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Groundwater flow evaluation in the whole Fukushima Prefecture and around the Fukushima Daiichi Nuclear Power Plant

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Groundwater flow simulation was conducted to contribute the reconstruction from the disaster by the 2011 off the Pacific coast of Tohoku Earthquake. Wide and detailed 3D hydro-geological models were built for the saturated and constant simulation of whole Fukushima Prefecture and around the Fukushima Daiichi Nuclear Power Plant. The dataset of geologic basement depth in the whole Japan (Koshigai et al., submitting), which is one of the AIST's DB of geology and groundwater in the whole Japan, was used to set the depths of layers for the wide model. This dataset includes the depths data of four formations in Quaternary (H, Q3, Q2, Q1) and three in the Neogene (N3, N2, N1) compiled by krigging using more than 12,000 logging data.

Two layers were extracted for the wide model which represent the Quaternary and Neogene. The hydraulic conductivities were defined as 10^{-4} and 10^{-6} [m/s] in horizontal and vertical directions of the Quaternary, and homogeneously 10^{-6} [m/s] in the Neogene, referred from the internal information of previous groundwater flow research in the closed coal mine in Fukushima Pref. The boundary conditions set the hydraulic heads fixed with the elevation around the model and a constant recharge to the surface The constant recharge was given from the dataset of submarine groundwater discharge in the Japan Islands (Ito and Marui, 2010) which is also one of the AIST's DB, as 833[mm/yr] from the average in the year of 1993 - 2002 on Abukuma River basin, which locates in the center of Fukushima Pref. The simulated groundwater flow directions are shown in Fig.1. More outward groundwater flows are represented from the west and south than the north around the zone of radius 30 km of Fukushima Daiichi Nuclear Power Plant. It indicates some risk to make influence to the domestic water of city area in Koriyama and Iwaki when reaching the polluted water. In these cities, deep wells may strengthen the water supply system to avoid pollution risk, because deep groundwater has little influenced from surface pollution.

The detailed model, which has an approximate same range with the radius 10km of Fukushima Daiichi Nuclear Power Plant, has three layers which equal to the Quaternary, the upper and lower of Neogene. The hydraulic conductivities were defined homogeneously as 10^{-5}, 10^{-7}, and 10^{-6} [m/s] in each layer respectively, from the previous report by the local government (Tohoku Agricultural Bureau, 1979). The boundary conditions fix the hydraulic head of rivers, lakes, and ponds with the elevations, and the sea area with 0m. Result showed the groundwater flows into the sea with the flux of 0.01 [m/d] in the top Quaternary which has 5m width. In the upper and lower Neogene, which has 20m and 200m width, the fluxes were calculated around 0.00001 and 0.0001 [m/d]. It means the pollutants can flow out through the Quaternary into the sea by relatively fast groundwater flux, as the main facilities of the power plants are built on the Quaternary. Additionally, it is difficult to infiltrate the pollutant into the Neogene by the low permeability.

Reference

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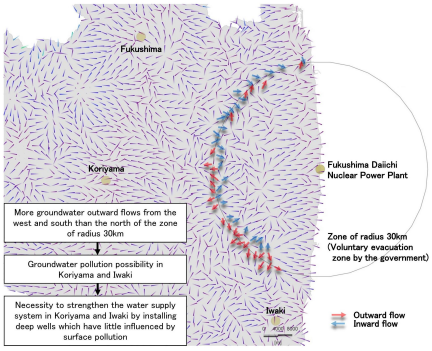

Fig.1 Groundwater flow directions around the radius 30km of Fukushima Daiichi Nuclear Power Plant

Keywords: Fukushima Daiichi Nuclear Power Plant, radiation protection, pollution of surface soil, outward flow, domestic water, deep well