Rift Valley fever outbreaks in Africa and Middle east: forecasting, surveillance and control

Crédit photos
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RVF Workshop

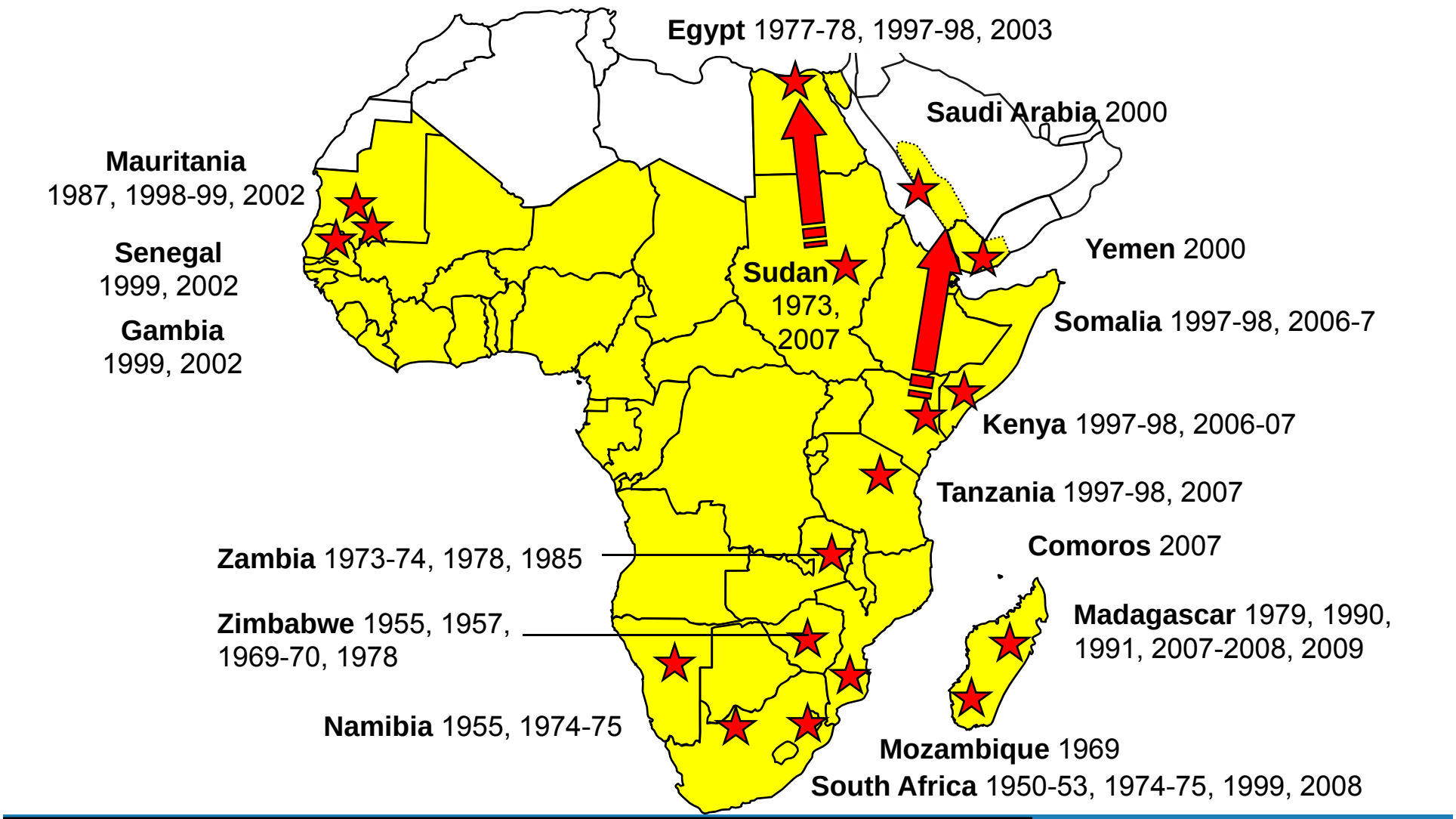
P. Formenty and S. De la Rocque – 27 January 2009
Cairo, Egypt

Rift Valley fever outbreaks

- Background on RVF
- The 3 times of the strategy to detect and control RVF outbreaks
- Forecasting
- Surveillance
- Outbreak control

Rift Valley Fever the virus

Rift Valley Fever distribution, outbreaks and spread



Rift Valley Fever history

- **1912, description of the disease in livestock in Kenya.**
- **1931, RVF virus isolated by Daubney in Kenya.**
- **Until 1977, known in South and East Africa with severe epizootic in animals. In Human was described as a benign disease (dengue like). Until 1975 only one human death was reported.**

Rift Valley Fever history

Since 1977

- Egypt 1977: 600 deaths, 2000 cases hosp, 20.000 infect°
- Mauritania Senegal 87,
- Madagascar 90, Egypt 93,
- Enzootic in West and central Africa
- 1997-98, Somalia, Kenya and Tanzania (flooding)
- 2000, Saudi Arabia and Yemen
- 2006-07, Somalia, Kenya and Tanzania
- 2007-08, Sudan, Comoros, Madagascar
- 2009, Madagascar

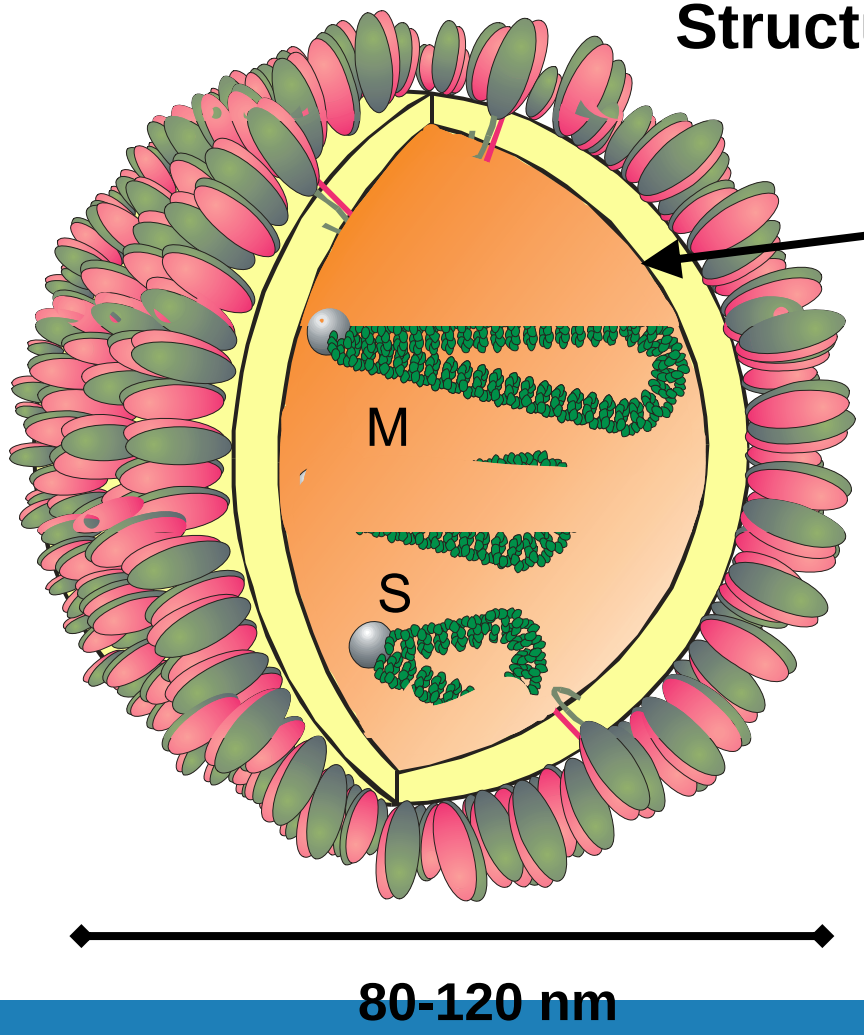
Rift Valley Fever

- **Family Bunyaviridae, genus Phlebovirus, RNA virus**
- **Vector = mosquitoes**
- **BSL 4 or 3**
- **Incubation 2-6 days**
- **Zoonosis**
- **Case Fatality Ratio 1-20%**

- **Vaccines Animal & experimental vaccine in Human**
- **Treatment symptomatic and specific:**

  Red cells, platelets, rehydratation, electrolytic balance, intensive care.

Rift Valley Fever



Structure of Bunyaviridae particle

Lipid envelope

G1: glycoprotein 1

G2: glycoprotein 2

N: nucleoproteins

L: RNA polymerase

Rift Valley Fever: transmission

- **Transmission**

  Most human infections due to direct or indirect contact with infected animal blood or organs (e.g. liver, spleen) (farmers, slaughtering house, veterinarians, etc…)

  Mosquito bites : *Aedes caballus, A. theileri, A. circumluteolus, Culex pipiens, Eretmapodites spp.*

  Laboratory infection frequent

  No person to person transmission has been documented

- **Amplification**

  Amplification during epizootics in animal : cattle, sheep, goats, camels

Rift Valley Fever: vectors

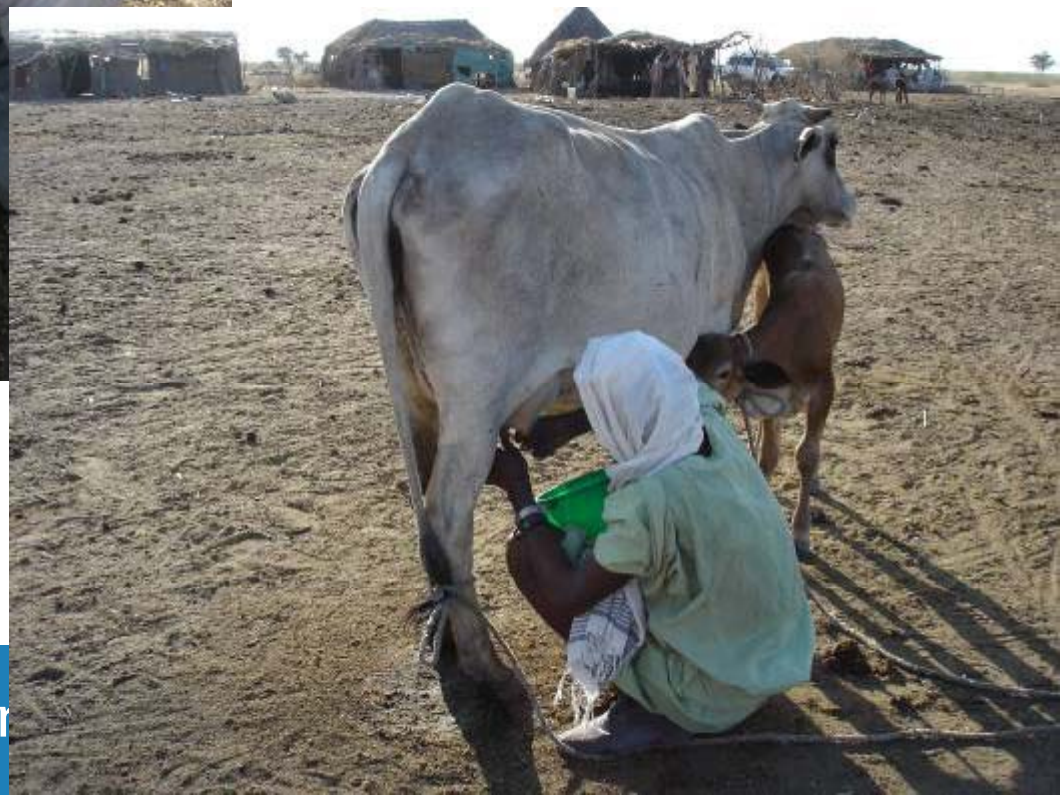
Genus (Subgenus)	Species	Locality (year)	Reference
Aedes (*Aedimorphus*)	*cumminsii*	Kenya (1981-84)	Linthicum *et al.* (1985b)
		Burkina Faso (1983)	Saluzzo *et al.* (1984)
	dalzieli	Senegal (1974, 1983)	Fontenille *et al.* (1998)
	dentatus	Zimbabwe (1969)	McIntosh (1972)
	durbanensis	Kenya (1937)	Mulligan (1937)
	ochraceus	Senegal (1993)	Fontenille *et al.* (1995)
	tarsalis	Uganda (1944)	Smithburn *et al.* (1948)
	vexans arabiensis	Senegal (1993)	Fontenille *et al.* (1995)
		Saudi Arabia (2000)	Jupp et al. (2002)
Aedes (*Neomelaniconion*)	*circumluteolus*	Uganda (1955)	Weinbren *et al.* (1957)
		South Africa (1955)	Kokernot *et al.* (1957),
		South Africa (1981)	Jupp *et al.* (1983)
	macintoshi	Zimbabwe (1969)	McIntosh (1972)
		South Africa (1974-75)	McIntosh *et al.* (1980a)
		Kenya (1981-84)	Linthicum *et al.* (1985b)
	palpalis	Central African Republic (1969)	Digoutte *et al.* (1974)
Ochlerotatus [1] (*Ochlerotatus*)	*caballus*	South Africa (1953)	Gear *et al.* (1955)
	caspius [2]	Egypt, suspected (1993)	Turell *et al.* (1996)
	juppi	South Africa (1974-75)	McIntosh *et al.* (1980a)
Aedes (Stegomyia)	*africanus*	Uganda (1956)	Weinbren *et al.* (1957)
	demeilloni/dendrophilus	Uganda (1944)	Smithburn *et al.* (1948)
Aedes (Diceromyia)	*furcifer* group [3]	Burkina Faso (1983)	Saluzzo *et al.* (1984)
Anopheles (*Anopheles*)	*coustani*	Zimbabwe (1969)	McIntosh (1972)
		Madagascar (1979)	Clerc *et al.* (1982)
	fuscicolor	Madagascar (1979)	Clerc *et al.* (1982)
Anopheles (Cellia)	*christyi*	Kenya (1981-84)	Linthicum *et al.* (1985b)
	cinereus	South Africa (1974-75)	McIntosh *et al.* (1980a)
	pauliani	Madagascar (1979)	Clerc *et al.* (1982)
	pharoensis	Kenya (1981-84)	Linthicum *et al.* (1985b)
	squamosus	Madagascar (1979)	Clerc *et al.* (1982)
Culex (Culex)	*spp.* [4]	Madagascar (1979)	Clerc *et al.* (1982)
	antennatus	Nigeria (1967-70)	Lee 1979
		Kenya (1981-84)	Linthicum *et al.* (1985b)
	neavei	South Africa (1981)	McIntosh *et al.* (1983)
	pipiens	Egypt (1977, 1978)	Hoogstraal *et al.* (1979)
		Egypt (1977, 1978)	Meegan *et al.* (1980)
	poicilipes	Senegal (1998)	Diallo *et al.* (2000)
	theileri	South Africa (1970)	McIntosh (1972)
		Zimbabwe (1969)	McIntosh (1972)

