A geospatial technique for estimating urban built volume using remote sensing data

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Introduction

Geospatial techniques based on remote sensing and GIS are important in urban studies. However, the analysis of the intensity and spatial pattern of urban land use is, in most cases, based only on the lateral extent of built-up lands (two-dimensional) (Koomen et al. 2009).

The increasing availability of geospatial data, such as remote sensing satellite imageries and digital surface models, provides an opportunity to integrate into urban studies the third dimension in urban analysis, i.e. height of urban features such as high-rise buildings, and thus enables the estimation of urban built volume (UBV). This study introduces a geospatial technique for estimating UBV, focusing on the use of a digital surface model (DSM) derived from ALOS PRISM data. It also presents a method for deriving a digital terrain model (DTM) from a DSM. This presentation presents the application of the proposed technique in Makati City, Metro Manila, Philippines.

Methodology

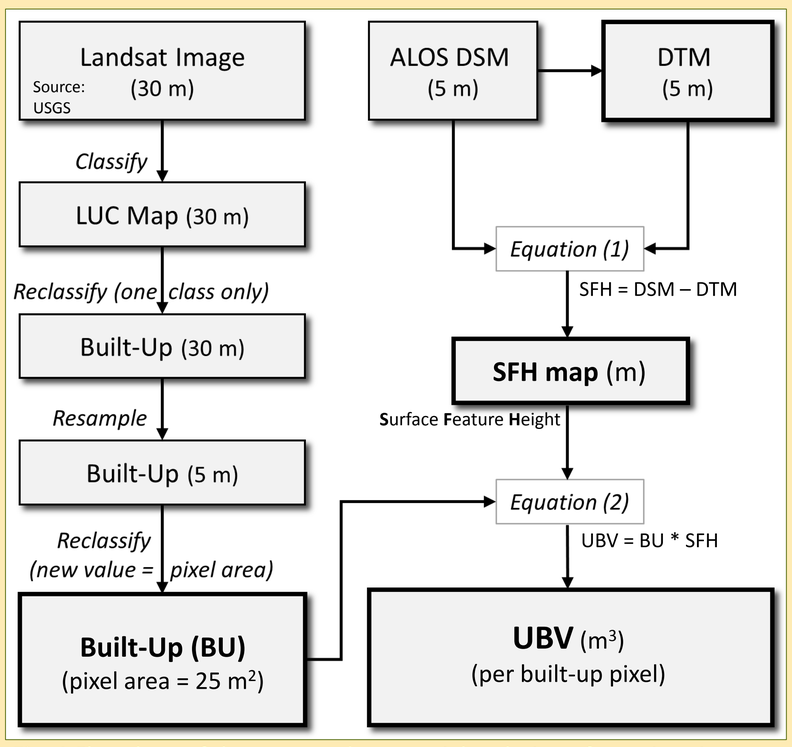

Fig. 1 Flowchart of the proposed geospatial technique for estimating UBV from remote sensing data.

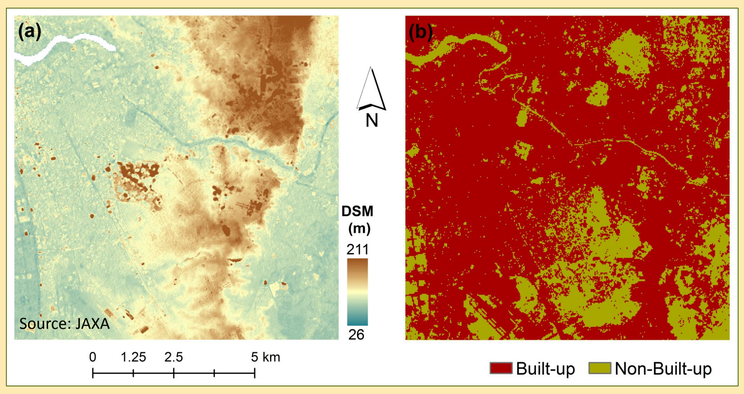

Fig. 2 (a) ALOS PRISM DSM ; (b) Land-use/cover (LUC) map (2009).

