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Submission #317

Synthesis of evidence regarding potential health and wellbeing risks associated with unconventional gas mining in the NT

Presentation for the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory August 1, 2017

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We acknowledge the Traditional Custodians of the Land on which we meet, and pay respects to Elders past and present…

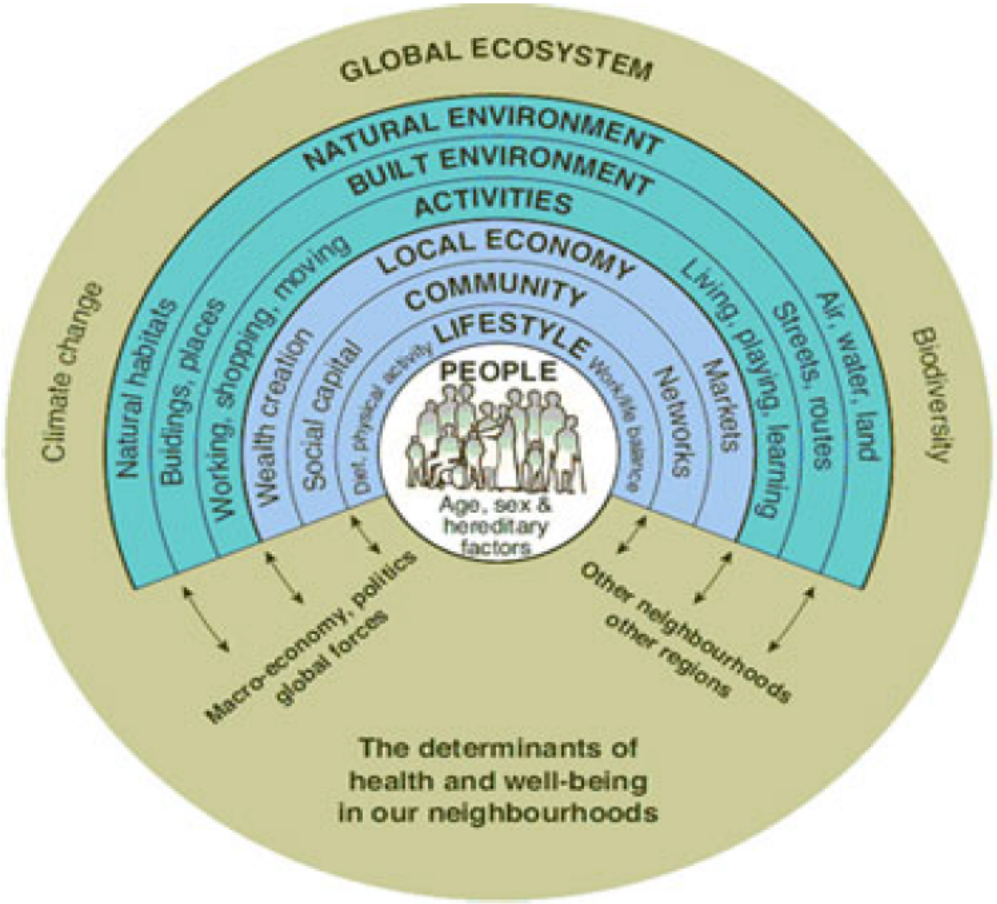
... and reflect that for at least 65,000 years these custodians sustained health and life all over this continent of extremes through intimate knowledge, connection and protection of environmental values.

This Presentation will:

- Highlight some important insights needed for deeper understanding of health and wellbeing risks for those who would have to deal with this complex issue
- Emphasise the interconnectedness of all issues as public health impacts, across time, place and generation
- Offer some reflection on the approach taken in the Inquiry and Report
- Consider ethics and to what extent unconventional gas mining is likely to help close the gap in the NT – can we envision ourselves as stewards and ancestors for the quality of life of current and future generations

The Environmental Determinants of **Health** --- Good health depends on a working and living environment conducive to both physical & mental health, including:

Doctors for the Environment Australia



- ***Clean air***
- ***Water safety and security***
- ***Secure supply of nutritious, safe & affordable food***
- ***Stable and safe climate***
- ***Meaningful livelihood***
- ***Resilient and cohesive communities***

http://www.local.gov.uk/web/guest/health/-/journal_content/56/10180/3511260/ARTICLE

Human health risk assessment is…

A process of estimating the potential impact of a chemical, biological, physical or social hazard on a specified human population or ecological system under a specific set of conditions and for a certain time frame'

- *enHealth, 2012*

Expectation of life at birth in years for Indigenous people and the total population, by sex, selected jurisdictions, Australia, 2010-2012

Population	Males	Females
Indigenous		
Australia (unadjusted)	67.4	72.3
Australia (headline)	69.1	73.7
NSW	70.5	74.6
Qld	68.7	74.4
WA	65.0	70.2
NT	63.4	68.7
Total population		
Australia (unadjusted)	79.8	83.2
Australia (headline)	79.7	83.1

Note:

1. This table includes two estimates for Australia. The 'headline' estimate includes adjustments based on Australia-wide census-related information. The headline estimates should be used in all situations except those requiring comparisons with the estimates for the states and territories, for which Australia-wide information could not be applied. The unadjusted Australian estimate should be used in situations requiring such a comparison.
2. The Australian Indigenous estimates are based on deaths in all states and territories

Source: ABS, 2015

Quick Rundown on some notable studies not captured in the Interim Report

The peer reviewed literature on health impacts is very young but growing fast.

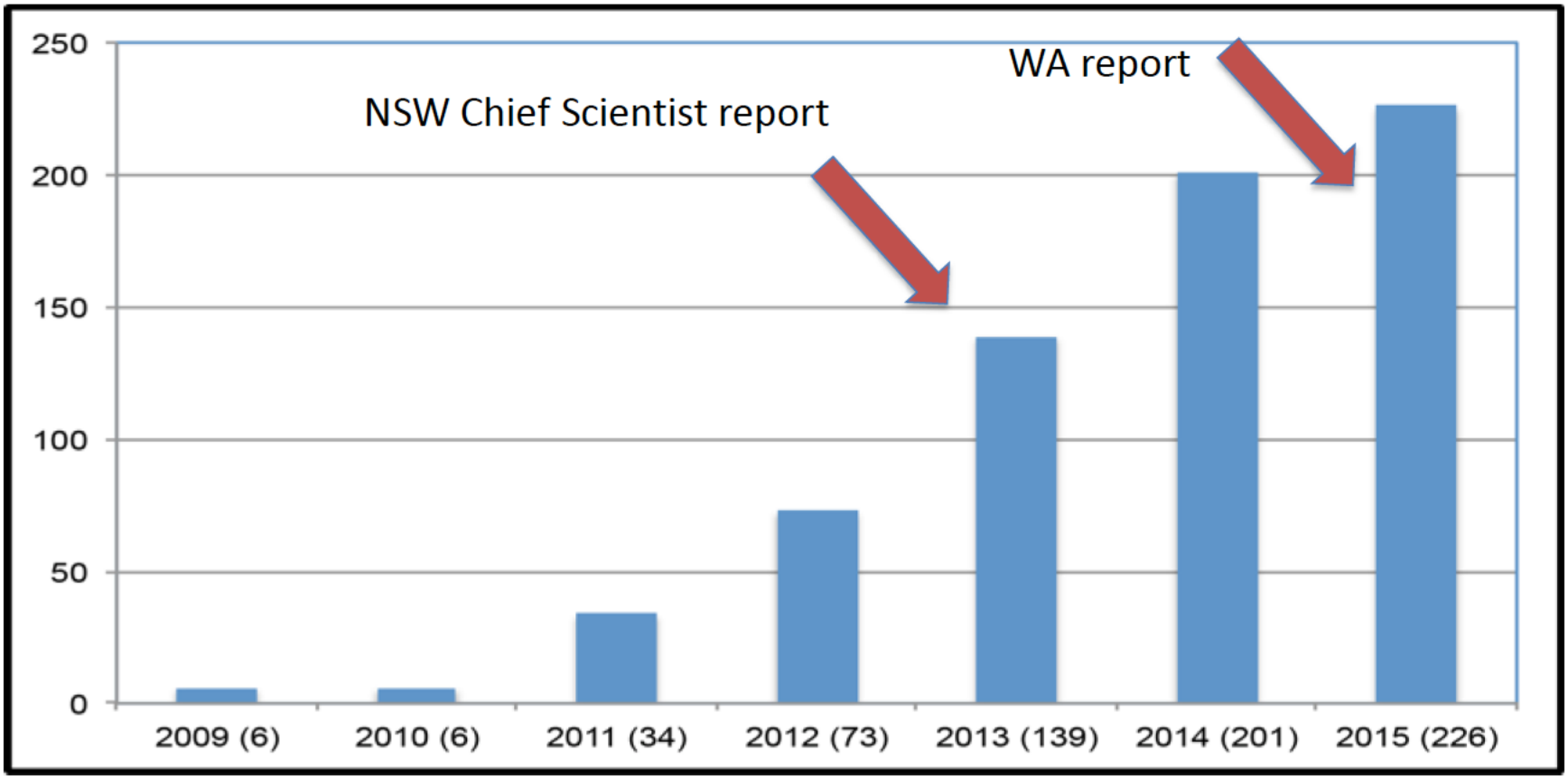


Figure taken from Hays & Shenkoff (2016), Towards an understanding of the environmental and public health impacts of unconventional gas development: a categorical assessment of the peer-reviewed scientific literature, 2009-2015. PLOS One http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0154164

Air pollution is an under-recognised but important health risk for workers and people near operations (*some pollutants can travel far)

- Methane
- Volatile organic compounds, BTEX
- NOx, Hydrogen Sulfide, Formaldehyde
- Diesel fumes, Particulate Matter*, fine silica
- Ground level Ozone*
- Endocrine disrupting chemicals

DOI 10.1515/reveh-2014-0002 — Rev Environ Health 2014; aop

David Brown*, Beth Weinberger, Celia Lewis and Heather Bonaparte

Understanding exposure from natural gas drilling puts current air standards to the test

Recent and projected growth in the oil and gas production sector has underscored the need for EPA to gain a better understanding of emissions and potential risks from this industry sector. Harmful pollutants emitted from this industry include air toxics such as benzene, toluene, ethylbenzene, and xylene; criteria pollutants and ozone precursors such as NO_x and VOCs; and greenhouse gases such as methane. These pollutants can result in serious health impacts such as cancer, respiratory disease, aggravation of respiratory illnesses, and premature death. However, EPA has limited directly-measured air emissions data on criteria and toxic air pollutants for several important oil and gas production processes. [These] limited data, coupled with poor quality and insufficient emission factors and incomplete NEI data, hamper EPA's ability to assess air quality impacts from selected oil and gas production activities.

– US Environmental Protection Agency (EPA) Office of Inspector General (1)

There have been some significant new studies

- New diesel fuel exposure study
- New ground level ozone study
- New noise study

See the USB stick.

Psycho-social and economic impacts

These are well captured in some of the report chapters so will not detail, except to show some data from Queensland where CSG mining has progressed rapidly.

Stresses are clear and undeniable.

