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A novel model to estimate the impact of Coal Seam Gas extraction on agro-economic returns

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ABSTRACT

There is an ever growing demand for energy worldwide and the demand for gas alone is predicted to double between 2010 and 2035. This demand together with concurrent advances in drilling technologies caused the production of unconventional natural gas such as shale gas and coal seam gas (CSG), which is in the focus of this paper, to grow rapidly in the last decades. With the gas bearing coal seams extending across vast areas within their respective basins and with CSG production having to follow these seams through a network of production wells, pipelines and access roads, CSG activity affects large areas and therefore interferes with existing land uses, predominantly agriculture. For the eastern Australian Surat Basin and the southern Bowen Basin alone there are projected well numbers in excess of 15,000 to 20,000 between the years 2020 and 2030. The interference of CSG with agriculture on a large scale has raised concerns about the impact of CSG on farmland, food security, water resources and the socio-economic environment within the affected regions and beyond. This paper presents a newly developed spatial model which provides order of magnitude figures of the impact of CSG activity on gross economic returns of current agricultural land uses in a given region over the time of CSG production. The estimated gross figures do not account for any compensation payments received by farmers. The model is capable of accounting for a variation in a variety of parameters including impact frequency of distinct infrastructure elements, differences in soil types and associated varying responses of soil productivity, varying length of the CSG production phase and more. The model is flexible in that it can be transferred and applied in other regions as well. Based upon a literature review and given that CSG is an industry that started operating at larger scales relatively recently, we claim that the presented model is the first of its kind to provide these important agro-economic indicators.

1. Introduction

The demand for energy is growing worldwide and the demand for gas alone is predicted to double between 2010 and 2035 (Lyster, 2012). This ever growing demand as well as advances in drilling technologies caused the production of unconventional natural gas such as shale gas and coal seam gas (CSG) to grow rapidly in the last decades. CSG resources in eastern Australia are to complement the conventional, largely offshore, gas resources (Jaques et al., 2010) and annual CSG production in Australia increased from 1 PJ in 1996 to 240 PJ in 2010–11 (Geoscience Australia, 2012). With estimated Economic Demonstrated Resources (EDR) of around 35,900 PJ and taking the 2010–11 production rates as a baseline CSG reserves can be projected to last some 150 years. This does not account for Australia's substantial sub-economic demonstrated resources of 65,500 PJ and "very large" inferred CSG resources (Geoscience Australia, 2012).

Of the 35,900 PJ in EDR, some 92% (or 33,000 PJ) are in Queensland and the remaining 2900 PJ in New South Wales. Nearly all current reserves are contained in the Surat (69%) and Bowen (23%) basins with smaller amounts distributed across basins in New South Wales (Clarence-Moreton (1%), Gunnedah (4%), Gloucester and Sydney basin (Geoscience Australia, 2012; Moore, 2012). While CSG production was largely centred in the Bowen Basin in the mid 1980s to 1990s, the Walloon subgroup, a geological coal seam bearing unit in the Surat Basin, became the focus of gas companies from the year 2000 (Queensland Government, 2008). Fig. 1 shows the major coal basins of Australia.

Another factor that contributed to the rapid increase in the production of this energy source is the growing awareness of the implications of the release of greenhouse gas (GHG) emissions on climate which forces governments to consider the implementa-

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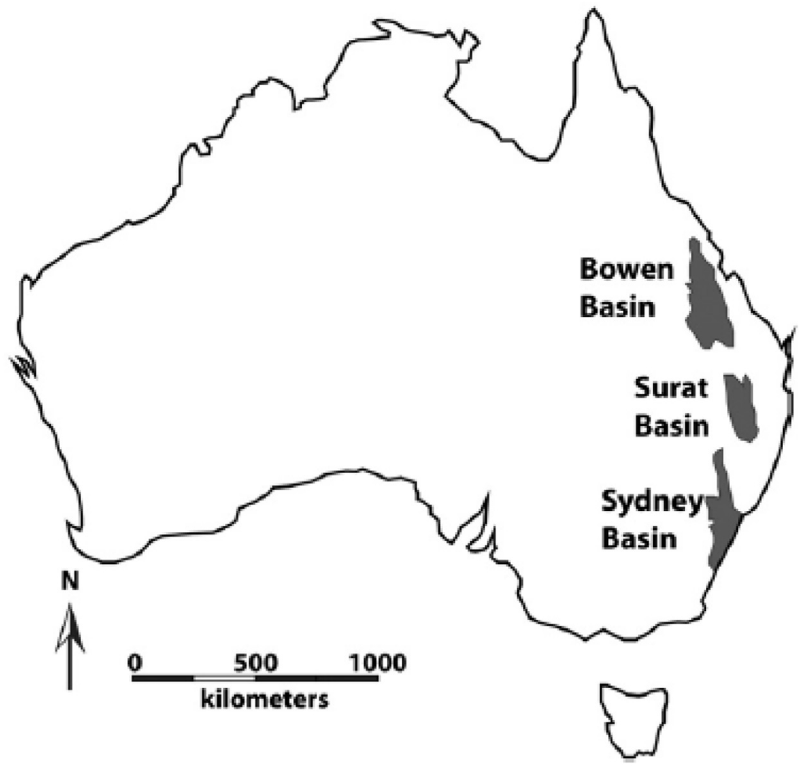

