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Findings from the International Research Network on Risk Assessment for CO_2 Geological Storage

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Introduction

The Risk Assessment (RA) network, one of several international research networks operated by the IEA Greenhouse Gas R & D Programme, was launched at a meeting hosted by TNO-NITG in Utrecht, Netherlands, in August 2005. Subsequent meetings were held hosted by the Lawrence Berkeley National Laboratory in California during October 2006, and by Imperial College, London during August 2007. Representatives from the RA network attended a joint network meeting held in New York in June 2008, and the 2009 RA network meeting is scheduled to be held in Melbourne, Australia in April 2009.

Early studies by IEA GHG and others concluded that to gain public acceptance of CO_2 Capture and Storage (CCS), two key areas need to be demonstrated: that the technology is safe, and that its environmental impact is limited. RA provides a structured framework through which potential problems of safety and environmental impact can be evaluated. These considerations led to the formation of the network in 2005.

Aims and Objectives of the Network

The overall aim of the network is to bring together the key groups working on risk assessment for CO_2 storage from around the world, to share knowledge and experiences. There is an emphasis on potential regulatory requirements with regard to CCS safety and impact assessment.

At the launch meeting in 2005, specific aims and objectives were set for the network:

- Develop an open and transparent process to allow different risk assessment approaches and associated results to be understood,
- Provide a forum where different approaches to risk assessment can be compared,
- Provide an 'umbrella group' for international collaboration,
- Identify knowledge gaps and determine actions required to close these gaps,
- Act as an informed body on risk assessment and to maintain dialogue with regulators and NGO's

Key Findings

RA provides a structured framework for the assessment of potential adverse impacts and is used in a wide variety of applications. Risk can be defined as a function of both the impact/severity of

a potential hazard, and the probability of that hazard occurring. Risks can be assessed qualitatively, based solely on expert opinion and engineering judgement, or quantitatively (QRA). Deterministic or probabilistic approaches to QRA may be employed; for complex systems which need to account for variability and uncertainty, probabilistic calculations are required as deterministic QRA is may give misleading results. A definition of risk assessment in the context of storage was defined as the means of identifying, estimating or calculating and evaluating potential risks of storage to human health and safety, the environment and assets.

The magnitude of potential impacts and consequently levels of risk, are anticipated to decline with time after injection is completed, due to the progressive trapping of stored CO_2 by secondary mechanisms including dissolution and mineralisation. These processes are likely to reduce pressure and diminish leakage potential, by decreasing the proportion of CO_2 stored as free-phase. A key challenge facing researchers is to better understand and quantify the various trapping mechanisms that determine the long-term fate of injected CO_2, allowing more accurate determination of storage capacities and better assessment of associated risks. These factors are of particular importance for deep saline formation (DSF) storage projects, where greater potential capacity must be weighed against greater levels of uncertainty.

