AI for Urban Sustainability

Backup Generator Use Prediction using Geo-Spatial ML

PRESENTED BY

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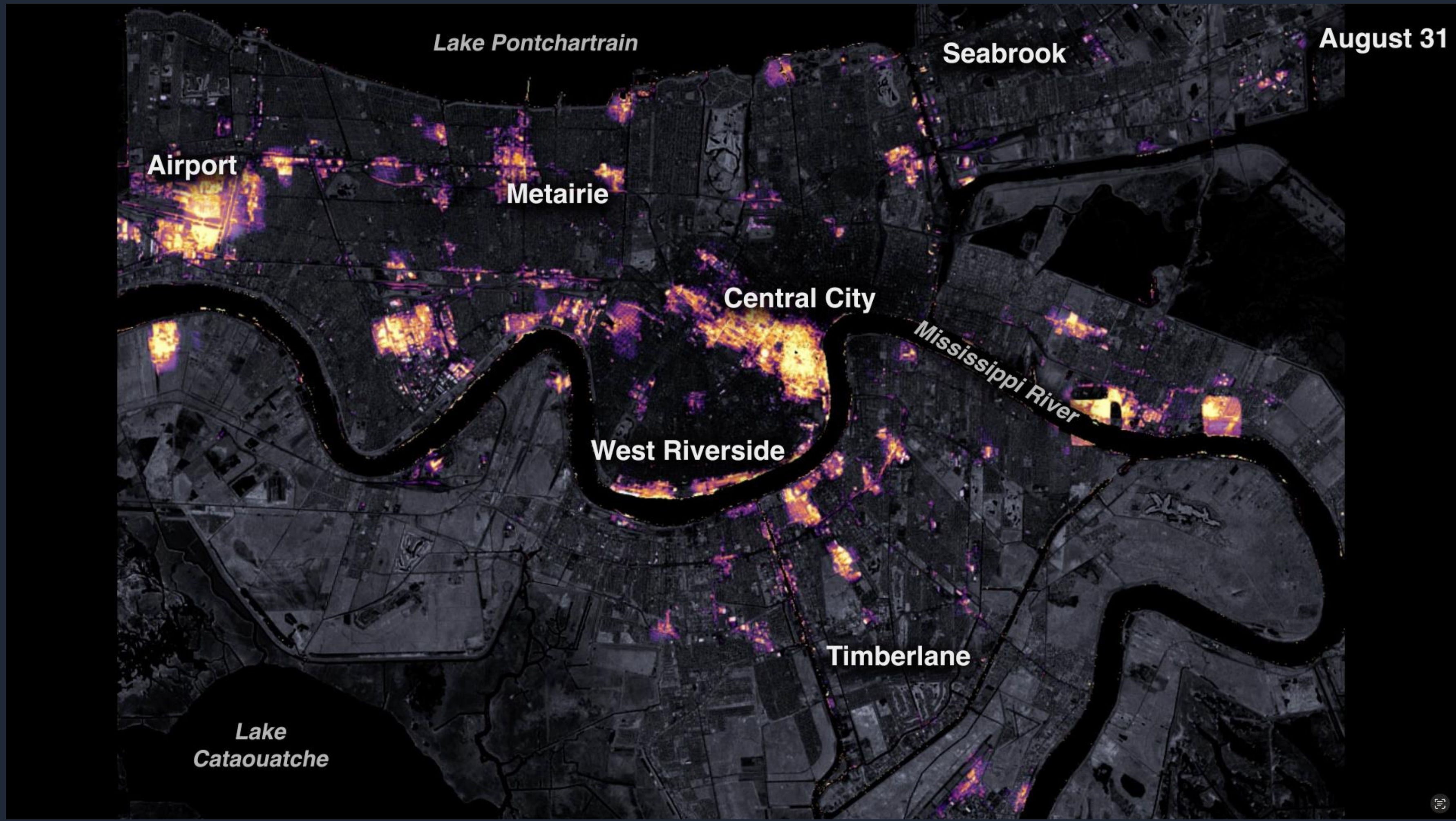
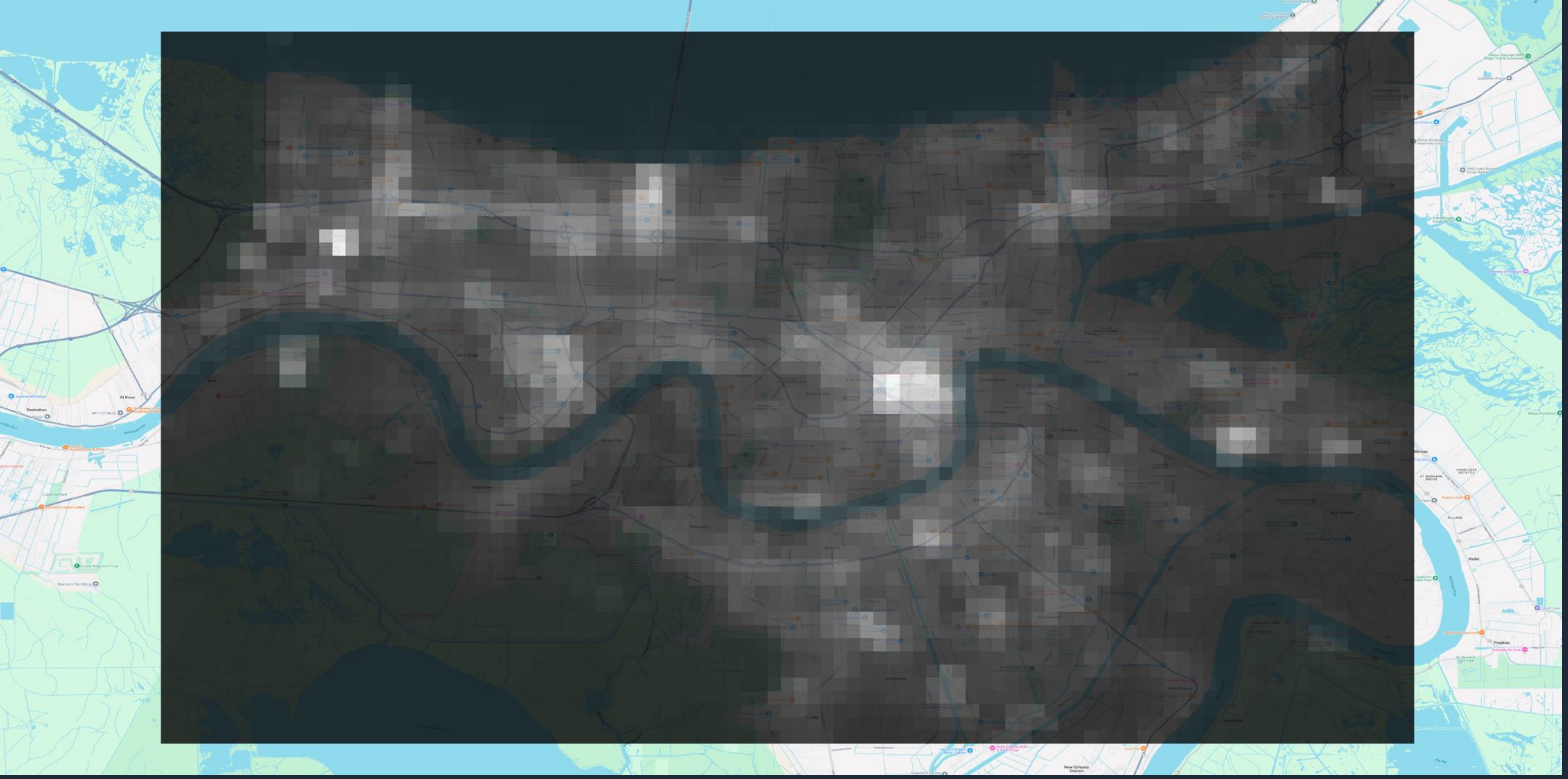
Introduction

