Rift Valley Fever forecasting at FAO and Decision Support Tool

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FAO Animal Health Service (AGAH) mandate:

- Prevent, contain and control the world’s most serious livestock diseases at their source, while also surveying for newly emerging pathogens in a changing environment

Core activities:

- *Early warning, forecasting* and *early detection* to enhance early action and response
Risk modelling and mapping in Animal Health

• More than simply plotting the disease outbreaks on a map
• The process of estimating, understanding, predicting / forecasting and displaying the risk of emergence, spread and/or persistence of animal health threats with a map
• Risk maps can inform decision-making; support animal disease prevention, management and control
• E.g., risk-based surveillance; prioritization of vaccination; vector control; biosecurity; control measures; reduce costs; improve interventions; evaluate effect of mitigations
• FAO is active on Avian Influenza, Anthrax, Ebola, FMD
• ... and on monitoring and forecasting Rift Valley Fever
Rift Valley Fever (RVF): What we know

- Major zoonotic viral vector-borne disease (affecting cattle, sheep, goats, camels, wildlife and humans)
- Transmitted by mosquitoes species (e.g., Aedes, Culex), but also through the contact with infected animals
- Seasonal patterns are influenced by environmental and anthropogenic factors
- Any change in those factors (e.g., prolonged and heavy rains, floods, drought, agriculture expansion/irrigation schemes), have an impact on the host, vector, pathogen & environment (HPE) system
- And can facilitate the emergence, spread, transmission of RVF
- Strong environmental and dynamic component (climate)
RVF: Changing environment and climate

• Changes in the climate patterns and ecosystems affect:
  • Host: immunity, distribution, abundance and movements
  • Pathogen: resistance and selection of the host
  • Vector: distribution, abundance and vectorial capacity
  • Ecosystem/environment: availability and accessibility of water, food resources and shelter

• Such changes are expected to increase due to climate change, favoring the introduction, spread or persistence of RVF at the human-wildlife-livestock interface

• Growing concern of geographical spread (Middle East and Europe)
RVF vector ecology, epidemiology

East Africa - **Flooding areas** (e.g., dambos, Kenya)

West Africa - **Temporary ponds** and **dry spells** (e.g., Senegal)

This regional variation in rainfall patterns has been captured to predict vector(s) dynamics and RVF at-risk areas in East and West Africa.

Source: Vignolles et al 2011

Source: FAO 2012
Past and current RVF Risk modelling approaches and projects at FAO

- Bayesian spatial regression approach in Senegal (Royal Veterinary College; ISRA; 2007);

- Non linear discriminant analysis for the whole of Africa (Oxford University; 2011);

- Multi-criteria Decision Analysis (MCDA) in Uganda, Ethiopia, Kenya, Tanzania (One Health project/CIRAD; 2013) and for the whole of Africa (Clements et al. 2006)

- Climate-based model in East Africa (FAO; 2012-2014) adapted in West Africa/Vmerge project (several partners)

- Mitigating the risk of Rift Valley Fever (RVF) emergence and impacts in East Africa” (2019) – RVF dynamic environmental model implemented in a DST
RVF monitoring, risk modelling, forecasting and mapping at FAO

- Over the past 10 years FAO and partners (NASA, WHO, OIE) have successfully forecasted hotspots for RVF vector amplification providing recommendations and early warning messages for countries at risk of RVF outbreaks;

- The dynamic model used by FAO builds upon the work by NASA (Anyamba et al. 2009), who developed a monitoring and risk mapping system that utilizes NDVI and rainfall anomalies as a proxy for ecological dynamics to map areas at potential risk of RVF in East Africa;

- The model has been calibrated by FAO (2016-2017): maps are updated every month at 250 m spatial resolution using satellite images in a cloud-based platform (Google Earth Engine).
RVF Early Warning Tool (FAO prototype)

Near-real time monitoring and risk mapping of RVF vector amplification with GEE

Transition from a desktop to a cloud-based platform
Achievements over the past 24 months:

- > 600 RVF risk maps for Africa (since 2002--)
- Numerous risk assessments (jointly with NASA, WHO, OIE and field) and 5 alerts for West (1), East (3) and Southern Africa (1)
- RVF forecasts in quarterly FAO bulletins (FCC and EWEA)

