

Numerical Interpolation and Prediction of Released CO₂ Fluxes at Unsaturated Zone when CO₂ were Injected Artificially

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Abstract

Directly storing CO₂ in the geologically safe underground formations is considered to be an effective way to reduce CO₂ concentration in atmosphere. However, CO₂ can be released through unexpected faults or abandoned wells from the targeted storage formations. When the abundant CO₂ is released to the surface, elevated CO₂ concentration can significantly damage the groundwater and ecological system. Thus, it is important to detect the CO₂ flux initially when it started to release to the surface. However, when monitoring CO₂ flux, there also exist that natural background CO₂ produced by the respiration of plants and microorganisms. Therefore, the purpose of this research is to predict the natural background CO₂ fluctuation to detect the anthropogenic release of CO₂, and to replace the value of CO₂ flux when it could not be measured.

In Eumseong, Republic of Korea, the controlled CO₂ release site was developed by the Korea CO₂ Storage Environmental Management (K-COSEM) Research Center. CO₂ was released from the 50 m PVC pipe buried at 2.5 m-depth unsaturated zone and CO₂ fluxes and concentration were monitored in addition to extra parameters such as meteorological data, soil moisture, and soil temperature. The HYDRUS-1D simulation package was utilized with SOILCO₂ and predicted CO₂ fluxes at the unsaturated zone. Furthermore, simulated surface CO₂ fluxes were compared with field-observed data to validate the CO₂ transport model and evaluate CO₂ leakage process more precisely.

Our research concluded that, without CO₂ release, the Hydrus-SOILCO₂ model predicted the variation in soil CO₂ natural background fluxes at surface precisely. In addition, both measured and simulated data indicated that major environmental factors controlling the surface CO₂ fluxes were atmospheric temperature and precipitation. Finally, in order to improve the simulated prediction of CO₂ fluxes, biological and soil hydraulic factors in the study area should be preceded.