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Impacts of unconventional gas development on rural community decline

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ABSTRACT

This paper looks at the impact of a new extractive industry, namely unconventional natural gas, on rural decline. Rural decline is defined as comprising loss of rural youth, reduced human capital and increasing rural poverty. Since the start of the current century, the unconventional natural gas industry has been expanding around the world, often in close proximity to pre-existing agricultural communities. The social impacts of this new industry represent a growing area of interest in rural studies. We contribute to this new research area through a case study of coal seam gas (CSG) development in Queensland, Australia, comparing regions where gas development occurred between 2001 and 2011 against a control group of similar regions without gas development. The study eliminated the influence of non-resident workforces by analysing census data based on place of usual residence as well as place of enumeration. A key finding of the study is that regions with CSG development have experienced a growing youth share of the population and, of particular note, a growing female youth share of the population. CSG regions had a higher proportion of youth with university degrees and advanced technical training compared to other rural regions. Poverty reduction was also observed in some specific CSG regions. The extensive spatial footprint of unconventional gas and increased female rural youth populations indicate a diversion from traditional boomtown social impacts observed in previous energy booms. Taken together, the results show signs of mitigating and reversing rural community decline.

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1. Introduction

As the world population has become more urban than rural, scholars of rural studies have increasingly grappled with the issue of rural decline. The expansion of urban populations has prompted researchers to look closely at the effects on rural areas, including demographic changes, economic changes and different settlement patterns in rural towns (Bloom et al., 2008; Montgomery, 2008). Much of the focus on rural decline has looked at changes in agriculture, such as increased mechanisation and diminishing terms of trade. Yet, alongside decreases in some traditional economic activities, some rural regions are experiencing expansion in other economic areas. One substantial economic change which has developed over the past decade, and which has significant impacts for rural areas with a history of agriculture, is a new industry in the

form of unconventional natural gas (herein unconventional gas). Understanding the implications of new extractive industries such as unconventional gas for rural localities is a crucial issue for the field of rural studies (Woods, 2012). The rationale for putting these new industries under the microscope is that they pose new challenges and opportunities for rural communities. In part, this is due to operational differences that affect the viability of existing rural communities in different ways from conventional mining and energy production. This paper looks at one such change – the development of unconventional gas – and considers how this is affecting rural decline in communities experiencing coal seam gas development in Queensland, Australia.

1.1. An overview of rural decline

The term ‘rural decline’ refers to a wide range of issues, from demographic changes through to rural political discourses (Lockie, 2000). Underpinning most of these discussions are three substantive changes, which flow through to issues of identity and aspiration in different rural contexts. The first is rural net migration loss,

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and in particular rural youth out-migration which leads to a skewed demographic profile in rural areas (Stockdale, 2004). The second is declining human capital due to the loss of skilled and educated young people (Winkler et al., 2012). The third area is the lower incomes of rural regions compared to urban areas (Argent and Walmsley, 2008). In practice this often boils down to questions of whether young people have a future in rural locations (Stockdale, 2004).

With some exceptions such as the UK, out-migration is the dominant trend for most rural regions around the world (Woods, 2011). Out-migration of youth in particular (including in the UK) is an issue because it is recognised as damaging to rural communities in terms of skewed demographic profiles, reductions in services and loss of local culture as expressed through festivals and related events (Stockdale, 2004). Young women are more likely to leave rural regions than their male counterparts (Argent and Walmsley, 2008). The ‘exodus’ of youth from rural areas has been a concern for decades in Australia, and shows empirical evidence of accelerating over the last two decades (Gabriel, 2002; Argent and Walmsley, 2008). Similarly, in the USA, a general trend of youth out-migration from rural areas to urban areas was observed during the second half of the twentieth century. In particular, the Great Plains region experienced consistent net migration loss, widening in recent years to include the corn belt and upper Great Lakes regions (Johnson et al., 2005; Johnson, 2011).

The causes of rural youth out-migration are multiple and complex, but partly explained by push factors including a lack of employment for school leavers (Golding, 2014). To some extent this is explained by the reduced demand for agricultural labour forces, which has been influenced by farm amalgamations, declining terms of trade and increased mechanisation. Other factors include escaping the perceived dullness of rural locations in favour of ‘city lights’, and increasing propensity to seek tertiary education which tends to be concentrated in metropolitan areas (Woods, 2011; Argent and Walmsley, 2008). The extent to which net migration loss is a problem, and what might be done about it, are areas of debate (Gibson and Argent, 2008). While it is not possible to engage with all aspects of net migration loss in this article, our focus in this paper is to consider how the development of a new extractive industry in the form of unconventional gas is reflected in opportunities to attract and retain rural youth.

Compounding the loss of rural youth, a related component of rural decline is reduced human capital (Johnson, 2011; Winkler et al., 2012). In particular, a concern about losing ‘the best and brightest’ has long been recognised in rural studies (Gabriel, 2002; Winkler et al., 2012). According to Stockdale (2004) those with ability or ambition have little choice but to leave rural communities. Others suggest that the development of human capital in rural contexts may accelerate the departure of the most capable (Corbett, 2007). Some scholars note the potential advantage for rural regions of youth out-migration, provided that some of the out-migrants return with the knowledge and skills they have developed through programs which are only available in urban centres (Gibson and Argent, 2008). Thinking along these lines, Stockdale (2004) considers that the number of youth returning to rural communities is perhaps more important than the numbers who leave. In concrete terms this is an important phenomenon to consider as human capital is fundamental for the development of entrepreneurship, innovation and long term growth.

