

Automated Extraction of Built-Up Areas by Fusing VIIRS Nighttime Lights and Landsat-8 Data

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Abstract: As the world urbanizes and builds more infrastructure, the extraction of built-up areas using remote sensing is crucial for monitoring land cover changes and understanding urban environments. Previous studies have proposed a variety of methods for mapping regional and global built-up areas. However, most of these methods rely on manual selection of training samples and classification thresholds, leading to low extraction efficiency. Furthermore, thematic accuracy is limited by interference from other land cover types like bare land, which hinder accurate and timely extraction and monitoring of dynamic changes in built-up areas. This study proposes a new method to map built-up areas by combining VIIRS (Visible Infrared Imaging Radiometer Suite) nighttime lights (NTL) data and Landsat-8 multispectral imagery. First, an adaptive NTL threshold was established, vegetation and water masks were superimposed, and built-up training samples were automatically acquired. Second, the training samples were employed to perform supervised classification of Landsat-8 data before deriving the preliminary built-up areas. Third, VIIRS NTL data were used to obtain the built-up target areas, which were superimposed onto the built-up preliminary classification results to obtain the built-up area fine classification results. Four major metropolitan areas in Eurasia formed the study areas, and the high spatial resolution (20 m) built-up area product High Resolution Layer Imperviousness Degree (HRL IMD) 2015 served as the reference data. The results indicate that our method can accurately and automatically acquire built-up training samples and adaptive thresholds, allowing for accurate estimates of the spatial distribution of built-up areas. With an overall accuracy exceeding 94.7%, our method exceeded accuracy levels of the FROM-GLC and GUL built-up area products and the PII built-up index. The accuracy and efficiency of our proposed method have significant potential for global built-up area mapping and dynamic change monitoring.

Table S1. Percentages of pixels with DN=0 and DN>high threshold in the four study areas.

Study Area	Percentages of pixels with DN=0 (%)	Percentages of pixels with DN>high threshold (%)
1 (Paris)	51.3	0.4
2 (Ankara)	54.4	0.5
3 (Madrid)	46.9	0.9
4 (Lisbon)	60.1	0.7

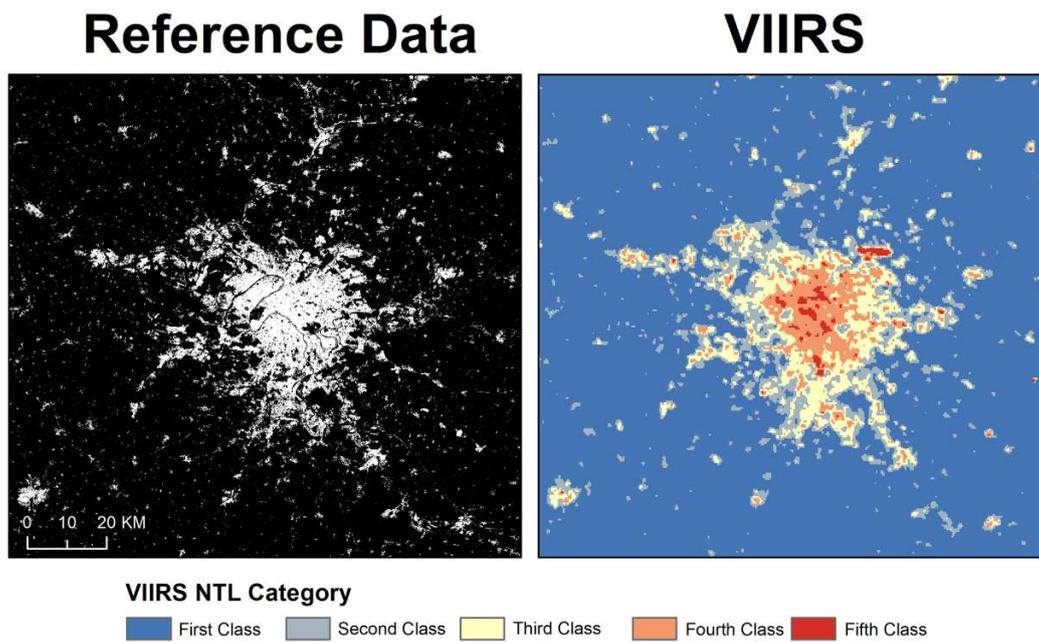


Figure S1. VIIRS nighttime lights categorized using the Jenks natural breaks algorithm in an example area (Study Area 1, Paris). White pixels correspond to built-up area while black pixels represent non-built-up areas in HRL IMD 2015 reference data.

