

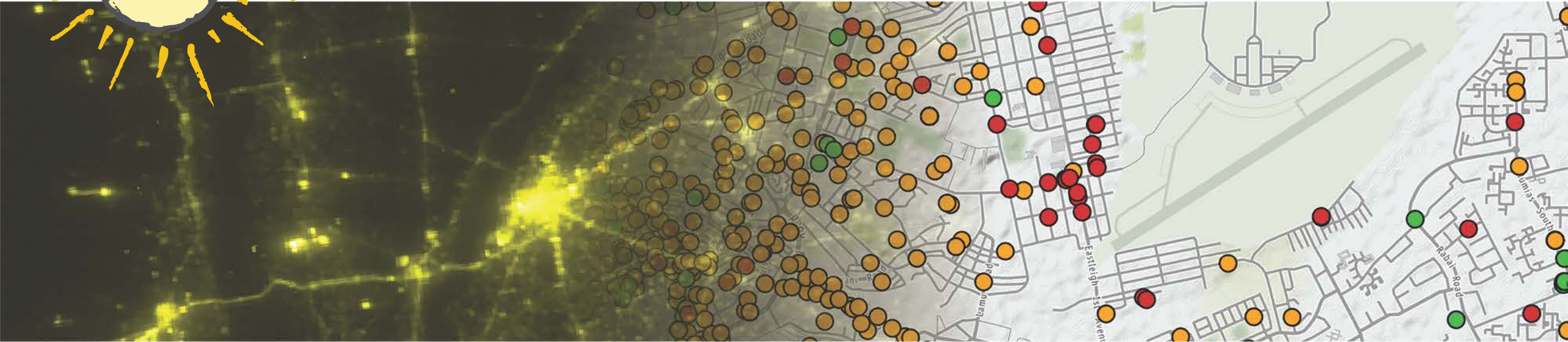


IE CONNECT FOR IMPACT

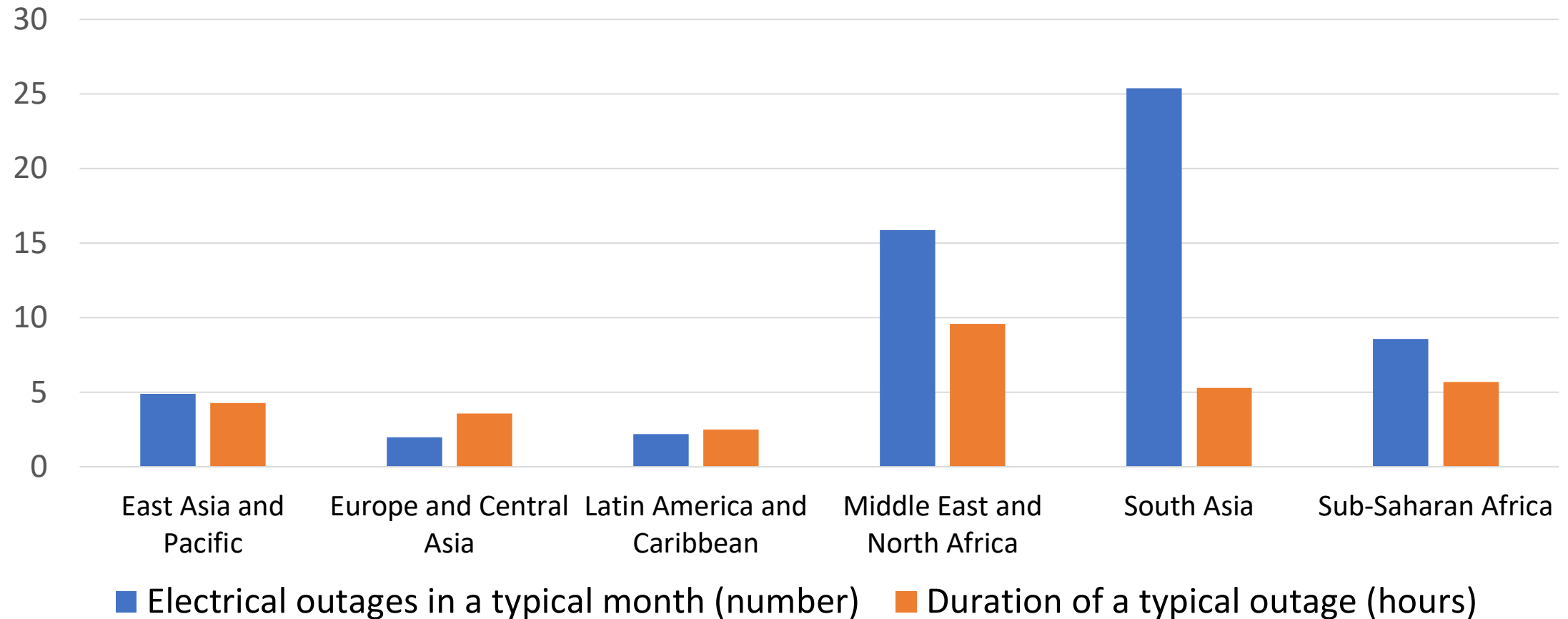
Transforming the Growth Potential
of Transport Investments

