EGU22-10115, updated on 13 Aug 2022
https://doi.org/10.5194/egusphere-egu22-10115
EGU General Assembly 2022

Environmental hazard quantification toolkit based on modular numerical simulations

Morgan Tranter[1,2], Svenja Steding[1,2], Christopher Otto[1], Konstantina Pyrgaki[3], Mansour Hedayatzadeh[4], Vasilis Sarhosis[4], Nikolaos Koukouzas[3], Georgios Louloudis[5], Christos Roumpos[5], and Thomas Kempka[1,2]

[1]GFZ German Research Centre for Geosciences, Fluid Systems Modelling, 14473 Potsdam, Germany
[2]University of Potsdam, Institute of Geosciences, Karl-Liebknecht-Str. 24–25, 14476 Potsdam, Germany
[3]Centre for Research and Technology, Hellas (CERTH), 52 Egialias, 15125, Marousi, Greece
[4]University of Leeds, Woodhouse Lane, LS2 9JT Leeds, United Kingdom
[5]Public Power Corporation of Greece, 104 32 Athens, Greece

Comprehensive risk assessments for subsurface utilisation projects such as in-situ coal conversion, deep geothermal energy, geological storage, and waste disposal are implemented to a limited extent in common practice. The impacts of subsurface processes on environmental hazards (e.g., migration of groundwater-borne contaminants, induced seismicity, and subsidence) are often convoluted and therefore not trivially to predict. Furthermore, decisions on project feasibilities are commonly based on expert knowledge subject to non-standardised approaches. However, an objectively and transparently developed risk assessment is imperative for a publicly accepted, long-term economic and environmentally friendly design of future subsurface utilisation.

We propose a new environmental hazard quantification framework based on modular simulations. The aim is to create a uniform basis for both project developers and authorities to carry out risk analyses. The approach streamlines state-of-the-art numerical models [1,2], accounting for multiphase flow, geomechanics, geochemistry, and heat transport, to determine the likelihood and severity of hazards. The method uses the results of the computational expensive Monte Carlo simulations of each module to train gradient boosting machine learning algorithms. These surrogate models facilitate loose coupling within the framework and a seamless integration into a graphical user interface for demonstrating hazard probability distributions.

The approach was applied to two example study areas with complex geological settings as part of a risk assessment for in-situ coal conversion. A substantial rock volume is extracted during this operation, and a contaminant pool is potentially left behind, which may put the environment at risk. With our presented approach, the shortcoming of using conceptually simplified models are substantially reduced, since subsurface complexities are accounted for. The transparency of the assessment basis should generally increase the acceptance of geoengineering projects, which is considered one of the crucial aspects for the further development and dissemination of geological

subsurface utilisation.

[1] Hedayatzadeh et al.: Ground subsidence and fault reactivation during in-situ coal conversion assessed by numerical simulations, EGU22, https://meetingorganizer.copernicus.org/EGU22/EGU22-11736.html, 2022.
[2] Kempka et al.: Probability of contaminant migration from abandoned in-situ coal conversion reactors, EGU22, https://meetingorganizer.copernicus.org/EGU22/EGU22-11204.html, 2022.