Ambient air quality in the Surat Basin

Knowledge transfer session

Dr Sarah Lawson | 4 September 2018
Co-authors

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Background:

- CSIRO-led study - first comprehensive air monitoring study in coal seam gas region of Australia
- Based in the Chinchilla-Miles-Condamine area of Surat Basin, South West Queensland
- Monitoring component (3 years) and modelling component
  - Real time monitoring - 5 ambient sites (2015 onwards)
  - Passive gas monitoring - 10 sites (2014 – 2016)
- Driven by community concern about airborne pollutants
  - Community discussions
- Focus on transparency of project outputs
Review of CSG emission characteristics to determine pollutants, monitoring sites

• Identified CSG-related infrastructure and processes - gas plants, water treatment facilities, compressor stations, wells, flares, gathering networks

• Reviewed water and gas composition, radiological survey data (Origin Energy)

CSG production in study area is a likely source of nitrogen oxides, carbon monoxide, carbon dioxide, methane, VOCs (including small hydrocarbons, BTEX, aldehydes and ketones), and particles
CSG composition data available

Appendix A.1 – Measurements of CSG-related sources and emissions
A.1.1.1 Talinga February 2010
A.1.1.2 Talinga August 2013
A.1.2 Talinga GPF gas composition and WTF water composition
A.1.2.1 June 2011
A.1.2.2 Nov 2013
A.1.3 Emissions Monitoring: Talinga gas combustion emissions
A.1.3.1 May 2014
A.1.3.2 Sep 2015 VOC and aldehyde emissions
A.1.3.3 Sep 2015
A.1.4 Orana and Talinga wellhead gas and water composition
A.1.4.1 Talinga April 2014
A.1.4.2 Orana February 2016
A.1.4.3 Orana March 2016
A.1.4.4 Orana May 2016
A.1.4.5 Orana July 2016

Study area and monitoring sites

3 gas field stations (15-25 wells within 2 km, gas plant within 1-3 km)
2 regional background stations (GISERA regional methane flux project sites)
10 passive gas monitoring sites
Pollutants measured - monitoring stations

- Nitrogen oxides (NO\textsubscript{x})
- Carbon monoxide (CO)
- Ozone (O\textsubscript{3})
- PM\textsubscript{2.5}, PM\textsubscript{10}, TSP
- Methane (CH\textsubscript{4})
- Carbon dioxide (CO\textsubscript{2})

Meteorology

- Ecotech/CSIRO oversight and approval of final data set
- CSIRO method comparison for PM\textsubscript{10}, PM\textsubscript{2.5}
Live data streaming to DES website

- Data can be compared to air quality objectives and other regions at a glance
- Maximum transparency for concerned community
Passive gas measurements

• 54 speciated gases - VOCs (BTEX), aldehydes, hydrogen sulphide
• gas field, regional and Chinchilla
• 10 sites for 16 months (fortnightly)
• SGS Leeder / CSIRO method validation

Subsequent passive gas monitoring reported from these and other sites (2016-2017) as part of GISERA Impacts of hydraulic fracturing project
Air monitoring stations: air quality objectives

- Measurements compared to
  - Environment Protection (Air) Policy (EPP 2008)
  - Ambient Air NEPM (2016)
  - TSP Nuisance Dust Guidelines (NZ Ministry for the Environment 2016) - DES
- CO, NO₂, O₃ within air quality objectives (all sites)
- Occasional exceedance of 24 hour average air quality objectives for PM₂.₅, PM₁₀ and TSP at gas field sites
- Exceedances over entire study:
  - PM₁₀  3 (0 - 1 per site per year)
  - PM₂.₅  7 (0 - 2 per site per year)
  - TSP     18 (0 - 4 per site per year)
Investigating sources of exceedances

Exceedances (28) and near exceedances (48) (>80% of air quality objective) investigated using a qualitative protocol:

• combination of wind speed and direction, identification of emission sources upwind and comparing measured and published pollutant ratios
  - CH$_4$/CO$_2$ - emissions associated with cattle farming, PM$_{2.5}$/CO and CO$_2$/CO - smoke from vegetation fires

• Aim was to identify main source/s which increase concentration above typical levels, not all sources

• It was sometimes not possible to identify source/s
Identified likely main source of PM$_{2.5}$ 24 h average exceedances

![Bar chart showing PM$_{2.5}$ exceedances at Hopeland, Miles Airport, and Condamine]
Identified likely main sources of PM$_{10}$ 24 h average exceedances

- Dust (unknown source)
- Smoke and dust (from roads/CSG activities, regional dust, unknown)

