Quantitative evaluation of global-scale free DEMs for mountain glaciology

*Hiroto Nagai[1], Takeo Tadono[1]

1. Japan Aerospace Exploration Agency

Aerial and space-borne stereo photogrammetry provides topographic data, digital elevation model (DEM), which has been developed in various ways, resulting in several kinds of DEM dataset. Earth observation satellite generated DEMs which have an important role in obtaining homogeneous-quality geospatial information in remote high mountain areas, thereby contributing to studies of mountain glaciology. This study validates the accuracy of ASTER GDEM, SRTM, ALOS World 3D-30m (AW3D30), which use 30-m pixel spacing and have recently been released free of charge, against check points (CPs) managed by GSI in glacialized topography in the Northern Alps, the hillslope of Mt. Fuji, and the alluvial plain of the Tone River in Japan.
Statistical results of elevation differences at each study site show that AW3D30 has the nearest elevation values to those of CPs. The largest variability is seen in the Northern Alps, where ASTER GDEM and SRTM1 are 13-18 m lower than the CPs, with a 15-20 m standard deviation (elevation difference to CPs). There are fewer differences between the accuracies of the three DEMs with gentler-sloped topography, and an equivalent accuracy between SRTM1 and AW3D30 (+0.1+/-3.1 m) is denoted in an almost flat paddy field in Tone. In addition, at this site, the mean difference and standard deviation of difference to CP elevation values of ASTER GDEM is in a range of less than 5 m. Our results thus determine that the various DEMs have differing levels of accuracy in association with particular types of topography. AW3D30 has the highest accuracy in steep topography of the Northern Alps, and SRTM1 has a better accuracy in moderate reliefs.
DEMs generally contains no-data area (“void”) where original stereo-pair data have an inadequate number of matching points. The characteristics of void distributions are important factors when selecting a DEM for a particular study purpose. The void distribution of the three above-mentioned DEMs are thus compared in the Nepal Himalayas. AW3D30 is mainly found to contain voids around the important peaks of the Himalayan main range; this is probably related to the continuous snow covering in high elevation areas around the peaks, which makes tie point acquisition from ALOS optical stereo pair-images difficult. SRTM1, voids are mainly distributed in areas of lower elevation with steepness of around 45°, which can be reasonably explained by steep mountain slopes hampering the acquisition of original SAR data, thereby resulting in shadowing and/or layover. ASTER GDEM, which was generated using the longest-term observation record of ASTER stereo pair images, has no voids in the study region and is therefore of use in cases that require moderate accuracy without any missing data, such as regional-scale watershed generation.

Keywords: SRTM, GDEM, AW3D