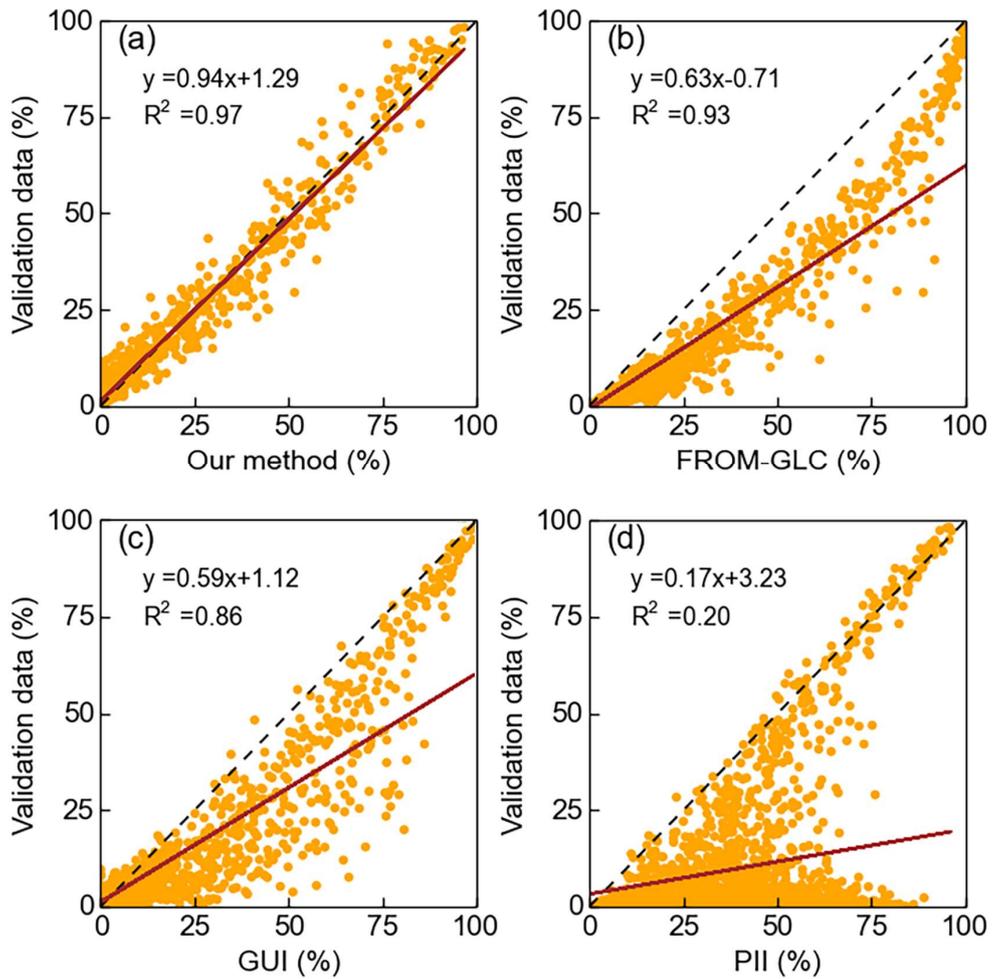


Figure S2. Built-up area scatter plots. The scatterplots compare the percentages of built-up areas in Study Area 1 (Paris) using validation data in 9 km² grids against those of (a) our method, (b) FROM-GLC, (c) GUI, (d) PII.

