CSIRO scientist collecting water samples.

This project, conducted through CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA), improves understanding of soil, surface water and groundwater microbiology in the Narrabri region.

Establishing baseline data is an important step that allows for ongoing environmental monitoring and reduces uncertainty around potential impacts of CSG activities on water and soil quality.

The research also extends CSIRO's growing body of knowledge of microbial degradation processes, especially in relation to the degradation of CSG chemicals likely to be used in the Narrabri region.

This project generated comprehensive microbial and chemical baseline data on groundwater, surface water and soil samples for the Narrabri Gas Project (NGP) area, with some samples also taken outside its boundaries.

Sample collection was carried out at 14 groundwater, 16 surface water and 32 soil locations. A total of 54 groundwater, 52 surface water and 99 soil samples were collected across two sampling campaigns in November 2022 and June 2023.

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 | tamboran Resources | Empire Energy

Addressing community concerns

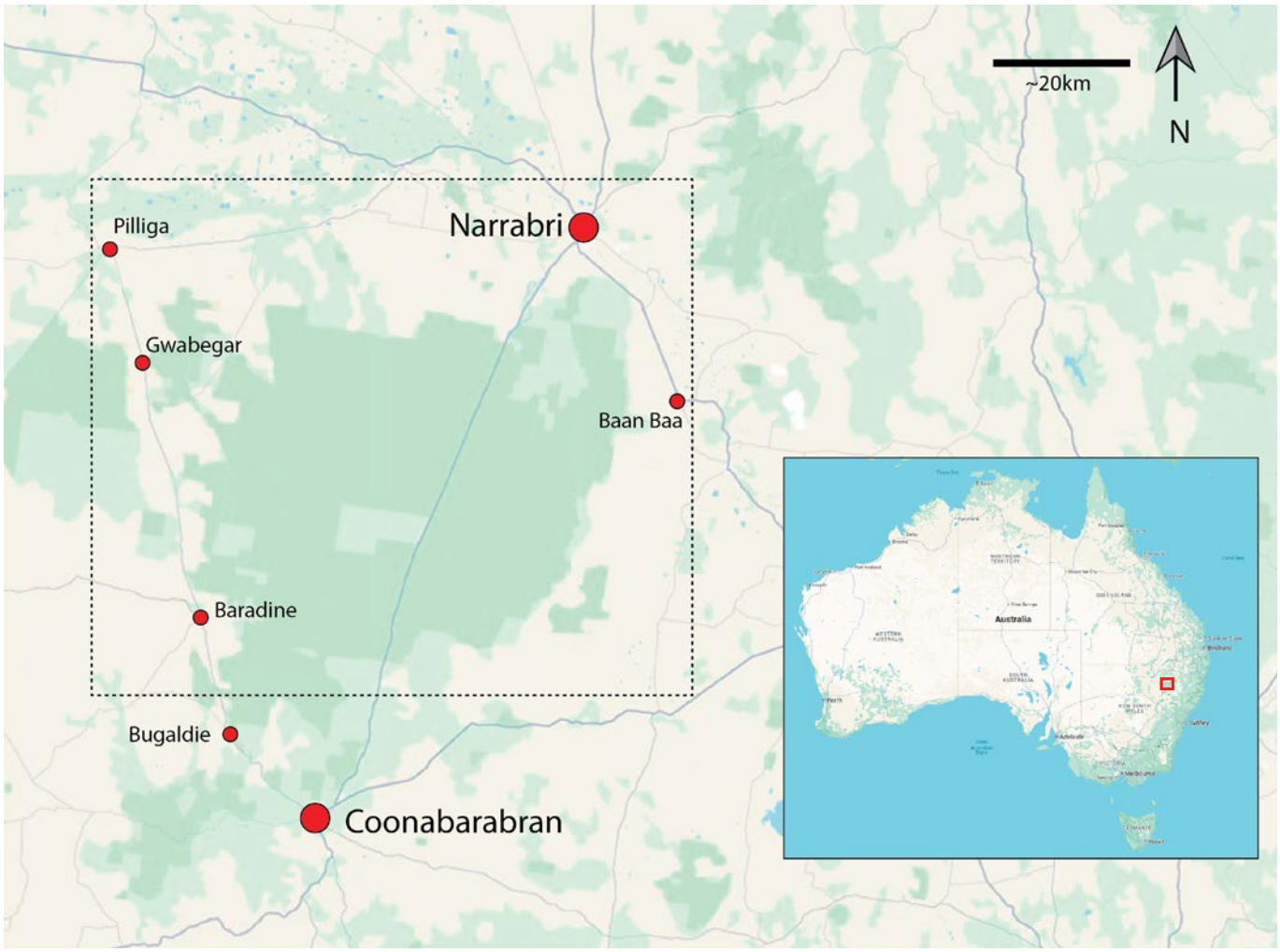
The Narrabri Shire, in north-west NSW, covers approximately 13,000 square kilometres and is home to around 13,000 people. It is primarily a grazing and farming region, with irrigated cotton the main high-value crop. Regionally important aquifers, including the Namoi Alluvium Aquifer and the Pilliga Sandstone Aquifer, hold significant cultural, environmental and economic values.

