Global Precipitation Measurement Mission

Case Studies developed for the GPM Disease Initiative

These case studies illustrate the many ways in which NASA Earth-observing data is being used to predict, respond to, and better understand vector-borne and water-related disease.

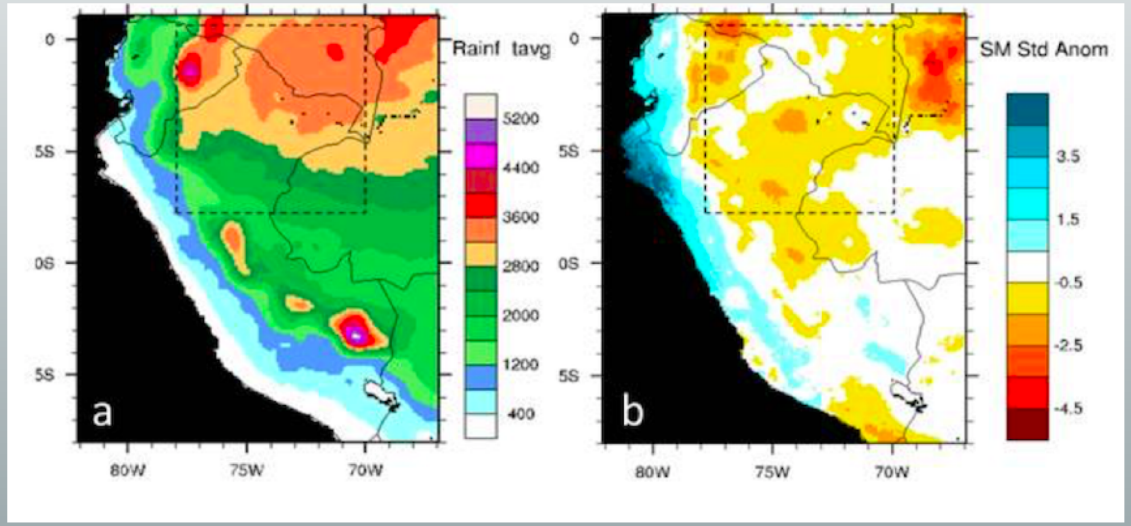
Using NASA Satellite Data to Predict Malaria Outbreaks

JOHNS HOPKINS UNIVERSITY

In the Amazon Rainforest, few animals are as dangerous to humans as mosquitos that transmit malaria. Predicting favorable conditions for mosquito breeding and survival relies on identifying areas with warm air temperatures and calm waters, such as ponds and puddles.

A map showing the rivers the Peruvian Amazon and surrounding areas.
Credits: NASA's Scientific Visualization Studio

To tackle this problem, a group of researchers are using a range of NASA satellites, including GPM, SMAP, Landsat, Terra and Aqua, to identify human and environmental events that typically precede an outbreak. With funding from NASA's Applied Sciences Program, they are working in partnership with the Peruvian government to develop a system that uses satellite and other data to help forecast outbreaks at the household level months in advance and prevent them from happening.

