Quantifying Cropland Loss to Urban Growth in China using MODIS Time Series and Nighttime Lights Data

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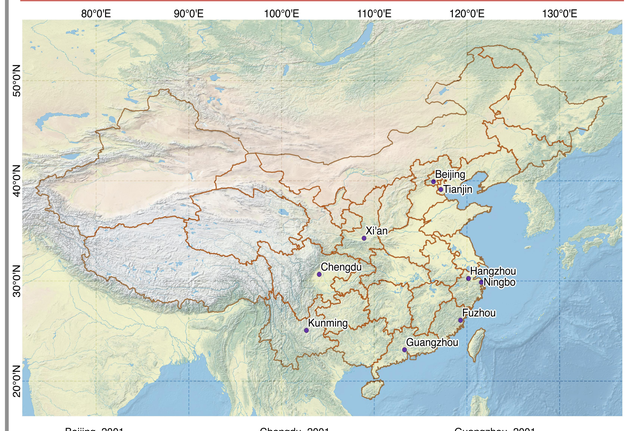
Abstract

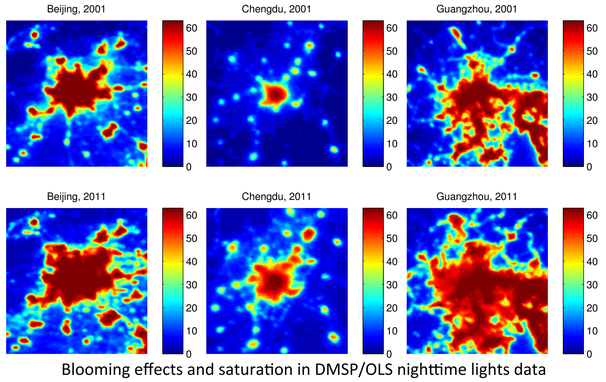
We used data from the Moderate Resolution Imaging Spectroradiometer (MODIS) combined with stable nighttime lights data from DMSP/OLS instruments to map urban expansion in and around major cities in China. We focused on the conversion from agricultural lands to built-up between 2001 and 2011 around 9 major cities in China and mapped changes in sub-pixel percentage urban at 250m spatial resolution. Training data based on Landsat-scale change maps is used to estimate Random Forest regression models for year 2001 and 2011, respectively. The Random Forest algorithm was used combined information from MODIS spectral bands, land surface temperature, and DMSP/OLS nighttime lights, and is shown to capture urban growth comparable to Landsat scale results. The fractional urban information can provide an improved basis for studying environmental impacts of urbanization.

1. Objectives

- Developing regression-based models for estimating fractional urban cover at 250m spatial resolution in and around major cities in China.
- Assessing the capability of combined multi-source coarse resolution remote sensing data for estimating conversion from agriculture to urban (assuming change is unidirectional).

2. Study Area





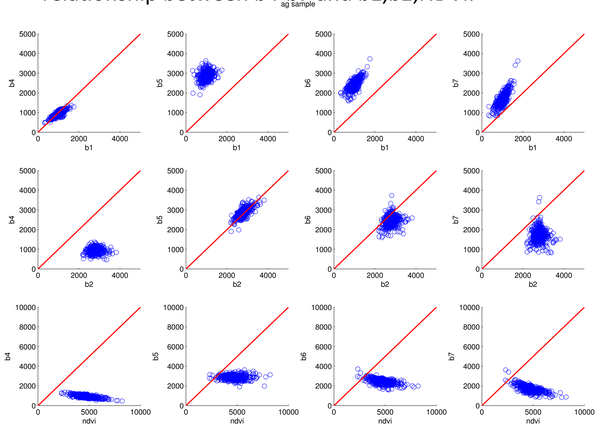
Blooming effects and saturation in DMSP/OLS nighttime lights data

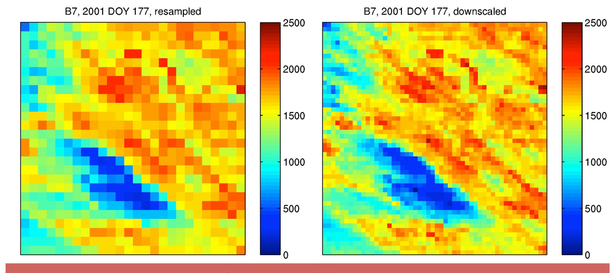
3. Data and Methods

- We combined MODIS 250m-1km data and DMSP/OLS nighttime stable lights data. All reprocessed to MODIS 250m sinusoidal grids.
- We estimated Random Forest regression models to estimate % urban in 250m MODIS pixels for 2001 and 2011, respectively.
- Training pixels are selected by stratified random sampling based on % urban information at 250m from Landsat change maps.
- 4 input feature sets were tested.

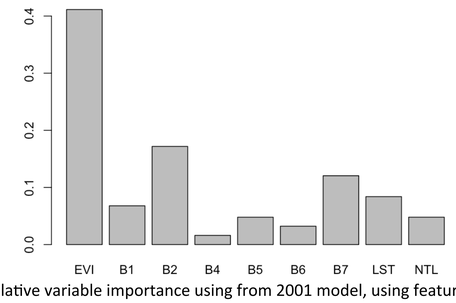
Input set	Features	Feature type	Total # features
1	B1,B2,EVI	Annual features (mean,min,max), two years (2001-2002, 2011-2012)	18
2	B1,B2,EVI,B7	B7 resampled from 500m to 250m	24
3	B1,B2,EVI, B4-B7,LST,NTL	B4-B7,LST,NTL resampled to 250m	50
4	B1,B2,EVI, B4-B7,LST,NTL	B4-B7 downscaled to 250m, LST and NTL resampled to 250m	50

- Downscaling (distributing) 500m values to 250m using relationship between b4-b7 and b1,b2,NDVI.



