Updated IP: IEAGHG Information Paper; 2013-IP33;
RISCS workshop 25th September 2013, London

RISCS is a European project which aims to improve the understanding of the possible environmental impacts of geological storage of CO_2. There are 24 organisations participating in RISCS including research institutions, industry, environmental associations and IEAGHG. The project has studied a wide range of potential impacts to provide a scientific basis for developing appropriate legislation and to ensure the safe management of CO_2 storage sites. This Information Paper is a summary of the workshop held in London on 25th September.

The workshop consisted of a series of presentations on the results of a four year collaborative project to investigated CO_2 emissions from both natural seepages and experimental sites. The objective of the project is to determine the environmental impact of CO_2 on natural habitats in the event of leakage from a future storage site. The workshop was split between marine and terrestrial environments. The potential impact of CO_2 leakage into a ground water aquifer was also included. When new sites are identified there will need to be comprehensive Environmental Impact Assessments (EIAs) to determine potential impacts and mitigation strategies. It is also possible that unlike incidents like major crude oil spills CO_2 leakage will dissipate into the atmosphere and the natural habitat affected by the leak will recover once the leak has been stopped. The RISCS study is aimed at the potential evolution of hypothetical situations. It is not attempting to make predictions.

A key point, emphasised throughout the workshop, was the necessity to complete thorough baseline surveys. These surveys need to take account of natural variability in seasonality, salinity and tidal currents. Consequently, baseline surveys need to be repeated to ensure that natural variability is fully appraised.

Marine Environments

The impact of CO_2 on marine ecosystems has been investigated by evaluating occurrences of natural submarine seeps and artificially controlled environments (mesocosms).

Mesocosm experiments have been used to evaluate how changes in pH affect organisms in a marine environment. Crabs exposed to a progressive reduction in pH from 8.7 to 7 showed an increased tolerance to this shift expressed in lower mortality rates. However a sudden reversal to pH8.7 caused a sharp increase in mortality. This experiment suggests crabs are unable to tolerate sudden shifts in pH. The crabs' ability to acclimatise to a drop in pH requires a greater energy demand to sustain homeostasis. In situations where there is an abundance of food, and therefore energy supply, organisms might be able to counteract environmental stress such as a fall in pH to the extent that growth and even reproduction are possible.

Other experiments revealed that acidification induced by CO_2 emissions would be detrimental particularly for calcifying species. Observations from mesocosm experiments show that there is a reduction in species abundance and greater vulnerability to acidification below pH6. Algal growth increases in the presence of CO_2 generating a greater abundance of food.

Natural CO_2 seepage sites in shallow marine conditions north of Sicily were investigated. A video presented at the workshop showed different areas with varying intensities of bubble streams. In some areas there are high rates of discharge forming bubble curtains. In other areas there were diffuse and limited emissions. The abundance of fish and even an octopus attest to the extent of natural adaptability to the proximity of limited CO_2 emissions.

The presence and accumulation of algal / cyanobacteria mats can indicate the presence of natural seeps. There is also a reduction in the colonisation of juvenile bivalves. Subsea surveys have revealed the presence of mini craters caused by the build-up and then sudden release of gas.

Recolonisation of purged areas occurs once leakage stops or is severely reduced. The larval stages of marine organisms such as bivalves are dispersed in the open sea and will colonise suitable substrate.

Key points raised in general discussion highlighted a number of issues:

- Rates of CO_2 used in models reflect different conditions. An example of a 1,500 t/day emission is not representative of natural seepages, but it might represent a worst case scenario such as a blow-out.
- CO_2 emissions and the resultant decrease in pH can have secondary impacts. For example, low pH causes heavy metals to become mobilised and released as toxins into the environment.
- Broad scale monitoring might also detect false positives i.e. seeps or other phenomena that are wrongly interpreted as CO_2 leakage from a geological storage reservoir.
- Research shows that organisms that live in sea water with low temperatures (Arctic) or low salinity (Baltic) are more sensitive to environmental change. Other factors such as exposure to industrial pollutants have similar effects.
- Bespoke monitoring that concentrates on multivariant analysis is essential to take account of variability in pH, pCO_2, tidal currents, salinity, seasonality and nutrient influxes from terrestrial sources. This is especially important in coastal seas around the north west European shelf.
- Baseline surveys could mean expensive procedures and techniques. The use of Automated Undersea Vehicles (AUVs) might offer a solution. AUVs might be able to scan comparatively large areas of sea-floor to provide baseline data. This AUV technology is currently under development with Energy Technologies Institute support.