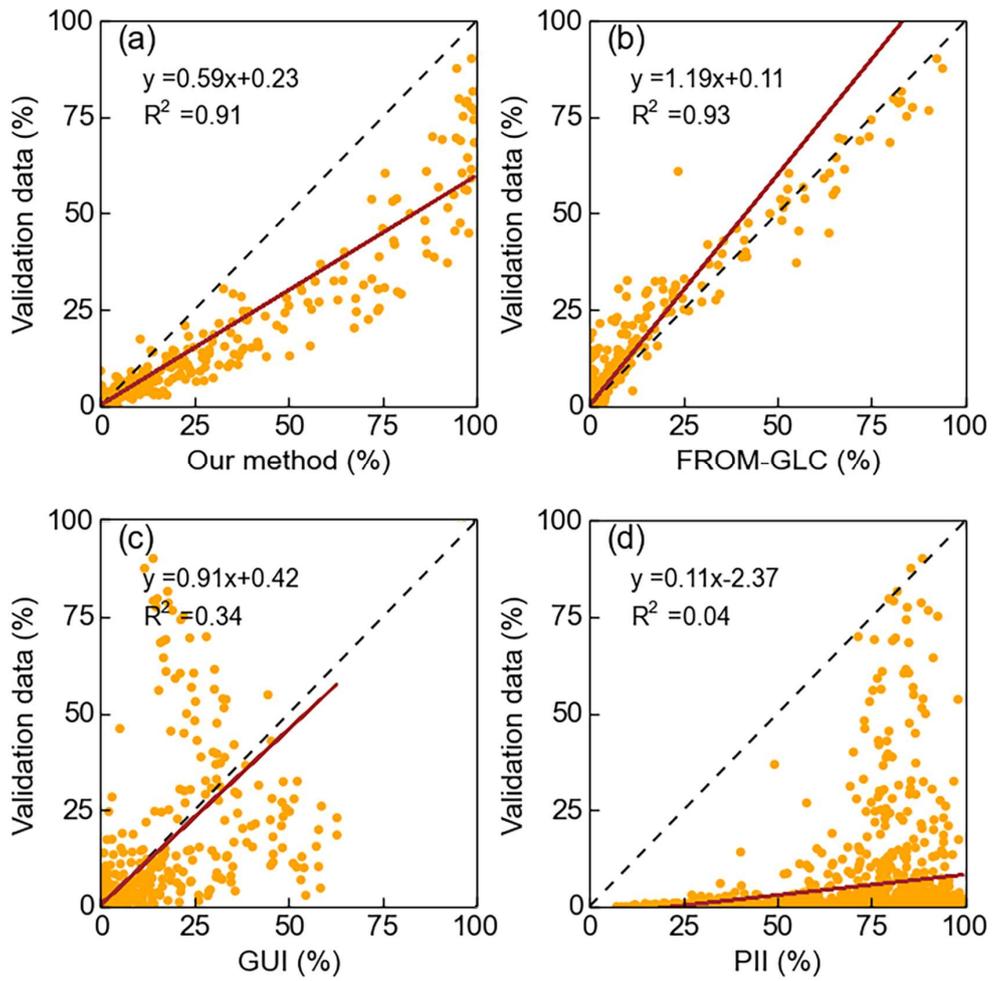


Figure S3. Built-up area scatter plots. The scatterplots compare the percentages of built-up areas in Study Area 2 (Ankara) using validation data in 9 km² grids against those of (a) our method, (b) FROM-GLC, (c) GUL, (d) PII.