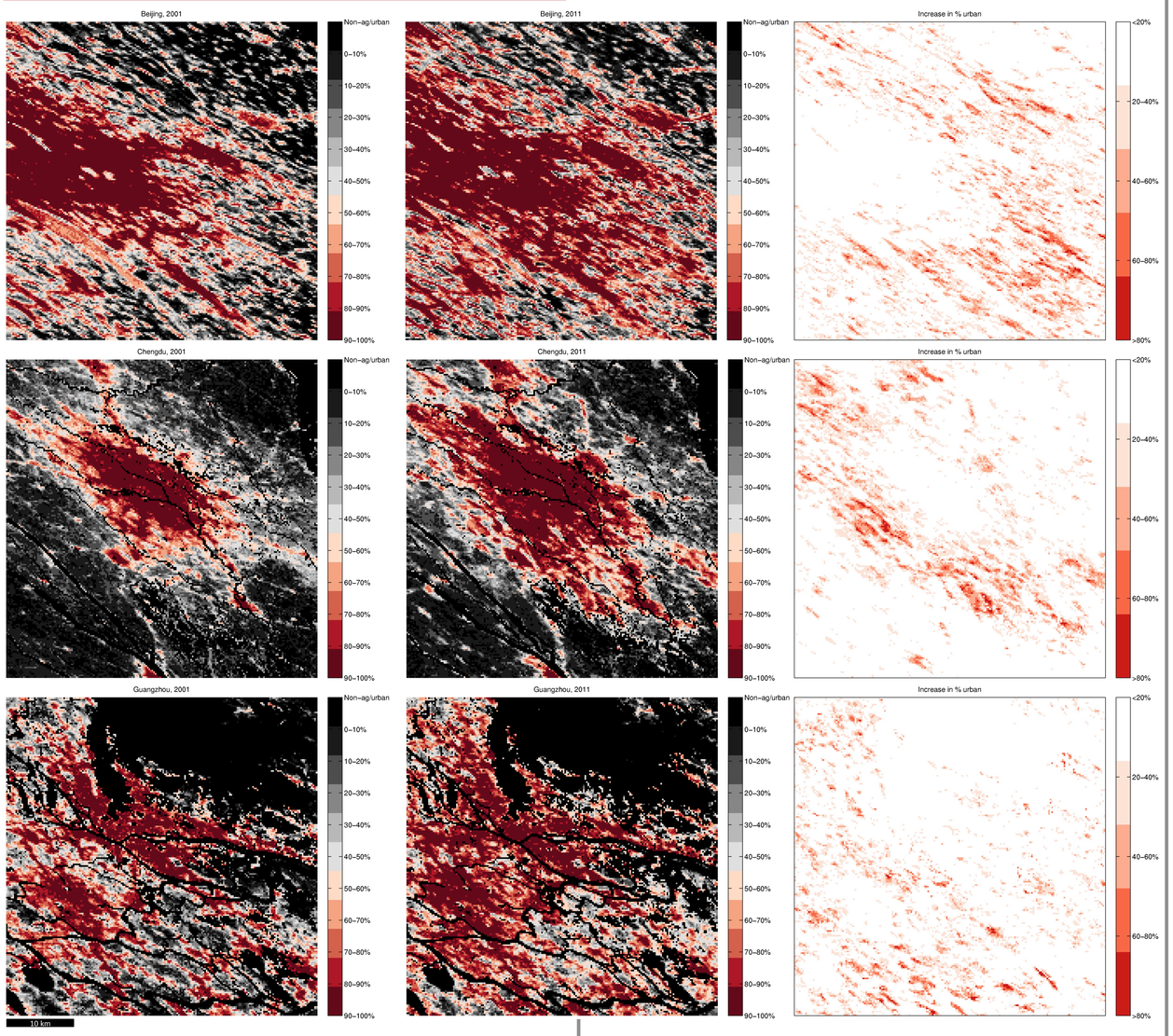


4. Results: Variable Importance

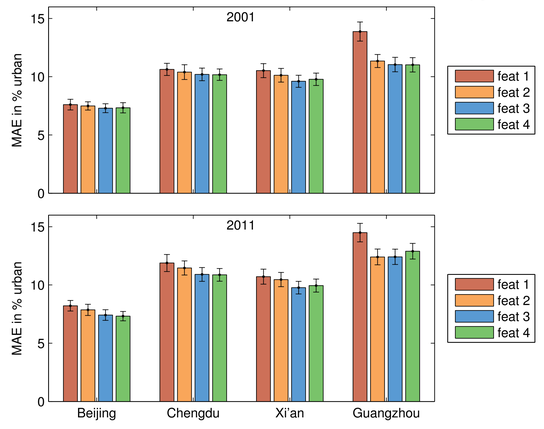


Relative variable importance using from 2001 model, using feature set 4

5. Results: Percent Urban in 2001 and 2011



Mean Absolute Error (MAE) calculated as $MAE = \frac{1}{n}\sum_{i=1}^{n}|\hat{y}_i - y_i|$



6. Summary

- Regression models were established to estimate % urban at 250m using combined information from MODIS and DMSP/OLS nighttime lights data. Addition of coarser spatial resolution features (≥500m) improves model performance.
- Ongoing efforts include improving % urban estimation by using region-specific models and application to more major urban agglomerations in China.

References

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