Increasing income disparities between rural and urban areas – which are common in many countries – are another component of rural decline (Pritchard and McManus, 2000; Hu, 2002; Stockdale, 2004). Low incomes for residents in agricultural regions compared to cities are particularly significant due to the interrelated impacts of market access, trade liberalisation, structural adjustment,

declining commodity prices and property amalgamations (Goetz, 1992; Argent and Walmsley, 2008; Connell and McManus, 2011). It is also important to recognise that there are varying levels of poverty between rural regions, in part depending upon the size and productivity of the agricultural sector (Fleming et al., 2010), therefore the rise of the resources sector may affect different types of rural regions in different ways.

While rural decline is a crucial area for study, some call for caution when applying the label to particular locations, as the stigma attached to this phenomenon may hasten its development (Gibson and Argent, 2008). Young people may be inherently mobile – seeking exploration and new challenges – so some of the intrinsic factors such as low incomes in rural areas may not always be strong drivers of out-migration (Delisle and Shearmur, 2010). Others reject the inevitability of rural decline, viewing it more as the outcome of particular policy choices (Markey et al., 2008). Some have tentatively observed ‘rural revival’, as jaded urban dwellers seek better lifestyles in rural areas (Connell and McManus, 2011).

2. The rise of unconventional natural gas extraction in rural landscapes

Internationally, the growing demand for energy and, at the same time, for lower carbon emissions has fuelled demand for new types of energy resources. Interest in ‘unconventional’ energy has grown increasingly since the end of the 20th century, requiring new mechanisms to harness this energy (Rogner, 1997). Much of this development has occurred in the USA, where unconventional natural gas has been a major component of strategic programs aimed at increasing self sufficiency in energy with a lower carbon emission burden compared with other fossil fuels (Stedman et al., 2012; Gunter et al., 1997). The ‘unconventional natural gases’ comprise sources of methane which include shale gas (the most widely exploited), coal seam gas (also known as coal-bed methane) and the lesser known ‘tight gas’ trapped in rock formations (Law and Spencer, 1993; Wright, 2012). Shale gas is extracted in substantial volumes in the USA, notably in the Marcellus and Barnett shales. Potential for shale gas production has been recognised in several parts of Europe, including Austria, China, Germany, Norway, Poland, Romania, Sweden, Turkey and the UK (Schulz et al., 2010; Selley, 2005; Weijermars, 2013; Wiśniewski, 2011). Reserves of shale gas are also located in Argentina, Australia, Brazil, Canada and Mexico (Ross and Bustin, 2007; Wright, 2012).

Coal seam gas (CSG), geologically distinct from shale gas, is also expanding throughout the world. Coal seam gas is currently extracted in a dozen countries including the United States, Canada, Australia, India and China (GA and ABARE, 2010). Previously thought of as a fugitive gas waste product from conventional coal mining, it is now an industry in its own right due to developments in technology to harvest methane trapped in coal seams (Cheng et al., 2011). This has enabled extraction of methane from deep coal seams which are not economical for conventional coal mining.

Australia has all three types of unconventional gas resources, with varying levels of known accessibility (GA, 2012). The largest estimated reserves are for shale gas, notably in Western Australia, although exploration is still in early stages. Exploration for tight gas is even less developed, with no viable reserves identified. Of the different forms of unconventional gas, the most developed in Australia is CSG, which has rapidly expanded in the state of Queensland in the past decade (Morrison et al., 2012; GA, 2012; Fleming and Measham, 2014a). Queensland possesses over ninety per cent of the country’s economically demonstrated resources (EDR) of CSG known to 2011 (GA, 2012), distributed mainly across the Surat and Bowen basins (see Fig. 1). Moreover, exploration activity has revealed increasing quantities of commercially viable

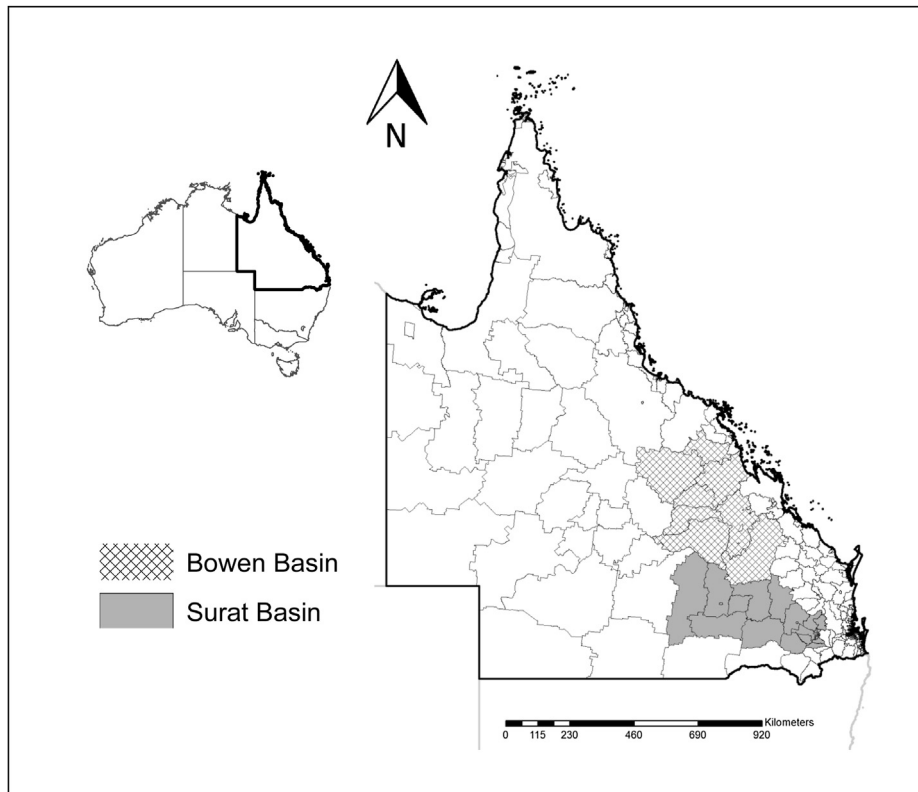


Fig. 1. Queensland SLAs and the Bowen and Surat basins.

