



RESEARCH UPDATE

SITUATION ANALYSIS

KENYA

The Dynamic Drivers of Disease in Africa Consortium is an ESPA¹-funded research programme designed to deliver much-needed, cutting-edge science on the relationships between ecosystems, zoonoses, health and wellbeing with the objective of moving people out of poverty and promoting social justice. This document offers a research update on the Consortium case study exploring the drivers of Rift Valley fever in Kenya.



Photo: Salome Wanyoike

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INTRODUCTION

Rift Valley fever (RVF) affects both animals and humans. The disease is zoonotic (passed from animals to humans), and is caused by the RVF virus (RVFV). The virus is transmitted by mosquitoes or through contact with body fluids of infected animals.



MOSQUITO

Photo: T. Jonsson

In Kenya, where the [Dynamic Drivers of Disease in Africa Consortium](http://www.driversofdisease.org) (www.driversofdisease.org) is working, RVF is endemic. There are also periodic epidemic outbreaks. The emergence and spread of RVF is influenced by climate change and land-use patterns. As dry savannah grasslands are irrigated to create crop lands, and climate change forces pastoralists to migrate to high-risk mosquito-populated areas, answers to questions surrounding RVFV transmission and emergence are becoming increasingly urgent.

A holistic understanding of RVF will be essential to its management. For this reason, Drivers of Disease researchers are using interdisciplinary methods to investigate the large variety of factors – from genetic to habitat level – which play a role in RVF ecology and dynamics.

KEY QUESTIONS

The research is exploring how land-use variation (in particular irrigation) and climate change affect ecosystem and biodiversity changes and so affect RVFV occurrence and its transmission.

Specific questions for the research include:

- How does irrigation modify the biodiversity of pastoral areas?
- Specifically, does irrigation affect the population dynamics of mosquito species associated with RVFV transmission?
- Are livestock populations and people at greater risk of RVFV infection from proximity to irrigation schemes, and if so which groups of livestock and people?
- How does the impact of RVF on health, wellbeing and economy differ qualitatively and quantitatively in areas undergoing land-use change from those in little-altered areas?
- How do people interact with ecosystems as they pursue their livelihoods and how does this influence the risk of their exposure to RVF?
- How do people understand and experience RVF? How does it contribute to the health burden in general?
- What RVF control measures are there, and how do they influence RVF transmission?

BACKGROUND

RVFV was first identified in Kenya in the 1930s but is now endemic in much of Africa. In recent years it has spread to Madagascar, Saudi Arabia and Yemen, and it is increasingly recognised as a major transboundary disease threat.

In East Africa, sudden RVF outbreaks can follow periods of prolonged heavy rainfall. In most cases the disease causes a mild, flu-like illness in people but in up to 20 per cent of cases it can be severe, resulting in haemorrhagic fever, encephalitis or retinitis. It can be fatal. The disease in livestock – mainly sheep, goats, cattle and camels – primarily causes abortions and perinatal mortality, but disease manifestation varies across livestock species.

Pastoralist communities who are dependent on livestock for their food (mainly milk, meat and blood) are most severely affected by RVF outbreaks. Additionally, quarantine measures and related bans on eating livestock products during disease outbreaks mean pastoralists cannot trade or exchange livestock to buy other foods.

Interventions in epidemics include bans on the slaughter of animals, animal quarantines, restrictions on animal movements, mosquito spraying, disease surveillance and public health messages. Outbreaks of RVF in animals can be prevented by a sustained programme of animal vaccination. However, during epidemics mass vaccination is not recommended.



TANA DELTA

Photo: Bernard Bett

Tana River County, where Drivers of Disease researchers are working, is an arid/semi-arid area inhabited by nomadic societies, who live in the mainland, and crop farmers, who settle in the irrigation schemes that have been developed adjacent to the river. The riverine vegetation also serves as a dry season grazing ground for the nomadic communities. There have been frequent rivalries between these communities as each seeks unfettered access to the river, Kenya's longest. Because of these rivalries, security in the region has deteriorated and delivery of services, e.g. public health and

veterinary services, has been affected. The area also lies within a livestock migratory corridor, often used to transport or trek livestock from northern Kenya, Ethiopia or Somalia to the coastal areas where demand for livestock products is high. The area therefore gets exposed to multiple transboundary animal diseases. African animal trypanosomiasis (AAT), or *nagana*, is also prevalent due to the presence of tsetse fly.

KNOWN AND UNKNOWN

In eastern and southern Africa, RVF epidemics are known to occur after periods of exceptionally heavy rainfall in grassland areas with shallow depressions, known as *dambos*. Indeed, data analysis indicates that the disease in livestock is associated with factors that cause or exacerbate flooding. These include, in addition to rainfall, poor-draining soil types, low altitude and thick vegetation. Flooding creates ideal conditions for mosquito breeding and development. Animals are exposed to the virus when they come into contact with infected mosquitoes while either drinking or grazing around the *dambos*.

Any factor affecting mosquito population dynamics is going to affect RVFV transmission. These factors include climatic changes, with RVF outbreaks closely linked to the El Niño/Southern Oscillation (ENSO) phenomena. Extreme temperature increases and rainfall also affect mosquito populations.

