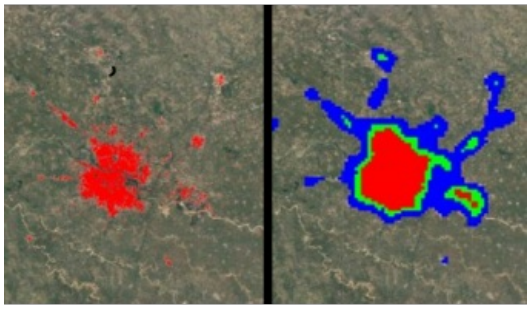
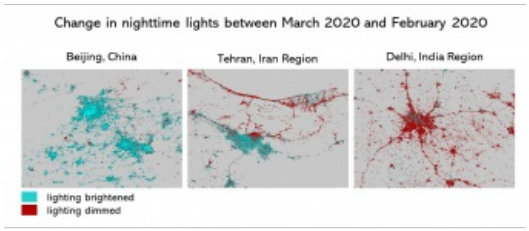
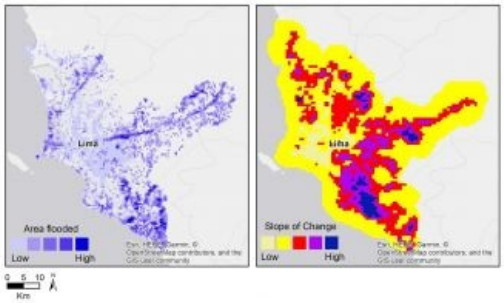
HOW NIGHTTIME LIGHTS HAVE REVOLUTIONIZED THE WAY WE UNDERSTAND OUR WORLD

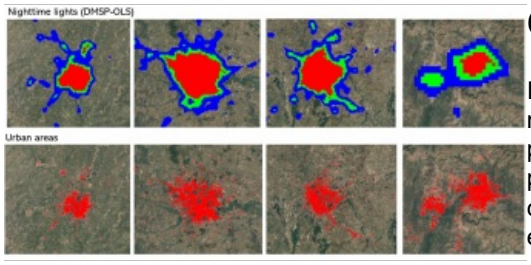
Shedding Light on Earth







Images of Earth taken at night are revolutionizing our ability to measure and understand nearly every dimension related to human activity on Earth and allow us to get a glimpse into human/Earth interactions in near real time. The recent COVID-19 outbreak exemplifies how nighttime lights can help us understand the impacts of shocks on populations, economies and markets. Given the interdisciplinary nature of remote sensing-based socioeconomic research, a special issue of 'Remote Sensing' journal will bring together original and novel studies demonstrating innovative applications of nighttime lights-based analysis to broaden our understanding of human society and its further implications.



Seeing the Impacts of COVID-19 at Night

In mid-December 2019, COVID-19 began emerging in Wuhan, China and in just 30 days rapidly spread to the entire country, causing significant impacts not only on the health of people in China, but on the entire economy, the job market and the daily life of the population. Within several weeks the disease started spreading globally, with millions of confirmed cases recorded around the world, together with significant implications to global economies.

The need to track and predict outbreaks, and understand the impacts of COVID-19 on economies, have led to the utilization of unique sources of data that could help track the spread of the pandemic in close to real time. Satellite observations - including those taken at night - are becoming a primary source of data for tracking the progress of the pandemic and its impacts on energy consumption, transportation, social interactions, the functionality of critical infrastructure, tourism, trade emissions, etc. They provide a compelling and striking picture of the large-scale impacts of COVID-19 on Earth, from the impacts of the pandemic on businesses and transportation networks to monitoring the gradual recovery of cities around the world. The idea of using nighttime lights to understand pandemics is not new, and previous studies have already shown, for example, how nighttime lights can be used to estimate seasonal measles epidemics, which are directly linked to spatiotemporal changes in population density as measured by anthropogenic light emissions.