Fig. 1. Coal basins in Australia (from Moore, 2012).

tion of cleaner forms of energy (Poisel, 2012) and the production of electricity through the combustion of natural gas produces less GHG emissions than that from coal (Kember, 2012). However when comparing the life cycle GHG intensities per MWh of electricity produced Hardisty et al. (2012) found that the technology used in the combustion of gas can affect the degree of GHG intensity. Some authors (Kember, 2012; Hardisty et al., 2012) also point towards the necessity to include fugitive emissions from gas operations in these life cycle calculations e.g. at well sites or along pipelines. Hardisty et al. (2012) considered these emissions to be manageable by applying best practice. A recent study (Day et al., 2014) showed that fugitive emissions of the Australian CSG industry are below 1–2% and were considered very low compared to overall production.

Gas bearing coal seams extend across vast areas within their respective basins. CSG production follows these seams through a network of production wells, pipelines and access roads. CSG activity therefore affects large areas and interferes with existing land uses – predominantly agriculture. Klohn Crippen Berger Ltd (2012) provide estimates of active wells in excess of 15,000 to 20,000 between the years 2020 and 2030 for the Surat basin and the southern Bowen basin in Queensland. Given an average well density of one to two wells per square kilometre and accounting for all the infrastructure associated to wells the total area footprint will be substantial.

The interference of CSG with agriculture on a large scale has raised concerns about the impact of CSG on farmland and food security in Australia (Lyster, 2012) and in the U.S. where the impacts of shale gas production in the Pennsylvanian Marcellus shale on forest ecosystems and surface water were discussed by various authors (Drohan et al., 2012; Rahm and Riha, 2012; Olmstead et al., 2013; Drohan and Brittingham, 2012). Australian state governments are aware of these issues and are committed to strategies which involve a simultaneous increase of primary production and resource production while reducing GHG (Owens, 2012).

In Australia cropping land resources and related industries are considered key components of the economy. In Queensland alone the gross value of agricultural production was estimated at $13.7 billion in 2012-13 with an estimated 324,000 people employed across the whole food supply chain (Qld DAFF, 2013). In order to protect and preserve land that is highly suitable for cropping and to facilitate strategic planning the Queensland Government has imposed a variety of legislative frameworks (Queensland Government, 1992; Queensland DPI and DHLGP, 1993). More recent legislation includes the Strategic Cropping Land Act. This Act was repealed in June 2014 by the Regional Planning Interests Act 2014 (RPI Act) (Queensland Government, 2014) which provides a single integrated legislative framework that applies various existing policies including existing strategic cropping land policies. This legislation is intended to protect and preserve of the most valuable agricultural land and manage impacts of development on that land.

Agriculture has been the mainstay of economic development in southern Queensland, and the coal basins located there, throughout the 20th century (Schandl and Darbas, 2008). As such, agriculture has historically shaped regional landscapes and identities which, due to CSG development led by resource development, now face significant change. These changes and associated impacts are multifacetted and interfere with the biophysical, social and economic landscape.

The impacts that are subject of this paper are the impacts of CSG activity and its associated infrastructure elements on agricultural production and its returns. Because of the large scale of CSG development and its spatial intersection with agriculture there will be impacts on agricultural revenues due to:

- direct impacts on the soil resource base in that fertile soils will be compacted or removed and stockpiled (and later used for rehabilitation) resulting in reduced soil productivity, and
- the spatial footprint associated to CSG infrastructure elements which is equal to taking land out of production.