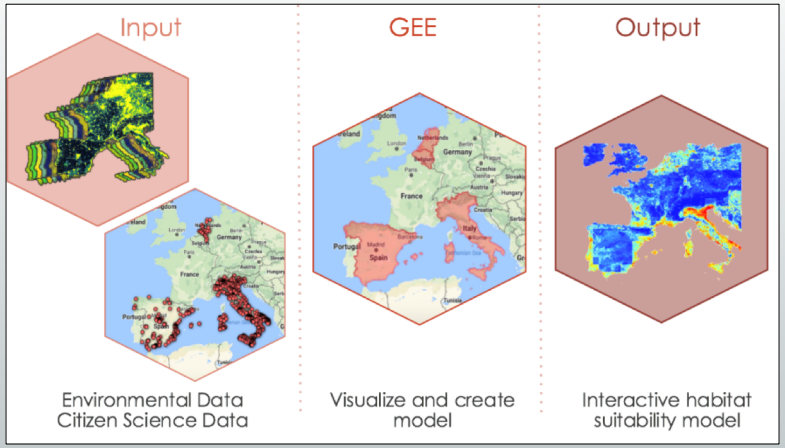


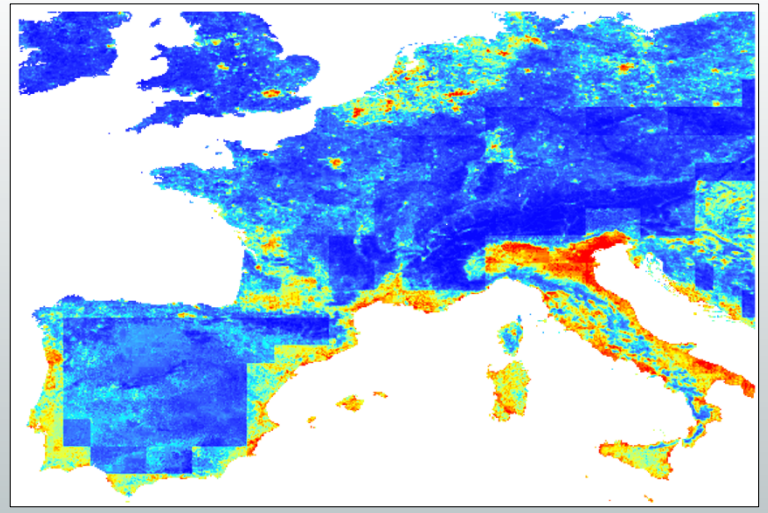
Long-term mean annual precipitation for Peru and Ecuador based on TMPA data (1998-2013) (left) and an example of a monthly standardized soil moisture anomaly for March 1998 (right). The dashed box shows the approximate location of the western Amazon focus region.

"We use TRMM/GPM to monitor rainfall conditions in data scarce regions of the western Amazon basin. The rainfall data drive a water balance model that is used to predict conditions favorable for mosquito breeding and survival, which in turn informs our malaria transmission risk estimates."
-Ben Zaitchik, John Hopkins University

Integrating NASA Earth Observations with Citizen Science Data

The NASA Develop program is working with multiple organizations to integrate NASA Earth observations with citizen science data from Western Europe to understand the location and timing of disease outbreaks and improve outbreak predictions.



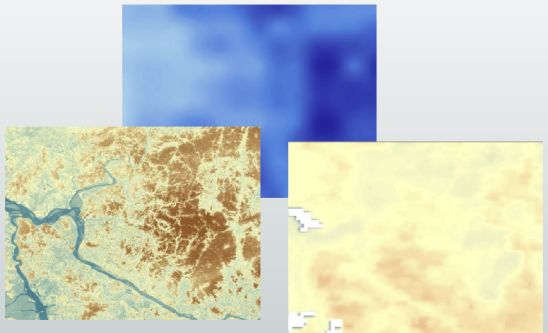


NASA and partners are working towards a shared, coordinated platform and protocol to leverage citizen science for the global surveillance and control of disease-carrying mosquitoes. Specifically, data from citizen science and environmental data from NASA Earth observations, including precipitation (from GPM IMERG), elevation, humidity, land cover, soil moisture, and land surface temperature will be used as parameters for a mosquito habitat suitability model and incorporated into a open-source interactive map. The tool will assist policy makers and public health officials in identifying environmental factors associated with mosquito outbreaks and deciding where to focus disease mitigation efforts.

Using NASA Derived Environmental Data to Predict Dengue Spread in Cambodia

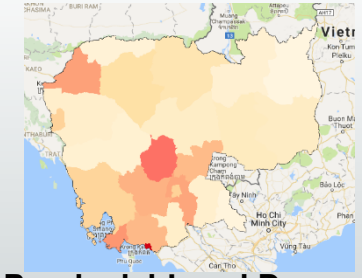
NASA satellite products have been incorporated into US Army Corps ERDC-GRL's "Vulnerability Assessment Software Tool: Spatial Analytics for Force Health and Readiness" (VAST-SAFHR), to predict the occurrence of dengue outbreaks in Cambodia.