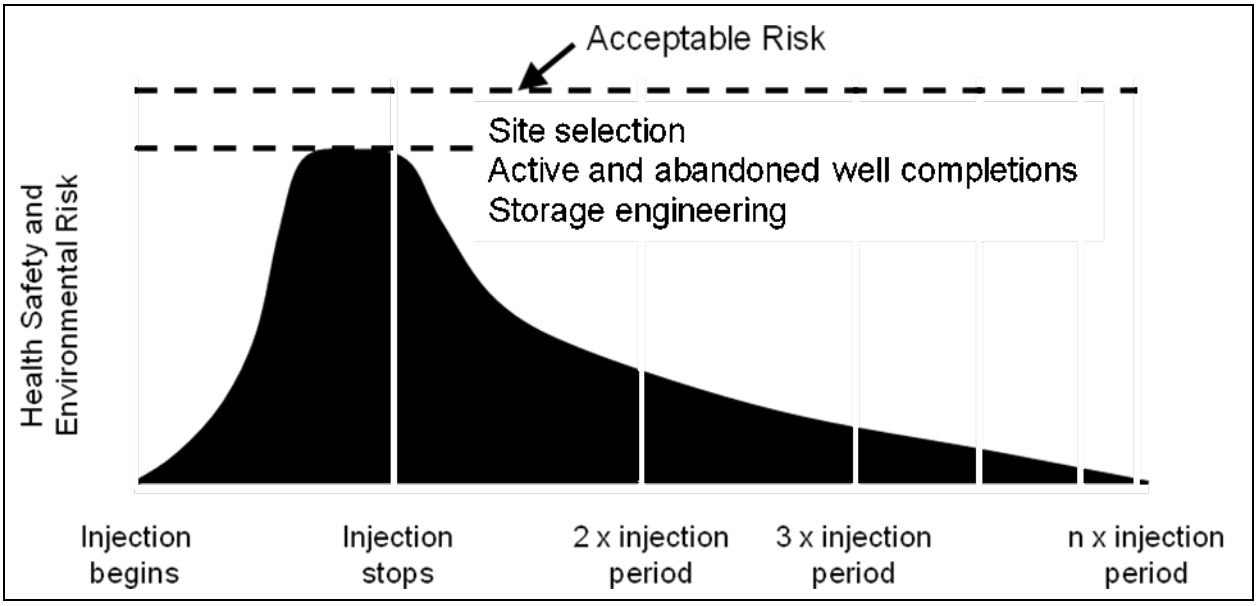

Figure 1. Theoretical Risk Profile for CO_2 Geological Storage (adapted from Benson 2008)

Natural storage analogues have been discussed and identified as a means to build confidence in storage:

- Helping understand leakage and trapping mechanisms,
- Verification of numerical models and risk assessment procedures,
- Interpretation and risk management,
- Helping to communicate the safety of CO_2 storage sites.

By compiling a database of events from natural and industrial analogues comparable to those that could occur from CO2 storage, a matrix could be constructed to allow comparison and communication of storage risks in a readily understandable manner.

The network quickly identified a need for dialogue with the regulatory bodies, concerning their needs and expectations of risk assessment within regulatory processes. Consequently, a study was commissioned by IEA GHG in 2007 on the role of risk assessment in the regulatory framework. For this study, a briefing document and accompanying questionnaire was sent to actual/potential implementers and regulators of CCS projects.

The briefing document included several key messages, including the relatively long timescales that CCS projects require RA to cover, the difficulty in predicting leakage rates, and the importance of analogues (industrial/natural) and monitoring to demonstrate confidence in CCS.

Analysis of the questionnaire responses, encouragingly, showed no major discrepancies between regulator and implementer opinions. Implementers stressed the need for clear regulatory guidance, standardised RA methodologies and assessment criteria, and improved predictive modelling with support from experimental and analogue data. Regulators emphasised the importance of R&D in shaping regulatory opinion and also noted the need for leakage detection and for verification of storage capacity estimation.

Network meetings have debated alternative use of quantitative, qualitative, or simple analytical methods to analyse storage risk, and concluded that whilst quantitative risk assessment is preferable, present knowledge could restrict methods to semi-quantitative or predominantly qualitative approaches.

RA, which is ‘problem orientated’, was identified as part of a larger risk management framework, which focuses more on monitoring and remediation and is ‘solution orientated’. Consensus was reached in network discussions that for risk communication, emphasis should be placed on ‘solutions’ ahead of ‘problems’. At the joint network meeting in 2008, the formation of a new IEA GHG network on storage modelling was debated. A workshop on this topic, co-organised by BRGM, Schlumberger and CO_2GeoNet, was held in Orleans, France in February 2009; the event attracted over 100 participants from 14 different countries, thereby demonstrating the justification for a network on modelling, which will hold a first meeting in 2010. As with the IEA GHG networks on monitoring and wellbore integrity, it is envisaged that the new modelling network will support the RA network, which will provide facilitated discussions on the wider aspects of the entire risk management process.

Next Steps

In the concluding session of the third meeting and at the subsequent joint network meeting, a number of issues were identified that will steer the agenda for future meetings. With regard to RA terminology, Imperial College is performing a study to identify and define key terms that are integral to storage risk assessment. It is intended that this study will include a questionnaire to people within the industry, in order to build consensus on the terms used and their definitions.

A number of additional issues/questions raised during network meetings need to be addressed. These include:

- Risk assessment guidelines? – are they required and if so, what is the best way of formulating them?
- What level of confidence can be placed in modelling results generated for storage projects?
- How long do we need monitoring after the cessation of CO_2 injection?
- How applicable is the accident/worst case scenario approach to the overall risk assessment process?

For the future development of RA methodology, demonstration projects will undoubtedly be a significant source of information that can be drawn upon to help develop confidence and inform future risk assessment. These projects will naturally take time to produce the required results; in the interim, natural and industrial analogues may be used as sources of information and to generate confidence in geological storage of CO_2 as a safe and environmentally acceptable mitigation option.