Effect of Urbanization and Land Use on The Subsurface Environment of Nagaoka Area, Niigata Prefecture, Japan.

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The aim of this study is to estimate the effect of urbanization and land use on groundwater temperature changes and, chemistry and isotope disturbances in the Nagaoka area. Thirty observation wells, twelve pumping wells and one spring were used to conduct the study. While the depth of the observation wells ranges from 20 to 115 m, the screen level of the pumping wells is between 25 and 195 m depth.

Temperature-depth profiles were measured four times in the observation wells during the period 2000-2001, and water was sampled from both the observation and pumping wells during the same period. To detect the effect of urban warming, the recently measured subsurface temperature data of this study were compared with the data measured in the same wells during the period 1977-1983 (Taniguchi, 1986). As a result of correlating the old profiles with the new ones, three groups of wells can be distinguished. The first group located in the urban area shows a significant temperature increase; i.e. high increase of temperature may be due to urban warming. The second group of wells shows a temperature decrease, this phenomenon is interpreted as the result of induced recharge from the Shinano River due to severe pumping in the urban area and specially, during winter season. The third group does not show temperature changes.

To examine the effect of land use, urbanization and pumping on the groundwater of the area, chemical and isotopic analyses were conducted. These analyses show extremely variable chemical and isotopic composition and great disturbance in the urban area. The groundwater flow system appears to be divided in three main parts,: shallow, intermediate and deep. The shallow water is composed of Ca-HCO3 chemical type and considerable concentration of NO3 probably contaminated by agriculture pollution; and its isotopic composition different values probably due to different sources of water recharge (paddy fields, irrigation channels and precipitation).

The intermediate groundwater is composed of Mg-Ca-Na-HCO3 chemical type with isotopic composition intermediate between the shallow and deep waters. The deeper flow has a very low concentration of the dissolved salts and lighter isotopic composition than the shallow indicating high altitude recharge.

As a result of severe pumping during the winter season from about 40 years ago, the shallow groundwater flowed from different directions toward the urban area, moderately deep water flowed upward to the shallow zones, polluted surface water highly recharging the groundwater and oxygenated fresh water recharged from the Shinano River. Mixing all of these water types is clearly suggested from the isotope and chemical data. The disturbances in temperature profiles, chemical and isotopic composition groundwater have reached about 50m deep under the urban area.