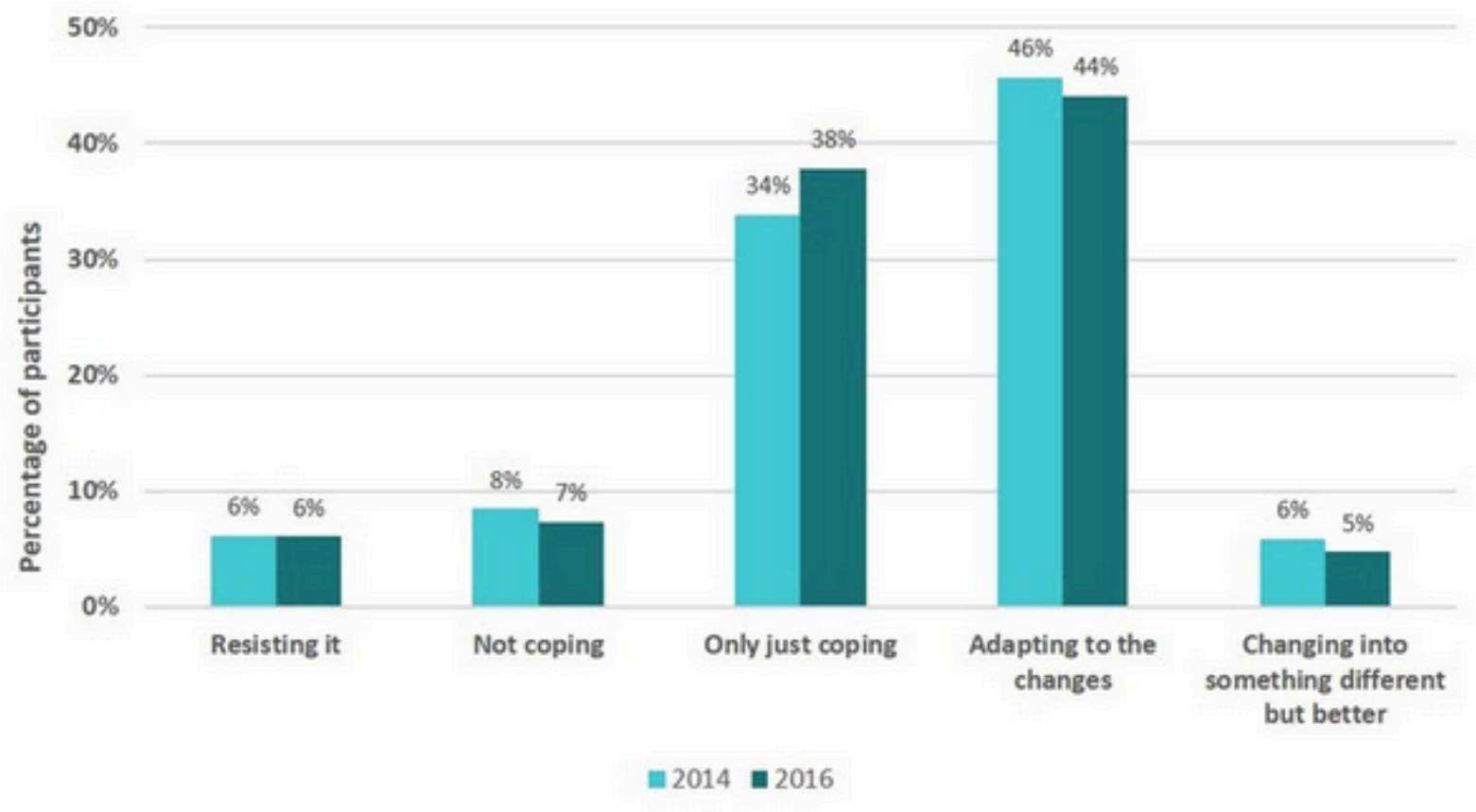
These factors can contribute to reduced mental health, and increase the risk of depression and anxiety, that can also contribute to other physical health problems.

CSIRO survey of Community Wellbeing and responding to change:

Western Downs region in Queensland

Andrea Walton, Rod McCrea and Rosemary Leonard September 2014 followup in 2016

When asked about how they saw their communities responding to change, only half (49%) thought their communities were "adapting to changes" or "changing into something different but better", which is similar to how residents viewed their communities back in 2014.



Community perceptions of adapting to CSG development. Note: Differences between 2014 and 2016 were not significantly different. CSIRO

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep

Fracked: Coal seam gas extraction and farmers' mental health

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University of New England, Armidale, Australia

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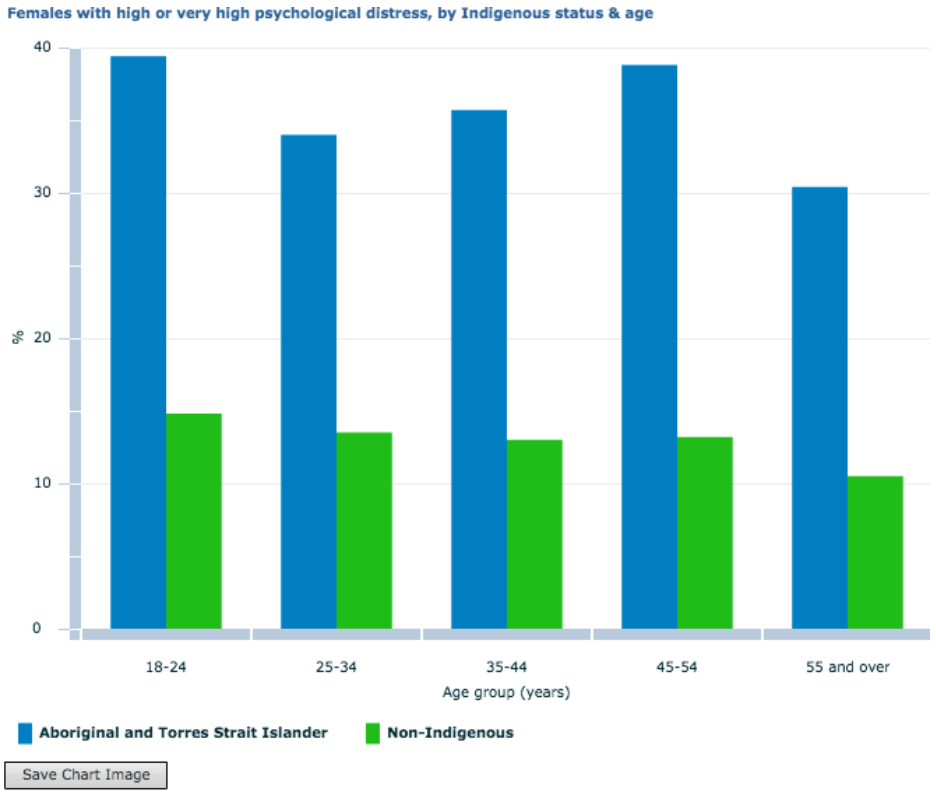
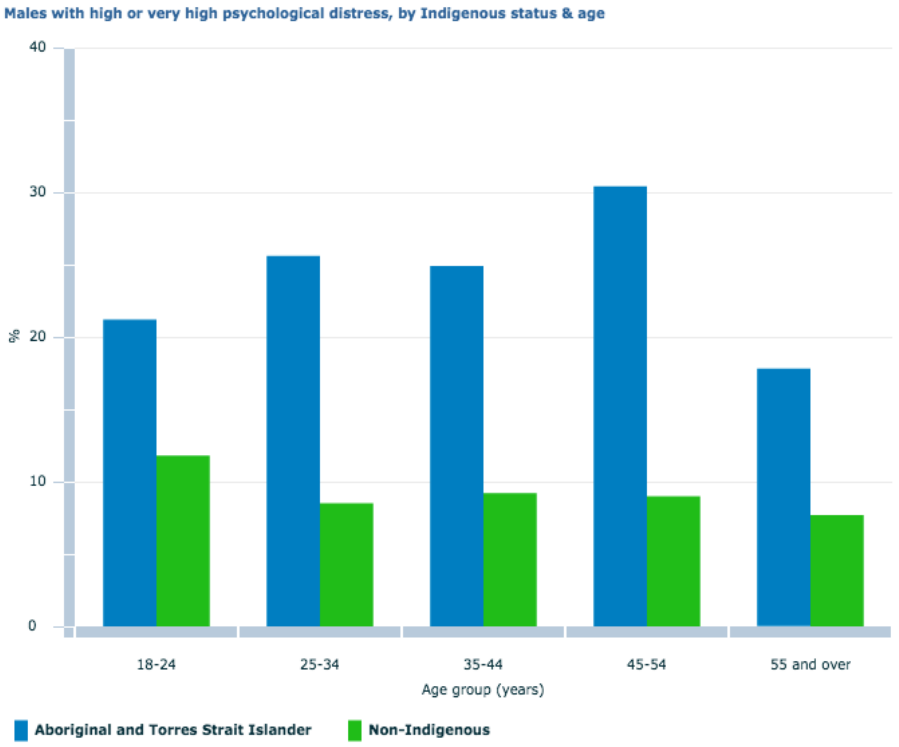
Mental health

ABSTRACT

Farmers are exposed to a unique range of vocational stressors, and while mental health morbidity is similar to their non-rural counterparts, suicide rates in the farming community are higher. We examined the contribution of coal seam gas (CSG) extraction to the global stress burden and mental health of 378 Australian farmers (mean age = 53.08 years; *SD* = 10.28). Exploratory factor analysis revealed that CSG items added two unique dimensions to the Edinburgh Farming Stress Inventory (EFSI): Off-Farm CSG Concerns (concerns about possible impacts of CSG extraction on human health, communities, and the environment) and On-Farm CSG Concerns (potential CSG impacts on farm profitability, disruption of farm operations, and privacy). Subscales based on the new factors correlated significantly with farmers' self-reported levels of depression, anxiety and stress reactivity, as assessed by the DASS-21. Latent profile analysis categorized farmers into four distinct segments based on their overall stress profiles: *Non-Stressed* (39%), *Finance-Stressed* (31%), *CSG-Stressed* (15%) and *Globally-Stressed* (15%). Farmers in the *CSG-Stressed* and *Globally-Stressed* profiles exhibited clinically significant levels of psychological morbidity. This information can be used to inform strategies for improving mental health outcomes in the agri-gasfields of Australia.

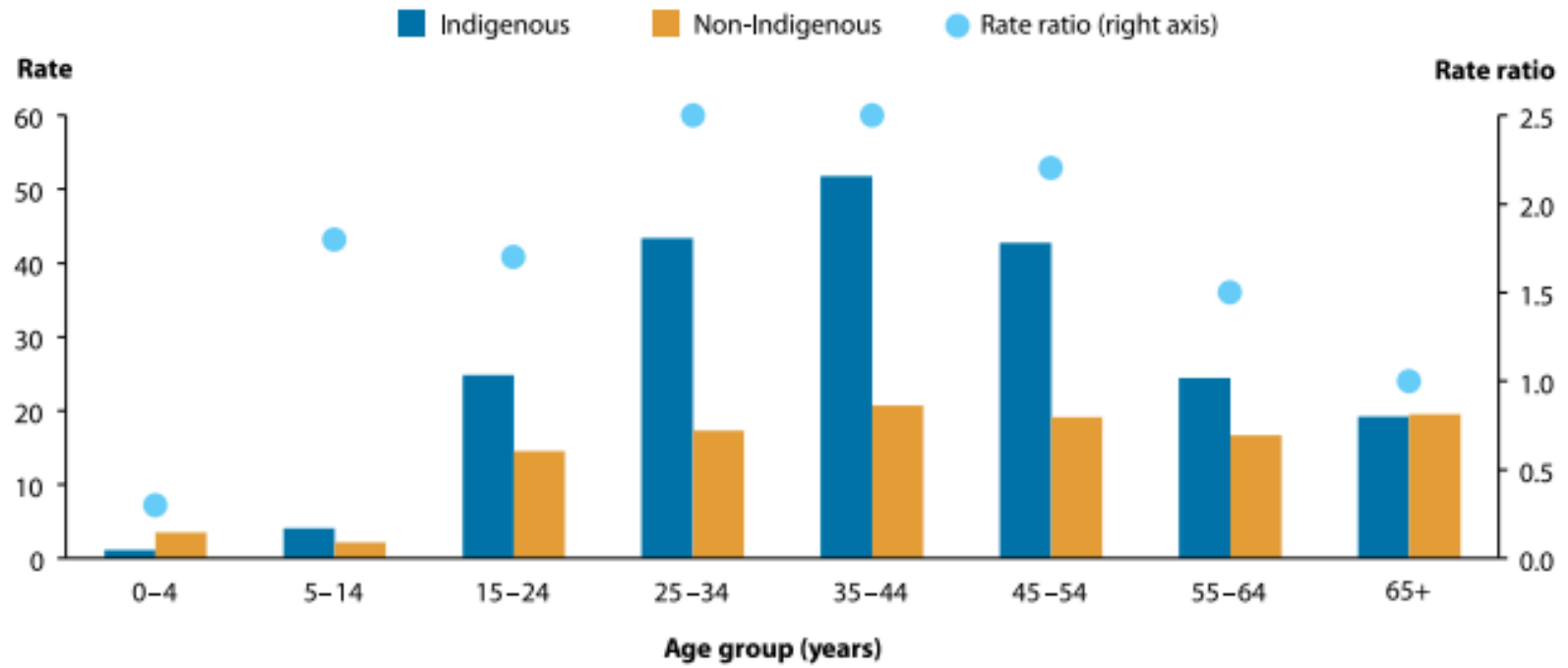
High distress levels among Aboriginal people particularly common among females across the age groups





Source(s): 2012-13 Australian Aboriginal and Torres Strait Islander Health Survey and 2011-12 Australian Health Survey

Mental health conditions across the lifespan



Notes

1. Rates are expressed per 1,000 population.
2 Data for this figure are shown in Table S5.7.

Source: AIHW National Hospital Morbidity Database.

