Change in groudnwater and subsurface thermal environment in the Tokyo metropolitan area

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Information on three-dimensional subsurface temperature distribution and its change were examined by measuring of temperature-depth profiles at observation wells in 2001-2002 and 2005-2006, to evaluate the subsurface thermal environment in and around the Tokyo Area.

Regional variation was observed as follows: low temperatures were found in the Musashino and Shimousa Uplands, and high temperatures were observed in the central part of the Tokyo Lowland. Low temperatures are considered to result from groundwater recharge, and the high temperature area corresponds to an area where the lower boundary of groundwater flow is relatively shallow. These regional variations suggest the effects of groundwater flow in the Tokyo area.

The high temperature area in the central part of the lowland corresponds also to an area with severe land subsidence resulting from excessive groundwater pumping, and there are local low temperature spots along the rivers and Tokyo Bay. In the eastern part of the Musashino Upland groundwater is pumped up by 0.5 million m3/day, and the temperature at pumping depths is lower than surrounding areas. Depth and low temperature varies by locations. Not only the effects of a natural ground water flow, but also this local variation shows effects of the human activity such as groundwater pumping.

In the lowland, a comparison between past data (1956 - 1967) and present data (after 1999) revealed widespread decreasing temperatures of less than 0.5 ^{o}C along the Arakawa and the Sumida River. This is explained by downward groundwater flow based on an analysis of temperature-depth profiles. However, groundwater levels have been increasing since the institution of pumping regulations in the 1950s. It is suggested that the past groundwater flow change affected by the pumping is recorded in the present subsurface temperature data.

On the other hand, subsurface warming at the shallow part affected by ground surface warming is recognized in almost all of this area. The subsurface warming represents a minimum in temperature-depth profiles. In the Musashino Upland, depths of minimums are deeper than the lowlands, and temperature above minimum depths is warmer in the eastern urban area than the western suburban area. A comparison of 2001 to 2002 data and 2005 to 2006 data shows the subsurface warming above the minimums of about 0.06 ^{o}C/year in the urban area and 0.02 ^{o}C/year the suburban area. This fact suggests the existence of the heat island phenomena in the subsurface environment. Subsurface environment shows the various changes in the depth, location and amplitude due to the effects of human activity.