Climate Change and Zoonoses Adaptation and Mitigation – learning from RVF and HPAI

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Presentation Outline

- Overview on climate and zoonoses
- Adaptation and mitigation tools (risk mapping and early warning)
  - ✓Rift Valley fever
  - ✓Avian influenza
- Lessons learnt

Outline

Host(s), pathogen, environment interaction

Warmer, wetter, wider variation → sicker?

	Warmer	Wetter / (drier)	Wider variation
D	↑growth rate ↓ generation time ↑ ↓ survival ↑ season ↑ activity	↑ ↓ Survival in air ↑ Fecal-oral transmission ↑ Movement in water	Post disasters disease Endemic instability Spread/shrinkage
I	Wildfires Air Pollution (O_3, PM, GHG) Nuisance Plants More intense air movement	Change farming systems Population movements Increase in biomass Change trade patterns	

25 Major Human Diseases – 17 Zoonoses

Malaria

Cholera

Meningococcal meningitis

Leishmaniasis

Dengue

Japanese encephalitis

St Louis encephalitis

Rift Valley Fever

Ross River Fever

Murray Valley Fever

Influenza

Diarrhoea

Filiariasis

Int. nematodes

Sleeping sickness

Chagas

West Nile

Yellow Fever

Lyme disease

Schistosomiasis

STDs

Trachoma

Tuberculosis

River blindness

Childhood disease

High climate sensitivity

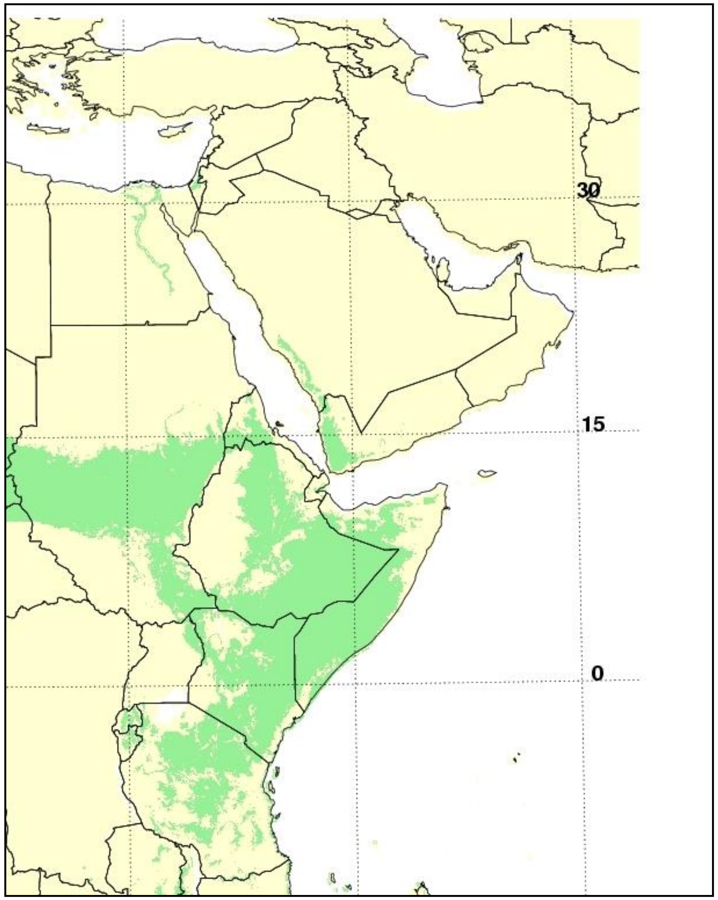
- **Of 1500 human infectious diseases, 58-65% zoonotic**
- **Of around 150 to 200 EID, 75% are zoonotic**
- **One new disease emerges every 7 months**

Rift Valley Fever

- Arbovirus, mosquito vector (*Aedes*)
- Ruminants (domestic, wild)
- Zoonotic (mild fevers, <1% severe)
- **Strong climate related risk factors:** vector populations, host populations, high rainfall, flooding, temperature
- **Climate sensitivity:** high

Risk Maps and RVF Early Warnings 06/07

Did they help with prevention/ early detection?



Assaf Anyamba and DoD-GEIS & NASA Goddard Space Flight Center Rift Valley Fever Monitoring Team.