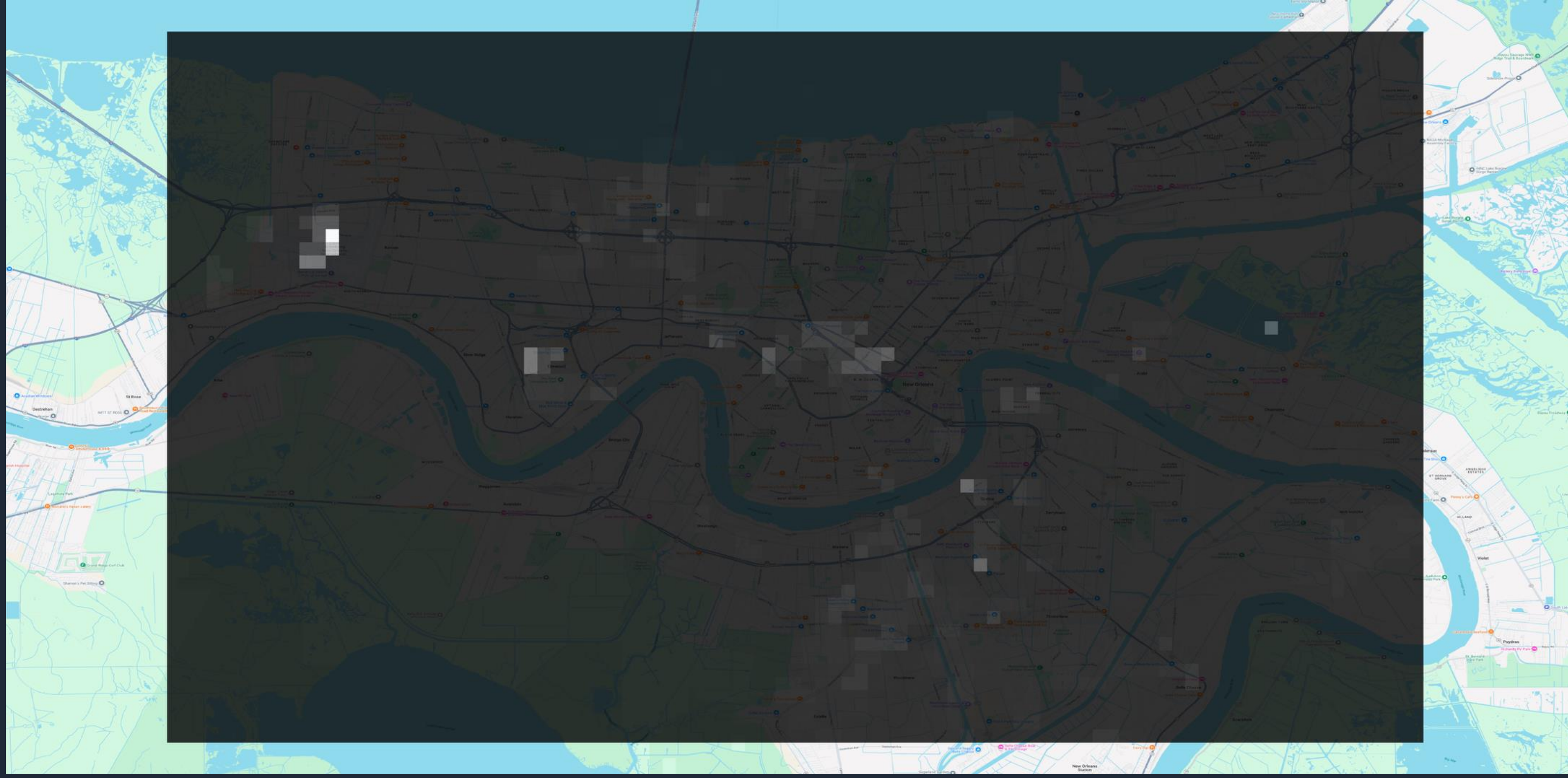
- Natural disasters cause major human and infrastructure losses and frequently lead to widespread power outages (Botzen et al., 2019; FEMA, 2025).
- Preparedness varies substantially across communities (Chandra et al., 2011).
- Backup generators can partially protect some areas from the worst effects of outages.
- We apply geospatial methods and machine learning, using Hurricane Ida in New Orleans as an example, to:
    - Profile the sociodemographic characteristics of more resilient areas
    - Test the predictive power of socioeconomic and other variables for identifying locations with more generator use.