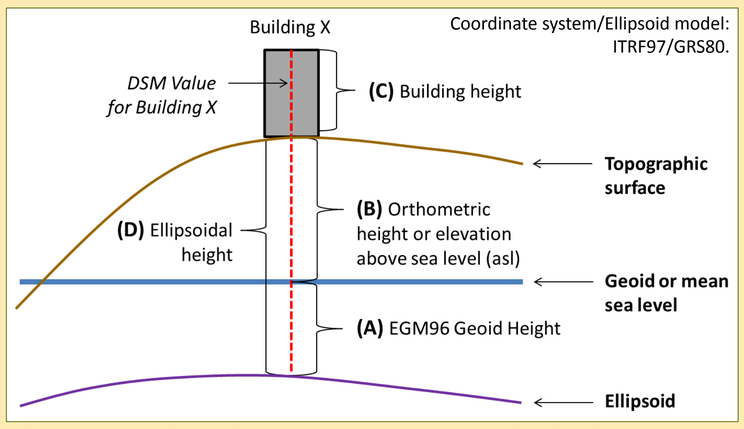

Fig. 3 Illustration of the ALOS PRISM DSM, highlighting the DSM value of hypothetical building x (DSM = A+B+C = C+D).

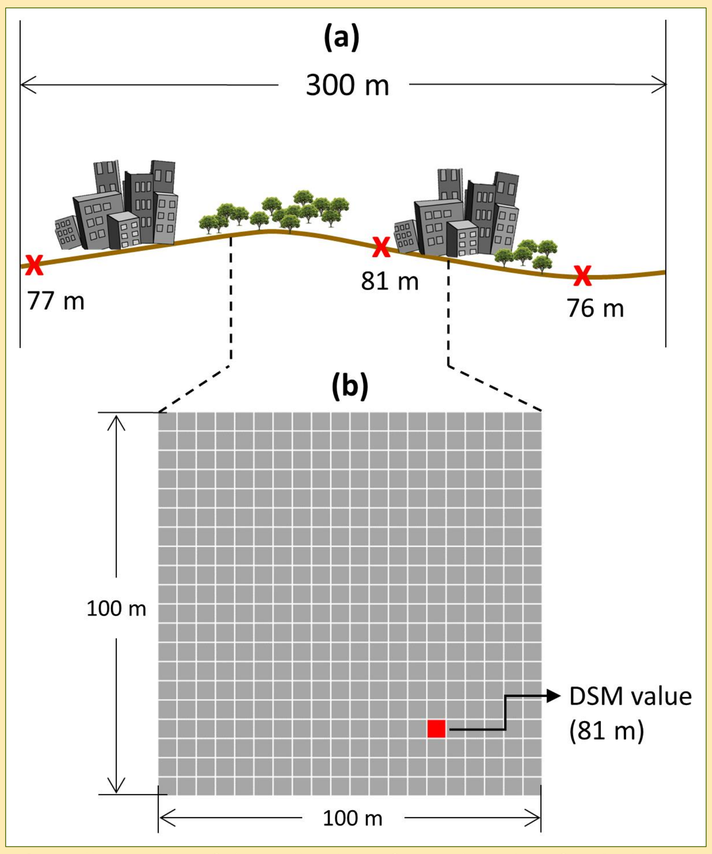

Fig. 4 Illustration of the collection of sample points for deriving a DTM from a DSM using a grid-based method.

(a) Cross section of a 300-m hypothetical urban landscape; and (b) a 100-m grid showing the hypothetical pixel with the lowest DSM value.

In this study, various grid or mesh sizes were examined , including 100 m, 150 m, 200 m, 250 m, 300 m, 350 m, and 400 m.

The Empirical Bayesian Kriging approach (Krivoruchko 2012) was used in the DTM interpolation.

The resulting DTMs were labelled DTM100, DTM150, and so on. Likewise for the resulting SFH and UBV maps (see Figs. 5-8).

