Climate-driven Mosquito Population Modeling

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A *multi-factorial* relationship between hosts, agents, environment, and vector.

**Host** (Human, Livestock)

**Pathogen** (Virus, Bacteria, Parasite)

**Vector/Reservoir** (Mosquito, Bird)

**Environment** (Climate, Vegetation)

**Dengue Virus**

**West Nile Virus**
Weather/Climate Influences on Vector-borne Disease Ecology

Environment:
- Temperature
- Immature Habitat
- Precipitation

Vector:
- Development
- Survival
- Reproduction

Pathogen:
- Development
- Transmission

Relationships:
- Positive Relationship
- Negative Relationship
- Positive or Negative

Diagram showing the interactions between weather/climate, disease vectors, and pathogens.
Temperature Relationships

- Development Period
- EIP
- Survival Rate (Egg to Adult)
- Adult Feeding Rate
Example Results (San Juan, PR)

<table>
<thead>
<tr>
<th>Year</th>
<th>Reported Cases</th>
<th>Simulated Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R^2 = 0.90$</td>
<td></td>
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<tr>
<td>2011</td>
<td></td>
<td>$R^2 = 0.83$</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>$R^2 = 0.94$</td>
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<tr>
<td>2013</td>
<td></td>
<td>$R^2 = 0.25$</td>
</tr>
</tbody>
</table>
Example Results (Hermosillo, MX)

- **2006**: $R^2 = 0.67$
- **2007**: $R^2 = 0.76$
- **2008**: $R^2 = 0.70$
- **2009**: $R^2 = 0.01$
- **2010**: $R^2 = 0.20$
- **2011**: $R^2 = 0.30$
Forecasting Techniques

- Iterative weekly process: using weather forecasts (SPoRT) and weekly reported dengue data

  - Run multiple simulations of model using weather data
  - Evaluate model with dengue data
  - Choose best fit simulations
  - Drive model with weather forecast data
  - Make predictions based on model results

Dengue Cases

Time

Small increase in dengue incidence
Challenges and Opportunities for Forecasting Vector-borne Disease Risk

- **Knowledge gaps**
  - Vector population dynamics
  - Extrinsic Incubation Period (EIP)
  - Transmission probabilities

- **Vector-Disease**
  - Misdiagnosis
  - Subclinical cases
  - Availability of data

- **Environmental data**
  - Availability/Reliability
  - Resolution
  - Predictability

- **Surveillance Data**
  - Model parameterization
  - Model evaluation
  - Data integration

- **Expertise**
  - Behavioral risk factors
  - Demographic risk factors
  - GIS and mapping

- **Environmental data**
  - Observations
Thank You for Your Attention

Questions?

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