resources: the EDR of CSG has increased from 15 trillion cubic feet in 2008 (GA and ABARE, 2010) to around 33 trillion cubic feet in 2011 (GA, 2012). Sinking of production wells has accelerated since around 2003, focused particularly in the Surat and Bowen basins. By 2011, hundreds of wells had been developed along with substantial pipeline infrastructure to distribute the gas. The initial rationale for developing unconventional gas resources stemmed from increasing the proportion of electricity generated from gas (which has lower carbon emissions) rather than coal. However, the increasing quantities extracted and insatiable global demand for energy have shifted the focus to exports, with thousands of additional wells planned and the development of liquefied natural gas export processing facilities commenced in the town of Gladstone (GA, 2012).

Unconventional gas poses different impacts on rural communities compared with other forms of resource extraction. In particular, the imprint of unconventional gas is extensive rather than intensive – an analogy in agriculture might be the way grazing or ranching differs from cropping or horticulture. Whereas the impacts of oil rigs and coal mines concentrate the process of extraction on relatively small areas, unconventional gas spreads its impact across a much wider spatial extent. Whereas intensive energy extraction requires exclusive access to relatively small sites, the extensive extraction of unconventional gas tends to be co-located with other land uses – usually agriculture (Lawrence et al., 2013). This has the effect of thrusting different and potentially competing industries together in the same parcel of land. This can generate new types of conflicts, and potential benefits (Kinnaman, 2011; Measham et al., 2013).

Given that the installation phase of CSG extraction is spread over a wider area, the development phase of CSG occurs over a longer period than individual mines, such that installation labour forces may be required for a decade or more. Moreover, the operational

phase and the installation phase are less distinct compared to those of conventional resource extraction, with each completed well becoming operational as the installation process moves across the landscape to the next well site. While some of the skills required during the installation phase are highly specialised and need to be brought in from beyond the region, others are much more familiar to agricultural communities, such as the need to fence off every well site to prevent stock intrusion, and can be sourced locally.

During the operational phase, many of the labour demands are relatively low skilled, and can be sourced either from local towns or from nearby town centres. Whereas conventional mining for coal or metal ores tends to use a small number of large machines, unconventional gas tends to use a large number of small machines, such as water pumps and gas separators, connected by an elaborate system of pipes. Each of these requires checking and maintaining on a regular basis, providing a need for skills that are relatively transferable between sectors. Similarly, skills such as truck driving and grading roads make up a large part of the CSG labour force and can be sourced locally or from other towns and cities. These characteristics have resulted in a net increase in the total employment in CSG regions, as well as a transfer of labour from the agricultural sector to the resources sector (Fleming and Measham, 2014a).

3. Social impacts of unconventional gas on rural communities

The development of unconventional gas has been described as having more potential to change local economies and social relations in rural areas than any other phenomenon in recent history (Stedman et al., 2012). In attempting to understand the types of changes experienced by rural communities, several authors have turned to the energy boomtown and social disruption research of rural sociologists during an earlier energy boom in the 1970s and

1980s (England and Albrecht, 1984; Greider and Krannich, 1985). The boomtown research focused on the impacts of large oil, gas, coal and uranium mines developed in small communities. These projects were associated with overwhelming population growth, causing strain on local services and dramatic changes to social structure. Much of the focus of this research was on the sense of crisis experienced by local residents following increased crime and substance abuse and weakened social ties (Greider and Krannich, 1985). However, it is important to note that the impacts of energy and mineral booms are variable in time and space and that negative impacts associated with boomtowns are not inevitable (Krannich and Greider, 1984).

Some authors have drawn attention to the distinct role of gender in boomtown-like effects (Carrington et al., 2010). Because the resources sector is predominantly occupied by males, the mining sector has different impacts for men and women (Tonts, 2010; Baker and Fortin, 2001; Reeson et al., 2012). Large mines and conventional gas fields concentrate a large number of young single men with little commitment to local communities. This demographic phenomenon has been historically linked to particular types of social impacts such as alcoholism, sexually transmitted diseases and violence, with the effect of discouraging young women from staying in the affected communities and contributing to underlying rural decline (Carrington et al., 2010; Ruddell, 2011; Goldenberg et al., 2008).

While the boomtown research provides a useful starting point for considering the social and economic impacts of new energy developments, unconventional gas differs in some important ways from the types of projects which were the focus of the original boomtown research (Stedman et al., 2012). First of all, unconventional gas is a more extensive form of resource development, with potentially thousands of wells across a large landscape, such that the effects of resource development are experienced over a wider area (Stedman et al., 2012). Moreover, unconventional gas is often located in rural areas with relatively high population density prior to resource development, so more people are likely to experience the impacts of gas development (Stedman et al., 2012; Measham et al., 2013). Compared to conventional energy projects (Haslam Mckenzie, 2013), this means that more people are likely to experience the negative sides of development, such as dust, noise and traffic (Theodori, 2009), disruption to place based identities (Jacquet and Stedman, 2014) and possible health impacts (Colborn et al., 2011), but also potential benefits (Fleming and Measham, 2014a; Stedman et al., 2012). Benefits may be direct, in the form of compensation for hosting infrastructure, rental income, employment in the resource extraction sector or indirect, such as through job spillovers (Jacquet, 2012; Kriesky et al., 2013; Weber, 2012; Fleming and Measham, 2014b; Muehlenbachs et al., 2014).

