Climate change and infectious livestock diseases:
The case of Rift Valley fever and tick-borne diseases

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Climate change influences the occurrence and transmission of a wide range of livestock diseases through multiple pathways. Here, we use two well-studied vector-borne diseases — Rift Valley fever (RVF) and tick-borne diseases (TBDs) — as case studies to describe pathways through which climate change influences infectious disease-risk in East and Southern Africa.

The case of Rift Valley fever and tick-borne diseases

Since the 19th century global average surface temperatures have risen steadily impacting:

- rainfall patterns
- intensity of droughts
- viability of ecosystems

Climate change influences the incidence and spatial distribution of livestock diseases either directly or indirectly

Direct impact: Increased risk of disease due to heightened vector-pathogen-host contact

Indirect impact: Changes in disease transmission patterns

Rift Valley fever (RVF)

Rift Valley fever (RVF) is a mosquito-borne viral zoonosis mainly affecting sheep, goats, cattle, buffaloes and camels but also humans.

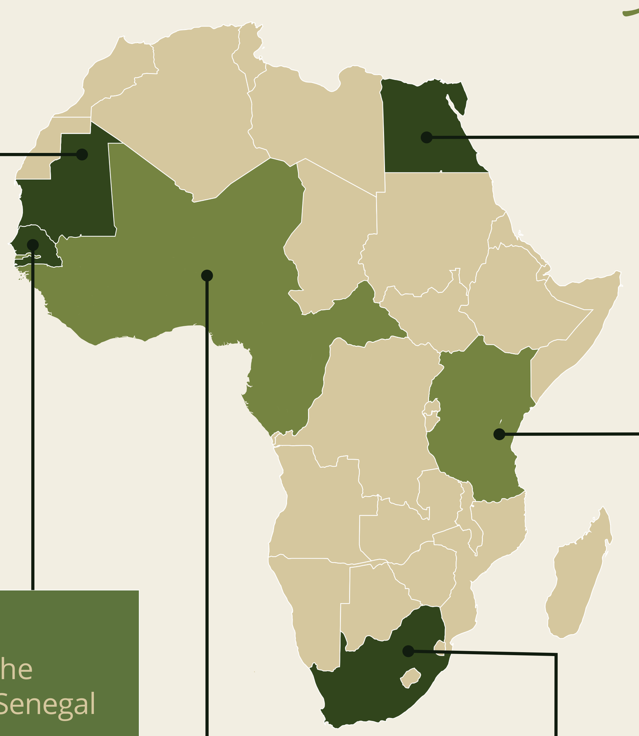
Key drivers of outbreaks of RVF

Following periods of above-normal precipitation (Kenya, South Africa, Tanzania and Uganda)

Relentless and widespread strong seasonal rainfall and high soil saturation (Southern Africa)

Warm phase of the El Niño /Southern Oscillation (ENSO) phenomenon in East Africa (Note: there have been a few incidences [e.g. in mid-1989] when an elevated RVF activity was not ENSO-driven)

Interlude between a dry period, lasting for about a week, and a period of heavy precipitation in Western Africa



MAURITANIA:
2009/2010: Outbreak affected small ruminants, camels and people due to a fourfold increase in rainfall in a desert region in northern Mauritania.

SENEGAL:
1987/1988: During the construction of the Senegal dam on the Senegal-Mauritania border.
2013/2014: RVF outbreak which was intensified by extensive livestock movements.

WEST AFRICA:
1998, 2003, 2010 and 2012: RVF outbreaks occurred after an interlude between a dry period, lasting for about a week, followed by a period of heavy precipitation.

EGYPT:
1977: Outbreaks of RVF associated with the construction Aswan High dam.

EAST AFRICA:
Mid-1989: Outbreaks associated with warm phase of El Nino/Southern Oscillation (ENSO) phenomenon although there have been a few incidences when an elevated RVFV activity was not ENSO-driven.
2006/2007: Outbreak of RVF.

SOUTH AFRICA:
2008 – 2011: RVF outbreaks were associated with relentless and widespread seasonal rainfall and high soil saturation.
Other: Outbreaks of RVF have been reported following flood irrigation in Orange River region and Western Cape Province.