It is known that irrigation schemes bring about similar ecological changes to those experienced in flooded *dambos*, especially those flood irrigation technologies for growing crops such as rice. No studies have been carried out to show the relationship between RVF and the development of irrigation schemes in Kenya but a number have shown a significant increase in mosquito numbers in irrigated areas as well as changes in mosquito species.

The flight range of mosquitoes is also an important factor in transmission dynamics, and it is expected that animal movements would play an even greater role in spreading RVF. Exactly how is not yet determined. This is an important area of inquiry given the nomadic lifestyle of pastoralists, as well as the international trade of livestock and livestock products.

In general, little is known about the processes that promote RVFV emergence and transmission. RVFV has been isolated from more than 40 species of mosquitoes but it remains unknown exactly how each vector differs in its capacity to sustain and transmit RVFV. Previous outbreak history is known to be a significant RVF risk factor, with areas that have experienced an outbreak in previous years having a higher chance of presenting a new outbreak in the future. A low level of viral activity occurs during normal wet seasons between epidemics but the importance of this phenomenon in maintaining the virus has not been investigated.

A comprehensive knowledge of RVFV transmission and maintenance is complicated by the fact that disease dynamic varies across ecological zones – with different mosquito and susceptible species, each with its own biological and behavioural properties, responsible for transmission in different ecozones. This may make transmission patterns especially sensitive to ecosystem changes. Studies indicate that during the first half of the last century Zimbabwe acted as a hub from which RVFV spread, with Kenya becoming the epicentre of RVF epidemics during the second half of the century. However, it is not known what ecological changes, if any, led to the decline of RVF risk in countries like Zimbabwe.

Finally, it is known that most people become infected following a bite from an infected mosquito or after intensive contact with acutely infected animals or infected tissues. Therefore, herders, farmers, slaughter-house workers and veterinarians represent particularly high-risk occupations. There is also

some evidence indicating that people may acquire the disease by drinking unpasteurised or uncooked milk from infected animals. How socio-cultural and political factors such as livelihood patterns, social status, festivals, community knowledge and awareness are linked to disease outbreak and patterns have yet to be fully explored, though studies show that knowledge in pastoral communities on risk practices such as eating raw meat, drinking raw milk, touching and herding aborted animals and consuming products from such animals remains limited.

CASE STUDY METHODOLOGY

The Kenya Drivers of Disease team is undertaking multidisciplinary research in Bura and Hola irrigation schemes in Tana River County and in Ijara division, a pastoral rangeland in Ijara district. The objective is to explore and compare the ecology and transmission processes behind RVF in those two systems. Ijara is being used as a control site as the land-use changes occurring here are at a much slower pace than in Tana River County, where the Government, through the National Irrigation Board, is expanding irrigation schemes. Both sites are in an RVF endemic area and have high poverty levels. They are representative of many other dry savannah grasslands that are being converted into crop lands through irrigation.



PARTICIPATORY RESEARCH *Photo: Johanna Lindahl*

Researchers are using cross-sectional and longitudinal participatory methods to understand the complex interactions that link people's livelihood practices and landscape features with risk and vulnerability to disease, and hence poverty and wellbeing. Contemporary and historical data on people (differentiated by gender, age, ethnicity, wealth and social status), livestock and health are being collected.

Field activities and data analysis is being guided by process-based models, which integrate all the components of the disease system, including ecological, epidemiological, entomological and socio-economic factors. Approaches to be used range from collation of historical data to assess trends in land-use change and disease prevalence in animals and people, to mapping and modelling ecosystem services to analyse and predict changes in ecosystem services in time and space, to fieldwork to collect new data. Social, economic and environmental values are also being explored using, for example, questionnaires, impact analyses, simulation studies and cost-effectiveness analyses.

Researchers are also undertaking a range of activities to demonstrate linkages between ecosystem functions, services and RVF risk.

Finally, the three modelling approaches – participatory, process-based and empirical spatial disease modelling—will be used for a holistic, multidisciplinary investigation of the RVF transmission processes.

PATHWAYS TO IMPACT

Internationally, RVF is increasingly being recognised as a major disease problem. In Kenya, its burden is particularly severe. Kenya is classified as one of the most food insecure countries, with about 10 million people living on food relief. An ongoing study estimates RVF may add up to 340 Disability Adjusted Life Years (DALYS) per 100,000 inhabitants. New understandings of how people are exposed to RVFV will highlight new opportunities to develop interventions decreasing people's risks of infection and so alleviate the poverty impacts this disease brings.

Drivers of Disease researchers are entering into dialogue with a wide range of stakeholders in health, environment and development at the local, national and international levels. The intention is that the research can inform policy and practice, as well as increase scientific understanding. This will promote greater joined-up action across government departments and other relevant agencies, so that effective [One Health](http://www.onehealthinitiative.com) (www.onehealthinitiative.com) policies can be pursued which will enhance health for animals, people and the environment.

FURTHER INFORMATION

For more information on the work of the Dynamic Drivers of Disease in Africa Consortium:

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