Results (DTM maps; SFH maps; UBV maps)

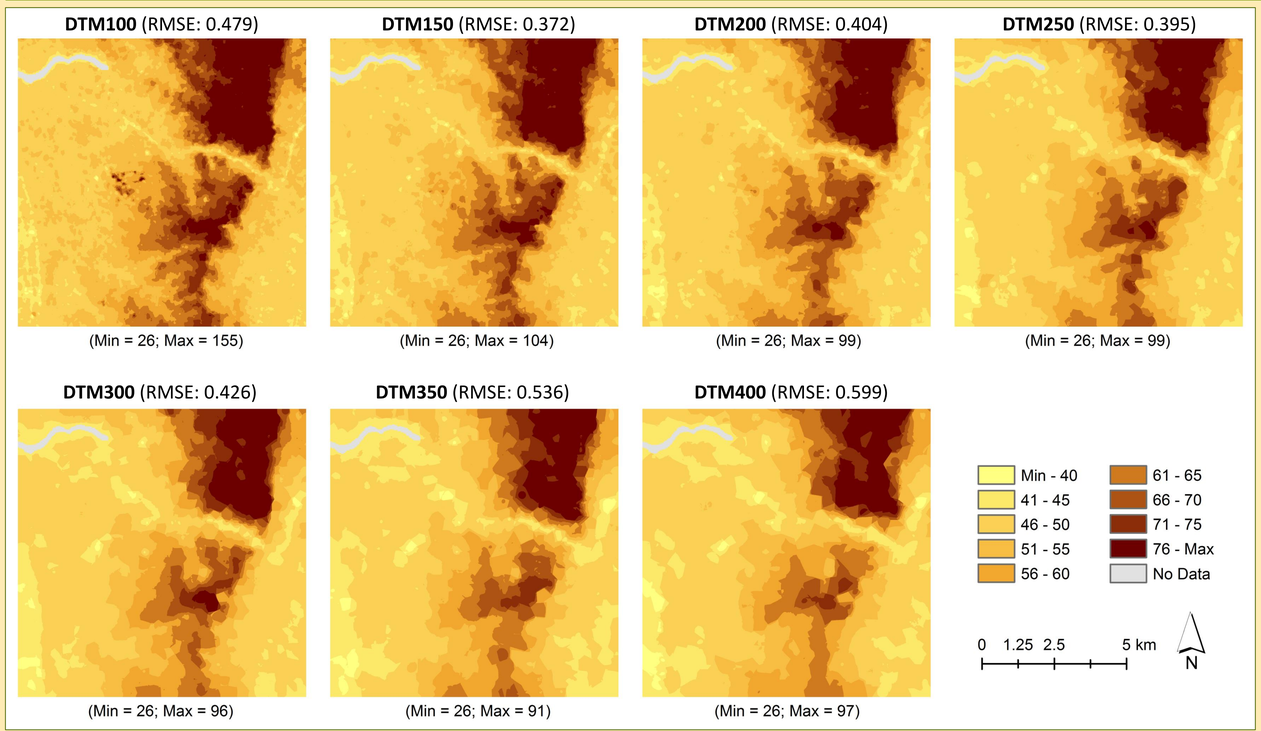

Fig. 5 The DTMs (m) derived from the ALOS PRISM DSM using the grid-based method.