Like other forms of resource development, a number of environmental concerns have been raised about unconventional gas. These include general concerns such as the threat of increased invasive pests, loss of wildlife and reduced air quality (Bergquist et al., 2007; Brasier et al., 2011). They also include specific concerns, held by farmers and environmentalists, about land subsidence and the risks of damage to aquifers by raising salts to the surface and through the use of chemical additives in gas extraction (Lawrence et al., 2013). In addition to these environmental concerns, the logistics of unconventional gas extraction pose a high risk of disruption to the practice of agriculture. In Queensland thousands of planned and existing wells, connected by pipes and access roads, will reduce the area available for farming and complicate the logistics of farming in some of the most productive agricultural lands in Australia. Together these environmental and logistical challenges contribute yet another challenge to a wider set of concerns faced by Australian agriculture (Lawrence et al., 2013). An

alternative perspective on this theme, noted in Marcellus Shale in the USA, was that the pool of farmers may be reduced, because some may become so wealthy from gas payments that they abandon farming altogether (Brasier et al., 2011).

4. Case study of coal seam gas in Australia

In Australia, two neighbouring regions, the Bowen basin and the Surat basin (Fig. 1), have considerable development of unconventional gas in the form of CSG. The former is a region with an established history of resource extraction. Notably, the Bowen basin is one of Australia's largest coal-producing regions, where the development of unconventional gas represents a step further down the path of mineral and energy extraction (Morrison et al., 2012). By contrast, the Surat basin region has had very little exposure to the resources sector prior to the development of unconventional gas. The region includes some of the most productive soils in the country and its identity has been dominated by agriculture (Lawrence et al., 2013). For this reason, the development of unconventional gas is much more likely to be a challenge for rural communities in the Surat basin compared with those in the Bowen basin, who are more familiar with the resources sector (Schandl and Darbas, 2008; Fleming and Measham, 2014a).

4.1. Methods

Based on our discussion of rural decline, in this study we are interested in tracking changes in three indicators: female/male youth population, educational attainment and poverty. Data for youth population and educational levels are available from population censuses. In contrast, poverty levels are not officially reported by the Australian Bureau of Statistics (ABS). Rather the ABS (2013) reports the relatively complicated Index of Economic Resources, one of four Socio-Economic Indexes for Areas (SEIFA), for which low income is only one of 14 variables which also include the size of dwellings, home ownership, unemployment, vehicle ownership and percentage of single-parent households, amongst others. While this index provides a valuable insight into economic resources in Australia, we chose not to use it in this study in favour of a simple poverty line measure in order to facilitate future research comparing the impacts of unconventional gas on rural decline across different national contexts, where the SEIFA indexes may not be available.

Rather, we used the poverty line threshold calculated by the Melbourne Institute of Applied Economics and Social Research (MIAESR, 2002, 2012), which in Australia for the period in focus corresponds to \$538.88 per week in 2001 and of \$863.68 per week in 2011 for a family of four (two adults and two children). Considering these income lines and the census data for family income provided in blocks, we generated an 'extended poverty rate' variable for 2001 and 2011 considering the proportion of families of four (a couple and two children) living with less than \$599 per week and \$999 per week, respectively.

In order to track changes across our indicators, we considered a regional analysis based on observations at Statistical Local Area (SLA) level using the Time Series DataPack (Catalogue number 2069.0.30.003). SLAs are the smallest sub-state regions for which census data is publicly issued in a time series format, corrected by ABS for any modifications to collection boundaries over the period in focus. For this study we use SLA 2011 boundaries, for which census time series data are available for 2001, 2006 and 2011 (ABS, 2013). In 2011 Queensland had 475 SLAs in total.

Considering SLAs as our units of observation, we first defined the regions substantially affected by CSG development across the Surat and Bowen basins. Following Fleming and Measham (2014a),

we did this by selecting SLAs where most of the wells associated with the CSG industry between 2001 and 2011 were placed. Using geospatial data available from the Department of Natural Resources and Mines of the Queensland Government (DNRM, 2012), we defined eight SLAs in the Surat basin and six SLAs in the Bowen basin, which together encompassed more than 95% of all CSG related wells in Queensland in 2011, as ‘CSG SLAs’ (Fleming and Measham, 2014a). We also included an observation in our analysis given by the SLA of Chinchilla, which is one of the eight CSG SLAs in the Surat basin. We provide detailed data on Chinchilla to include observations from one particular and representative town in the middle of the CSG development region which was not previously exposed to the resources sector.

In order to compare changes in our indicators across the CSG defined regions, we selected a control group given by Queensland SLAs with similar population density in year 2001, as described in Fleming and Measham (2014a). This comparison group comprises 81 rural SLAs located across the state without (or with very low) CSG extraction during the period 2001 to 2011. Our control group, when combined with the CSG regions, contained 15 per cent of the State’s total population in 2001.

Due to boundary modifications and imputation errors for incomplete addresses affecting widespread areas in 2001, the complete Time Series DataPack is not available based on place of usual residence for the period 2001 to 2011 (neither as a standard product nor as a consultancy service). Initially, we calculated all indicators using the Time Series DataPack based on place of enumeration data and then considered, for each type of indicator how to control for the effect of non-resident workers, also known as long distance commuting (LDC) workforces (Storey, 2001; Measham et al., 2013). Details of how we did this for each indicator are presented in the Supplementary materials.

4.2. Results

4.2.1. Migration effects

The percentage of youth by age and sex who had moved to CSG regions and the control group since the previous census period, based on place of usual residence data, is presented in Table 1. Considering the 15–19 age group, we see little change between the CSG regions and the control group. Considering the 20–24 and 25–29 age groups, the percentages for CSG regions are all markedly higher than the control, reflecting increased movement to these regions for both males and females. The data also show that female youth are generally more mobile than their male counterparts, including amongst the control group.