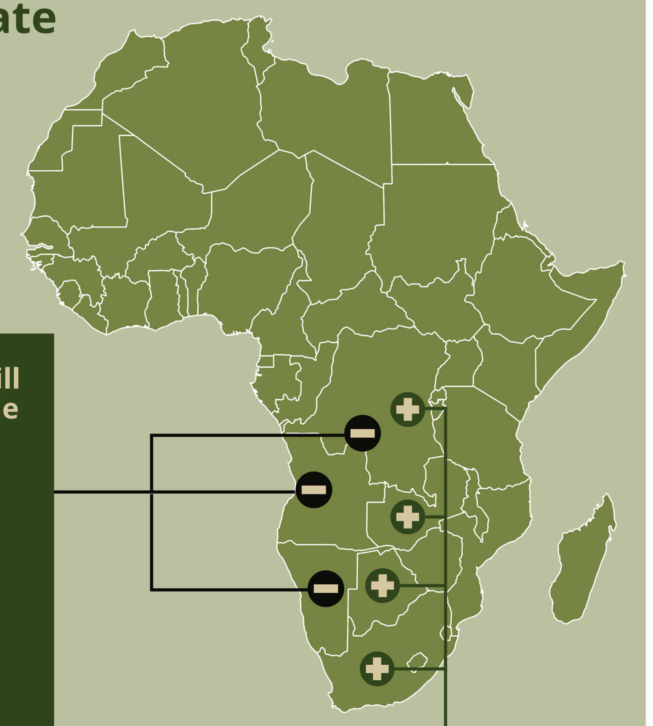
Changes in the distribution and frequency of above-normal precipitation increases the frequency of RVF epidemics.

Ticks and tick-borne diseases (TBDs)

Ticks are important vectors of a wide range of pathogens that cause many diseases in livestock such as:

- theilerioses
- cowdriosis
- anaplasmosis
- babesisosis
- ehrlichiosis
- coxiellosis (Q fever)
- Crimean Congo haemorrhagic fever
- East Coast fever

The effects of climate change on the distribution of ticks based on climate anomalies for 1990s vs 2020s



Increasing temperatures will make the climate unsuitable for ticks

Decrease
Western Angola
Southern DRC
Namibia

Increased rainfall and a rise in minimum temperatures will make the climate more suitable for ticks

Increase
South Africa
Botswana
Zambia
Eastern DRC

An increase in temperature would cause shifts in the spatial distribution of TBDs, with cooler and wetter areas expected to experience heightened risk with climate change.

Mitigations and adapatations

It is expected that the incidence and impacts of climate-sensitive diseases will increase. These diseases have established and alternative control measures in place.

Established control measures

- quarantine
- import bans
- identification and removal of suspicious animals
- premises surveillance and reporting
- vaccination
- disinfection
- compensation

However, deployment strategies are inadequate as the animal health delivery systems in most of these countries have deteriorated.

Challenges with vector control

Insecticides

any small reduction achieved is neutralised by re-emergence of large populations of naïve mosquitoes

Acaricides

tick resistance to acaricides is threatening to limit its effectiveness

Alternative control measures

- **use of tick vaccines (specifically for *Boophilus spp.*)**
- **immunization of animals through infection-and-treatment methods (ITM)**
- **breeding of TBD-resistant animals**
- **strategic use of acaricides**

RVF can be reliably controlled using livestock vaccination but delays in response do not provide beneficial outcomes. Studies are underway for alternative vaccination strategies for RVF that might involve periodic vaccination in the high-risk areas in place of reactive or emergency vaccinations.

Surveillance systems control measures

Efficient surveillance systems

- **promptly detect and report disease occurrence patterns for action**
- **guide the prioritization of interventions to geographical regions or periods where/when interventions would yield the best outcomes**

New surveillance systems

- **based on citizen science methods and cloud computing**
- **can help identify the distribution of infectious diseases**
- **provide input data for real-time disease forecasting**
- **are able to analyse surveillance data with climate and land use/land cover data as predictors to generate dynamic risk maps**

Climate change is expected to increase the risk of many vector-borne diseases, including RVF and TBDs as well as reduce the effectiveness of control measures such as vector control efforts. Further research needed in assessing the distribution of these diseases and investigating ways of managing them.

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