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Changes in subsurface temperature and groundwater quality induced by in-situ long-term thermal loading test

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Ground source heat pump (GSHP) systems have gradually become popular for space cooling and heating in recent years. The GSHP systems discharge waste heat into subsurface environment for cooling or taking up heat of groundwater for heating, inducing the thermal disturbance. The thermal disturbance might affect the subsurface environment including groundwater quality. However the influences of GSHP systems on the subsurface environment have not been well understood and studied. In this study, the changes in subsurface temperature and groundwater quality by operating the GSHP system over a long time period were monitored and discussed.

The GSHP system was installed with 50 m length U-tube as a heat exchanger at the campus of Saitama University. Four groundwater monitoring wells were installed for the upper (GL-16.25 m to 17.80 m) and lower (GL-38.70 m to 40.15 m) aquifers at 1 m (W1), 2 m, 5 m and 10 m distance from the U-tube heat exchanger. At each monitoring well, resistance-type temperature detectors were placed at 10 depths with 5 m interval. For in-situ thermal loading test, 40 C hot water has been circulating inside the U-tube since August 2012. The groundwater have been continuously sampled from all monitoring wells for every 1-2 weeks, and chemical properties (pH, EC, DO, ORP, dissolved gases, dissolved organic carbon, dissolved inorganic ions and heavy metals) were measured.

The subsurface temperature has increased from 15-18 C to 22-24 C at the monitoring well ”W1” by the thermal loading test for 5 months. For the groundwater from upper aquifer, some heavy metals such as Li and B clearly increased at the monitoring well ”W1” with the temperature rise, while for the groundwater from lower aquifer, there were no specific variations.

Keywords: thermal loading test, subsurface temperature, groundwater quality, heavy metals