‘Unknown’ likely airborne soil but source challenging to determine
Identified likely main sources of TSP 24 h average exceedances

- Dust (unknown source)
- Dust from cattle farming and unknown source
- Dust from cattle farming
- Dust from roads/CSG activities, regional dust
- Smoke and dust (from roads/CSG activities, regional dust, unknown)
- Smoke

‘Unknown’ likely airborne soil but source challenging to determine

Number of TSP events

- Hopeland exceedances
- Miles Airport exceedances
- Condamine exceedances
Methane

- CSG in study area is ~98% methane – trace level VOCs. No AQ objective – included as tracer
- Background concentration at gas fields broadly similar to regional sites - peaks above background.
- 30 largest gas field methane events identified and investigated – mostly CSG related – none coincided with AQ exceedance for other pollutants (PM, CO, NO₂, O₃).

Investigation of regional methane emissions addressed in GISERA Regional methane flux project
Passive gas results

- Measurements compared to annual objectives
  - Queensland Environmental Protection (Air) Policy (EPP), 2008
  - Texas Commission on Environmental Quality Air Monitoring Comparison Values and Effects Screening Levels (2016).
- Pollutant levels were consistently well below air quality objectives
- Detection limits generally tens to hundreds of times lower than the relevant ambient air quality objectives
Passive sampler results – commonly detected gases

- Of 54 gases targeted, 31 gases measured above detection limit in one or more sample, 23 gases never detected (including hydrogen sulphide)
- Highest number of detects at Chinchilla township site
- Most commonly detected gases:
  - Benzene, toluene, xylenes (BTX) (~90% of Chinchilla samples, ~30% of gas field and regional samples)
  - Formaldehyde, acetaldehyde (90-100% of all samples)
  - Carbon tetrachloride (100% of samples)
The EPP (air) objective for benzene is 3 ppbv

The EPP (air) objective for toluene is 100 ppbv

The EPP (air) objective for xylenes is 200 ppbv
Ratios of benzene/toluene from woodsmoke/fire, vehicle exhaust, urban and rural areas

- Woodheater smoke (EA 2002)
- Tasmania 2006 (rural bushfire)
- Ovens, VIC, 2006/2008 (woodsmoke)
- Manjimup, WA, 2006/2007 (woodsmoke)
- Launceston, TAS, 2003 (woodsmoke)
- Vehicle exhaust (Duffy et al 1999)
- Melbourne In-Traffic, 1997 (traffic)
- Melbourne In-Traffic, 1990 (traffic)
- Melbourne In-Traffic, 1983/84 (traffic)
- Perth In-Traffic, 1993/1994 (traffic)
- Melbourne (Torre at al 2000)
- Sydney urban fringe (Linfoot et al 1998)
- Launceston, TAS, 2003 (Urban)
- Chinchilla (this study)
- Aspendale, VIC, 2003/2004 (Urban)
- Randwick, NSW, 2007 (Urban)
- Melbourne, 2008/2009 (Urban)
- Darwin, 2007/2008 (Urban)
- Westmead, NSW, 2012 (Urban)
- Bringelly, NSW, 2007 (Urban fringe)
- Burrup, WA, 2004/2008 (Rural)
- Wagga Wagga, NSW, 2008 (Rural)

Chinchilla ratio is typical of other urban/residential environments
BTX: this study compared to other sites

- This study Regional
- This study Gas-Field
- This study Chinchilla
- Brisbane 2015
- Melbourne 2008-2009
- Sydney fringe 2007
- Ovens VIC 2006 - 2007
- Cape Grim Tas 2006, 2015
Other commonly detected gas concentrations compared to other sites

![Graph showing gas concentrations comparison](chart.png)
Air quality modelling

• Simulating emission, transport and reaction of gases and aerosol (12 months)
• Emissions inventory – includes all CSG and non-CSG emission sources
• Will investigate impact of CSG emissions to total air pollutant levels over 900 m²
Conclusion and next steps

• Air pollutants generally well below air quality objectives (occasional 24-hr av exceedances of TSP, PM$_{10}$, PM$_{2.5}$)
• Most PM exceedances likely due to sources typical of rural regions (fires, wind blown dust, vehicles on unsealed roads, agriculture)
• CSG influence on exceedance/near exceedance events limited to coarse particle events (TSP, PM$_{10}$)
• VOC levels typical of other rural regions in Australia
• Real time air quality data – high transparency
• Data useful for health, other environmental studies, validating model output
• Study design potentially useful in other unconventional gas regions
• Monitoring at Hopeland, Miles Airport and Tara Region likely until end of year (industry funding) – outside scope of this project