Figure 5.4: Age-specific hospitalisation rates for mental health-related conditions, by Indigenous status, 2012–13

Studies reporting associations between unconventional gas developments and negative human health impacts

Increased hospitalisation rates in postcodes associated with density of wells

Cardiology inpatient prevalence rates were significantly associated with number of wells per zip code ($p < 0.00096$) and wells per km^2 ($p < 0.00096$) while neurology inpatient prevalence rates were significantly associated with wells per km^2 ($p < 0.00096$). Furthermore, evidence also supported an association between well density and inpatient prevalence rates for the medical categories of dermatology, neurology, oncology, and urology. (Abstract)

Jemielita T. et al. (2015) Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates. PLoS ONE 10(7): e0131093.doi:10.1371/journal.pone.0131093

Hospitalisation rates for Aboriginal people in the NT are already very high

Numbers of hospital separations and age-standardised separation rates, by Indigenous status and jurisdiction, and Indigenous:non-Indigenous rate ratios, NSW, Vic, Qld, WA, SA and the NT, 2013-14

Jurisdiction	Aboriginal and Torres Strait Islander		Non-Indigenous		Rate ratio
	Number	Rate	Number	Rate	
NSW	83,576	553	2,787,756	353	1.6
Vic	21,166	653	2,467,512	403	1.6
Qld	99,956	795	1,971,174	418	1.9
WA	85,801	1,554	984,598	394	3.9
SA	23,816	927	701,798	378	2.5
NT	86,536	1,874	37,297	319	5.9
Australia	408,165	896	9,294,139	384	2.3

Notes:
1. Rates per 1,000 population
2. Non-Indigenous rates and numbers include separations for which Indigenous status was not stated
3. Rate ratio is the Indigenous rate divided by the non-Indigenous rate
4. Numbers and rates for the NT are for public hospitals only; separate numbers and rates are not included for Tas or the ACT, but included in totals where applicable
5. The incomplete identification of Indigenous status means that these figures probably under-estimate the true difference between Indigenous and non-Indigenous rates

Source: AIHW, 2015

Newest study in JAMA: exacerbation of asthma attacks assoc with well activity

JAMA Intern Med. 2016 Jul 18. doi: 10.1001/jamainternmed.2016.2436. [Epub ahead of print]

Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations.

Rasmussen SG[1], Ogburn EL[2], McCormack M[3], Casey JA[4], Bandeen-Roche K[2], Mercer DG[5], Schwartz BS[6].

Key Points

Question Is there an association between unconventional natural gas development (UNGD) and asthma exacerbations?

Findings In this nested case-control study of 35 508 patients with asthma, those in the highest quartile of residential UNGD activity had significantly higher odds of 3 types of asthma exacerbations (new oral corticosteroid medication orders, emergency department visits, and hospitalizations) than those in the lowest quartile.

Meaning UNGD activity near patient residences was associated with increased odds of mild, moderate, and severe asthma exacerbations.

Table 2. Associations of Unconventional Natural Gas Development Activity Metrics and Asthma Outcomes[a]

Activity Metric[b]	Odds Ratio (95% CI)		
	Asthma Hospitalizations	Asthma Emergency Department Visits	OCS Orders
Pad			
Low	1.26 (1.06-1.50)	1.53 (1.06-2.23)	1.54 (1.37-1.74)
Medium	1.37 (1.15-1.64)	1.77 (1.2-2.6)	1.66 (1.47-1.87)
High	1.45 (1.21-1.73)	1.37 (0.94-1.99)	1.59 (1.41-1.81)
Spud			
Low	1.16 (0.98-1.37)	1.53 (1.06-2.21)	1.45 (1.29-1.63)
Medium	1.26 (1.05-1.50)	1.54 (1.04-2.27)	1.98 (1.75-2.24)
High	1.64 (1.38-1.97)	1.57 (1.08-2.29)	1.99 (1.75-2.26)
Stimulation			
Low	1.13 (0.96-1.33)	1.51 (1.05-2.19)	1.23 (1.09-1.39)
Medium	1.31 (1.10-1.57)	1.74 (1.17-2.61)	2.22 (1.95-2.53)
High	1.66 (1.38-1.98)	1.71 (1.16-2.52)	3.00 (2.60-3.45)
Production			
Low	1.10 (0.92-1.30)	1.47 (1.01-2.14)	1.28 (1.13-1.46)
Medium	1.16 (0.97-1.38)	1.10 (0.74-1.65)	2.15 (1.87-2.47)
High	1.74 (1.45-2.09)	2.19 (1.47-3.25)	4.43 (3.75-5.22)

Abbreviation: OCS, oral corticosteroid.

[a] Multilevel models with a random intercept for patient and community were adjusted for age category (5-12, 13-18, 19-44, 45-61, 62-74, ≥75 years), sex (male or female), race/ethnicity (white, black, Hispanic, or other), family history of asthma (yes vs no), smoking status (never, former, current, or missing), season (spring, March 22–June 21; summer, June 22–September 21; fall, September 22–December 21; winter, December 22–March 21), Medical Assistance (yes vs no), overweight/obesity status (normal, body mass index [BMI], <85th percentile for children or <25 for adults; overweight, BMI, 85th to <95th percentile for children or 25 to <30 for adults; obese, BMI, ≥95th percentile for children or ≥30 for adults; or BMI missing), type 2 diabetes (yes vs no), community socioeconomic deprivation (across quartiles), distance to nearest major and minor arterial road (truncated at the 98th percentile, measured in meters, *z* transformed), squared distance to nearest major and minor arterial road (truncated at the 98th percentile, measured in meters, *z* transformed), maximum temperature on the day prior to event (measured in degrees Celsius), and squared maximum temperature on the day prior to event (measured in degrees Celsius).

[b] For all activity metrics, very low activity was the reference group.

Asthma is already a very serious issue for Aboriginal people

RESPIRATORY AND SLEEP HEALTH IN INDIGENOUS AUSTRALIANS .

Report of:
Thoracic Society of Australia and New Zealand and
Australasian Sleep Association
Australian Lung Foundation

Working Party: Rob Pierce (Convenor)
Ral Antic
Anne Chang
Mark Howard
Alan James
Graeme Maguire
Anthony Matthiesson
Bill Musk
Robert Roseby
Graham Simpson
Paul Torzillo

TSANZ working group: Christine Jenkins
Peter Wark

Summary points

COPD and asthma

- COPD is recognised as one of the four most common chronic diseases (after cardiovascular disease, diabetes and renal disease). COPD affects approximately 20% of indigenous people nation-wide but the prevalence is higher in remote communities
- The significantly higher prevalence of COPD and rate of hospital admission (separation rate for indigenous people is 5 times that of other Australians) translates to a higher mortality from this condition (rate ratio 2.8)
- The overall prevalence of asthma in indigenous people is 16.5 (95% CI 14.9–18.1) which is higher than in other Australians at 10.2 (95%CI 9.7–10.7).
- Asthma morbidity is higher in indigenous people, with higher hospital separation and hospitalisation days for all age groups. The hospital separation rate for asthma was 2.1-fold higher in indigenous people
- Indigenous people are 3.2 times more likely to die from asthma (age-specific mortality)

Other research has found living nearer wells associated with:

- Higher frequencies of self-reported symptoms such as migraines, nasal and sinus problems and fatigue
- Higher frequencies and average number of skin and upper respiratory symptoms
- A new study provides a new level of rigour to these cross sectional studies, uses a case control design and finds a doubling of risk of migraine and sinus disorders among those living near operations.

Associations between Unconventional Natural Gas Development and Nasal and Sinus, Migraine Headache, and Fatigue Symptoms in Pennsylvania

Aaron W. Tustin,[1] Annemarie G. Hirsch,[2] Sara G. Rasmussen,[1] Joan A. Casey,[3] Karen Bandeen-Roche,[4] and Brian S. Schwartz[1,2,5]

[1]Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA; [2]Center for Health Research, Geisinger Health System, Danville, Pennsylvania, USA; [3]Robert Wood Johnson Health and Society Scholars Program, University of California, San Francisco, San Francisco and University of California, Berkeley, Berkeley, California, USA; [4]Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA; [5]Department of Medicine, Johns Hopkins School of Medicine, Baltimore, Maryland, USA

BACKGROUND: Unconventional natural gas development (UNGD) produces environmental contaminants and psychosocial stressors. Despite these concerns, few studies have evaluated the health effects of UNGD.

OBJECTIVES: We investigated associations between UNGD activity and symptoms in a cross-sectional study in Pennsylvania.

METHODS: We mailed a self-administered questionnaire to 23,700 adult patients of the Geisinger Clinic. Using standardized and validated questionnaire items, we identified respondents with chronic rhinosinusitis (CRS), migraine headache, and fatigue symptoms. We created a summary UNGD activity metric that incorporated well phase, location, total depth, daily gas production and inverse distance–squared to patient residences. We used logistic regression, weighted for sampling and response rates, to assess associations between quartiles of UNGD activity and outcomes, both alone and in combination.

RESULTS: The response rate was 33%. Of 7,785 study participants, 1,850 (24%) had current CRS symptoms, 1,765 (23%) had migraine headache, and 1,930 (25%) had higher levels of fatigue. Among individuals who met criteria for two or more outcomes, adjusted odds ratios for the highest quartile of UNGD activity compared with the lowest were [OR (95% CI)] 1.49 (0.78, 2.85) for CRS plus migraine, 1.88 (1.08, 3.25) for CRS plus fatigue, 1.95 (1.18, 3.21) for migraine plus fatigue, and 1.84 (1.08, 3.14) for all three outcomes together. Significant associations were also present in some models of single outcomes.

CONCLUSIONS: This study provides evidence that UNGD is associated with nasal and sinus, migraine headache, and fatigue symptoms in a general population representative sample.

CITATION: Tustin AW, Hirsch AG, Rasmussen SG, Casey JA, Bandeen-Roche K, Schwartz BS. 2017. Associations between unconventional natural gas development and nasal and sinus, migraine headache, and fatigue symptoms in Pennsylvania. Environ Health Perspect 125:189–197; http://dx.doi.org/10.1289/EHP281

large economic costs, and possible links to environmental risk factors through chemical toxicity, irritation, odors, or stress (Hastan et al. 2011; Bhattacharyya 2009; Shashy et al. 2004; Tan et al. 2013; Friedman and De ver Dye 2009; Sjöstrand et al. 2010; Bell et al. 1998; Griffith and Zarrouf 2008; Ranjith 2005; Ricci et al. 2007). The purpose of this study was to test the null hypothesis that UNGD is not associated with these three outcomes. To do so, we performed a case–control analysis in which we compared individuals having one or more of these health outcomes with selected participants having no or minimal evidence of these diseases.

Methods

Study Overview

In early 2014, we performed a cross-sectional survey of primary care patients of the Geisinger Clinic. Information was gathered via a questionnaire designed to study general chronic rhinosinusitis (CRS)

Address correspondence to B.S. Schwartz, Johns

Some considerations regarding local jobs

CHAPTER 7

Occupational Health and Safety Aspects of Oil and Gas Extraction

Eric J. Esswein*, **, Kyla Retzer, Bradley King**, Margaret Cook-Shimanek†**
*University of the Witswatersrand, School of Public Health, Johannesburg, South Africa; **National Institute for Occupational Safety and Health (NIOSH), Western States Division, Denver, CO, USA; †University of Colorado at Denver and Health Sciences Center, Denver, CO, USA

Chapter Outline

Silicosis and exposure to various chemicals in the vicinity are serious, understudied occupational health concerns

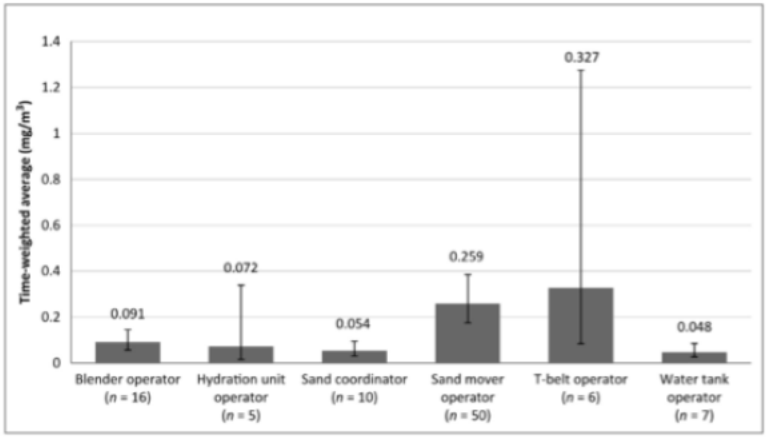
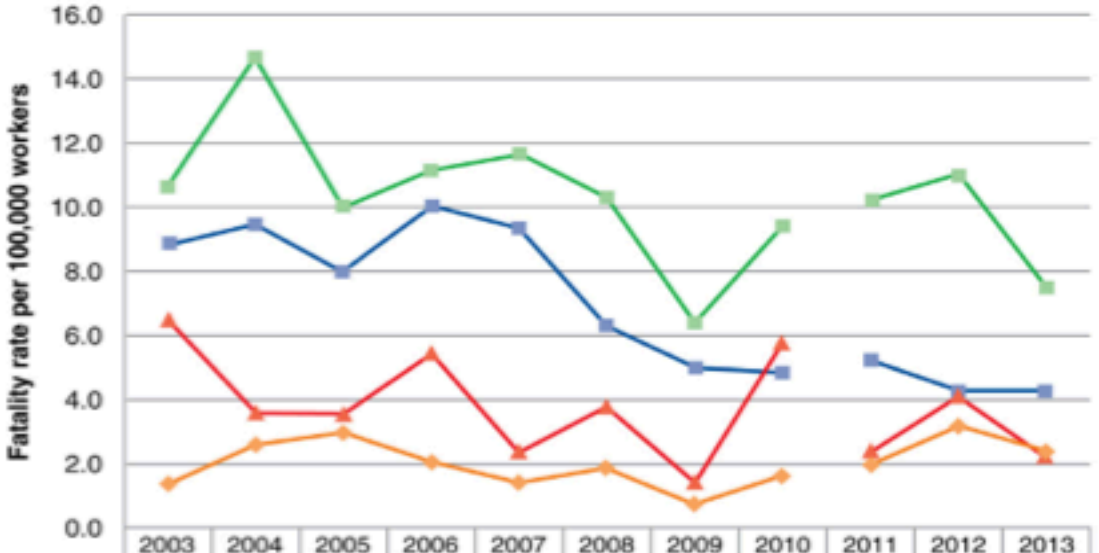


FIGURE 7.3
Respirable crystalline silica, time-weighted average geometric means (mg/m³) and 95% confidence intervals for 6 job titles of workers conducting hydraulic fracturing operations.
Source: Esswein et al. (2013).

