

The annual and secular movements of vertical component in GEONET sites caused by groundwater usages

*Seiichi Shimada¹, Masaatsu Aichi¹

1. Graduate School of Frontier Sciences, University of Tokyo

Annual and secular movements are observed in vertical components of many GEONET sites caused by the groundwater usage. Observation of vertical movements associated with groundwater drawing is an indispensable observation element for establishing groundwater circulation model, as well as observations of groundwater level and meteorological factors. The Geospatial Information Authority of Japan plans to switch the monitoring method of vertical movements from conventional leveling survey to the space geodetic techniques such as GNSS measurements, and in the near future vertical movement monitoring by GNSS observations is likely to become an observation tool indispensable for groundwater usage and management through groundwater circulation model. In order to observe ground subsidence, one of the largest obstacles in the groundwater usage, installation of antenna pillar for GNSS observations will become indispensable near the water well that pumps a large amount of groundwater, in the near future.

In this presentation, we show examples of annual and long-term secular variations associated with groundwater usage, which we find by the analyses of GEONET sites in the Kanto region and Niigata prefecture. In the analysis, we determine at first the daily coordinates of the GEONET sites with 23 fiducial sites of IGS network in East Asia and the surrounding area. We apply the ITRF 2014 coordinates and the VMF1 mapping function as well as 10° cutoff elevation angle. We estimate every hourly zenith delay and every four-hourly atmospheric gradient simultaneously with the site coordinates and ambiguities. Then we apply the 30-day window Kalman filter to eliminate the short cycle fluctuation and clarify the annual/semi-annual and secular vertical movements from long-term observation data.

In the GEONET sites in the Kanto region, vertical movements due to agricultural usage of ground water are detected in the central to northern part of the Kanto plain, centering on Saitama prefecture. For example, at the Tsukuba1 site (92110 site) in the campus of the Geospatial Information Authority of Japan, annual variations that subside in summer are observed caused by the groundwater usage of the rise field around the site, that are harmonious with VLBI and groundwater level observations (Tobita et al., 2004; Munekane et al., 2010; Shimada et al., 2017).

In the Kujukuri area, a large amount of subsiding is observed caused by the groundwater mining for refining natural gas. At the Oami-Shirasato site (93027 point) and the Chosei site (93033 site) in this area, in addition to the annual variation subsiding in the winter, the long-term ground subsidence are detected harmonizing with the level survey and the InSAR observations (Harada, 2018; Shimada et al., 2018).

In Niigata prefecture including the Niigata plain, groundwater usage for snow melting is widespread, and vertical subsidence is observed caused by the groundwater usage. For example, at the Niigata Sakae site (970810 site) in Sanjo city, as well as the annual variation that settling in winter, progress of inelastic secular subsidence is seen especially in the years when the amount of snow fall is large and the amount of ground subsidence also large (Shimada, 2018).

Keywords: GNSS measurements, GEONET, Groundwater usage, Annual movements, Secular movements