Impacts of Urbanization: Vegetation and Surface Temperature in Surat, India

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Introduction

As with many cities in India, Surat has been met with a massive increase of urbanization as it becomes more and more globalized. The city transitioned from a merchant economy of trades and locally made goods as well as agriculture, to a globalizing city largely involved in the information technology economic sector (Kundu, 2000). The rising population has demanded an increase of housing which has led to the municipality of Surat to demolish old houses to be replaced with compact city housing (Udeaja, 2020). The urban area has of course also continued to expand outward, far past its historic days as a walled city. These changes have affected the patterns of land use, which can be seen through the increase in built-up areas over areas previously consisting of open land or vegetation, as well as the consistent pattern of land surface temperatures being hottest in urbanized areas.

The changes in its morphology as a result of industrialization and globalization has caused problems for the residents, especially in the inner city with overcrowding and unequally distributed and quality of infrastructure (Bipinchandra, 2020). The wealth disparity of the population is increasingly polarized, leaving many without vital services and amenities such as housing, clean water, and breathable air. The situation in the city will continue to depreciate unless properly managed.

Studying urbanization processes is important in understanding how the city functions and the directions it may go, which is why Earth Observation technology is a vital resource for such solutions.

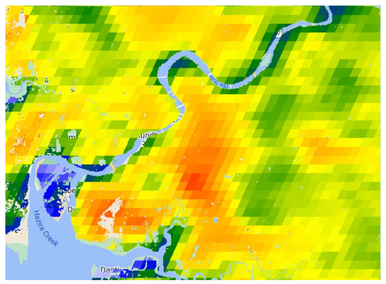
Methodology

Using Google Earth Engine, I created a split panel layout displayed over an Normalized Difference Vegetation Index (NDVI) visualization. I used Landsat 8 imagery to create an image classification distinguishing between built-up areas and non built-up areas. The map on the left panel shows the built-up areas in 2013 in black, and the right map shows the built-up areas in 2020 in red.

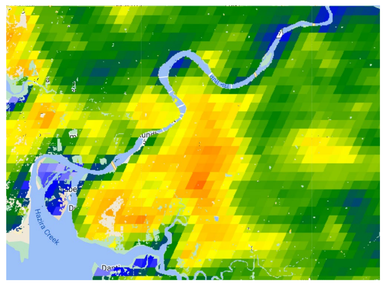
For my second data visualization I used the slider UI to display land surface temperature by year from 2003 - 2021 using data from MODIS.

Results

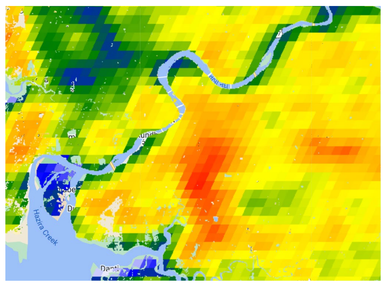
2005



2010



2015



2020

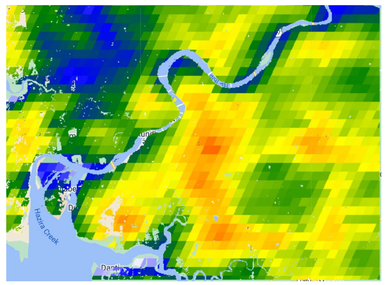


Figure 1. MODIS Land Surface Temperature by year during the winter/early spring months of January through March from 2003 - 2021.

Temperatures range from approximately 31 degrees Celsius (88 degrees Fahrenheit) to 43 degrees Celsius (110 degrees Fahrenheit). Red represents highest land surface temperatures and blue represents the lowest land surface temperatures. Despite only using data from the same three months each year, temperatures still fluctuate within this range year by year. A consistent pattern, however, is that the pixels representing the highest land surface temperatures are not in the historic core of the city but instead surround the city.

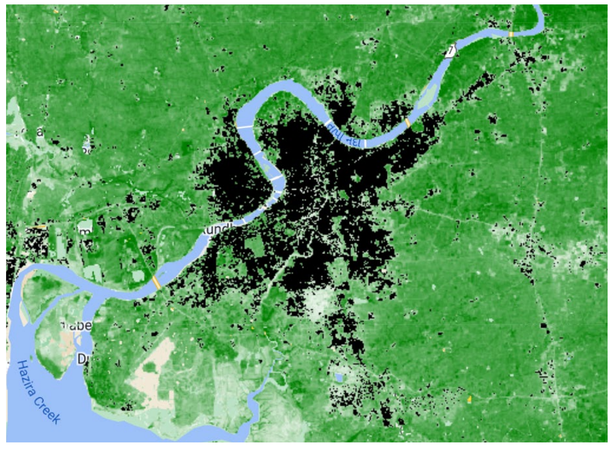


Figure 2. Classification of built up areas in 2013

Black pixels represent pixels that were classified as being built-up in 2013. Built-up areas correlate to high urbanization. Non-built-up areas include anything from open fields, agricultural land, other vegetation, and water.

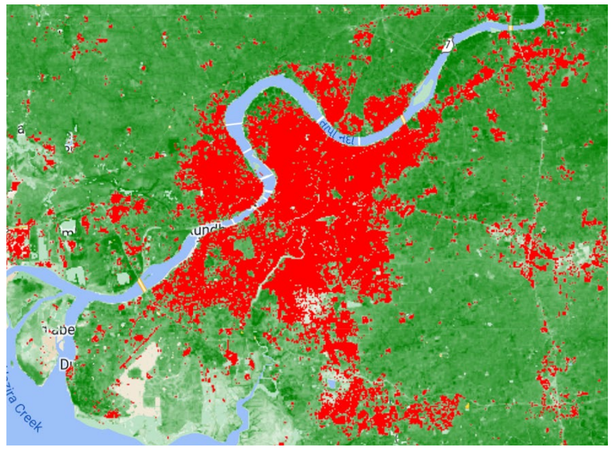


Figure 3. Classification of built up areas in 2020

The red pixels on this map are part of the same class as the black pixels in Figure 2 but here the data is from 2020 and represents the built-up areas in 2020.

Faculty Advisor: Michelle Stulhmacher, Ph.D.

Significance

Comparing the maps of built-up areas from 2013 to 2020 shows the rapid urban sprawl Surat experienced in just seven years. The mapped distribution of Land Surface Temperature, Built-Up areas, and Normalized Difference Vegetation Index very clearly display the urbanization pattern of Surat as well as its suburbs and its sprawling urban fringes. The map of land surface temperature provides additional perspective to Surat's urbanization pattern. While the hottest areas are not the city core and instead lie just outside of the city core, this makes sense in relation to the land use patterns within Surat where the inner city is mainly residential intertwined with commercial, and industrial areas are peripheral. The LST data also matches the same spatial pattern as the Built-up areas and NDVI, indicating that as urban areas grow and replace vegetative or agricultural areas, it would correlate to an increase in the area of higher land surface temperatures.

My findings indicate the pattern of rapid urbanization globalizing cities are facing and support claims of Surat's exponentially increasing need for housing, resources, and infrastructure. It is also an indication for focus on sustainability and resiliency in urban design in terms of protecting the health of both the environment and the people. Rapid urban change is rarely evenly distributed, instead it often targets the underserved areas, disproportionately affecting the people with the most needs. Analyzing the changes on the land and in the environment brought about from the urbanization in Surat from remote sensing data can help policy makers and other stakeholders to see what areas are in most need of resources as well as the priority levels of different issues needing to be addressed. It is important to recognize such phenomena in order for the city government to best manage the situation and make informed decisions with regard to the city's future and needs of the residents.

Citations

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