Whose Power Gets Cut? Monitoring power outages from the outer space

Brian Min, Fan Zhang



Unreliable electricity in the developing world



Power outages are costly



Households

- Lower income
- Fewer study time
- Less gender equality



Firms

- Loss in productive capital
- Less operating flexibility
- Smaller firms more affected

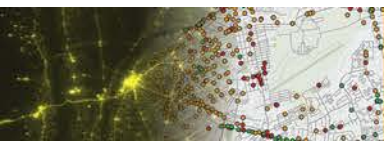


Environment

- Kerosene lighting
- Diesel-based captive power

Monitoring power outages is difficult

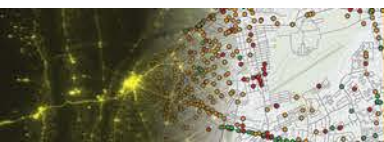
- Utility reported data are unreliable and rarely available
- Household surveys are costly, highly aggregated, and with low frequency
- Alternative monitoring system has limited geographic coverage



Research Question and Empirical Strategy

How can we identify power outages across the world without reliable utility-level data?

- **Premise:** Electrified areas appear bright when the power is working and dark when it is not.
- **Implication:** Areas prone to power outages will have higher variability in nighttime light output than areas with stable power supply
- **Method:** Drawing on a set of 30,000 nighttime satellite images, we compute the PSI index, a new village-level measure of power supply irregularities





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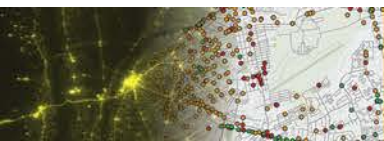
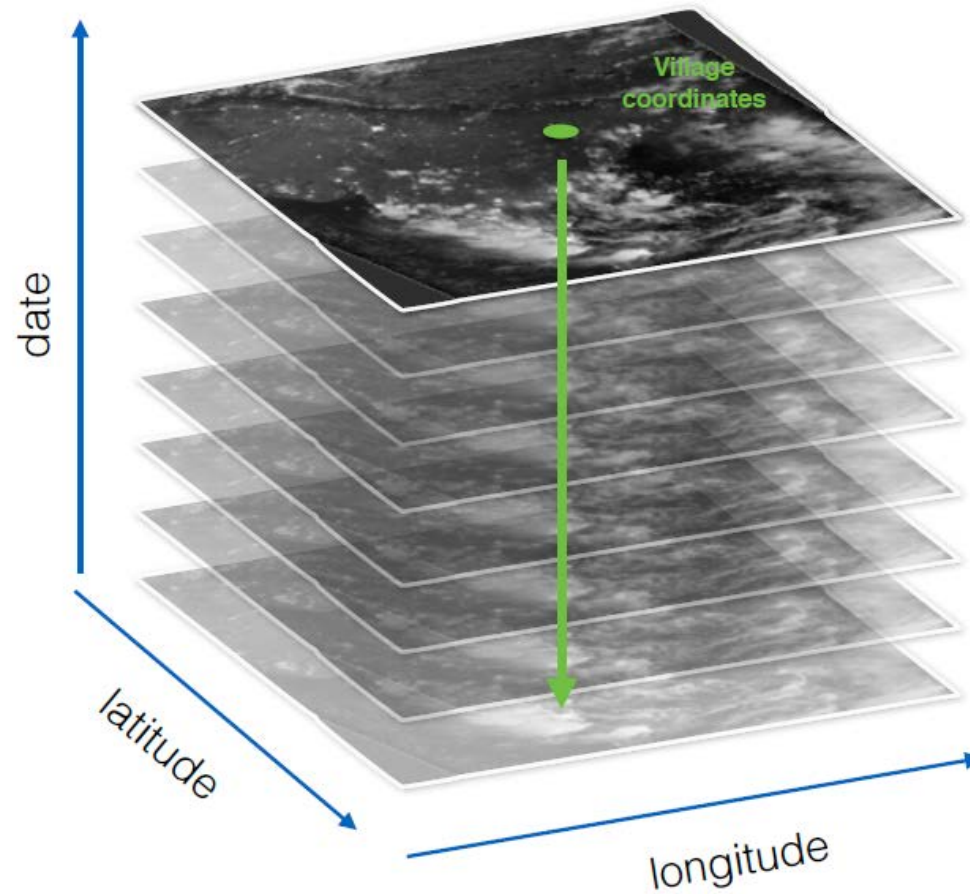
30,000 Images of India at Night, 1993–2013

