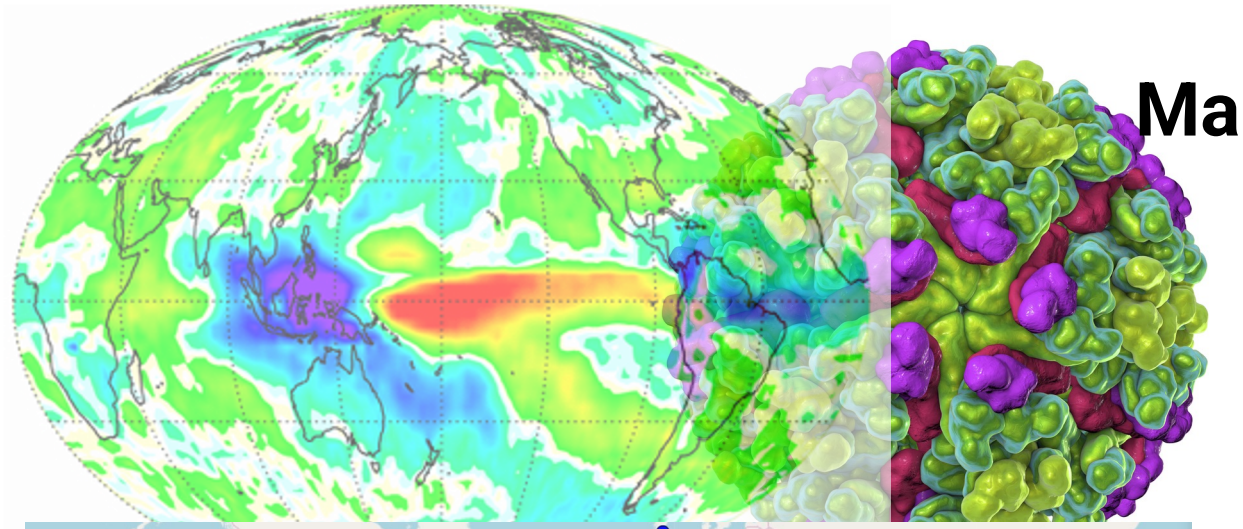
CHIKRisk
MAPPING, MONITORING AND FORECASTING CHIKUNGUNYA RISK



Mapping, Monitoring and Forecasting Climate-sensitive Diseases: Chikungunya

Assaf Anyamba*[1] Bhaskar Bishnoi[1] Heidi Tubbs[1] Jennifer Small[1] Richard Damoah[1] Wassila Thiaw[2] Ana Rivière Cinnamond[3] Kenneth J. Linthicum[4]

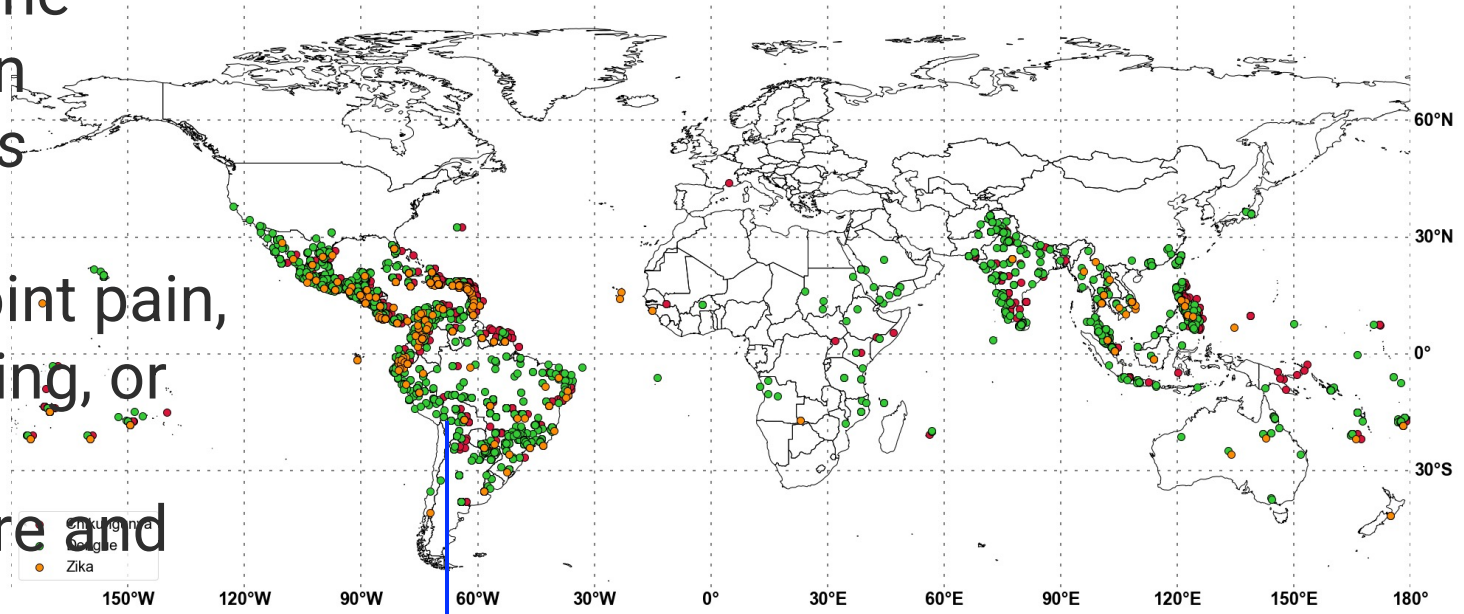
1 NASA Goddard Space Flight Center, Biospheric Sciences Laboratory, Greenbelt, United States, 2 NOAA Center for Weather and Climate Prediction, International Desks, College Park, United States, 3 Pan American Health Organization/World Health Organization, Health Emergency Department, Washington, United States, 4 Center for Medical, Agricultural & Veterinary Entomology , Mosquito and Fly Unit, Gainesville, Florida, United States