<table>
<thead>
<tr>
<th>Forecasted RVF events</th>
<th>Date of RA/Alert</th>
<th>Date of reporting</th>
<th>Date of observation</th>
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</thead>
<tbody>
<tr>
<td>The Gambia</td>
<td>15 Sept 2017</td>
<td>19 Jan 2018</td>
<td>10 Dec 2017</td>
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<tr>
<td>Senegal</td>
<td>15 Sept 2017</td>
<td>March/Apr 2018</td>
<td>Feb/Mar 2018</td>
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<tr>
<td>South Africa</td>
<td>5 Feb 2018</td>
<td>16 May 2018</td>
<td>28 Apr 2018</td>
</tr>
<tr>
<td>Kenya</td>
<td>March 2018</td>
<td>8 June 2018</td>
<td>3 June 2018</td>
</tr>
<tr>
<td>Rwanda</td>
<td>March 2018</td>
<td>June 2018</td>
<td>May 2018</td>
</tr>
<tr>
<td>Kenya</td>
<td>10 Oct 2018</td>
<td>14 Feb 2019</td>
<td>31 Dec 2018</td>
</tr>
<tr>
<td>Sudan</td>
<td>10 Oct 2018</td>
<td>21 Nov 2018</td>
<td>Oct/Nov 2018</td>
</tr>
<tr>
<td>Mauritania</td>
<td>10 Oct 2018</td>
<td>30 Jan 2019</td>
<td>NA</td>
</tr>
<tr>
<td>Horn of Africa</td>
<td>16 Oct 2019</td>
<td>January 2020 (Uganda)</td>
<td>December 2019</td>
</tr>
</tbody>
</table>
May 2018: RVF reported in South Africa

June 2018: RVF reported in Kenya
RVF Early Warning and Forecasting System at FAO HQ

Methods

- **RVF Monitoring/Forecasting tool** (observed cumulative vegetation anomalies over the past 3 consecutive months; builds upon the model by NASA)
- **Observed precipitation anomalies** (over the past 3 consecutive months)
- **Forecasted precipitation** (over the coming 3 months)
- **ENSO forecasts**
- Past and current **RVF outbreaks**
- Expert knowledge on **animal movements** and **disease ecology**

- **RVF EW/Decision Support Tool**
  - To enhance interpretation of risk maps
  - To provide recommendations
  - To support and enhance early action
Decision-support tool for prevention and control of Rift Valley fever epizootics in the Greater Horn of Africa

Version 1
Rift Valley fever (RVF) - Early Warning/Decision Support Tool

- Decision Support Tool (DST) integrates the near real-time RVF risk maps with relevant geospatial products, classification, expert knowledge, assessment of the risk and recommended actions to guide appropriate response to RVF at country level (Kenya, Uganda, Tanzania).
  
- Rwanda recently vaccinated 67% of livestock following the FAO alert
- Emergency Management Centre (EMC)-AGAH Incident Coordination Group (ICG) activated
- EMC-AGAH Response Mission in Uganda
- Joint FAO-IGAD alert messages
The Irish project: objectives and implemented activities (Jan 2019 – Jan 2020)

- **Objective:**
  To enhance the animal health systems for prevention, detection and response to RVF emergence, incursion and spread in EA through the IT development of a web-based RVF early warning/Decision Support Tool

- **Pilot countries:**
  Uganda, Kenya and Tanzania

- **Main activities:**
  - RVF dynamic model and risk factors reviewed
  - Expert elicitation through consultative meetings and workshops
  - Contingency plans reviewed and a guideline document for Preparedness Plans prepared
Characteristics of the Decision Support Tool (Beta version):

- Website with restricted access
- Online interactive maps, navigation over time
- Environmental and climatic risk factors
- Analysis per point time series and cumulative time series charts
- Analysis per polygon (predefined country, drawn on map or uploaded simplified shapefile)
- Percentages of risk levels and recommended actions report for different risk levels
- Printfriendly report for selected polygon including risk map, chart, statistics and recommended actions
- Link to metadata record, download of maps
- Access to historical archive or risk maps
Scaling up the RVF DST to South Sudan

- Review of risk factors and preparation of spatial data
- Locations and distribution of historical RVF outbreaks
- Review and validation of the current dynamic risk model
- Review of Contingency Plans
Potential hotspots for RVF vector amplification for June 2020:

The areas suitable for the RVF vector amplification increased in eastern South Sudan, Somalia, south and central Ethiopia and still persist in Kenya, northern Tanzania, northern Uganda and to a lesser extent in Rwanda, Burundi, Eritrea, Sudan, Djibouti, DRC and Yemen.

Increased risk in:
- Somalia
- South Sudan
- Ethiopia

Persistent risk in:
- Kenya
- Uganda
- Tanzania
Potential hotspots for RVF vector amplification for June 2020 in South Sudan.
RVF risk areas in June 2019
Precipitation forecasts for the next 3 months (initial conditions: June 2020)

**IRI ENSO forecast:** continuation of ENSO neutral conditions in summer, with approximately equal chances of ENSO-neutral or La Niña for fall and winter (Published: 19 June 2020)
Conclusions

Considering the predicted vector amplification maps, observed and forecasted rainfall and vegetation anomalies, past and current RVF outbreaks as well as expert knowledge on animal movement of potential infected animals, we consider:

<table>
<thead>
<tr>
<th>REGIONS</th>
<th>RISK of RVF occurrence</th>
<th>Countries</th>
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<tbody>
<tr>
<td>Eastern Africa</td>
<td>High-to-moderate</td>
<td>Whole region, particularly South Sudan, Ethiopia, Somalia, Kenya, Uganda, Tanzania</td>
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