priorities

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

IESC Priorities for Research

The Committee provides advice to the Australian Government Minister with responsibility for the Environment, on priorities for research projects to address knowledge gaps and improve the scientific understanding of the potential water-related impacts of coal seam gas and large coal mining developments.

In 2013, the Committee identified priorities for research projects under four broad themes: Hydrology, Ecology, Chemicals and Cumulative Impacts. The priorities were based on an analysis of current and emerging research, and were informed by public consultation undertaken in 2012. Workshops were also held with academia, Australian and state government agencies, industry and the community, with a mix of expertise and experience in geology, hydrology, hydrogeology and ecology, as well as geographic coverage. The Department of the Environment and Energy commissioned $19 million of research projects guided by the 2013 IESC priorities.

Given the completion of the Department of the Environment and Energy's $19 million research program in 2017, the Committee reviewed the IESC research priorities. The updated research priorities were informed by consultation with Australian and state government agencies, industry, researchers and non-government organisations and take into account current and emerging research. The research priorities were recommended to the Australian Government Minister with responsibility for the Environment by the Committee in June 2017. The IESC research priorities may inform research institutions, research funding bodies, government science agencies and industry in developing research plans and priorities.

Reflections on the lake at the Hunter Wetlands Centre (Shortlands Wetland), ©Department of the Environment and Energy

This initiative is funded by the Australian Government.

Research priority	Key research needs
HYDROLOGY	
1 Characterising hydraulic properties of aquifers and aquitards	Modelling of the impacts of coal seam gas extraction and coal mining on groundwater requires an understanding of the lithology, hydrogeological characteristics and geological structures of aquifers and aquitards. A better understanding is needed at local and regional scales of hydrogeological characteristics including values of storage properties and vertical hydraulic conductivity for key aquifers and aquitards.
1a Leveraging from petroleum engineering and geology data	The petroleum industry has detailed information and data on the properties of petroleum reservoirs. There is a research opportunity to improve understanding of deep aquifers by better linking hydrogeology and petroleum data. A process is needed to capture data on hydrogeological characteristics from both sources in national databases.
1b Linking groundwater models of different scales	Groundwater models used in assessment of impacts of coal seam gas extraction and coal mining are often at different spatial scales. A review of methods to link groundwater models of different scales would assist in analysing potential cumulative impacts of multiple developments. Linked to Hydrology priority 5c.
1c Dual phase and dual porosity flow and geomechanical effects in groundwater models	The research needs are to identify methods for representing these processes in a simplified way for regional modelling and estimating the magnitude of the consequent errors; assess the extent to which these factors influence regional modelling and prediction of the volumes of produced water; and develop relationships to identify the areas/environments and times for which these factors are important for regional groundwater modelling.
2 Impacts to upland peat swamps and water bodies associated with coal mining	Temperate Highland Peat Swamps on Sandstone and Coastal Upland Swamps in the Sydney Basin Bioregion (collectively termed upland peat swamps) are listed as endangered ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999*. Longwall coal mining beneath upland peat swamps may fracture the sandstone substrate and alter the swamps' water balance. An improved hydro-geomechanical understanding is needed of the depth of fracturing near the ground surface, the height of fracturing above the mined seam that may enable connectivity to surface, and non-conventional subsidence including mining-induced reactivation of geological faults. Each of these processes may impact on the water holding capacity of the swamps.
3 Hydraulic fracturing	The experience of hydraulic fracturing in Australian coal seams could be reviewed to assess the impact of fracture stimulation activities on well integrity, the failure rates associated with coal seam targeting during perforation, and to improve understanding of fracture growth in and beyond coal seams. This could potentially include developing leading practice guidelines for fracture growth modelling.
4 Voids	There is a lack of knowledge of the status and impact of final voids associated with open cut coal mines. The research need is to determine the number of voids; their types; water qualities; surrounding groundwater qualities; comparison of water qualities/quantities with model predictions; interaction between voids; impacts on surrounding environments; depth profiles of redox in voids and the effect on groundwater quality and flow characteristics.