10.20.2012 |Virtual

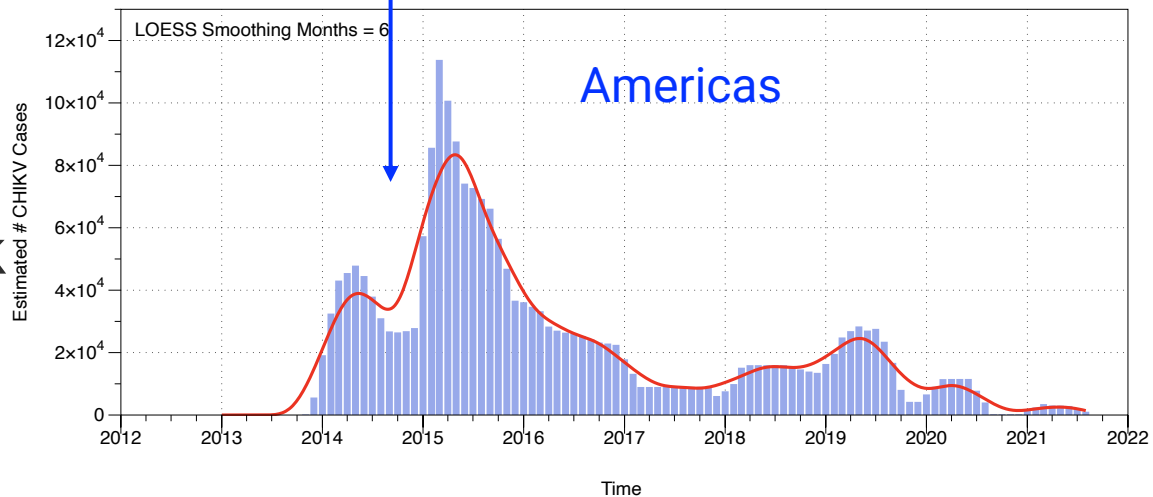
Background

CHIKRisk
MAPPING, MONITORING AND FORECASTING CHIKUNGUNYA RISK

- Chikungunya is part of ~ 17% of the global vector-borne disease burden
- Spread by *Aedes aegypti* and *Aedes albopictus* mosquitoes
- Common symptoms - fever and joint pain, headache, muscle pain, joint swelling, or rash.
- No death - symptoms can be severe and disabling - Lost work hours.
- Economic Impacts - Tourism
- Retrospective: Current Public/Military Surveillance systems track cases and trends across populations
- No predictive/anticipatory systems of risk assessment
- Increasing global spread of VBDs