World Health Organization

Rift Valley Fever: transmission

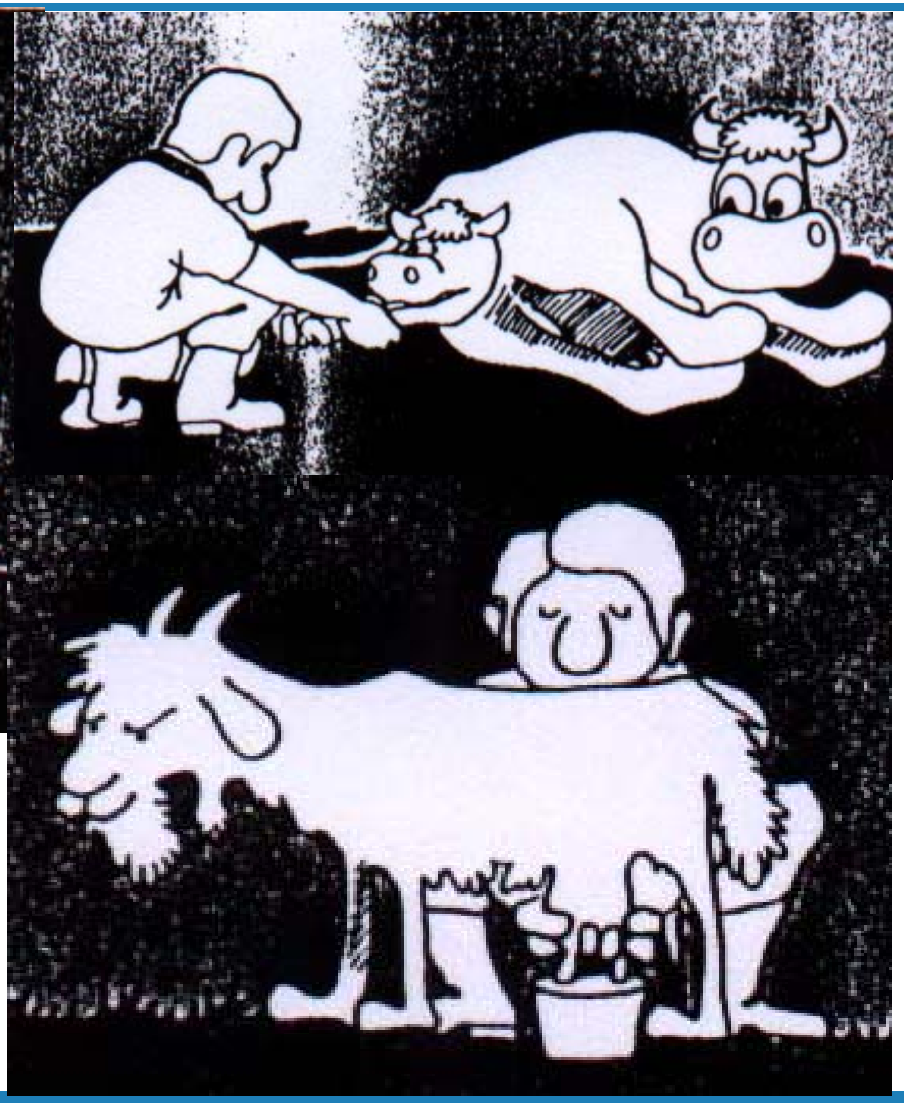
Rift Valley Fever: transmission

Veterinarians
Animal autopsy



Herdsman milking animal

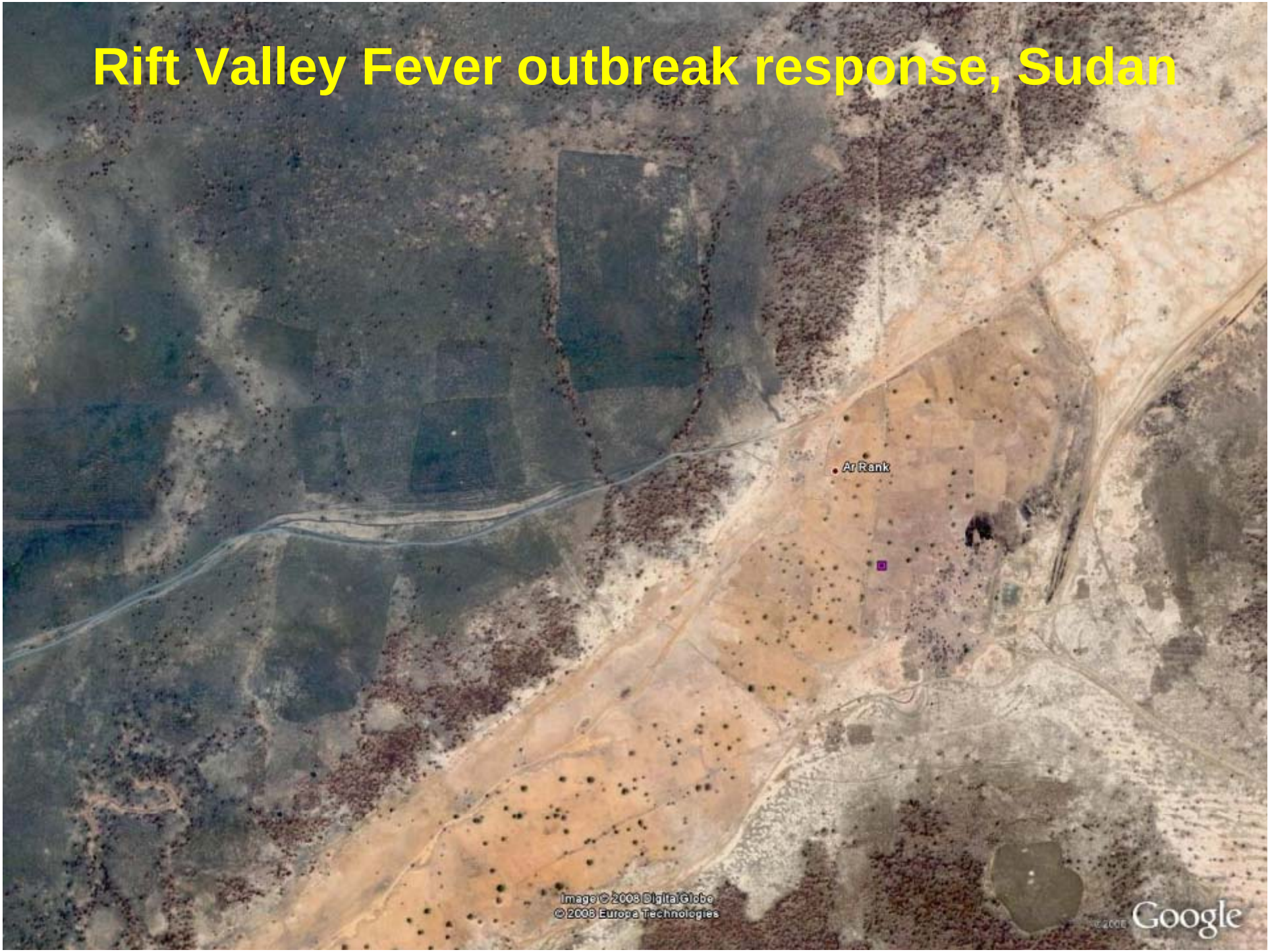
Rift Valley Fever: transmission



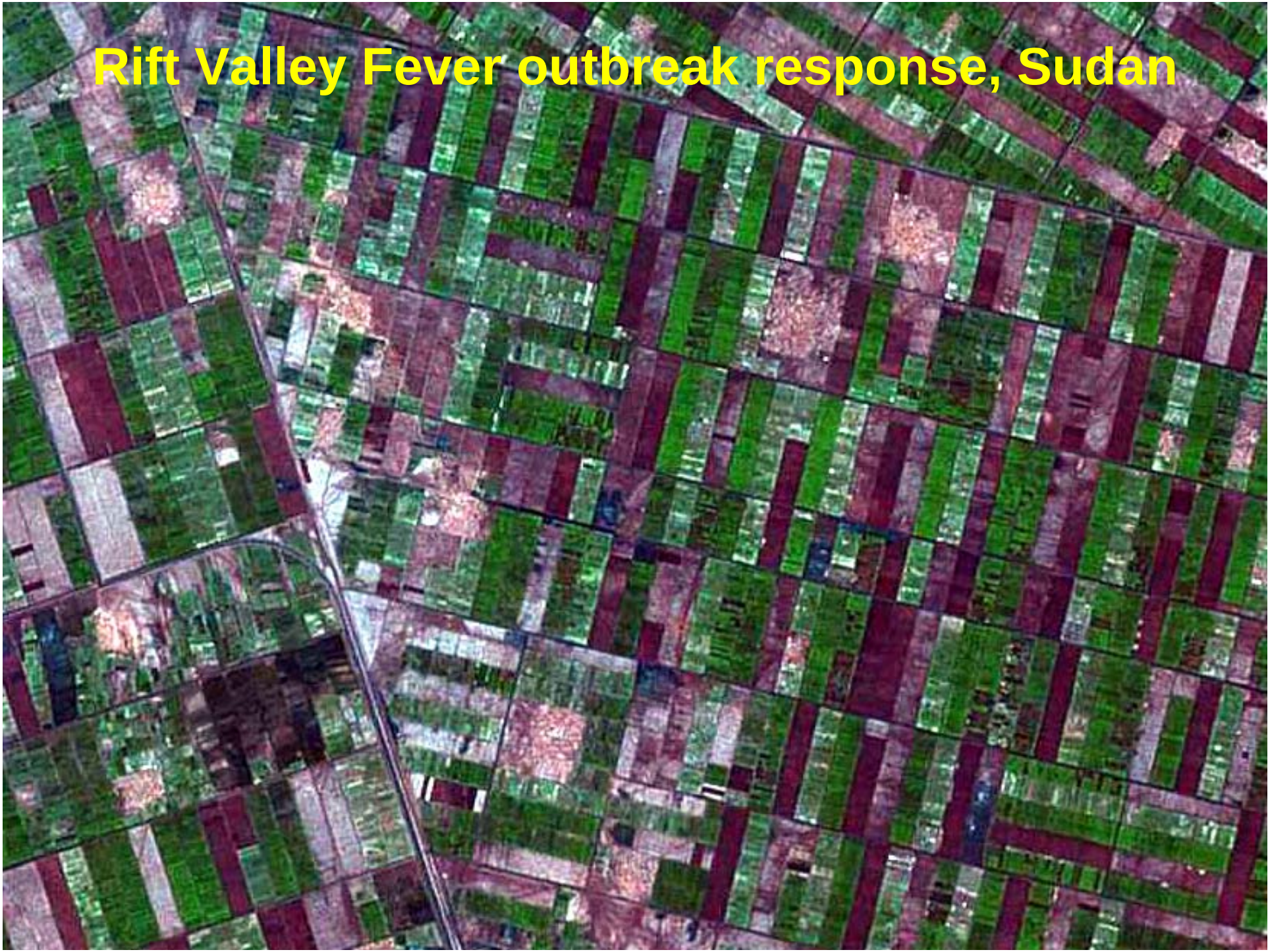
Rift Valley Fever

different ecotypes
different transmissions

Rift Valley Fever outbreak response, Sudan

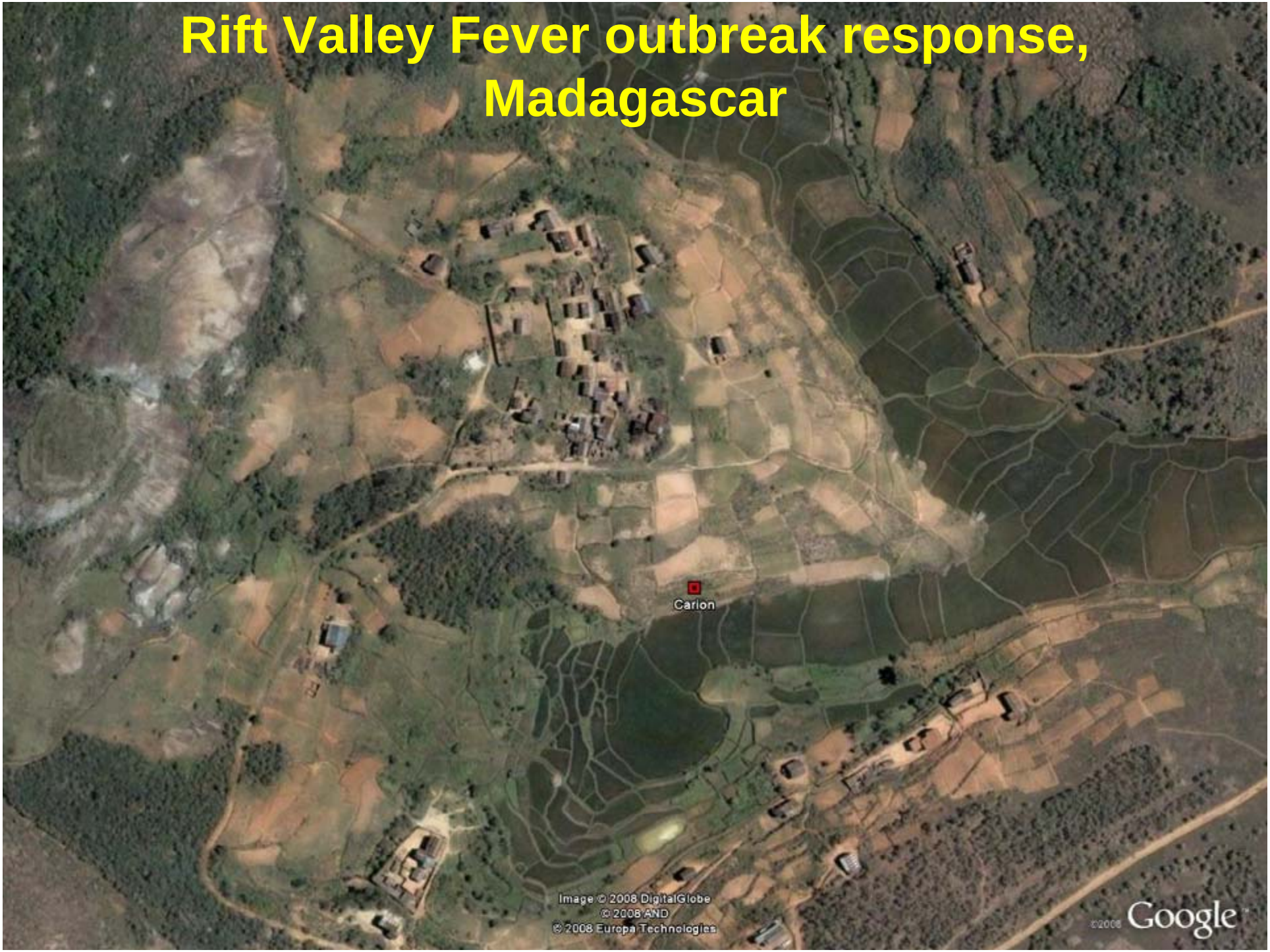


Rift Valley Fever outbreak response, Sudan

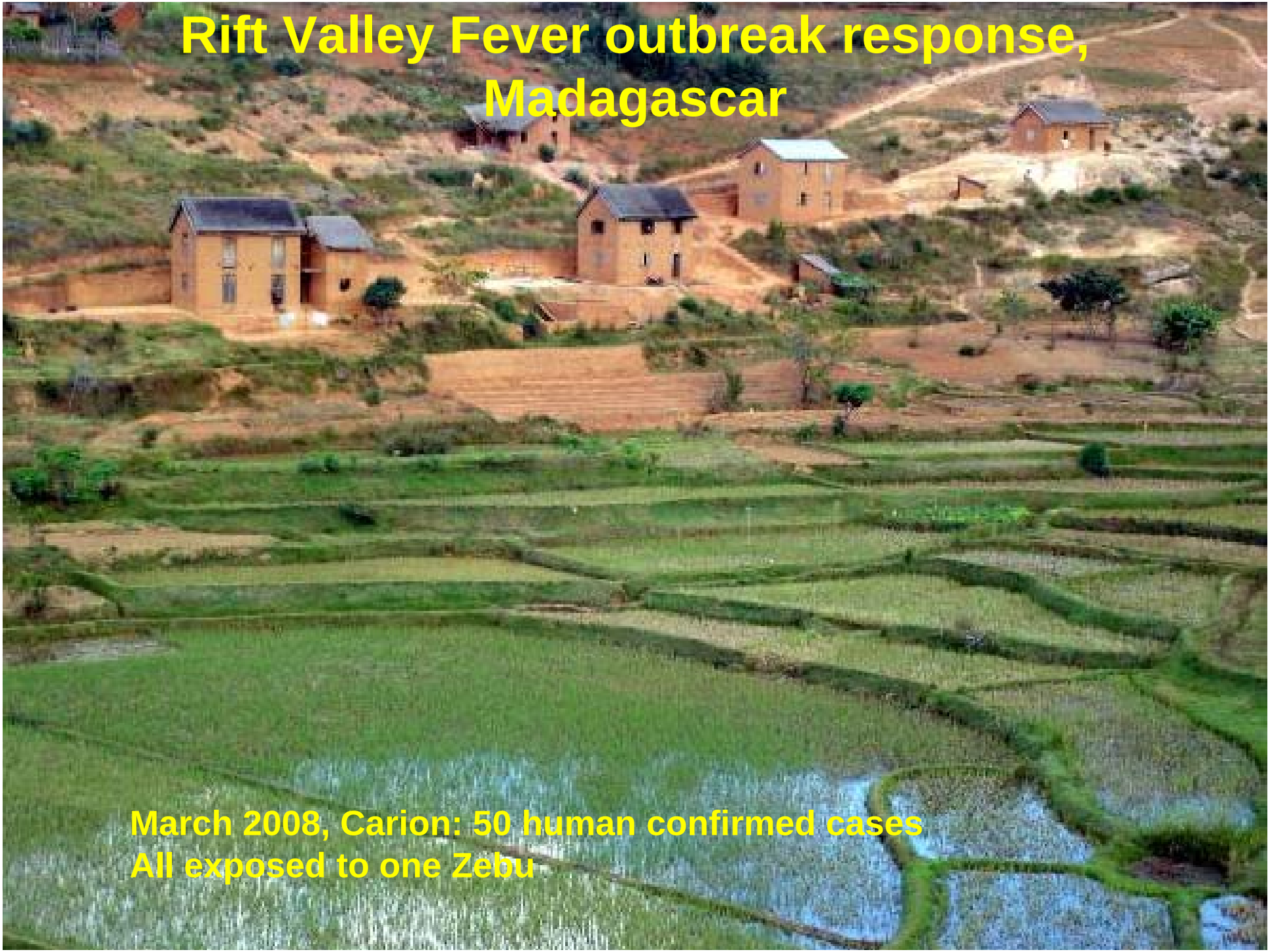

Rift Valley Fever outbreak response, Sudan

Rift Valley Fever outbreak response, Sudan

Rift Valley Fever outbreak response, Madagascar



Rift Valley Fever outbreak response, Madagascar



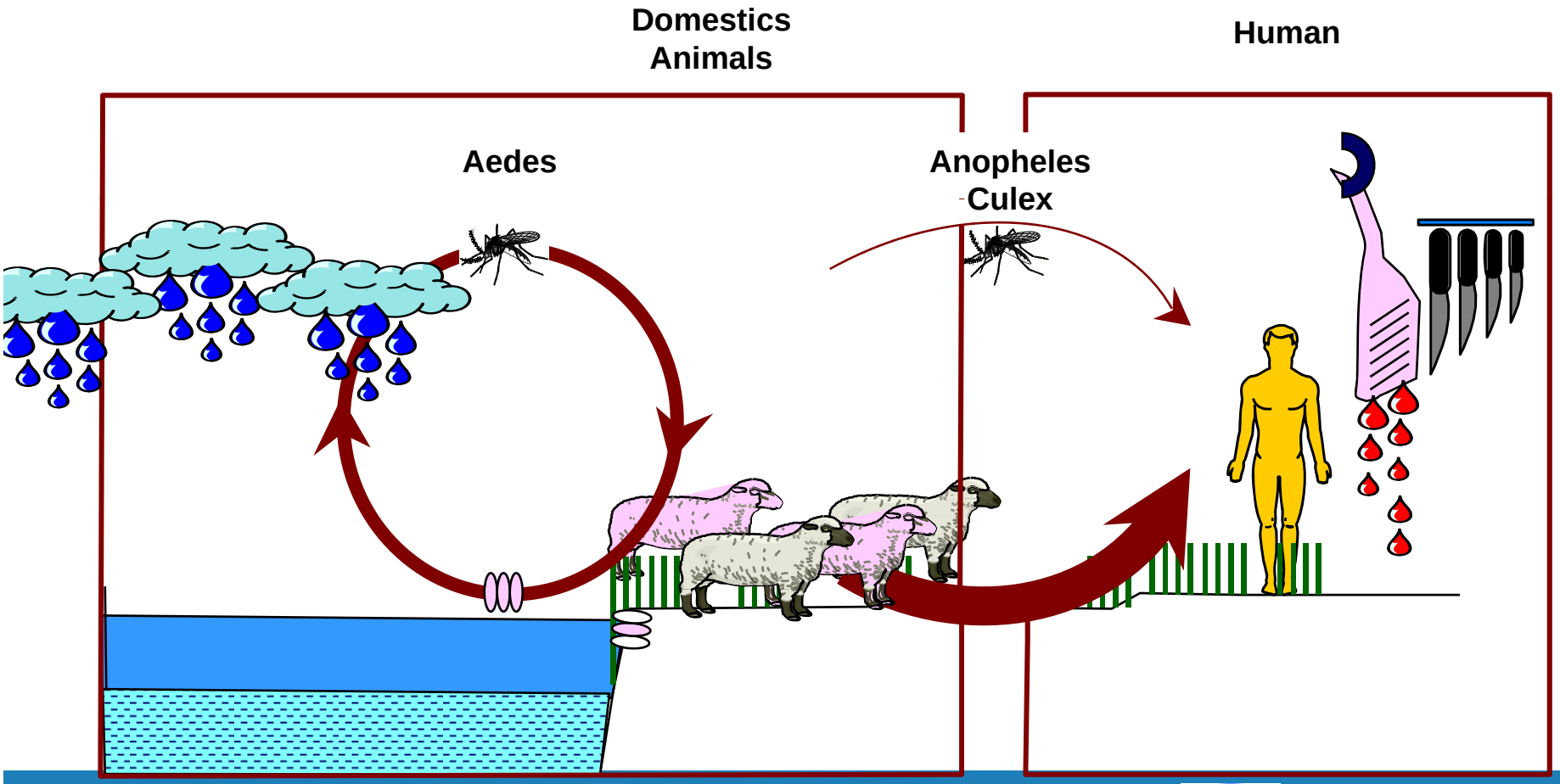
March 2008, Carion: 50 human confirmed cases
All exposed to one Zebu

