A Study of the Environmental Conditions associated with the 2015 Dengue Outbreak in Southeast Brazil using Remote Sensing Satellite Data

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Abstract

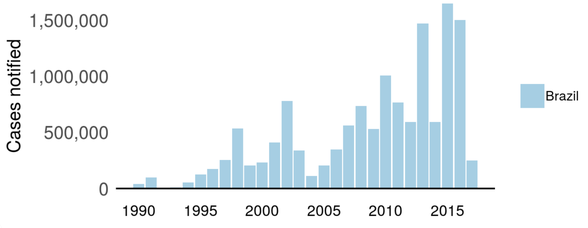
One of the major carriers of diseases are mosquitos and the diseases they have carried have resulted in epidemics with widespread impact. Among these diseases is the Dengue fever. In 2015, the southeast area of Brazil including Rio de Janeiro and São Paulo, was the source of a Dengue virus outbreak.
In the project, conditions that led to this outbreak have been studied. Environmental and land cover data pertaining to mosquitos in southeast Brazil, around 2015 have been studied.

The environmental parameters such as soil moisture, precipitation rates, soil temperature, and land water storage were obtained from remote sensing Earth Orbiting Systems. Through this land cover data, I have come to the main cause of the Dengue outbreak of 2015.

Introduction

Mosquitos are one of the most prominent and potent carriers of diseases. They are vectors for Malaria, Zika, West Nile and Dengue. An estimated 700 million people worldwide are affected by these diseases.

In 2015 there was a Dengue virus outbreak in Brazil. During this outbreak, about 1.5 million cases and 1032 dengue deaths were reported.



Research Question

What environmental factors in southeast Brazil contributed to the Dengue outbreak of 2015 through increased mosquito population? Can land cover data find this out?

GLOBE Badges

Research Methods

Land cover data was accessed from Geospatial Interactive Online Visualization and Analysis Infrastructure (Giovanni), developed by the NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC), also known as Giovanni.

Global Learning and Observations to Benefit the Environment (GLOBE) Program for Globe Observer Mosquito Mappers data

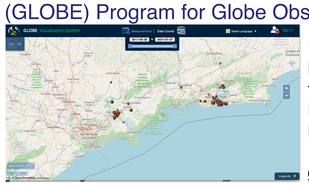


Image 2: Globe Observer Mosquito Mappers reporting observations from Southeast Brazil. Global Learning and Observations to Benefit the Environment (GLOBE) Program, 7/27/2021 accessed, globe.gov

The data accessed from the above sources were then graphed and analyzed using Google sheets.

Data Analysis

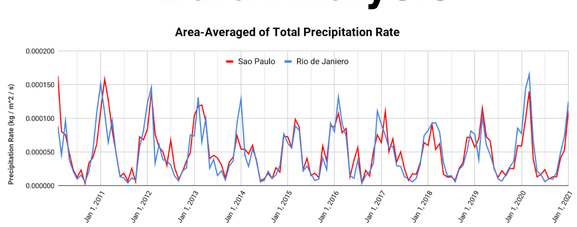


Figure #1: precipitation rate in Sao Paulo and Rio de Janeiro
The peak rainfall during and before 2015 is less than usual, especially with Rio de Janeiro.

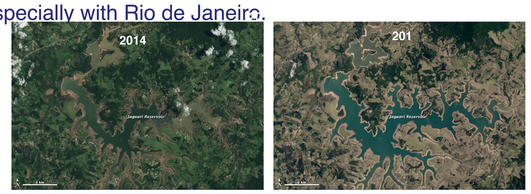


Image 3: NASA Earth Observatory images by Joshua Stevens and Jesse Allen, using Landsat data from the U.S. Geological Survey. Caption by Mike Carlowicz, with image interpretation from Divino Figueiredo (INMET Brazil), Michael Coe (WHRC), Marcos Heil Costa (Universidade Federal de Vicosa), and Alice Grimm (Universidade Federal de Parana). Published March 7, 2015. Data acquired February 8, 2014 - February 11, 2015. ***Sources:*** *Landsat 8 > OLI, Terra > MODIS*

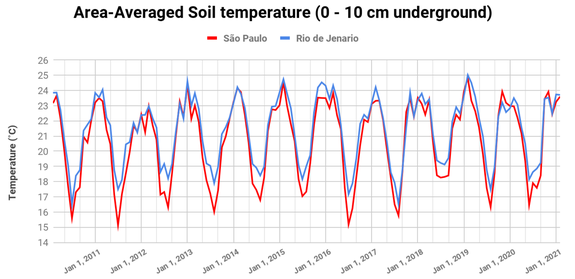


Figure #2: Soil Temperature in Sao Paulo and Rio de Janeiro.
Temperatures for Rio de Janeiro and São Paulo show a slight upward trend and plateau around 2014.

