**NASA DEVELOP National Program**

****Ames Research Center

**Fall 2015**

**Short Title: Puerto Rico Health and Air Quality**

**Subtitle:** Utilizing NASA Satellite Imagery to Analyze the Effects of Climate Variability on Dengue Cases in Puerto Rico

**VPS Title:** Dengue Bites

**Project Team & Partners**

**Project Team:**

Andrew Nguyen (Project Lead), Andrew.nguyen@nasa.gov

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**Advisors & Mentors:**

Dr. Juan Torres-Perez (Bay Area Environmental Research Institute)

**Past or Other Contributors:**

N/A

**Partner Organizations:**

Medical Sciences Campus of the University of Puerto Rico (End-User), POC: Dr. Pablo Mendez-Lazaro

U.S. Centers for Disease Control and Prevention (CDC) Dengue Branch (End-User), POC: Dr. Roberto Barrera

Puerto Rico Department of Health (End-user), POC: Jessica Cabrera

**Project Details**

**Applied Sciences National Applications Addressed:** Health and Air Quality

**Study Area:** San Juan, Puerto Rico

**Study Period:** 2007-2012

**Earth Observations & Parameters:**

Terra, MODIS - Sea surface temperature, land surface temperature, Evapotranspiration

TRMM, PR – Rainfall measurements

**Ancillary Datasets Utilized:**

* USGS National Land Cover Dataset (NLCD) - land cover
* National Climatic Data Center- Weather Station Data
* Caribbean Coastal Ocean Observing System (CariCOOS)- Sea Temperature Buoy Data
* Dengue fever cases in Puerto Rico - Dengue Branch of the Centers for Disease Control and Prevention (CDC) and the Puerto Rico Department of Public Health (PRDH) Passive Dengue Surveillance System (PDSS)
* Dengue fever cases in San Juan-*In-situ* datasets provided by Dr. Pablo Mendez-Lazaro
* Downscaled soil moisture, ambient temperature, runoff, rainfall, humidity, soil saturation, and wind speed – University of Puerto Rico-Hydroclimate Data Download Center

**Models Utilized:**

* Clark Labs’ TerrSet- Habitat and Biodiversity Modeler

**Software Utilized:**

TerrSet – Modelling

ArcGIS - raster manipulation/analysis, model builder, image enhancement & map creation of Aqua/Terra MODIS

**Project Overview**

**80-100 Word Objectives Overview:**

To assess the effects of environmental variables related to the presence of the dengue virus in Puerto Rico and San Juan. Additionally, to derive and statistically evaluate these variables to produce a Vulnerability Index Method with the goal of complementing early warning systems for dengue and vector-based diseases in Puerto Rico.

**Abstract:**

Dengue fever is the fastest-growing vector-borne disease in the world and has been declared endemic in the Caribbean and Puerto Rico. The dengue virus pathogen is transmitted by tropical mosquitoes and can lead to fever, hemorrhagic fever, shock, and death in severe cases, posing a major threat to the health of Caribbean communities. A high occurrence of the primary vector of the dengue virus *(Aedes aegypti*.) has been detected in the city of San Juan, contributing to several dengue outbreaks, including instances in 2007 and 2010. This study examines the climatic and environmental conditions contributing to low, increasing, peak, and decreasing seasonal Reported Dengue Cases (RDCs) from 2007-2012 using monthly NASA Terra Moderate Resolution Imaging Spectroradiometer (MODIS) 1 X 1km resolution evapotranspiration (ET), land surface temperature (LST) products, along with Climate Hazards Group InfraRed Precipitation (CHIRP) rainfall (TP) data. These data were incorporated into a maximum entropy species distribution model to spatially delineate potential dengue risk and output the statistical contribution of variables based on reported cases in San Juan. Additionally, the statically significance results were seasonally compared to the number of RDCs from 2007 to 2020. Lastly, MODIS 1 X 1km sea surface temperature (SST) products were correlated to reported dengue cases to better understand the relation between oceanic conditions and mosquito transmission behavior. Results indicate a moderate significance of LST and TP and low to moderate significance of ET regarding reported dengue cases in San Juan. These results will assist Puerto Rico disease control agencies with decision making processes regarding prevention and mitigation policies.

**Community Concerns:**

* The dengue virus is the fastest-growing vector-borne pathogen in the world and has been declared endemic in the Caribbean and Puerto Rico.
* Several dengue outbreaks have recently been recorded in San Juan, Puerto Rico, including instances in 1994, 1998, 2007, and 2010.
* Due to elevating sea levels, the San Juan Bay estuary boundaries are shifting toward the coast of Puerto Rico; this suggests that there is a higher chance of the dengue virus affecting the island, as there is a strong correlation between mean sea level, dengue, and mosquito vector populations.
* There is a moderate correlation between Sea Surface Temperature (SST) and an increase in the dengue transmission as salinity-tolerant mosquitoes become more abundant in the coastal zones of other tropical countries.

**Current Management Practices & Policies**:

Currently, the various entities involved in this project use quantitative research on vector-borne diseases and outbreaks such as dengue to inform public policy on vector control measures that can be taken to prevent the spread of such illnesses. The Department of Health provides citizen services, public announcements, and conducts health assessments pertaining to dengue awareness on the island. The Dengue Branch of the CDC employs public health practices such as education of household spread of dengue, surveillance systems of dengue-infected hospitals, and diagnostic testing. They also conduct molecular research and field investigations regarding dengue contraction and control.

**Decision Support Tools & Benefits:**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Vulnerability Index Method (VIM) | Terra, MODIS  TRMM, PR | Show where dengue is most suitable in Puerto Rico and San Juan according to environmental factors for potential early detection of dengue. The VIM also includes the next two products. This will assist the Department of Public Health and CDC Dengue Branch in assessing which communities may require the most disease prevention resources and training. |
| Time Series of Past Outbreaks for 2007-2012 | Terra, MODIS  TRMM, PR | Show where dengue outbreaks have occurred in Puerto Rico outside of reported cases through a maximum entropy suitability model. This provides historical context to the dengue outbreak and will allow the Department of Public Health and CDC to analyze whether these regions should continue to be of greater concern. |
| Statistical Results from the Indices | Terra, MODIS  TRMM, PR | Provide a better understanding of the significance each environmental variable contributes to dengue. This will assist the Department of Public Health and CDC in prescribing varying preventative health measures to Puerto Ricans based on ecological residency. |
| Vulnerability Index Method (VIM)Tutorial | Terra, MODIS  TRMM, PR | Allows end users the ability to recreate results using NASA EOS and for future research opportunities. |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)