Rift Valley Fever outbreak response, Madagascar

Rift Valley Fever outbreak response, Madagascar

Rift Valley Fever: transmission

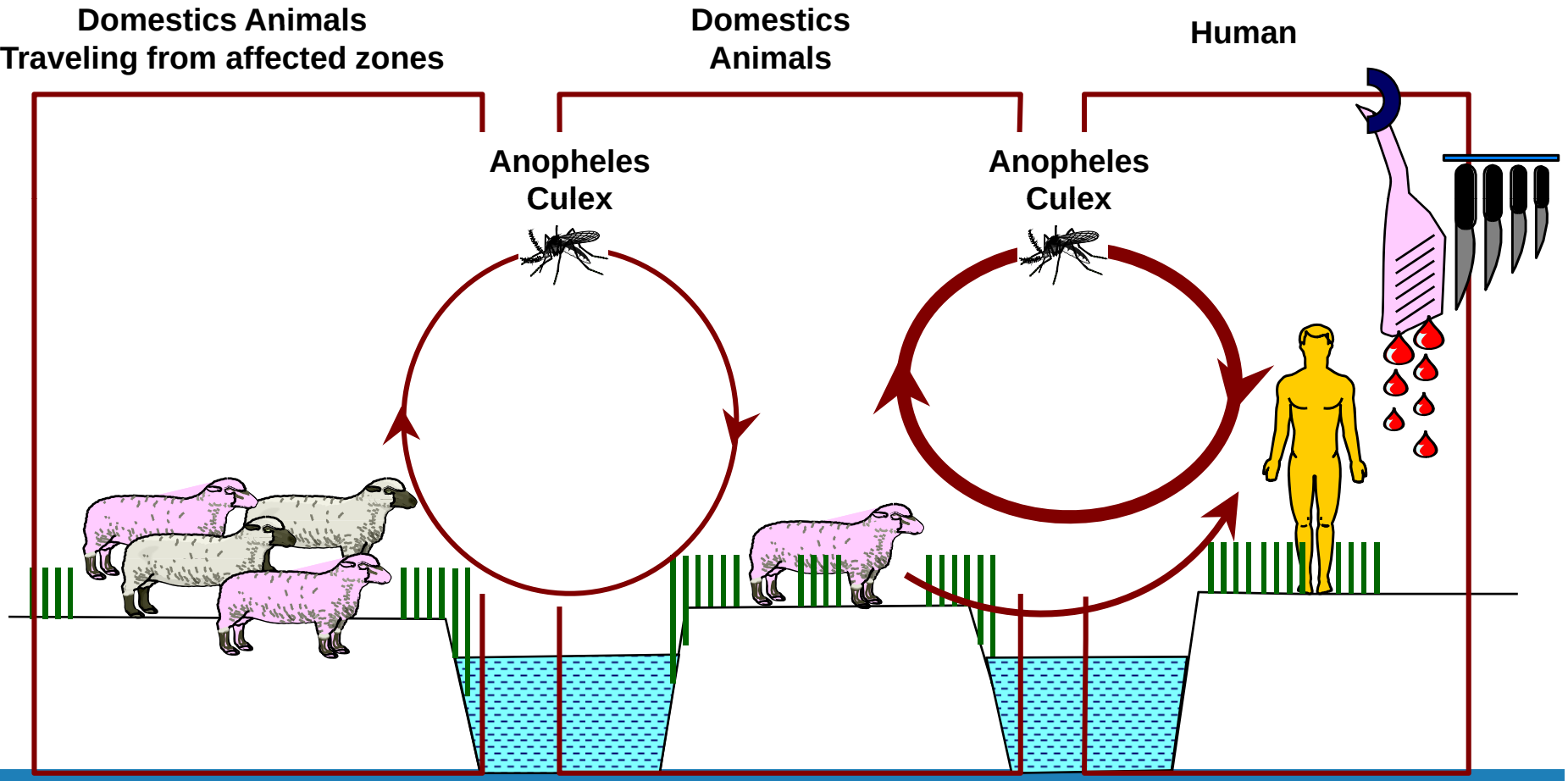
Breeding sites flooded (Dambos)



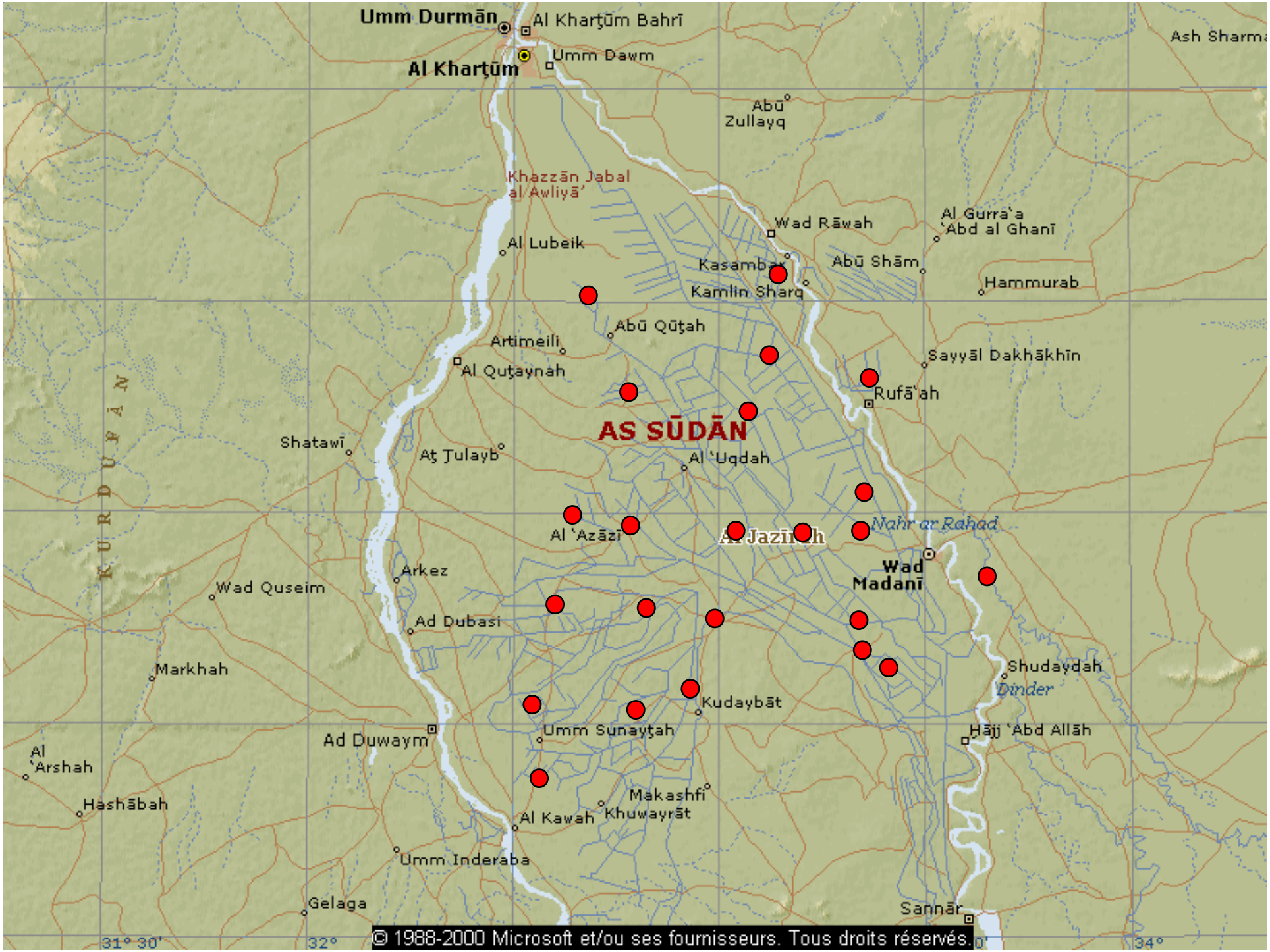
Rift Valley Fever outbreak response, Sudan

Rift Valley Fever: transmission

Irrigation scheme



Rift Valley Fever outbreak response, Sudan


Umm Durmān
Al Kharţūm Bahrī
Al Kharţūm
Umm Dawm
Ash Sharma
Abū Zullayq
Khazzān Jabal al Awliyā'
Wad Rāwah
Al Gurra'a
'Abd al Ghanī
Al Lubeik
Kasamba
Abū Shām
Hammurab
Kamlin Sharq
Abū Qūţah
Artimeili
Al Quţaynah
Sayyāl Dakhākhīn
Rufā'ah
AS SŪDĀN
Shatawī
Aţ Ţulayb
Al 'Uqdah
KURDUFĀN
Al 'Azāzī
Al Jazīrah
Nahr ar Rahad
Wad Madanī
Arkez
Wad Quseim
Ad Dubasi
Markhah
Shudaydah
Dinder
Kudaybāt
Ad Duwaym
Umm Sunayţah
Hājj 'Abd Allāh
Al 'Arshah
Hashābah
Makashfi
Khuwayrāt
Al Kawah
Umm Inderaba
Gelaga
Sannār
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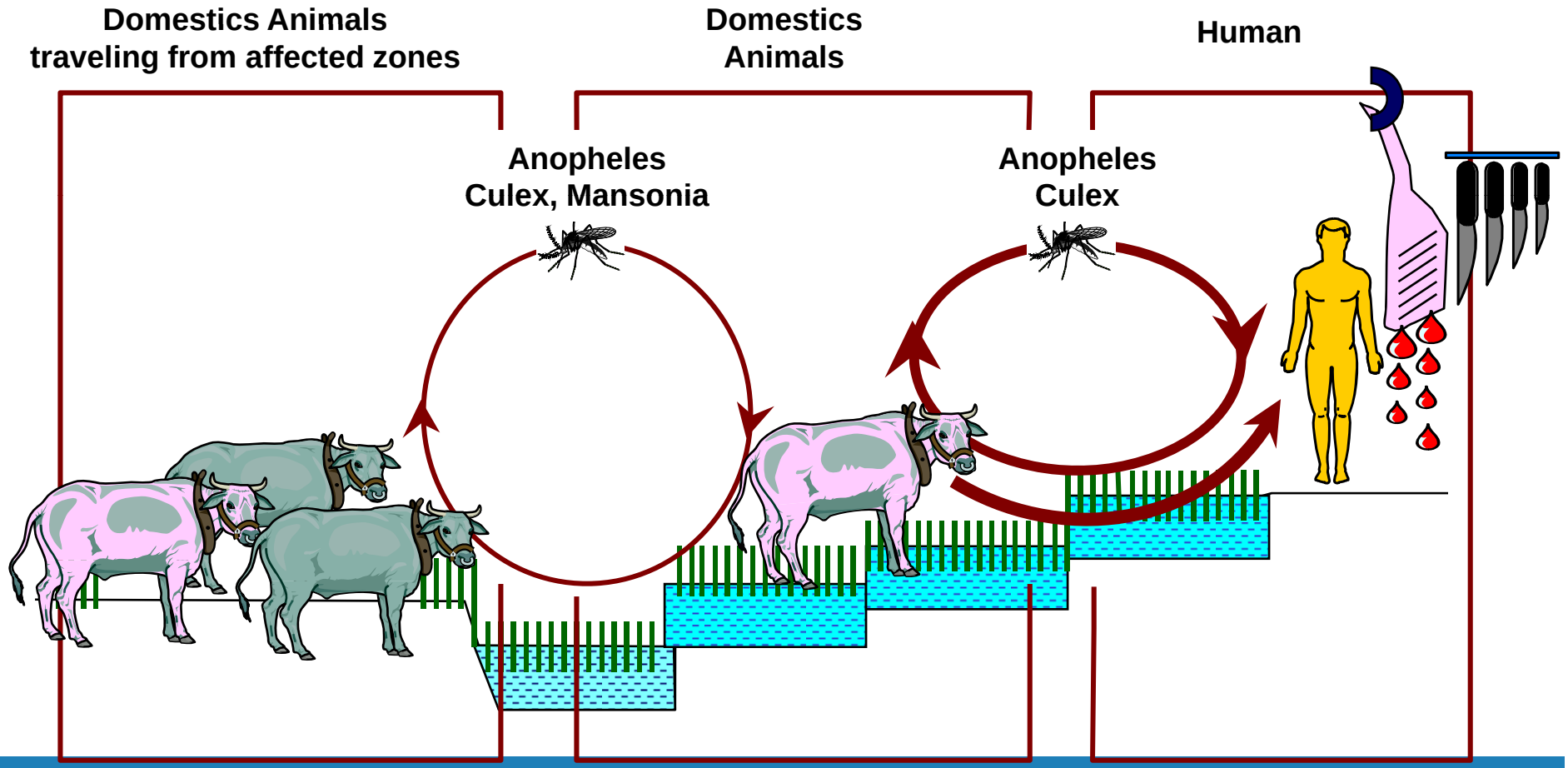
31° 30'
32°
34°

Rift Valley Fever: transmission

Madagascar Rice irrigation system



Rift Valley Fever the disease

Rift Valley Fever in Human

- 98 % cases are unnoticed or develop a mild disease
- characterized by a feverish syndrome with sudden onset, flu-like fever, myalgia, arthralgia and headaches. Hyperleucocytosis is followed by a leucopenia.
- Some patients develop a neck stiffness, anorexia, photophobia, nauseas and vomiting; in its early stages RVF can be mistaken for meningitis.
- These symptoms last in general from 4 to 7 days, after which the antibodies can be detected (IgM and IgG) as well as the disappearance of the virus in the blood

Rift Valley Fever in Human

- Pregnant women: vertical transmission have been reported in Saudi Arabia with fatal outcome in a newborn.

From Madani, *et al*,
CID, 2003;37:1084
From Arishi *et al*,
Ann Trop Paed, 2006; 26:251

Rift Valley Fever in Human

- 2 % of the cases are serious with complications:
  - Ocular form (most frequent, around 2% of the RVF cases): chorioretinitis, temporary blindness. Patients reported blurred or decreased vision
    - **Chorioretinitis appears between one and three weeks after the first symptoms.**
    - **Symptoms resolved spontaneously within 10 to 12 weeks from the onset of systemic symptoms.**
    - **Macular retinitis, paramacular retinitis, and optic atrophy are the most frequent causes of visual loss in RVF.**
    - **When the optic disc is affected, there is a permanent fall of vision (50% of cases).**
    - **The deaths are rare.**

Rift Valley Fever in Human

- Ocular form (most frequent):

BILATERAL BLINDNESS:
Ijara district, Kenya 2007

OCULAR RVF: MACULAR SCARRING
From Madani et al, CID, 2003;37:1084

Rift Valley Fever in Human

- 2 % of the cases are serious with complications:
  - Meningo-encephalic form: intense cephalgias and meningitides. Loss of memory, hallucinations, confusion, disorientation, vertigo, convulsions, lethargy, coma.
    - **Appears one to four weeks after the first symptoms.**
    - **Neurological complications can appear later (> 60 days).**
    - **The deaths are rare.**
    - **Severe or residual neurologic deficit is common sequelae.**

Rift Valley Fever in Human

- Meningo-encephalic form:

NEUROLOGICAL COMPLICATIONS:
Ijara district, Kenya 2007

NEUROLOGICAL COMPLICATIONS:
Ifakara district, Tanzania 2007

Rift Valley Fever in Human

- 2 % of the cases are serious with complications:
  - Hemorrhagic icterus form: **2-4 days after the beginning of the disease**, the patient presents the signs of a hepatic attack engraves with icterus and hemorrhages: vomiting of blood, blood in the saddles, petechiae, purpura (rash caused by cutaneous bleedings), menorrhagia, bleedings from the gums and venipuncture sites, ecchymoses of the skin.
    - **Death between day 3 and 6 post-onset.**
    - **Miscarriage**
    - **Viraemia up to 10 days.**
    - **CFR around 50 %.**

