

Suitability of VIIRS Nighttime Lights (NTL) Satellite Data for Population and Migration Modeling.

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Abstract

We investigated the potential link between changes in NASA's Black Marble nighttime lights (NTL) data from 2012 to 2015, and changes in the 2010 census and 2015 population estimates from the Instituto Nacional de Estadística y Geografía (INEGI) at the municipal level in the State of Oaxaca, Mexico in order to characterize the usefulness of NTL for larger-scale migration modeling. Our results show that **NTL are useful in indicating settlement development**, particularly in semi-urban areas, which confirms established broad migration patterns, namely that (1) urban populations around the world are growing primarily due to population growth, thus, expanding the footprint of urban centers and that (2) there is a dramatic increase in the percentage of people moving into urban areas when compared to rural areas; **however, in already-developed areas, NTL data may not be as useful in modeling population dynamics nor as an indicator of emigration.**

Data Sources

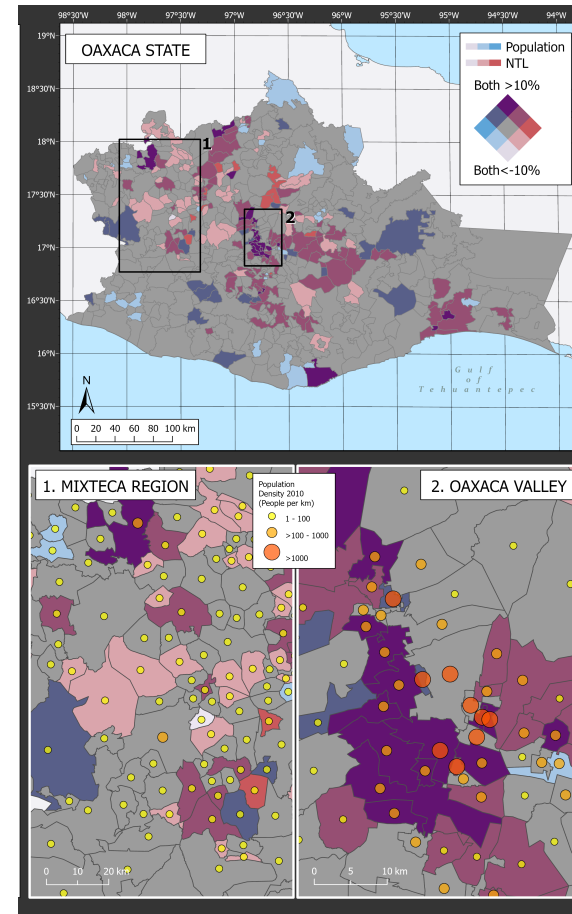
Daily NPP/VIIRS Moonlight-adjusted Nighttime Lights Daily L3 Global 500m SIN Grid V001 (VNP46A2) Band 1: DNB_BRDF-Corrected_NTL data were downloaded from the NASA Level-1 and Atmosphere Archive & Distribution System Distributed Active Archive Center (LAADS DAAC) archive. **Black Marble.** Population census counts for 2010 and population estimates for 2015 for the municipalities of Oaxaca were downloaded from the INEGI Sistema para la Consulta de Información Censal 2010 (SCINCE, an online census information system).

Introduction

Human migration has increased over the last two decades, both in scope and complexity, with significant social economic, and political implications. **Migration is primarily driven by economic disparities, social and cultural factors, and environmental change. Migration is sometimes used as a response to climate variability and environmental change, and has potential benefits for sustainable economic and social development.**

Mexico was the largest emigration country in Latin America and the Caribbean between 2009-2019 with over 12 million Mexicans living abroad in 2019. Additionally, there are three major international migrant corridors that run through Mexico, two of which traverse through the **State of Oaxaca**, which itself is experiencing a demographic transition characterized by a slowing growth in population and an increased intensity in emigration.

The UN recognizes that socioeconomic affairs may be managed more effectively through evidence-based decision-making processes that rely upon data such as censuses. Such data should be reproducible, and should provide information at a variety of spatial and temporal scales. NTL could be applied as a novel data source that could further refine the accuracy, resolution, and timeliness of population and migration models.



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Methods

Changes in the ratio of NTL and population were calculated:

$$\text{Ratio Change} = (\text{Final_Value} - \text{Initial_Value}) / \text{Initial_Value}$$

Municipalities were classified by their significant change, where a **change $\geq \pm 10\%$ is considered significant** and a **change $< \pm 10\%$ is considered insignificant (Top Figure).**

Results & Conclusions

NTL is useful in identifying the status of settlement development. Municipalities with significant increases in population and NTL tended to be clustered west of Oaxaca's capital, Oaxaca de Juarez (Bottom Figure, 2). Municipalities with significant decreases in population tended to be clustered in the rural Mixteca Region (Bottom Figure, 1), but they did not show significant decreases in NTL, suggesting that, **once infrastructure is installed, NTL has limitations in population modeling because the signal tends to remain flat despite migration occurring.**

Incorporating NTL with census data adds context as to how the population may be affecting the natural environment, such as infrastructure development or infrastructure abandonment. Datasets like NTL will increasingly become more needed and useful as the world faces increased impacts as a result of climate change. **Black Marble is a significant data source with the qualities needed inform settlement modeling, policy, and decision-making at all levels of government in a timely manner.**