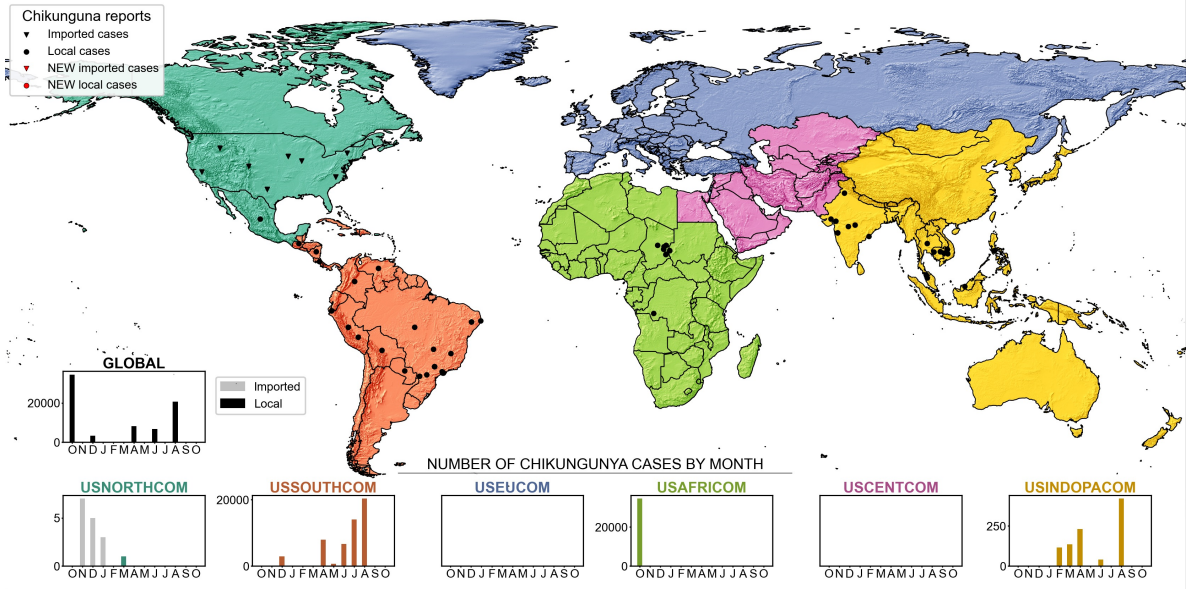


Global distribution of convergent cases of dengue, chikungunya, and Zika: 2013-2016



Stakeholders

- Defense Health Agency/ Armed Forces Health Surveillance Division - Global Emerging Infections Surveillance Branch (GEIS)
  - **Inform global health threats and enable Force Health Protection**



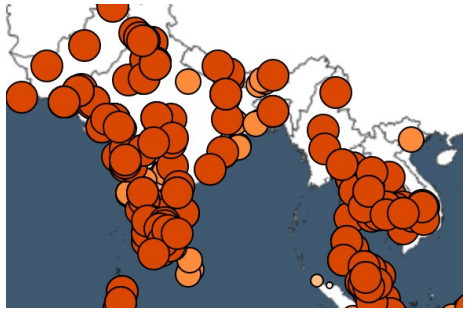
- Pan-America Health Organization
  - **Enable Public Health Surveillance in the Americas**

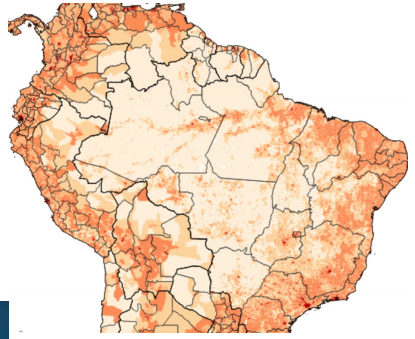
Meshing Biosurveillance and Climate Data

CHIKRisk
MAPPING, MONITORING AND FORECASTING CHIKUNGUNYA RISK

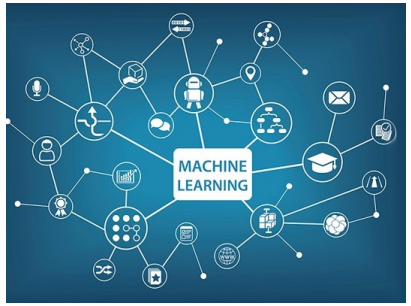
- Chikungunya outbreaks/epidemics are associated with specific climate anomaly conditions
- Employ Machine Learning Methods by Meshing – multi-decade climate measurements and climate forecasts, historical outbreak data, vector distribution and population density to forecast and map areas at risk
- Tested various ML Methods (Random Forest, Support Vector Machines, Neural Networks etc..)
- Enable early surveillance and control
- Reduce disease burden

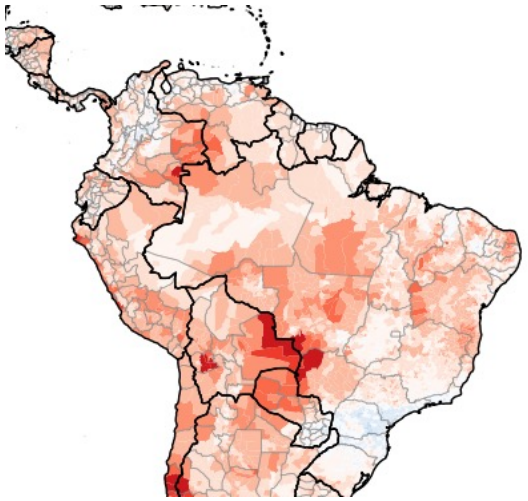
Outbreak Data (ProMED, PAHO, AHSU)



