

# Modeling as a Tool for Preparing for Agro- and Bio-terrorism: Rift Valley Fever

**FAZD CENTER**

NATIONAL CENTER FOR FOREIGN ANIMAL  
AND ZOO NOTIC DISEASE DEFENSE

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# Outline

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- **Some threats models can address**
- **A model of Rift Valley fever**
- **Initial model validation and next steps**

## Acknowledgements

Dr. Holly Gaff (UMB)

Dr. Jimmy Wu (TAMU)

Dr. Nicole Leahy (UMB)

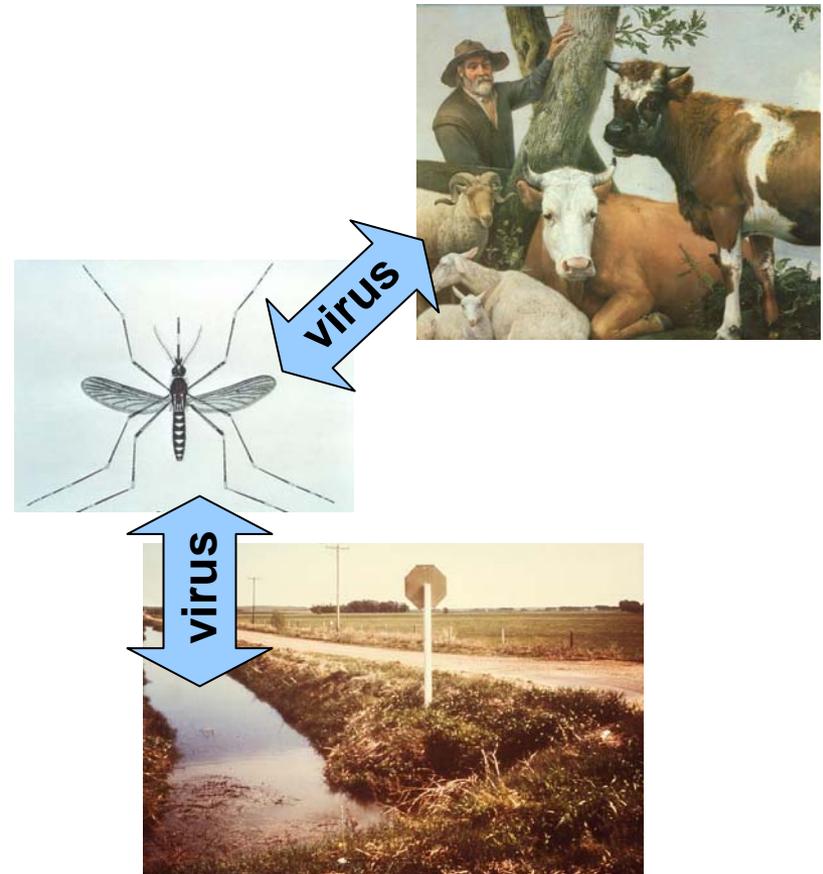
Ms. Jennifer Jacobs (TAMU)

Dr. CJ Peters (UTMB)

Mr. Jay Angerer (TAMU)

# Rift Valley Fever

- **An emerging disease and agro-bio-terror threat**
  - Mosquito-borne viral disease of humans and livestock
  - Transmission modulated by environment and weather
  - Unknown outside of Africa and Arabian Peninsula
  - Demonstrated ability to travel
- **Appearance in US expected to impact agriculture sector severely**
  - Cost of cattle illness & death
  - Potential bans on US livestock



*Simplification of Rift Valley fever transmission cycle*

# Threats in Need of Analysis

- **What geographic areas are vulnerable to attack or introduction?**
- **In the event of a release or introduction**
  - **Is transmission likely to be intense?**
  - **How might we control the outbreak?**
  - **Is disease likely to become endemic?**
  - **Is geographic spread likely (where and how fast)?**
  - **How might we prevent geographic spread?**
- **Human and agricultural health alike**
  - **This work: focus on agriculture**



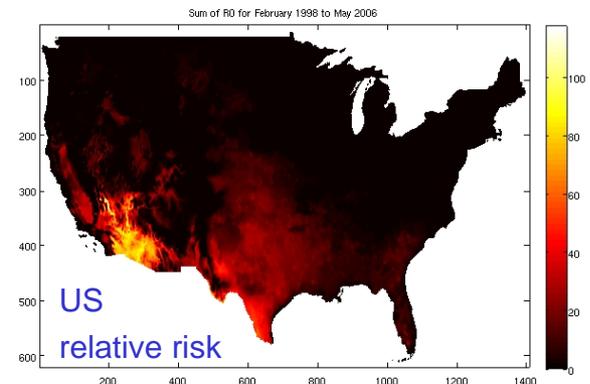
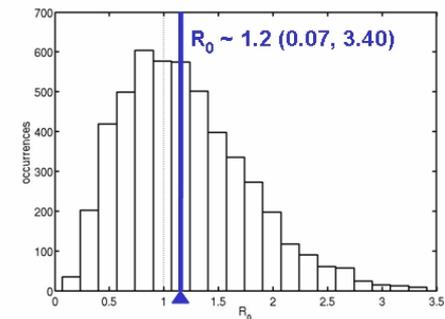
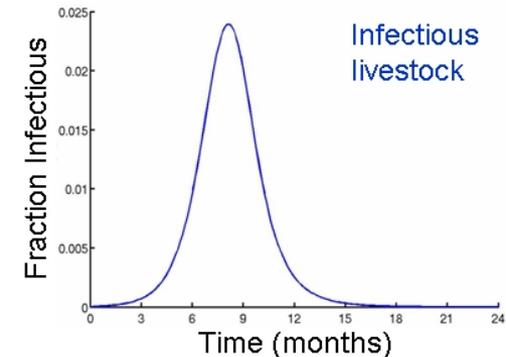
# Options for Assessment

