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## Estimation of influence of long-term topographic and climatic changes on groundwater flow conditions

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In this study, estimation of influence of the long-term topographic and climatic changes with glacial-interglacial oscillations on groundwater flow conditions has been tried in the Tono area, Central Japan. Paleo-topography has been estimated using the data of combining height and distribution of river terraces with DEM data and the GIS. The recharge rates of glacial and interglacial periods have been also estimated using surface hydrological data and the paleo-climatic data from pollen analysis. Hydrogeological models, which are taking into account the estimated paleo-topographies at high terrace age, middle terrace age, lower terrace age and present, have been constructed. Steady state groundwater flow simulations under saturated and unsaturated conditions have been carried out using the hydrogeological models. The estimated recharge rate has been used for setting upper boundary condition. Results of these simulations show that simulated deep groundwater flow conditions taking into account the estimated paleo-topographies at middle terrace age, lower terrace age and at present are similar. On the other hand, it is found that the difference of groundwater flow conditions between high terrace age and others is relatively larger. It is also recognized that the hydraulic impact due to climatic changes has spatial difference. It is concluded that the influence of long-term topographic and climatic changes on groundwater flow conditions have heterogeneity on time and spatial scales. Therefore, this study suggests that it is necessary to develop the method for estimation of the long-term changes of groundwater flow conditions.

Keywords: topographic change, climatic change, groundwater flow condition