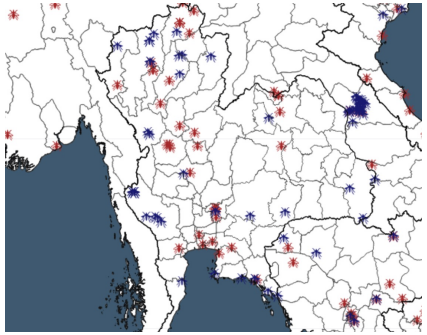


Population Density(NASA-CIESEN



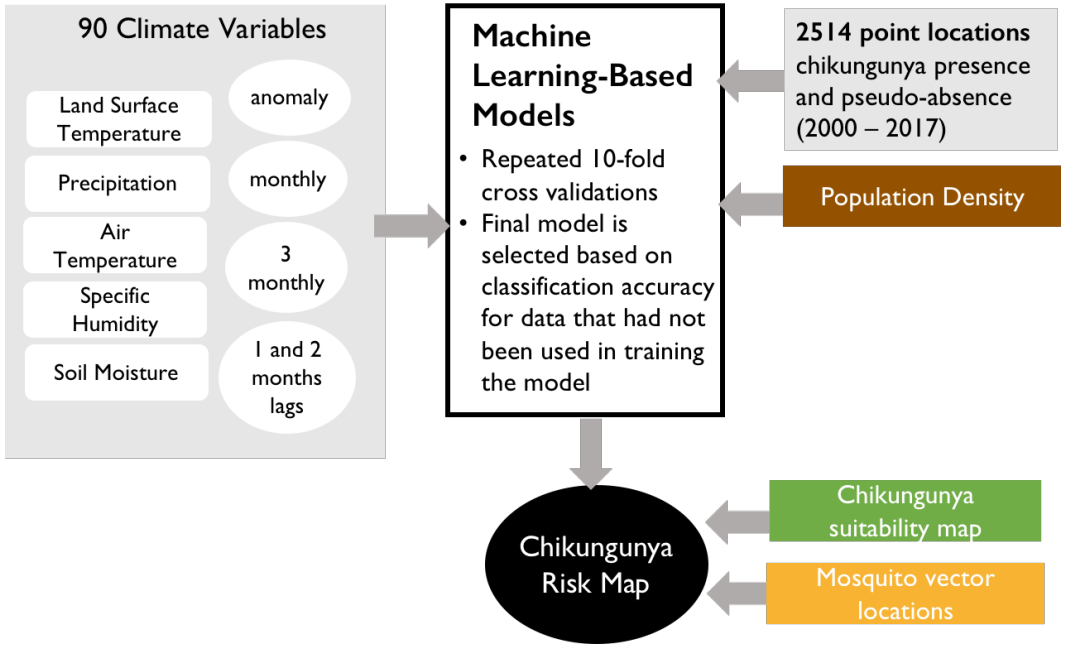


Climate Data (NASA, NOAA)



CHIKV Vectors(WRBU, NIAID-BRC)