Fatality rate in Oil & Gas Workers Seven x Higher than national average



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Transportation	10.59	14.66	10.05	11.15	11.69	10.29	6.40	9.43	10.21	11.01	7.50
Contact with objects/equipment	8.88	9.45	7.98	10.11	9.35	6.30	4.98	4.83	5.21	4.26	4.26
Fires/explosions	6.49	3.58	3.55	5.44	2.34	3.78	1.42	5.75	2.40	4.08	2.22
Falls	1.37	2.61	2.96	2.07	1.40	1.89	0.71	1.61	2.00	3.19	2.39

FIGURE 7.1
US O&G extraction worker fatality rates, leading causes of death, 2003–2013.
The break in 2011 represents revisions in the coding system. *Sources: National Institute for Occupational Safety and Health (NIOSH), using data from Bureau of Labor Statistics Census of Fatal Occupational Injuries and Quarterly Census of Employment and Wages.*

Northern Territory already has a problem with road traffic accidents and fatalities

24.21 ROAD TRAFFIC FATALITIES

	2009			2010		
	no.	per 100,000 persons(a)	per 10,000 motor vehicles registered(b)	no.	per 100,000 persons(a)	per 10,000 motor vehicles registered(b)
New South Wales	453	6.35	0.71	421	5.82	0.63
Victoria	290	5.32	0.51	288	5.19	0.49
Queensland	331	7.48	0.71	249	5.51	0.51
South Australia	119	7.33	0.80	118	7.17	0.68
Western Australia	190	8.45	0.77	193	8.40	0.79
Tasmania	63	12.52	1.30	61	6.11	0.54
Northern Territory	31	13.71	1.79	49	21.33	2.88
Australian Capital Territory	12	3.40	0.34	18	5.02	0.46
Australia	**1 489**	**6.78**	**0.69**	**1 367**	**6.12**	**0.61**

(a) Estimated resident population at 30 June.

(b) Number of registered motor vehicles and motor cycles (excludes tractors, caravans, plant and equipment) at 31 March.

Source: Department of Infrastructure and Transport.

Increased traffic accident rates associated with shale gas drilling in Pennsylvania

Added By	hays452
Item Type	Journal Article
Title	Increased traffic accident rates associated with shale gas drilling in Pennsylvania
Author	Graham, Jove
Author	Irving, Jennifer
Author	Tang, Xiaoqin
Author	Sellers, Stephen
Author	Crisp, Joshua
Author	Horwitz, Daniel
Author	Muehlenbachs, Lucija
Author	Krupnick, Alan
Author	Carey, David
Abstract	AbstractObjectives We examined the association between shale gas drilling and motor vehicle accident rates in Pennsylvania. Methods Using publicly available data on all reported vehicle crashes in Pennsylvania, we compared accident rates in counties with and without shale gas drilling, in periods with and without intermittent drilling (using data from 2005 to 2012). Counties with drilling were matched to non-drilling counties with similar population and traffic in the pre-drilling period. Results Heavily drilled counties in the north experienced 15–23% higher vehicle crash rates in 2010–2012 and 61–65% higher heavy truck crash rates in 2011–2012 than control counties. We estimated 5–23% increases in crash rates when comparing months with drilling and months without, but did not find significant effects on fatalities and major injury crashes. Heavily drilled counties in the southwest showed 45–47% higher rates of fatal and major injury crashes in 2012 than control counties, but monthly comparisons of drilling activity showed no significant differences associated with drilling. Conclusions Vehicle accident have measurably increased in conjunction with shale gas drilling.
Publication	Accident Analysis & Prevention
Volume	74
Pages	203–209
Date	January 2015
Journal Abbr	Accident Analysis & Prevention
DOI	10.1016/j.aap.2014.11.003

Age-standardised death rates, by Indigenous status, and Indigenous:non-Indigenous rate ratios, NSW, Qld, WA, SA and the NT, 2009-2013

Jurisdiction	Indigenous rate	Non-Indigenous rate	Rate ratio
NSW	804	585	1.4
Qld	964	590	1.6
WA	1,323	552	2.2
SA	818	611	1.3
NT	1,461	612	2.4
NSW, Qld, WA, SA and the NT	985	585	1.7

Notes:
1. Rates per 100,000 are directly age-standardised using the 2001 Australia estimated resident population
2. Rate ratio is the Indigenous rate divided by the non-Indigenous rate
3. Due to the incomplete identification of Indigenous status, these figures probably under-estimate the true difference between Indigenous and non-Indigenous rates

Source: AIHW, 2015

Median age at death, by Indigenous status and sex, NSW, Qld, WA, SA and the NT, 2014

Jurisdiction	Indigenous		Non-Indigenous	
	Male	Female	Male	Female
NSW	57.7	64.1	79.0	85.3
Qld	57.4	62.8	77.7	84.4
WA	49.9	60.0	77.9	84.5
SA	56.5	60.5	80.3	85.8
NT	53.4	57.5	68.3	71.3
NSW, Qld, WA, SA and the NT	55.4	61.5	78.6	85.0

Notes:
1. Information is not available for the other jurisdictions because of the relatively small numbers of deaths
2. Median age of death is the age below which 50% of deaths occur

Source: ABS, 2015

Recommend a serious look at the types of other jobs created

- Fast food outlets?
- Alcohol outlets?

Numbers and rates of the leading causes of Aboriginal and Torres Strait Islander deaths and Indigenous:non-Indigenous rate ratios, NSW, Qld, WA, SA and the NT, 2013

Cause of death	Number	Rate	Rate ratio
Coronary heart disease	321	127	1.6
Diabetes mellitus	202	90	6.0
Chronic lower respiratory disease	148	65	2.4
Lung cancer	140	56	1.8
Suicide	138	24	2.2
Cirrhosis and other liver diseases	124	31	4.7
Cerebrovascular disease	122	67	1.6
Land transport accidents	72	13	2.4
Diseases of the urinary system	66	35	3.1
Certain conditions originating in the perinatal period	60	5.5	2.3

Notes:
1. See source for the ICD codes for the causes of death
2. Rates are deaths per 100,000, standardised to the Australian 2001 Estimated Resident Population
3. Rate ratio is the Indigenous rate divided by the non-Indigenous rate (not shown)

Source: ABS, 2015

Some considerations of birth outcome studies so far and their implications for the NT

What about fetuses, infants and kids? Consider:

During gestation

- Exquisite sensitivity to developmental processes and signals in the uterine environment
- Evidence of air pollution (PM2.5) on birth weight

And infancy and childhood

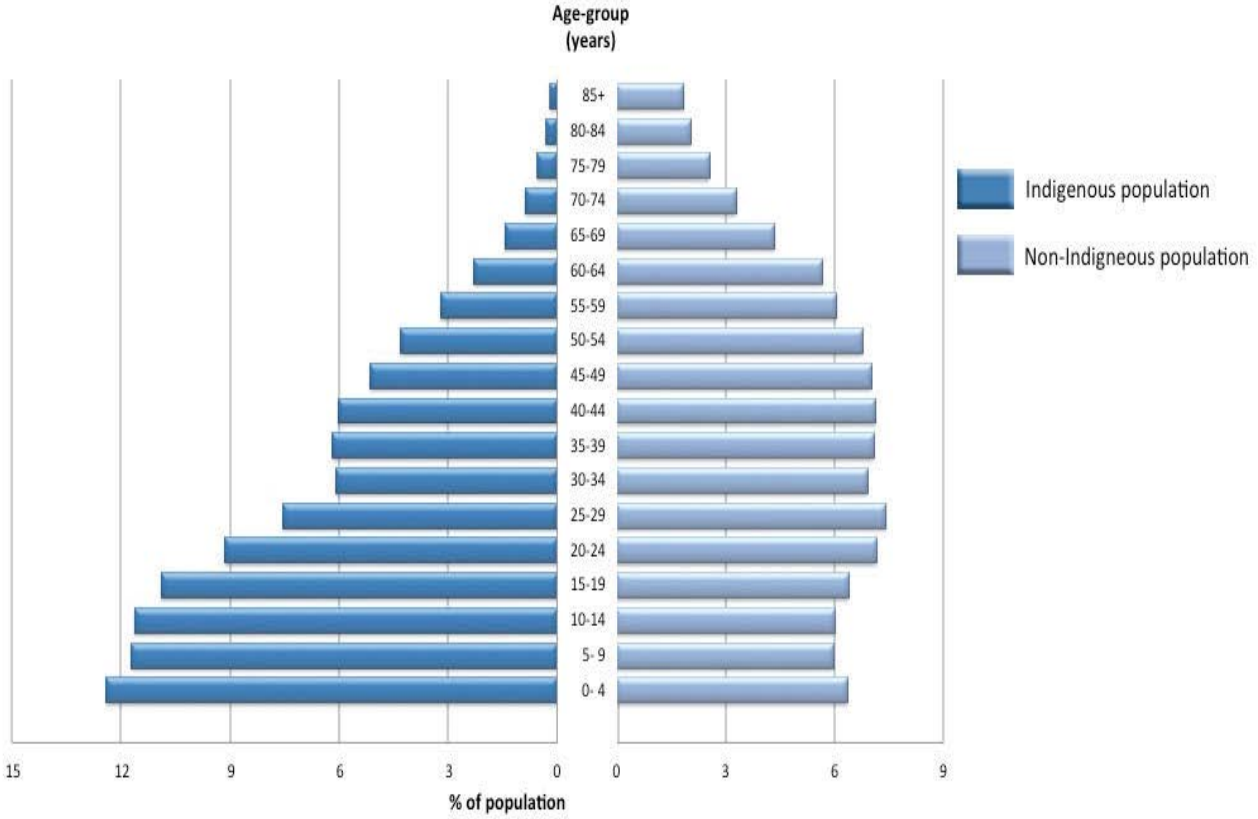
- High metabolic rate
- Small body size for intake
- Developing organs, including the liver, lungs, kidney
- Playing and running in the environment

And all three groups

- High vulnerability to psycho-social and community stressors, including noise, others' negative emotions and witnessing conflict

Much higher proportion of Aboriginal people are infants and children

(data from 30 June 2011)



- Source: ABS, 2012

What studies have been done?