The share of male and female youth as a proportion of the population for years 2001, 2006 and 2011 based on place of usual residence data can be observed in Fig. 2. For males, the data show a

steady increase in the Surat basin in the age category 20–24 between 2001 and 2011 and a slight decrease for males in the Bowen basin over the same time frame (based on usual place of residence). By contrast, for males in the Surat aged 25–29 we see an initial decrease from 2001 to 2006 followed by a subsequent increase. This subsequent increase is small for the Surat region in general and large for the town of Chinchilla in particular. Males aged 25–29 in the Bowen basin show a steady increase from 2001 to 2011.

For females in the age group of 20–24 we see evidence that the share of the population increased in all CSG-affected regions between 2001 and 2011. For females in the age group 25–29 there was an initial drop in all CSG regions from 2001 to 2006 and then an increase between 2006 and 2011, demonstrating a growing female population share in this age range for CSG-affected SLAs in both the Surat and Bowen basins from 2006. In contrast to the CSG regions, the control group reflected a steady decline of youth as a proportion of the population for males and for females in all age categories (Fig. S1 in supplementary materials).

The origins and destinations of youth movements to and from Chinchilla between 2006 and 2011 are presented in Figs. 3 and 4. Focussing first on the origins of youth moving to this town, the most common origins are located in Queensland and mostly surrounding Chinchilla such as Toowoomba and Dalby. Also making it into the top ten origins are other mining regions such as Mt Isa, coastal locations such as Hervey Bay and urban areas such as St Lucia and Ipswich. However, a large proportion of migrants have come from diverse locations scattered across Australia comprising a mix of coastal, urban and rural locations. In addition, around 15 per cent of male youth and 7 per cent of female youth came from overseas. Female youth migrating to Chinchilla between 2006 and 2011 originated from more diverse origins than their male counterparts.

Considering migration of youth away from Chinchilla during the same period, nearby locations such as Toowoomba and Dalby remain important, along with a higher number of coastal locations such as Southport and Mackay and Brisbane suburbs. Considering the in-migration and out-migration profiles alongside, we see a net youth increase of 257 people, divided approximately evenly between males (130) and females (127).

To understand more about the relationship between migration and employment we considered changes in employment by industry by sex. Full details of these changes were not available as a time series so we provide these details only for the period 2006–2011 (ABS, 2013). In particular, female employment increased in construction, mining and accommodation/food services in CSG regions. Women employed in agriculture increased slightly on average in the Surat SLAs and decreased slightly on average in the Bowen SLAs. Interestingly, the mean values for male employment in the Bowen and Surat CSG regions increased in all categories except retail trade. The largest gains were in mining and accommodation/food services. Though agricultural employment amongst males increased slightly on average in CSG regions during the period 2006–2011, this has to be considered in the context of a broader decline in agricultural employment occurring in CSG regions. Specifically, recent research has shown a statistically significant decline in agricultural employment (males and females combined) in areas experiencing CSG development for the period 2001–2011 (Fleming and Measham, 2014a). Additional details of employment changes are presented in Tables S1 and S2 in the supplementary materials.

4.2.2. Skills and education

The skills and educational attainment for youth in the control group and CSG-affected regions is presented in Table 2. When we compare education outcomes on a place of usual residence basis

Table 1
Percentage of youth new to region since previous census.

	15–19		20–24		25–29	
	Male	Female	Male	Female	Male	Female
2006						
Bowen	27	33	49	59	57	63
Surat	26	30	39	50	42	55
Chinchilla	20	27	40	46	42	57
Control	23	24	30	39	34	42
2011						
Bowen	31	30	48	63	59	64
Surat	28	24	38	44	50	59
Chinchilla	25	36	40	53	60	61
Control	23	24	27	37	36	41

Notes: based on place of usual residence data (ABS, 2013).

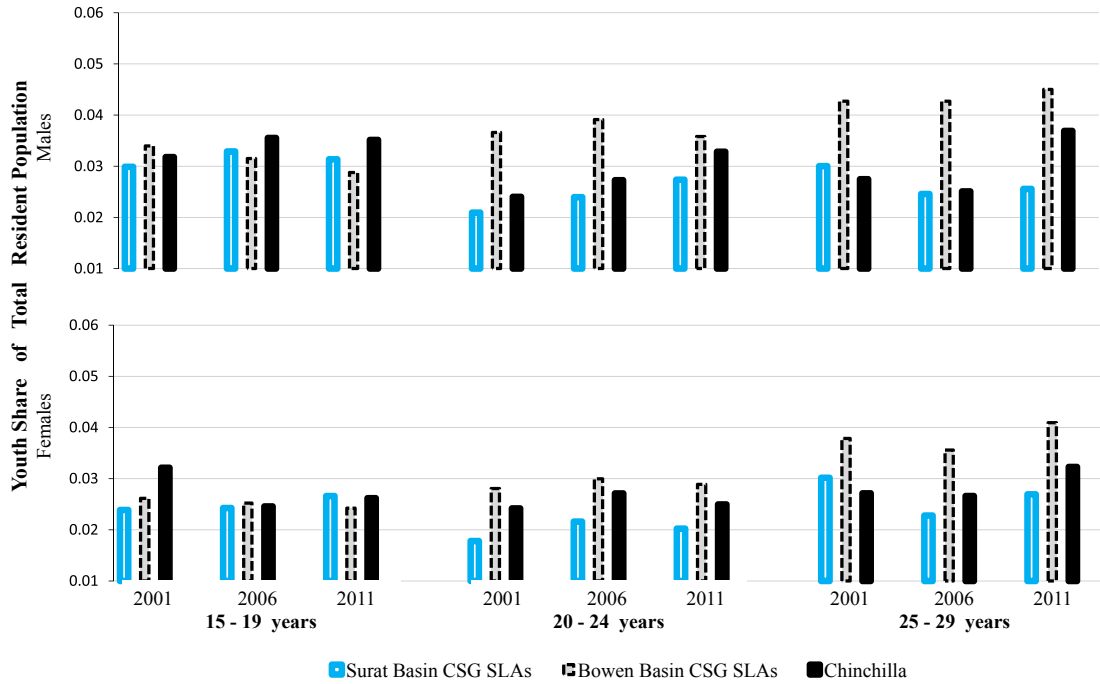


Fig. 2. Male and Female youth population share of total population based on place of usual residence.