Datasets



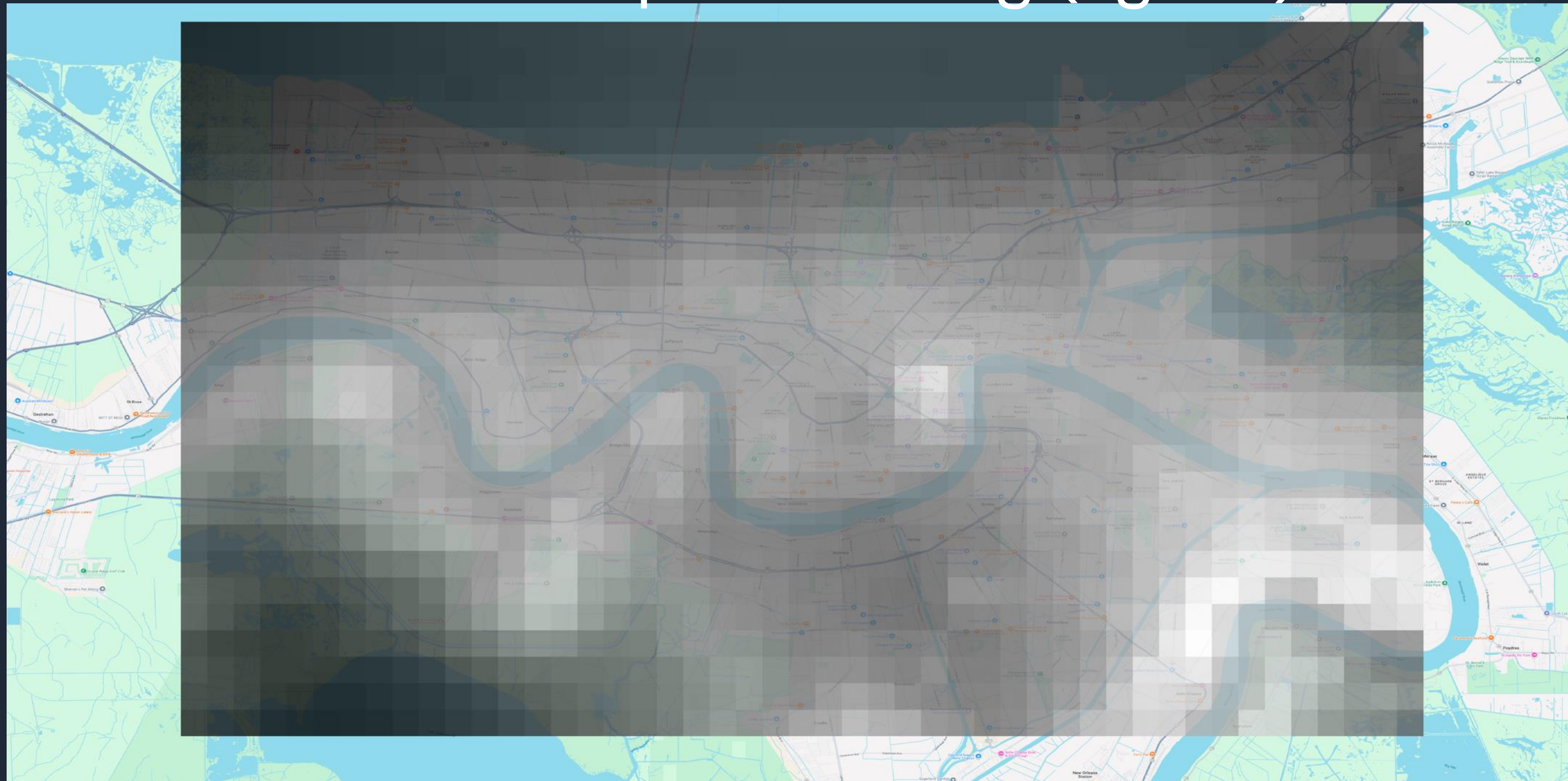
Pre-event NTL (Aug 9, $nW \cdot cm^{-2} \cdot sr^{-1}$)