<http://nightlights.io>

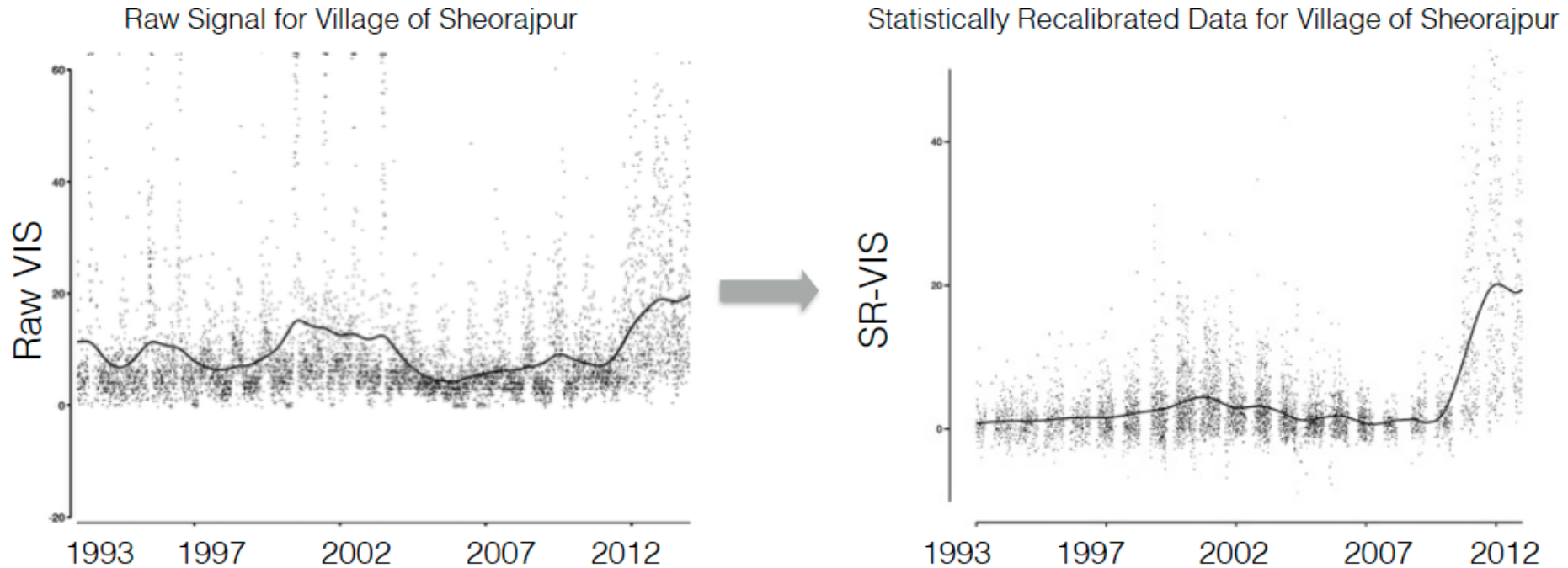
25 Sept 2012
7:49 PM

F18201209251419.WB.OIS.vis

Data Extraction



