Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

STT59-01 Room:414 Time:April 29 09:00-09:15

DEM accuracy evaluation in mountain area by utilizing topographic corrected products of high-resolution TerraSAR-X data

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The commercial high-resolution Synthetic Aperture Radar (SAR) sensors have been developed during past few years and became essential source of information in Earth Observation. The production of the maps is examined in the various fields, such as the damaged area caused by disaster, paddy field area, and forest etc. The interpretation of the objects from the images and the positional accuracy of the images are highly important for the map creation and several basic studies for such issues are also conducted by applying high-resolution SAR data.

TerraSAR-X is one of the commercial SAR satellites, and has acquired data worldwide after it was launched in June 2007. Furthermore, TanDEM-X (TerraSAR-X add-on) was launched in 2010. Both satellites are currently acquiring land surface of Earth for creating global and homogeneous Digital Elevation Model (DEM) of very high precision. TerraSAR-X has several processing level products, and the Geocoded Enhanced Ellipsoid Corrected (EEC) is amplitude data projected to the digital elevation model (DEM), which makes possible for users to integrate other optical data and GIS data. Pre-geocoded Single Look Slant Range Complex (SSC) product is complex data with two axes in the azimuth-slant range plane, and used for interferometric and polarimetric analysis.

It was reported that the geometric accuracy of SSC product was better than 1 m in several previous studies, however there are no reports stating details for the validation results of the EEC product using the actual TerraSAR-X data though it is utilized by the most of users. Therefore the authors evaluated the geometric accuracy of the EEC product by performing in-situ experiment using reflectors on the flat area, simultaneously conducted during satellite passed over. The results showed that the accuracy satisfied several meters in case of utilization of SRTM DEM. In the next stage, we developed the model showing the relationships between the geometric accuracy of range direction, DEM accuracy, incidence angle, and it was revealed that the accuracy of the model was about 1 m in the flat area.

The purpose of this study was to evaluate the accuracy of utilized DEM for the topographic correction by applying the model to TerraSAR-X data in the mountain area. The utilized TerraSAR-X data were 2 data sets of high-resolution SpotLight mode (about 2 m resolution) with the different incidence angles, and the DEMs were produced by ASTER with the mesh of 30 m and SRTM with 90 m. We also used the airborne optical data with a geometric accuracy (Digital topographic level of 2,500 scales) for a validation.

Firstly we selected 25 validation points from the intersections and curves of roads easily interpreted both from TerraSAR-X and airborne data. The average, standard deviation, and Root Mean Square Errors (RMSE) value of the difference between TerraSAR-X and reference optical data were evaluated for X-, Y-, and X-Y plane. In the next stage, we examined to apply the model to data in the mountain area. We estimated DEM's errors by assuming that the variation of the differences of the X-direction was corresponded to the errors of the topographic correction since the range direction was almost same for X direction. The results were summarized based on the evaluations of both flat and mountain areas.

Keywords: Geometric accuracy, TerraSAR-X, topographic correction, ASTER, SRTM