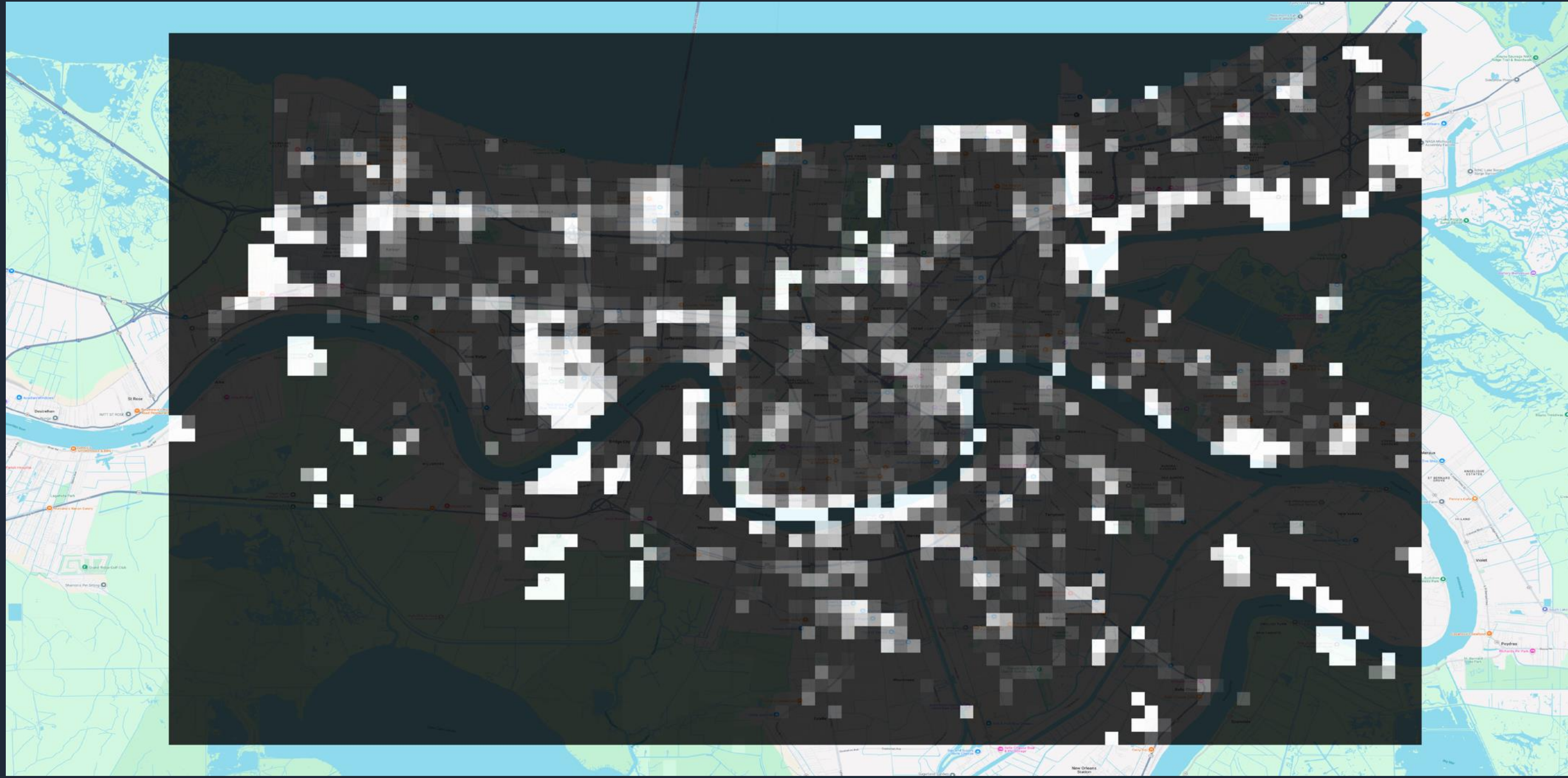
Post-event NTL (Aug 31, $nW \cdot cm^{-2} \cdot sr^{-1}$)