Machine Learning Implementation



A. CURRENT RISK MAPPING

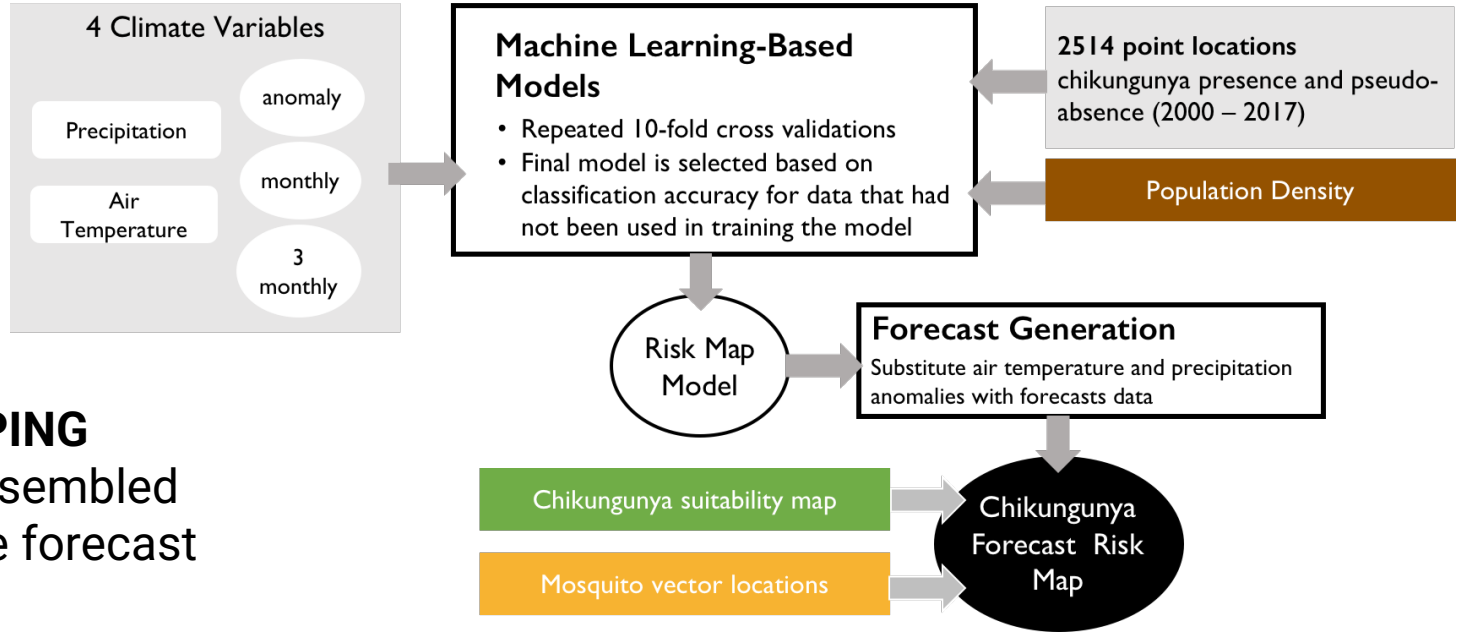
Based on observed climate and historical chikungunya locations

Accuracy

(calculated based on data not used in training the model)

Partial Least Square	0.808 (0.605, 0.775)
Neural Network	0.816 (0.783, 0.846)
Random Forest	**0.889 (0.861, 0.912)**
Support Vector Machine	0.815 (0.782, 0.844)

Random forest had highest performance with accuracy of: **0.859** (95% CI: 0.829, 0.886)



