30-meter Resolution Urban Classification in Google Earth Engine

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ABSTRACT

Global representations of modern day urban land use and land cover (LULC) extent are becoming increasingly prevalent, yet considerable uncertainties in the representation of built environment extent (i.e., global classifications generated from 250m resolution MODIS imagery or the United States' National Land Cover Database) remain because of the scarcity of systematic, globally consistent methodological approaches. We aim to increase resolution, accuracy, and improve upon past efforts by establishing a data-driven definition of the urban landscape, based on Landsat 5, 7 & 8 imagery and ancillary data sets.

METHODOLOGY

Image classification with machine learning algorithms were developed in Google Earth Engine (GEE), a powerful online cloud-based geospatial storage and parallel-computing platform. The algorithm is responsive to variation through 1) hexagon tiling and 2) data driven parameter selection.

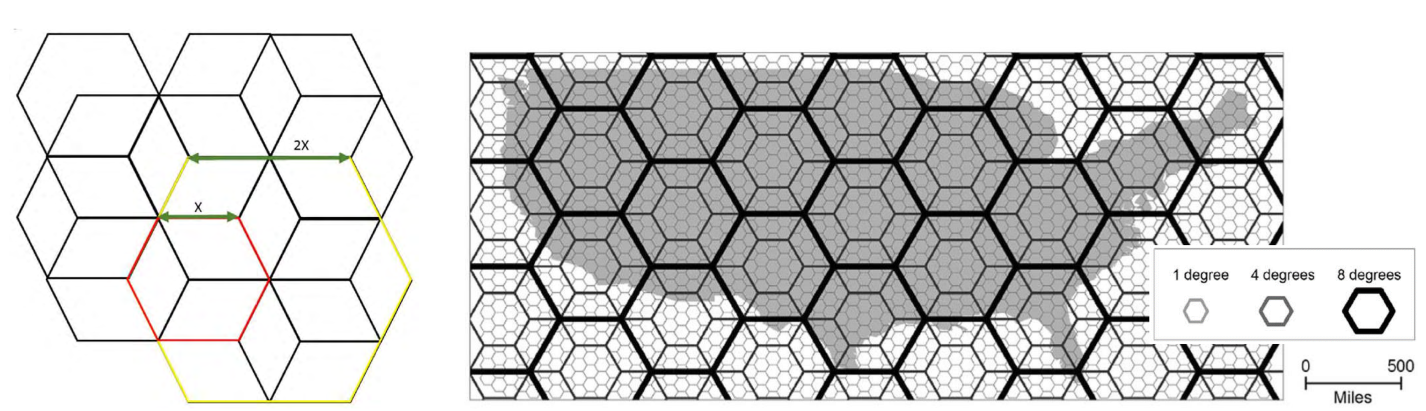

Figure 1. Nesting hexagons at three different scales were used to optimize for capturing regional variations.

Values are computed for each hexagon based on percentiles. For the vegetation mask we tested the 50th, 75th, 90th, 95th, 99th percentiles of NDVI, for DMSP-OLS "highly lit" pixels 50th, 75th, 90th, 95th, 99th percentiles of DN, and for DMSP-OLS "low lit" pixels the 10th, 25th, 50th, 75th percentiles.

