



## **Assessing the risks to groundwater contamination from hydraulic fracturing in the UK: A probabilistic modelling approach**

Olivia Milton-Thompson, Akbar Javadi, and Zoran Kapelan

Exeter University, College of Engineering, Mathematics and Physical Sciences, United Kingdom (om271@exeter.ac.uk)

Hydraulic fracturing has been a successful industry in the US, which has prompted other countries to exploit their shale gas to improve their own energy production and reduce their need to import. In addition, the burning of shale gas is cleaner than other fossil fuels and many countries could be sitting on decade's worth of shale gas, reducing the need to use other diminishing fossil fuels. The UK has taken an interest in exploiting its shale gas resources but experiences from the US have heightened the public's concern relating contamination of water resources to hydraulic fracturing holding back the production of shale gas in the UK.

If the UK develops a shale gas industry it is important to establish a fully informed risk management strategy to ensure the protection of water resources. Therefore, this project focuses on developing an integrated model to quantify the individual probabilities of contaminants reaching groundwater within a generic scenario so this can be applied to specific case studies around the UK.

The development of the integrated risk assessment follows three main stages. To understand in detail all the risks to groundwater associated with hydraulic fracturing, a qualitative list of all the contaminant pathways leading to groundwater is developed. This takes the format of a database. This database is used to develop event trees, initially qualitatively, to define branch probabilities for a specific contamination pathway. Literature, data, models and expertise knowledge is used to quantify these branch probabilities where feasible and to determine the severity of each event. The engineered risk is quantified as the product of probability and consequence.

All individual risks which might lead to groundwater contamination have been defined using a features, events and processes (FEP) approach; a method which has been used in the risk assessment of carbon capture storage. This database produced 49 individual FEPs which considered all the potential pathways of contaminant movement to groundwater throughout the life cycle of a hydraulically fractured well, from initial site setup to closure and long-term abandonment of the well. A risk matrix has been used to rank the importance of each pathway. Well integrity, spills and management of wastewater are the main culprits for groundwater contamination as demonstrated from the risk matrix and these are the initial focus for event tree development and quantification. Event tree development for well integrity and spills has been the focus for the project at this stage.

Some areas of risk to contamination of groundwater have already been quantified and can be used on the event trees. However, a challenge remains for assessing individual branch probabilities, which will require domain knowledge and individual expertise. This project aims to take a generic overview, so the probabilistic risk model can be applied to any area within the UK assuming the necessary parameters are available.