Research priority	Key research needs
5 **Assessment and modelling of groundwater and surface water connectivity**	Groundwater extraction may lead to changes in the flow regimes in connected stream and wetlands. Prediction of the water-related impacts of coal seam gas extraction and coal mining relies on understanding the nature of the groundwater and surface water connectivity regime.
5a **Improving understanding of groundwater recharge from surface water bodies**	Groundwater recharge from floods is a major component of recharge to alluvial systems, but few groundwater models include flooding. A first step is a review of techniques to estimate flood recharge to alluvial systems near existing or proposed coal and coal seam gas operations, and consequent leakage to deeper aquifers.
5b **Seepage relationships between surface water and groundwater**	Seepage relationships between groundwater and surface water bodies are poorly quantified. Integrated modelling and measurements of seepage in priority areas will improve understanding of potential water-related impacts of coal seam gas extraction and coal mining.
5c **Linking surface water and groundwater models**	Surface water and groundwater models are usually at different spatial and temporal scales. This research priority would investigate ways to improve modelling of surface water impacts at finer scales. Linked to Hydrology priority 1b.
CHEMICALS	
1 **The fate, transformation and degradation of hydraulic fracturing fluids**	There is limited information about liquid and gas migration from production wells *or target coal seams* to aquifers (particularly at depth), and long-term liquid and gas migration from the fracture zone via pathways in subsurface rock formations. Developing and applying stable isotope methods to detect contamination in aquifers is one possible research strategy.
2 **The effects of fracturing fluids on the release behaviour of geogenic contaminants**	Hydraulic fracturing fluids have the potential to mobilise geogenic contaminants. Potential mobilisation is affected by elevated temperature, pressure, coal type and fracturing fluid composition. Improved understanding is needed of the transformation and fate of geogenics, including volatile geogenics and new products formed during fracturing, under different physico-chemical conditions.
3 **Composition and effects of flowback and produced water**	Knowledge on the composition and effects of flowback and produced water is required. In particular: development of analytical laboratory methods for detecting and quantifying their composition; characterisation of their physico-chemical, chemical and ecotoxicological properties; identification of factors that influence their composition (e.g. formation type, fracturing fluids used, sub-surface processes, interaction with mobilised geogenics and residence time); and determination of their bioaccumulation and effects on aquatic ecosystems. The toxicity of mixtures and the interactive effects of chemical additives also need investigation.

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4 **Waste water management**	A review of treatment options (e.g. reverse osmosis) for waste water from coal seam gas and coal mining operations, considering: their effectiveness especially for total dissolved solids and endocrine-disrupting chemicals; effects of conductivity and total dissolved solids on freshwater aquatic biota (e.g. stygofauna, turtles, frogs); the persistence and mobilisation in soil/sediments of naturally occurring radioactive material decay products; and effects-directed screening approaches to assess endocrine-disrupting and other effects of mixtures.
5. Emerging issues	In addition to the research priorities outlined above, there is a need to identify and investigate emerging issues, such as the impact of microbially enhanced CSG production.
ECOLOGY	
1 **Assessment of water-related habitat requirements for selected species and ecosystems**	Prediction of responses of species and ecosystems to hydrological change in areas with current or potential coal resource development remains a research need which is hampered by paucity of data at adequate spatial and temporal scales. Predicted responses derived from modelling approaches need to be validated using field data. This research would build on existing information (such as bioregional assessments) to articulate a set of specific hypotheses and supporting conceptual models for field-testing predicted responses of priority ecological endpoints (taxa, communities or ecological processes) to hydrological variables.
2 **Linking hydrogeological and ecological conceptual models**	Conceptual modelling is a fundamental tool which facilitates shared multidisciplinary working, makes assumptions explicit and informs hypothesis generation. Hydrogeological and ecological conceptual models are usually at very different scales. Development of a protocol for linking ecological and hydrogeological conceptual models would enable identification and assessment of vulnerable biota and their ecological responses to hydrological changes associated with coal seam gas and coal mining development.

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