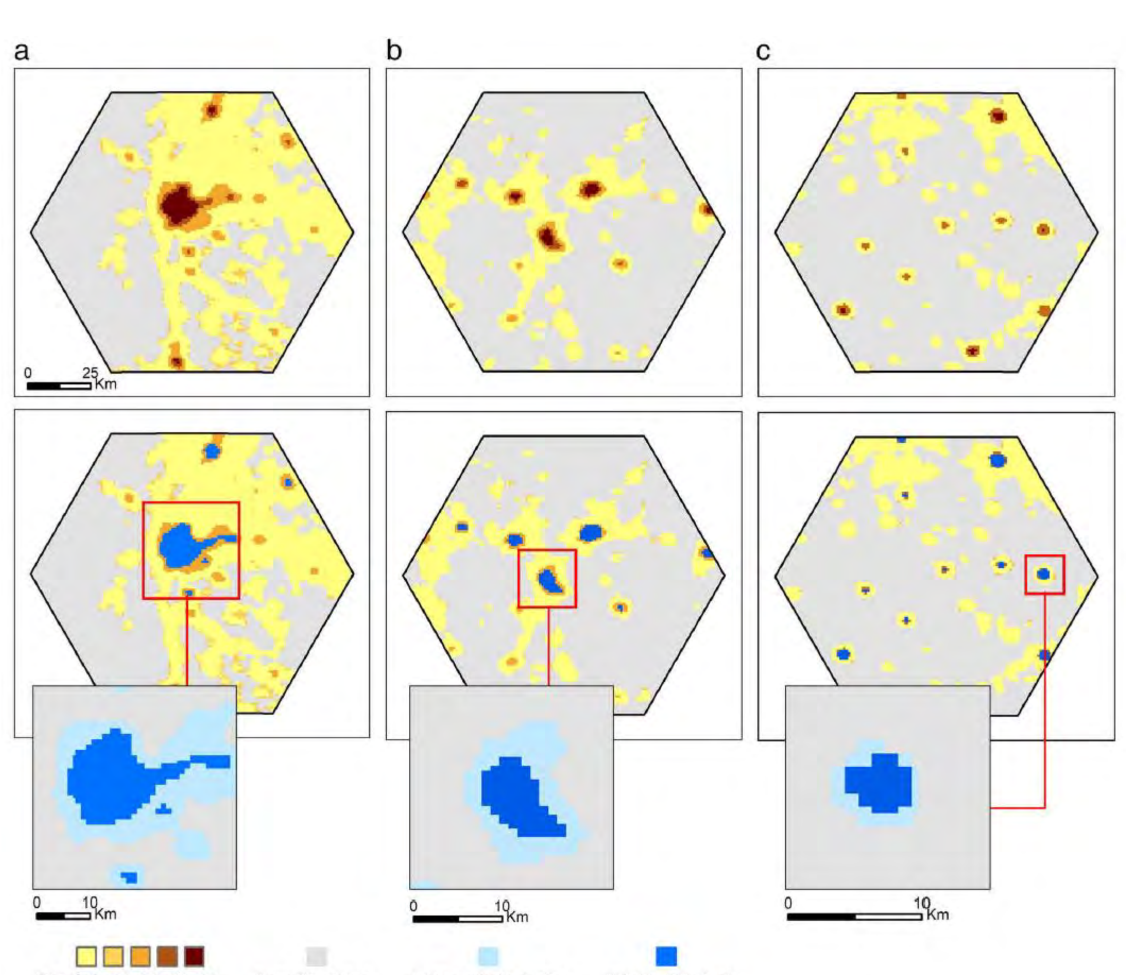

Figure 2. Percentiles determined for each hexagon allow for the capture of urban core and hinterlands independent of the size or density of the urban area.