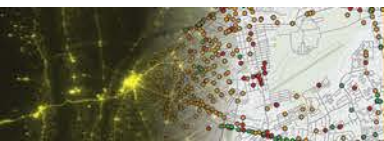
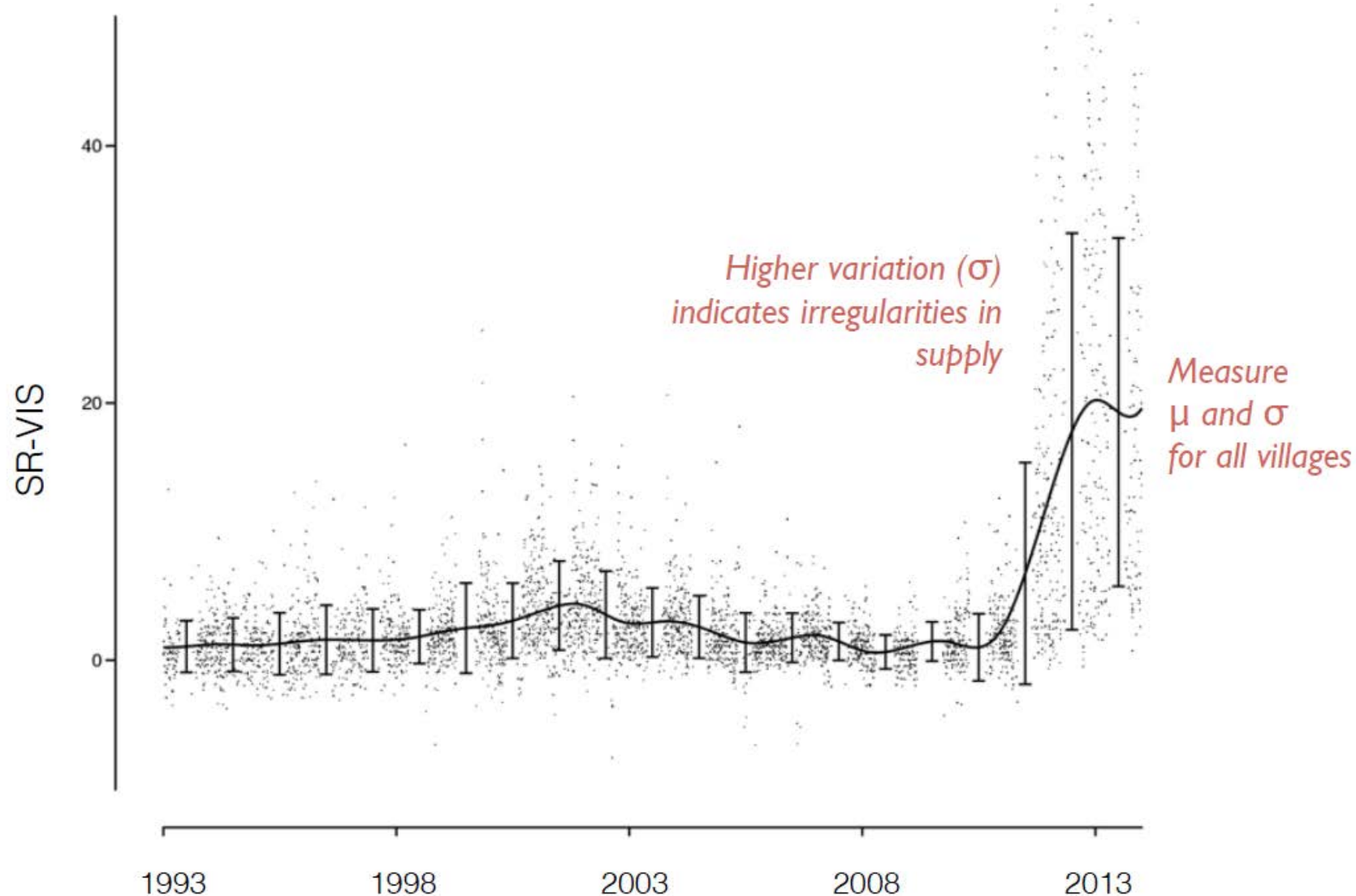
Statistical recalibration of raw VIS signal



