Geospatial Analysis of Rural Electrification in Uttar Pradesh

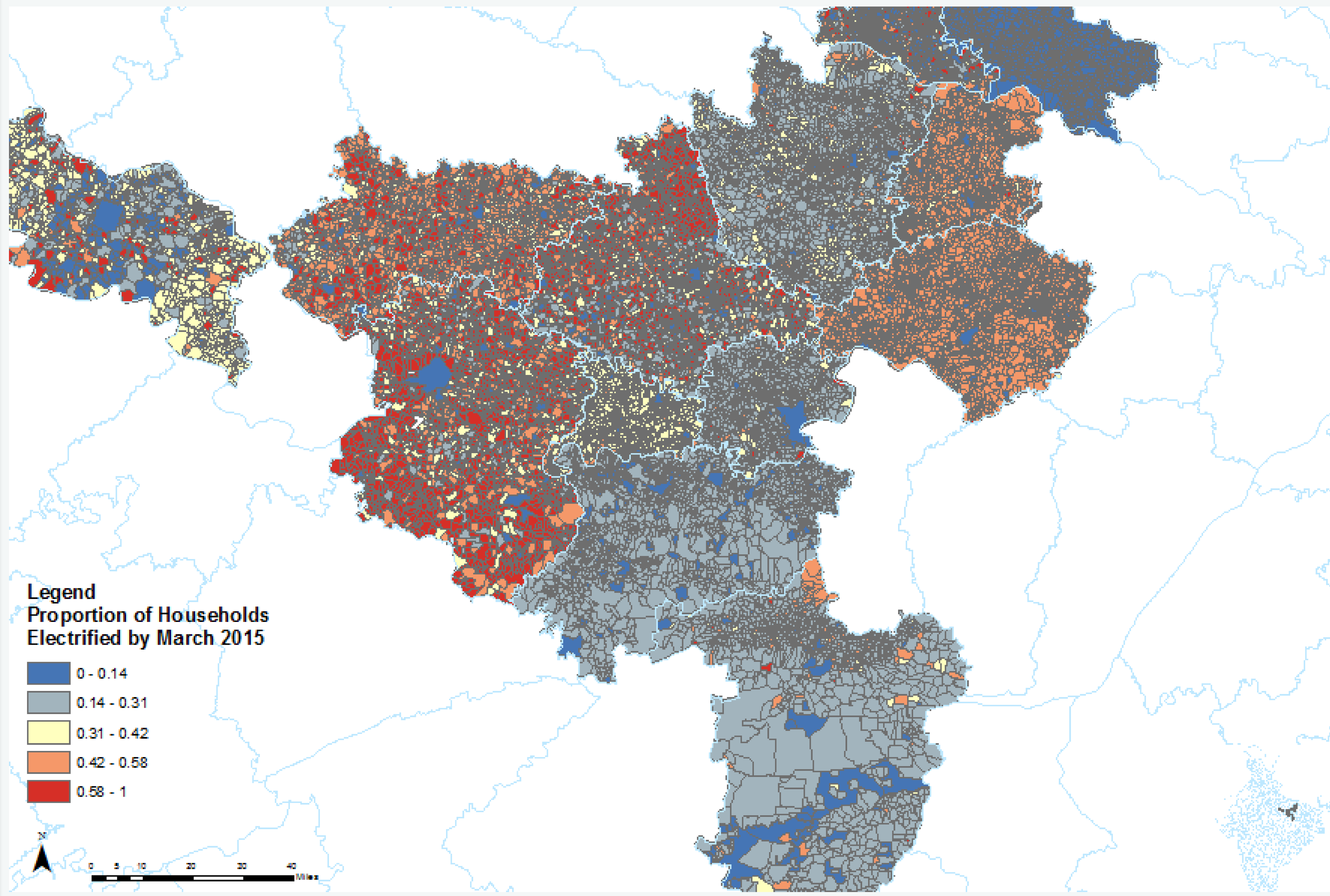
Introduction:

This project seeks to understand the temporal and spatial evolution of rural electrification in India from 2005 to 2015. The study focuses on 14 districts of Uttar Pradesh where electrification density varies dramatically across villages. These electrification projects are highly subsidized by the union government of India. Below poverty line households are granted free connection to the grid and different levels of administrative authorities, from central to state and district governments, may have tried to maneuver the project outcome. I want to explore through spatial analysis the most important influencing factors, either natural or policy components, that have affected the order or variation in the implementation of rural electrification.

Methodology:

To correct the strong spatial autocorrelation in electrification rates due to some district-level administrative factors, I run spatial lag, spatial error and district-fixed effects regressions on the entire dataset. Then, I split up the districts into highly and lowly electrified regions, and run the spatial error regression, which has the smallest standard error among all models, separately on the two samples to examine spatial heterogeneity. Next, I observe the residual graph of spatial error regression on the whole dataset, seeking clues about whether some of the residuals at the very high or low end can be explained by spatial heterogeneity, particularly by differentiated spatial distribution of villages with large proportion of people living in small habitations with a population of 100 to 300 in size.

