Environmental Computational Science and Earth Observation Laboratory

Comparative Analysis of Satellite Sensor Data in Humanitarian Crisis Contexts

Context

In regions affected by humanitarian crises, timely monitoring is essential to guide relief efforts and support vulnerable populations. Satellite remote sensing offers unique advantages, particularly through nighttime lights (NTL) data, which can reveal activity in areas that are otherwise hard to access. This potential underpins our joint project between ECEO and the International Committee of the Red Cross (ICRC), aimed at advancing NTL monitoring for crisis response.

While NTL data has traditionally been used as a proxy for economic activity and urbanization [1], recent advances, such as NASA's Black Marble with 500 m resolution and nightly imagery, enable tracking more rapid, localized changes. Emerging research has begun to show how NTL shifts can indicate the impacts of conflicts and natural disasters [2]. We want to extend this line of research to areas where other data sources, such as eyewitness accounts and news reports, are scarce. However, many such areas show very low detectable light [3], raising the question of whether newer, higher-resolution sensors can better capture activity in these low-light environments. A systematic comparison of sensor capabilities in such contexts has yet to be carried out.

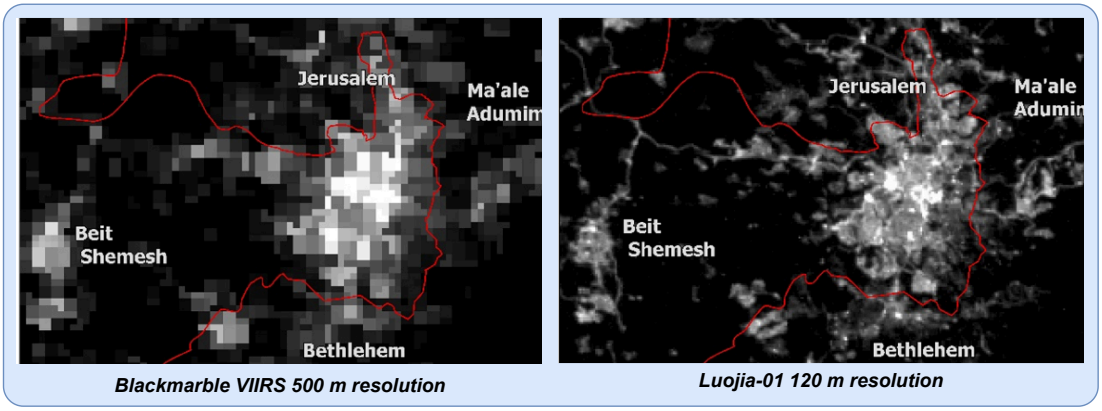

Figure: Comparison of nighttime light imagery of Jerusalem, captured by NASA's VIIRS Black Marble (left) and Luojia-1 (right). Figure adapted from citation [4].

With more satellites now capturing nighttime imagery, there is a need to assess which sensors are best suited for humanitarian monitoring. The project will evaluate key trade-offs, data accessibility, spatial resolution, and temporal frequency, to determine their suitability for detecting NTL changes in crisis-affected rural regions. This baseline will support future efforts to leverage NTL data for improved crisis detection and response.

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Project

This project aims to systematically compare satellite sensors for monitoring humanitarian crises, with a particular focus on rural crisis-affected regions such as Myanmar and South Sudan. Specifically, the project will:

- Identify locations where multiple satellite sensors overlap and compare their imagery to qualitatively assess differences in what each sensor captures.
- Evaluate the sensitivity of each sensor (e.g., VIIRS Black Marble, Luojia-1, SDGSAT-1, EnMAP, and Landsat 8) in detecting small settlements and villages in low-light, low-activity rural contexts.
- Analyze how differences in satellite overpass times affect detection capabilities.
- Identify case study areas where multi-sensor time series data are available before and after humanitarian crises, enabling comparison of NTL changes across sensors during crisis events.

The project will involve geospatial data processing, cross-sensor comparison, statistical analysis, and visualization. By taking this approach, it will provide concrete insights into the relative strengths and weaknesses of current nighttime light sensors and help guide their effective use in crisis response for rural settings.

Requirements

- Experience or strong interest in remote sensing and geospatial data analysis.
- Experience in Python and relevant libraries (e.g., GDAL, rasterio, geopandas, numpy, matplotlib).
- Strong willingness to learn and ability to work independently and interest in contributing to projects with real-world humanitarian impact.

References

[1] Keola, S., Andersson, M., & Hall, O. (2015). Monitoring economic development from space: using nighttime light and land cover data to measure economic growth. *World Development*, *66*, 322-334.

[2] Chakraborty, S., & Stokes, E. C. (2023). Adaptive modeling of satellite-derived nighttime lights time-series for tracking urban change processes using machine learning. *Remote Sensing of Environment*, *298*, 113818.

[3] Bara, Corinne & Sticher, Valerie. (2024). The Rural Limits of Conflict Monitoring Using Nighttime Lights. *Preprint*.

[4] Guk, E., & Levin, N. (2020). Analyzing spatial variability in night-time lights using a high spatial resolution color Jilin-1 image–Jerusalem as a case study. *ISPRS journal of photogrammetry and remote sensing*, *163*, 121-136.

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