EMPRES WATCH

emergency prevention systems

Possible RVF activity in the Horn of Africa

1. Introduction

Rift Valley fever (RVF) is an arthropod-borne viral disease of ruminants, camels and humans. It is a significant zoonosis which may present itself from an uncomplicated influenza-like illness to a haemorrhagic disease with severe liver involvement and ocular or neurological lesions. In animals, RVF may be unapparent in non-pregnant adults, but outbreaks are characterised by the onset of abortions and high neonatal mortality. Transmission to humans may occur through close contact with infected material (slaughtering or manipulation of runts), but the virus (Phlebovirus) is transmitted in animals by various arthropods including 6 mosquito genus (*Aedes*, *Culex*, *Mansonia*, *Anopheles*, *Coquillettidia* and *Eretmapodites*) with more than 30 species of mosquitoes recorded as infected and some of them been proved to have a role as vectors. Most of these species get the infection by biting infected vertebrates, yet some of these (specifically *Aedes* species) transmit the virus to their eggs. These infected pools of eggs can survive through desiccation during months or years and restart the transmission after flooding, and then other species (*Culex* spp.) may be involved as secondary vectors.

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This vertical infection explains how the disease can persist between outbreaks.

RVF virus (RVFV) is recorded to occur from South Africa to Saudi Arabia including Madagascar, in varied bioclimatic ecotypes, ranging from wet and tropical countries such as the Gambia, irrigated regions such as the Senegal River Valley or the Nile Delta, to hot and arid areas such as Yemen or Chad. The occurrence of RVF can be endemic or epidemic, depending on the climatic and vegetation characteristics of different geographic regions. In the high rainfall forest zones in coastal and central African areas it is reported to occur in endemic cycles which are poorly understood. Currently available evidence suggests that this may happen annually after heavy rainfall, but at least every 2-3 years otherwise. In contrast, in the epidemic areas in East Africa, RVF epidemics appear at 5 to 15 year cycles. These areas are generally relatively high rainfall plateau grasslands, which may be natural or cleared from forests. In the much drier bushed Savannah grasslands and semi-arid zones, which are characteristic for the Horn of Africa, epidemic RVF has manifested itself only a few times in the past 40 years, in 1961-62, 1982-83, 1989 and in 1997-1998.

In addition the possibility exists that RVFV may spread outside traditionally endemic areas, or even out of the continent of Africa, mostly due to the large range of vectors capable of transmitting the virus and requires a level of viraemia in ruminants and humans that is sufficiently high to infect mosquitoes. Such a situation occurred following the unusual floods of 1997-1998 in the Horn of Africa countries, and subsequently the disease spread to the Arabian Peninsula in 2000.

2. Disease ecology and climatic drivers in the horn of Africa

The ecology of RVF has been intensively explored in East Africa. Historical information has shown that pronounced periods of RVF virus activity in Africa have occurred during periods of heavy, widespread and persistent

Mean Intervals Between Key RVF Events: Kenya 2006/7

start of heavy rains and appearance of mosquito swarms	23.6 days
first appearance of mosquito swarms and first suspected RVF case in livestock	16.8 days
first suspected RVF case in livestock and first suspected human case	17.5 days
first suspected RVF case in livestock and first veterinary service response	61.7 days
first suspected RVF case in livestock and first public health service response	50.0 days
first suspected human case and first public health service response	30.0 days

Kenya 06/07 RVF Timeline

September			October			November (EMPRES warning)			December			January		
early	mid	late	early	mid	late	Early	mid	late	early	mid	late	early	mid	late
	1st significant rains, Saingilo, according to herders		1st mosquito swarms according to herders		1st livestock cases, Ijara, Kotile, Fafi, according to herders	1st human cases Ijara, Kotile, Fafi, according to herders		30 Nov human index case according to WHO trace back	4 Dec First DVO record of herder report, outbreak start date as reported to OIE	17 Dec First vet service intervention (Garissa market closure)	22 Dec Vet lab confirmation	8 Jan Start of livestock vaccinations as part of MOH, MOA, NGO mixed team response using helicopters provided by MOH		

40 days from Rains to 1st Cases - Prevention with Vaccine?

