ENVIRONMENTAL RISK ANALYSIS AND RISK MANAGEMENT TECHNIQUES ASSOCIATED WITH CCS:

A comparison between the FTA and AHP methods

Behdeen Oraee-Mirzamani[1], Tim Cockerill[1] and Zen Makuch[1]

[1]Centre for Environmental Policy, Imperial College London

PROJECT OVERVIEW

In order to attract investment in the CCS industry, the risks have to be well understood. Therefore, this project aims to study and understand the risks involved and to discover the gaps in knowledge of CO_2 storage. This project aims to present a coherent understanding of the chain of events that could lead to major failures in CO_2 storage projects. This will enable insurance companies and regulators/policy makers to adjust their current terms and premiums for insuring CCS projects against the risks and to help them better understand the risks and hence legislate more effectively to address the risks associated with CCS respectively.

This research project has attempted to study and understand the risks involved in the storage of CO_2 and the way in which they can be quantified in order to gain a better understanding of the likelihood of their occurrence. The project aims to achieve this by calculating a set of probability distributions using the FTA method in conjunction with the AHP method. By doing this, insurance companies can be instructed as to which risks they have to take into account more in comparison with others so that they can minimise the financial risks by tying them down and therefore lower their premiums for insuring CCS projects.

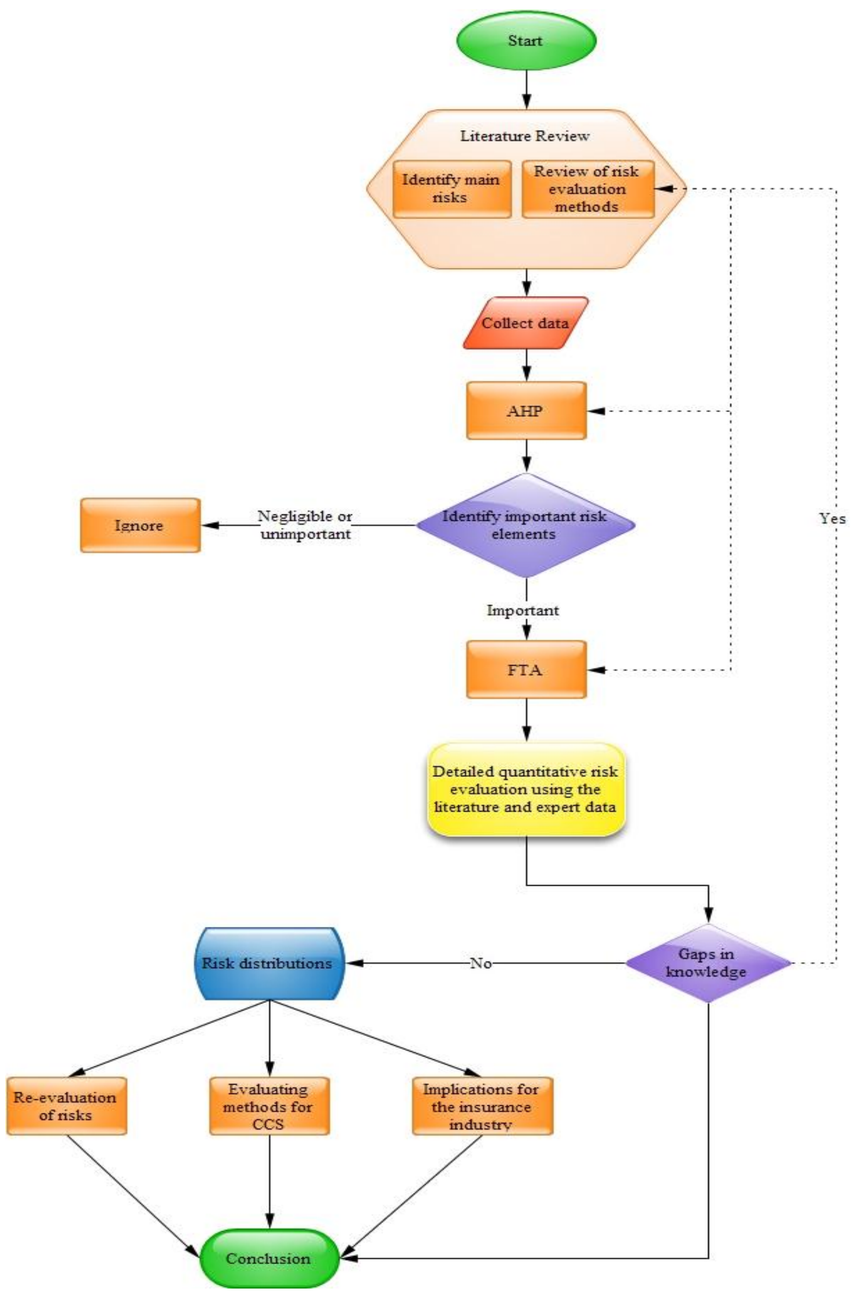

Figure 1, shows the methodological framework of this project

METHODOLOGY

This project aims to systematically quantify the risks associated with CO_2 storage by using the Fault Tree Analysis (FTA) method in conjunction with the Analytical Hierarchy Process (AHP) method. These methods have been rarely used in CCS projects whereas they have been used widely in other similar industries (similar in terms of the risks involved and their potential consequences) such as Nuclear, Oil and Gas.

The way that this analysis is going to be carried out is as follows. Firstly, the risk events identified in the study are going to be presented to a set of experts in the field of CCS in the form of online surveys. This will be done in order to find out which one of the said risks are actually significant enough.

The chosen experts are going to use the AHP method in order to rank the risk events. It is expected that the AHP method will partially provide the input for the FTA method. This will be in the form of different weights for different risk elements within the fault tree developed in the study. The FTA method will then calculate a set of probability distributions for the risk events using Monte Carlo analysis. Furthermore, these probability distributions are going to be combined together in different combinations in order to obtain an overall probability distribution of the risks in question.