between the CSG-affected regions and the control group in 2011, the main finding is that regions with CSG development have higher proportions of youth with university degrees for both males and females in all age categories compared with the control group (with the exception of females aged 15–24 in the Surat basin). In addition, certificate III and IV qualifications tend to be higher in regions

experiencing CSG development, while certificate I and II qualifications tend to be similar between CSG regions and the control group. Considering changes over time from 2001 to 2011 based on place of enumeration (Table S3 in supplementary material), the most striking result is the overall decline in university degrees across all observations, including the control group, and the increase in

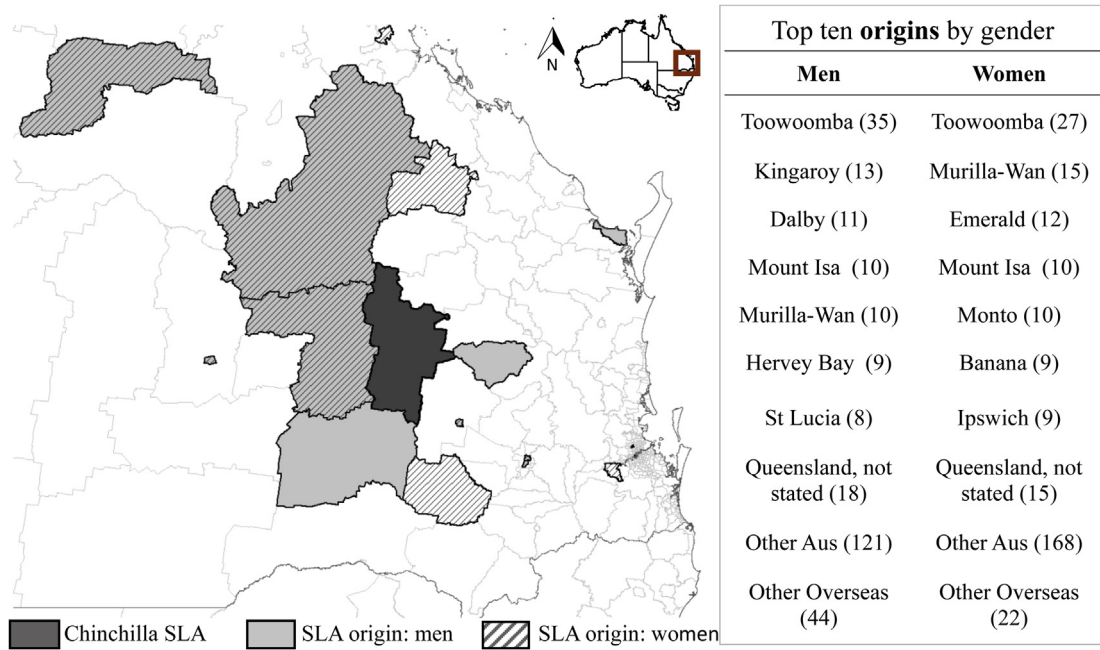


Fig. 3. Map of southeast Queensland showing top ranked statistical local areas (SLAs) from where youth immigrated to Chinchilla between 2006 and 2011. Notes: Total immigration of youth between 15 and 29 years old (age in 2011) shown in parenthesis. Except for ‘overseas’, ‘Queensland, not stated’ all values correspond to data by SLAs. Toowoomba includes data from 5 SLAs, and ‘Other Aus’ from 21 SLAs in men and 36 SLAs in women. Mount Isa SLA not shown in map. Source: Own elaboration with data from ABS (2013).

