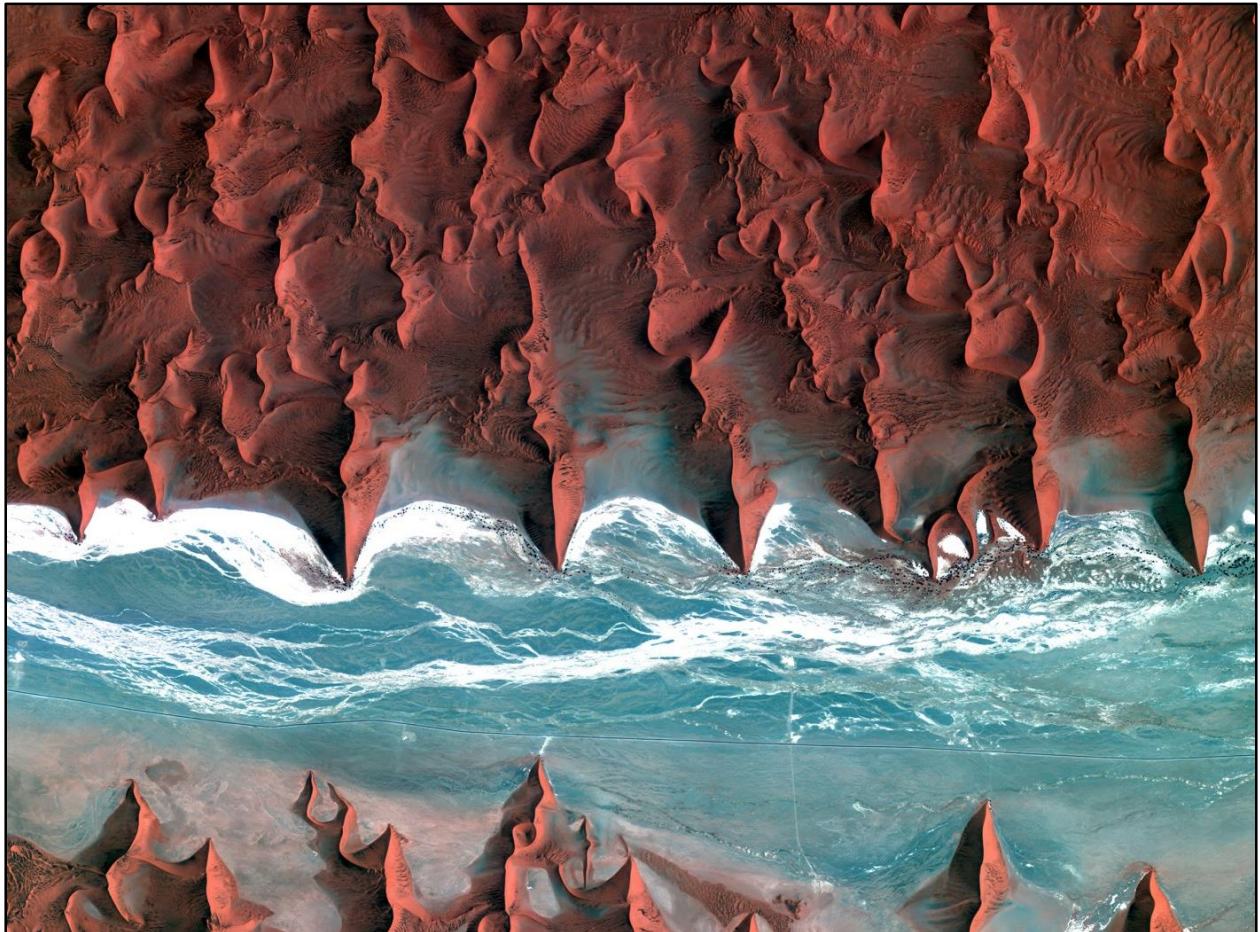# DEVELOP National Program
Health & Air Quality Project Proposals
Spring 2015

Proposals Snapshot

1. Southwest Health and Climate: Assessing the Spread of Sin Nombre Virus Vector-Borne Disease Using NASA Earth Observations in the Southwestern and Midwestern United States (MSFC)

The objective of this project is to assess the potential spread of the Hantavirus strain, Sin Nombre throughout the Southwest and Midwest United States as the habitat for the deer mouse evolves with climate change. This will be accomplished by first determining the habitat locations of the deer mouse, Peromyscus maniculatus, and then determining how climate change affects the mouse's habitat and, thus, the spread of Sin Nombre.