CHIRPS Precipitation (5km)

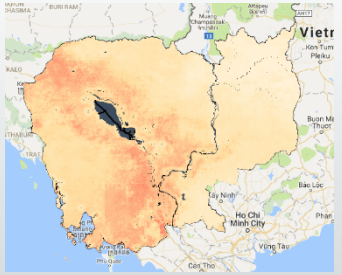


NDVI (30m) **LST (1km)**

Step 1: Combine NASA products into uniform pixel size

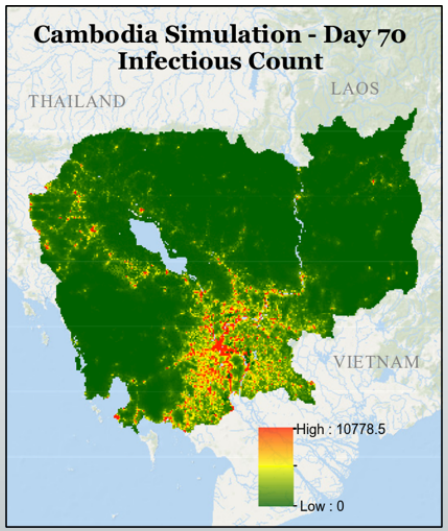


Provincial-Level Dengue Incident Rates*



Downscaled Pixel-Level Dengue Incident Rates

Step 2: Downscale Provincial-Level Disease Data

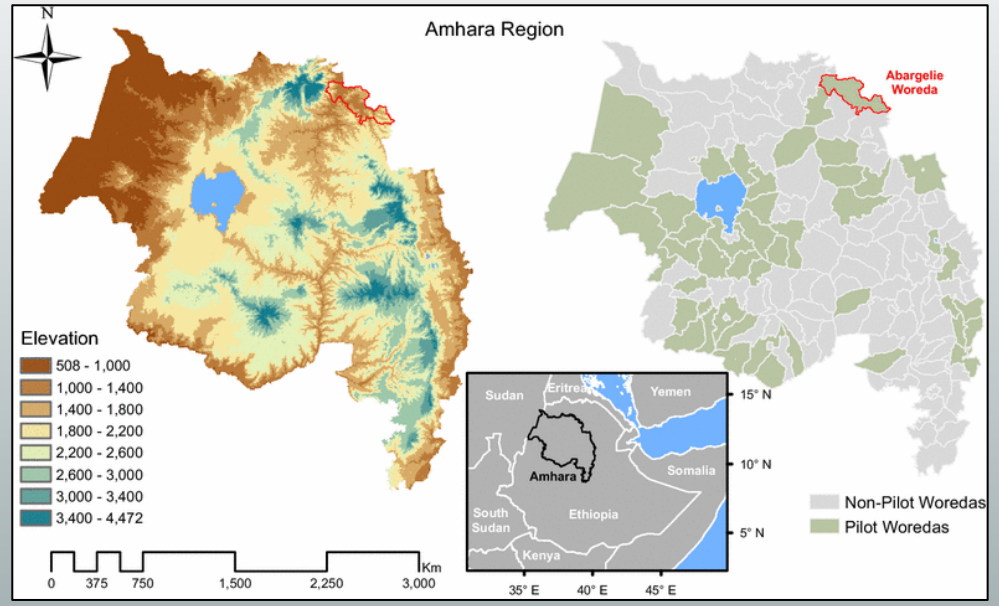


Step 3: Stochastic Simulation of Vector-Borne Disease

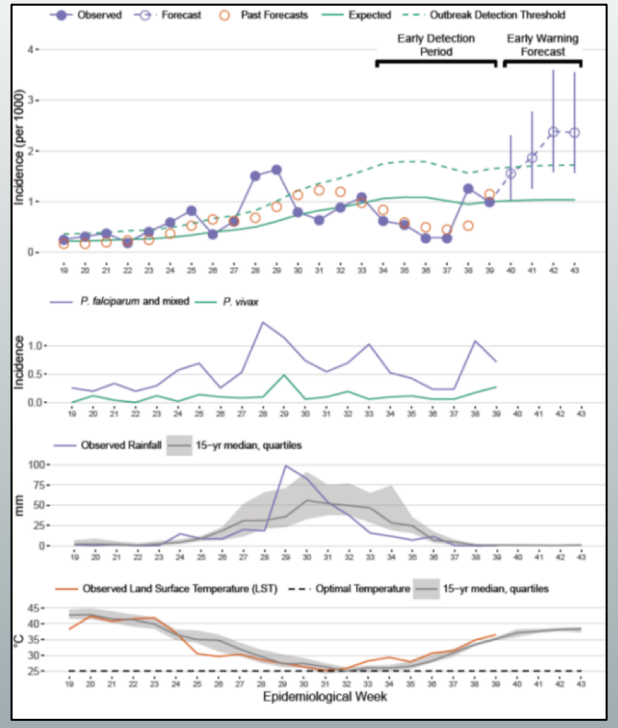
The purpose of VAST-SAFHR is to develop a computational framework to model, map and predict the spatial and temporal movement of dengue within Cambodia. The movement of dengue is highly dependent upon mosquitoes and their environment, which can be modeled with NASA derived products of Normalized Difference Vegetation Index (NDVI), land surface temperature (LST), and precipitation data using NASA sensors MODIS Terra and Aqua and TRMM/GPM. These environmental variables plus population density are used to calculate pixel level dengue incident rates which are then used to predict the occurrence of dengue outbreaks in Cambodia.