- Very few, **Roughly** about 12 publications have specifically focused on risks and impacts to fetuses, infants and children

- Most on potential exposures to chemicals with developmental and/or reproductive toxicity and endocrine disruption

- Very few on health outcomes, despite huge grey literature and social media communication

Three published studies reporting negative birth outcomes linked to well proximity and/or density

Lower mean birth weight and higher frequency of small for gestational age (OR 1.34 (95% CL 1.10-1.63))

- Stacy SL, Brink LL, Larkin JC, Sadovsky Y, Golstein, BD, Pitt EO, et al. Perinatal outcomes and unconventional natural gas operations in Southwest Pennsylvania. PLoS ONE. 2015; 10:e0126425 doi: 10.1371/journal.pone.0126425

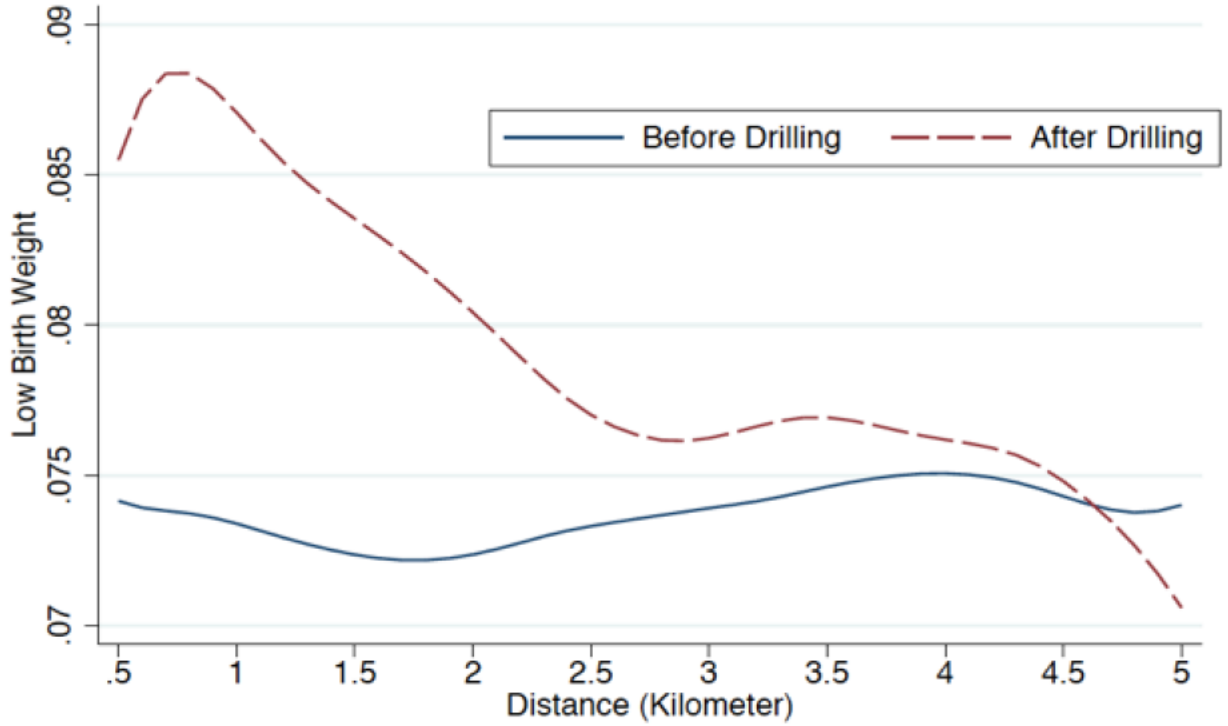
Preterm birth (OR 1.4(95% CL 1.0-1.9) & high risk pregnancy (OR 1.3 (95% CL 1.1-1.7)

- Casey JA, Savitz DA, Rasmussen SG, Ogburn EL, Pollak J, Mercer DG, et al. Unconventional natural gas development and birth outcomes in Pennsylvania, USA. Epidemiology 2016; 163-172.

Birth defects (congenital heart defects (OR 1.3 (95%CL 1.2-1.5)), neural tube defects (OR 2.0, (95% CL 1.0-3.9)) but slightly higher birth weight nearer wells

- McKenzie LM, Guo R, Witter RZ, Savitz DA, Newman LS, Adgate JL. Birth outcomes and maternal residential proximity to natural gas development in rural Colorado. Environmental Health Perspectives 2014; 122(4): 412-417.

Reduced birthweights associated with closeness to wells (avg reduction of 48.5g) (increased % of low birth weight) (Hill, 2012)



Results from a local polynomial regressions (bandwidth=0.1 km) of low birth weight on distance from closest well's future/current location. Source: Author calculations from Pennsylvania Department of Health Vital Statistics.

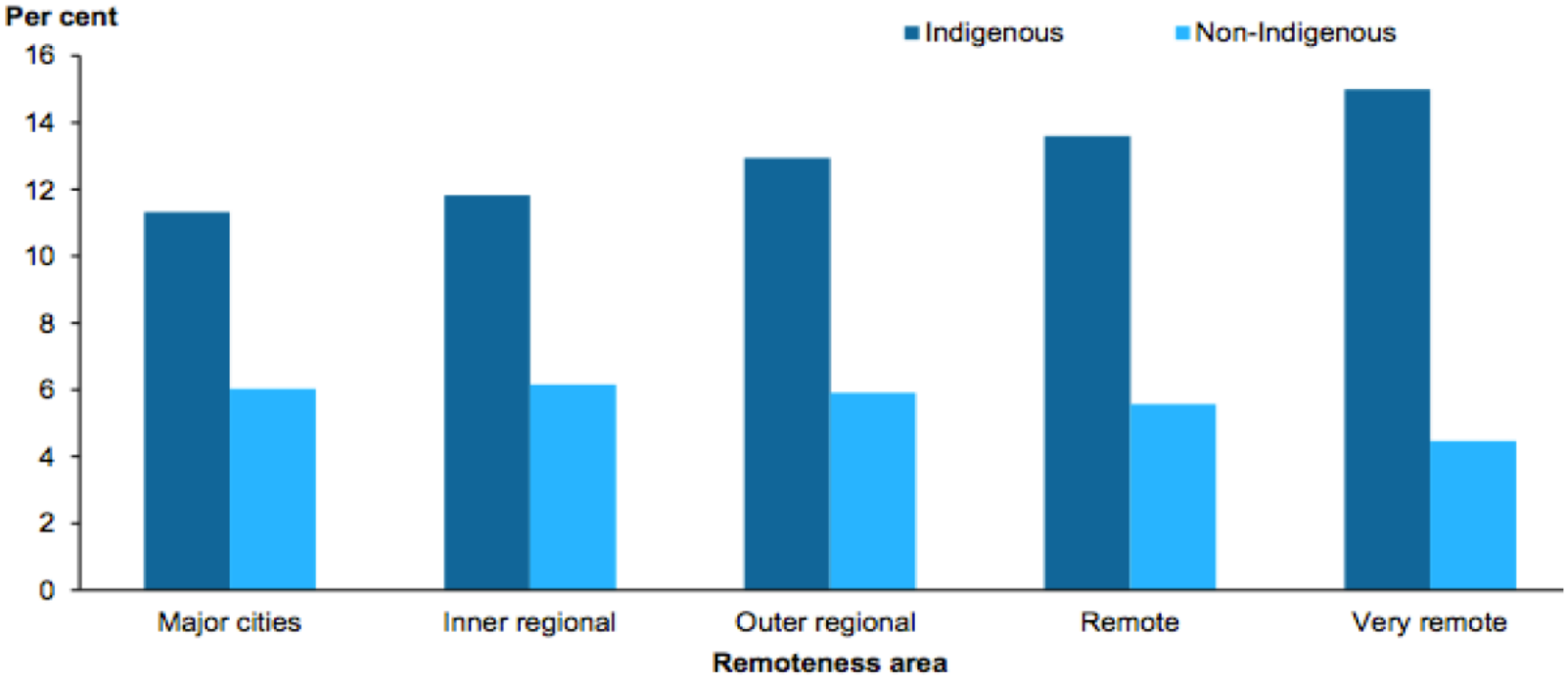
http://dyson.cornell.edu/research/researchpdf/wp/2012/Cornell-Dyson-wp1212.pdf

Why should we protect Aboriginal people from an industry that may impact on birth weight and complications?

- Newborns of Indigenous mothers were twice as likely to be low birthweight (12.6% [15.6% in NT] vs 6.0%); or 2.5x higher excluding twins+ (11.2% vs 4.2%) in 2011
- Average birthweight of single Indigenous babies was 191g lower (3,215g vs 3,406 g); and 3,089g for all babies in NT
- Low birthweight is linked to higher death rates, higher chronic diseases, inhibited growth and cognitive development
- 36% of all babies born in NT were of Indigenous mothers, much higher proportion born in remote areas than non-Indigenous mothers (more likely to be urban based)

- Australian Institute of Health and Welfare 2014. Birthweight of babies born to Indigenous mothers. Cat. no. IHW 138. Canberra: AIHW.

Low Birthweight already particularly common among infants of Aboriginal mothers in Remote Areas



Note: Data for this figure are shown in Appendix Table C4.6.

Source: AIHW National Perinatal Data Collection.

Figure 4.7: Liveborn low birthweight babies, by Indigenous status of the mother and remoteness, 2011

Infant mortality rates, by Indigenous status and sex, and Indigenous:non-Indigenous rate ratios, NSW, Qld, SA, WA and the NT, 2012-2014

Jurisdiction	Indigenous		Non-Indigenous		Rate ratio	
	Males	Females	Males	Females	Males	Females
NSW	4.6	4.2	3.7	3.1	1.2	1.4
Qld	6.7	5.5	4.1	4.1	1.6	1.3
WA	5.8	4.4	2.1	2.1	2.8	2.1
SA	9.0	6.0	3.0	2.4	3.0	2.5
NT	13	12	3.1	4.2	4.1	2.9
All jurisdictions	6.5	5.5	3.5	3.2	1.9	1.7

Notes:
1. Infant mortality rate is the number of infant deaths per 1,000 live births
2. Rate ratio is the Indigenous rate divided by the non-Indigenous rate
3. The Indigenous rates are likely to be under-estimated, due to the incomplete identification of Indigenous status on births and deaths records
4. Due to the small number of deaths registered in Vic, Tas and the ACT, these jurisdictions have been excluded

Source: Derived from ABS, 2015

Numbers and rates of the leading causes of Aboriginal and Torres Strait Islander deaths and Indigenous:non-Indigenous rate ratios, NSW, Qld, WA, SA and the NT, 2013

Cause of death	Number	Rate	Rate ratio
Coronary heart disease	321	127	1.6
Diabetes mellitus	202	90	6.0
Chronic lower respiratory disease	148	65	2.4
Lung cancer	140	56	1.8
Suicide	138	24	2.2
Cirrhosis and other liver diseases	124	31	4.7
Cerebrovascular disease	122	67	1.6
Land transport accidents	72	13	2.4
Diseases of the urinary system	66	35	3.1
Certain conditions originating in the perinatal period	60	5.5	2.3

Notes:
1. See source for the ICD codes for the causes of death
2. Rates are deaths per 100,000, standardised to the Australian 2001 Estimated Resident Population
3. Rate ratio is the Indigenous rate divided by the non-Indigenous rate (not shown)

Source: ABS, 2015

Concerns about Climate Change

The climate advantage of Unconventional gas remains highly controversial –
there is much we don't know.

To proceed without clear knowledge is a very big health risk.

GHG emissions → Climate Change = a significant human health risk

- Underestimated potency of fugitive methane emissions during drilling, production and transportation adding to, not protecting against, climate change and its health consequences
- Accidents like Aliso Canyon can release huge quantities of methane in a single event
- Modelling (and our experience) indicates unconventional gas mining is competing with, not bridging to, renewables

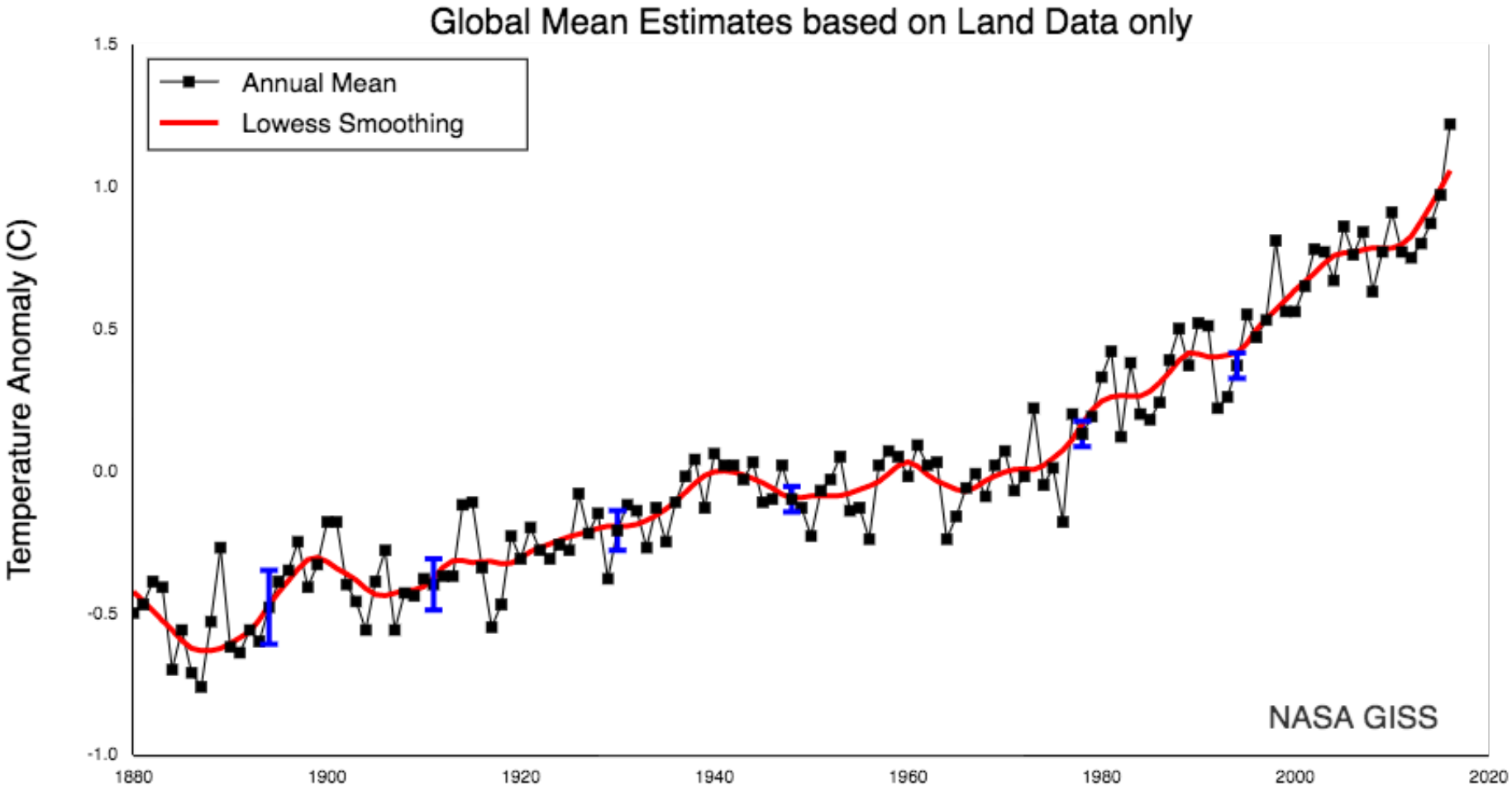
A review of current and future methane emissions from Australian unconventional oil and gas production