Partners Overview

Federal Partners
- Centers for Disease Control and Prevention (Partner)
- Rocky Mountain National Lab (Partner/End-User)

Project Proposals

1. Southwest Health and Air Quality & Climate (MSFC)

Assessing the Spread of Sin Nombre Virus Vector-Borne Disease Using NASA Earth Observations in the Southwestern and Midwestern United States

Objective:
The objective of this project is to assess the potential spread of the Hantavirus strain, Sin Nombre throughout the Southwest and Midwest United States as the habitat for the deer mouse evolves with climate change. This will be accomplished by first determining the habitat locations of the deer mouse, *Peromyscus maniculatus*, and then determining how climate change affects the mouse's habitat and, thus, the spread of Sin Nombre.

Community Concern:
Sin Nombre causes Hantavirus Pulmonary Syndrome, HPS, which is spread when individuals come into contact with the urine, droppings, and saliva of the deer mouse (*Peromyscus maniculatus*). It is the most common strain of Hantavirus in the United States. With no cure and symptoms resembling the flu, HPS has a mortality rate of 38-50% (CDC). Since the initial outbreak in May 1993, there have been 639 reported cases of HPS in 34 states. The largest concern for this disease is people coming into contact with contaminated areas. Activities such as cleaning, opening with mice populations, and utilizing trail shelters during hiking or camping increases the risk of contracting the virus even when neither the rodent nor their droppings are seen. Changing temperatures may allow increased mouse activity during winter months, increasing the likelihood of human-vector contact.

End-Users/Partners/Boundary Organizations:
Centers for Disease Control and Prevention (CDC) (Partner, POC: Name, Position/Title)
Rocky Mountain National Lab (NIAID) (Partner/End-User, POC: Dr. David Safronetz, Disease
        Modeling and Transition Section)

Lines of communication have opened with CDC and NIAID and future discussions will further refine project objectives and strategy for end-user engagement during the project.

Decision Making Process:
Currently, research is being done on the virus to create a vaccine or treatment. Organizations such as the Centers for Disease Control and Prevention (CDC) issue information regarding the disease on their webpage. They offer preventative measures for keeping rodents out of the home and recommend proper cleaning up mouse urine, droppings, and nests. Currently, remote sensing is not being utilized to monitor the spread of the deer mouse and evaluate conditions conducive to Sin Nombre.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat 4, 5, 7, 8	TM, ETM+, OLI	Land Cover
Terra	ASTER	Digital Elevation Model
Suomi NPP	VIIRS	Land Surface Temperature, Vegetation Index
TRMM/GPM	PR/DPR	Precipitation

NASA Earth Observations to be Highlighted:
Landsat 4 Thematic Mapper (TM), Landsat 5 TM, Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI) data will provide scenes of the study area and will be used to create land cover classifications that will identify potential deer mouse habitats. The Landsat data will also help determine other land cover characteristics as well. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensor onboard Terra will provide information regarding the currently favored elevation range of the deer mice infected with the Sin Nombre virus and how that may alter with climate change. The Visible Infrared Imaging Radiometer Suite (VIIRS) onboard Suomi NPP will provide data on land surface temperature and vegetation index which will determine what types of vegetation are in the study area as well as provide information to assess changes in land surface temperature as the climate changes. Finally, the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) and Global Precipitation Measurement (GPM) Microwave Imager (GMI) will provide data on the changes of the amount of precipitation that the study area receives during the study period.

Ancillary Datasets:
- Income data, United States Census Bureau (to determine the locations of poverty and low income)
- Population data - NASA's Socioeconomic Data and Applications Center (SEDAC), proximity to fields or ideal habitat of the deer mouse
- Climate projection - National Center for Atmospheric Research (NCAR)

Models:
Princeton University, Maximum Entropy Distribution Model (Maxent)

Decision Support & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Suitable Deer Mouse Habitat Map	Identify where the deer mouse resides and the most suitable habitat locations	Aerial imagery and field surveys
Sin Nombre Probability Map	To increase knowledge on where Sin Nombre cases are likely to occur	Currently, they have a map of where the cases have occurred

Suitable Deer Mouse Habitat Map – This map will highlight the current suitable habitat for the deer mouse to determine its coverage, including elevation. The map will include the mouse's preference for urban verses rural areas as well as grasslands verses forested areas.