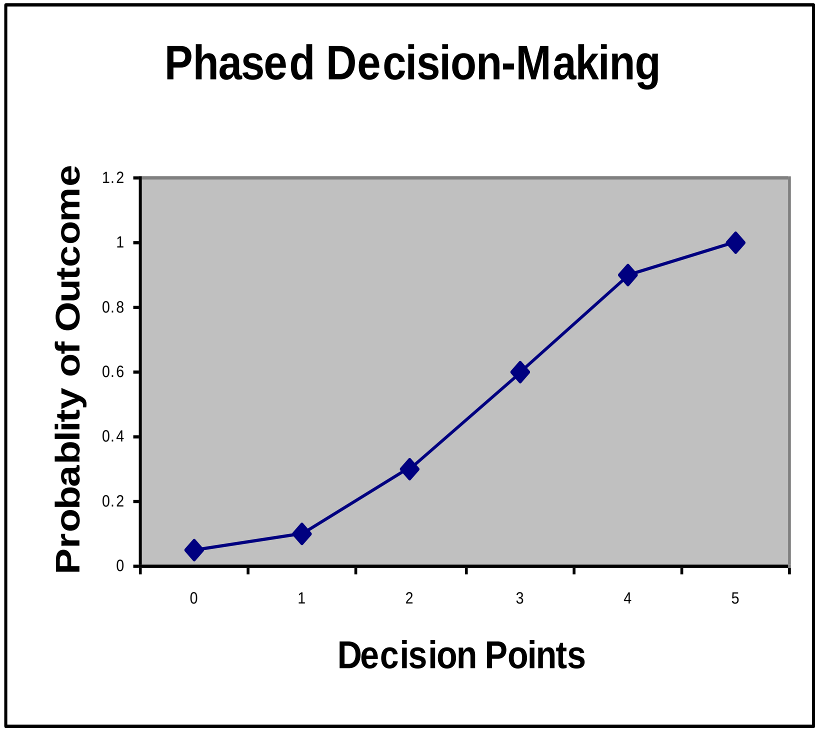
Ksh 2.1 billion (US$32 million)

7 May

Time between each pair of outcomes (days)	Outcome
141	**Total days lapsed before herd immunity achieved**
7	Target livestock population immune
20	Completion of vaccination campaign
7	Start of vaccination campaign in targeted high risk area: 100,000 animals, 2 vaccination teams each of 5 persons; 2,500 animals vaccinated per day per team
7	Movement of vaccine from central store to high risk area
3	Vaccine delivery and stock management at central level
90	Shipment of vaccine
7	Manufacturer receives order and starts vaccine production
	Vaccine ordered

Progressive Risk Mitigation

- **Risk** = consequence x probability of outcome
- Probability increases at each **decision point** of a disease event
  - ✓ Justification for investment in risk mitigation increases
  - ✓ Risk of making the wrong decision decreases



Progressive Risk Mitigation – RVF Decision Support Tool

Decision-support tool for prevention and control of Rift Valley fever epizootics in the Greater Horn of Africa

This decision-support tool is an output of a joint ILRI/FAO consultative process funded by USAID OFDA under the project OSRO/RAF/706/USA

Version 1
December 2008

Sequence of events related to RVF epizootics in the Greater Horn of Africa:

1. Normal situation between outbreaks
2. Early warning of RVF issued (such as GEIS) and/or early warning of heavy rain by national meteorological departments
3. Localized, prolonged heavy rains reported by eye-witnesses
4. Localized flooding reported by eye-witnesses
5. Localized mosquito swarms reported by eye-witnesses
6. First detection of suspected RVF in livestock by active searching and/or rumours from herders
7. Laboratory confirmation of RVF cases in livestock
8. First rumour or field report of human RVF case
9. Laboratory confirmation of first human RVF case
10. No new human cases for 6 months
11. No clinical livestock cases for 6 months
12. Post-outbreak recovery and reflection
13. Normal situation between outbreaks

2008 – have we learned?

- Kenya RVF contingency plan
- Decision support tool
- **EMPRES warning in September**
- **Kenya technical coordination committee** – GoK (MOPHS, DVS, Meteo, KEMRI, KARI, KWS), KVA, IBAR, FAO, ILRI, NGOs, donors, bilaterals….
  - Response project concept paper for donors
  - Monitoring and surveillance
  - RVF alerts to field staff
  - Vaccination protocol
  - Quarantine protocol
  - Vector control protocol
  - Weekly forecast updates
- EWS closer to empowering decision makers

EMPRES WATCH

emergency prevention system

Climate models predict increased risk of precipitations in the Horn of Africa for end of 2008

FAO and WHO warn countries in Africa and the Arabian Peninsula that Rift Valley Fever may strike again at the end of 2008