Rift Valley Fever in Human

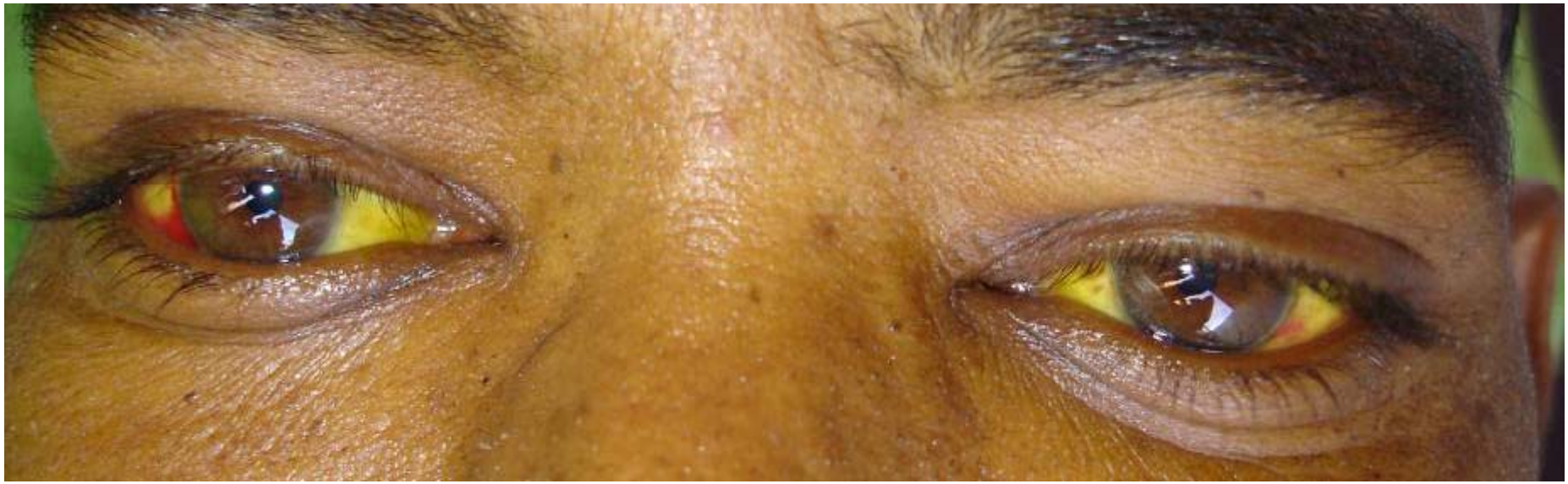
- Hemorrhagic icterus form:

BLEEDING FROM THE GUMS:
Kosti, Sudan 2007

BLEEDING FROM NOSE:
Sinnar, Sudan 2007

Rift Valley Fever in Human

- Hemorrhagic icterus form:



ICTERUS AND CONGESTED CONJUNCTIVITIS:
Monaqil, Gezira State, Sudan 2007

Rift Valley Fever in Human

- Hemorrhagic icterus form:

HEMORRHAGIC ICTERUS form: Saudi Arabia 2000

HEMORRHAGIC ICTERUS form: Kenya 2007

RVF in Human : Treatment

- Symptomatic: replacement of the blood volume and components, red cells, platelets, rehydration, electrolytic balance, intensive care, +/-antibiotics and/or antimalarial drugs
- Contraindicated: aspirin
- Warning: Ribavirin was employed in the treatment of confirmed cases of RVF during the 2000 outbreak in Saudi Arabia without success (unpublished data)

RVF in Human : Vaccines

- Inactivated TSI-GSD-200 developed by the Salk Institute. Three subcutaneous doses (0, 7 and 28 days) of 0.5 ml. Shown to be safe and immunogenic in human studies. Testing of this vaccine in 598 at-risk laboratory personnel from 1986-1997 showed only minor side effects in 3% of all vaccinees and good long-term immunity at 12-year follow-up.
- Experimental MP 12 live attenuated vaccine (1 dose) development by NIAID. Open-label, single dose, phase II study ongoing to assess the safety, immunogenicity, and genetic stability of RVF MP-12 vaccine in humans.
- Clone 13 and R566 in development.

Rift Valley Fever

Clinic in Animal

Rift Valley Fever in Animal

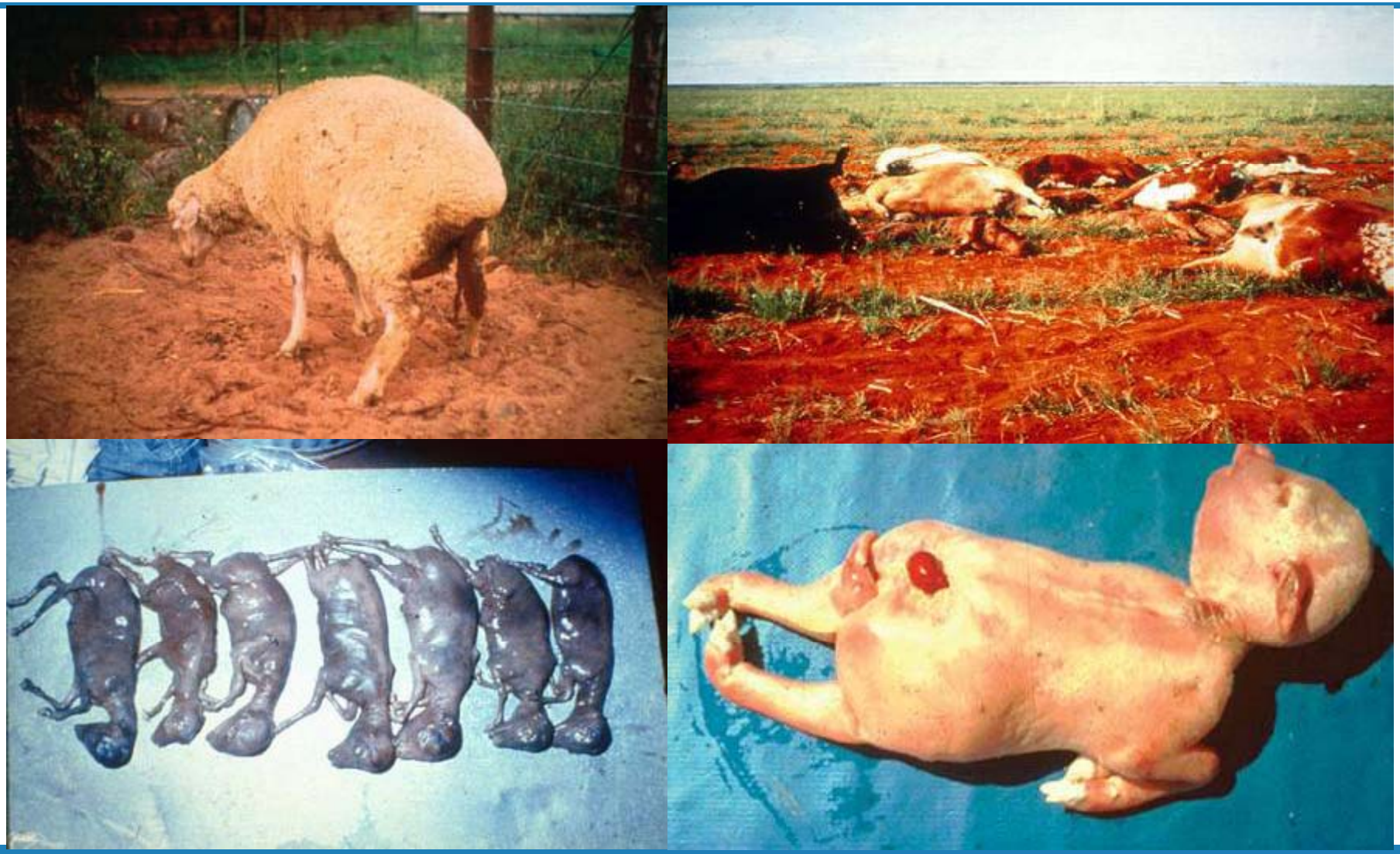
- Sheep are more sensitive.
- Lambs: fever + anorexia and high CFR around 100%.
- Adults: fever, muco-purulent throwing, melaena and CFR around 20%.
- The abortions are frequent in pregnant females, abortion rate in herds can reach 85%
- Epizootics can last 6 to 8 weeks

Rift Valley Fever in Animal

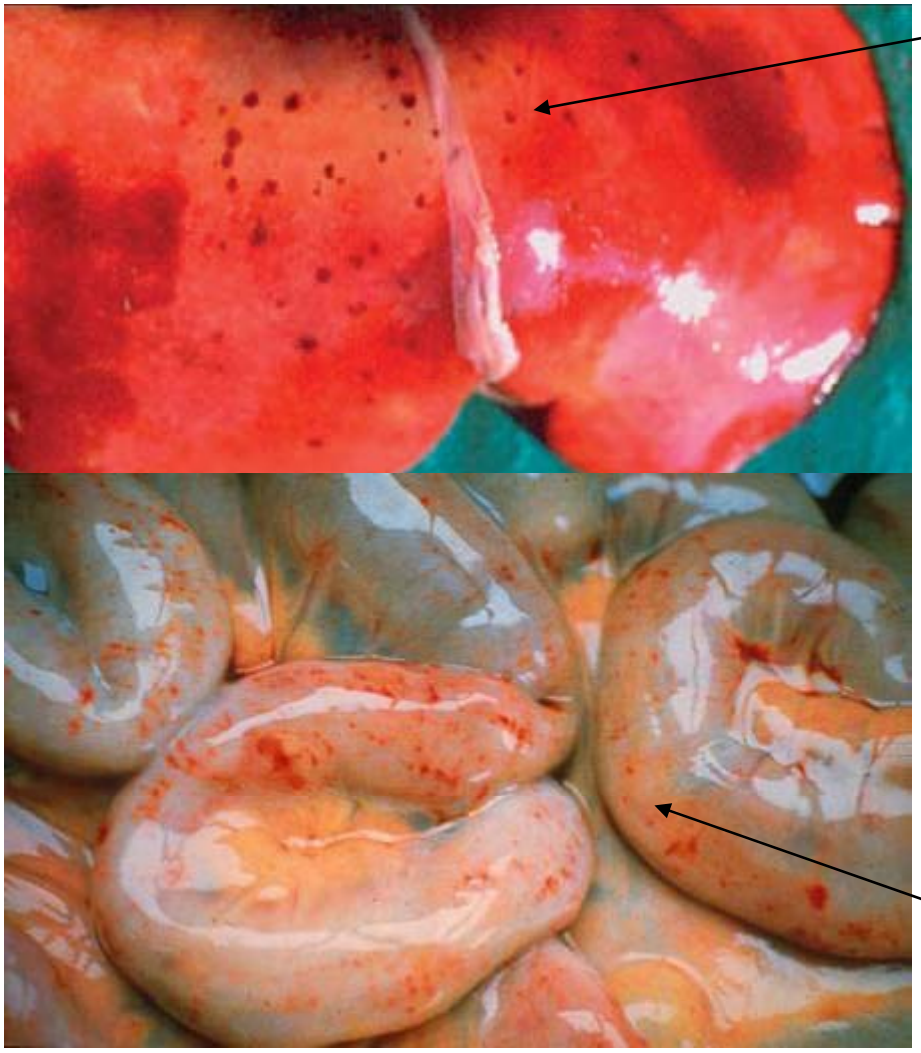
- **Sheep:** **~20-30% mortality, abortions (up to 85%)**
- **Cattle:** **~10-15% mortality, abortions**
- **Goat:** **~5-10% mortality, abortions**
- **Camel:** **low mortality, low viraemia, abortions.**
- **African Buffalo (*Syncerus caffer*): experimental inoculation, survive, low viraemia, abortions**
- **Other African ungulates: antibodies, symptoms ?**

- Mortality depends on breeds, other health and stress factors.
- Infections of adult animals end in death if viremia high.
- Immature animals have higher viraemia and mortality.
- Abortion seems to be a complication of most viremic infections.

Rift Valley Fever in Animal



Rift Valley Fever in Animal



Hepatic Syndrome : vasculitis and necrosis of liver

Intestine : hemorrhages and petechia

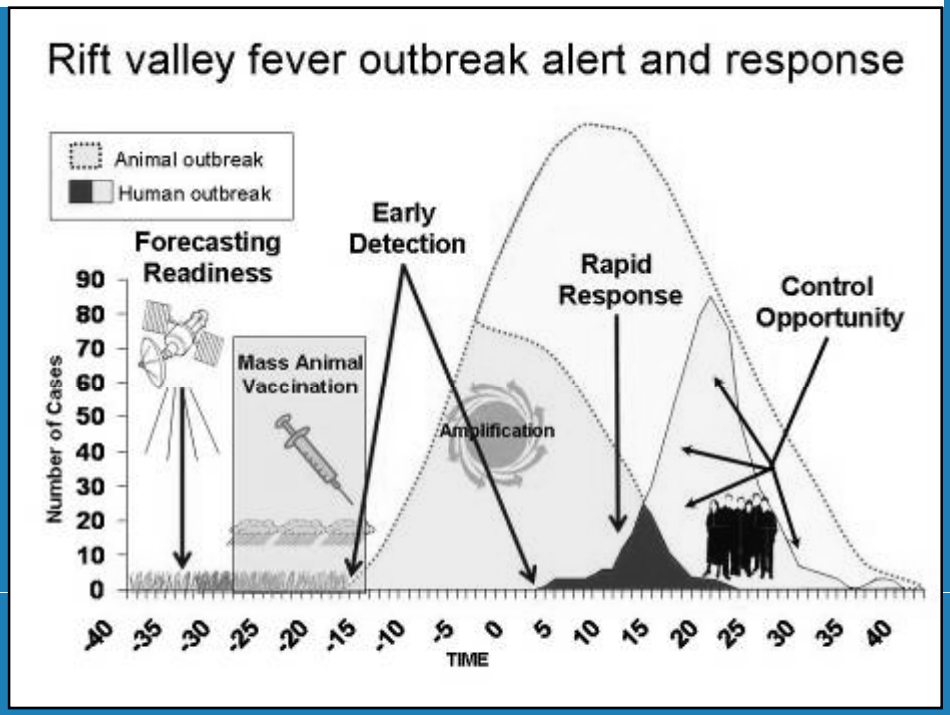
RVF in Animal: vaccines

- Smithburn, MVP12. Lifelong immunity but only partially attenuated. Responsible for abortions.
- Inactivated vaccine is expensive and requires 2 injections for prime boost and booster every year.
- Real danger of needle propagation during mass vaccination operations
- Vaccination cost effective for exotic breeds
- Long term strategy possible in exotic breeds

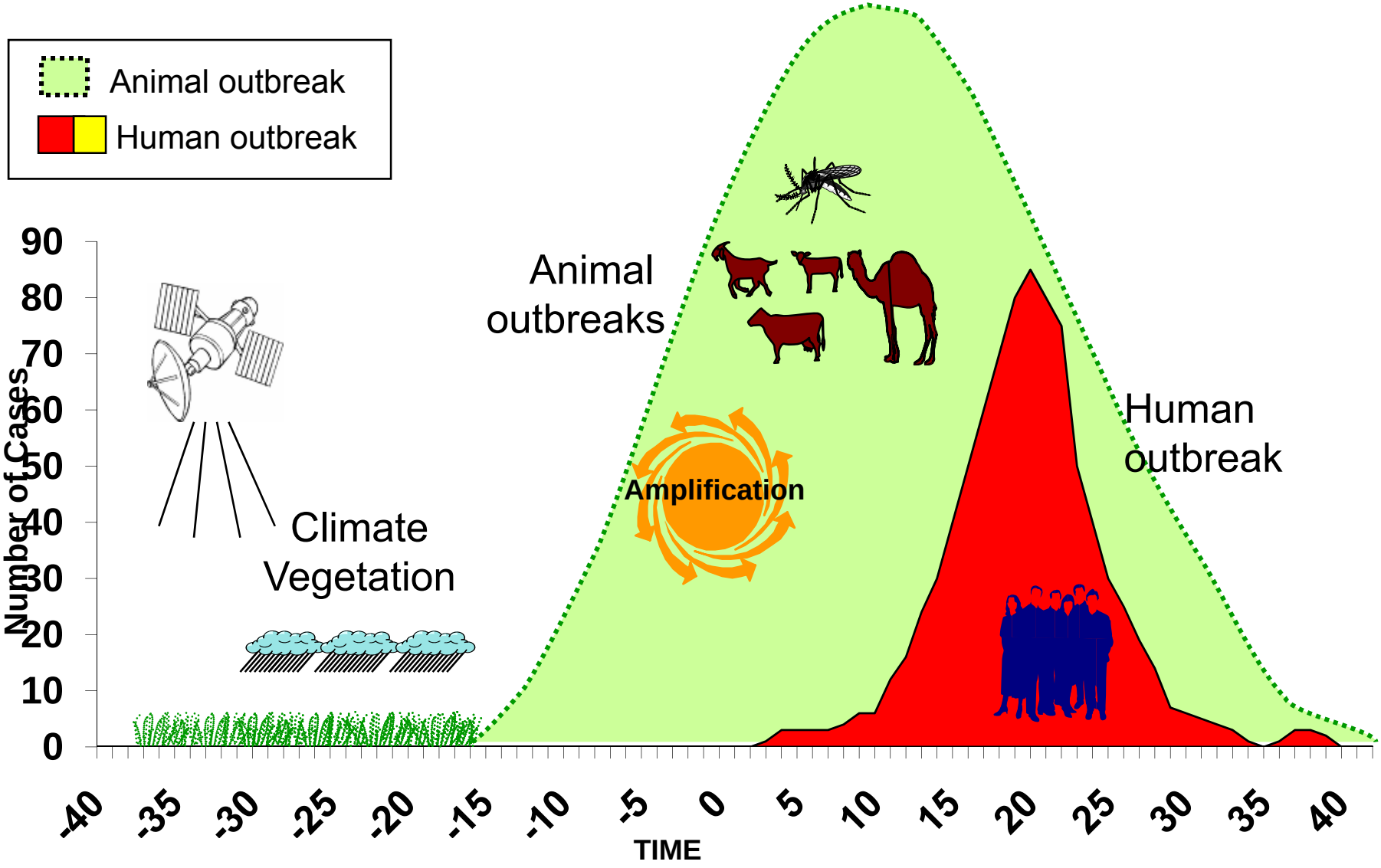
RVF in Animal: vaccines

- Are RVF forecasting analysis good enough to drive cost effective vaccination strategies?
- Problem of availability of vaccine.
- Prospects of new vaccines clone 13 or R566
- Are veterinary services capable of implementing safely mass vaccination campaigns?

