Establishing an effective environmental baseline for offshore CCS

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Abstract

The proposed storage of CO_2 in sub-seabed geological reservoirs could make a practical and significant contribution to reducing atmospheric CO_2 emissions. However, before any new, potentially disruptive, activity can be conducted, the environmental risks posed by that activity should be assessed. In addition, understanding what is 'natural' or 'normal' for an area is essential when establishing criteria against which potential environmental impacts can be identified, monitored and quantified. To that end, all offshore CCS projects will require an effective environmental baseline to be constructed. Due to the large spatial extent of storage complexes and the expectation that storage will be for many decades, there are a number of financial, logistical and methodological issues associated with constructing such baselines.

Firstly, sub-seabed storage complexes are sizeable and, therefore, the full extent of seafloor that could potentially be affected by any industrial scale Carbon dioxide Capture and Storage (CCS) project could also be large. The marine environment in general is highly spatially variable in terms of its physical, chemical and biological makeup with scales of variability ranging from the sub-metre scale corresponding to benthic patchiness, to dynamic boundaries between water masses of different origins, which may stretch for many kilometres. Consequently, the large areas above CCS reservoirs will inevitably contain a mosaic of different seabed habitats and biological communities, as well as varying water masses and pelagic biomes. This large spatial extent and high level of spatial variability, raises problems of affordability when conducting the comprehensive baseline environmental surveys necessary to meet licencing requirements and to confidently assess the potential environmental risk of CCS activities and provide suitable protection for sensitive marine ecosystems. To meet this challenge, new approaches in baseline data collection and analysis are needed.

In addition to the problems of adequately describing the environmental conditions across large areas of the sea, the marine environment also displays high levels of temporal variability through time meaning that the observational data needed to adequately describe baseline environmental conditions, including tidal, seasonal, annual and decadal trends and cycles, would take many years to collect and would delay the rapid deployment of CCS projects. This is particularly relevant to many of the environmental parameters that may be used to indicate CO_2 leakage from CCS projects, such as changes in carbonate chemistry parameters which can undergo large and rapid fluctuations as a result of naturally occurring biological and physical processes.

In addition to naturally occurring short-term fluctuations described above, longer-term changes in environmental conditions are being driven by man-made pressures such as climate change and changes in human activities (e.g. fishing, resource extraction, pollution). These gradual, chronic changes are especially important when considering the typical life-span of a CCS project. With the intention of storing CO_2 for hundreds, maybe thousands, of years it is essential that future changes in environmental conditions over this timeframe are understood and such changes are not falsely attributed to CCS activities.

In this talk we will illustrate new approaches and opportunities for combining a variety of data types, such as satellite images and previous environmental surveys, with the outputs from computer based models to extend environmental baselines through time and expand their spatial coverage. We will present an integrated, hierarchical approach to constructing an effective environmental baseline suitable for supporting offshore CCS activities in terms of leak detection monitoring, environmental risk assessment and impact quantification. This approach uses satellite and remote sensing data to map and describe habitat distributions, environmental conditions and ecosystem functioning across large areas. Coupled ecosystem-biogeochemical models are used to extrapolate data through space and time in order to determine monthly, seasonal or inter-annual modes of variability and trends in the biochemical and biological parameters of these areas. Results from such models are then used to structure the design and implementation of *in-situ* data collection activities, focussed on monitoring those areas at highest risk from leakage or those with the greatest potential sensitivities to impact. Whilst each storage site will have a unique baseline due to *in-situ* bio-physical characteristics, the baseline quantification techniques and approaches presented here are designed to be generic, allowing them to be applied to the majority of offshore storage sites located within coastal shelf seas.