Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development

fact sheet

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Subsidence from coal seam gas extraction

What is subsidence?

Subsidence is a localised lowering of the land surface. It occurs when underground voids or cavities collapse, or when soil or geological formations (including coal seams, sandstone and other sedimentary strata) compact due to reduction in moisture content and pressure within the ground.

How does coal seam gas extraction occur?

Coal seam gas extraction involves the construction of production wells in coal seams, and extraction of groundwater from the coal seams at rates sufficient to lower the water pressure within them and enable gas to be released. This gas is then pumped to the surface along with the groundwater.

Economically viable gas-bearing coal seams are typically located at depths of more than 300 metres below ground, where the pressure is high enough to hold the gas within the seams. For gas to be released from coal seams, the groundwater level in the coal formation is typically lowered to within 35 to 40 metres of the uppermost coal seam by pumping groundwater from the seam. It may take up to five years of pumping to gradually lower the water pressure to the required level for gas to be released. Pumping continues at the rate necessary to maintain water pressure at the required level.

How does coal seam gas extraction cause land subsidence?

When groundwater and gas are extracted from coal seams, the reduction in water pressure may result in compaction of the geological units in which depressurisation has occurred (including the coal seam, and layers above and below). In addition, the liberation of gas from coal seams may result in additional compaction of the coal.

Compaction occurs as water is removed from the pores of saturated, high porosity layers (usually clays and silts, which form 'aquitards' - layers that retard the flow of groundwater). These layers cannot maintain the increased vertical stress as water pressure reduces, and the layers compact, resulting in subsidence of the land surface. Some of the compaction is elastic, allowing a degree of recovery and reversal of subsidence when groundwater pressure is returned (Figure 1).

Compaction and subsidence can also occur from groundwater pumping for other purposes, such as irrigation and town supply.

How much subsidence occurs?

The amount of subsidence will depend largely on the depth and thickness over which depressurisation and compaction occurs, and the properties of the geological units overlying the depressurised unit.

There is no documented evidence of subsidence occurring from coal seam gas developments in Australia. Modelled

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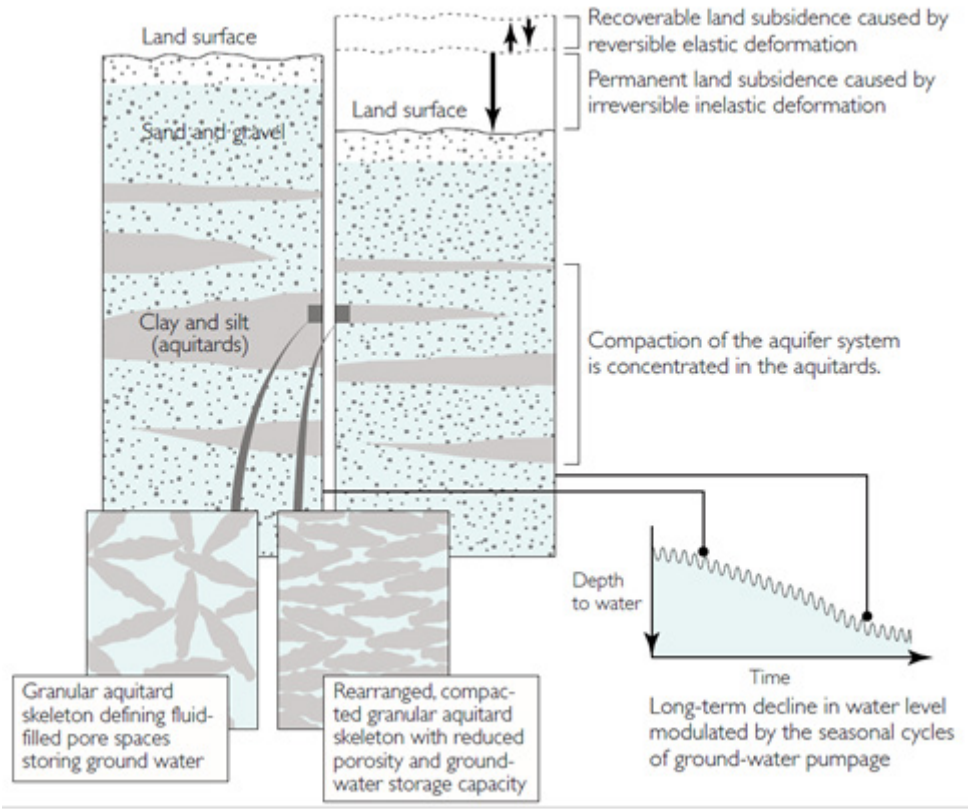

