Effect of Terrain Relief and Vegetation Cover on the Accuracy of TanDEM-X DEM

Deo, Rinki - IIT Bombay, Centre of Studies in Resources Engineering
Rao, Y S - IIT Bombay, Centre of Studies in Resources Engineering

Recently launched TanDEM-X SAR mission (June, 2010) aims to generate a consistent global DEM equaling HRTI-3 specification. In view of global DEM generation using TanDEM-X InSAR data, it is very important to evaluate their accuracy over various test areas. To understand the effect of various terrain conditions on TanDEM-X DEM accuracy, four test sites representing a range of vegetation cover and topographic characteristics have been selected. We have derived DEM using interferometric technique from TanDEM-X data for all the four test sites and evaluated their accuracy with accurate DGPS points collected as ground truth. Mumbai (Flat Terrain) is in the west coast of India with a reserved deciduous forest and is surrounded by highly populated city with multi storied buildings. TanDEM-X DEM is evaluated with 27 uniformly distributed accurate DGPS points for this area and observed that the elevation error varies centered around ±1.76 m with correlation (R2) 0.98. The calculated RMS error is 1.78 m. This indicates that for flat terrain the quality of DEM generated from TanDEM-X interferometric data is quite impressive. Koyna (moderate Terrain) is located in the western part of Maharashtra, India. The vegetation over the land is tropical evergreen forest and mixed deciduous forest. TanDEM-X DEM for this area is evaluated with ICESat and also with DGPS data. Generated DEM almost matches with the ICESat data demonstrating its potential of having high vertical accuracy. Evaluation of the effect of slope on DEM accuracy for this area shows that the error increase with the slope as expected. A variation of 22.7 cm per degree of slope was observed. Bare area with no vegetation cover shows 3.6 ± 5.59 m as an average absolute error, while it is 5.89 m ±16.81 m in vegetation covered areas. Further, it is observed that the error is higher even at lower slopes in vegetated areas, whereas in bare areas the error value increases gradually with the increase in slope. When evaluated with 28 DGPS points distributed uniformly in accessible barren areas, it is seen that descending pass TanDEM-X DEM is close to DGPS height value with average 5m difference and RMS value 25 m, while ascending pass DEM shows a variation of around 200 m from DGPS height value. This signifies that apart from other factors, orientation of slopes also affects the accuracy and this may be overcome by fusion of ascending and descending pass DEMs. Katerniaghat Wildlife Sanctuary (reserved forest) is located in Bahraich district, Uttar Pradesh, India. It is a tropical dry deciduous forest dominated by Shorea robusta natural forests and planted forest species Tectona grandis with a maximum height of 35 meters. The test area is relatively flat with only 30 meter elevation change from one side of the forest to other. Total 32 uniformly distributed DGPS points were collected in the adjacent open areas and also in the gaps present within the forest area. TanDEM-X DEM for this area is compared with collected DGPS height values. At the Indo-Nepal border area, one side of the border is having Sal trees with average 25 m height while the other side is totally bare land. Height difference between the two adjacent areas should be equal to the average tree height within a resolution cell. Generated DEM with HH polarization shows a height difference of around 18 m between bare and sparse forest area. This denotes the return of X-band signal from somewhere below the top of the canopy due to presence of gaps between the trees and penetration of microwaves through the vegetation. However, for dense forest area, the difference is approximately same as the tree height denoting the phase center height same as the top of canopy. Gangotri area covers gangotri glacier in the Uttarkashi district of Uttarakhand, India, representing rugged terrain with elevation varying from 3000 meters to 6500 meters. Evaluation of DEM over this area is in progress.