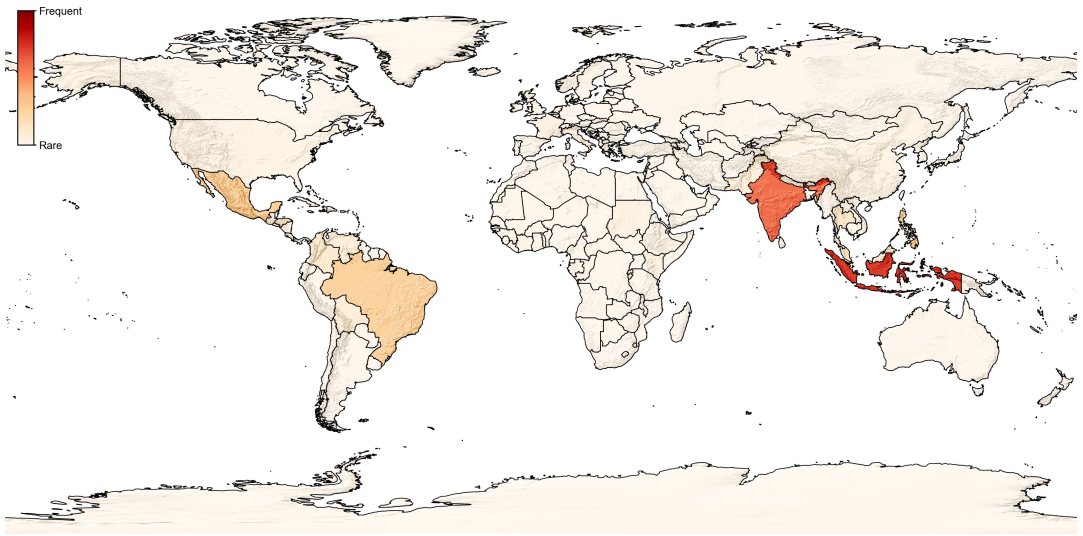
B. FORECAST RISK MAPPING

Substituted observed/assembled climate data with climate forecast

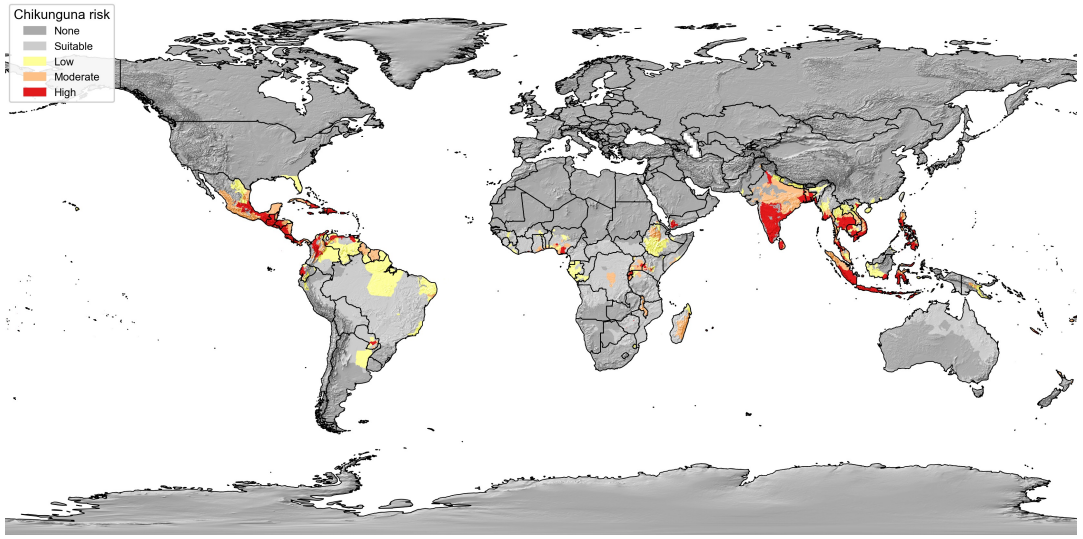
Enabling Early Surveillance

CHIKRisk
MAPPING, MONITORING AND FORECASTING CHIKUNGUNYA RISK

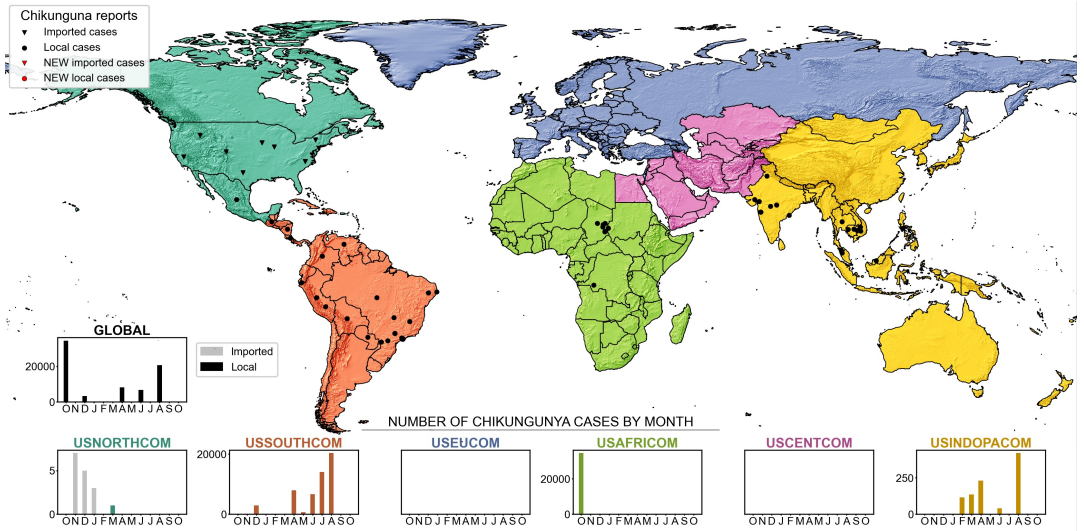
DoD MONTTHLY PRODUCTS



BASELINE RISK: OCTOBER – DECEMBER



CHIKV RISK FORECAST: NOVEMBER 2021



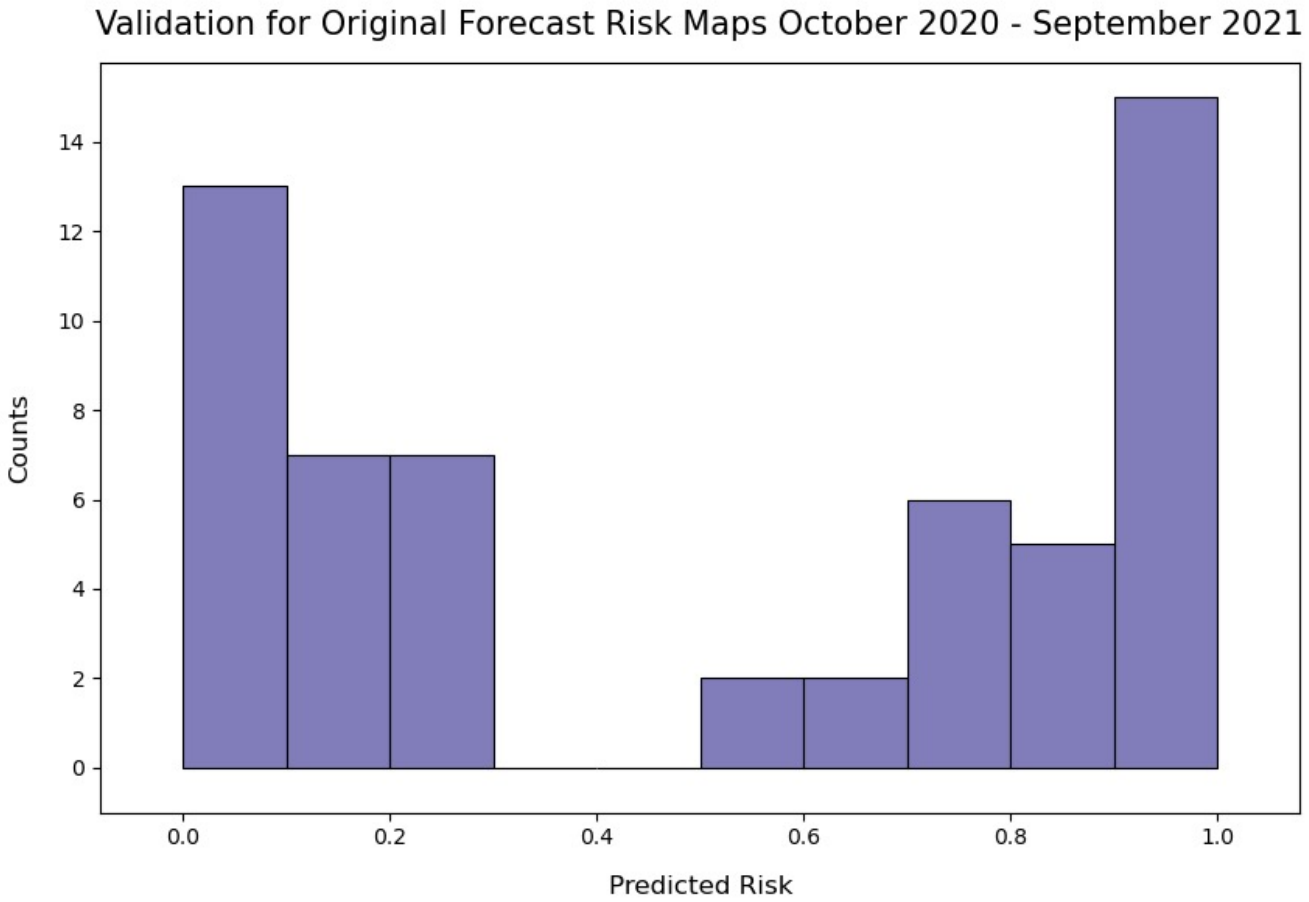
TRENDS: OCTOBER 2020 – OCTOBER 2021

Reporting

1. Context: Monthly Force Health Protection – baseline risk, observed trends by COCOM, forecast risk areas.
2. FHP Threat Ranking (High, Moderate, Routine) – based on 1
3. Dissemination: Recommend sharing broadly within DoD and among the U.S. interagency

Validation & Observations

CHIKRisk
MAPPING, MONITORING AND FORECASTING CHIKUNGUNYA RISK



- ~75.86 % of reported locations with chikungunya activity were predicted to be at risk by the forecast risk maps

- 2021-2021, USSOUTHCOM and USAINDOPACOM have accumulated the highest number of cases.
- Unusual CHIKV outbreak cluster in Chad in 2020 - outside the current suitability envelope
- Reporting indicates COVID Impacts on surveillance globally