GIS Data Source:
https://sedac.ciesin.columbia.edu/data/set/india-india-village-level-geospatial-socio-econ-1991-2001
https://censusindia.gov.in/
http://www.upptcl.org/
http://www.devdatalab.org/shrug
Projection Coordinate System: WGS 1984 UTM Zone 44N



Variation in Electrification Rates Over the Years (2005-2015) in 14 Districts of UP

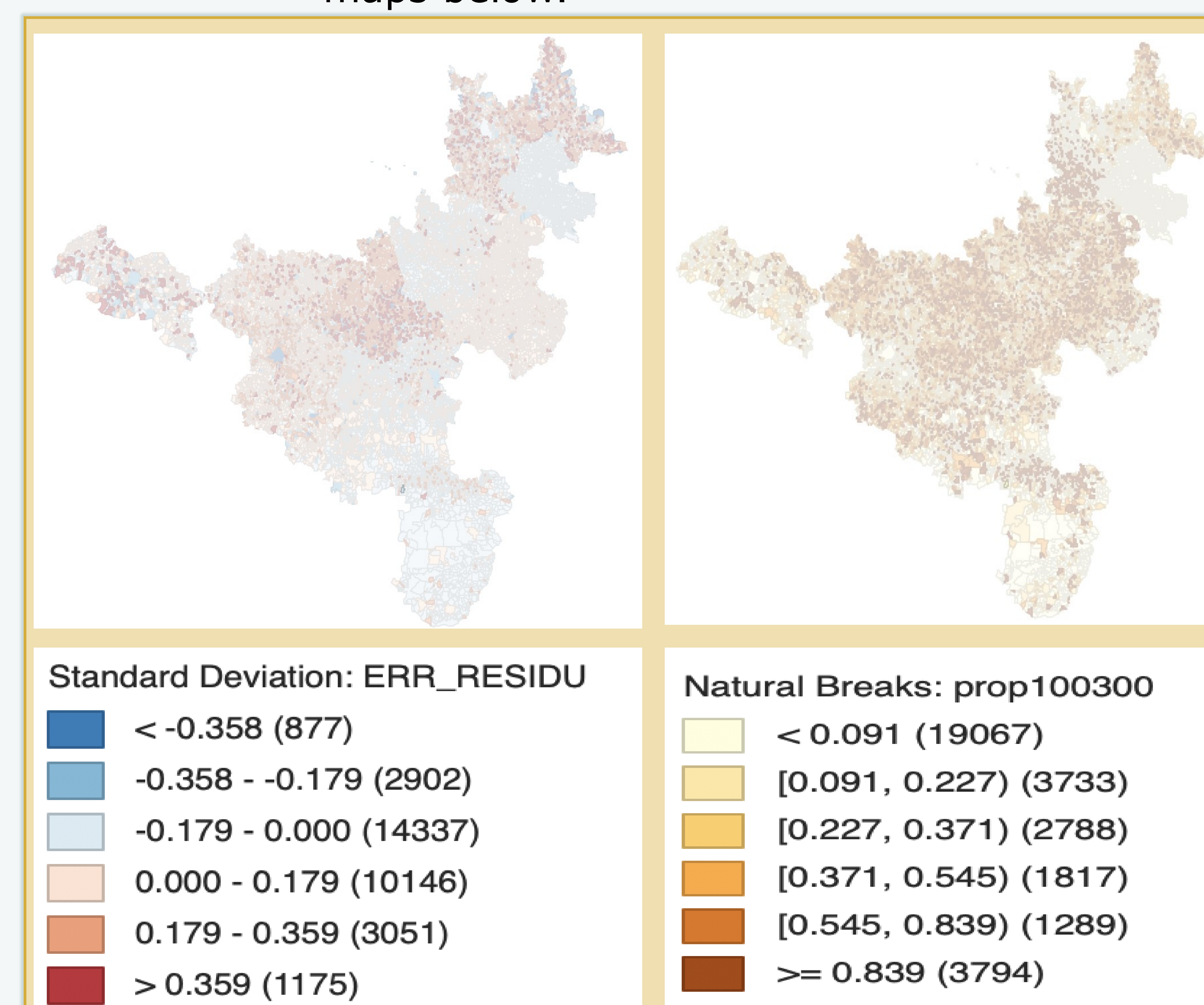
Comparable Regression Results from District-Fixed Effects Model and Spatial Lag and Error Models

VARIABLES	District Fixed Effects Model	Spatial Error Model	Spatial Lag Model
Prop_BPL_HH	0.320***	0.378***	0.227***
	(0.0108)	(0.0089)	(0.00663)
Prop_100_300	0.0202***	0.03698***	0.042573***
	(0.00296)	(0.00312)	(0.00315)
State_Highway	0.0124***	0.0157***	0.0164***
	(0.00269)	(0.00254)	(0.00209)
Area	-3.15e-05***	-3.028e-05***	-2.22e-05***
	(3.54e-06)	(3.93e-06)	(3.78e-06)
All_Weather_Road	0.00994***	0.009996***	0.01618***
	(0.00227)	(0.00244)	(0.00216)
Distance_100KCity	0.000436**	0.00354***	0.00125***
	(0.000222)	(0.000474)	(0.000181)
Dist_50KCity	-0.000262	-0.00309***	-0.001279***
	(0.000219)	(0.000489)	(0.000186)
Dist_10KCity	0.000377*	-0.001895***	-0.001289***
	(0.000216)	(0.00052)	(0.000219)
Constant	0.251***	0.283***	0.0469***
	(0.00785)	(0.00490)	(0.002846)
Observations	28,777	32,488	32,488
R-squared	0.486	0.505	0.498

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results:

Basic mapping of electrification rates, a strongly positive Moran's I correlation coefficient of 0.553 as well as small estimate for forest area (the only statistically significant natural factor) all point to district-level administrative factor as the main influencer for electrification outcome. This is further confirmed by the coefficients of district-fixed effects regression, which are close to those of the special weighted regressions. In all regressions, the proportion of BPL households and the proportion of people living in small habitations are the most important predicators of electrification intensities. Separate regressions on samples with highly and lowly electrified districts show very different coefficients for the village structure indicator, e.g. 0.05 for the former and 0.008 for the later, indicating that habitation structure matters only in districts where the project has been well-implemented. Given these differences in the estimates for habitation structure on the entire and separate samples, I expect residuals at the very high end to coincide with high concentration of villages with small habitations, which is partially true as shown by the maps below.



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