Malaria Early Warning in the Amhara Region of Ethiopia

A collaboration between South Dakota State University (SDSU) scientists and public health stakeholders are using NASA satellite data as input variables for a web-based malaria informatics system for epidemiological and environmental data acquisition and harmonization. Specifically, GPM precipitation, MODIS land surface temperature, and MODIS surface reflectance are used for environmental data sources to develop malaria forecasts in the Amhara Region of Ethiopia.



Study Area: The Amhara region of Ethiopia, including 47 pilot woredas (districts) that were select to encompass the most malaria-prone parts of the region.



Example malaria forecasts generated for Abargelie districts in October 2016

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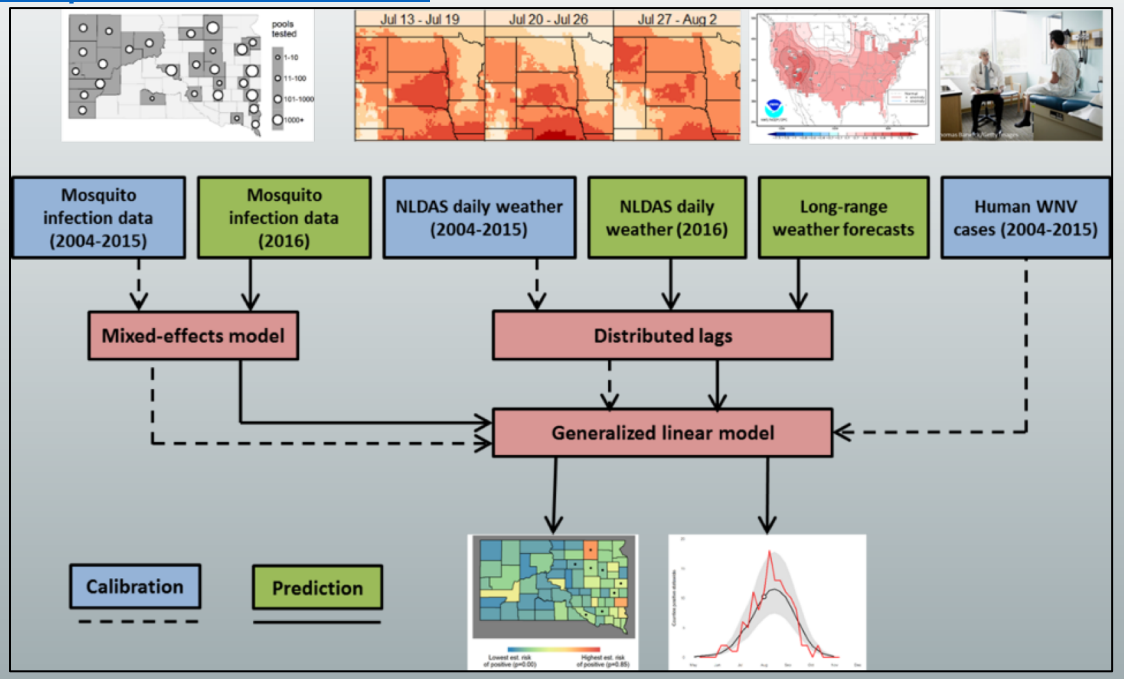
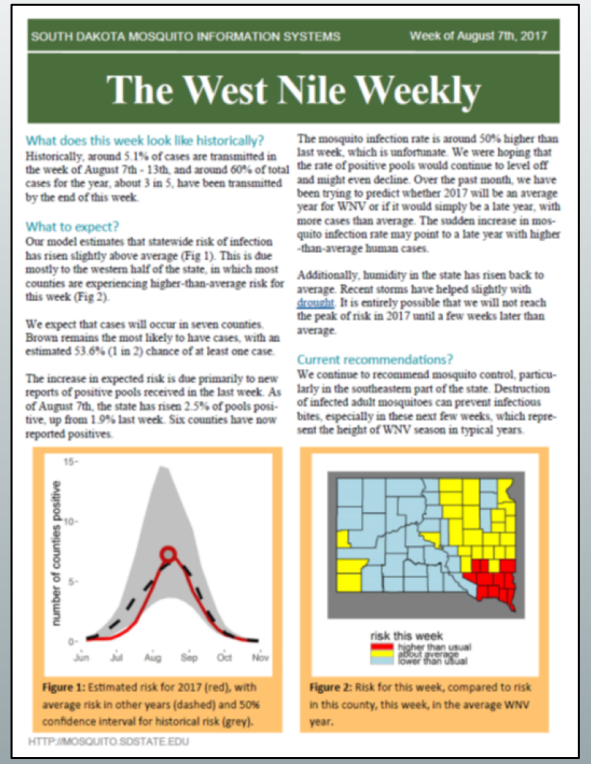
Supported by NIH-NIAID (R01AI079411, PI: Wimberly)/ See Merkord et al. (2017), Malaria Journal for more information

