Exploring Power Grid Inconsistencies Using Satellite Data in Accra, Ghana

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Motivation

Dearth of grid sensing infrastructure
↓
Limited insight into the grid
↓
Underestimation of grid unreliability
↓
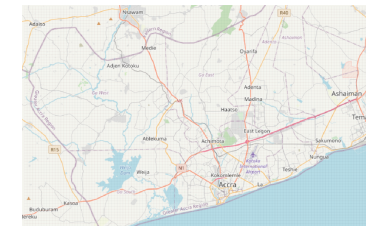**Inconsistent power supplies**
↓
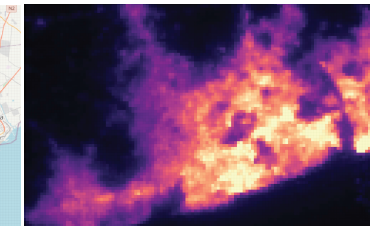**Economic & social costs**

Proposed solution:

Proxy measurements of grid reliability using nighttime satellite observations.
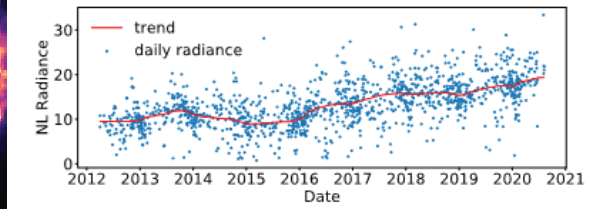
Area of study: Accra, Ghana

Datasets

Open street map of Accra

VIIRS nightlight map of Accra

Single pixel radiance profile

|	Nightlights (primary dataset)	Power Watch (ground truth dataset)
Mode of measurement	Satellite	Smart meters
Spatial resolution	~ 450 meters	Point data
Temporal resolution	Daily	1 minute
Timeline	Apr 2012 - Sep 2020	Jun 2018 - Sep 2020

Outage Detection

→**NL-based metrics** for identifying power outages:
- Z-score of radiance
- Dispersion index of radiance

→**Proof of concept:** DUMSOR case study

→**Observations:**
- Unreliable areas exhibited higher variance in lighting levels (Z-scores).
- Wide-area outages are easier to detect than localized outages.
- 3 months of historical data is sufficient to make accurate outage predictions.
- Nightime supply inconsistency is representative of supply inconsistency during the entire day.
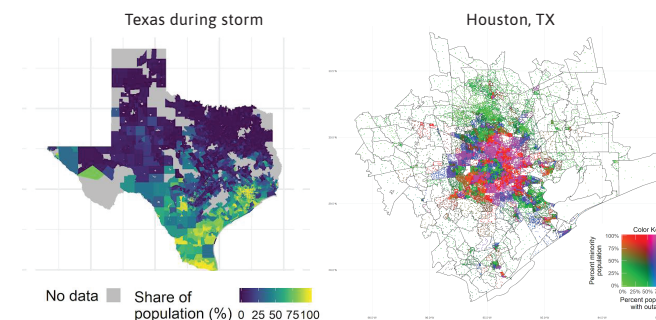

DUMSOR Case Study

Results
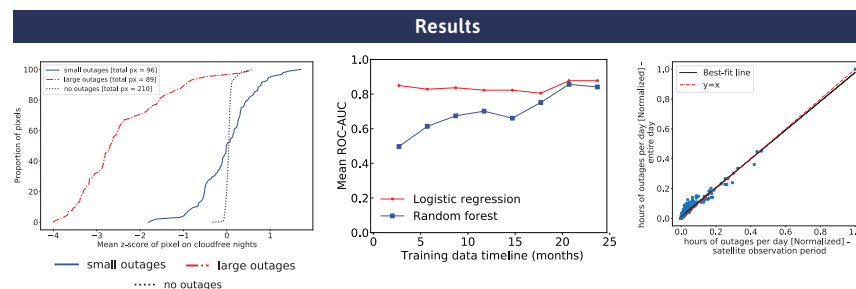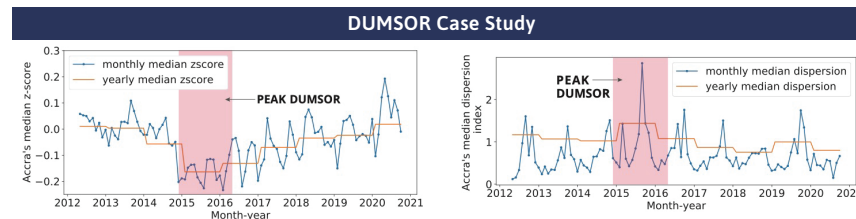
Applications

→ Provide high confidence measurements of wide-area outages.
- Use case: Feb 2021 Texas outages.

→ Compare supply inconsistencies across multiple cities.

Texas during storm

Houston, TX

Future Work

→ Improve **predictive performance.**
- Collect more ground truth
- Bootstrapping and simulation

→ Improve **generalizability.**

Electrical and Computer Engineering Department

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