Sin Nombre Probability Map – This map will identify conditions in which the virus flourishes which will determine where cases are currently likely to occur. The map will be created using the information obtained from the previous map using weighted values.

Project Details:
National Application Areas Addressed: Health and Air Quality, Climate
Source of Project Idea: This project idea came from a participant's interest in epidemiology. There were also reported cases of Hantavirus in September 2012 in Yosemite that had an impact on visitors there.

Advisor: Dr. Jeff Luvall (NASA at NSSTC)
# of Participants Requested: 3-4
Project Timeline: 2 Terms: Spring 2015 to Summer 2015

Study Location: Southwestern and Midwestern states, United States: Arizona, Colorado, Kansas, New Mexico, Oklahoma, Texas, and Utah
Period being Studied: 1993-2030

Previous Related DEVELOP Work:
- Dengue Fever in Mexico: Public Health Concerns Regarding Dengue Fever in Mexican States - Fall 2011 (DEVELOP Wise)
- Bangladesh Health and Water: Connecting Environmental Observations with Cholera Outbreaks in Bangladesh - Summer 2011 (DEVELOP Goddard)
- Vector Borne Disease: Risk Mapping in Mobile County, Alabama - Spring 2011 (DEVELOP Mobile)
- Ethiopia Health: Utilizing NASA Earth Observations to compare malaria incidences with temperature, precipitation, and vegetation, as well as altitude to better understand the dynamics of malaria parasite species in Oromia, Ethiopia - Spring 2013 (DEVELOP IRI)

Multi-Term Objectives:
- **Term 1 (Proposed Term)** – The goal of this term is to determine the current habitat of the deer mouse within the south and mid-western states. A map of suitable deer mouse habitat will be created. From this map, the Sin Nombre probability map will be created showing who is currently at risk of infection. Additionally, data regarding population and income will be utilized as ancillary datasets. The population data will identify locations where people and mice coexist. The income data can help identify who may be at a higher risk of rodent contact due to living in run-down buildings and proximity to rodent territory.
- **Term 2** – The goal of this term will be to develop a model or tool to forecast how future climate change will impact the range of the deer mouse and lend to more favorable conditions for Sin Nombre to flourish. Using climate change analysis techniques to monitor changes in land surface temperature and precipitation amounts, and create urban growth maps showing the forecasted impact and likelihood of impact. This term will finalize the project and hand-off a tool to end-users which they can utilize for policy and decision making.

Notes: The Deer Mouse's habitat usually consists of wooded or brush areas; however, the Deer Mouse occupies nearly every type of habitat.

Methodology and statistics can be found in the following article:
Bagamian, Karoun H., Richard J. Douglass, Arlene Alvarado, Amy J. Kuenzi, Brian R. Amman, Lance A. Waller, and James N. Mills. "Population Density and Seasonality Effects on Sin Nombre Virus Transmission in North American Deermice (Peromyscus Maniculatus) in Outdoor Enclosures." Ed. Frederick R. Adler. PLoS ONE 7.6 (2012): E37254. Web.
Loehman, Rachel A., Joran Elias, Richard J. Douglass, Amy J. Kuenzi, James N. Mills, and Kent Wagoner. "Prediction Of Peromyscus Maniculatus (Deer Mouse) Population Dynamics In Montana, Usa, Using Satellite-Driven Vegetation Productivity And Weather Data." Journal of Wildlife Diseases 48.2 (2012): 348-60. Web.
Luis, Angela D., Richard J. Douglass, James N. Mills, and Ottar N. Bjørnstad. "The Effect of Seasonality, Density and Climate on the Population Dynamics of Montana Deer Mice, Important Reservoir Hosts for Sin Nombre Hantavirus." Journal of Animal Ecology 79.2 (2010): 462-70. Web.