# Numerical Simulation of a Potential Impact of Large-Scale Geologic $CO_2$ Storage on Regional Groundwater Systems


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### Abstract

In future industrial-scale geological $CO_2$ storage projects, the amount of $CO_2$ fluid injected into an aquifer can be several million tons per year at a single storage site. However, the impact of such a large-scale fluid injection on the subsurface environment has not been quantitatively evaluated.

In this study we investigated a potential impact of $CO_2$ geologic storages on the groundwater flow and environment. As a case study, a large-scale numerical simulation of hypothetical industrial-scale $CO_2$ injection under the Tokyo Bay was performed. A regional hydrogeological model of about 70km x 60km area in the Kanto Plain was constructed, using data from a few dozen deep boreholes and several seismic reflection surveys. Included in the model are the surface topography and the subsurface geology of the area that mainly consists of late Pliocene to early Pleistocene sedimentary formations. The whole model domain was discretized into 10 million gridblocks. To solve the high-resolution model, we used the parallelized multiphase flow simulator TOUGH2-MP (Zhang et.al, 2003) with ECO2N fluid properties module of sub/supercritical $CO_2$ (Pruess, 2005) on the Earth Simulator (5120 CPUs, 40 TFLOPS).

In the simulation, we considered a continuous injection of $CO_2$ for 100 years into the storage aquifer at about 1km depths under the Tokyo bay. The simulation results suggest that even if containment of $CO_2$ plume is ensured, significant build-up of groundwater heads can occur in shallow confined layers of extensive regions including urban inlands. The discharge rate of groundwater to the land surface and seabed increased locally up to about 1% of the annual precipitation. To better understand the significance of these changes to the environment, further studies are needed.



**Keywords:** large-scale simulation, CCS, $CO_2$, global warming, groundwater

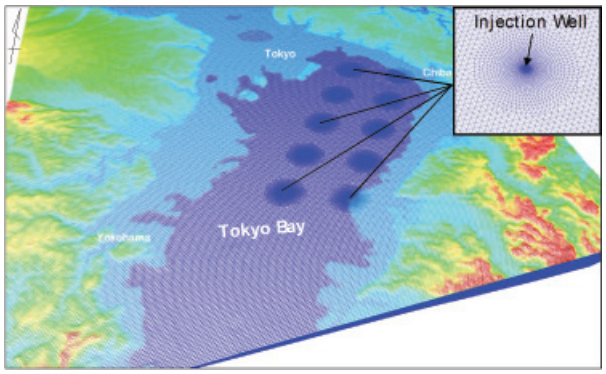


Figure 1　Gridblocks

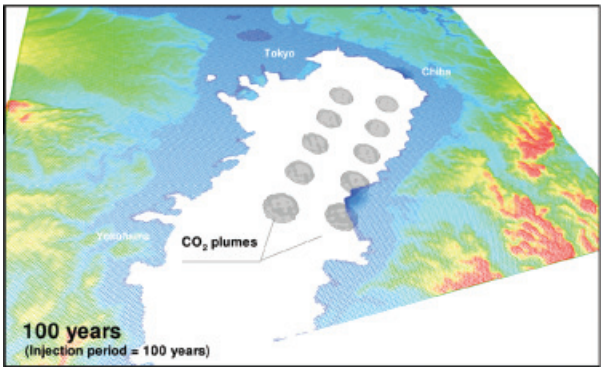


Figure 2　$CO_2$ plumes (after 100 years injection)

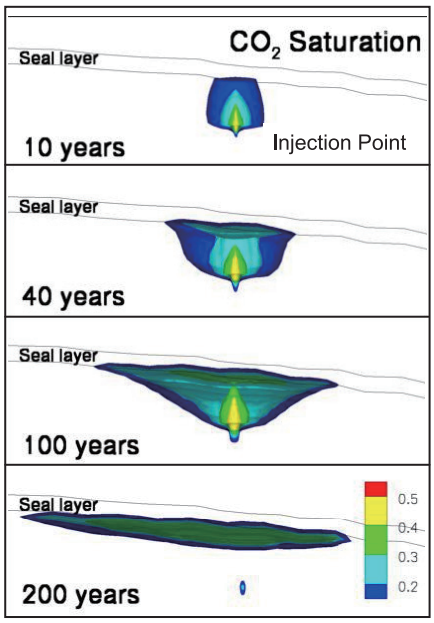


Figure 3　Time evolution of $CO_2$ plume migration

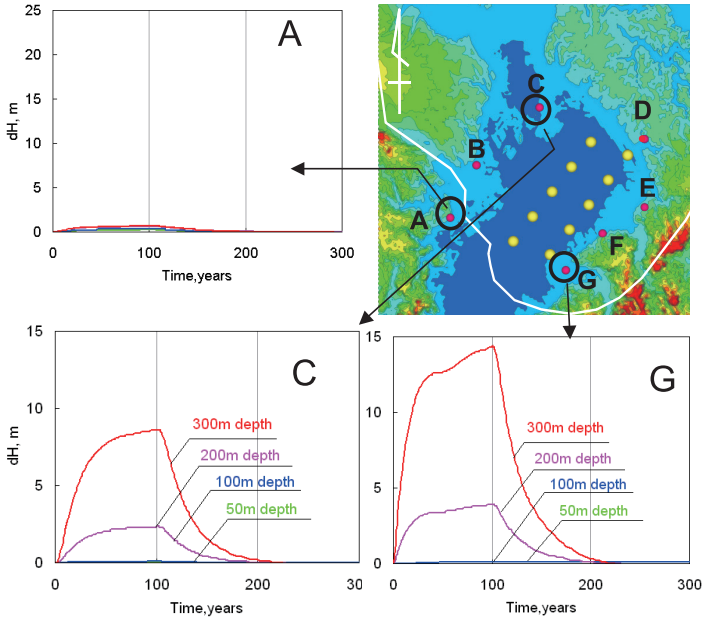


Figure 4　Impact on groundwater pressure urban inland