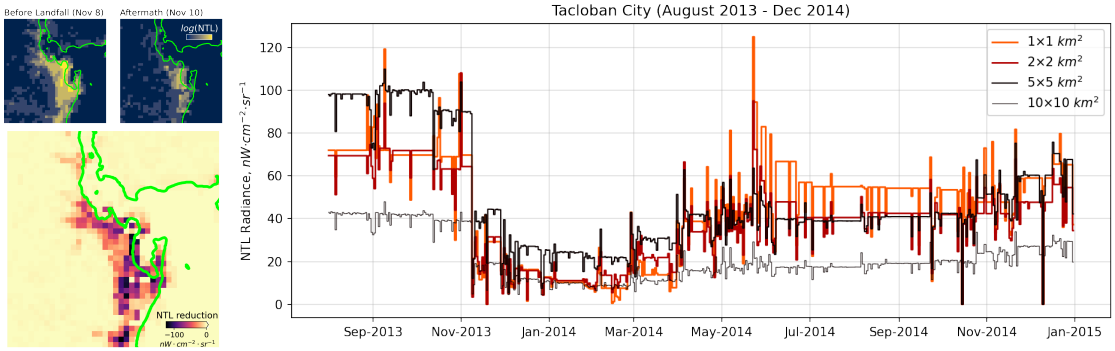
1 Nighttime Lights (NTL) Dataset

NASA's Black Marble Nighttime Lights Product Suite for daily data from 2014-2022
`https://doi.org/10.5067/VIIRS/VNP46A2.001`

The NTL that the satellite detects is a combination of multiple light sources from artificial lighting observations (streets, buildings, boats, etc.) and natural sources (aurora, bioluminescence, etc.). Since its availability in the 1970s, a multitude of studies has exploited NTL as a sufficient proxy for a wide array of social, economic, and environmental indicators [1]. NTL's standard unit of measurement is the radiant power per unit area per unit solid angle ($nW \cdot cm^{-2} \cdot sr^{-1}$) – essentially the intensity or flux density of radiant energy over a given area and within a specific solid angle. The following three are the most established NTL datasets and their specifications:

- **DMSP-OLS**: Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) (`https://www.ngdc.noaa.gov/eog/download.html`)
  - Resolution: 2.7 km spatial, annual temporal, 6-bit radiometric
- **VIIRS-DNB**: Visible Infrared Imaging Radiometer Suite - Day and Night Band (`https://www.ngdc.noaa.gov/eog/download.html`)
  - Resolution: 500 m spatial, monthly temporal, 16-bit radiometric
- **Black Marble NTL**(`https://ladsweb.modaps.eosdis.nasa.gov/`)
  - Resolution: 500 m spatial, daily temporal, 16-bit radiometric



(a) NTL reduction (b) NTL time series profile

Figure 1: Black Marble NTL fluctuations centered across Tacloban City, Leyte shows ephemeral decrease as a result of Yolanda. NTL daily observations show the post-disaster recovery.

As shown in Figure 1, a daily time series data can be extracted which shows NTL fluctuations. These NTL radiance values is a net effect of a complex system which (1) directly shows power consumption and emission, (2) implies economic development, urbanization, disaster response and recovery, and (3), show social and cultural aspect of energy demands, public health, and environmental footprint as shown by the sample studies listed.

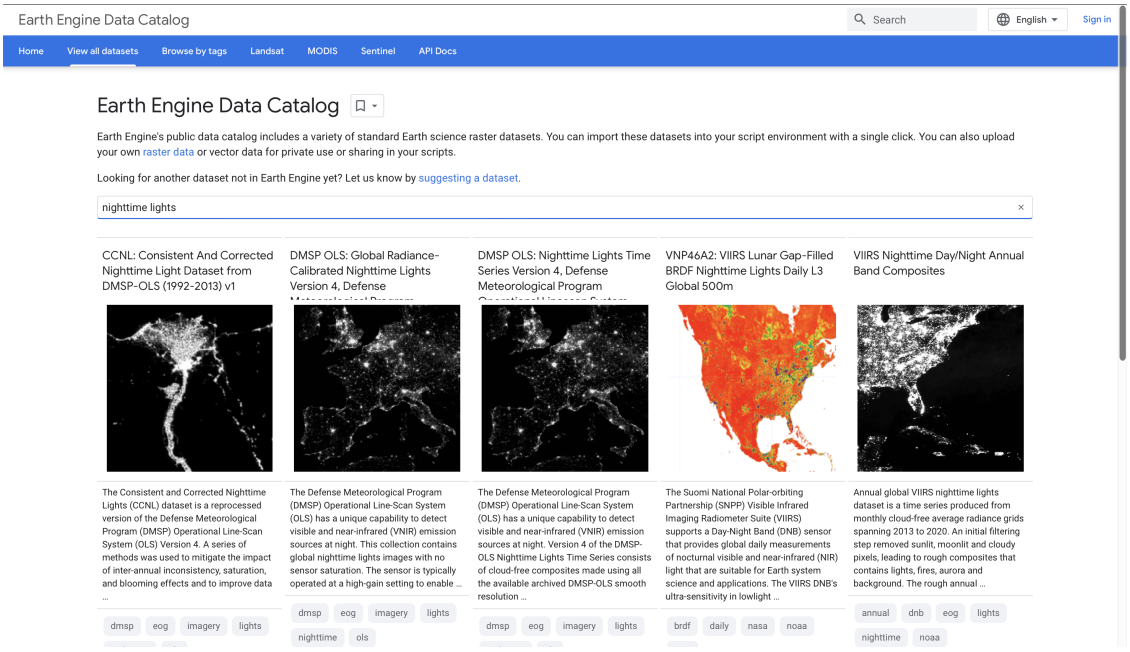


Figure 2: Global NTL datasets accessible via the Google Earth Engine Catalog (`https://developers.google.com/earth-engine/datasets/catalog`

Geospatial data extraction can carried out conveniently in the Google Earth Engine platform through Google Colab which easily links hundreds (or even thousands) of global Earth science raster datasets with one line of code, and that includes the aforementioned NTL datasets as shown in Fig. 2. It also includes Level 1-4 administrative shapefiles which facilitates zonal statistics calculation.