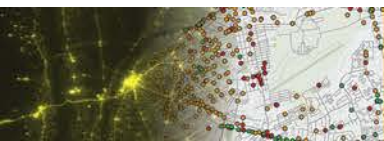
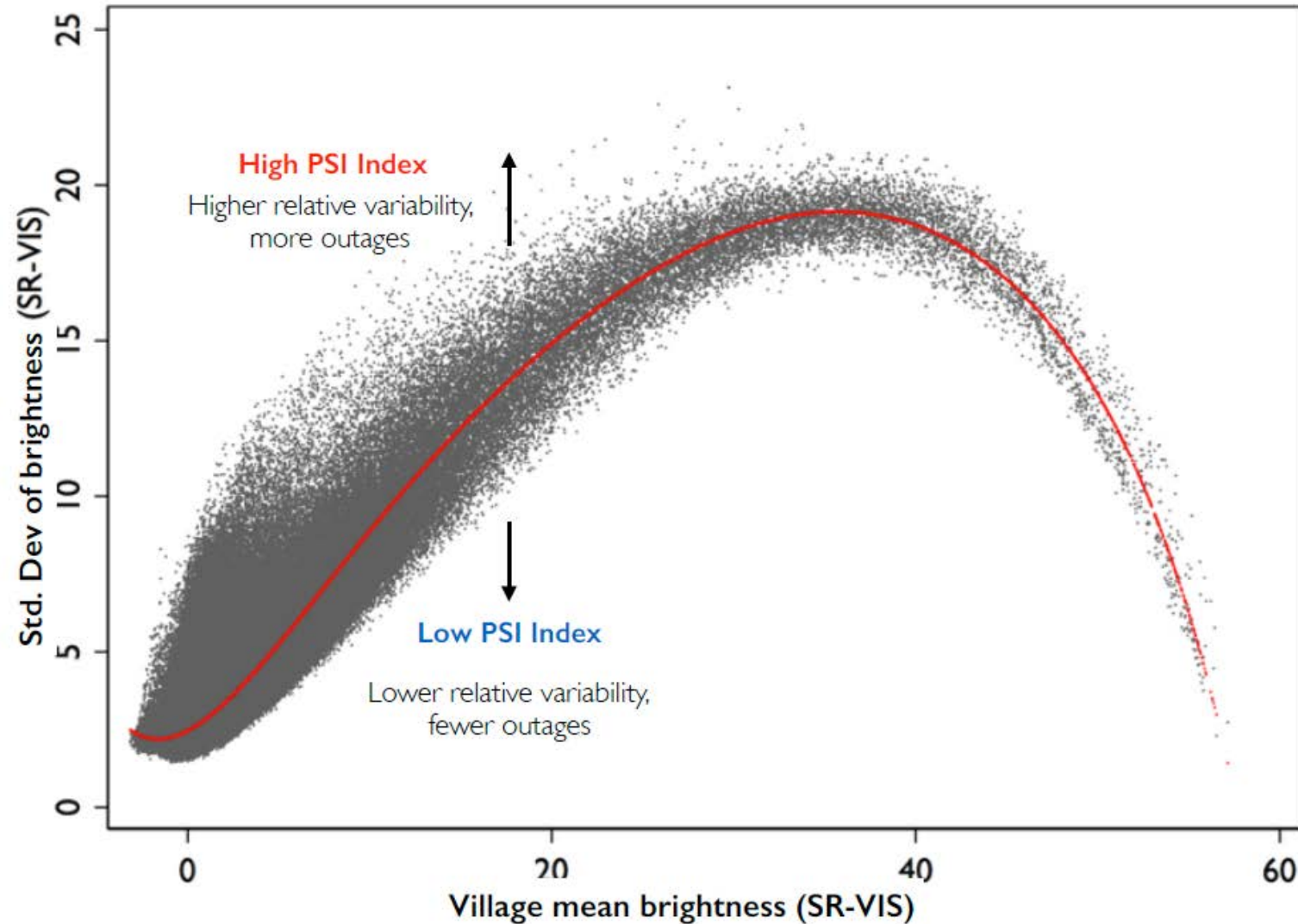
Data quality filter (drop clouds, solar glare)
Background noise removal
Statistical data smoothing to identify trends

