tonnes by 2030. The Kyoto Protocol proposed an emission cut that requires a reduction of 1.75 billion tonnes of carbon dioxide [15].

Geological storage of CO_2 is a proposed solution to fight global climate change. Clear operational criteria and policies must be made to avert unwanted consequences. Concerns connected to putting a large mass of CO_2 into underground geological formations are not limited to the spatial distribution of the injected fluid. The pressure signals imposed through the injection point can travel beyond the scale of the zones where CO_2 is present. Although geological barriers can hinder the pressure exchange between different regions, pressure can transfer through low-permeable rocks where the CO_2 is trapped by capillarity.

In addition to the depleted oil and gas fields, deep geological aquifers are practical targets for the geological storage of CO_2. If one is injecting into brine aquifers, the pressure waves can push the brine into connected fresh water aquifers, contaminating them. Brine displacement issues are discussed in [5] by defining open, closed, and semi-closed aquifer boundaries. Brine might also leak through abandoned wells into other zones. Cailly et al. [4] discuss well design considerations to prevent any leakage through wells.

Geomechanical deformations are important during the injection period. They can lead to changes in effective permeability and porosity. It is possible that the pressure build-up around injection wells can crack the rock with uncontrolled fractures extending to the structural sealing layers. Faults can be activated due to high pressure in the system, providing a leakage path across layers. In addition to the increased spatial spread of CO_2, an intensive induced fracture network can result in local earthquakes.

Pressure constraints must be considered for injection operations to limit the pressure build-up. However, this comes with the cost of injection rate reduction. Rock quality within the injection region has a significant impact on pressure build-up and therefore geological uncertainty plays a considerable role in assessing the success and feasibility of the operation.

Geological uncertainty is a major issue in pressure analysis. Most of the pressure-related studies in the literature provide either deterministic case studies or generic preventive measures based on theoretical studies [12, 16, 8, 17, 14, 13]. It is important to include realistic geological descriptions in any geological uncertainty study. For example, permeability variation in the grid should be included in the form of realizations of geological realistic formations. To the best of our knowledge, this is the first pressure study in the context of CO_2 storage that considers the geological uncertainty in the form of structural and sedimentological variables.

Within the context of oil recovery, the impact of geological uncertainty is thoroughly investigated in the SAIGUP project for shallow marine depositional systems [7, 9, 10]. In the SAIGUP study, variations of geological features are examined in a set of field development strategies via several injection/production patterns. The study concludes that geological uncertainty has a dramatic influence on the oil recovery estimates. A number of geological realizations from the SAIGUP project are used in [1, 2] to investigate the impact of geological uncertainty on the injection and early migration of CO_2. The focus in these studies is to measure the sensitivity of the spatial CO_2 distribution to the variation of the geological description. Certain structural features are considered for those studies and flow responses are defined to measure the storage capacity, the trapping efficiency, and the leakage risk. The sensitivity of these responses to variations in geological parameters is investigated. The results show large variation in responses. Aggradation angle and barriers are found to be the most influential in the CO_2 flow behavior [1, 2].