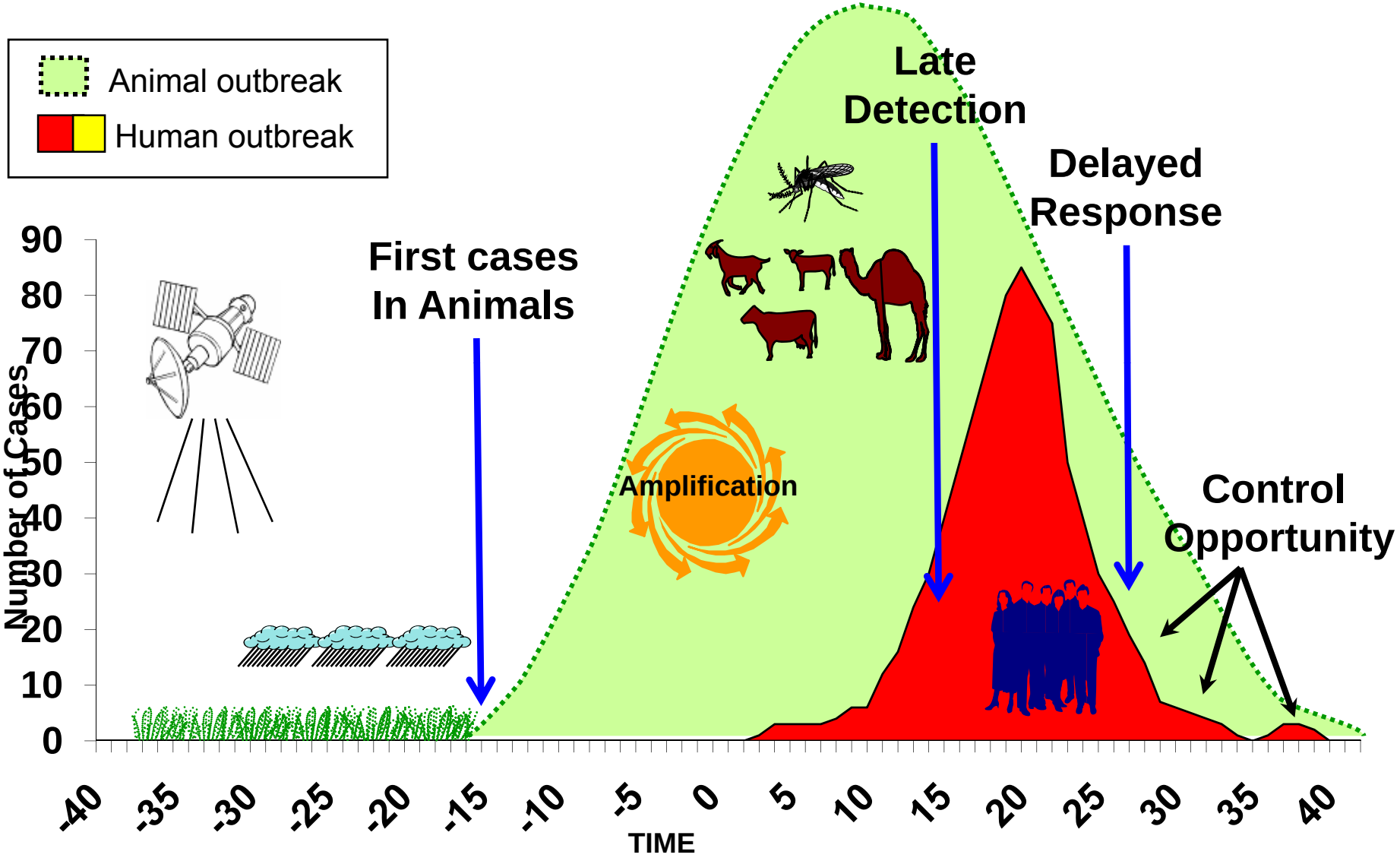
Rift Valley Fever
From forecasting to outbreak control



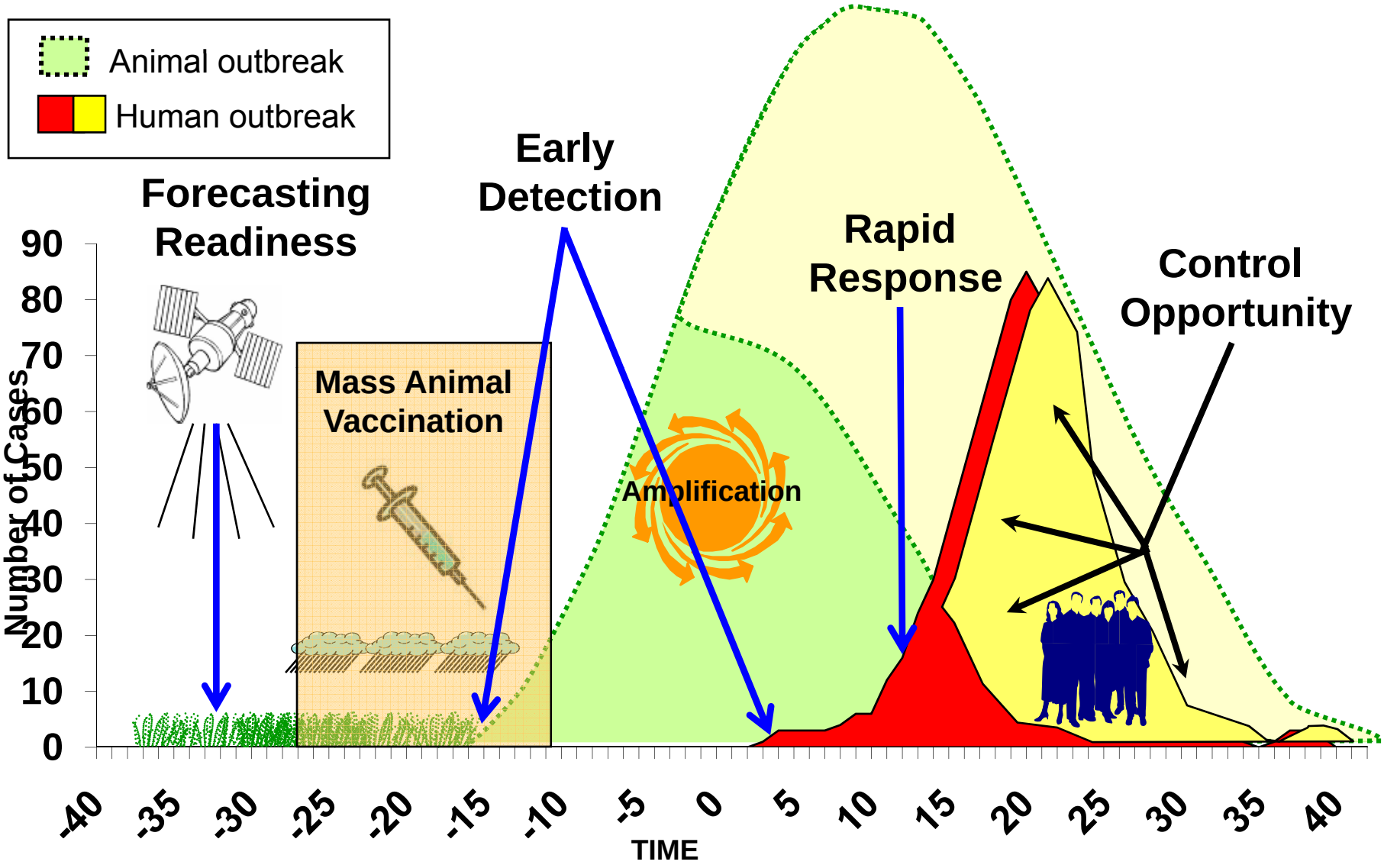
Rift Valley fever outbreak alert and response



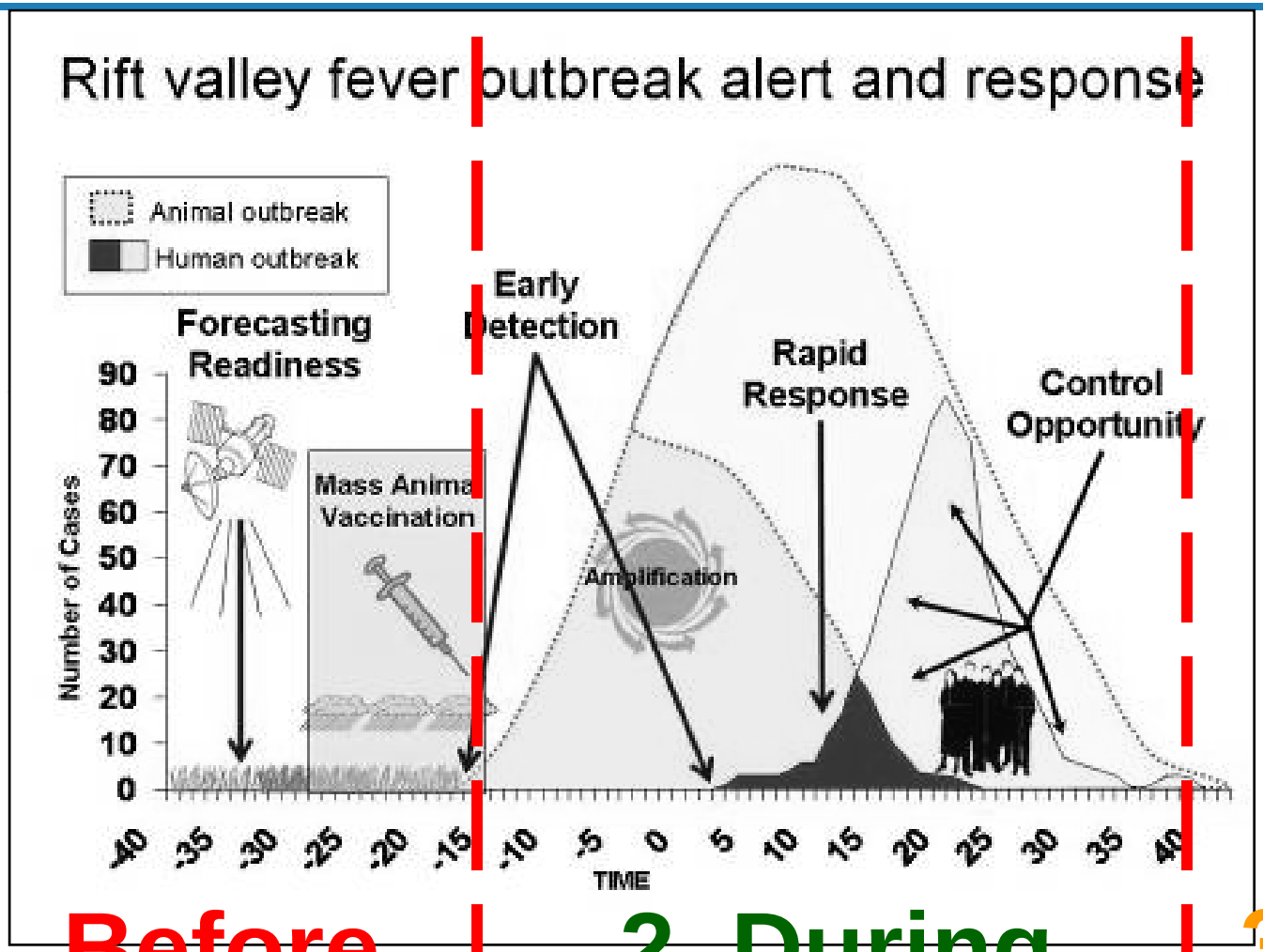
Rift Valley fever outbreak alert and response



Rift valley fever outbreak alert and response



Surveillance et contrôle de la FVR



1. Before | **2. During** | **3. After**

1. General strategy to MITIGATE RVF outbreaks

- RVF outbreaks are closely coupled with above normal rainfall periods and in East Africa, with the El Niño/Southern Oscillation (ENSO) event.
- **Forecasting** : forecasting models and early warning systems based on satellite images and weather/climate forecasting data for Rift valley fever have been successfully develop. They provide
  - accurate forecasting data that can predict emergence of RVF 2 to 4 months in advance
- **Animal Health** : efficient veterinary public health services capable of implementing emergency mass animal vaccination prior to the beginning of the epizootic.

1. General strategy to MITIGATE RVF outbreaks

- Authorities to prepare in case of an epidemic:
  - Inform public / health education / **social mobilization**
  - Standard precautions in health care settings.
  - Heighten animal and human **surveillance + diagnostic**
  - Strengthen Human and Animal health collaboration
- Implement appropriate **vector control** program based on entomological surveys

2: General strategy to CONTROL RVF outbreak

- Establish **co-ordination** mechanism for response
- Inform public / health education / **social mobilization**
  - Restrict practices that promote transmission and source of infection
- **Partnership with media**
- **No Human-to-Human transmission** reported
  - Standard infection control practices.
  - Establish RVF ward or harm reduction strategy at home
  - Safe and Humane **case management**
  - Conduct safe funerals that allow the process of mourning.
  - Psychosocial support (patients, families, HCW).

2. General strategy to CONTROL RVF outbreak

- Establish active **surveillance** system
  - Identify new cases. Follow-up clinical complications (ocular, neurological, haemorrhagic)
  - Stop human source of infection: link with animal surveillance
- Implement appropriate **vector control** program based on entomological surveys
- **Animal Health** :
  - Restrict animal movement from epizootic areas to clean areas
  - Control slaughtering activities – at home, and in facilities
  - Do not vaccine in epizootic areas.

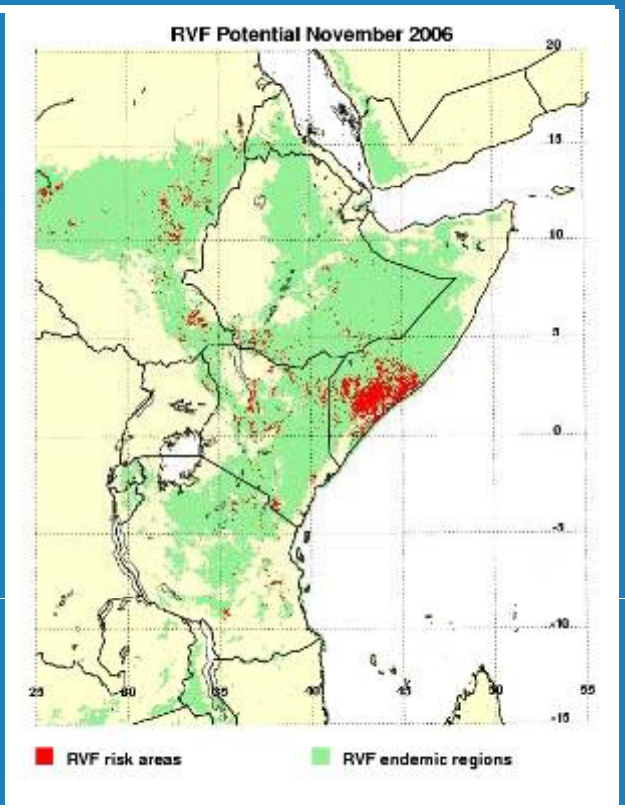
2. General strategy to CONTROL RVF outbreak

- International Organizations
  - Inform member states FAO, WHO and OIE.
  - +/- WHO recommendations on travel (IHR 2005)
  - +/- OIE recommendations on animal trade

3. General strategy to AFTER RVF outbreaks

- To announce the end of the epidemic and ensure follow-up with press coverage.
- To evaluate outbreak management
- To work out an end of the outbreak report
- To file outbreak documents in archives
- To go back to surveillance activities of the pre-epidemic phase
  - Monitoring of the climatic data
  - Monitoring of the human and animal epidemics

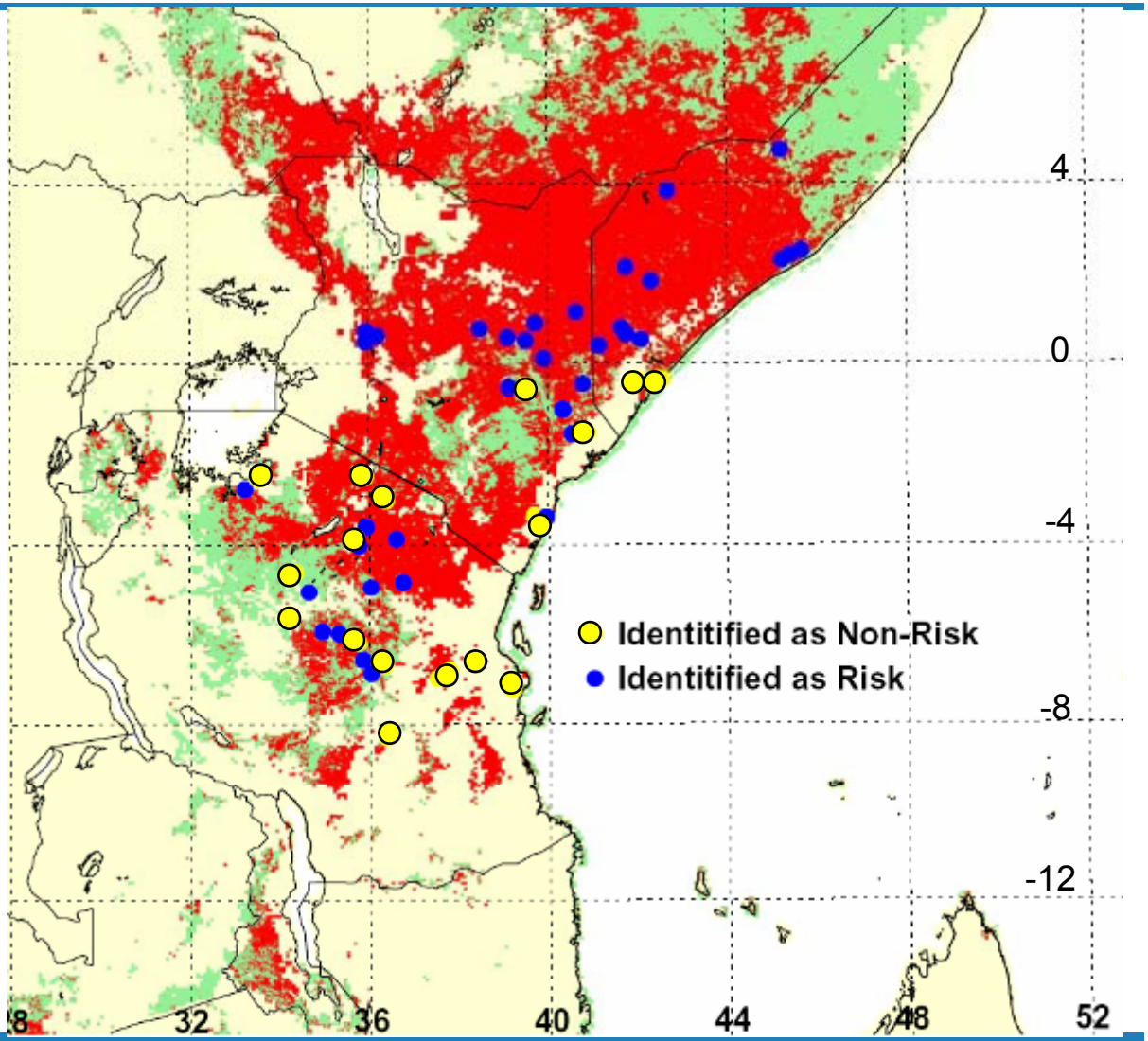
Rift Valley Fever Forecasting



HoA climatic and ecological conditions and RVF outbreak sites Sept 2006 to May 2007