US RESULTS

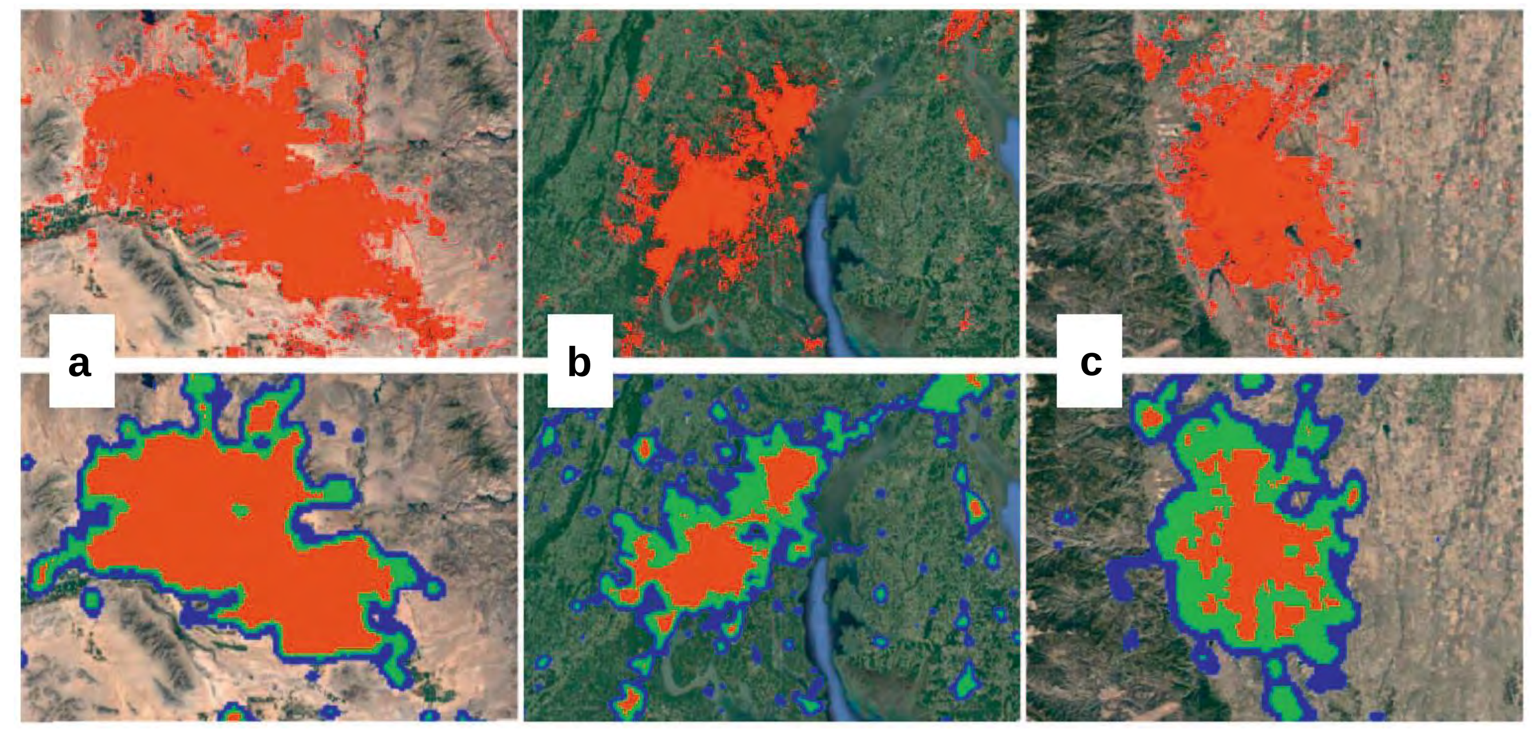

Figure 3. Our classification (top row) compared to nighttime lights (DMSP-OLS; bottom row) in (a) Phoenix, Arizona; (b) Washington, DC; (c) Denver, Colorado.