Figure 1 Subsidence from groundwater withdrawal and depressurisation.
Source: USGS, 1999.

predictions of surface subsidence for individual coal seam gas fields in Queensland range from 30 to 850 millimetres (Coffey Geotechnics, 2013).

There is little international information available describing observed subsidence from coal seam gas extraction. However, in the Powder River Basin, Wyoming (USA), data collected from 1997 to 2000 and 2004 to 2007 indicate 47 and 83 millimetres of subsidence respectively, with the major subsidence signals correlating spatially with the areas of greatest groundwater drawdown (Grigg et al., 2013).

When does subsidence occur?

It is expected that subsidence caused by coal seam gas extraction will not occur instantly, but may take several years to develop.

What are the potential impacts of subsidence?

Surface subsidence poses a range of potential impacts, including surface cracking (especially in areas towards the edges of subsidence zones), diversion of surface water and groundwater from existing flow paths, and damage to infrastructure. Analysis by coal seam gas development proponents suggests

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that the subsidence impact from coal seam gas operations is likely to be undetectable from background landscape movement, and the risk of damage to infrastructure is anticipated to be low (Australian Government, 2014).

How is subsidence from coal seam gas extraction predicted?

Subsidence is predicted using numerical models that first estimate the amount of depressurisation that may occur in the various geological formations both above and below coal seams. This information is then used to predict compaction due to both changes in groundwater pressure and degassing of coal seams.

How is subsidence measured?

Subsidence can be measured using a variety of techniques. In Australian coal seam gas areas, preferred techniques to monitor for subsidence include:

- satellite-based InSAR (Interferometric Synthetic Aperture Radar); this remote sensing method provides images of the earth's surface from different points in time that can be compared to detect elevation changes to an accuracy of 5 – 10 millimetres over large areas.
- borehole extensometers; these are located within boreholes and measure change in height between the bottom of the bore and land surface to an accuracy of about 3 mm. Multiple readings over time measure changes in bore height above a reference point, and therefore infer subsidence at a single location.

How can subsidence impacts from coal seam gas extraction be minimised or remediated?

Subsidence impact management requires prediction of subsidence depth and extent, identification of assets potentially affected and their associated risks, monitoring of groundwater and land surface changes, and implementation of actions to address potential or observed adverse impacts.

Actions to address potential or observed impacts may include modifying wellfield design, repair/make-good actions for impacted assets, and injection of water into geological formations to reduce the extent of depressurisation.

Future directions: knowledge gaps and strengthening the science

Large scale coal seam gas extraction is a relatively new area of development, within Australia and internationally, and there is a lack of data on associated observed subsidence. In this environment, it is important that predictions of groundwater drawdown, compaction and subsidence are well documented, and monitoring is undertaken to:

- establish robust baseline datasets; and
- provide sufficient history and both spatial and temporal resolution to detect change and understand cause and effect relationships.

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Potential areas for investigation and research into subsidence from coal seam gas development include:

- understanding the risk of subsidence in Australian coal seam gas fields and the levels of uncertainty associated with this risk;
- determining the potential for subsidence to alter the permeability of geological units; and
- identifying the data requirements and availability in coal seam gas fields to describe the properties of the key layers for subsidence modelling.

References

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