World-first experiment on a controlled sub-seabed CO2 leak demonstrates minimal environmental impact and rapid recovery

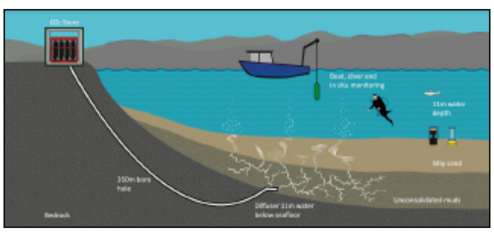
Press release issued by Plymouth Marine Laboratory: 28 Sep 2014

This week in *Nature Climate Change* an international team of scientists have published results of the first ever sub-sea carbon dioxide impact, detection and monitoring experiment relevant to Carbon dioxide Capture and Storage (CCS) in sub-seabed storage reservoirs. This innovative study was designed to understand how marine life on the seabed and in the water above might react to a real-life leakage, as well as determine methods for detection and monitoring of a small-scale carbon dioxide (CO_2) leak event. The research found that, for a leak of this scale, the environmental damage was limited; restricted to a small area and with a quick recovery of both the chemistry and biology.

The Quantifying and Monitoring Potential Ecosystem Impacts of Geological Carbon Storage (QICS) project was led by Plymouth Marine Laboratory's (PML) Jerry Blackford and funded by the Research Councils UK, the Natural Environment Research Council, the Scottish and Japanese Governments. A number of UK and Japanese institutes collaborated with the experimental controlled release of CO_2 undertaken in Ardmucknish Bay, (near Oban) Scotland in 2012; the experiment was co-ordinated by the Scottish Association for Marine Science (SAMS).

4.2 tonnes of CO_2 (less than the annual CO_2 emission of a gas-heated UK home*) was injected over 37 days from a land-based lab via a borehole drilled through rock to the release site, 350 meters from the shore and 11 meters below the seabed (see illustration below). Scientists initially monitored how the CO_2 moved through the sediment and the 12 meters of water above. Over the following 12 months the impact on the chemistry and biology of the surrounding area was assessed using a combination of techniques, including chemical sensors, listening for bubbles and diver-mediated sampling.

A combination of chemical sensors and bubble acoustic techniques are shown to provide the optimal monitoring technology to detect leakage or give assurance of no leakage.



The impact of this simulated leak shows that the impact of escaped CO_2 on a similar scale would be limited. CO_2-induced chemical changes occurred towards the end of the CO_2 release but impacts including changes to environmental chemistry returned to background levels within 17 days of turning off the CO_2 release.

No biological effect was observed during the early stages of the release. At the end of the release period and early in the recovery period, there was a change in seabed-dwelling communities as well as the gene expression of microbes. These impacts were not catastrophic or long lasting and full recovery was seen in weeks.

Project leader Jerry Blackford, at PML, said: "These findings are contributing to the growing knowledge base necessary for optimal deployment of CCS as a climate change mitigation measure; in particular for the regulatory requirement for monitoring. The results show that small-scale leakage will not be catastrophic, although we do caution that impacts are likely to increase if a larger amount of CO2 is released. Water movement in the area is also important; impacts are estimated to be less and recovery quicker in environments with stronger water mixing so that the CO_2 is dispersed more rapidly.

This study did not address the integrity of storage in reservoirs situated 1km or more below the sea floor, but addressed the 'what if' scenario of leakage at the seabed. Leakage of CO_2 from storage reservoirs is thought to be unlikely.

Recommendations for CCS operators developing risk strategies are:

- CCS site selection should be below dynamic bodies of water to promote dispersal of CO2 in the unlikely event of leakage.
- A comprehensive baseline study, encompassing sediment structure and content, sea water chemistry, biological community structure and ambient noise, is required to maximise monitoring efficiency.
- A combination of chemical pH and bubble-listening sensors will maximise early leakage detection or alternately provide assurance that leakage is not occurring.

*** the typical annual energy use in a UK gas heated home equates to approximately 4.8 tonnes of CO_2 emissions (Ofgem 2010)**

Notes to editors

List of partners involved in the project:

- Plymouth Marine Laboratory, Scottish Association for Marine Science, National Oceanography Centre, British Geological Survey, University of Southampton, University of Edinburgh, Heriot-Watt University, all UK
- Research Institute of Innovative Technology for the Earth, Kyoto, International Institute for Carbon-Neutral Energy Research, Kyushu University, The General Environmental Technos Co, Central Research Institute of Electric Power Industry, University of Tokyo, National Institute of Advanced Industrial Science and Technology, all Japan

Relevant project links

- Introduction to quantifying and monitoring potential ecosystem impacts of geological carbon storage animation
- A QICS look back: project leader Jerry Blackford gives an overview of the project in this short video
- QICS website
- More about Carbon Capture and Storage (CCS)
- The paper will be available here

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