**NASA DEVELOP National Program**

****Marshall Space Flight Center

**Spring 2015**

**Southwest Health and Climate**

*Monitoring the Effects of Climate Change to Peromyscus maniculatus’ Habitat in Order to Better Predict Areas for Sin Nombre Virus*

**Project Team:**

Daryl Ann Winstead (Project Lead), daw0005@uah.edu

Megan Carter

Padraic Conner

**Advisors & Mentors:**

Dr. Jeff Luvall (NASA at NASA Space Science and Technology Center)

**Partner Organizations**

Montana Tech of the University of Montana, Collaborator/End-User, POC: Dr. Amy Kuenzi

Rocky Mountain National Lab (NIAD), Collaborator, POC: Dr. David Safronetz

**Applied Sciences National Applications Addressed:**

Health and Air Quality, Climate

**Study Area:** Southwestern and Midwestern states, United States: Arizona, Colorado, New Mexico, Montana, and Utah

**Study Period:** Spring Season, March 1993 – June 2013

**Earth Observations & Parameters**

TRMM, Precipitation Radar (PR) – Rainfall

Terra, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) – Digital Elevation Model (DEM)

Suomi NPP, Visible Infrared Imaging Radiometer Suite (VIIRS) Environmental Data Records (EDRs) – Land Surface Temperature and Vegetation Index

Landsat 8, Operational Land Imager (OLI) – Land Cover

Landsat 7, Enhanced Thematic Mapper Plus (ETM+) – Land Cover

Landsat 5, Thematic Mapper (TM) – Land Cover

Landsat 4, Thematic Mapper (TM) – Land Cover

**80 to 100 Word Objectives Overview**

The objective of this project was to create a map of habitats suitable for deer mouse (*Peromyscus maniculatus*) populations in the Southwestern and Midwestern United States. The deer mouse is the primary vector of the Sin Nombre Virus (SNV), which has been responsible for numerous deaths in the United States, primarily in the Southwest and Midwest regions. This was then combined with vector range, population, and demographic data to create a map showing likely areas of human infection by SNV.

**Abstract**

The deer mouse (*Peromyscus maniculatus*) is a broadly-distributed species which inhabits the majority of the United States. Deer mice are the primary reservoir of Sin Nombre Virus (SNV), a zoonosis in the Hantavirus genus. Humans contract the virus after being in contact with deer mouse saliva and excrement. Since the initial outbreak, SNV has been fatal to many young, healthy individuals rather than affecting young children and elderly individuals like other types of viruses. Utilizing the NASA Earth observations has helped to understand the suitable habitat for the deer mouse, which in turn helped identify more precisely where SNV infections may arise. Supervised land cover classifications during the spring season in 1993, 2003, and 2013 were developed using Landsat 8 Operational Land Imager (OLI), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 5 and 4 Thematic Mapper (TM). Using a Digital Elevation Model (DEM) from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensor onboard Terra, variables such as elevation were examined to determine the suitable habitat for the deer mouse. Environmental Data Records (EDRs) for land surface temperature and vegetation indices were used from the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard Suomi NPP. Variability of precipitation over the study period from the Tropical Rainfall Measuring Mission (TRMM) was used to examine net primary production (NPP). These variables were then used in the Princeton Maximum Entropy Model (MaxEnt) to create the habitat suitability map of the deer mouse. The suitable habitat was then used alongside ancillary income and population data in order to better predict areas of SNV infection. These products will benefit end-users by providing more precise locations to research for the SNV in deer mouse populations as well as future areas of concern as the climate changes.

**Community Concerns**

* Sin Nombre Virus (SNV) is contracted by individuals coming into contact with an infected deer mouse’s (*Peromyscus maniculatus)* excrements or saliva. There currently is no cure and the mortality rate is 38-50% (CDC).
* Since the initial outbreak in 1993, there have been 639 reported cases of SNV in 34 states, with the Southwest and Midwest United States being more prominent.
* Fluctuations in temperature and precipitation promote deer mice aggression and activity which results in higher spread rates of SNV among deer mice and potentially humans.
* Current monitoring practices using field surveys can potentially expose researchers to SNV.
* Due to the rapid onset and progression of SNV, as well as the similarity to flu symptoms, correct diagnosis of SNV is a concern.
* Due to the difficult nature of modeling future population trends in mammals, monitoring the spread of SNV is a concern.

**Current Management Practices & Policies**

Currently, researchers must primarily use field research techniques, such as trapping, in order to monitor the number of infected and uninfected deer mice (*Peromyscus maniculatus*) near areas of confirmed human outbreaks. This is not only costly and time consuming, but also potentially exposes researchers to Sin Nombre Virus. By using satellite-derived parameters that are suitable for infected deer mice populations, a probable risk map of Sin Nombre virus will be generated. This map will narrow down the area of concern which is beneficial to the end-user. The end-user can also use this map for monitoring future areas of concern.

**Decision Support Tools**

* Deer Mouse Habitat Suitability Map – maps showing suitable areas of habitat for *Peromyscus maniculatus*
* Sin Nombre Virus Probability Map – map predicting areas of concern for Sin Nombre Virus

**Benefit to End-User:**

* Elucidation of areas where human populations face greater susceptibility to potential infection
* Allow prioritization of resources towards areas most likely to be affected by SNV
* Clarification of environmental conditions conducive to SNV in populations of deer mice at a regional scale will enable the creation of models that can predict potential outbreaks of SNV, serving as an early warning system so as to allow physicians to be on the lookout for symptoms of HPS

**Models Utilized**

* Princeton University, Maximum Entropy Distribution Model (Maxent)
* Fuzzy Logic Model in ArcGIS

**Ancillary Datasets Utilized**

* NASA’s Socioeconomic Data and Applications Center (SEDAC) – Population data
* United States Census Bureau – Income data

**Software Utilized**

ArcGIS 10.2.1 - Raster Manipulation/Analysis, data processing of ASTER DEM and Landsat data, land cover classification of Landsat imagery, and map creation

ENVI 5.0 - Data processing of VIIRS and PR/DPR data