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- **Best guess based upon experience from endemic areas**
  - **Pro: Wealth of historical observational data**
  - **Con: Immunity and infrastructure will bias comparisons**
- **Lab studies**
  - **Pro: Controlled environment supports careful studies**
  - **Con: Lab environment often unrealistic**
- **Mathematical models**
  - **Pro: Can analyze a range of scenarios and threats**
  - **Con: Must be validated, diverse data needed**

# A Model of RVF

- **Encapsulates the basic biology of RVF**
  - **Multi-model approach: sub-models for vectors and livestock**
  - **Environmental and climate components included**
  - **Sensitivity analysis carried out**
  - **Humans not included in this iteration**
  - **Livestock transportation not included (next step)**
- **Typical output**
  - **Percent of population infected, epidemic potential, geographic vulnerability**
- **Runs on desktop PCs and small cluster computers**



# Validation Challenge

- **RVF erupts infrequently in endemic areas**
  - Lack of surveillance
- **2006-07 activity in Horn of Africa region provides test bed**
- **To test the model, we retrospectively estimated areas at risk for disease**
  - Temperature
  - Rainfall

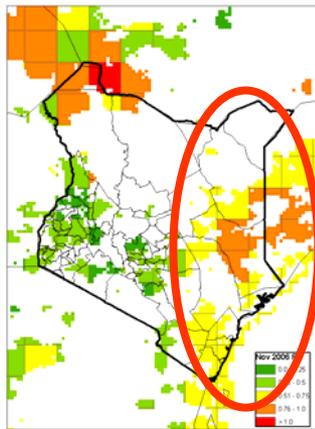
The screenshot shows a Mozilla Firefox browser window displaying the WHO website page for Rift Valley fever. The address bar shows the URL: [http://www.who.int/csr/don/archive/disease/rift\\_valley\\_fever/en/](http://www.who.int/csr/don/archive/disease/rift_valley_fever/en/). The page title is "WHO | Rift Valley fever". The WHO logo and navigation menu are visible at the top. The main content area is titled "Epidemic and Pandemic Alert and Response (EPR)" and lists several news items:

- 31 January 2007**: Rift Valley Fever in Kenya and Somalia - update 3. [Full text](#)
- 15 January 2007**: Rift Valley Fever in Kenya - update 2. [Full text](#)
- 27 December 2006**: Rift Valley Fever in Kenya - update. [Full text](#)
- 26 December 2006**: Rift Valley Fever in Kenya. [Full text](#)
- 26 October 2000**: 2000 - Rift Valley fever in Yemen - Update 4. [Full text](#)
- 25 October 2000**: 2000 - Rift Valley fever in Saudi Arabia - Update 3. [Full text](#)
- 19 October 2000**: 2000 - Rift Valley fever in Saudi Arabia - Update. [Full text](#)

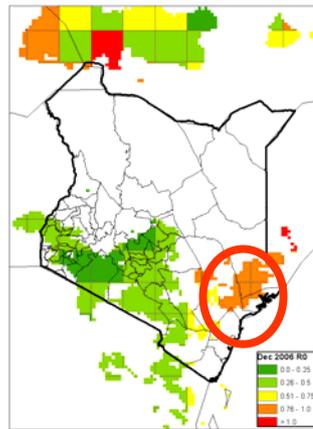
On the right side of the page, there are links to "WHO outbreak communications guidelines", "Outbreak Communication: Best practices for communicating with the public during an outbreak", "Avian influenza Latest information", and "Severe Acute Respiratory Syndrome (SARS) Latest information". A "DISEASE OUTBREAKS" section is also visible at the bottom right, listing "Situation in Egypt - update 6", "Situation in Egypt - update 5", and "Situation in Egypt - update 4".