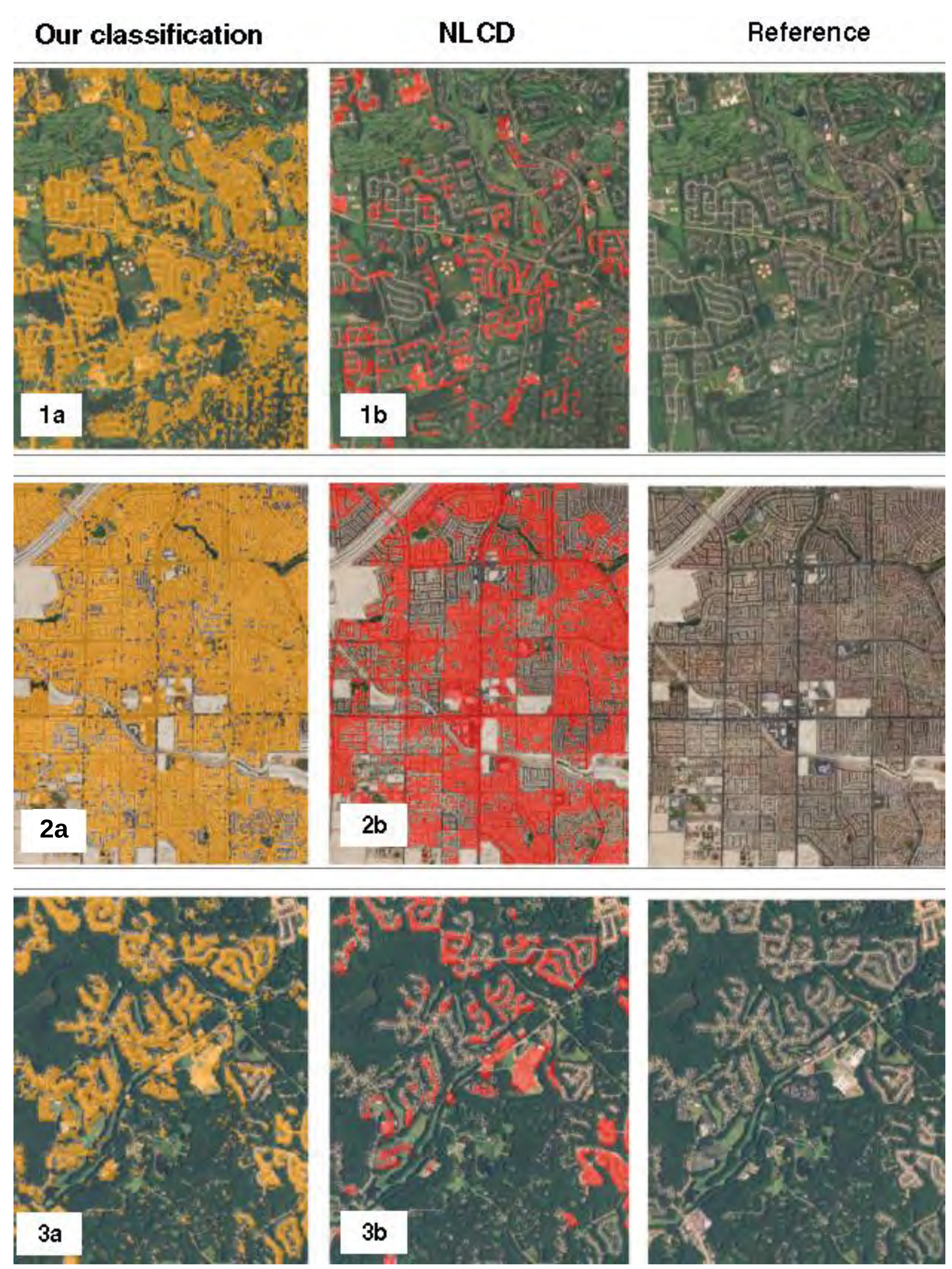

Figure 4. A comparison of our classification and NLCD's classification*, in (1) Columbus, Ohio; (2) Las Vegas, Nevada; (3) Atlanta, Georgia.*Classes 23–24: Developed, Medium and Intensity (Impervious surfaces account for 50% to 100% of the total cover).