DEM (m)

Mean Precipitation Aug (kg/m^2)



Total Built Up Area (m^2)



Proportion Non-Residential Area (0-1)

SVI (0 Least, 1 Most)

Proportion Black Population (0-1)

Final Dataset

- Our datasets come at different spatial resolutions.
- We rescaled all layers to a common grid.
- Specifically, we interpolated the rasters (bilinear/sum) to an approximately 1km x 1km resolution.
- We also:
  - Filtered using a built-up mask.
  - Removed pixels with missing (NaN) values.
- The final dataset contained 727 observations with 8 variables: 7 predictors (X), and 1 outcome (Y).

	Proportion of nonresidential buildings	Total building area	Social Vulnerability Index (SVI)
0	0.060025	129765.132812	0.7920
1	0.046921	133974.000000	0.7920
2	0.146761	112335.718750	0.8239
3	0.109099	48501.304688	0.2054
4	0.724698	16594.326172	0.4468
...	...	...	...
722	0.717450	927.069519	0.6362
723	0.127171	61031.414062	0.2864
724	0.004273	35688.750000	0.1799
725	0.009318	685.421631	0.5638
726	0.014204	5344.844727	0.5638

	Proportion of the black population	Light intensity pre-event	Elevation	August precipitation average
0	0.907866	22.476677	-0.760366	289.0
1	0.937779	37.694191	-1.682369	290.0
2	0.912659	54.834995	-2.120839	289.0
3	0.954641	29.959541	-2.577648	289.0
4	0.977401	9.843662	-1.664050	290.0
...	...	...	...	...
722	0.227170	10.562560	-0.611508	364.0
723	0.035694	17.541546	0.789200	363.0
724	0.019813	15.089442	2.265380	351.0
725	0.000000	7.428401	1.803369	349.0
726	0.000000	5.212087	0.237641	367.0

Methodology

1. Use VNP46A2 daily for (post-event).

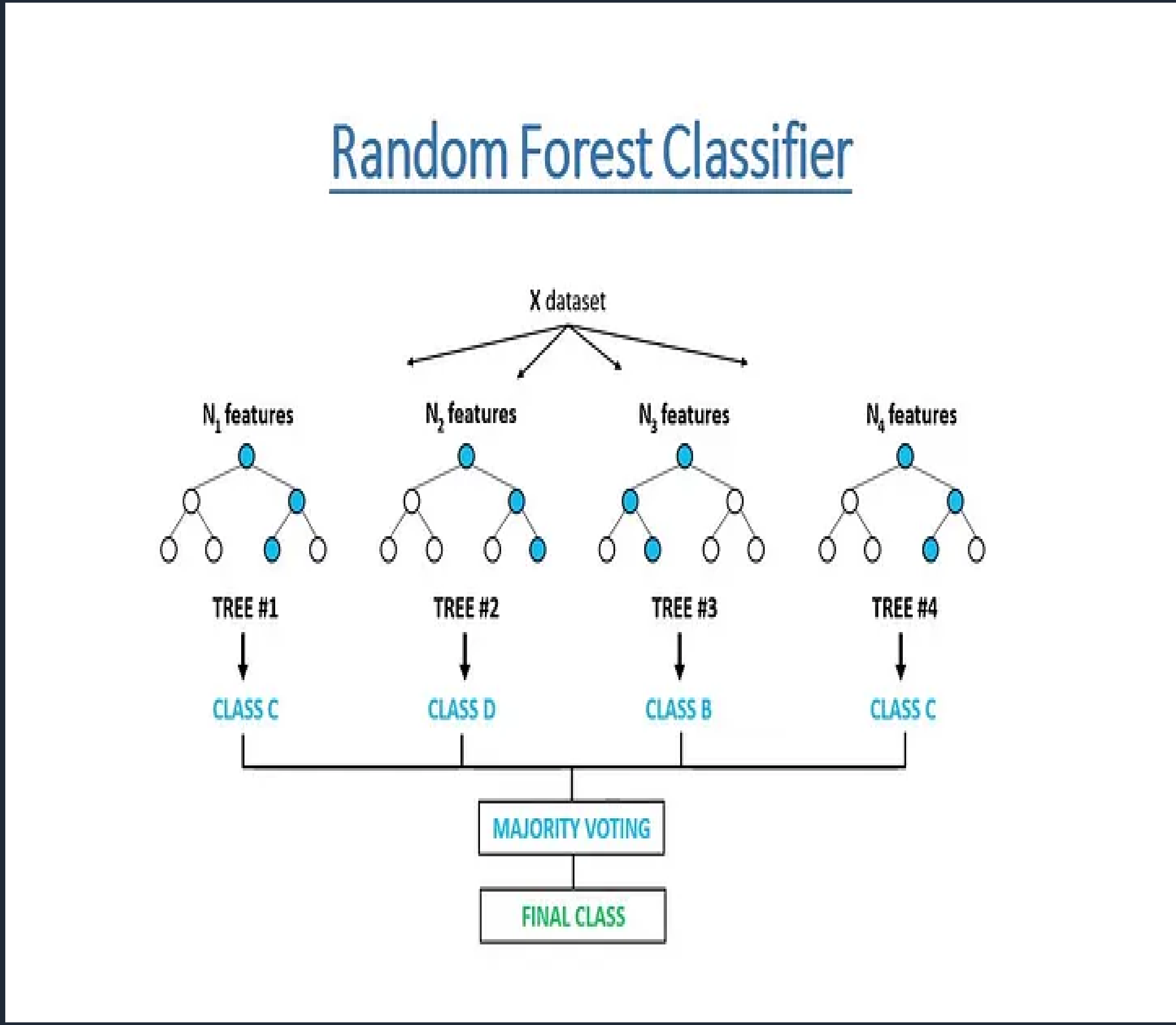
2. Use VNP46A3 monthly composites for (pre-event).

