Integrated groundwater monitoring required for sustainable basin water resources management: Evaluation of effects of groundwater development utilized existing observation well network in the Tokyo metropolitan area

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Three-dimensional subsurface temperature distribution and its long-term change were examined by repeated observations of temperature-depth profiles at monitoring wells since 2000 in order to evaluate effects of regional-local groundwater flow change due to groundwater development and pumping regulation, urbanization and climate change on groundwater and subsurface thermal environment in the Tokyo metropolitan area, Japan. Results of these studies have suggested that groundwater and subsurface thermal environment shows complex changes over a long term, wide area and deep part in the metropolis. Miyakoshi et al. (2017) have reported the subsurface warming at the shallow part in the southern part of the Kanto Plain from the comparison of temperature-depth profiles measured at the land subsidence and groundwater level observation well distributed in Tokyo and Saitama prefecture in the past 10 years. It was considered that effect of the subsurface warming reaches deeper at the upland corresponding to groundwater recharge area in comparison with the lowland. Miyakoshi et al. (2016) have reported the temperature changes was found at 100 to 300m deep in the southern part of Gunma and Tochigi prefecture by the comparison between present data and past data measured in 1960s and 1970s in the northern part of the plain. This temperature change at the deep part was induced by the effects of groundwater flow changes due to groundwater development and pumping regulation in this area. These results show that the changes in groundwater flow is detected as an anomaly of subsurface temperature distribution and its change.

These previous studies are based on the intermittent repeated measurement in several years. On the other hand, groundwater development shows changes according to social groundwater demand by different periods, and recent demand shows increasing tendency. Groundwater monitoring which respond quickly to its environmental change is required at the regional scale in addition to water resource management at the basin scale, in order to sustainable management of groundwater resource. The groundwater environmental change includes subsurface thermal environmental changes caused by waste heat from surface/underground buildings and climate change. Subsurface temperature monitoring has been conducted since 2012 at 6 wells in Tokyo (Miyakoshi et al., 2017) and since 2007 at 4 wells in Saitama prefecture. These monitoring results showed the continues warming tendency at the shallow part, however differences in the rates of warming and seasonal fluctuation trend were found and it was shown the effects of reginal groundwater flow changes due to artificial effects.

Additionally, it is assumed that not only pumping volume and time but also depth of groundwater development will change with diversified groundwater demand. In order to accord such diversification of groundwater development, it is required to integrate usage of current observation wells and to accumulate efficiently groundwater data. Monitoring of temperature-depth profile by using distributed temperature sensing technology (Yamano and Goto, 2001; Bense et al., 2016) is cited as an example of integrated subsurface temperature observation at the observation wells in addition to temperature monitoring at the several depths by using temperature data loggers, and these monitoring results are expected to detect changes of groundwater flux at the several aquifers. It is possible to detect and

evaluate quickly to respond effects of groundwater development and urbanization by analyzing the observed temperature fluctuation in comparison with hydrogeological information and local groundwater flow changes. Establishment of groundwater monitoring system respond quickly to groundwater development is considered to required for the basin water resource management and sustainable groundwater usage. This study was conducted as a part of Saitama Pref. –Akita Univ.– AIST Joint Research.

Keywords: Basin water resources management, Sustainable groundwater development, Groundwater and subsurface temperature monitoring, Land subsidence and groundwater level observation well network, , Tokyo metropolitan area