West Nile Virus Forecasting and Risk Mapping in the Northern Great Plains

South Dakota State University (SDSU) scientists are using a web-based informatics system to integrate mosquito surveillance data with environmental data to predict outbreaks of West Nile virus in the Northern Great Plains of the United States. West Nile virus risk forecasts are generated using models that incorporate precipitation (GPM), temperature, and humidity from the North American Land Data Assimilation System (NLDAS) with recent infection rates from mosquito surveillance. These forecasts are then disseminated as weekly reports on the project website at http://mosquito.sdstate.edu/.



Schematic of West Nile virus forecasting using the South Dakota Mosquito Information System (SDMIS) illustrating data flows for calibration and prediction.



SOUTH DAKOTA MOSQUITO INFORMATION SYSTEMS — Week of August 7th, 2017

The West Nile Weekly

What does this week look like historically?

Historically, around 5.1% of cases are transmitted in the week of August 7th - 13th, and around 60% of total cases for the year, about 3 in 5, have been transmitted by the end of this week.

What to expect?

Our model estimates that statewide risk of infection has risen slightly above average (Fig 1). This is due mostly to the western half of the state, in which most counties are experiencing higher-than-average risk for this week (Fig 2).

We expect that cases will occur in seven counties. Brown remains the most likely to have cases, with an estimated 53.6% (1 in 2) chance of at least one case.

The increase in expected risk is due primarily to new reports of positive pools received in the last week. As of August 7th, the state has risen 2.5% of pools positive, up from 1.9% last week. Six counties have now reported positives.

The mosquito infection rate is around 50% higher than last week, which is unfortunate. We were hoping that the rate of positive pools would continue to level off and might even decline. Over the past month, we have been trying to predict whether 2017 will be an average year for WNV or if it would simply be a late year, with more cases than average. The sudden increase in mosquito infection rate may point to a late year with higher-than-average human cases.

Additionally, humidity in the state has risen back to average. Recent storms have helped slightly with drought. It is entirely possible that we will not reach the peak of risk in 2017 until a few weeks later than average.

Current recommendations?

We continue to recommend mosquito control, particularly in the southeastern part of the state. Destruction of infected adult mosquitoes can prevent infectious bites, especially in these next few weeks, which represent the height of WNV season in typical years.

Figure 1: Estimated risk for 2017 (red), with average risk in other years (dashed) and 50% confidence interval for historical risk (grey).