1. Compute Percent Light change (PL) = (pre-post)/pre.

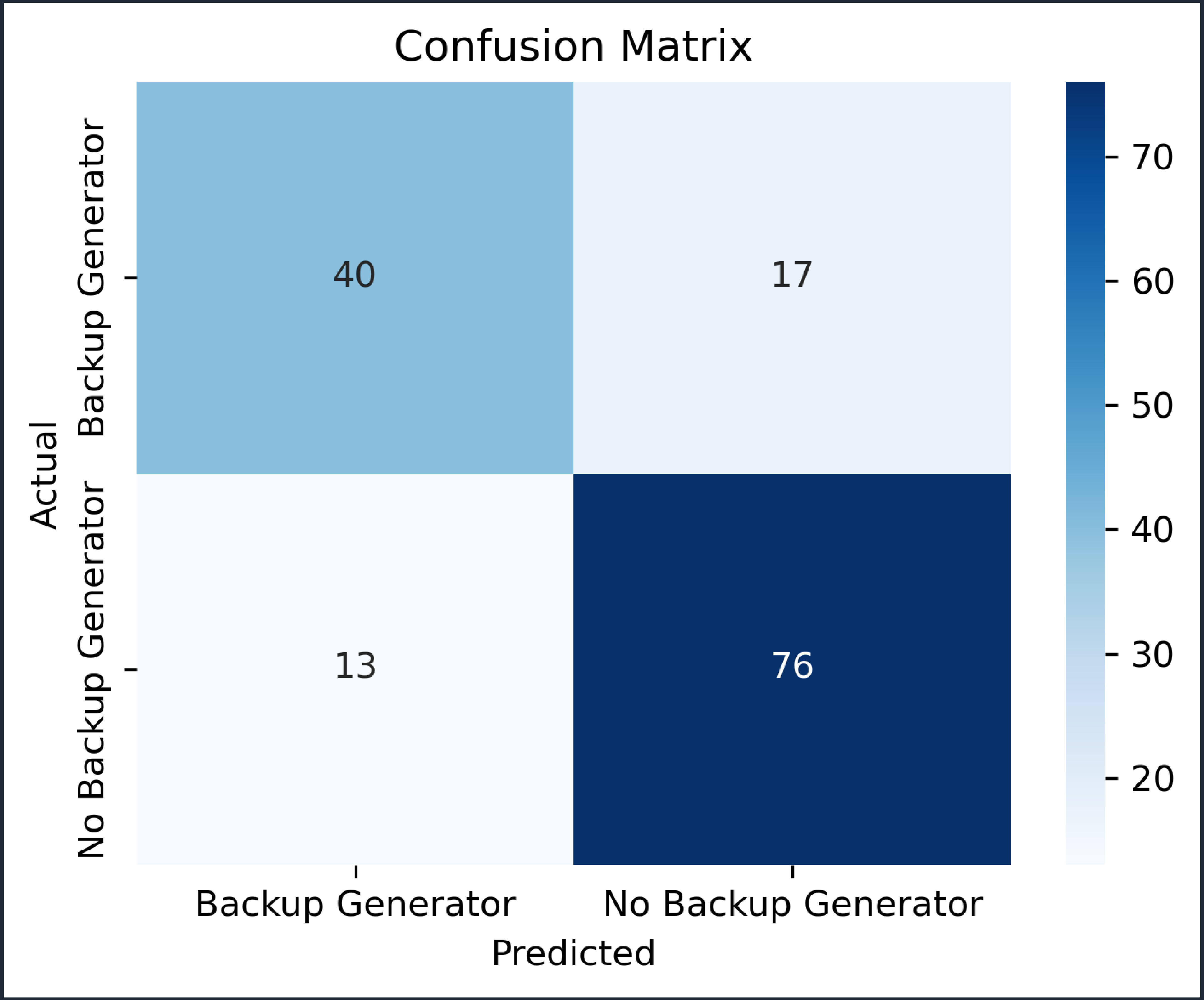
2. Recode PL as a binary indicator, No Back Up Use, where 1 denotes no generator use (100 percent PL), and 0 denotes generator use (Less than 100 PL)