October 2016

Dimitri Lafleur - PhD student, Australian-German Climate and Energy College[1]
Tim Forcey - Energy Advisor, Melbourne Energy Institute[1]
Hugh Saddler - Hon. Assoc. Professor, Crawford School[2]
Mike Sandiford - Professor of Geology, School of Earth Sciences[1]

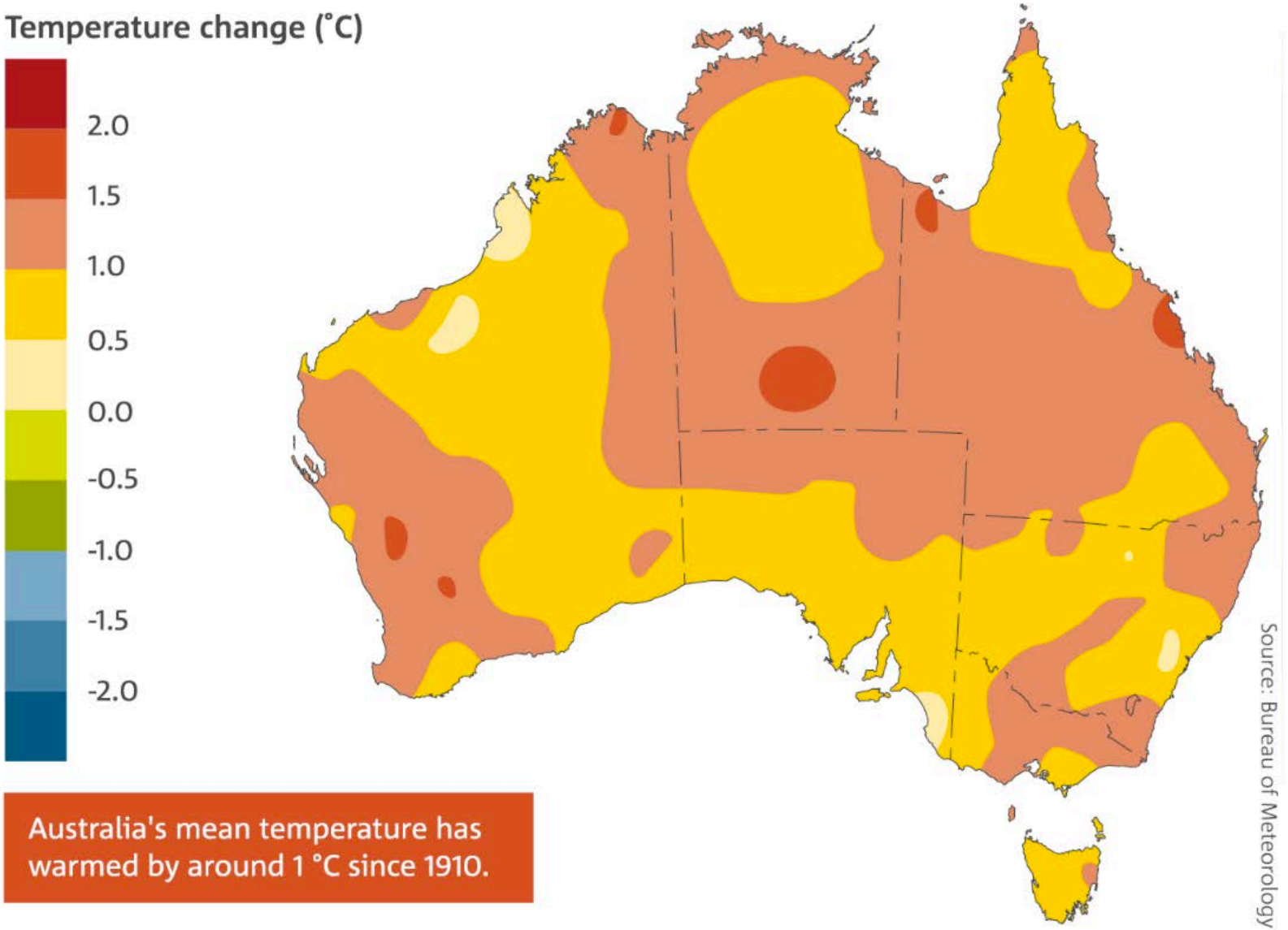
1. University of Melbourne
2. Australian National University

Last few years – Even steeper rises (figure to 2016)



https://data.giss.nasa.gov/gistemp/graphs/

NT already differentially feeling the heat: besides a health risk, also a water scarcity risk

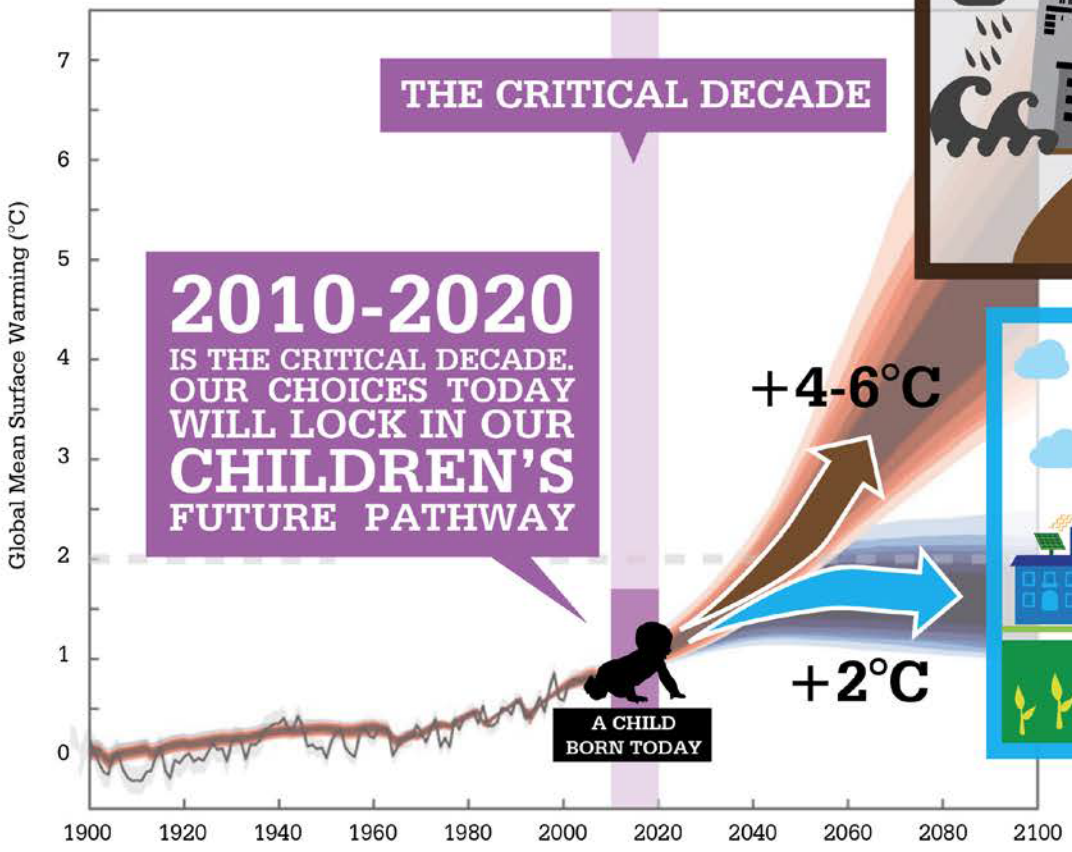


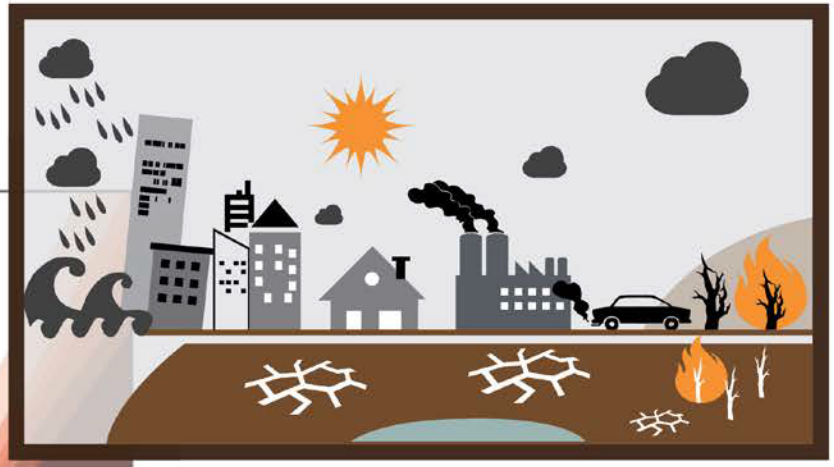
CLIMATE COMMISSION

The decisions we make today will lock in our children's future

THIS IS THE CRITICAL DECADE FOR ACTION

Find out more: www.climatecommission.gov.au





Source: Adapted from Meinshausen et al. (2009)

NATURE | COMMENT

Three years to safeguard our climate

Christiana Figueres, Hans Joachim Schellnhuber, Gail Whiteman, Johan Rockström, Anthony Hobley & Stefan Rahmstorf