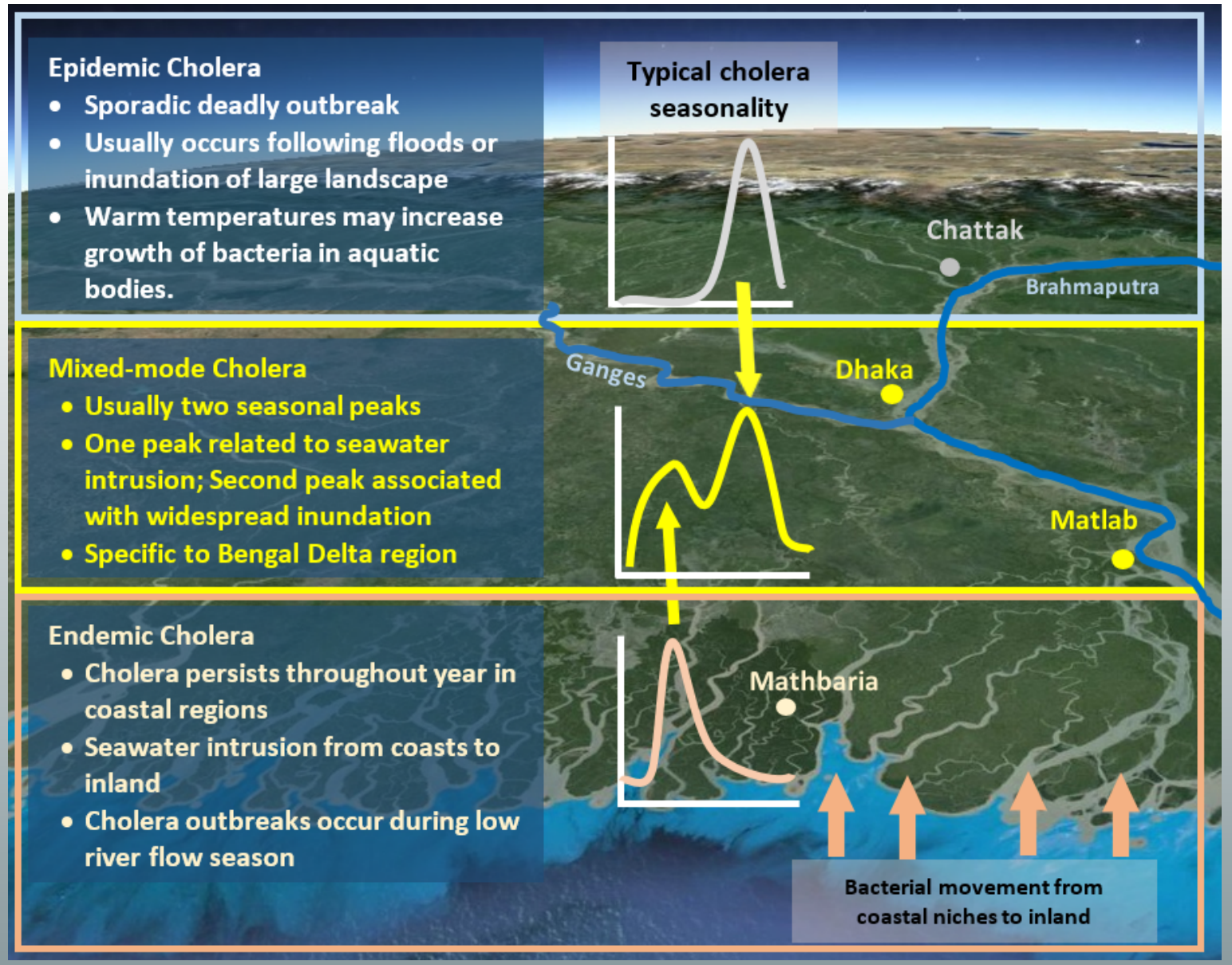
Figure 2: Risk for this week, compared to risk in this county, this week, in the average WNV year.