Mapping of the RVF human case locations shows that

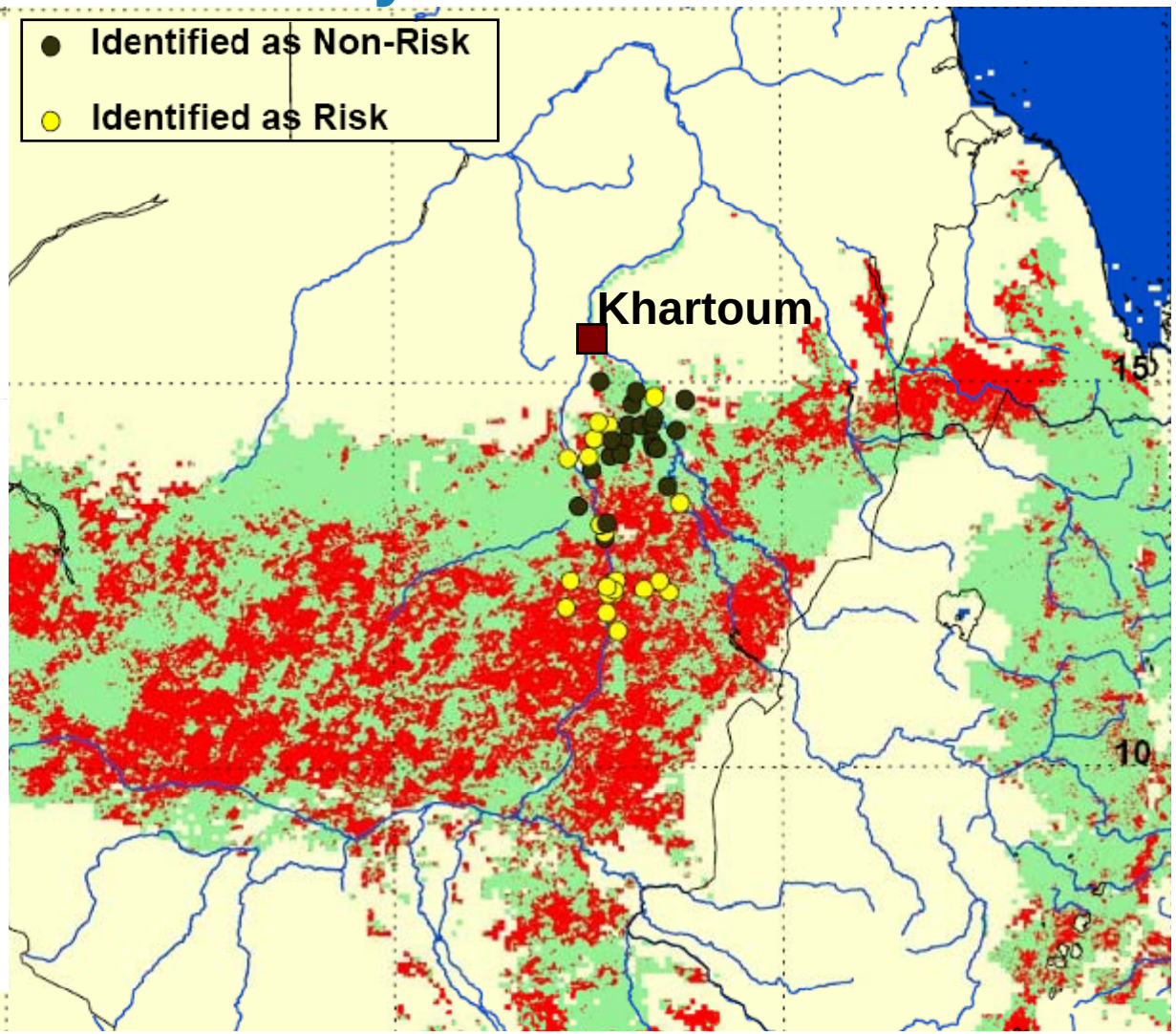
- 64% of the cases were reported in areas at risk within the RVF potential epizootic area,
- 36% were reported in areas not thought to be at risk of RVF activity



Sudan climatic and ecological conditions and RVF outbreak sites May to November 2007

Mapping of the RVF human case locations shows that

- 50% of the cases were reported in areas at risk within the RVF potential epizootic area,
- 50% were reported in potential epizootic areas not thought to be at high risk of RVF



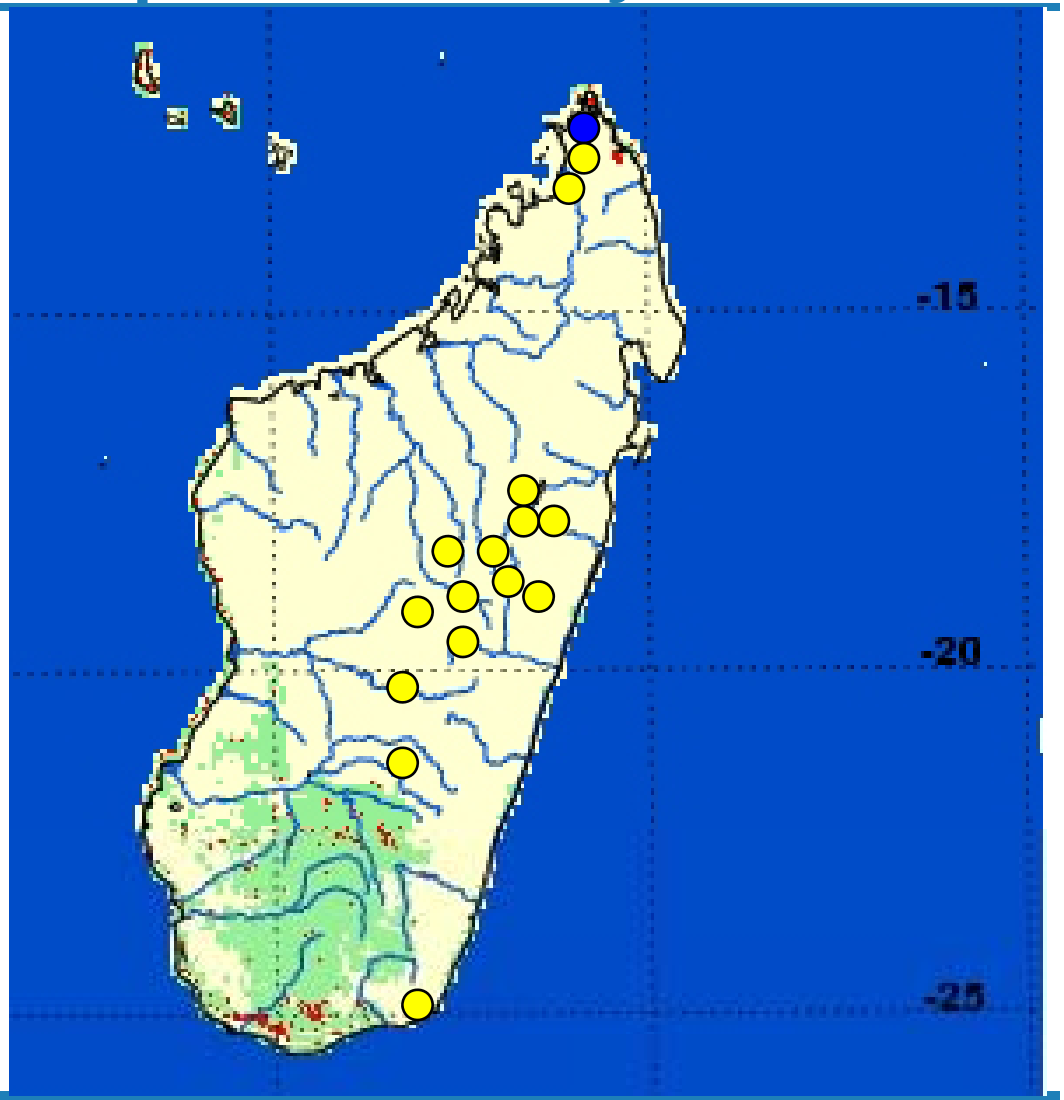
Madagascar climatic and ecological conditions and RVF outbreak sites Sept 2007 to May 2008

RVF Risk Area

RVF Potential Epizootic Area

Outbreak identified as Non-Risk

Outbreak identified as Risk



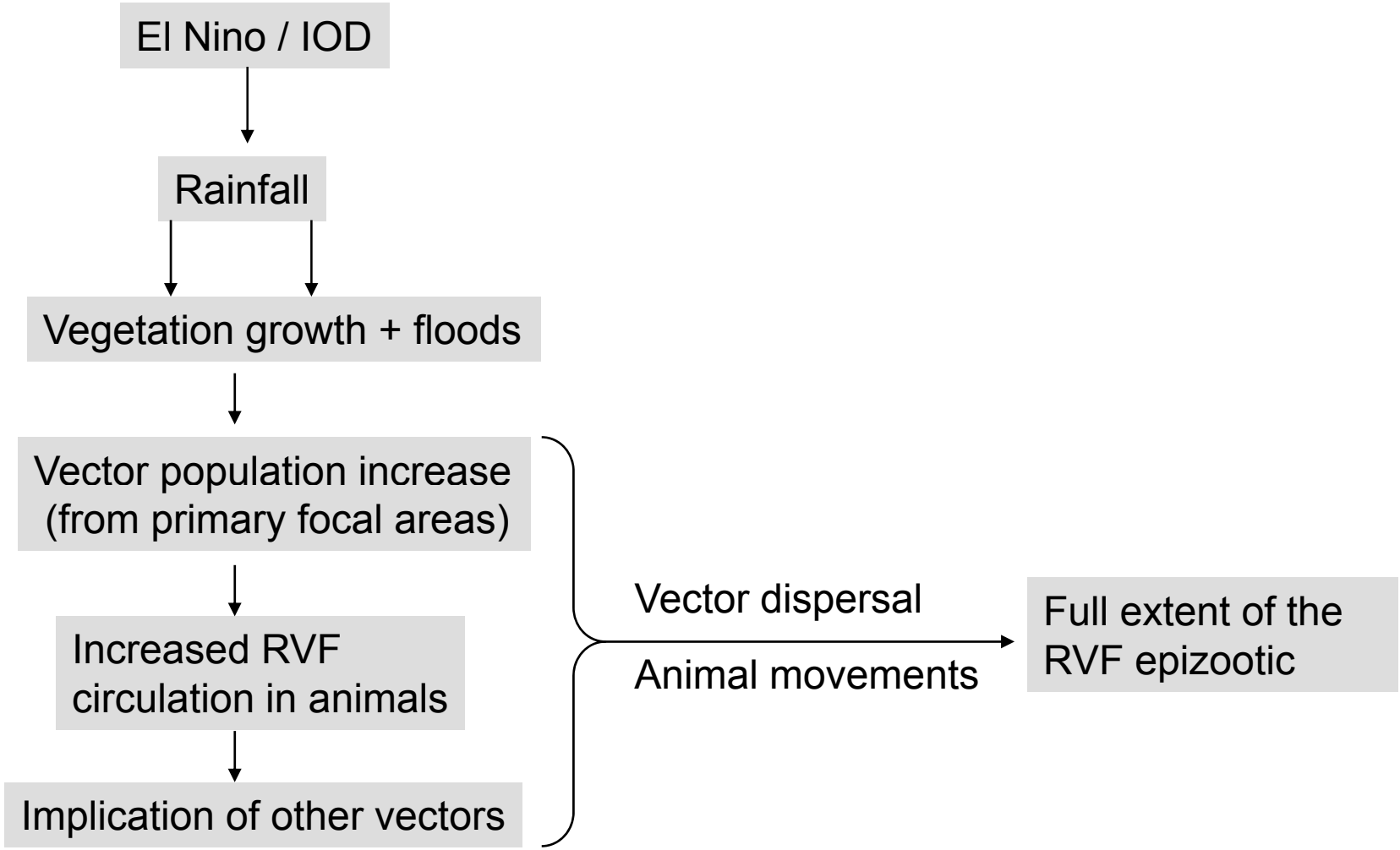
Rift Valley Fever forecasting limitations (1)

- when should FAO WHO Alert the countries? How to interpret RVF monthly risk maps: only 1 big outbreak (2006-07) in 7 years
- Could model framework be improved with good field data, soil type, elevation, vector ecology maps..
- models are mapping risk for Arbovirus emergence (not only RVF)

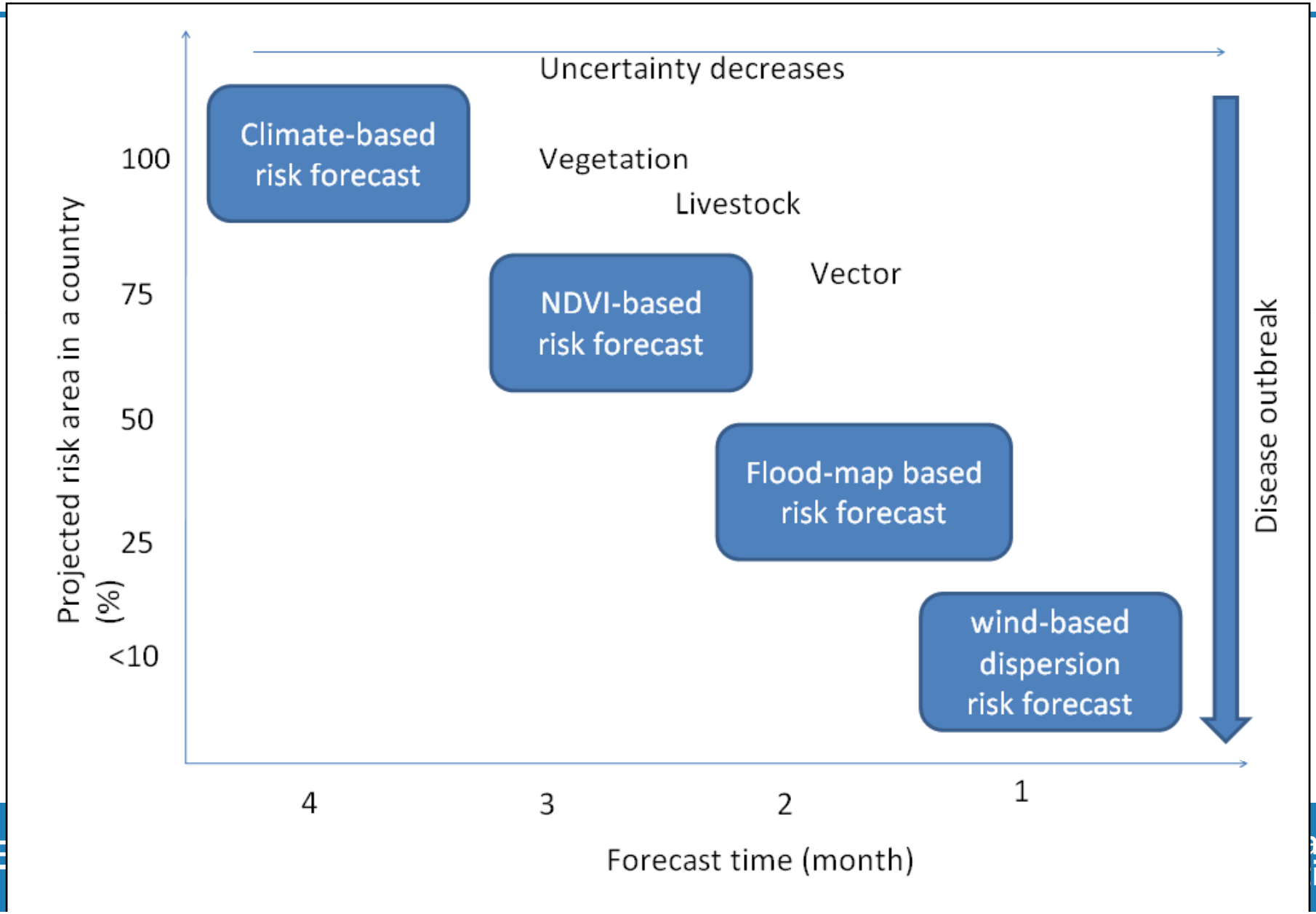
Rift Valley Fever forecasting limitations (2)

- model apply well in East and South Africa, more difficult in West Africa
- RVF warning given 2 months in advance BUT we need a 6 month period between Forecasting Alert and outbreak to allow mass animal vaccination

Rift Valley Fever forecasting: general pathway



Rift Valley Fever forecasting: questions?



Rift Valley Fever forecasting: questions?

Outbreaks / animal cases, human cases ?

- **Primary cases or Secondary cases ?**

Vector distribution ?

- **Some vectors implicated in maintaining RVF in inter-epidemic periods**
- **Some vectors implicated in epizootic conditions**
- **Is this homogeneous across Africa, or are there regional variations ?**

Risk area is dynamic

- **Focal in inter-epizootic period**
  - **Starts from areas that combine abnormal vegetation growth and floods**
  - **Artificial flooding through irrigation practices (semi-permanent vector breeding areas)**
- **Expands during epizootic period, because**
  - **New vectors may become implicated**
  - **Animals movements, migrations**
  - **Vectors may move over some distances**

Rift Valley Fever forecasting: questions?