Village: 0945000405505200
Sheorajpur, Allahabad, UP

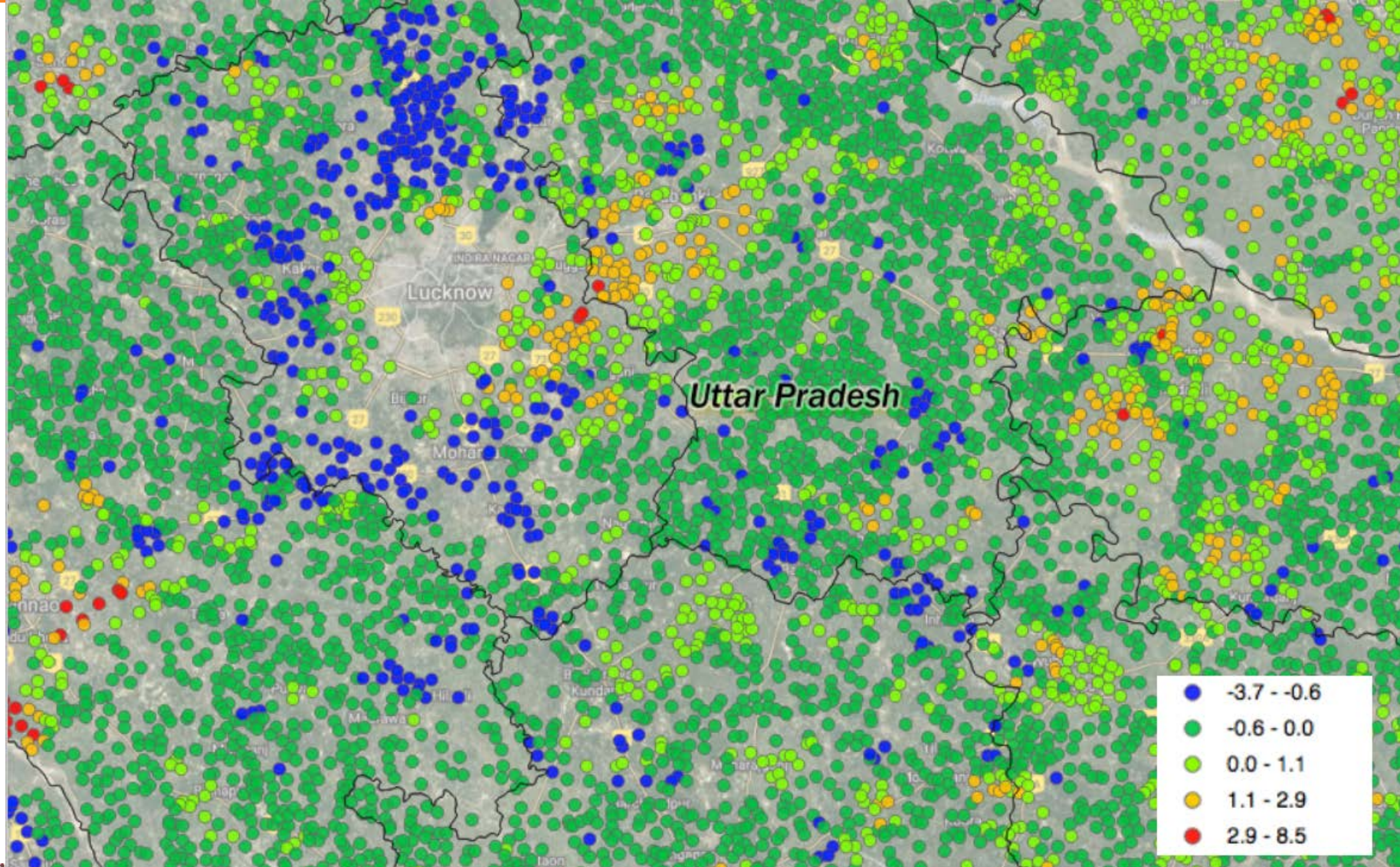
Detecting power supply irregularity



