Validation of surface feature height model (SFH) in Tsukuba City.

Manjula Ranagalage (Doctoral Program in Geoenvironmental Sciences)

1. Motivation

Estimating of urban green volume (UGV) and urban built volume (UBV) is essential for city planning and sustainable development of the cities. UGV and UBV estimation can be considered as a one of proxy indicator for identifying urban development pattern. Digital Surface Model (DSM), Digital Terrain Model (DTM) used to calculate the Surface Feature Height (SFH) model. Building and green footprint and SFH model used to calculate the UGV and UBV. The accuracy of volume estimation mainly defends the accuracy of the SFH model. Hence, the motivation of this study is to measure the accuracy of surface feature height model (SFH) in Tsukuba City.

2. Introduction

Identify the spatial distribution of green and built-up area is vital for urban sustainability. Traditionally, urban development pattern was estimated using two-dimensional (2D) extents. This 2D extent was converted in to 3D extents due to availability of remote sensing and geospatial data. Estimation of 3D extents mostly used to calculate UGV and UBA for vertical development of urban areas.

3. Study Area

The study has carried out Tsukuba City covers a 2.5 km radius from the City center. The total land area is 19.6 square kilometers.

4. Methodology

Figure 1 shown methodology adopted to the study. SFH model was derived using ALOS PRISM DSM with a spatial resolution of 5 m was obtained at 23rd February 2011 from the Japan Aerospace Exploration Agency (JAXA), and DTM based on 200 meters mesh size is used in this study. The DSM and DTM used to extract the SFH model of the study area. Height and location (X, Y) of the 55 buildings were selected for validating the SFH model. ArcGIS online based map used to digitize the footprint of the building, and zonal analysis used to extract the maximum SFH values within each building. Finally, actual building heights and extracted building heights were used to calculate RMSE and an R^2 value of Tsukuba City.
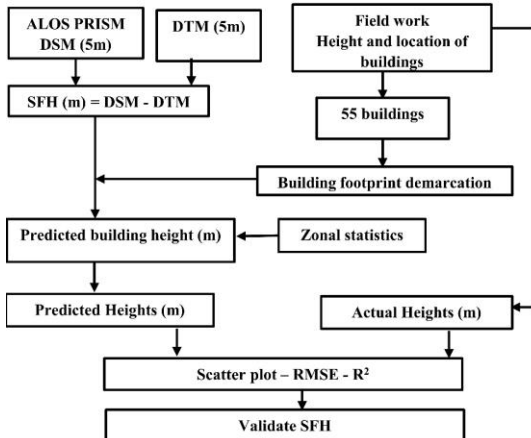

Figure 1: Methodology flow chart

5. Results and Discussion

5 m DSM value range from 30m to 150 m in Tsukuba City. 200 m mesh size used in the study to generate DTM using the grid-based method. 3.28 rote mean square error (RMSE) had been recorded during the interpolation process. DTM value range from 30.3m to 69.9m. The extracted SFH had ranged from -11.6 to 93.9m (Figure.2).

During the fieldwork, 55 buildings were selected to measure the actual heights. The building with less complex rooftops was selected to maintain the accuracy of the heights. Reference building heights were measured using two methods (1) used Rangefinder to calculate building height and (2) floor number and heights floor was measured manually using a measuring tape. There was some mismatch of the two heights from two different methods. Hence, manually calculated heights used for accuracy assessments.
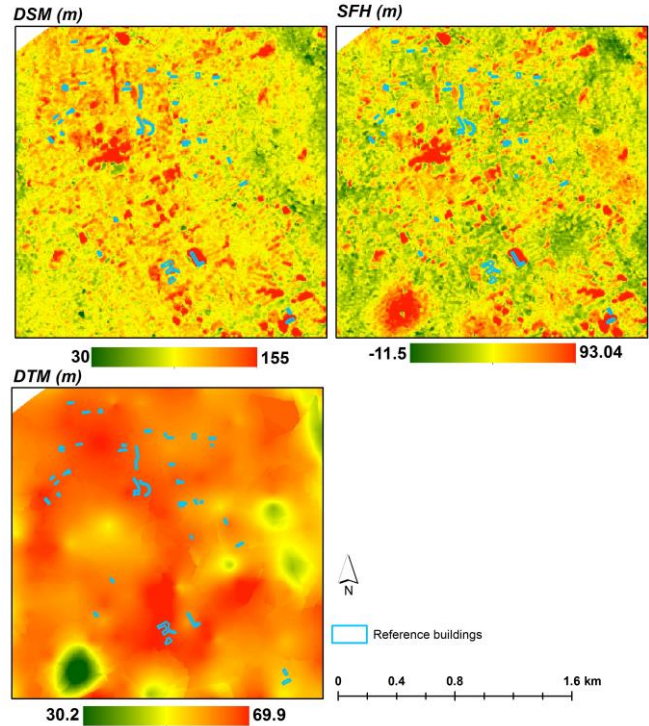

Figure 2: ALOS PRISM DSM, DTM and SFH maps derived from the ALOS PRISM DSM using the grid-based method of Tsukuba City. Data Source: JAXA.

The measured building heights and extracted building heights using SFH of the buildings used to validate the SFH. The Figure. 3 shows the relationship between measured height and observed height. RMSE and R^2 were calculated using above mention two heights. During this study, RMSE value was 6.8 m, and R^2 between to heights was shown as 0.78. Previous research had found the closer RMSE value of this study. An RMSE value closer to zero indicates higher accuracy. Hence, the SFH model can be considered in future UGV and UBV estimation studies.
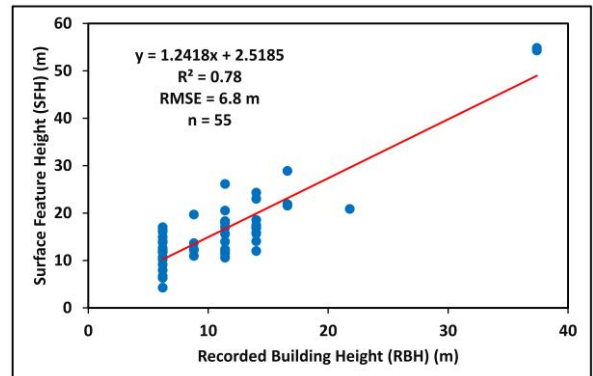

Figure 3: Scatter plots of the RBH data and ALOS PRISM DSM-derived SFH data in Tsukuba.