1. INTRODUCTION

Rift Valley Fever (RVF) is an arthropod-borne viral disease associated with high rates of abortion and neonatal mortality in ruminants and influenza-like illness in humans that may progress to neurologic, ocular, or hemorrhagic disease and death. The vast majority of human infections result from direct or indirect contact with the blood or organs of infected animals. Human infections have also resulted from the bites of infected mosquitoes. Ruminant infections occur in areas of high competent vector populations. Adult animals may be asymptomatic or develop mild disease that is typically first noted with the occurrence of abortions in the flock but some breeds, especially local ones, are more resistant to disease. Neonatal and young animals are more severely affected with a high mortality rate. The disease is transmitted by several different types of arthropod vectors (*Culex*, *Aedes*, *Anopheles*, *Mansonia*, *Eretmapodites*, *Culicoïdes*), with mosquitoes of the *Aedes* genus serving as the virus reservoir in nature through transovarial transmission. These infected eggs can survive through years of drought or desiccation. During increased precipitation, low-lying mosquito-breeding habitats are flooded, and the reservoir vectors re-emerge. Then the virus is amplified in domestic ruminant hosts, additional arthropod species can transmit the virus to other susceptible hosts including man. This increase of viral activity initiates a rapid spread of the disease.

RVF has been documented in most sub-Saharan African countries, as well as Egypt and the Arabian Peninsula. The virus occurs in a variety of ecotypes and can spread to new geographic areas with animal movement. Previously affected areas must be considered endemic. In rainforest ecological zone, such as central African countries, the disease can be observed regularly with low incidence of disease. In semi-arid and arid regions of the Horn of Africa, large epidemics of RVF occur following periods of unusually high rainfall and flooding in 5 to 15 year cycles that have been associated with global climatic events and especially El Niño. Once spread to a new area, RVF can cause significant disease and economic loss in an immunologically naïve animal population. This scenario has occurred several times in newly affected areas, such as the emergence of RVF in 1977 in Egypt or in 2000 in the Arabian Peninsula.

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2. CLIMATIC FORECASTING OF DISEASE

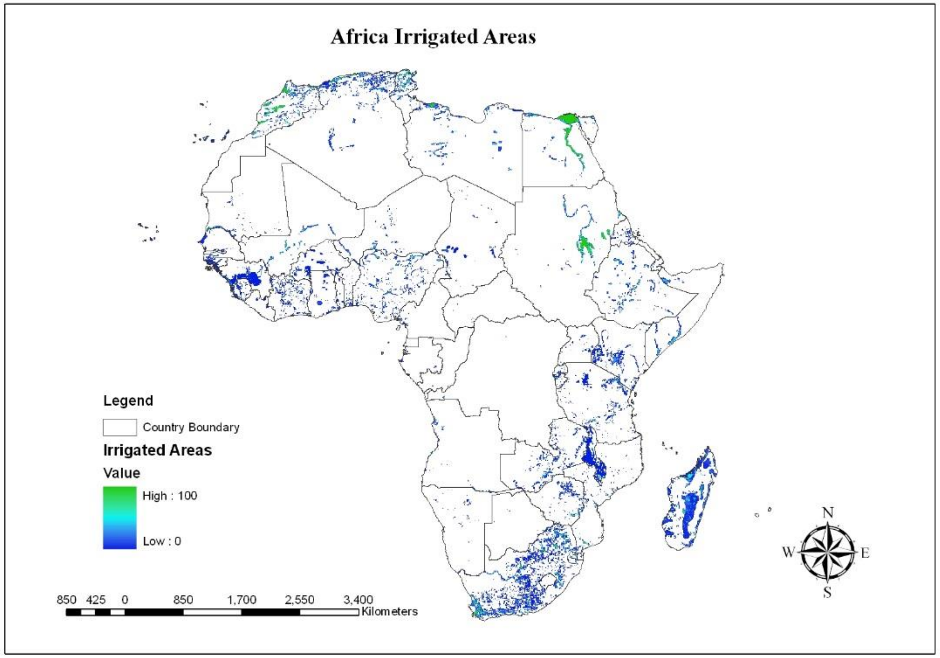
The disease ecology of RVF in East Africa has been extensively studied. Following a period of persistent, heavy rainfall, the breeding habitats of *Aedes* floodwater species, such as the temporary ground pools known as *dambos* in Kenya, become flooded and promote the hatching of mosquito eggs. Eggs lain by RVF infected females harbour the virus and produce adult mosquitoes capable of infecting vertebrate hosts and propagating disease outbreak.