ANALYTICAL HIERARCHY PROCESS (AHP)

The AHP method is used in order to derive ratio scales from paired comparisons of the risk elements within CCS. Experts' opinions have been used as a case study in order to demonstrate the use of this method. The four risk elements shown in table 1 were ranked according to their importance and criticality by experts. The "migration of CO_2 along a fracture or permeable zone" was ranked first being the most likely to happen should failure occurs, the second most probable failure mechanism according to expert opinions was "percolation of CO_2 through the caprock" and "leakage through or along the injection well" was ranked to be the third most probable failure mechanism. Finally, the least probable failure mode was "leakage through other wells" with only about 8% chance of occurring.

	Migration of CO_2 along a fracture or permeable zone	Percolation of CO_2 through the caprock	Leakage through or along the injection well	Leakage through other wells	Average	Weight (%)
Migration of CO_2 along a fracture or permeable zone	0.26	0.53	0.13	0.27	0.29	29.94 (Rank 2)
Percolation of CO_2 through the caprock	0.13	0.26	0.52	0.36	0.32	32.08 (Rank 1)
Leakage through or along the injection well	0.52	0.13	0.26	0.27	0.29	29.73 (Rank 3)
Leakage through other wells	0.08	0.06	0.08	0.09	0.08	8.25 (Rank 4)
Total	1.00	1.00	1.00	1.00	1.00	100

Table 1, matrix that the participants were asked to fill in by comparing the element in pair-wise

CONCLUSIONS

This project has produced preliminary results that shows how the AHP method can be used in the CCS industry. In addition, this project has also identified how the AHP and FTA methods can work together in order to assess the importance and criticality of the risks associated with the storage CO_2.

There are a number of challenges in this project and the most important one was identified using the survey used within the AHP method. This study has made it clear that the major challenge in addressing the risks associated with CO_2 storage and the long term liability problem is the lack of credible quantitative data about risks in CCS. Therefore, the AHP method has been used in a wider scale to perform sensitivity analysis in order to form an understanding of the importance and criticality of those risks.

REFERENCES

1.Makuch, Z., Georgieva S. and Oraee-Mirzamani, B., Carbon Capture and Storage in the United Kingdom (254 pages), (Imperial College Press), 2011

2.Benson, S.M., 2006, "Carbon dioxide capture and storage assessment of risks from storage of carbon dioxide in deep underground geological formations". Lawrence Berkeley National Laboratory.