HTTP://MOSQUITO.SDSTATE.EDU

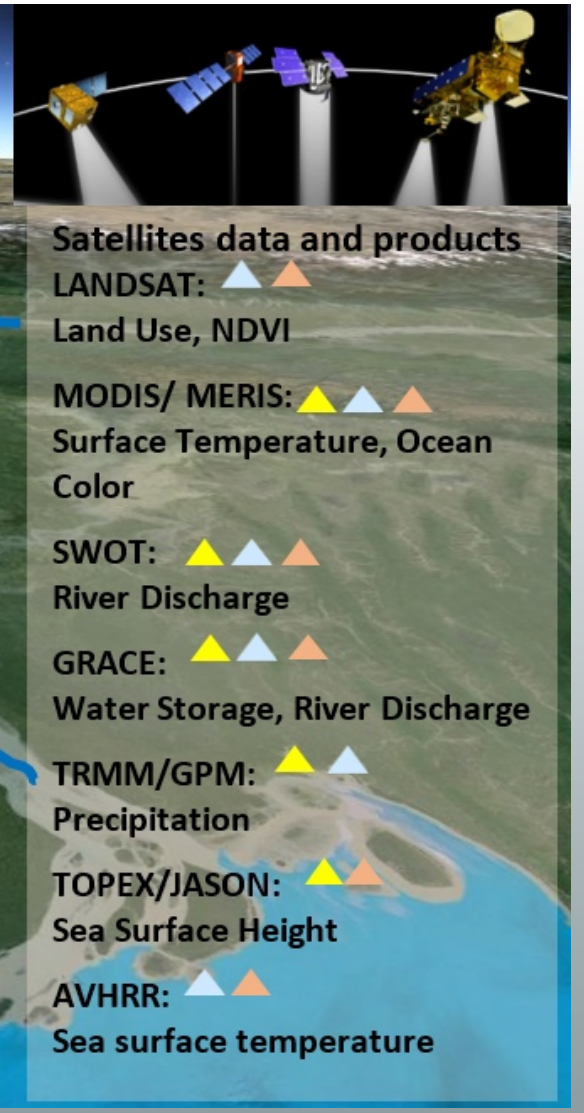
West Nile virus forecast report from August 2017.

Michael C. Wimberly (michael.wimberly@sdstate.edu), Geospatial Sciences Center of Excellence, South Dakota State University/
Supported by NASA (NNX15AF74G, PI: Wimberly)/ See Davis et al. (2017), PLOS Currents: Outbreaks for more information

