Rift Valley fever virus seroprevalence among ruminants and humans in northeast Kenya

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Today’s talk

1. An introduction to vector-borne diseases and Rift Valley fever
2. Our project
3. Conclusions
### Ecosystem services – and disease emergence

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>Importance</th>
<th>Effect of decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning</td>
<td>Economics, livelihoods</td>
<td>Increased poverty</td>
</tr>
<tr>
<td>Regulating</td>
<td>Health, environment</td>
<td>Increased disease</td>
</tr>
<tr>
<td>Cultural</td>
<td>Well-being, recreation</td>
<td>Increased stress?</td>
</tr>
<tr>
<td>Supporting</td>
<td>Basis for the other services</td>
<td>Increase in all above</td>
</tr>
</tbody>
</table>
Why are vector-borne diseases emerging?

Climate and climate changes
Globalization
Urbanization
Land use changes
## Vector capacity and competence

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k$</td>
<td>Probability that a vector feeding on an infected host gets infected</td>
</tr>
<tr>
<td>$P_f$</td>
<td>Probability that a vector survives from one meal to the next</td>
</tr>
<tr>
<td>$P_e$</td>
<td>Probability that a vector survives the extrinsic incubation period, EIP</td>
</tr>
<tr>
<td>$Q$</td>
<td>Probability that a vector feeds from the right host – blood index for the host</td>
</tr>
<tr>
<td>$H_{Br}$</td>
<td>Host biting rate, the number of vectors feeding from an animal per day</td>
</tr>
<tr>
<td>$v$</td>
<td>Probability of pathogens becoming infectious in the vector</td>
</tr>
</tbody>
</table>

Vector capacity

$$C = H_{Br} Q v k P_e / (1 - P_f)$$
Rift Valley fever

- Bunyaviridae, phlebovirus
- High mortality, abortions in ruminants
- Haemorrhagic fever, encephalitis in humans

- Arbovirus – but also directly transmitted
Why irrigation?

More and more range lands in Africa are being converted to crop lands through irrigation to alleviate food insecurity

Results: major trade-offs in ecosystem services

- More food produced (provisioning services) at the expense of biodiversity and regulatory services (disease, flooding, erosion)
Case study- irrigation and disease

Anthropogenic action:
Increased irrigation

Effect on ecosystem:
Creates more larval habitats

Vector consequence:
More infected vectors

Epidemiologic consequence:
More individuals exposed

Increased disease
Our project

• Rift Valley fever prevalence
  – Humans
  – Ruminants

• Land use changes
  – Protected area vs. irrigated area
  – Pastoralist areas
Irrigation in an arid and semi-arid area increases the risk for Rift Valley fever.

But other diseases can also be affected by this...

... and the doctors don’t know if it is Rift Valley fever.

Study site with stagnant water in irrigation canals – source of water for the locals but also breeding grounds for mosquitoes.
Study area
Tana River and Garissa counties, northeastern Kenya
Land use change

• Making changes in a highly diverse landscape
• Increased number of scavengers
• Increased numbers of mosquitoes
Dynamic drivers of disease in Africa
Case study: Kenya

- Cross-sectional
  - Humans
  - Ruminants
  - Mosquitoes
  - Wildlife
  - Ticks

- Longitudinal
  - Human febrile cases
  - Livestock: shoats
  - Mosquitoes
Prevalence in humans

Significantly higher prevalence in men

![Graph showing prevalence in irrigation, pastoral, riverine, and total populations, with irrigation at 21.12%, pastoral at 21.70%, riverine at 27.16%, and total at 21.94%]

![Image of children interacting with an animal]
## Prevalence in ruminants

<table>
<thead>
<tr>
<th></th>
<th>Ruminants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>25.59%</td>
</tr>
<tr>
<td><strong>seropositivity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Young</strong></td>
<td>12.31%</td>
</tr>
<tr>
<td><strong>Adults</strong></td>
<td>30.22%</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>14.81%</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>28.80%</td>
</tr>
</tbody>
</table>
RVF-only part of the problem

– Too many differentials: Malaria, RVF, Dengue, YF, *Brucella, Leptospira*, Chikungunya, CCHF
– Socioeconomic consequences and factors
How much did you spend last year on the following health protection (Kenyan shilling)?

<table>
<thead>
<tr>
<th></th>
<th>Mosquito nets</th>
<th>Vaccines and routine clinic visits for kids</th>
<th>Boiling or other water treatment</th>
<th>Insurance (annual fee)</th>
<th>Other health prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>762</td>
<td>254</td>
<td>6.8</td>
<td>0.9</td>
<td>586</td>
</tr>
<tr>
<td>Range</td>
<td>0-3150</td>
<td>0-5000</td>
<td>4 households paid between 150-600</td>
<td>220 households paid nothing, one household paid 200</td>
<td>0-6000</td>
</tr>
</tbody>
</table>

How much did you spend last year on the following health prevention for animals?

<table>
<thead>
<tr>
<th></th>
<th>Deworming</th>
<th>Vaccinations (to prevent not to treat)</th>
<th>Tick and fly treatments</th>
<th>Insurance (annual fee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>928</td>
<td>437</td>
<td>599</td>
<td>0</td>
</tr>
<tr>
<td>Range</td>
<td>0-11000</td>
<td>0-5000</td>
<td>0-5000</td>
<td>Not existing</td>
</tr>
</tbody>
</table>
The vicious cycle

- Poorer people, more disease
- Sick livestock, less income
- Healthy livestock, more production
- Better livelihoods, healthier people
Impact of poor animal health

GHG per kg of animal protein produced

Herrero et al. (2013)
Conclusions

- Land use changes can affect disease occurrence
- Irrigation can sustain inter-epidemic transmission
- More people, more food insecurity and more disease
Acknowledgements

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