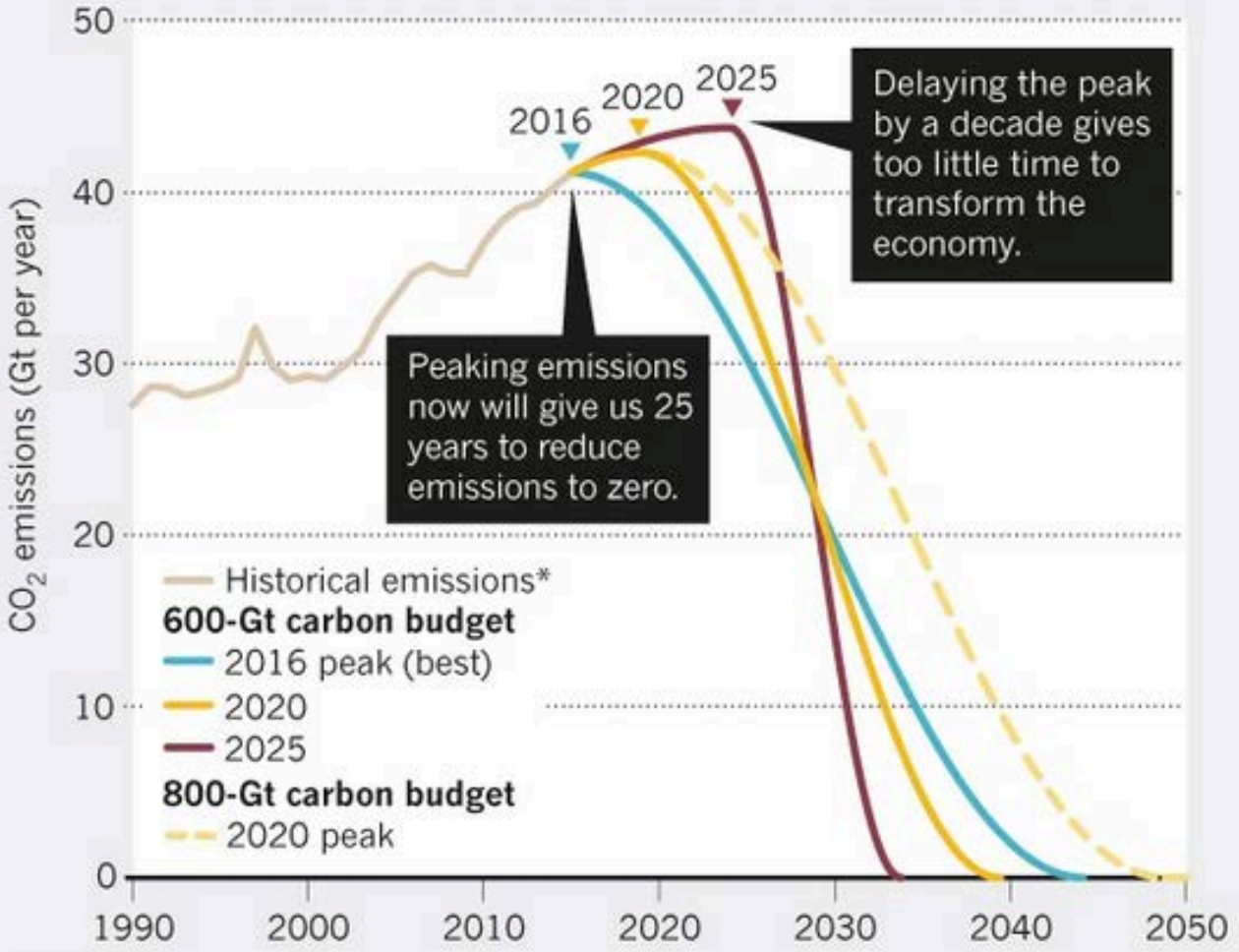
28 June 2017

Christiana Figueres and colleagues set out a six-point plan for turning the tide of the world's carbon dioxide by 2020.

https://www.nature.com/news/three-years-to-safeguard-our-climate-1.22201

CARBON CRUNCH

There is a mean budget of around 600 gigatonnes (Gt) of carbon dioxide left to emit before the planet warms dangerously, by more than 1.5–2°C. Stretching the budget to 800 Gt buys another 10 years, but at a greater risk of exceeding the temperature limit.



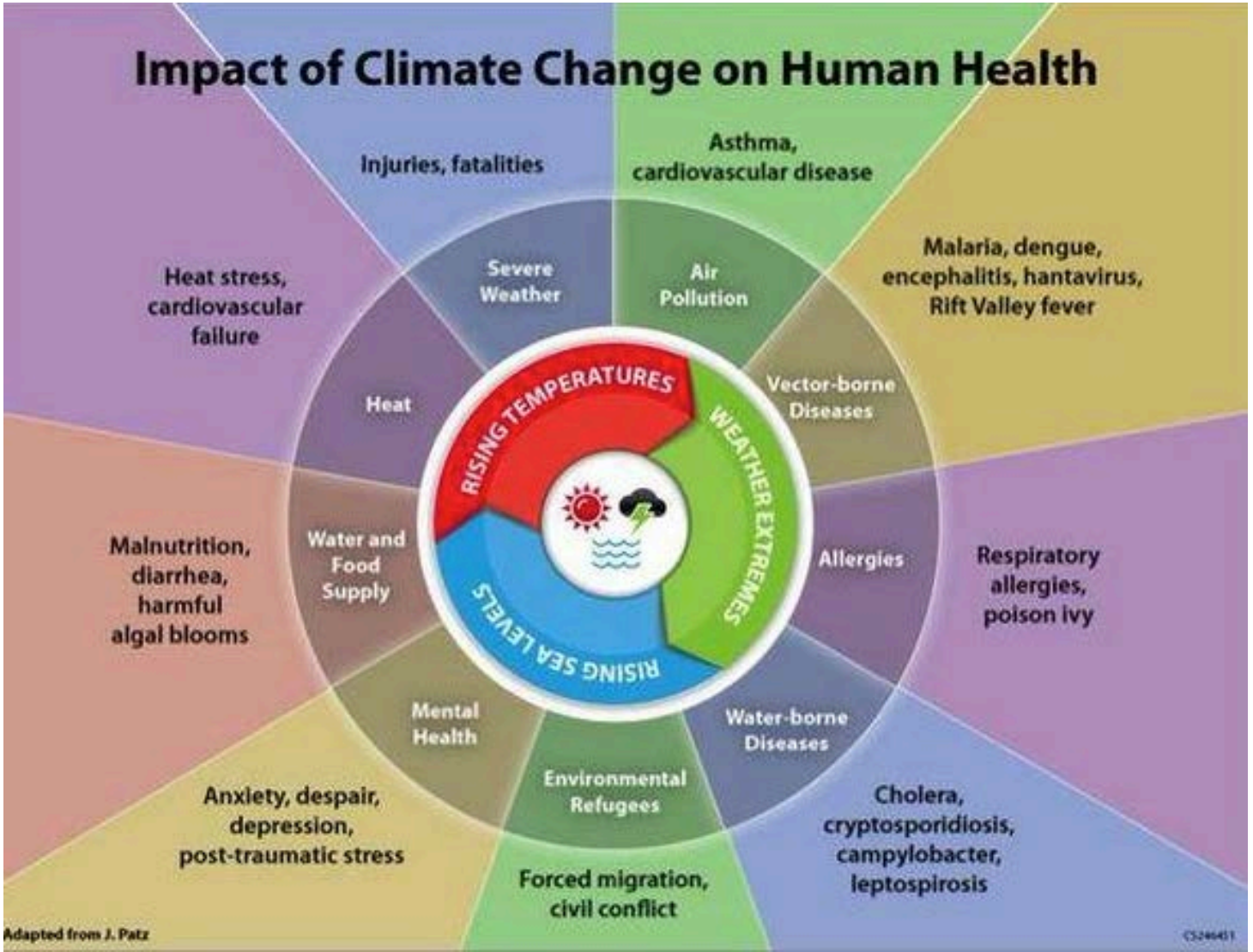
©nature

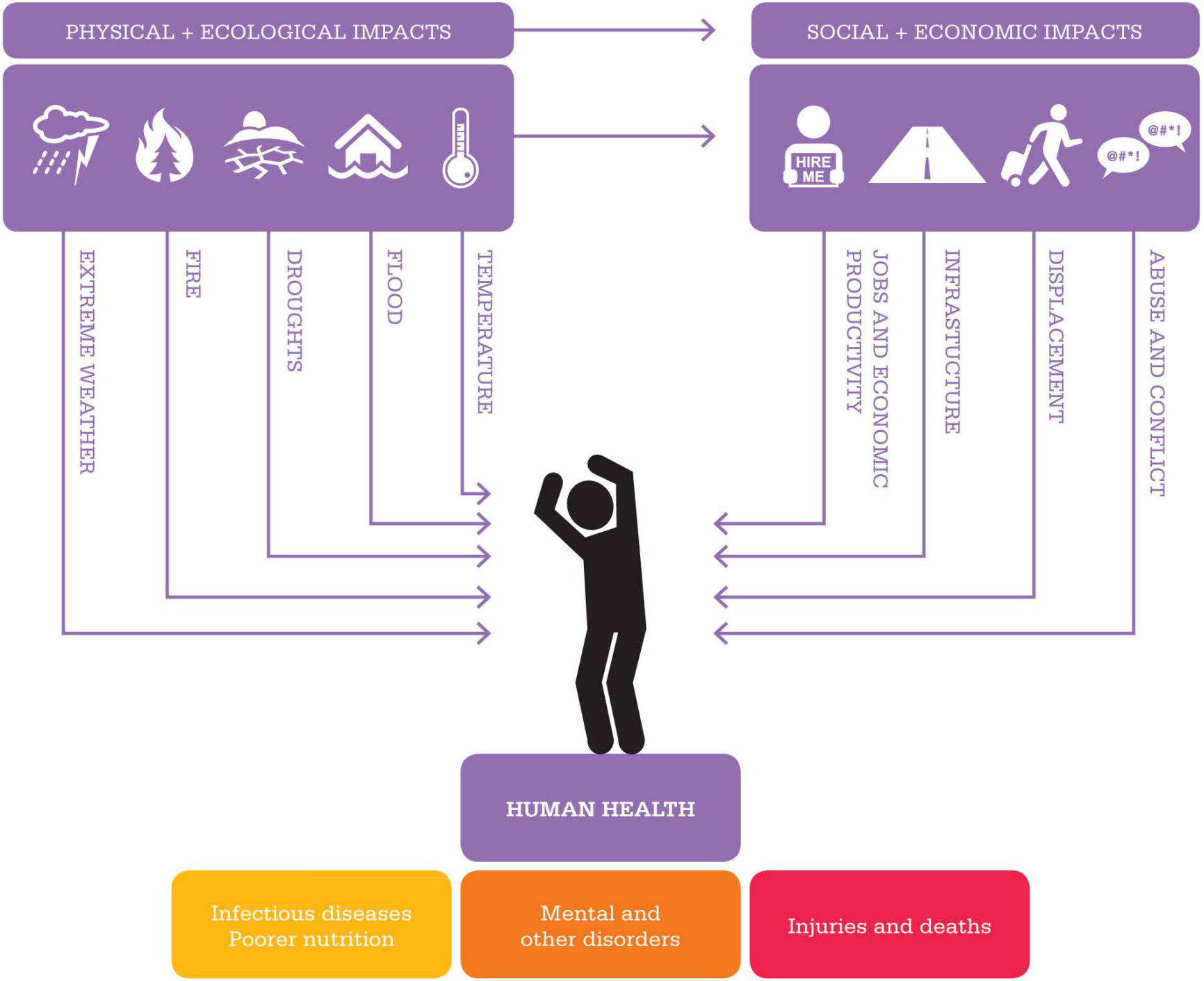
*Data from The Global Carbon Project.

Sources: Stefan Rahmstorf/Global Carbon Project; http://go.nature.com/2RCPCRU

Responding to climate change is the biggest health challenge of our time.

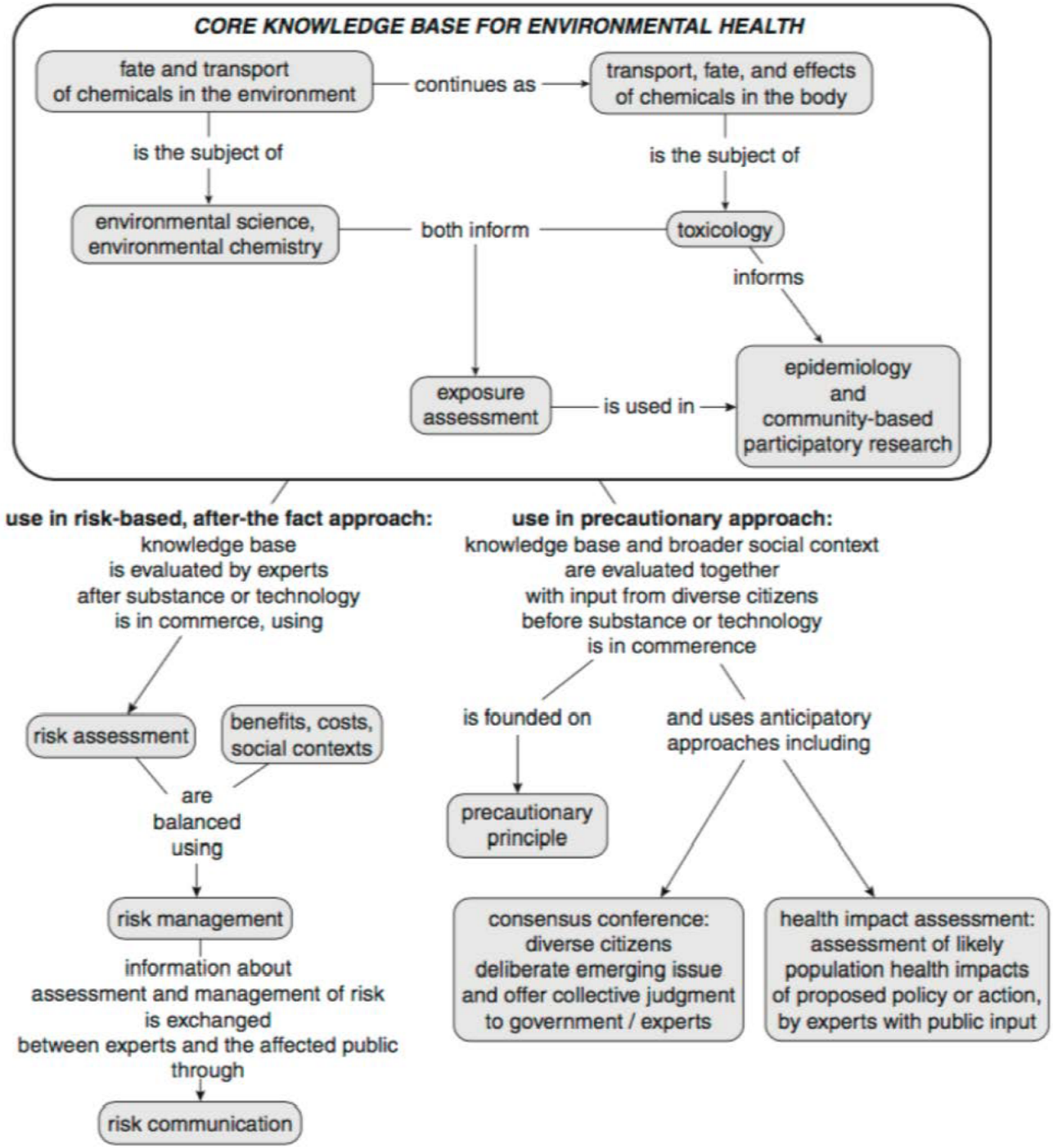
Lancet Commission on Health and Climate 2015 (2015). Health and climate change. http://climatehealthcommission.org/the-report/