Recent Publications:

- Tan, Xiaoyue, Ruilin Chen, Xiaolin Zhu, Xi Li, Jin Chen, Man Sing Wong, Shuai Xu, and Yi N. Xu. "Spatial Heterogeneity of Uncertainties in Daily Satellite Nighttime Light Time Series." International Journal of Applied Earth Observation and Geoinformation 123, (2023): 103484. `https://doi.org/10.1016/j.jag.2023.103484`

- Zheng, Qiming, Qihao Weng, and Ke Wang. "Characterizing Urban Land Changes of 30 Global Megacities Using Nighttime Light Time Series Stacks." ISPRS Journal of Photogrammetry and Remote Sensing 173, (2021): 10-23. `https://doi.org/10.1016/j.isprsjprs.2021.01.002`

2 Normalized Difference Vegetation Index (NDVI)

GMOD13A1.061 Terra Vegetation Indices 16-Day Global 500m
`https://doi.org/10.5067/MODIS/MOD13A1.061`

"The MOD13A1 V6.1 product provides a Vegetation Index (VI) value at a per pixel basis. There are two primary vegetation layers. The first is the Normalized Difference Vegetation Index (NDVI) which is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration-Advanced Very High Resolution Radiometer (NOAA-AVHRR) derived NDVI. The second vegetation layer is the Enhanced Vegetation Index (EVI) that minimizes canopy background variations and maintains sensitivity over dense vegetation conditions. The EVI also uses the blue band to remove residual atmosphere contamination caused by smoke and sub-pixel thin cloud clouds. The MODIS NDVI and EVI products are computed from atmospherically corrected bi-directional surface reflectances that have been masked for water, clouds, heavy aerosols, and cloud shadows." [2]

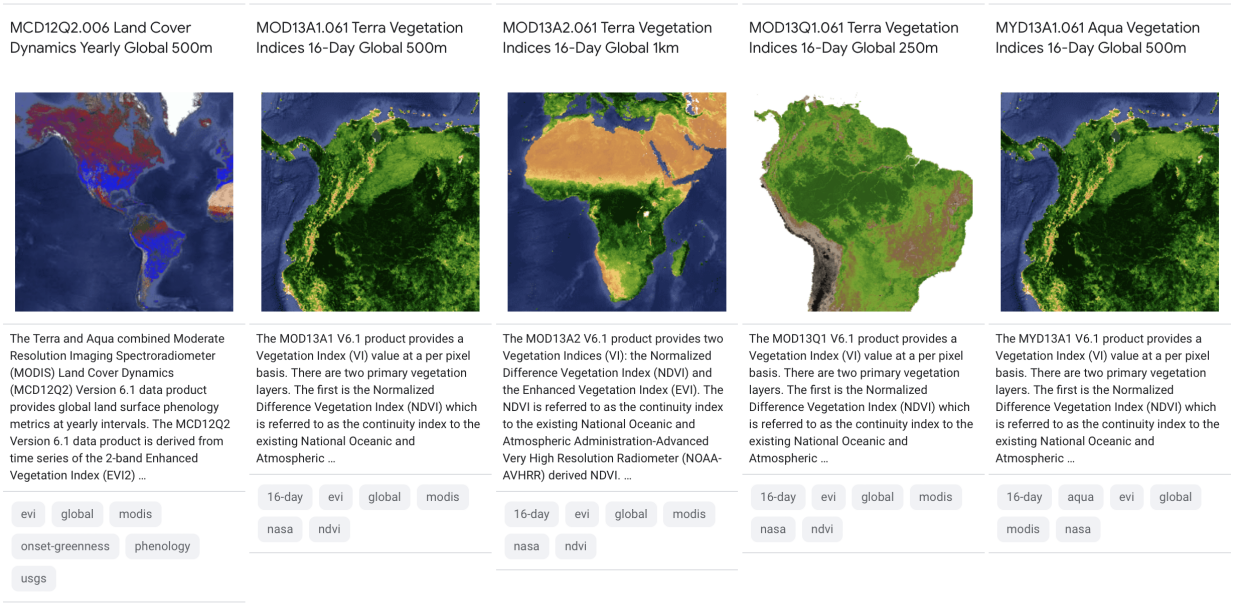


Figure 3: NDVI datasets available on Google Earth Engine platform (`https://developers.google.com/earth-engine/datasets/catalog/MODIS_061_MOD13A1#description`)

Recent Publications:

- THu, Tongxi, Elizabeth Myers Toman, Gang Chen, Gang Shao, Yuyu Zhou, Yang Li, Kaiguang Zhao, and Yinan Feng. "Mapping Fine-scale Human Disturbances in a Working Landscape with Landsat Time Series on Google Earth Engine." ISPRS Journal of Photogrammetry and Remote Sensing 176, (2021): 250-261. `https://doi.org/10.1016/j.isprsjprs.2021.04.008`
- Chen, Shijuan, Curtis E. Woodcock, Eric L. Bullock, Paulo Arévalo, Paata Torchinava, Siqi Peng, and Pontus Olofsson. "Monitoring Temperate Forest Degradation on Google Earth Engine Using Landsat Time Series Analysis." Remote Sensing of Environment 265, (2021): 112648. `https://doi.org/10.1016/j.rse.2021.112648`