In 2020, NSW Independent Planning Commission approved the Santos NGP. The NGP focuses on extracting CSG from targets in the Gunnedah Basin.

The local community is concerned about potential environmental impacts, particularly to groundwater resources.

A specific concern relates to the potential for accidental spills of chemicals used by CSG companies in drilling, workover and other activities. These chemicals include surfactants, biocides, and corrosion inhibitors.

As part of broader efforts to reduce uncertainty about potential environmental impacts, CSIRO scientists have established microbial and chemical baselines, and assessed the capacity of microbial communities to degrade a range of CSG chemicals likely to be used in the region.



Dotted line shows the soils, groundwater and surface water sampling area.

Research methods

This project generated comprehensive microbial and chemical baseline data on groundwater, surface water and soil samples for the NGP, with some samples also taken outside its boundaries.

Researchers sampled mainly sandy soils, although some agriculturally important clay soils were also included for comparison.

Although 52 sites were studied across two sampling trips, flooding and property access issues limited some samples to a single time point.

For the investigation into chemical degradation, the project focused on chemicals of 'higher hazard potential' with regards to their hazards to human or environmental health.

The chemicals studied were:

- **alcohol ethoxylates mixtures** (surfactant; used as detergents, cleaning agents, emulsifiers and wetting agents in industrial processes)
- **hydrocarbon mixtures** (surfactant; used in well workovers)
- **monoethanolamine** (surfactant; used in personal care products and detergents, textile and pharmaceutical applications, and in gas treatment processes to remove acidic gases such as carbon dioxide and hydrogen sulphide)
- **dazomet** (biocide; used as a soil fumigant in horticulture, golf courses, garden nurseries and turf businesses).
- **glutaraldehyde** (biocide; mostly used in hospitals and other medical settings to sterilize surgical instruments).
- **3'3'-methylenebis(5-methyloxazolidine)** (biocide; used to preserve water-based paints and cooling lubricants, and as a hydrogen sulphide 'scavenger' in oil and gas processing).

These chemicals were incubated in soil microcosms for four weeks and in surface water and groundwater microcosms for three months.

Key findings: microbial communities

The project delivered critical insights into the Narrabri region's groundwater, surface water and soil microbiomes.

Across the 14 groundwater sites, almost 6,000 prokaryotic species (single-celled organisms including bacteria and archaea) were found, with relatively low biodiversity in individual samples.

In contrast, the 16 surface waters had over 24,000 species, averaging around 5,100 species per sample. Soils had the highest biodiversity, with almost 38,000 species comprising over 1,000 unique genera.

Importantly, the project delivered new information about fungal diversity in non-cropping soils and surface waters. Fungal communities, particularly soil fungi, play an essential role in ecosystems. They contribute to nutrient cycling, support plant growth, and serve as a food source for small marsupials, even in nutrient-poor environments.

The soil fungal microbiomes in the region were diverse: across the soils studied, 2,846 distinct fungal species were detected, representing around 270 described fungal genera.

Many of these appeared to be novel ectomycorrhizal species: fungi that form beneficial symbiotic relationships with plants that improves nutrient uptake and allowing vegetation to thrive in nutrient-poor soils.

The study's findings offer a foundational understanding of fungal diversity in the region and its broader ecological significance.

Soil sampling site: Newell Highway

Key findings: microbial degradation of CSG-related chemicals

Another key finding from the project was that most chemicals tested degraded completely in groundwaters, surface waters and soils of the region.

Faster degradation occurred in soils than in groundwaters though some chemicals, particularly the alcohol ethoxylates mixtures, persisted in the groundwaters and trace amounts of these same compounds persisted in soils.

The inclusion of surface water sampling in this study yielded important new information about the ability of surface water microbial communities to also completely degrade most chemicals tested.

The study identified numerous microorganisms in groundwaters, surface waters and soils that are likely capable of degrading chemicals in the environment. These microbial communities offer an additional line of defence against environmental contaminants in the unlikely event of a spill.

A number of taxa were also identified that were sensitive to chemical additions in these environments. Such taxa may be useful targets for environmental monitoring programs.

The results of this Narrabri-based project build on the results of previous CSIRO studies conducted in South Australia and the Northern Territory. Researchers in these other studies also observed that microbial communities degrade chemicals used in CSG production activities – quite rapidly in soils and more slowly in groundwater.

More information

Read more about this project

Learn about other GISERA research in NSW

Find out about other CSIRO microbial degradation studies in South Australia and the Northern Territory

Water sampling site: Tullamullen Creek

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