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Simulating Past and Future Hydraulic Potentials by Groundwater Flow Modeling in Kanto Groundwater Basin

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While flood and drought doe to potential climatic change often occur and we have to take care of big earthquake, the voice of groundwater necessity as excellent water resources becomes louder. However, it is difficult to understand the quantitative mechanism on groundwater, because the groundwater is invisible and it has the large regional differences. Our study group has been collected and examined the data about the hydrogeological information, the groundwater flow index and the water budget to evaluate the mechanism of groundwater flow system in whole Kanto groundwater basin. Based on these examinations, three-dimensional groundwater flow analysis was performed on the distribution area of the Kanto Plain aquifer, and tried to understand the groundwater system and predict the future changes in hydraulic potentials.

The hydrogeological structure is classified into 10 units (I, II, III-1, III-2, IV, V, VI, VII, VIII and IX) based on examination results of the different geological strata on the depositional age and sedimentary environment. And the 9 units except IX are adopted as the model aquifers and incorporated into the model to quantify the hydrogeological structure. In the analysis, Visual MODFLOW equipped USGS three-dimensional finite differential groundwater flow model MODFLOW- 2000 was used. A model grid is about 2km size rectangle shape (four times the area of the 3rd order mesh defined by Japanese government). Simulated period is 84 years from 1920 through 2003 and the transient analysis was performed per year to reproduce the observed potential fluctuations in observation wells especially focusing on the area among Tokyo and southern part of Saitama Prefecture, where the large groundwater potential depression was occurred in 1970s as a result of the excessive pumping and the potential continues to ascend after pumping regulation. Pumping rates, one of the important model inputs, were reexamined for the model grid and distributed to the main model aquifers. Though the hydraulic parameters were assigned to every hydrogeological units, the Layer-I corresponds to the alluvium were subdivided into different hydrogeological classification because Layer-I is different in nature of marine or fluvial. To progress model calibration, the different hydraulic property was assigned to Layer-II (gravel Layer) in the Musashino Terrace where is difficult to reproduce the hydraulic potentials.

The actual groundwater heads can be classified into two types; one is nearly steady state that does not show the successive fluctuation and the other is in ascending process after intense drawdown. The former can be recognized in the shallow observation wells and the latter can be recognized in the deep observation wells. The model could simulate these feature of the wells especially screened at the position deeper than layer-V. This means that the successive fluctuations observed are consistent with the pumping rates around the observation points. In Layer-VII (main aquifer) calculated potential distribution in 1999, there is the potential depression extending from northeast Tokyo to east part of Saitama Prefecture. This result suggests that there is groundwater flow system towards the central region of the potential drop from the margin area of Kanto groundwater basin. The ascending trend of the observation well after the regulation is continuing now in the lowland. According to the predictive calculation using the calibrated model, about 5m groundwater head rise will be occurred at the terrace and that marginal area in Tokyo after 50 years if the present pumping rate is kept. This regional groundwater flow model is being applied to the simulation of land subsidence in clayey layer for the northern part of Kanto Plain by coupled groundwater flow/land subsidence with nested grid scheme.

Keywords: Groundwater flow model, Kanto groundwater basin, Regional groundwater flow system, Coupled groundwater flow/land subsidence model