At which spatial scale are we mapping the risk

- **Focal areas where it would start should the next abnormal rain arrive ?**
- **Large Areas where it would spread in epizootic conditions ?**
- **Potential epidemic mask <-> statistic map of probability of occurence**

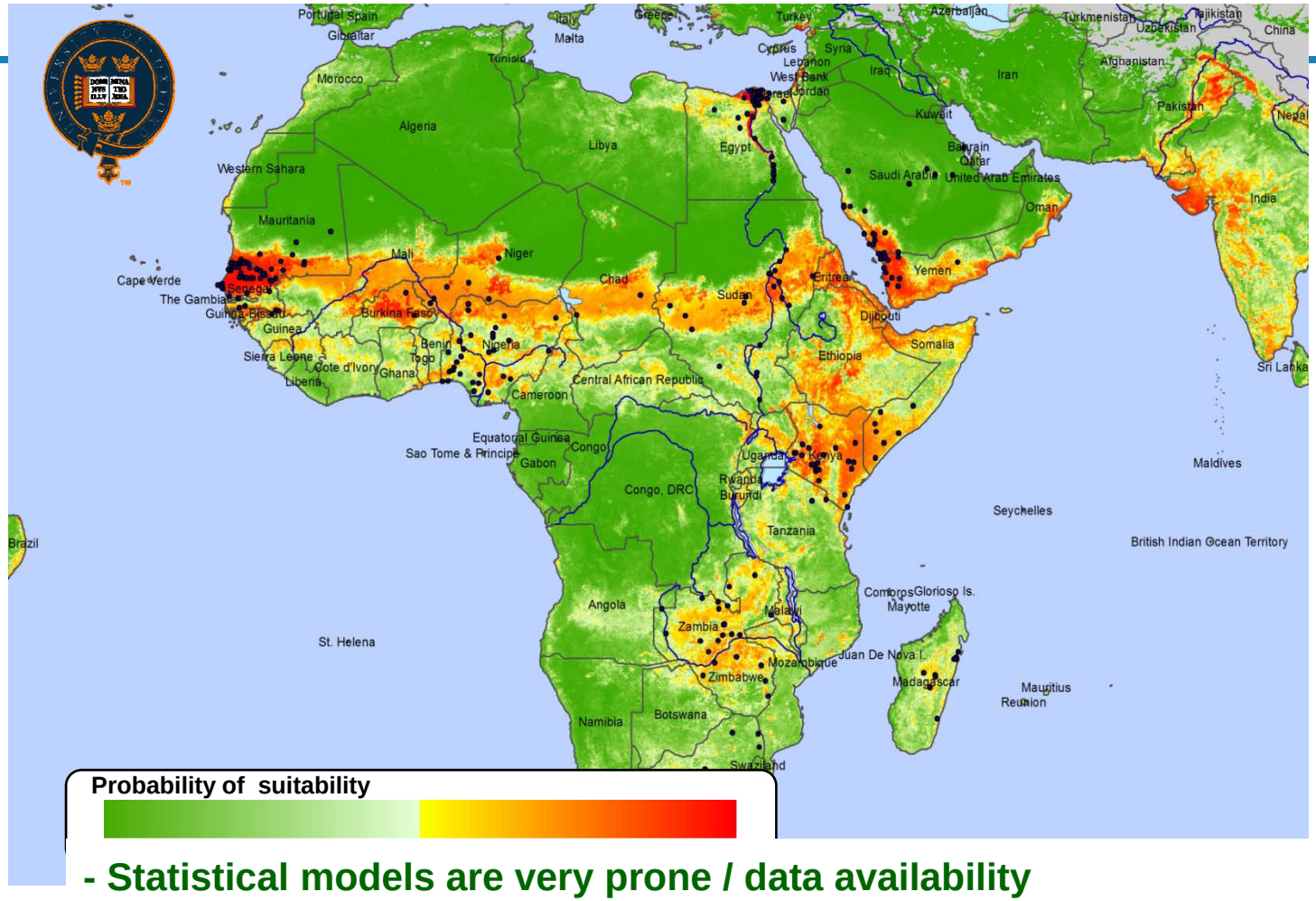
Temporal scale

- **What are the operational expectations ?**
- **What is technically feasible: Forecasting: 6 months ?**

Spatial

- **How can we deal with the uncertainty in spatial definition of the epidemiological data themselves ?**
- **What is the resolution at which dissemination of risk mapping outputs is appropriate given:**
  - **Animal and Vector movements**
  - **Intervention and needs of end-users: MoH, MoL, MoA.**

Rift Valley Fever Model



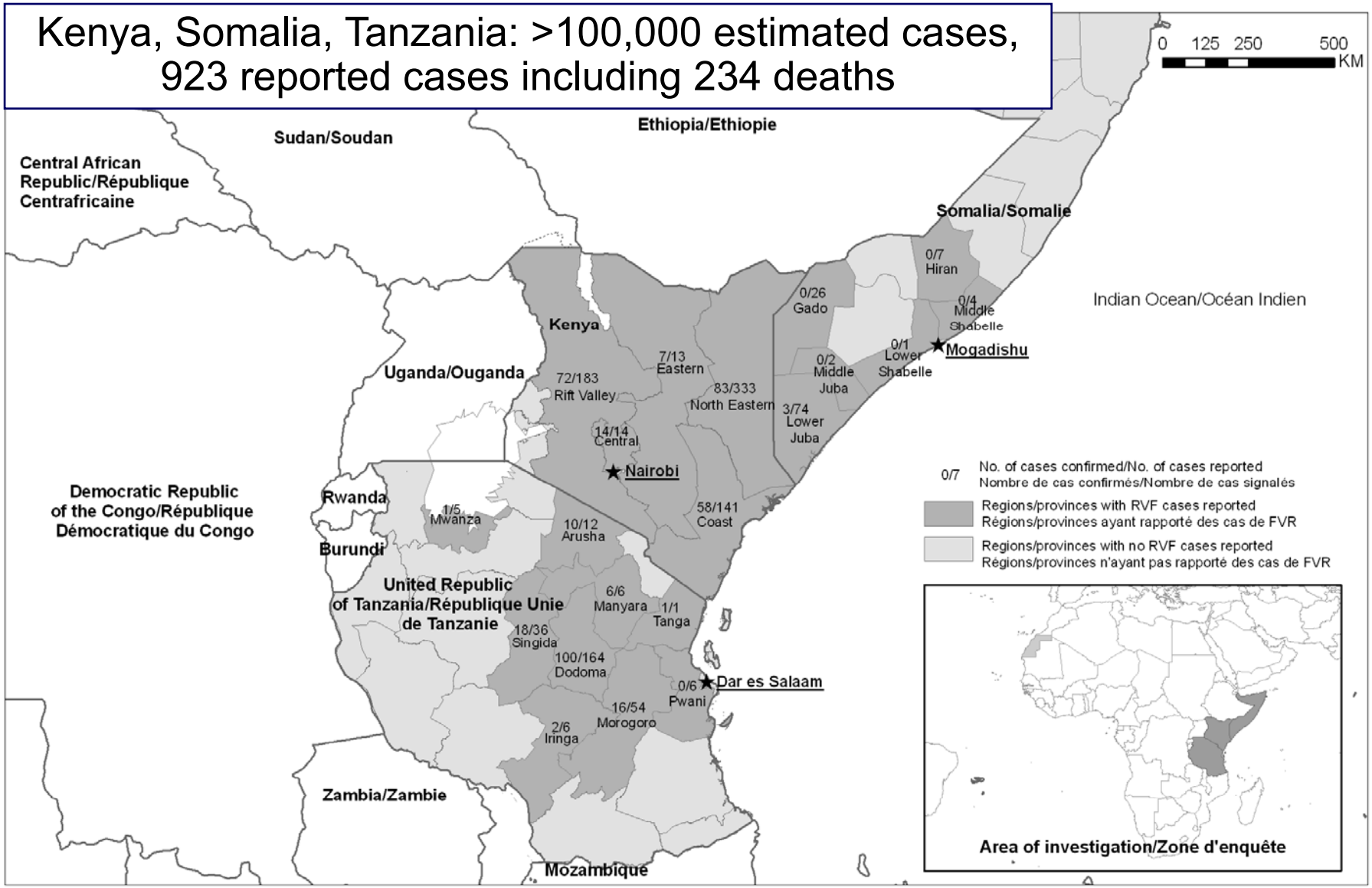
NOAA AVHRR -
- MIR
- LST
- NDVI
+ DEM
as predictors
(NO rainfall!).

- Statistical models are very prone / data availability
- Inclusion of rainfall <-> temporal resolution of products and risk ranking
- primary outbreak sites and RVF mask

Rift Valley Fever Surveillance

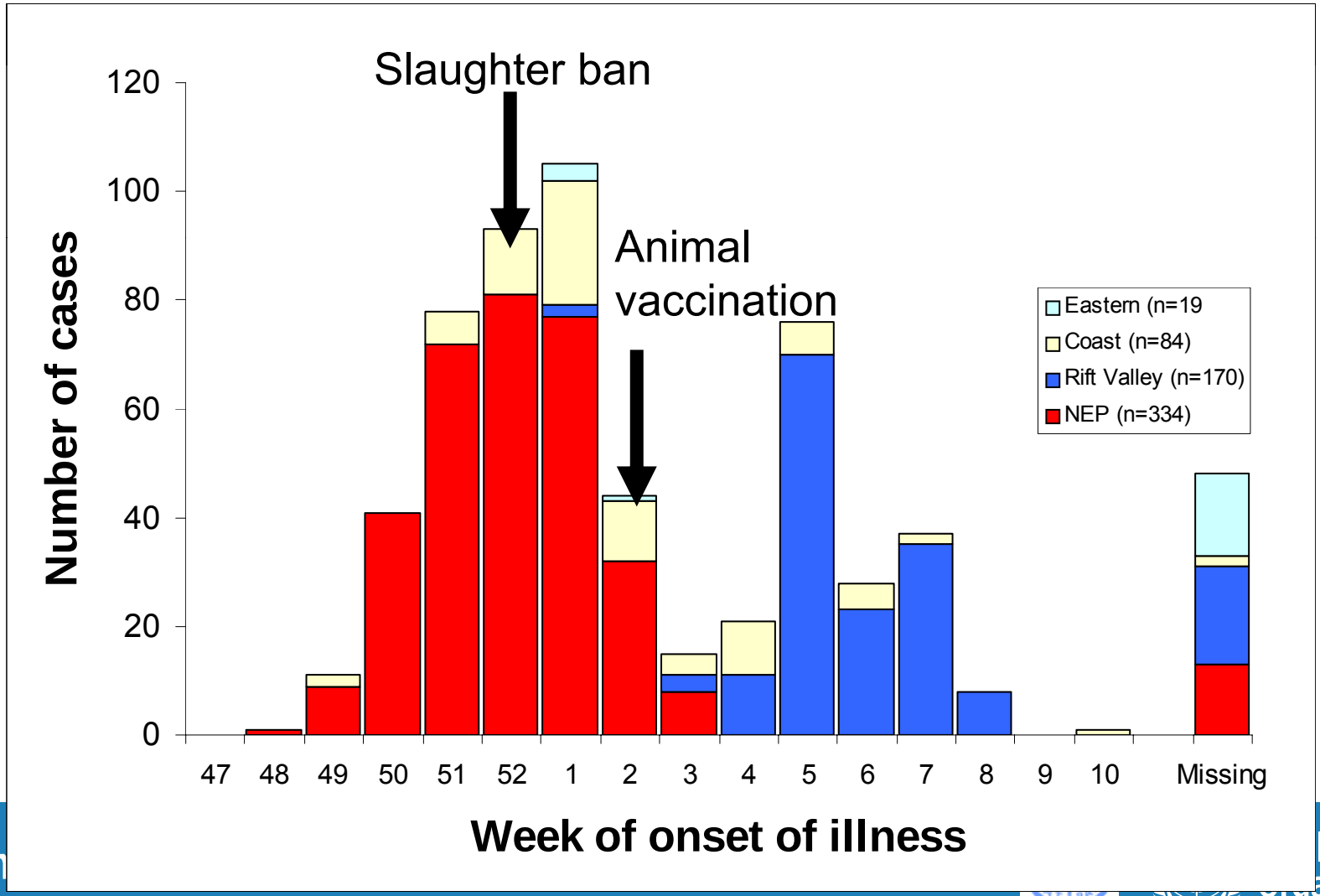
RVF 2007 Horn of Africa outbreaks

Kenya, Somalia, Tanzania: >100,000 estimated cases,
923 reported cases including 234 deaths



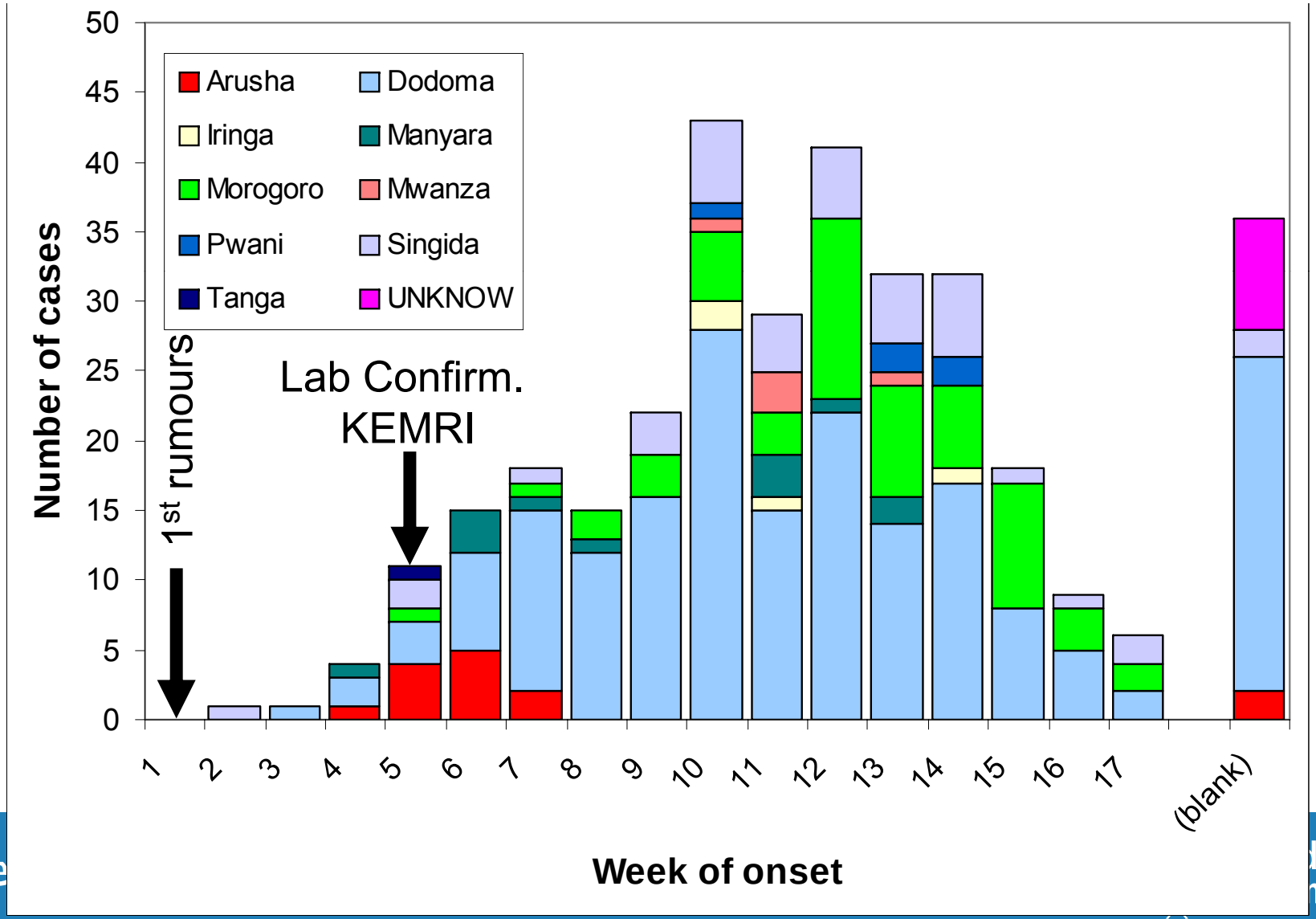
Rift Valley Fever, Kenya 2007

- Cases of RVF in Kenya, meeting inclusion criteria, by Province and onset of symptoms, December 2006 – March 2007 (n = 607 cases).



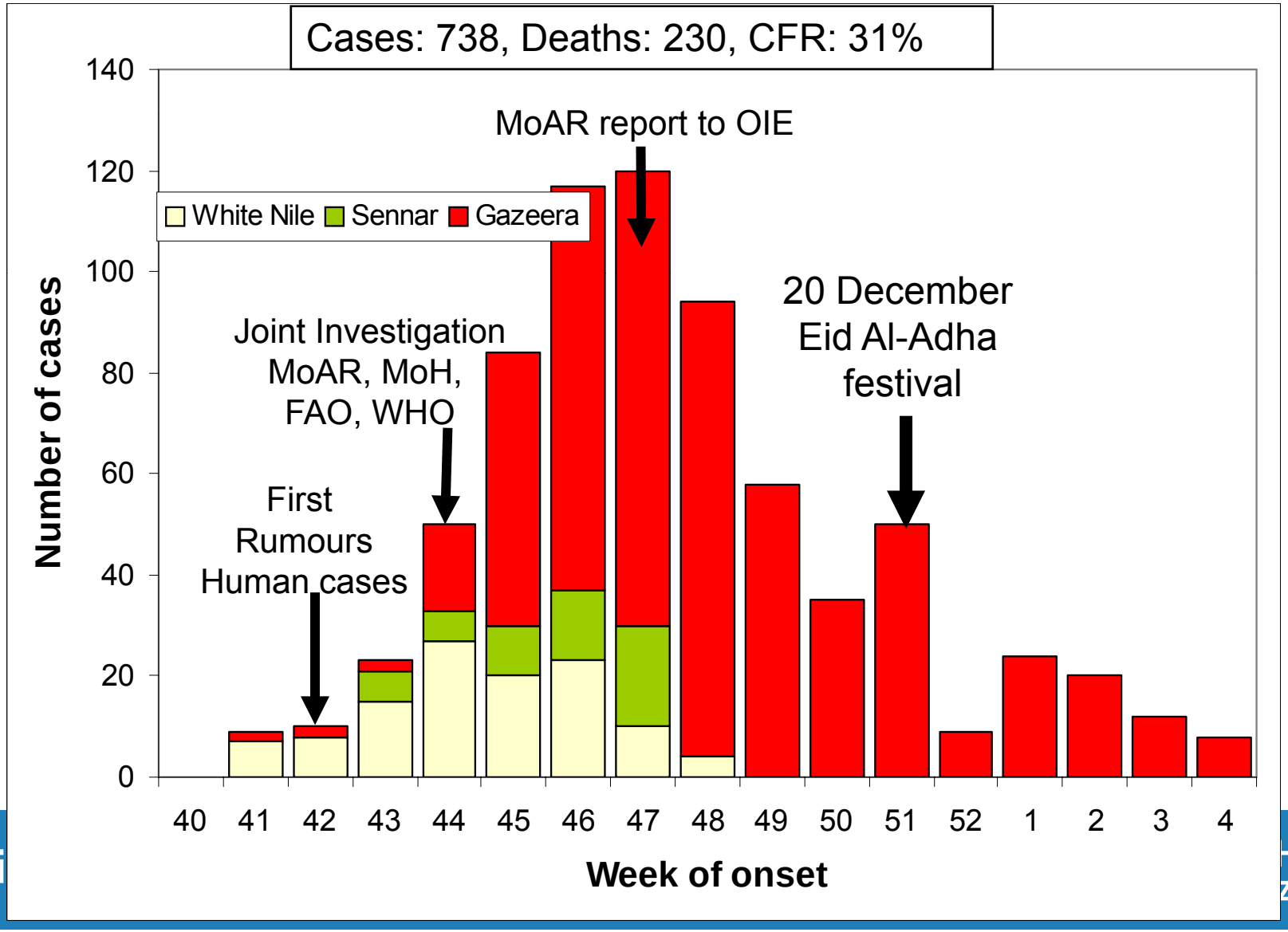
Rift Valley Fever, Tanzania 2007

Cases of RVF in Tanzania, by date of onset of symptoms (estimated for 104 cases) and Region, January to April 2007 (n = 333 cases).