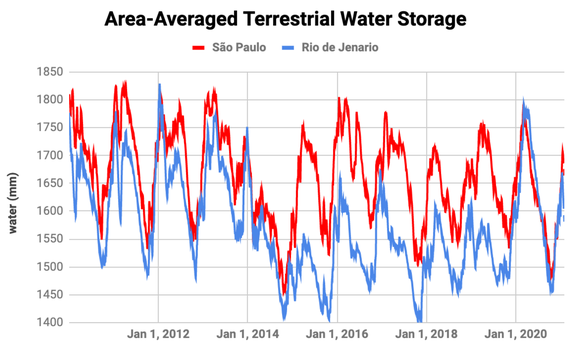


Figure #3: Land water storage in Sao Paulo and Rio de Janeiro.
In 2014 and 2015, both Rio de Janeiro and São Paulo, the overall amount dof water decreased so much that a "peak" in the cycle was lower than the lowest point in the previous cycle.

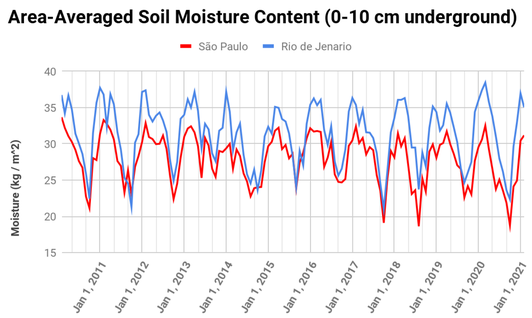


Figure #4: Soil moisture content in Sao Paulo and Rio de Janeiro.
The soil moisture in both cities remains relatively steady, only dipping slightly due to the drought around 2014 and 2015.

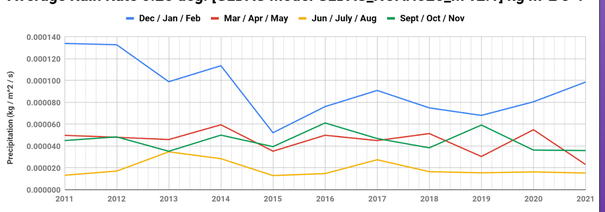


Figure #5: Rate of precipitation in Sao Paulo by season
A significant decrease in precipitation for all four seasons from 2014 to 2015.

Results & Discussion

- All of my data had a cyclical "wave" motion when put on a graph. This was because all of the data was taken monthly, and the cycle of seasons affects that data.
- However, there are still noticeable correlations over the years. The rate of precipitation and the land water storage amount both decreased from 2014 to 2015, while the temperature increased ever so slightly and the soil moisture was not affected much.
- The lack of rainfall and the decrease in land water suggests that whatever water was already there would have become stagnant, while the constant soil moisture means constant shade from vegetation, and the increased temperature means a faster incubation rate.

Conclusions

- Environmental conditions such as Precipitation, soil temperature, soil moisture content and land water storage that existed during the 2015.
- Dengue outbreak in Southeast Brazil were retrieved from the Giovanni database.
- During the 2015 outbreak, southeast Brazil was facing serious drought conditions which caused lakes and reservoirs to be depleted and stagnant.
- Due to the water scarcity, the population of São Paulo and Rio de Janeiro were storing water in containers. Long term water storage can provide a breeding ground for mosquitoes.
- Although the region was facing a drought, the vegetation was still dense because the vegetation uses in-ground moisture and not above ground water. Dense vegetation provides excellent habitat for mosquitoes.
- The soil temperature during the earlier part of the year was optimum for the breeding and incubation of the DEN2 virus which was the sero type that caused the 2015 outbreak
- In conclusion, the environmental conditions that could lead to a vector borne illness can be studied using Earth Observing Satellites and proper procedures to mitigate another such outbreak can be taken in a timely manner.

Bibliography

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