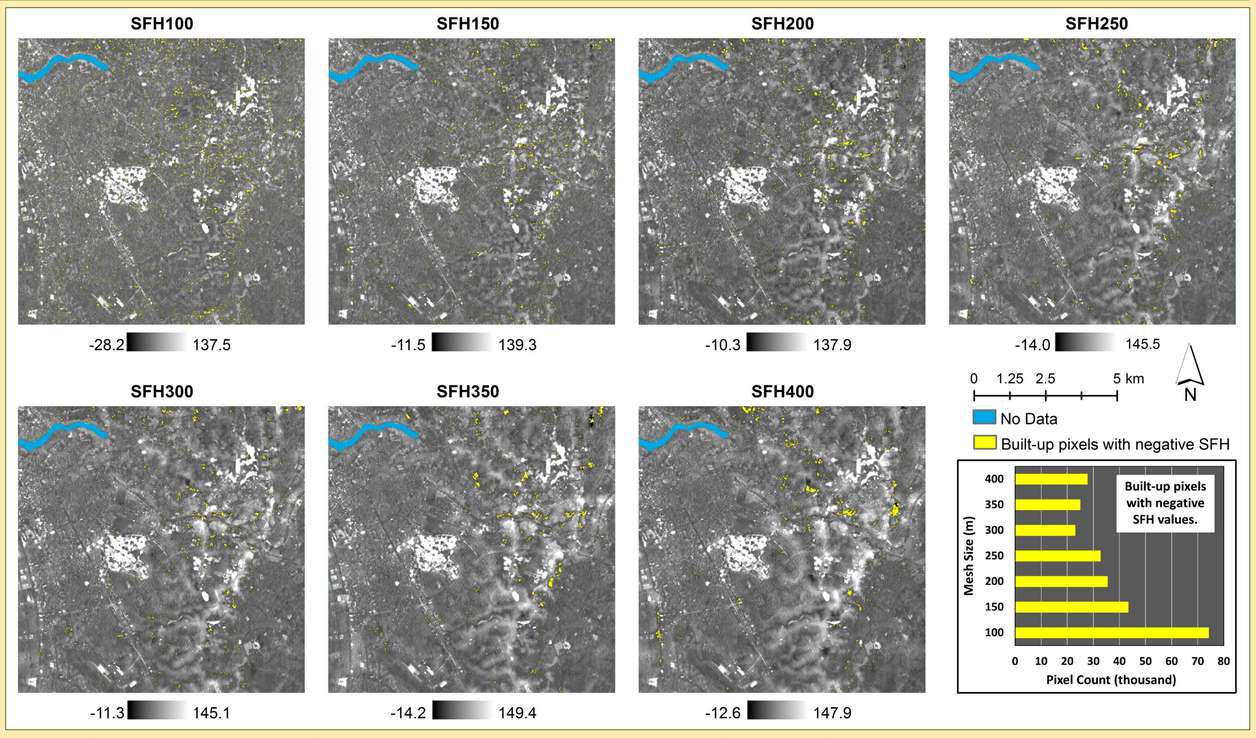

Fig. 6 The SFH maps (m) produced using the ALOS PRISM DSM and the derived DTMs.

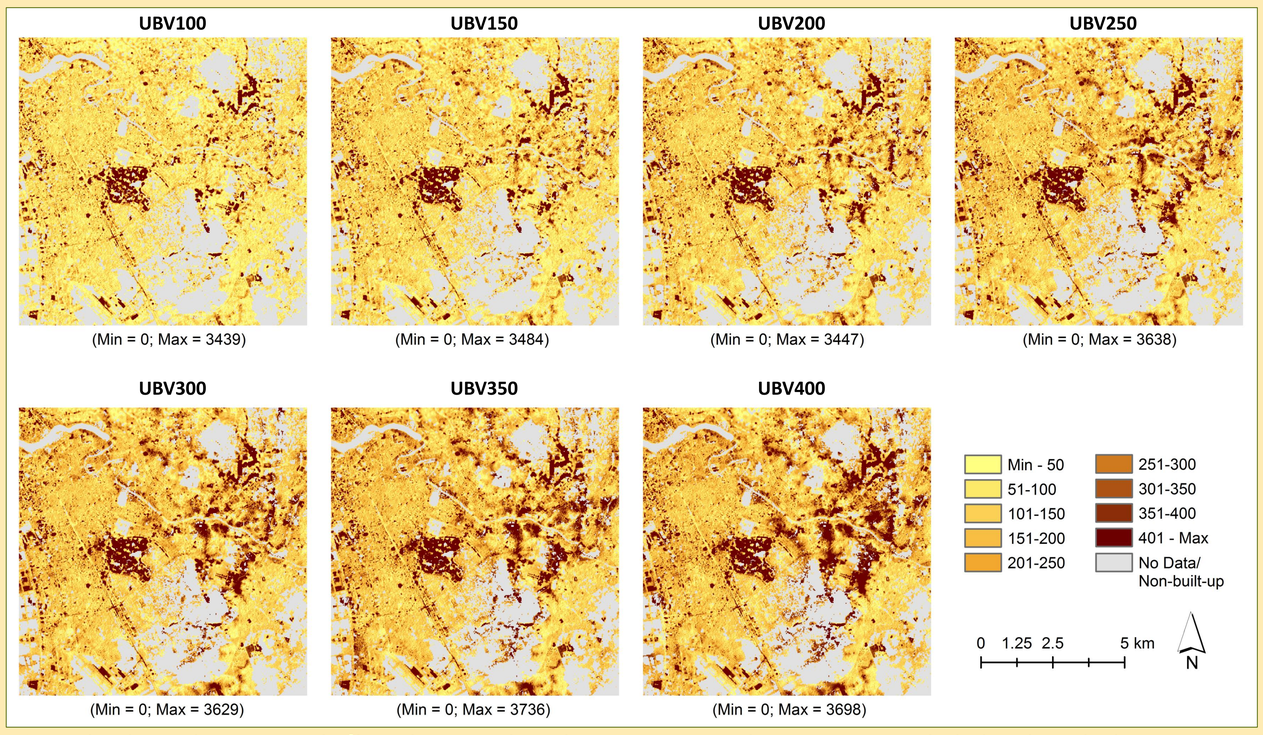

Fig. 7 The derived UBV maps (m^3). Built-up pixels with negative SFH values were not included in the calculation.

