

## INNOVATING CROSS-DOMAIN SOLUTIONS TO DETECT EMERGING BIOLOGICAL THREATS

# Integrating Biosurveillance And Climate Data For Vectorborne Disease Risk Mapping And Prediction

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In the realm of biological threat detection, the need to modernize and innovate detection capabilities is paramount, particularly concerning vector-borne diseases. Vector-borne diseases (VBD) are caused by pathogens spread by arthropod vectors such as mosquitoes, ticks, chiggers, sand flies, fleas, and midges. With over 700,000 annual cases, VBDs constitute 17% of infectious diseases and endanger over half the world's population<sup>1</sup>. These diseases pose a significant and even greater risk to military personnel deployed in diverse environments, as evident by the fact that 60% of the top 38 infectious diseases threatening our military forces are caused by VBDs.

The nexus between climate variability and vector-borne diseases underscores the urgency for predictive mapping and forecasting tools and the need for an interdisciplinary approach. We endeavor to harness diverse expertise and cutting-edge technologies to forecast and map the emerging risk of biological threats originating from VBD agents with a focus on chikungunya, dengue and Rift Valley fever as prominent case studies. The ability to forecast the outbreak risk could empower decision-makers with timely and actionable insights for threat evaluation and response planning.

Building upon previous research demonstrating the correlation between climate extremes and disease outbreaks<sup>3</sup>, this project aims to identify additional outbreak drivers that could improve model forecasts. Informed with cross-domain input from hydrologists, entomologists, and remote sensing experts, our model leverages biosurveillance data along with satellite and climate data from NASA and NOAA. The data sources present an opportunity to employ machine learning (ML) approaches for biological threat risk assessment. Unlike traditional statistical methods, ML-based algorithms offer agility in analyzing disparate data sets, enabling the identification of predictive patterns essential for accurate spatial predictions and early warning systems. Utilizing the high performance computing expertise and platforms at ORNL, this work is able to generate risk maps at a global scale.

The integration of dynamic risk maps and forecasting capabilities not only enhances the biological detection portfolio but can also equip the Joint Force and DoD decision-makers with actionable intelligence to mitigate the impact of emerging bio-threats on deployed personnel and associated beneficiaries. This work aims to address the critical importance of proactive measures in addressing vector-borne diseases, which pose significant challenges to military readiness. By leveraging interdisciplinary collaboration and technological innovation, the defense community strengthens its resilience against evolving biological threats, ensuring the protection of personnel and mission success in diverse operational environments.

### References

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