Changes in activity around the city of Wuhan, China, between 19 January and 4 February 2020, as retrieved by the Visible Infrared Imaging Radiometer Suite (VIIRS) using NASAâ€™s Black Marble product suite: https://blackmarble.gsfc.nasa.gov/. Source: NASAâ€™s Goddard Space Flight Center (GSFC) and Universities Space Research Association (USRA)

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The use of nighttime lights observations to monitor pandemics is only one example of how satellite observations can be used to help us better understand processes on Earth. Since the early 1990s, with the launch of DMSP-OLS, remotely sensed observations of nighttime lights have been a key instrument for understanding almost every aspect related to human activity on Earth; particularly in the data-scarce

region, without being filtered through national data agencies that are potentially inefficient or biased. Today, newer sensors, such as VIIRS/DNB, provide nighttime light data even at a higher spatial resolution and granularity. With advances in the availability and the quality of nighttime light data, together with improvements in data storage capabilities and the development of new analytical methods and workflows for analyzing the data, there is an ongoing increase in the number of scientific applications that exploit remotely sensed nighttime lights to measure our world.

Nighttime lights observations – or the measurements of the intensity of light emitted from Earth at night - provide a unique glimpse into human behavior and socio-economic patterns and into the nature of human-Earth interactions. Nighttime light observations are especially vital in countries where timely, accurate and reliable statistical or administrative data is poor. In these countries, nighttime light measurements can provide important insights into where people are, how people move, understand patterns of economic development or evaluate the economic impacts of investments in infrastructure. While in some cases nighttime light observations may prove to be noisy and carry inherent measurement errors especially when compared across space and time, there is a general consensus that nighttime lights are able to represent many dimensions related to human presence and activity on Earth.

Changes in the intensity of nighttime lights can be used to illustrate pace of recovery. These images show changes in nighttime lights between March 2020 and February 2020. Cyan = lighting brightened, Red = lighting dimmed. Source: Elvidge et al., 2020. The Payne Institute for Public Policy

Today, nighttime lights are being used to measure the extent and characteristics of urbanization processes, estimate economic growth at a national and sub-national level, map global poverty, track local household wealth, education and health, map population density, migration and mobility patterns, understand armed conflicts, measure accessibility to electricity and electrification, community resilience, fishing activity, coral reef health and more. Recently, researchers have also shown that nighttime lights can explain brain development and human behavior.

Moreover, by looking at the relation between the distribution of the population on Earth and the occurrence of different types of hazards, nighttime lights measurements can be used to evaluate how humans adapt and respond to hazards and utilized as an instrument to guide resilience planning. For example, the City Resilience Program utilizes nighttime light data in its City Scan product to highlight where hotspots of economic activity may be developing in flood- prone areas.

The City Resilience Program (CRP) incorporates nighttime light data in the Resilience City Scans to guide resilience planning and investments in infrastructure. The map on the right illustrates the intensity of change in the emission of nighttime lights (2013-2019) as picked up from VIIRS imagery â€“ as an indicator for changes in economic activity. The values represent the slope of a regression line (i.e., intensity of light against time). Blue areas represent a positive slope â€“ an increase in the intensity of nighttime light emission. Yellow areas represent a negative slope â€“ a decrease in the intensity of nighttime light emission. The map on the left illustrates the total area detected as flooded in numerous flood events since 2015.

A Special Issue of Remote Sensing Journal

In light of these advances in nighttime light remote sensing, *Remote Sensing* journal will host a Special Issue edited by the authors of this post, dedicated to the various applications of remote sensing in a wide range of domains. This issue will stimulate progress in the remote sensing research domain related to the utilization of nighttime lights in a wide range of scientific domains, including economics, social sciences, disaster management, environmental sciences, ecology, urban studies, and more. The issue will bring together original and novel studies demonstrating the applications of remotely sensed nighttime lights in a wide range of multidisciplinary and interdisciplinary domains. Review contributions are also welcomed.

Nighttime lights provide a good proxy for the distribution of built-up land cover and urban areas on Earth.