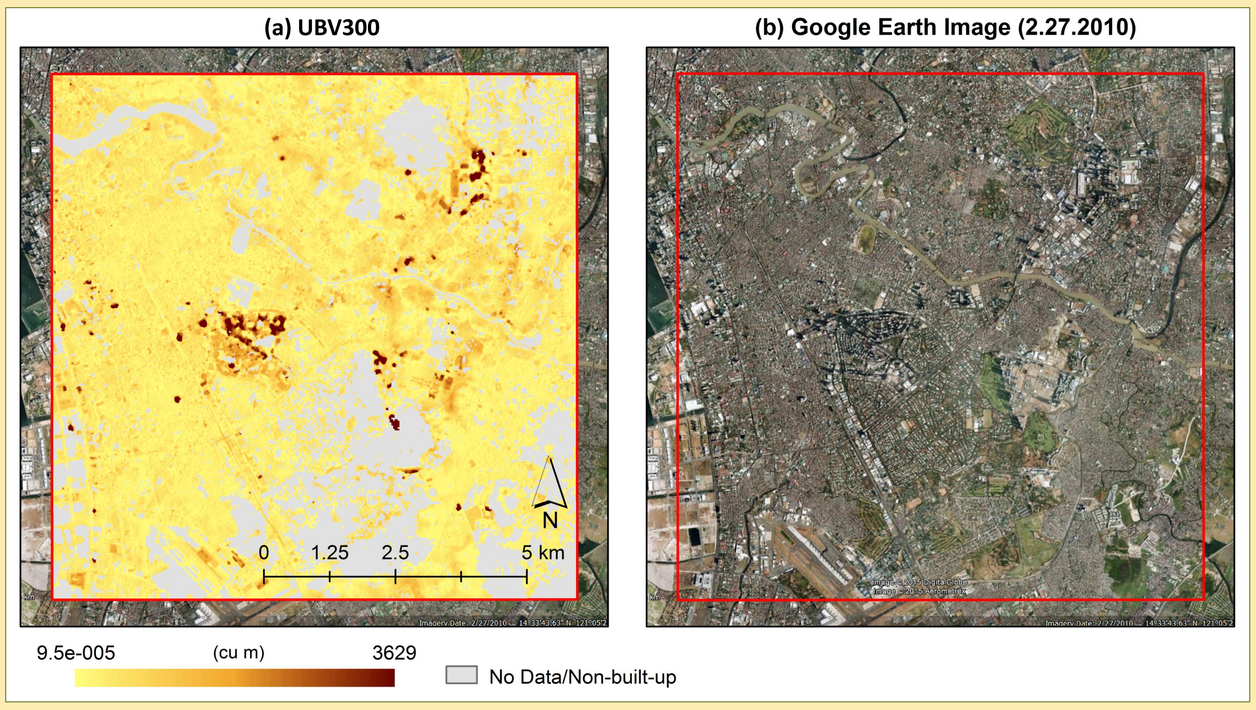

Fig. 8 Visual comparison between (a) UBV300 (c. 2009) and (b) Google Earth image (2010).

Conclusion & Prospect

- The proposed technique for estimating UBV is capable of taking into consideration the height dimension in urban analysis.
- Future prospects: development of validation methods for the results and implementation of the proposed technique in other cities.

Acknowledgements

Data Sources:

- DSM (JAXA, Rep.: Dr. Takeo Tadono and Dr. Rajesh B. Thapa)
- Landsat Image (USGS).

References

- Krivoruchko K. 2012. *Empirical Bayesian kriging…* ESRI, Redlands, CA, USA.
- Koomen E., Rietveld P. and Bacao F. 2009. *Environment and Planning B,* **36**:1008–1025.