Power supply irregularity (PSI) index

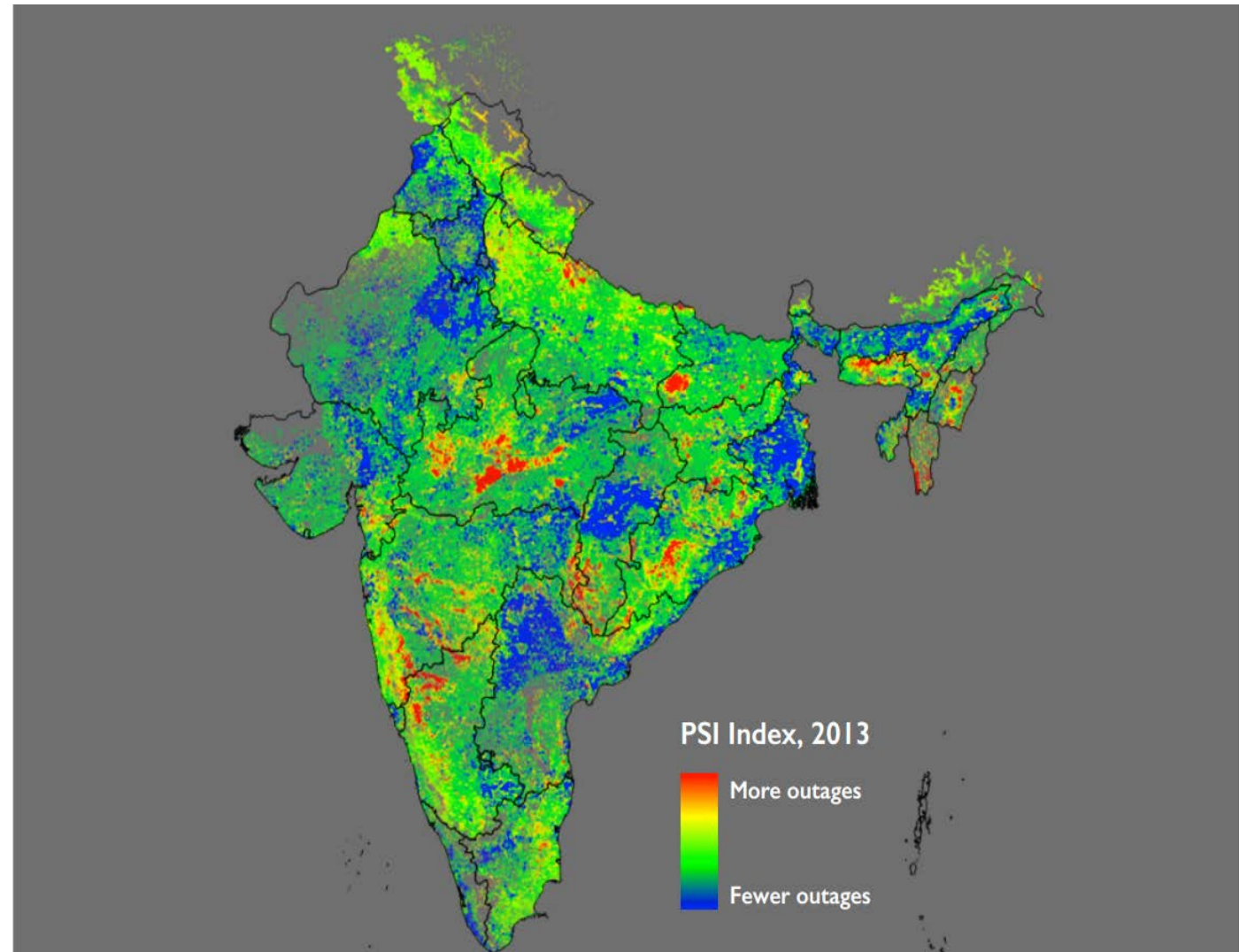


Power supply reliabilities of villages



Power supply irregularity index (2013)