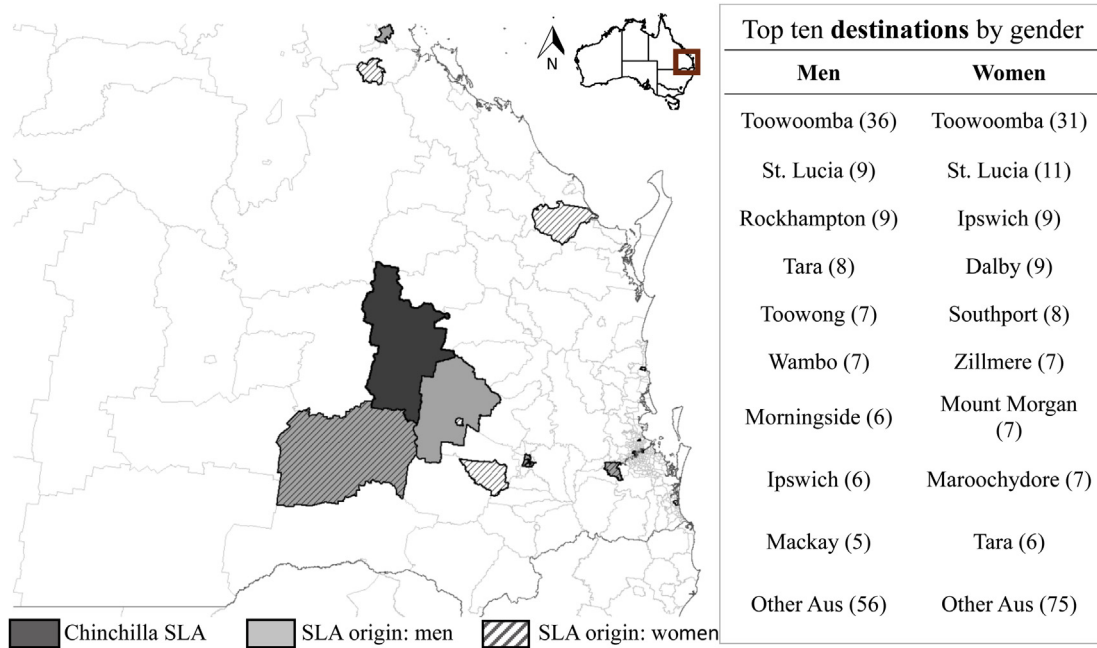


Fig. 4. Map of southeast Queensland showing top ranked statistical local areas (SLAs) to where youth out migrated from Chinchilla between 2006 and 2011. *Notes:* Total out migration of youth between 15 and 29 years old (age in 2011) shown in parenthesis. Values correspond to data by SLAs. Toowoomba includes data from 5 SLAs and 'Other Aus' from 17 SLAs in men and 21 SLAs in women.

Source: Own elaboration with data from ABS (2013).

certificate level (trade) qualifications over the decade from 2001 to 2011.

4.2.3. Poverty

The results for poverty alleviation are reported in Table 3. Using the expanded poverty line calculation described in the methods section, the proportion of resident families in the control group was nearly identical in 2001 and 2011. The proportion of families below the poverty line in the Surat and Bowen basins had decreased, but not by much. The most striking finding was that the proportion below the poverty line had greatly reduced in the town of Chinchilla. Whereas in 2001 Chinchilla had a higher proportion of poor families (couple with two children) compared to the control group, in 2011 it had a much lower proportion of poor families, a reduction from around 23 per cent to around 8 per cent, independent of long-distance workforces which do not count for family income calculations by the ABS (2013).

Table 2
Education attainment in CSG regions and control group in 2011.

		Surat	Bowen	Chinchilla	Control
Males 15–24	Bachelor	0.9	1.2	1.1	0.5
	Cert III and IV	5.8	5.7	7.1	4.8
	Cert I and II	0.8	0.6	0.3	0.8
Females 15–24	Bachelor	1.0	2.8	2.6	1.4
	Cert III and IV	4.2	4.7	5.2	3.2
	Cert I and II	1.5	1.4	1.4	1.6
Males 25–34	Bachelor	2.5	3.8	4.0	1.6
	Cert III and IV	9.2	13.6	13.1	8.5
	Cert I and II	0.6	0.6	0.2	0.6
Females 25–34	Bachelor	0.7	1.5	1.9	0.5
	Cert III and IV	5.3	8.6	8.0	5.4
	Cert I and II	1.4	1.4	1.4	1.3

Notes: based on place of usual residence. Values expressed as percentage of total male and female populations respectively.

Source: ABS (2013).

5. Discussion

The results provide key insights into the three core components of rural decline, namely rural out-migration, educational attainment, and poverty reduction; and how these are influenced by the development of unconventional gas. Taken together, the results show signs of mitigating and reversing rural decline during the period 2001–2011.

The youth out-migration described in Australia and USA is clearly visible in the control group in Fig. S1 in the supplementary materials (Gabriel, 2002; Argent and Walmsley, 2008; Johnson et al., 2005, 2011). The figure shows the decline is gradual but persistent, reflecting a chronic condition occurring in each youth age category. We see some signs of declining shares of males in the Bowen basin on a place of usual residence basis up until their mid 20s when this trend is reversed. We see stronger signs of increasing youth male share of the population in the Surat population. Moreover, by eliminating male-dominated LDC workforces, we see that the share of female youth is larger (and growing) in the place of usual residence data. This finding is counter to what one would expect in a region where growth is driven by a sector with male-dominated employment (Tonts, 2010; Baker and Fortin, 2001).

Table 3
Proportion of families (couples with two children) below 'expanded poverty line' measure.

	2001	2011
Surat Basin CSG SLAs ($n = 8$)	21.81%	18.35%
Bowen Basin CSG SLAs ($n = 6$)	7.52%	6.52%
Chinchilla ($n = 1$)	23.40%	8.33%
Control SLAs ($n = 81$)	21.28%	20.47%

Notes: Our 'expanded poverty line' in 2001 is \$599 and in 2011 \$999 (weekly), for a family of four (couples with two children). Proportions over total excluding families not reporting income in the Census.

Source: ABS (2013).

This is illustrated in the case of Chinchilla which shows substantial net youth increase for both males and females.

Considering the migration data for Chinchilla, the most common locations for origins and destinations are in the surrounding area. This is consistent with the principle that a large proportion of migrants to rural towns come from surrounding rural areas (Halseth, 1999; Argent and Walmsley, 2008). In addition, we can see youth moving between coastal locations such as Hervey Bay and Maroochydore, urban centres such as Brisbane and from other mining regions.

The boom in unconventional gas presented in this case study seems to be qualitatively different from the resource 'boomtown' effects reported in previous energy and mineral developments. Rather than accelerating the departure of young women from booming regions (Carrington et al., 2010), the case study presented here demonstrates an increase in female youth alongside the increase in young men. The data for female youth share of population provide clear evidence of mitigating youth out-migration, and show increases in some age categories. In particular there was a reversal of population decline in the age category 25–29 years during the period 2006 to 2011.

