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Prediction of radionuclide transport through integrated surface-subsurface modeling using HydroGeoSphere

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Radioactive elements released from nuclear facilities can pose significant risks to both the environment and human health. To prevent the spread of contamination and ensure effective remediation, precise analysis and predictive modeling are essential. In particular, predicting and evaluating the transport pathways of radioactive materials is a critical aspect of contamination control and safety management. This study aims to develop a predictive model that integrates surface and subsurface environments using HydroGeoSphere, a three-dimensional numerical model. The study site, a former research reactor facility in Korea, underwent field investigations to analyze its topographical, geological, and hydrogeological characteristics. Based on this information, a three-dimensional model of the site was constructed and implemented in HydroGeoSphere to define model layers. Subsequently, a model was developed by incorporating site-specific hydrogeological and soil properties, and calibration was performed using field investigation data including pumping tests. The modeling process comprehensively considers surface water infiltration, groundwater flow, and soil-groundwater interactions. Additionally, multiple scenario analyses will be conducted to assess the potential spread of radioactive elements by evaluating changes in groundwater flow and variations in the release rates of radioactive contaminants. The findings of this study are expected to enhance the predictive accuracy of radioactive contaminant transport, thereby contributing to the development of remediation plans and environmental risk assessments for contaminated sites. Furthermore, the integrated surface-subsurface modeling approach is applicable not only to nuclear facility sites but also to various environmental contamination cases, enabling more accurate predictions across a broader range of applications.