- A departure from prior research
 - Access (level) vs outages (volatility)
 - Annual composite images vs high-frequency images



Validation of PSI Measure



Indian Human Development Survey 2011

- Sample size: 42,152 households in 33 states and union territories
- Households report average daily duration of power outages

South Asia Spatial Database

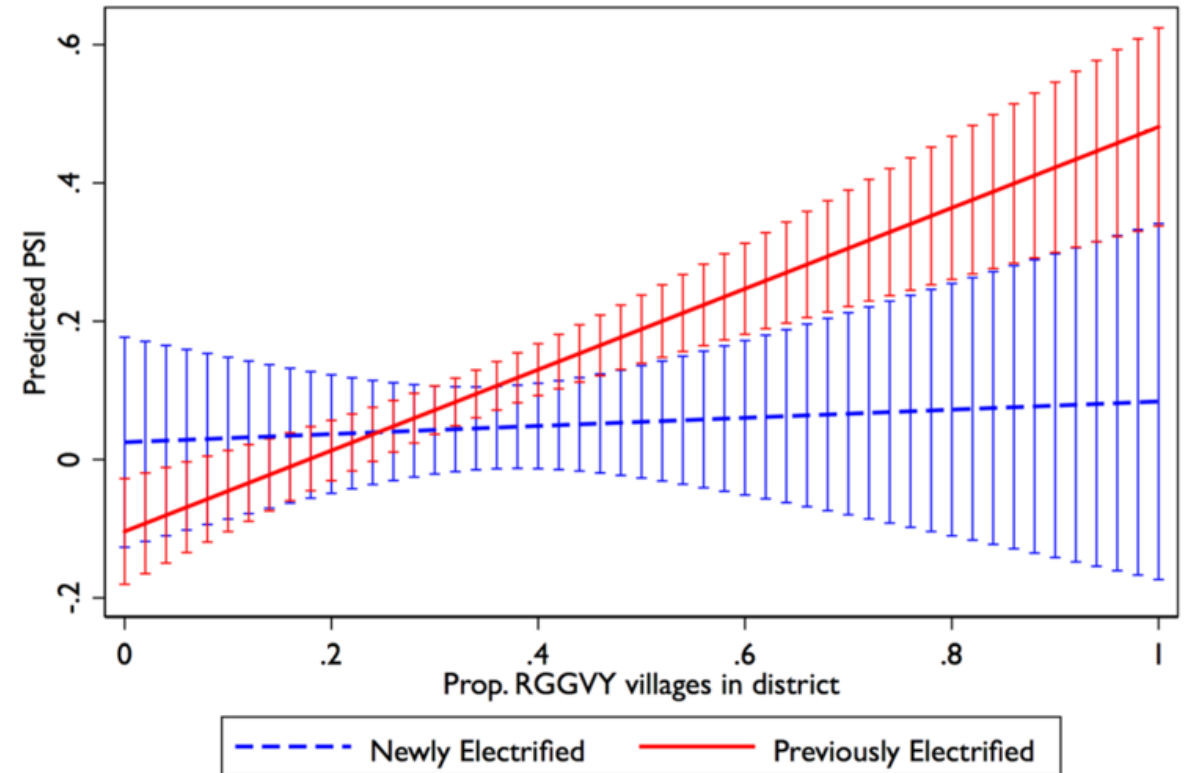
- Percent of agricultural workers, total area, forest area, population

	(1)	(2)
Outage duration	0.0358** (0.0140)	0.0503*** (0.0143)
Forest		0.00266 (0.00535)
Area		0.0000160 (0.0000102)
Population		-0.0000920** (0.0000364)
% Farmers		0.00304 (0.00360)
N	217	206
adj. R-sq	0.025	0.077

Note: Standard deviation clustered on district in parentheses.
 *** statistically significant at 1% level, ** significant at 5% level

Policy
Recommendations
Prioritize quality, not just access

Outages affect previously electrified villages more often



Note: Bars indicate 90% confidence intervals.