Satellites Search for Cholera in the Bengal Delta

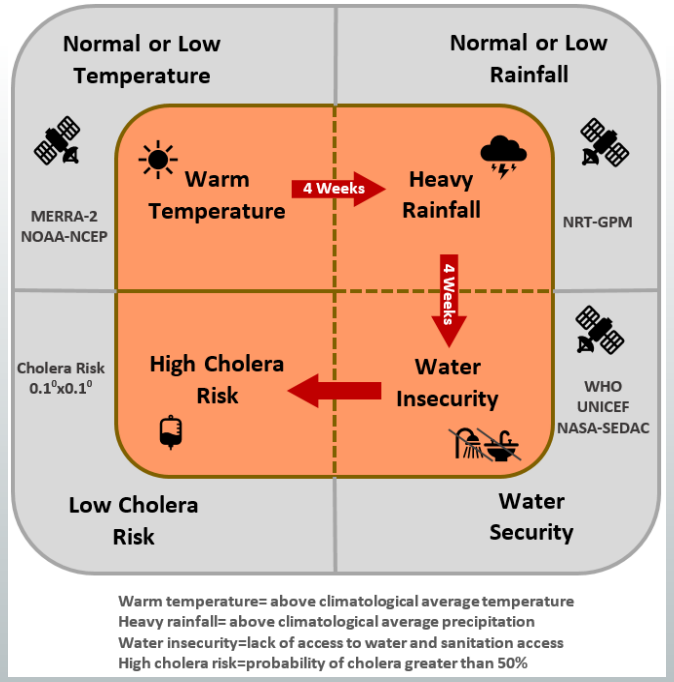


NASA Satellites and Products

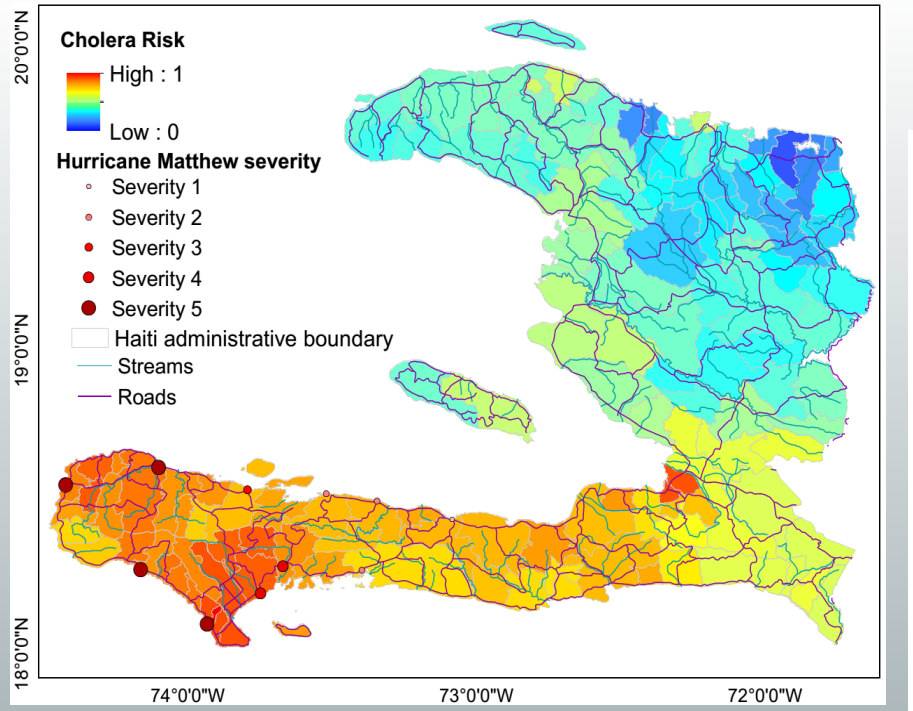


Predicting Cholera Using NASA Satellites

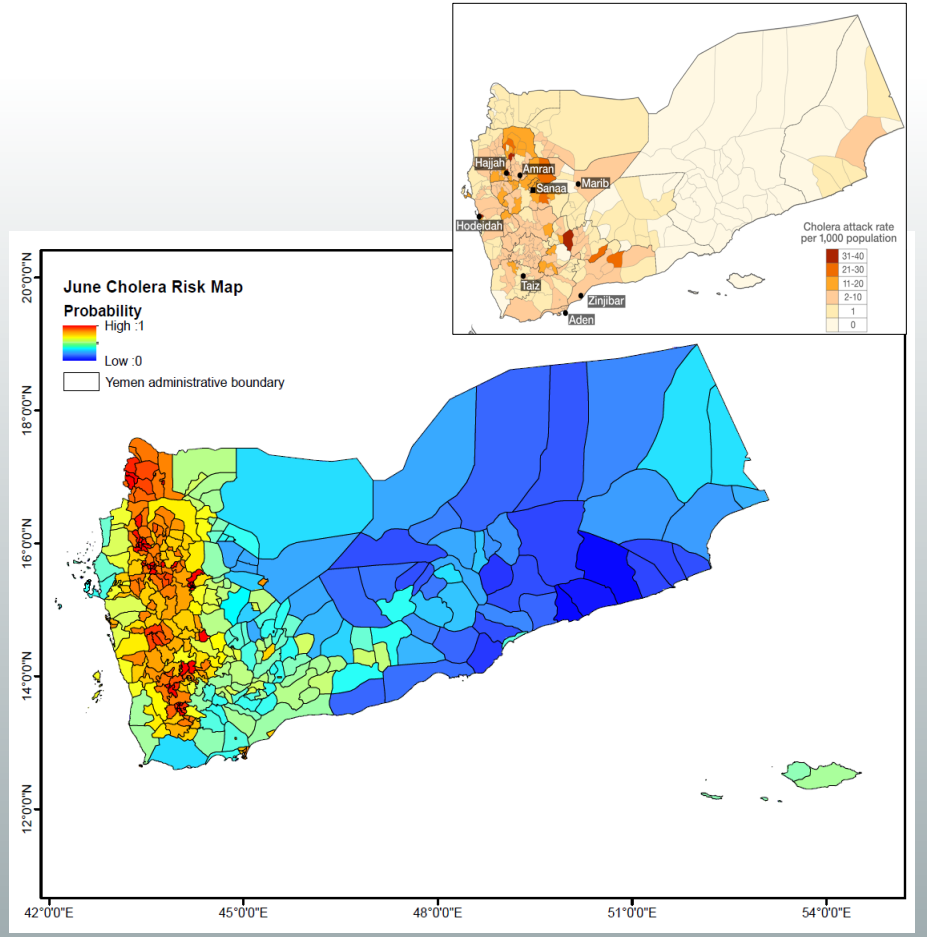
NASA satellites and other satellites are being used to predict potential locations where cholera outbreaks may occur.



Environmental indicators for cholera outbreak with NASA Satellites and Products used to forecast outbreaks



Prediction of October 2015 cholera depending on Hurricane Matthew severity



Real-time cholera prediction for Yemen

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