**Anopheles albimanus** (Diptera: Culicidae) Ensemble Distribution Modeling: Applications for Malaria Elimination

Charlotte Rhodes¹, Mariel D. Friberg², Gabriel Hamer³, Luke Bergmann³, Rodrigo Marin Rodriguez⁴ and Luis Fernando Chaves⁴,⁵

¹Department of Entomology, Texas A & M University  ²NASA Goddard Center  ³Department of Geography, University of British Columbia  ⁴Vigilancia de la Salud, Ministerio de Salud de Costa Rica  ⁵School of Public Health, Indiana University, Bloomington

**Abstract**

Here, we illustrate the use of an ensemble species distribution model (SDM) as a tool to assess the potential exposure to *An. albimanus* Wiedemann in palm and pineapple plantations, and to also assess the potential involvement of this mosquito vector in transmission foci where entomological surveillance is not feasible. We found that both oil palm and pineapple plantations are very likely to harbor *An. albimanus*. By contrast, environments at the Crucitas open-pit gold mine, the epicenter of malaria transmission in 2018 and 2019, have low suitability for this mosquito species. Our results suggest that medium to high resolution SDMs can be used to plan vector control activities.

**Introduction**

Costa Rica is approaching malaria elimination. Under such scenario malaria outbreaks often occur in areas without entomological surveillance and SDMs could help establish if dominant malaria vectors are potentially present in a given area. This information is critical as it might help to support control measures directed to dominant vectors or prioritize the gathering of further entomological information before proceeding with vector control. Here we explore how SDMs could be used to assess the presence of *An. albimanus*, the dominant malaria vector in Mesoamerica and the Caribbean.

**Methods**

We used mosquito presence data from several sources and environmental layers that included MODIS Images for land surface temperature and NDVI. We fitted the ensemble model employing logistic models, multiple adaptive regression splines, artificial neural networks, regression trees, random forests and boosted trees. Models were cross validated.

**Results I**

<table>
<thead>
<tr>
<th>Presence of Anopheles albimanus</th>
<th>AUC (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative District</td>
<td>0.983 ± 0.001</td>
</tr>
<tr>
<td>Positive District</td>
<td>0.983 ± 0.001</td>
</tr>
</tbody>
</table>

**Results II**

- **Plantationocene key for the species**
  - Species unlikely a vector at Crucitas goldmine
  - But likely present at Boca Arenal

**Acknowledgements**

This research was funded by Costa Rica’s Ministry of Health. Additional support came from the Canada Foundation for Innovation, WestGrid and Compute Canada as well as the NASA High-End Computing (HEC) Program through the NASA Center for Climate Simulation (NCCS).