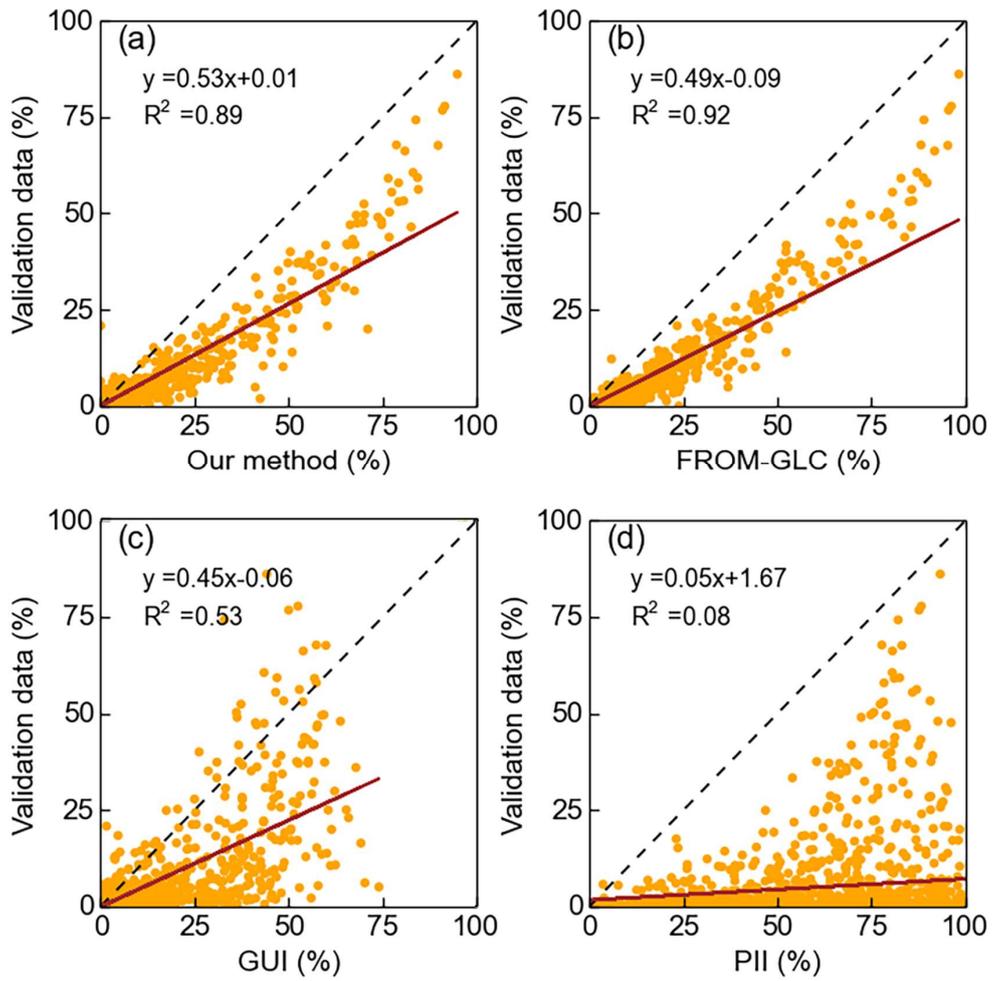


Figure S4. Built-up area scatter plots. The scatterplots compare the percentages of built-up areas in Study Area 3 (Madrid) using validation data in 9 km² grids against those of (a) our method, (b) FROM-GLC, (c) GUI, (d) PII.

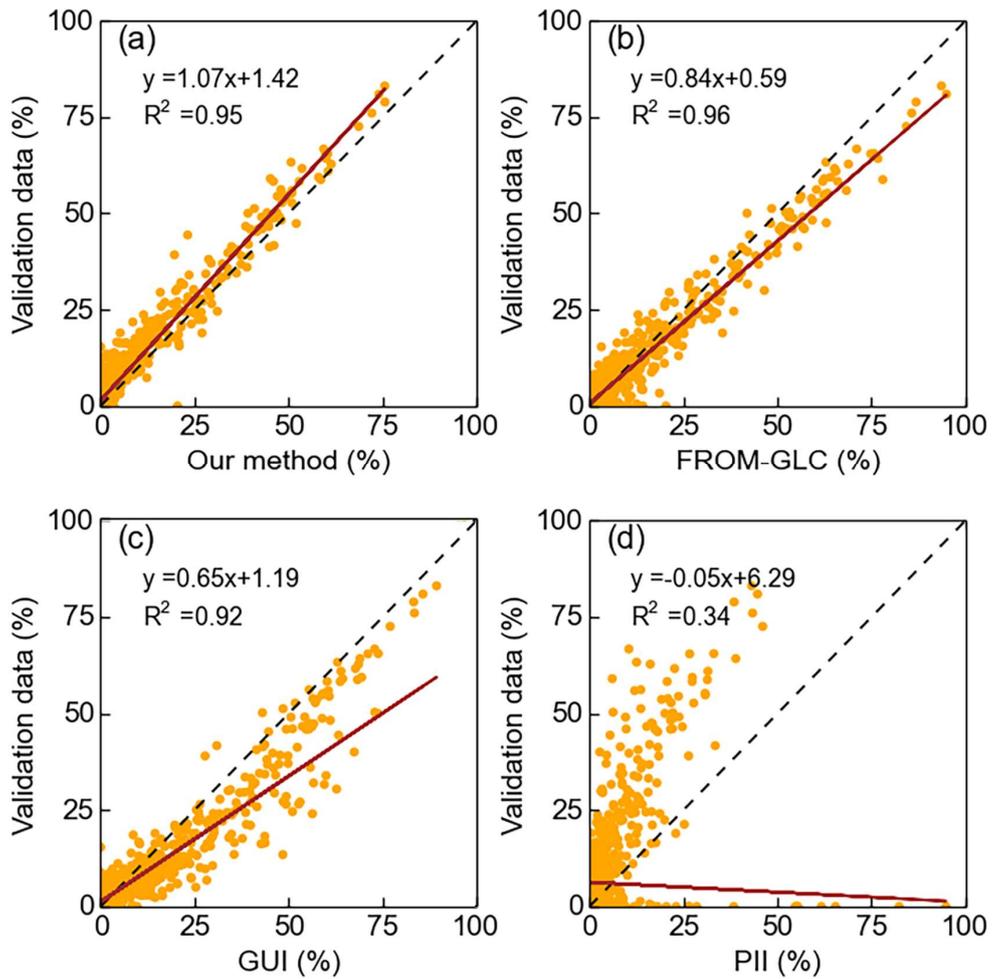


Figure S5. Built-up area scatter plots. The scatterplots compare the percentages of built-up areas in Study Area 4 (Lisbon) using validation data in 9 km² grids against those of (a) our method, (b) FROM-GLC, (c) GUL, (d) PII.