An estimated 1.2 billion people around the world do not have electricity access, and far more have unreliable electricity access (World Energy Outlook, 2017). Energy access is correlated with improvements in health, economic prosperity, and gender equality outcomes. Particularly, access to electricity is linked to an increase in student enrollment in schools, time students spend studying, available business hours, agricultural productivity and labor supply, and a reduction of the poverty rate (Khandker et al., 2012). We present a technique to determine regional electricity access from satellite imagery to aid electrification efforts.

Using the electrification data from Bihar, we developed a process for automating the classification of satellite imagery data from a region as electrified or un-electrified (Figure 3). We curated a dataset of satellite imagery, village level, which is an order of magnitude improvement in spatial resolution.

This project aims to fill a data gap by producing high resolution estimates of electrification rates through a case study in the Indian states Bihar and Uttar Pradesh. India has over 300 million people without access to electricity (Khandker et al., 2012). Currently, however, electricity access estimates in India are generally available at a district level, which is still highly aggregated (Figure 2). The algorithm we developed through this work is able to classify electrification status at the village level, which is an order of magnitude improvement in spatial resolution.

The features our team extracted features include: Lights at night (VIIRS: Visible Infrared Imaging Radiometer Suite) data, population density, measures of possible agricultural activity including NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index), known irrigation activity, and Human Built-up and Settlement Extent (HBASE) index. We used data on urban extent and irrigated regions to focus our feature extraction on those areas with at least 100 or 400 households, respectively. Since villages with more households potentially present stronger visible signals in the satellite imagery, the confusion matrices to the right show the performance at three specific points along the ROC curves to the left.

### Conclusions & Future Work

Our results present evidence that it may be feasible to automate electricity access assessment using satellite imagery. This approach provides higher resolution data than existing data sources and can be used to produce estimates in regions of India (or other countries) which have not been surveyed down to the village level to determine electrification status. In the future, our village level data could be used to combine geospatial electricity grid data to identify the economically and environmentally optimal pathways to electrification for rural villages via grid extension, microgrid development, or off-grid systems such as solar photovoltaics.

### References

- Sebastian Brixey-Williams, Access to electricity is increasing fastest in these countries, World Bank, World Economic Forum, 2012

### Data Collection

Curate a dataset of electrification access survey data and satellite imagery for all villages in Bihar, India.

### Feature Extraction

Extract features from satellite bands for each village to input into classifier. (e.g. median value of light at night within the urban extent)

### Classifier Output

Create high-resolution electrification access map for any state in India. Model is trained on Bihar.

### Prediction State: Uttar Pradesh

- Training State: Bihar (Electrified)
- Prediction State: Uttar Pradesh (Unelectrified)

### Results

- Electrified
- Un-electrified
- No Data

- Villages with Over 100 Households
- Villages with Over 400 Households
- Villages with Over 1000 Households
- Villages with Over 100,000 Households

- Correct Detection Rate
- False Alarm Rate
- Enhanced Green Vegetation
- Green Vegetation
- Light Spectrum
- Population Density

- Enhanced Green Vegetation
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