One of the themes in the rural studies literature is the extent to which youth are retained by rural regions, or depart to urban areas for education and return with new skills (Stockdale, 2004). Considering the destinations and origins for youth migrating to and from Chinchilla sheds some light on this issue in the context of unconventional gas development. The most common origins for youth migration to Chinchilla are within the surrounding Darling Downs region. Others are coming from very different backgrounds, including mining towns, suggesting that Chinchilla is also affected by migratory workforces in the resources sector. There is also evidence of two-way movement between Chinchilla and university suburbs in the State capital of Brisbane, although we can't track individuals through this data, so it is not possible to determine whether these are the same young people going to university and returning with degree qualifications (Stockdale, 2004).

The education data demonstrate that regions with CSG development have generally higher proportions of youth with university degrees and certificate III and IV qualifications. Because these data are based on place of usual residence we can eliminate the impact of LDC workforces on this indicator. Relating these results to the literature considered in the introduction, we can see that regions experiencing unconventional gas have higher levels of human capital which is an important dimension of how rural regions experience resource development (Winkler et al., 2012).

When we consider employment data for the period 2006–2011, we can see increased female employment in the Bowen and Surat basins in the areas of construction, accommodation/food, mining and, somewhat surprisingly, manufacturing (particularly in the Bowen basin). Male employment increased in all categories apart from retail trade; however the slight increase in agriculture needs to be set in the context of a longer term decline in agricultural employment in CSG regions (Fleming and Measham, 2014a).

Clearly some specialised roles in developing the unconventional gas industry require some non-resident workers, but this requirement is not as high as in other forms of resource development. Part of the reason we see different effects in unconventional gas development from the 'boomtown social disruption phenomenon' is precisely because the boom is superimposed over a pre-existing agricultural community, rather than a remote frontier environment, which rely predominantly on large groups of long distance commuters concentrated in small, under-served communities (Carrington et al., 2010; Cheshire, 2010). As noted in the introduction, the wider spatial footprint of unconventional gas means that impacts, both positive and negative, are spread over a wider area

and are more likely to be absorbed into a larger body of people (Stedman et al., 2012).

The results show mixed effects for CSG on rural poverty. Compared to the control group, there was a small effect of poverty reduction in the Surat and Bowen basins. However the impact was not evenly spread. The town of Chinchilla was a standout, going from being a location with higher rural poverty than surrounding regions to having one of the lowest rates of rural poverty. The results are consistent with recent research which shows a 15% increase in family income over the same period (Fleming and Measham, 2014a). On the surface, this appears to be a positive effect for Chinchilla, but needs to be considered in the broader context of costs of living and quality of life in this town, which is beyond the scope of this paper.

The focus of this paper has been on the substantive elements of rural decline, namely youth out-migration, skills retention and poverty alleviation during the first decade of CSG development in Queensland. However, it will be important to see how these issues change into the future. Furthermore, it is important to acknowledge that rural decline is also an issue of identity. One of the challenges with resource development more broadly has been about displacing agriculture and rural communities. We see this for example in the Hunter Valley of Australia, where the continued expansion of the coal mining sector has substantially encroached on other land uses to the point of overwhelming other sectors (McManus and Connor, 2013). The extent to which unconventional gas has similar effects remains unresolved at the time of writing. Research from the Marcellus Shale in USA indicates that some residents felt that the additional income stream to farmers and existing residents allowed them to maintain their way of life. Others were concerned about the different types of people moving into their area who might not value their way of life (Brasier et al., 2011). This raises important questions for further research on sense of place and sense of community associated with the development of unconventional gas. Is the cost of reversing rural decline the erosion of regional identity? Or can unconventional gas be developed in a way that is consistent with regional identity?

Another important question for further consideration is to what extent the development of unconventional gas pushes existing rural regions towards being simply a 'resource bank' to support economic development beyond the region. This issue is not so much a question of whether the region contributes to the broader economy, so much as the terms under which it does so. The difference lies in the types of services, housing and infrastructure which are developed in the region, with a view towards supporting a wider regional economy rather than expediting the flow of capital out of the region (Markey et al., 2008). In practical terms, the 'resource bank' model is more likely to be dominated by non-resident workforces, infrastructure which is designed to accelerate the removal of resources, and non-local supply chains (Tonts et al., 2013). By contrast, a more place-sensitive model is more likely to involve development of permanent housing, employment of local residents and locally sourced supply chains. For these reasons, it is crucial to map the flow of benefits to CSG regions to determine the extent to which economic benefits are retained.

Emerging research in Queensland CSG regions shows some signs of diverging from the resource bank model. Qualitative data indicate that residents perceive benefits as well as disadvantages. The former include growth of local businesses and improved health services (Walton et al., 2013). Quantitative analysis demonstrates job spillovers to other sectors are positive overall, but mostly limited to construction and professional services, while agricultural employment has decreased since 2001 (Fleming and Measham, 2014a).

It is also crucial to consider how changes in the resource sector translate into problems such as traffic, crime and health impacts reported in other resource development contexts (Carrington et al., 2010; Ruddell, 2011; Theodori, 2009; Colborn et al., 2011). Certainly there is some evidence of these impacts occurring, with long term residents of Chinchilla having experienced increased traffic and noise, and a lack of neighbourly behaviour from new residents (Williams and Walton, 2013). Some residents are concerned about housing availability and housing costs (Walton et al., 2013) so it will be important to track these impacts over time.

6. Conclusion

This paper has focused on three substantive components of rural decline: rural youth migration, educational attainment, and poverty reduction; and how these are influenced by the development of unconventional gas. Taken together, the results show signs of mitigating and reversing rural decline during the period 2001 to 2011. Locations with unconventional gas development have larger, younger populations, with some income benefits. Youth in CSG regions were found to be more educated than their counterparts from regions without CSG development. These findings apply to residents of CSG regions and are not affected by non-resident workforces which were excluded from the analysis. It will be important to continue tracking how rural communities experience the full range of impacts of new types of resource extraction into the future.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jrurstud.2014.04.003>.

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