# Initial Validation

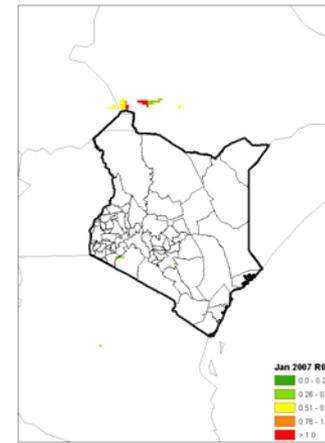
- **Geographic epidemic potential (“ $R_0$ ”) was plotted by month 2006-2007**
  - Highest = red
  - Medium = yellow
  - Lowest = green
- **Areas with predicted high risk in November overlap with reports of disease in December**
  - Lead time of approximately one month
- **Agreement suggests model validity**



November 2006



December 2006



January 2007

# What This Means

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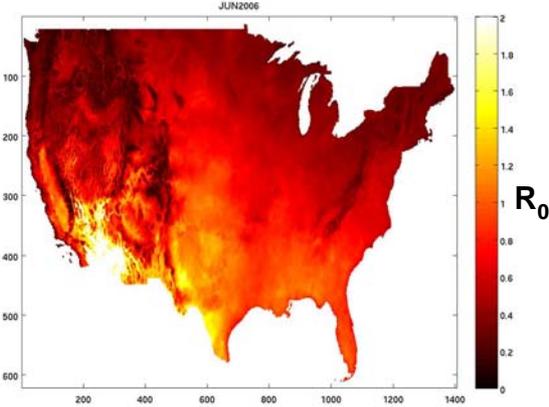
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- **We have constructed a model that can be applied to assess RVF vulnerability both overseas and in the United States**
- **Because the model is based on biology, it should be possible to analyze varied science and public health issues**
  - **Epidemic intensity, endemic prevalence, outbreak frequency, control options, payoff of vaccines in development, economic impacts, . . .**

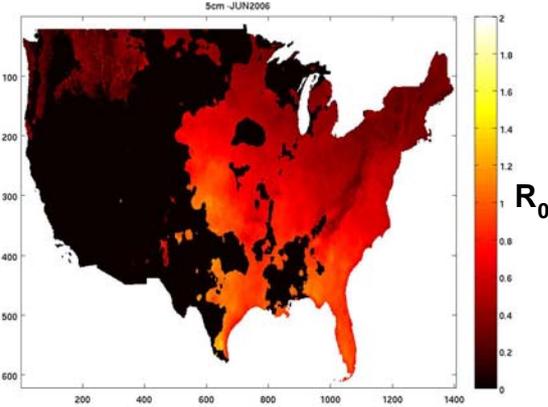
# Next Step: US Suitability Map

- **Vector emergence dependent upon different rainfall thresholds**

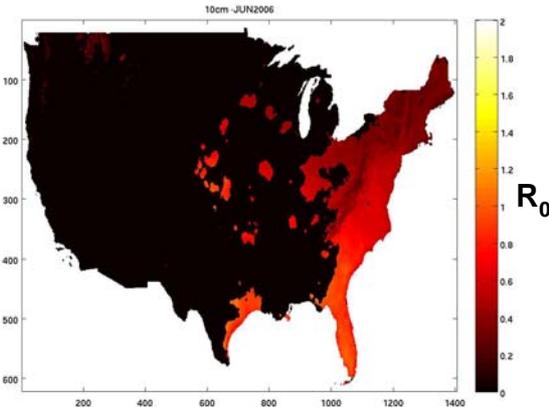
*June 2006*  
*vector*  
*emergence*  
*at 0cm*



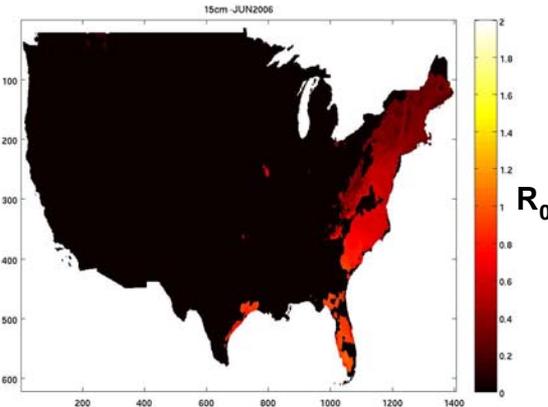
*June 2006*  
*vector*  
*emergence*  
*at 5cm*



*June 2006*  
*vector*  
*emergence*  
*at 10cm*



*June 2006*  
*vector*  
*emergence*  
*at 15cm*



# Additional Next Steps

- **Compare model predictions to other historic outbreaks**
  - Both spatial and temporal observations exist
- **Incorporate livestock transportation to model long-distance spread**
  - Transportation model development underway at Texas A&M
- **Analyze public health measures**
  - Tradeoffs between scenarios employing vaccination, vector control, and livestock culling
- **Support NBACC National Assessment with model & GIS approach**



# Conclusions

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- **Computer models can help fill important analytic gaps**
- **The mathematical model of RVF yields results consistent with observation in Africa**
  - **Additional validation tests are underway**
- **Potential applications of this baseline tool include**
  - **Examination of potential agricultural and human public health measures**
  - **Analysis of geographic vulnerability**
  - **Support estimates of economic impact**

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# Questions?