Historical data regarding sea-surface temperatures (SST) have found an association between anomalous SST, where the difference between weekly SST and historical average SSTs is measured, and heavy rainfall in East Africa. Concurrent positive western Indian Ocean SST anomalies and equatorial Pacific SST anomalies have occurred in conjunction with significant disease outbreaks in 1982-3, 1997-8, and 2006-7. Such events have also been associated with *El Niño* events and more recently with a positive Indian Ocean Dipole (IOD) event, which may occur in concert with or independent of an *El Niño* event. A positive IOD occurs when the Western Indian Ocean experiences abnormally high sea-surface temperatures and the Eastern Indian Ocean shows abnormally low sea-surface temperatures, causing a change in tradewind patterns to concentrate precipitation over the North Western Indian Ocean and bordering land areas (Figure 1). Such positive IOD events have been linked to prolonged heavy rainfall in East Africa and subsequent positive anomalies in vegetation indices, leading to disease outbreaks of Rift Valley Fever due to a surge in vector populations in flooded areas.

H5N1 HPAI

- Influenza Type A
- Poultry, waterfowl, other bird species
- Zoonotic (↓↓↓ morbidity, ↑↑↑ mortality)
- Weak climate related risk factors: wild birds, water points, human movements, human and poultry population densities
- Climate sensitivity: Medium

Risk Maps and HPAI Prevention/Early Detection



Risk mapping for HPAI in Africa in its infancy, and will not be a magic solution to mitigation - targeted, integrated surveillance and effective control policies are the keys

What it represents:

Irrigated areas represent sites of cultures/crops under man-made irrigation. Since irrigated areas are a focus for agricultural activities, they are typically in close proximity to human residences and associated domestic bird populations. These areas can also be used as resting / feeding sites by wild birds (migratory or resident). They can therefore represent sites of animal mixing within domestic bird population and between domestic birds and other wild birds.

What it does not represent:

- These data do not represent areas of poultry breeding.
- These data do not represent conventional resting sites for wild birds

Recommendations for use:

Use irrigated areas data as potential factor for the risk of virus spread within domestic poultry population.

Strategy for further development:

Potential overlapping with wetland needs to be checked. If the differentiation of wetlands according to their relationship with the risk of spread of the disease is achieved, "irrigated areas" can be included in the differentiation.

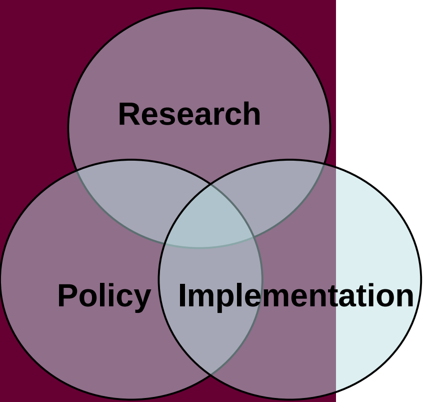
Data source: FAO

Kenya 06/07 RVF Cases by Wealth Group

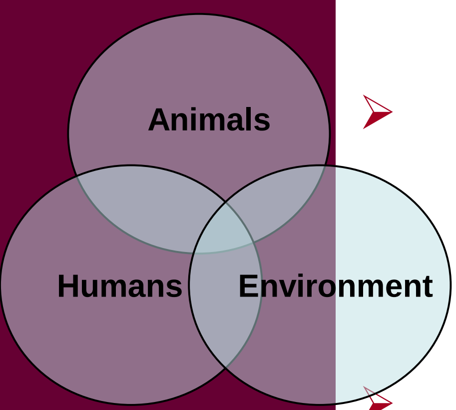
Wealth Rank	Garissa	Kilifi
Very poor	50%	40%
Poor	35%	40%
Middle	15%	15%
Wealthy		5%

- Majority were less than forty years
- Resided in rural areas of the districts
- 20-60% loss of work productivity reported in surviving cases

Lessons Learnt



- **Adaption and Mitigation**
  - ✓ ***Risk based decision making*** in animal and public health institutions
    - ***Risk of disease*** *outbreak*
    - ***Risk to decision makers*** from taking prevention and control measures
  - ✓ ***Appropriate level of technology***
    - Technology should be ***accessible and timely***
    - Most important are functional ***systems and policies*** for disease surveillance and control
    - ***Participatory approaches***



- **Advocacy** – ***soft skills***
  - ✓ Communication and prioritization skills are just as important as technical skills, and are key to ***institutional change***
  - ✓ Zoonoses are diseases of ***poverty***, and often neglected
- **Approach** – ***One Health***