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Measurement of long-term land subsidence by combination of InSAR and time series analysis - Application study to Kanto Plains of Japan -

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InSAR is an application technique of synthetic aperture radars and is now drawing attention as a methodology capable of measuring subtle surface deformation over a wide area with a high spatial resolution. In this study, the authors applied the method of measuring long-term land subsidence by combining InSAR and time series analysis to Kanto Plains of Japan using 28 images of ENVISAT/ASAR data. In this measuring method, the value of land deformation is set as an unknown parameter and the optimal solution to the land deformation amount is derived by applying a smoothness-constrained inversion algorithm.

The vicinity of the Kanto Plain started to subside in the 1910s, and became exposed to extreme land subsidence supposedly in accordance with the reconstruction efforts after the Second World War and the economic development activities. The main causes of the land subsidence include the intake of underground water for the use in industries, agriculture, waterworks, and other fields. In the Kujukuri area, the exploitation of soluble natural gas also counts. The Ministry of Environment reported in its documents created in fiscal 2006 that a total of 214 km2 in Tokyo and the six prefectures around the Plain had undergone a subsidence of 1 cm or more per a year.

As a result of long-term land subsidence over approximately five and a half years from 13th January, 2003, to 30th June, 2008, unambiguous land deformation was detected in six areas: (i) Haneda Airport, (ii) Urayasu City, (iii) Kasukabe-Koshigaya, (iv) Southern Kanagawa, (v) Toride-Ryugasaki, and (vi) Kujukuri in Chiba Prefecture. In particular, the results for the Kujukuri area were compared with the leveling data taken around the same area to verify the measuring accuracy. The comparative study revealed that the regression formula between the results obtained by time series analysis and those by the leveling can be expressed as a straight line with a gradient of approximately 1, though including a bias of about 10 mm. Moreover, the correlation coefficient between the two methods demonstrates an extremely high correlation, exceeding 0.85. In conclusion, the spatial geometry of land deformation derived by time series analysis is found as mirroring the precise area of deformation captured by the leveling technique with a high accuracy.