ACCURACY ASSESSMENT

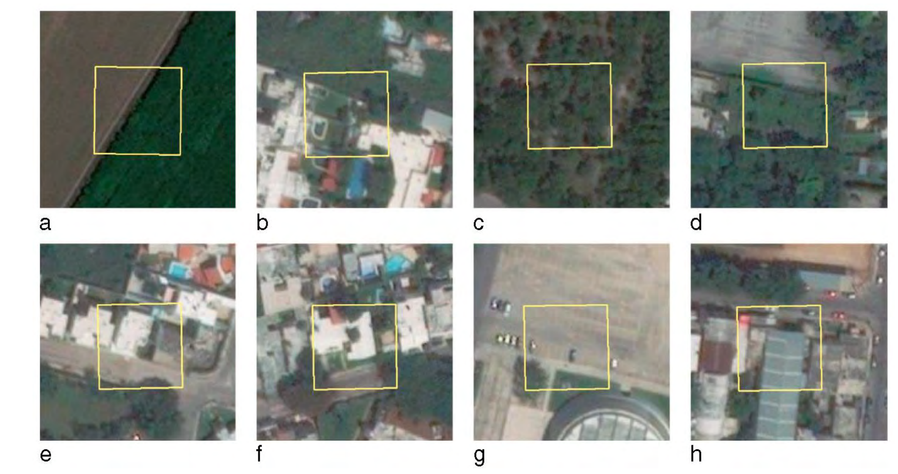

Figure 5. Ground-reference examples. Each 30x30 m polygon is labeled as "not built-up" (top) or as "built-up" (bottom) depending on the proportion of built-up area within the polygon. Over 50% built-up results in a built-up designation, while under 50% is not built-up.

To determine the accuracy of our classification, thousands of ground truth points were selected and hand labeled from high resolution imagery to fill in the previous lack of accurate data to be used for training and validation.

Figure 6. Our classification (top) compared to areas classified as built up and urban by MCD12Q1 UMD MODIS (bottom).

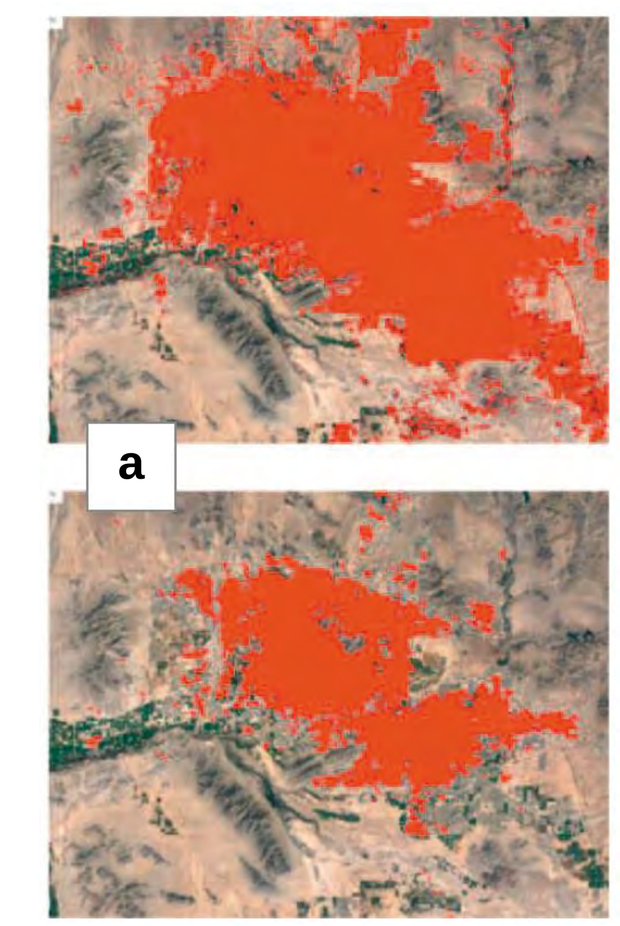

Table 1. Accuracy assessment table for the US

	Our classification	MODIS MCD12Q1
TPR	71.8%	64.4%
TNR	90.9%	87.3%
Balanced accuracy	81.4%	75.8%

DISCUSSION

Our more accurate, high resolution approach has direct implications for development of projected urban growth that is grounded on realistic identification of urbanizing hot-spots, with consequences for local to regional scale climate change, energy demand, water stress, human health, urban-ecological interactions, and efforts used to prioritize adaptation and mitigation strategies to offset large-scale climate change.

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CITATION

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