

UCSB Lab Studies Emergence and Disease Risk of Mosquito-Borne Viruses

By Katharine Chi

As of September 2023, the U.S. Department of Agriculture has recognized the urgency of the growing number of mosquito-borne diseases as large bodies of water are resurfacing after years of droughts, and has subsequently allocated funds for expedited research. The increase in meltwater and rainfall provides mosquitos with more breeding grounds and consequently, an exponential increase in mosquito populations. The cascading events create a trajectory of increased cases of avian-borne diseases such as West Nile, Zika and dengue. The USDA's [grant program](#) is focused particularly on the impact of extreme weather on food and agricultural systems.

Andrew MacDonald, an assistant professor at UC Santa Barbara's [Bren School of Environmental Science and Management](#), is leading a team that was awarded one of the program's grants. MacDonald is collaborating with researchers from other universities and working with the consolidation of satellite imagery and communication with ground vector control departments. Satellite imagery is used to track the emergence of water bodies on the basis of near real-time. Corresponding with ground vector control departments allows for an additional angle of analysis — the observation of how the water is affecting mosquito populations and the diseases associated with the increased growth.

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Two central sources of data illustrate the risk of mosquitos: satellite data and ground reports from vector control districts. Satellite programs such as the Landsat Satellite and the Copernicus Sentinel provide data in concern with temperature, precipitation and standing water. Vector control agencies are critical in mitigating mosquito-borne diseases as they monitor mosquito populations and track the spread of pathogens. In addition, the agencies work on population reduction by providing residents with free mosquitofish and treating vulnerable areas with chemicals such as methoprene and bacillus sphaericus. MacDonald's team is working specifically with land data from Kern County in combination with the Land Cover Dataset from the U.S. Geological Survey. With the integration of various land cover datasets, the reliability of the risk assessment and model will increase.

Mosquitos are highly adaptable to changes in the environment, but only a select few mosquito species are causes of concern. "Because mosquitos are ectotherms, they are very sensitive to environmental conditions. They need the temperature to be right, humidity to be high so they don't desiccate, water for breeding and vegetation for resting," MacDonald said in an email to the Nexus, discussing factors influencing mosquito behavior. "So, those conditions tend to be key in describing patterns of abundance of mosquitoes, and they are all things that we can remotely sense with satellite imagery."

Although adaptable, mosquito breeding behaviors are affected by temperature and the availability of water. The risk model of mosquito-borne diseases relies on the account of these pivotal factors. Birds are also known to be hosts of viruses such as West Nile. Because birds like crows and ravens can dwell in various habitats, the risk of disease is widespread. Viruses can be hosted from outside the classification of mosquitos, which drives researchers to pay attention to various vital factors, especially seasonality and the changes in global climate patterns.

"The human death toll attributed to malaria alone is by far more than all of the people that have died in all of the wars in human history," MacDonald said in his email to the Nexus. "That said, diseases like dengue are becoming much more common due to the expansion of the range of the mosquito species that transmit it."

As a multi-faceted issue, the strategy for solutions requires an approach from various aspects. On a large-scale, there are action plans such as treating mosquito-breeding sites, but with this comes determining which water bodies will make the greatest impact. On an individual level, one has the ability to incorporate mosquitofish into personal home ponds and the power to control any water sources that could potentially foster mosquito breeding.

In terms of prevention and resolution, both large-scale and individual choices are critical to tackling the rise of mosquito-borne diseases. And because of the efforts of researchers such as MacDonald, there is momentous development in modeling the disease risks as they respond to environmental changes on the scale of real-time. With data-driven awareness and action enacted on both a large and small scale, a communal effort towards the reduction of mosquito borne diseases will make way for a healthier and brighter future.

The main types of mosquitoes in California that pose threats:

Culex mosquitoes: avian-hosted diseases

- Active mostly during dawn and dusk
- Commonly found in urban and rural areas.
- Prefer to feed on birds

Aedes mosquitoes: tropical diseases

- Active throughout the whole day.
- Less common in California, but increasing concern as they are being found in Texas and Florida.
- Known to transmit dengue and Zika.