Assurance of CO_2 storage integrity through big data analysis, developing fast site-specific marine monitoring programs

Marius Dewar & **Jerry Blackford,** Plymouth Marine Laboratory (UK), made@pml.ac.uk

Formulating appropriate monitoring programs for offshore geological CO_2 storage projects, from either a regulatory or operator viewpoint, is difficult to achieve without a properly quantified cost-benefit analysis of what that monitoring could and should achieve. Monitoring programs have a role in communicating risks and benefits for storage projects and assure against unjustified accusations for having adverse environmental effects.

Evaluations of CO_2 storage monitoring techniques usually aim to determine the suitability to user-defined project scenario, or to assess the availability of sensors that can measure variables that are likely to fluctuate under a seepage scenario, or processes that are sensitive to CO_2-related stress. Less focus has been on how they perform relative to regulatory requirements, cost efficiency, and user friendliness.

We can use observations and models to characterise the natural variability of the marine system, or the noise from which an anomalous signal must be detected. We can use models to simulate hypothetical leak events thereby defining the monitoring target(s). We have algorithms that assess the cost-benefit of a range of anomaly criteria – i.e., a signal that would provoke a more concerted monitoring campaign and finally algorithms that can derive the optimal deployment strategy – i.e., where to monitor and when. The challenge is to collate these abilities into a coherent whole, which then allows the presentation of an evaluated monitoring system that can be judged against regulatory and societal expectations.

An open source, user friendly, pre-operational Decision Support Tool (DST) is developed int the ACT on Offshore Monitoring (ACTOM) project, that effectively develops a digital twin of a site based on big data analysis, then enables the operator to explore different sensitivity thresholds and determines an optimal sensor deployment strategy, based on local hydrodynamics and seabed features. The DST can design a site-specific marine monitoring programme that ultimately enables operators and regulators to quantifiably assess proposed monitoring strategies deliver an acceptable standard of assurance for stakeholders.

This enables operators to properly plan, cost and adapt effective environmental monitoring strategies to site specific circumstances whilst minimizing cost, but also enables regulators and operators to communicate the effectiveness of proposed monitoring strategies to enable informed societal consensus in view of marine spatial planning.

The DST is capable of simulating “what if” seep scenarios, as well as monitoring deployments, that can be used to deliver environmental impact assessments as required under the CCS (Carbon Capture and Storage) and EIA directives. As a result, recommended monitoring strategies could be delivered autonomously and be dependent on established generic operational marine simulation models, both factors reducing costs.