**NASA DEVELOP National Program**

****NASA Ames Research Center

**Fall 2015**

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

**Subtitle:** A Geospatial Assessment of Environmental Variability in Puerto Rico and its relation to Confirmed Dengue Fever Cases

**VPS Title:** Dengue Bites: Predicting Dengue Risk in Puerto Rico

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

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

**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 & Air Quality

**Study Area:** Puerto Rico

**Study Period:** January 2009- December 2013

**Earth Observations & Parameters:**

Terra, MODIS - Sea surface temperature (SST), land surface temperature (LST), evapotranspiration (ET)

TRMM, PR – Total Precipitation (TP) from the Climate Hazards Group InfraRed Precipitation and Satellite (CHIRPS) model

**Ancillary Datasets Utilized:**

* USGS National Land Cover Dataset (NLCD) - land cover
* USGS- Digital Elevation Model (DEM)
* NOAA National Climatic Data Center (NCDC) - weather station data
* Caribbean Coastal Ocean Observing System (CariCOOS) - Sea temperature buoy data
* 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) – Confirmed Dengue Fever Cases (CDFC)
* University of Puerto Rico Hydroclimate Data Download Center - Downscaled soil moisture, ambient temperature, runoff, rainfall, humidity, soil saturation, and wind speed

**Models Utilized:**

* Clark Labs’ TerrSet - Habitat and Biodiversity Modeler

**Software Utilized:**

TerrSet – Modeling

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. Additionally, to derive and statistically evaluate these variables to produce a Vulnerability Index Method (VIM) with the goal of complementing early warning systems for dengue and vector-based diseases in Puerto Rico.

**Abstract:**

The dengue virus is the fastest-growing vector-borne disease in the world and has been declared endemic in the Caribbean and Puerto Rico. This deleterious illness is transmitted by tropical mosquitoes and can lead to 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 2010, 2012, and 2013. This study examined the climatic and environmental conditions contributing to Confirmed Dengue Fever Cases (CDFC) from January 2009- December 2013 using monthly NASA Terra/ Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) 1km resolution evapotranspiration (ET), land surface temperature (LST) products, 0.5° Climate Hazards Group InfraRed Precipitation and Satellite (CHIRPS) total precipitation (TP) modeled data, elevation, and land cover. 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 Puerto Rico in monthly timesteps. Additionally, the statistical significance variables were seasonally compared to CDFC from 2009-2013. Lastly, MODIS 4km sea surface temperature (SST) products were separately correlated, using Time Series Frequency Analysis,  to all inputted model variables  to better understand the relation between oceanic conditions and land conditions contributing to dengue. Results indicate a moderate significance of LST and TP (p = ?) and low to moderate significance of ET (p =?) regarding confirmed dengue cases in Puerto Rico. SST and CDFC correlation coefficients resulted in 0.41 R value, indicating a moderate relationship.

**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 on causes for the 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, MODISTRMM, PR | Show dengue risk is in Puerto Rico according to environmental factors for potential early detection of dengue. 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, MODISTRMM, PR | Show where dengue outbreaks have probably 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 be of greater concern. |
| Vulnerability Index Method (VIM) Tutorial | Terra, MODISTRMM, PR | Allows end-users the ability to recreate results using NASA Earth observations 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)

**Software Release Requirements**

None