Land subsidence of the northern Kanto plains detected by JERS-1 SAR interferometry

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The ground water extraction for irrigation sometimes causes land subsidence in the northern Kanto plains. We made twenty SAR interferograms of the plains using JERS-1 data. The area and amount of subsidence from InSAR was consistent with the leveling. We then calculated the vertical displacement at benchmarks from InSAR and compared them to the leveling. Consequently, they have high positive correlation, but the InSAR result has a positive bias comparing to the leveling result. We think the bias comes from the incorrect interferometric baseline estimation in the process caused by the picking of GCP's from subsiding area. We try three method to decrease the influence of the subsidence on the baseline estimation.

We detect the land subsidence caused by the ground water extraction in northern Kanto area by SAR interferometry (InSAR) using JERS-1 data.

Since 1960s many areas in Japan have been suffering from land subsidence caused by the ground water extraction. Although the recent subsidence becomes moderate in many areas thanks to the legal control on the ground water extraction, it is still a problem in some areas.

The northern Kanto plains, which is the target area of our present study, is one of those areas. The ground water extraction for irrigation sometimes causes land subsidence. The summer of 1996 was very dry and much ground water was extracted. The land subsidence as much as 6.9cm per year was detected by the leveling at Nogi, Tochigi Prefecture.

There is a strong demand for accurate and economical method to monitor land subsidence to effectively control the water extraction. To evaluate the capability of InSAR to monitor land subsidence, we applied InSAR for the Kanto area where precise leveling data are available for the comparison. We used the JERS-1 data obtained from 1992 to 1998. We made 20 interferograms and unwrapped them to map the vertical displacement field.

The area and the amount of subsidence detected by InSAR were consistent with the yearly leveling result. We can conclude that the JRES-1 SAR interferometry have enough capability to detect the land subsidence of several centimeters on flat topography.

In order to estimate the accuracy of the amount of the subsidence detected by InSAR, we then calculated the vertical displacement at benchmarks from SAR interferograms we processed, and compared them to the vertical displacement of the benchmarks from the leveling for each interferograms. Consequently, there is good positive correlation between InSAR and leveling, but the regression line of each scene has a positive y-intercept. This means that the vertical displacement from InSAR has a positive bias comparing to the leveling.

We consider that this came from incorrect interferometric baseline estimation in InSAR process.

Following Rosen et al. (1996), we estimated baseline so as to fit the simulated topographic phase difference from DEM at GCP's to the actual interferogram. In this process, we picked part of GCP's from the subsiding area. As a consequence, the simulated interferogram from this baseline reproduce the topographic phase overlaid the phase due to subsidence. On the other word, simulated topographic phase is biased to the direction of subsidence.

The displacement phase, or the subsidence detected by InSAR, is calculated by the subtraction of the simulated interferogram from the actual one, so the resulting displacement phase is also biased to reduce the subsidence.

Therefore, to detect land subsidence more accurately, we must decrease the influence of the subsidence in the baseline estimation. We try three method: (1)Pick up the GCP's where no subsidence occurred. (2)Join two adjacent SAR data so that the subsiding area accounts for less portion of the image and then process. (3)Pick up GCP's from the location of the benchmarks and correct the phase of the actual interferogram using leveling data. We will report the result of these methods. We also intend to report the other area with land subsidence than northern Kanto plain.