Key parameters for baseline surveys should include:

- Year round pH measurements
- Identification of potentially sensitive species or associated habitats (e.g. calcifying species)
- Characterisation of the composition of benthic communities (e.g. coralline colonies).
- Characterisation of age distributions for example bivalves with long life spans (*Arctia islandia* or ocean quahog which can live up to 80 years).

The question of impacts on sensitive areas was raised. Most sensitive regions of the North Sea are already known and represent ~1% of the total sea area. Data on different habitats is available but it needs to be centrally collated. There is a website called Pangea which could be used to collate data. Centrally compiled databases are likely to have inputs form several different sources which may not necessarily have the same degree of quality control.

The question of CO_2 leakage impacts on designated areas protected by legislation was raised. The likelihood is that CO_2 leakage will be highly localised. It is also useful to compare CO_2 leakage across a confined area with much broader damage caused by impacts such as trawling. However, key habitats might need special attention.

Terrestrial

Results from six different terrestrial test sites was presented. They represent four examples of natural seepages and two examples of artificially induced CO_2 gas injection.

- Montmiral in the Rhône valley (France). Geochemical and isotope indicators were sampled from aquifers. The analyses revealed that the CO_2 present could not have originated from a deep source.
- San Vittorino, Italy. This is an area with natural springs where large volumes of CO_2 are also released. The emissions at this locality are associated with migration along faults.
- Latera, Italy. Observations of vents within the Latera caldera show that CO_2 has a comparatively limited impact on the local ecosystem despite high-flux rates. Botanical and microbial adaptation to these conditions is evident here.
- Florina, Greece. CO_2 emissions are well known in this geologically active area. Botantical studies show that plant species distribution is influenced by high concentrations of CO_2. Gas leakage anomalies align with the main faults in the region.
- Grimsrud, Norway and Asgard, Nottingham, UK. These are sites where artificially induced CO_2 fluxes have been applied to assess the impact on vegetation. Comparison with control plots has revealed that CO_2 has suppressed microbial activity and grass growth.

Discussion during the meeting highlighted the necessity for monitoring of target sites. The practice needs to be carried out 2 – 3 times a year to take account of seasonality and to build public confidence even though it might be excessive. There are a wide variety of techniques available for monitoring but not all have to be used. Large scale aerial monitoring offers the prospect of monitoring at regular intervals but it must be checked (ground-truth) with more detailed survey techniques to ensure that false-positives are not generated inadvertently. Initial pilot / demonstration sites will need comprehensive monitoring to build public confidence.

The question of what constitutes significant leakage was raised. CO_2 leakage is likely to be concentrated in confined and spatially limited areas therefore the term significant could be taken out of context. The scale of impact is likely to be small relative to natural and seasonal variability.

In the unlikely event of a large leak such as a blow out there could be an immediate impact but once it has been contained, and the gas has dissipated, the site will recover. The long-term effect is unlikely to be significant.

One delegate proposed that the term Rehabilitation should be used instead of the term Remediation. Rehabilitation infers restoration to a previous natural state without artificial intervention. Once CO_2 leakage stops the environment will revert back to its original state.

The Guide

Conclusions from the RISCS research and recommendations derived from the project will be compiled into a Guide for Impact Assessment. A more detailed technical report will also accompany the Guide. The purpose of the guide is to provide information on the best approaches to evaluate hypothetical impacts of unexpected CO_2 leakage and will include:

- 8 reference environments that are representative of the types of ecosystems that might be encountered above CO_2 storage sites.
- Scenarios for hypothetical leakage from storage sites.

- Potential impacts related to the 8 reference environments which include both terrestrial and marine storage sites.
- Implications of potential impacts for future CO_2 storage projects.

For further information visit the RISCS website http://www.riscs-co2.eu/

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January 2013