PHYSICAL + ECOLOGICAL IMPACTS
SOCIAL + ECONOMIC IMPACTS
HIRE ME
@#*!
@#*!
EXTREME WEATHER
FIRE
DROUGHTS
FLOOD
TEMPERATURE
JOBS AND ECONOMIC PRODUCTIVITY
INFRASTUCTURE
DISPLACEMENT
ABUSE AND CONFLICT
HUMAN HEALTH
Infectious diseases
Poorer nutrition
Mental and
other disorders
Injuries and deaths

Reflection on the process, decision making and ethics

There are two main pathways/tools in environmental health decision-making: note the points of philosophical diversion



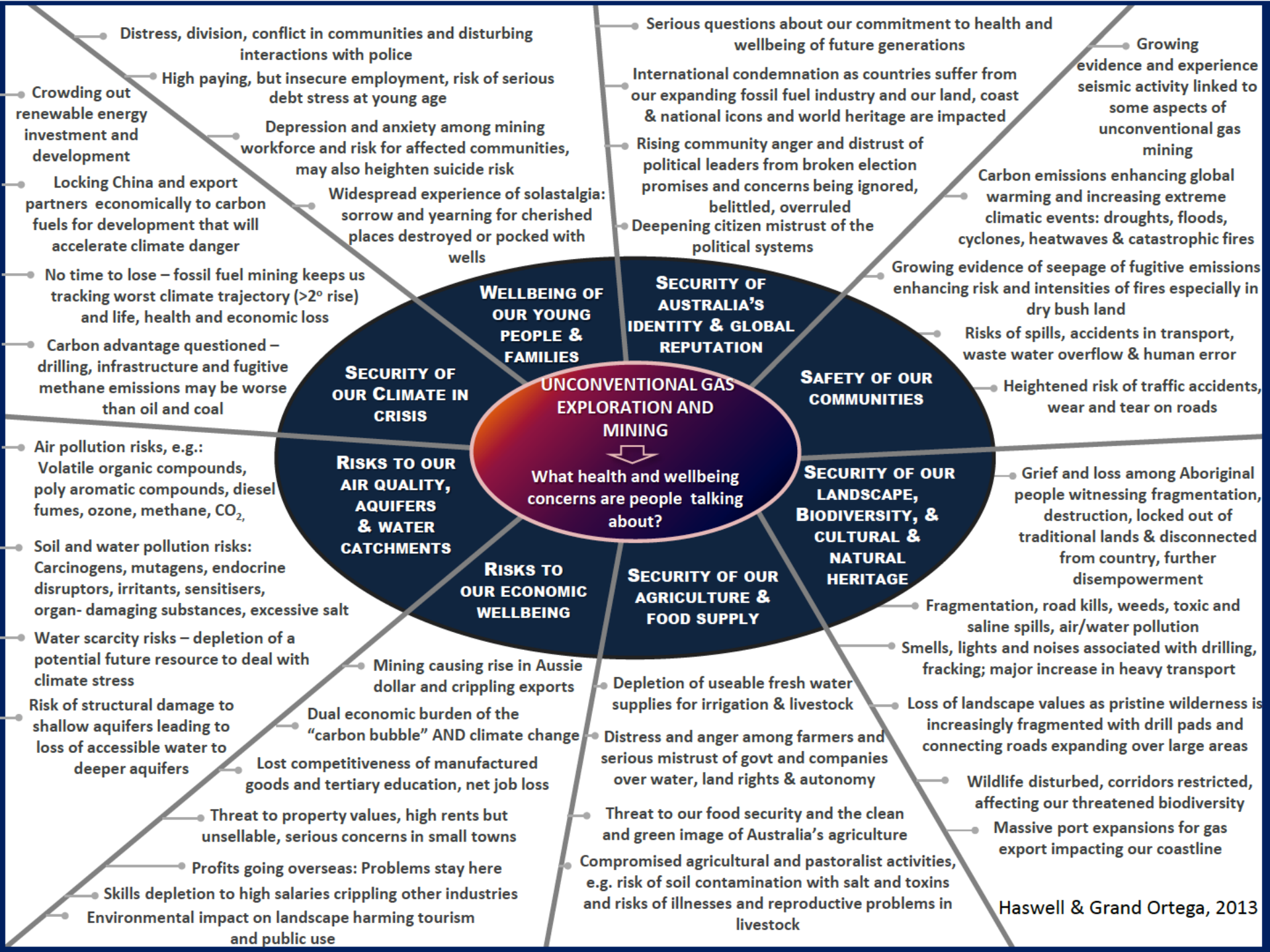
Human health risk assessment is…

A process of estimating the potential impact of a chemical, biological, physical or social hazard on a specified human population or ecological system under a specific set of conditions and for a certain time frame'

- *enHealth, 2012*

Underlying Assumptions of Health Risk Assessments

- Risks to human health from environmental hazards can be quantified
- Underlying concept behind most environmental health assessment
- Despite uncertainties and assumptions, is widely considered able to guide 'rational, scientific' decisions about safety
- ? Is therefore able to ensure protection of health and wellbeing of people through regulation


UNCONVENTIONAL GAS EXPLORATION AND MINING
What health and wellbeing concerns are people talking about?
WELLBEING OF OUR YOUNG PEOPLE & FAMILIES
Distress, division, conflict in communities and disturbing interactions with police
High paying, but insecure employment, risk of serious debt stress at young age
Depression and anxiety among mining workforce and risk for affected communities, may also heighten suicide risk
Widespread experience of solastalgia: sorrow and yearning for cherished places destroyed or pocked with wells
SECURITY OF AUSTRALIA'S IDENTITY & GLOBAL REPUTATION
Serious questions about our commitment to health and wellbeing of future generations
International condemnation as countries suffer from our expanding fossil fuel industry and our land, coast & national icons and world heritage are impacted
Rising community anger and distrust of political leaders from broken election promises and concerns being ignored, belittled, overruled
Deepening citizen mistrust of the political systems
SAFETY OF OUR COMMUNITIES
Growing evidence and experience seismic activity linked to some aspects of unconventional gas mining
Carbon emissions enhancing global warming and increasing extreme climatic events: droughts, floods, cyclones, heatwaves & catastrophic fires
Growing evidence of seepage of fugitive emissions enhancing risk and intensities of fires especially in dry bush land
Risks of spills, accidents in transport, waste water overflow & human error
Heightened risk of traffic accidents, wear and tear on roads
SECURITY OF OUR LANDSCAPE, BIODIVERSITY, & CULTURAL & NATURAL HERITAGE
Grief and loss among Aboriginal people witnessing fragmentation, destruction, locked out of traditional lands & disconnected from country, further disempowerment
Fragmentation, road kills, weeds, toxic and saline spills, air/water pollution
Smells, lights and noises associated with drilling, fracking; major increase in heavy transport
Loss of landscape values as pristine wilderness is increasingly fragmented with drill pads and connecting roads expanding over large areas
Wildlife disturbed, corridors restricted, affecting our threatened biodiversity
Massive port expansions for gas export impacting our coastline
SECURITY OF OUR AGRICULTURE & FOOD SUPPLY
Depletion of useable fresh water supplies for irrigation & livestock
Distress and anger among farmers and serious mistrust of govt and companies over water, land rights & autonomy
Threat to our food security and the clean and green image of Australia's agriculture
Compromised agricultural and pastoralist activities, e.g. risk of soil contamination with salt and toxins and risks of illnesses and reproductive problems in livestock
RISKS TO OUR ECONOMIC WELLBEING
Mining causing rise in Aussie dollar and crippling exports
Dual economic burden of the "carbon bubble" AND climate change
Lost competitiveness of manufactured goods and tertiary education, net job loss
Threat to property values, high rents but unsellable, serious concerns in small towns
Profits going overseas: Problems stay here
Skills depletion to high salaries crippling other industries
Environmental impact on landscape harming tourism and public use
RISKS TO OUR AIR QUALITY, AQUIFERS & WATER CATCHMENTS
Air pollution risks, e.g.: Volatile organic compounds, poly aromatic compounds, diesel fumes, ozone, methane, CO_2,
Soil and water pollution risks: Carcinogens, mutagens, endocrine disruptors, irritants, sensitisers, organ- damaging substances, excessive salt
Water scarcity risks – depletion of a potential future resource to deal with climate stress
Risk of structural damage to shallow aquifers leading to loss of accessible water to deeper aquifers
SECURITY OF OUR CLIMATE IN CRISIS
Crowding out renewable energy investment and development
Locking China and export partners economically to carbon fuels for development that will accelerate climate danger
No time to lose – fossil fuel mining keeps us tracking worst climate trajectory (>2° rise) and life, health and economic loss
Carbon advantage questioned – drilling, infrastructure and fugitive methane emissions may be worse than oil and coal
Haswell & Grand Ortega, 2013

What's missing?
What fits poorly into risk assessment?

- Environmental justice, power differentials
- Indigenous worldviews, ways of being and doing
- Intergenerational trauma, anger, racism
- Vastly different environmental health living conditions, multiplicity of vulnerabilities
- Complex interactions, mental health, endocrine disruptors
- Industries posing multiple, decentralised potential hazards, outpacing human health research, no baseline
- Climate change changing the environment
- Human error and human carelessness
- Politics, volatile markets

Why is evidence from the US particularly important to understanding health impacts?

- Australia's unconventional gas industry is in its infancy. Very little research has been done (no pre, post measurements, small sample sizes, etc.) to understand the impacts on health and wellbeing of affected communities.
- In contrast, an estimated 15.3 million Americans live within a mile of one or more unconventional gas or oil wells (fracked since 2000).
- This has occurred in many states, with varying regulatory regimes and physical and social conditions.
- Research is now building rapidly. This represents an invaluable resource that was not available to many US authorities when the industry began.

Perhaps most importantly

- We have witnessed what can happen to protective regulation very quickly in a Western democracy.

Approaches to environmental hazards

- **Precautionary approach**
  - In absence of scientific information (proof) err on side of caution (precautionary principle)
  - Often favoured by affected communities – its MY Health
  - Banning of chemicals, processes => substitution with less harmful alternatives
- **Risk assessment approach**
  - Base decisions on available scientific evidence
  - Define acceptable and unacceptable risk
  - Avoid unnecessary burden on industry by use of 'overconservative' standards

Role of ethics in shale gas policies
de Melo-Martin et al. (2014, p1114) argued:

"that policy makers have a prima facie duty to minimize false negatives [not proceed in the case of shale gas mining] based on three considerations:

(1) protection from serious harm generally takes precedence over the enhancement of welfare;

(2) minimizing false negatives in this case is more respectful to people's autonomy; and

(3) alternative solutions exist that may provide many of the same benefits while minimizing many of the harms".

Science of the Total Environment 470-471: 1114-1119.

Unproven efficacy of regulation in eliminating these risks and harms

Can – will – for how long – who pays?

Uncertainty about the effectiveness and feasibility of regulations to provide comprehensive, long term protection against the full range of health risks and concerns and cumulative environmental impacts.

In summary

- I have raised more questions than answers in this presentation and hope that I have raised awareness of opening eyes to the fuller complexities involved in making the right decisions.
- Health is impacted by all the dimensions studied here, with painful consequences for those who experience the potential risk.
- Science can only go so far – these are values questions impacting on people with very different value systems.
- I personally urge the NT government to look for win win solutions in development, and avoid situations such as unconventional gas mining where the most vulnerable face the greatest risks and benefit is questionable.

For further information, contact:

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[redacted]