Decision support framework for managing Rift Valley fever in the Horn of Africa

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Overview

- ILRI RVF Research Program
  - Decision Support Framework (DSF)
  - RVF Modelling
  - RVF Risk Factors
  - Economic Scenario Analysis of DSF

- Risk-Based Decision Support Framework
  - 2006-2007 Impact Study
  - Process and Publication
  - Future Directions
Risk-Based Decision Support Framework (DSF)

- Participatory Process:
  - Risk map
  - Matrix of actions matched to events
    - RVF epizootic events list
    - Action categories
    - Stakeholder built
  - Selected information, resources and references
RVF Modelling

- A spatial, agent based, stochastic model
- Mechanisms of RVF persistence
- Predict risk, impact of RVF and interventions
Risk Factor Analysis

• Descriptive analyses
• Regression models:
  – Generalized Linear Mixed models
    ▪ Poisson model for incidence
    ▪ Logit models for prevalence
  – MCMC/spatial multiple membership model
    ▪ To account for spatial autocorrelation
## Risk Factor Analysis - predictors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livelihood zones</td>
<td>FEWSNET</td>
<td>Livelihood practices as at 2006</td>
</tr>
<tr>
<td>Land cover</td>
<td>FAO on-line database</td>
<td>Global land cover data, 2000</td>
</tr>
<tr>
<td>Precipitation</td>
<td>ECMWF</td>
<td>Monthly minimum, maximum and average for the period: 1979 - 2010</td>
</tr>
<tr>
<td>NDVI</td>
<td>Spot Vegetation</td>
<td>Monthly average, minimum, maximum values from: 1999 - 2010</td>
</tr>
<tr>
<td>Elevation</td>
<td>CSI SRTM</td>
<td></td>
</tr>
<tr>
<td>Soil types</td>
<td>FAO</td>
<td>FAO’s Harmonized World Soil Database (HWSD), 2009</td>
</tr>
<tr>
<td>Wetlands (area as % of total)</td>
<td>ILRI GIS Unit</td>
<td></td>
</tr>
<tr>
<td>Parks/reserves (area as %)</td>
<td>ILRI GIS Unit</td>
<td></td>
</tr>
</tbody>
</table>
Risk Factors

Divisions that have had RVF outbreaks in Kenya between 1912 and 2010

- 505 divisions - 1999 population census
- 20.2 % (n = 102) of the divisions have had an outbreak at least once
- Mean outbreak interval : 5.4 (4.4 – 6.4) years
## Models for the persistence of outbreaks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level</th>
<th>Multi-level Poisson model</th>
<th>MCMC/Bayesian model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>-3.74 0.69</td>
<td>-6.18 0.92</td>
</tr>
<tr>
<td>Precipitation</td>
<td></td>
<td>0.11 0.03</td>
<td>0.16 0.04</td>
</tr>
<tr>
<td>NDVI</td>
<td></td>
<td>2.68 0.80</td>
<td>3.29 0.83</td>
</tr>
<tr>
<td><strong>Soil types</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solonetz</td>
<td></td>
<td>1.34 0.49</td>
<td>1.64 0.62</td>
</tr>
<tr>
<td>Luvisols</td>
<td></td>
<td>1.24 0.45</td>
<td>1.80 0.59</td>
</tr>
<tr>
<td>Elevation</td>
<td>&lt; 2300 m</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>&gt; 2300 m</td>
<td>-2.99 0.64</td>
<td>-3.79 0.95</td>
</tr>
<tr>
<td><strong>Random effects</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Livelihood zones</td>
<td></td>
<td>3.16 0.61</td>
<td>9.37 3.02</td>
</tr>
<tr>
<td>Deviance</td>
<td></td>
<td></td>
<td>841.57</td>
</tr>
</tbody>
</table>
Sandik Case Definition: RVF Compatible Event

- Abortion
- Heavy rains and mosquitoes
- Froth from the nose, often with epistaxis
- Salivation
- Fever
- Death, particularly in young animals

An outbreak in sheep and goats involving abortions during periods of heavy rain and abundance of mosquitoes, with two or more other listed clinical symptoms being observed in the herd, should be reported as RVF compatible disease to public health authorities. Cattle in the same area will be affected with similar but less severe symptoms, and rarely camels.
Average Timeline

Average time from:

- Onset of rains to mosquito swarm: **33.1 days**
- Mosquito swarm to first animal case: **19.2 days**
- First animal case to first human case: **21 days**
- First humane case to medical service intervention: **35.6 days**
- First medical service intervention to first veterinary intervention: **12.3 days**
- First animal case to veterinary service intervention: **68.9 days**

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Vectors</th>
<th>Livestock</th>
<th>Cases</th>
<th>Human</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Human</td>
</tr>
<tr>
<td>33.1 days</td>
<td>19.2 days</td>
<td>21 days</td>
<td>35.6 days</td>
<td></td>
<td>12.3 days</td>
</tr>
</tbody>
</table>
So why was the response so late?

- All or nothing decision
- Waiting for perfect information
- Risk avoidance
Optimal Decision-Making

• Recognizes
  – The need to balance the need for information against the need for a timely response
  – That information will be imperfect
  – That decision making involves taking risk

• How can we make decision-making less risky
  – Phased
  – Shared
Decision Points

• Early warning or alerts
• Localized heavy rains observed
• Localized flooding reported
• Mosquito swarms
• Livestock disease
• Laboratory confirmation
• Human disease
• Laboratory confirmation
Progressive Risk Mitigation

- Consequence x probability of outcome
- Probability increases at each decision point
- Justification for investment in risk mitigation increases
- Risk of making the wrong decision decreases
Decision-Making Trade Off

Risk of Being to Late

No Info

Perfect Info

Risk of Being Wrong
Methods

• Initial workshop
  – RVF events sequenced
  – Interventions inventoried
  – Actions matched to event sequences
• Expert review
• Follow-up workshop
• Peer review
Tool vs Framework

• Original name caused confusion
  – Informative dialogue

• Modellers assumed it was model
  – Efforts to ‘fix’ the tool
  – The tool itself should output the decision

• Strength of the ‘framework’
  – Created and owned by decision-makers
  – Models can inform the discussion, but not drive the process
The Future

DSF managing risk in trade

- Transparent framework for managing RVF
- Market events and interventions
- Regional meeting in Dubai
  - Horn of Africa, Middle East, OIE
  - regional framework for trade
  - extend to other disease.

- Current Application
  - Kenya and Tanzania
  - Development partnerships?