Optimal control analysis of leakage risk in geological CO_2 sequestration under uncertainties

Ben Mansour Dia *[1], Mazen Saad †[2], and Manal T. Alotibi ‡[3]

[1]CPG, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia.
[2]Laboratoire de Mathématiques Jean Leray,Ecole Centrale de Nantes, Nantes, France.
[3]CCM, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia.

Abstract

Since the Paris Climate Conference, the international climate agreement to keep the global warming in the interval from 1.5 to 2 degrees seems more and more challenging because of the impediments related to the economical objective of some countries. The best inclusive approach is to implement mechanisms that do not restrain the economical objectives and align with the international agreement of maximum greenhouse gases emission.

We address a responsible approach to store CO_2 in a lower aquifer of a geological reservoir from which a moderate leakage of CO_2 is tolerated according to the international standards. It consists in investigating uncertainty quantification methods that help in controlling permitted leakage rates so that the CO2 evaporates little by little through leaky wells, and the overall leakage quantity is controlled by the injection. Based on the leakage rate assessment proposed in [1], we formulate the optimal control problem to bound the leakage rate with uncertain geophysical properties, of the reservoir, treated as random fields. Because the data acquisition for geological problems is a time-consuming and very expensive process, synthetic data are used to train the inversion procedure of estimating the geophysical parameters (porosity, permeability) from transport and diffusion processes that take account the solubility of the CO_2 in the water. Subsequently optimal experimental design for inverse uncertainty quantification methods helps in reducing the level of uncertainty in the optimal control problem.

[1] Dia, B.M. (2021), "Bayesian experimental design for CO_2 sequestration with leakage risk assessment", Engineering Computations, Vol. 38 No. 3, pp. 1385-1401. https://doi.org/10.1108/EC-03-2020-0143

*ben.dia@kfupm.edu.sa
†mazen.saad@ec-nantes.fr
‡manal.alotibi@kfupm.edu.sa