Combining Sentinel-1 DInSAR Technique with Field Monitoring Data to Evaluate the Trend of Land Deformation in the Hualien Area of Taiwan

Ying-Ying Wu[1], Yun-Chen Tu[1], Hong-Mao Huang[2], Jhe-Syuan Lai[1], Bing-Shian Lin[3]*

[1] Department of Civil Engineering, Feng Chia University

[2] Institute of Earth Sciences, Academia Sinica

[3] Water Resources Engineering and Conservation, Feng Chia University

Earthquake and typhoon events occur frequently in Taiwan, causing terrain changes and multi-geohazards. This study selects Hualien area as the test site. Airborne LiDAR, optical satellite images, and interferometric synthetic aperture radar (InSAR) are commonly used for monitoring landscapes. Airborne LiDAR techniques have characteristics with higher cost, longer data processing, and lower temporal resolution. Optical satellite images might be affected by cloud, and geometric intersections between satellites and targets. InSAR can reduce above restrictions, but users difficultly and non-intuitively deal with these data. This study applies the differential InSAR (DInSAR) approach to obtain the land displacements of line of sight (LOS) between satellite and targets for the specific hazard events with a large scale, comparing with the field monitoring data.

The radar wave might be affected by many factors during transmission to cause inaccurate results. The field instruments can directly monitor terrains and landscapes without signal transmission issue but difficultly collect data for large regions. The field observations of E-GNSS (global navigation satellite system) and ground displacements are transformed into the LOS direction for examining them with DInSAR results. The differences between the field data and satellite products are used to perform the interpolation. DInSAR results will be refined after subtracting the interpolation outputs. One of commonly used methods, inverse distance weighting (IDW), is applied in this study to explore effect of the field locations. All and part field stations are included during interpolations. The time series analysis between the refined DInSAR results and the field observations are evaluated by the root-mean-square error (RMSE).

This study includes the E-GNSS and the ground displacement instrument for the IDW interpolation to explore the differences with all and part filed stations as the reference points, respectively. Experimental results in the E-GNSS case indicate that the RMSEs range 0.200-0.900, 0.002-0.800, and 0.002-0.010 m with original DInSAR, and the refined DInSAR using all and part field stations, respectively. In the case of ground displacement instrument, RMSEs show 0.200-1.800, 0.004-0.400, and 0.001-0.100 m with original DInSAR, and the refined DInSAR using all and part field stations, respectively. Consistence between satellite- and field-based monitoring can be observed after refining the DInSAR results, especially the case of the part field stations as the reference points for the IDW interpolation. It should be noted that ignoring the field station with extreme displacements is suggested in order to avoid distortion after interpolation.

Keywords: interferometric synthetic aperture radar (InSAR), differential InSAR (DInSAR), land displacement, inverse distance weighting (IDW) interpolation.