Publicly Accessible Application

CHIKRisk
MAPPING, MONITORING AND FORECASTING CHIKUNGUNYA RISK

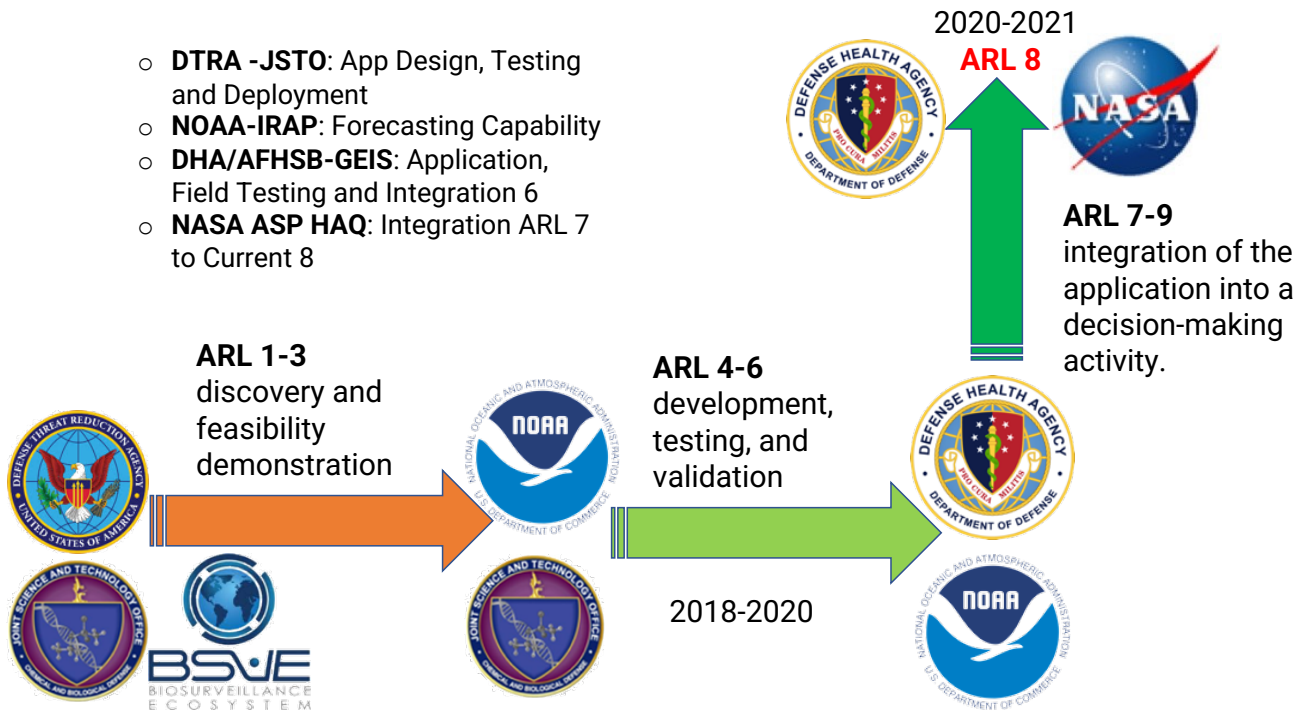
- Open and accessible
- Available for Field Testing
- Example for NextGen VBD EWS

CHIKRisk App: https://vbd.usra.edu

ARL's & Stakeholder Feedback

CHIKRisk App Evolution and Status

- **DTRA -JSTO**: App Design, Testing and Deployment
- **NOAA-IRAP**: Forecasting Capability
- **DHA/AFHSB-GEIS**: Application, Field Testing and Integration 6
- **NASA ASP HAQ**: Integration ARL 7 to Current 8



- **Timeliness**: Monthly findings for P0044_20_NS were consistently reported on time and there was excellent communication between the GEIS-PO and the PI.
- **Reporting New Findings**: P0044_20_NS was highly productive and reported new findings 100% of the required reporting months.
- **Inclusion in GEIS Monthly Surveillance Reports**: A summary of findings as well as maps and other visuals were regularly included in GEIS reports.
- **Recommendation**: Continue current submission process
- **Excellent**

2020/21Highlights

Presentations

- GLOBE Annual Meeting - July 14, 2021
- AmeriGEO Week 2021, August 24, 2021
- NASA Earth Science Applications Week 2021 August 9-12, 2021
- USAID One Health Meeting October 19, 2021
- International Meeting on Emerging Diseases and Surveillance, IMED 2021. November 4-6, 2021.
- AGU Fall Meeting 2021

Papers:

- Anyamba, A., Tubbs, H., Thomas, N., Bishnoi, B. (2021) Global SMAP Soil Moisture Patterns and associated disease outbreaks during the 2020-2021 La Niña Event" as a contribution to the Special Issue on "NASA Soil Moisture Active Passive Mission Observations and Results". IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (*In Review*)
- Anyamba, A. et al : Chikungunya Monitor: Supporting Operational DoD and Public Health Surveillance (*In Preparation* - BMC Public Health)

Student Engagement

- Micro-Biology 705 Science Diplomacy and the World Health, Georgetown University Medical Center, February 25, 2021, Washington, D.C
- Group on Earth Observations (GEO) Health Community of Practice (CoP) Student engagement w/ Rensselaer Polytechnic Institute

Joseph et al (2021) Scraping *Unstructured Data to Explore the Relationship between Rainfall Anomalies and Vector-Borne Disease Outbreaks.* 2021 IEEE International Conference on Big Data, December 2021.

Partnerships + Resources + Teamwork

CHIKRisk
MAPPING, MONITORING AND FORECASTING CHIKUNGUNYA RISK

- **NASA Applied Sciences Program – Health and Air Quality (17-HAQ17-0065)**