3. Run a Random Forrest classification model with Back Up Use as Y and datasets mentioned as X, with 80/20 split.

4. Calculate Variable Inclusion Proportion and correlation scores.



Results



89 No use pixels

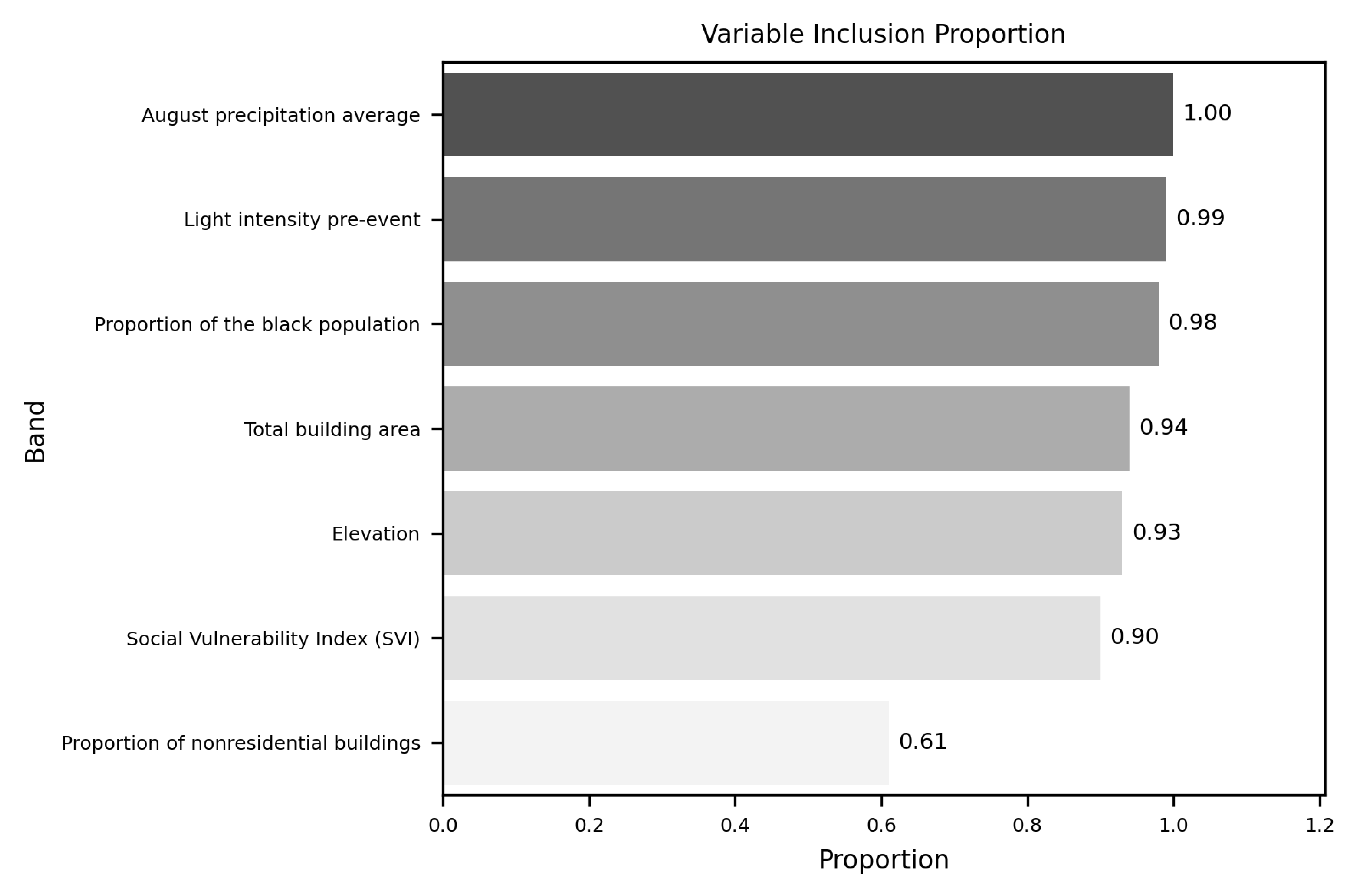
57 Use pixels

Overall, the matrix shows a balanced performance of our model

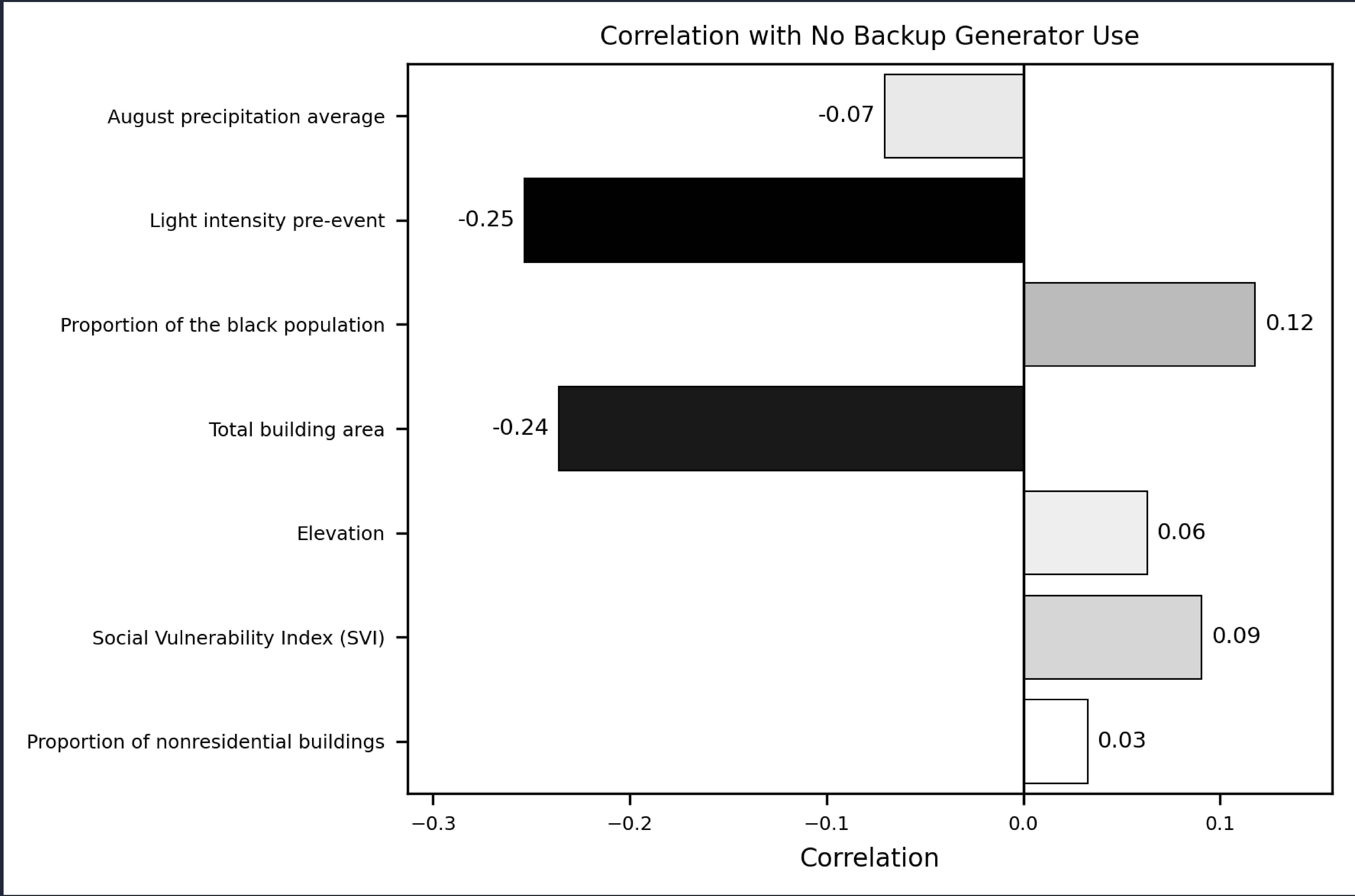
Accuracy: 80 percent

F1 Score: 84 percent

Because of the high accuracy and F1 score, we can be sure PL was not (mostly) noise



Variable Inclusion Proportion
August precipitation average
Light intensity pre-event
Proportion of the black population
Total building area
Elevation
Social Vulnerability Index (SVI)
Proportion of nonresidential buildings
1.00
0.99
0.98
0.94
0.93
0.90
0.61
Band
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Proportion


Correlation with No Backup Generator Use
August precipitation average
Light intensity pre-event
Proportion of the black population
Total building area
Elevation
Social Vulnerability Index (SVI)
Proportion of nonresidential buildings
-0.07
-0.25
0.12
-0.24
0.06
0.09
0.03
−0.3
−0.2
−0.1
0.0
0.1
Correlation

That’s all, Folks!

References

1. Botzen, W. J., Deschenes, O., & Sanders, M. (2019). The economic impacts of natural disasters: A review of Models and empirical studies. Review of Environmental Economics and Policy, 13(2), 167–188. https://doi.org/10.1093/reep/rez004

2. Chandra, A., Acosta, J., Howard, S., Uscher-Pines, L., Williams, M., Yeung, D., Garnett, J., & Meredith, L. S. (2011, March 1). Building Community Resilience to disasters: A way forward to enhance National Health Security. Rand health quarterly. https://pmc.ncbi.nlm.nih.gov/articles/PMC4945213

3. FEMA. (2025). Power outage incident annex: Managing the cascading impacts from a long-term power outage (Response and Recovery Federal Interagency Operational Plans). U.S. Department of Homeland Security. https://www.fema.gov/sites/default/files/documents/fema_incident-annex_power-outage.pdf