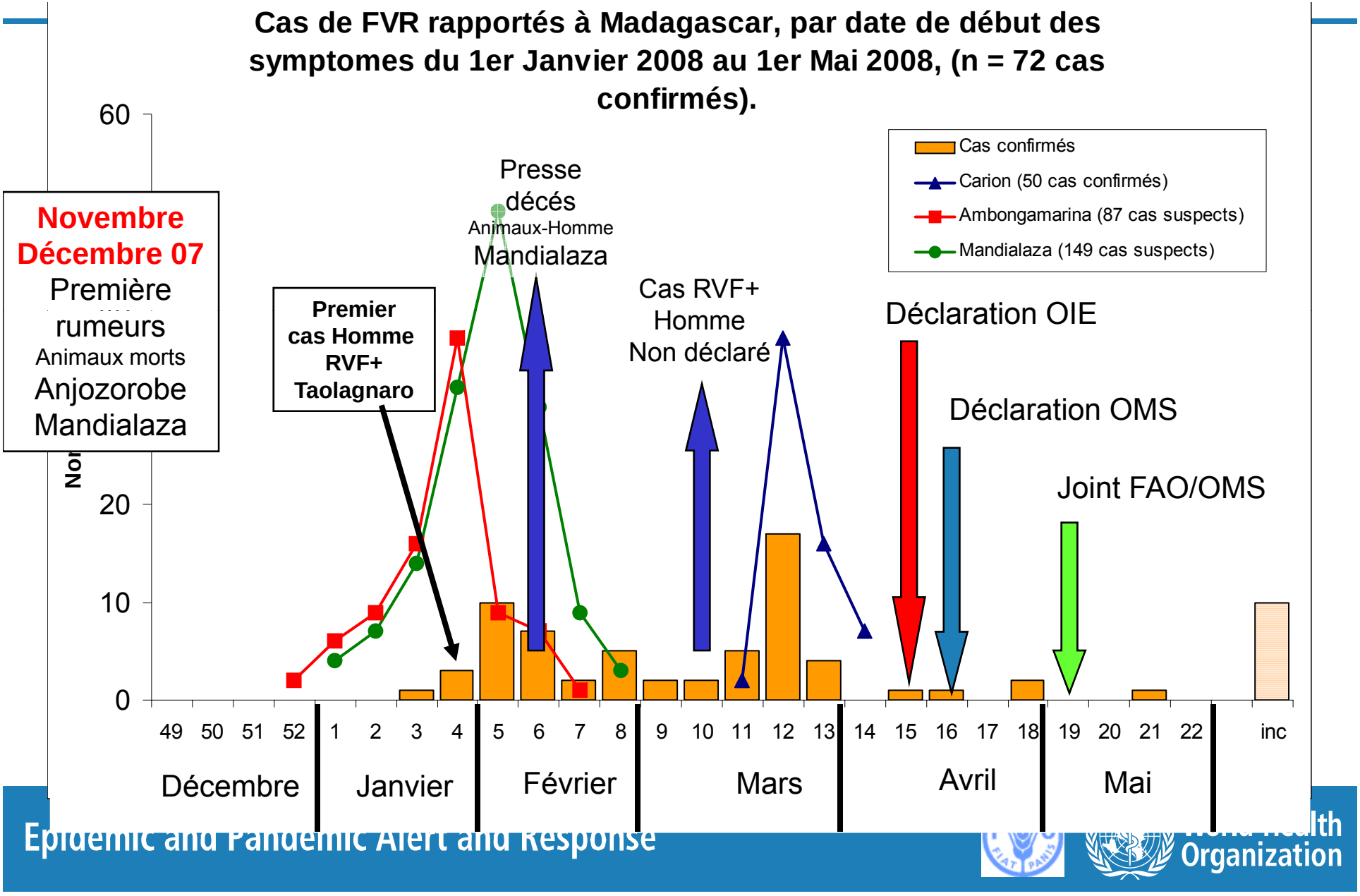


Rift Valley Fever, Sudan 2007-08

Cases of RVF reported in Sudan, by date of reporting from week 48/2007 to week 4/2008 (n = 738 cases).



Rift Valley Fever outbreak response, Madagascar.



Rift Valley Fever surveillance

- Animal RVF surveillance: weak to very weak. Need to recognize and declare
- Human surveillance: sentinels?
- GLEWS, GPHIN at international level
- Laboratory confirmation needed
- Who want to declare to OIE, FAO and/or WHO?

Rift Valley Fever
Outbreak control

Rift Valley Fever outbreak control

Animal Health

- Need a good immunity and safe RVF vaccine, available before outbreaks
- Good Vet services able to implement safe mass vaccination campaigns
- A better understanding of RVF disease and its epidemiology in animals (Bird and al., JoV 2008, Multiple virus lineages sharing recent common ancestry were associated with a large Rift Valley Fever outbreak among livestock in Kenya during 2006-07)

Rift Valley Fever outbreak control

Human Health

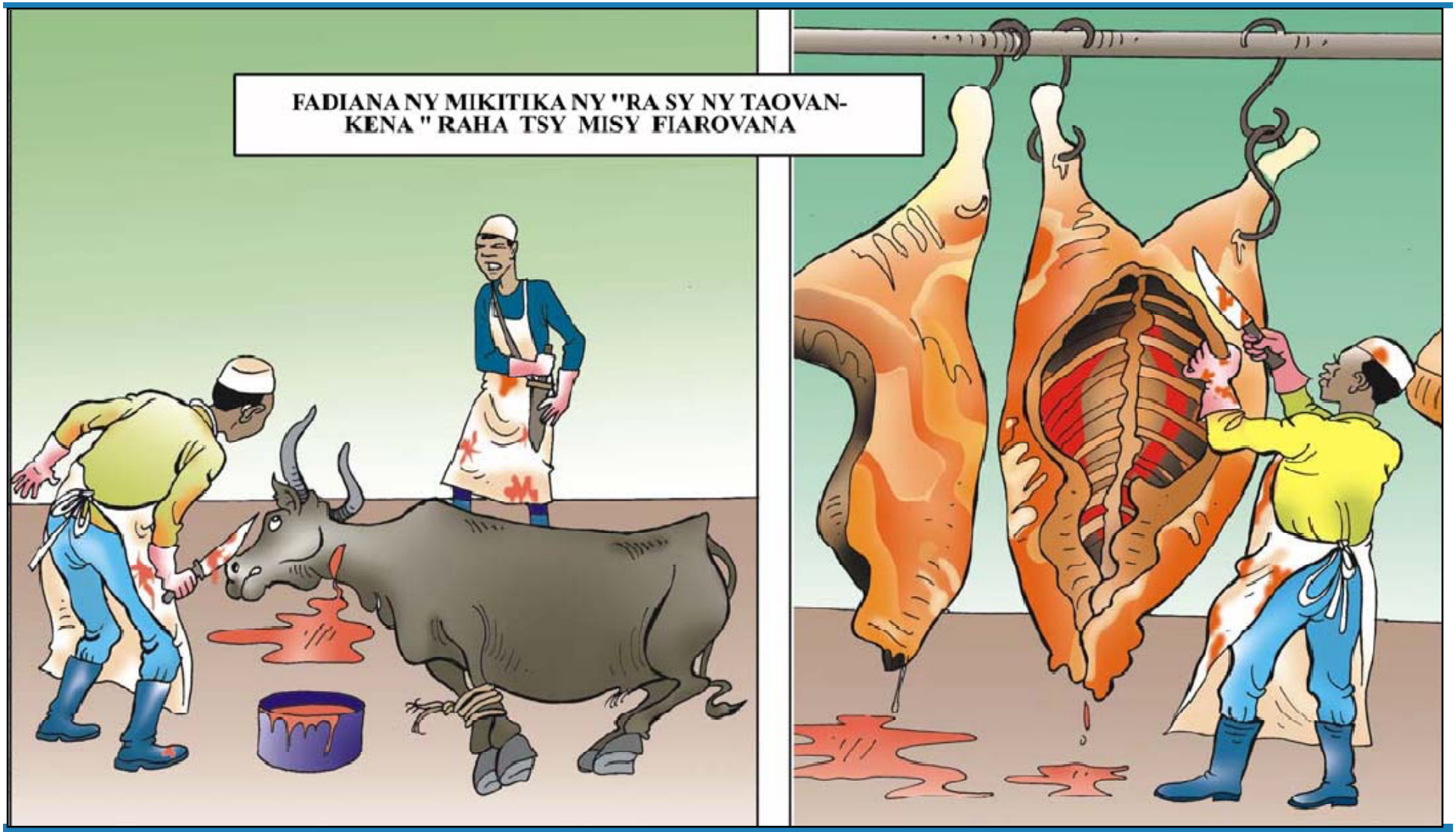
- RVF standard infection control practices: consider as a blood born pathogen. Blood safety, injection safety, uninterrupted supply.
- Early clinical diagnosis for early treatment : field guidelines for RVF clinical diagnostic (signs, symptoms, biochemistry, haematology, patient history).
- SOPs for treatment of different forms of RVF
- Need for new antiviral drugs

Rift Valley Fever outbreak control

Social Mobilization

- The social and cultural aspects are usually underestimated or neglected when they are key. The support of medical anthropology is highly beneficial.

Rift Valley Fever outbreak control



Epidemic and Pandemic Alert and Response

World Health Organization

Liberté . Égalité . Fraternité
RÉPUBLIQUE FRANÇAISE

Le Préfet communique

La fièvre de la vallée du Rift , « mieux vaut prévenir que guérir ! »

رسل بيريف
أودو «فيفير دلفل دو رفت»
الحذر قبل لحجر

La fièvre de la vallée du rift a été identifiée à Mayotte sur le bétail.
Cette maladie peut être transmise à l'homme.
Chez l'homme, la maladie est souvent inapparente.
Dans le cas contraire, les symptômes s'apparentent à ceux de la grippe. Il peut cependant exister, rarement, des formes plus graves, hémorragiques, oculaires ou neurologiques.

Comment se transmet la fièvre de la vallée du Rift ?

- au contact du bétail infecté
- par ingestion de viande mal cuite et de lait cru ou caillé
- par piqûre de moustique

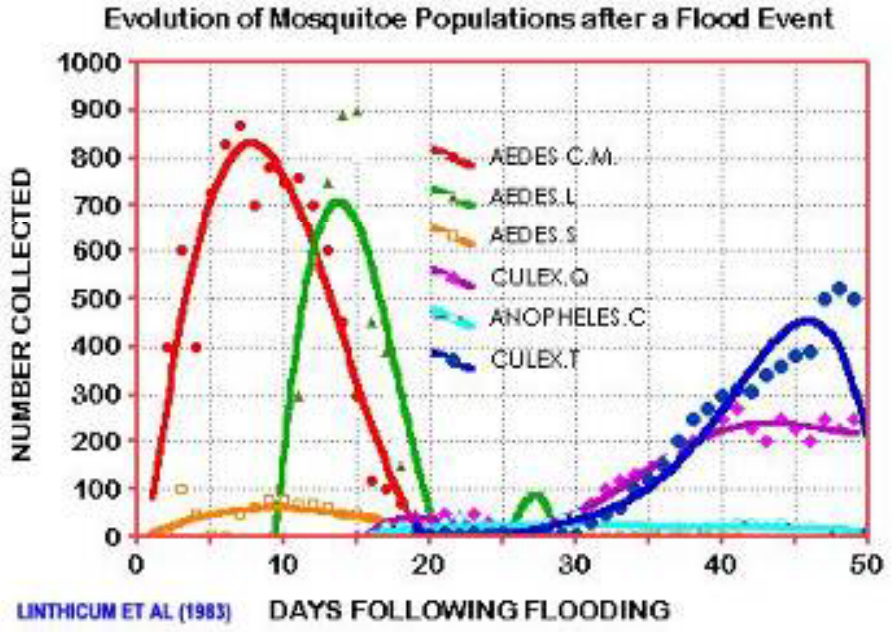
Que faut-il faire pour se prémunir de cette maladie ?

- **Pour les personnes pratiquant des abattages de zébus, de chèvres ou de moutons,**
  - se protéger : port de masques, lunettes et gants
  - Assurer une meilleure saignée des animaux : suspendre les carcasses et les nettoyer avec de l'eau potable
  - Se laver les mains avec du savon
- **Pour l'alimentation,**
  - bien faire cuire la viande
  - faire bouillir le lait
  - Ne pas consommer le lait caillé
- **Pour les piqûres de moustiques,**
  - éliminer les lieux de ponte
  - éviter les piqûres de moustiques

Rift Valley Fever outbreak control

Vector Control

- studies to understand vector capacity to transmit RVF virus and its implication in animal and human epidemiology
- New vector control strategies?
- Integrated approach
- When?



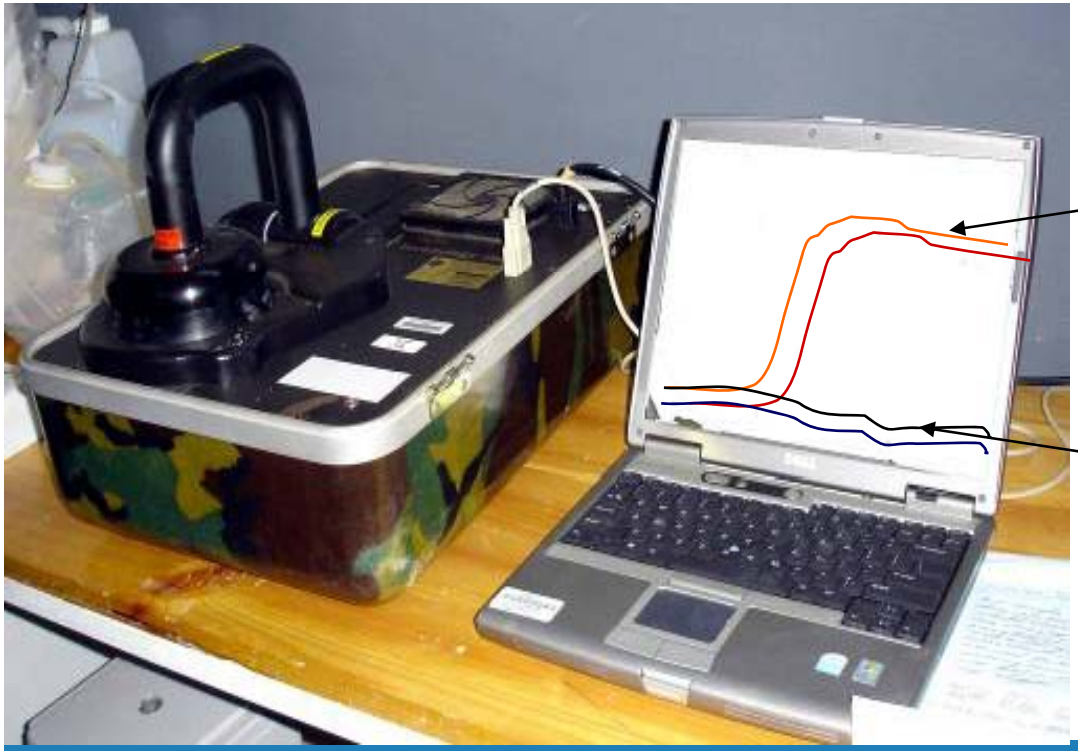
Rift Valley Fever outbreak control

Laboratory

- In the field support Animal surveillance and Human case management
- Support establishment of Regional reference laboratories and National lab capacities:
- Support international reference laboratories WHO-CC, FAO and OIE.

Rift Valley Fever outbreak response, Sudan

- Laboratory: NAMRU-3 was deployed in Kosti (PCR) for 5 days and in Khartoum (IgM by ELISA) for 7 days. NAMRU-3 confirmed 16/47 human cases in Kosti and Khartoum labs.



Rift Valley Fever
Lessons Learnt

Outbreaks of RVF from forecasting to control

- Need for an integrated approach and more collaboration between MoH, MoA, Vet Services (animal data)
- Forecasting. Several RVF Alerts send to countries and Regions. RVF forecast (2003, 2006, 2007) BUT
  - Only some countries take appropriates measures, prepare outbreak response team and vector control program
  - Need for a more systematic way of sharing forecasting maps with countries (web site is not enough)
  - Need to improve forecasting model (knowledge in ecology, Indian Ocean Dipole, database of outbreaks, generating risk maps, bioclimatic zones…)

Outbreaks of RVF from forecasting to control

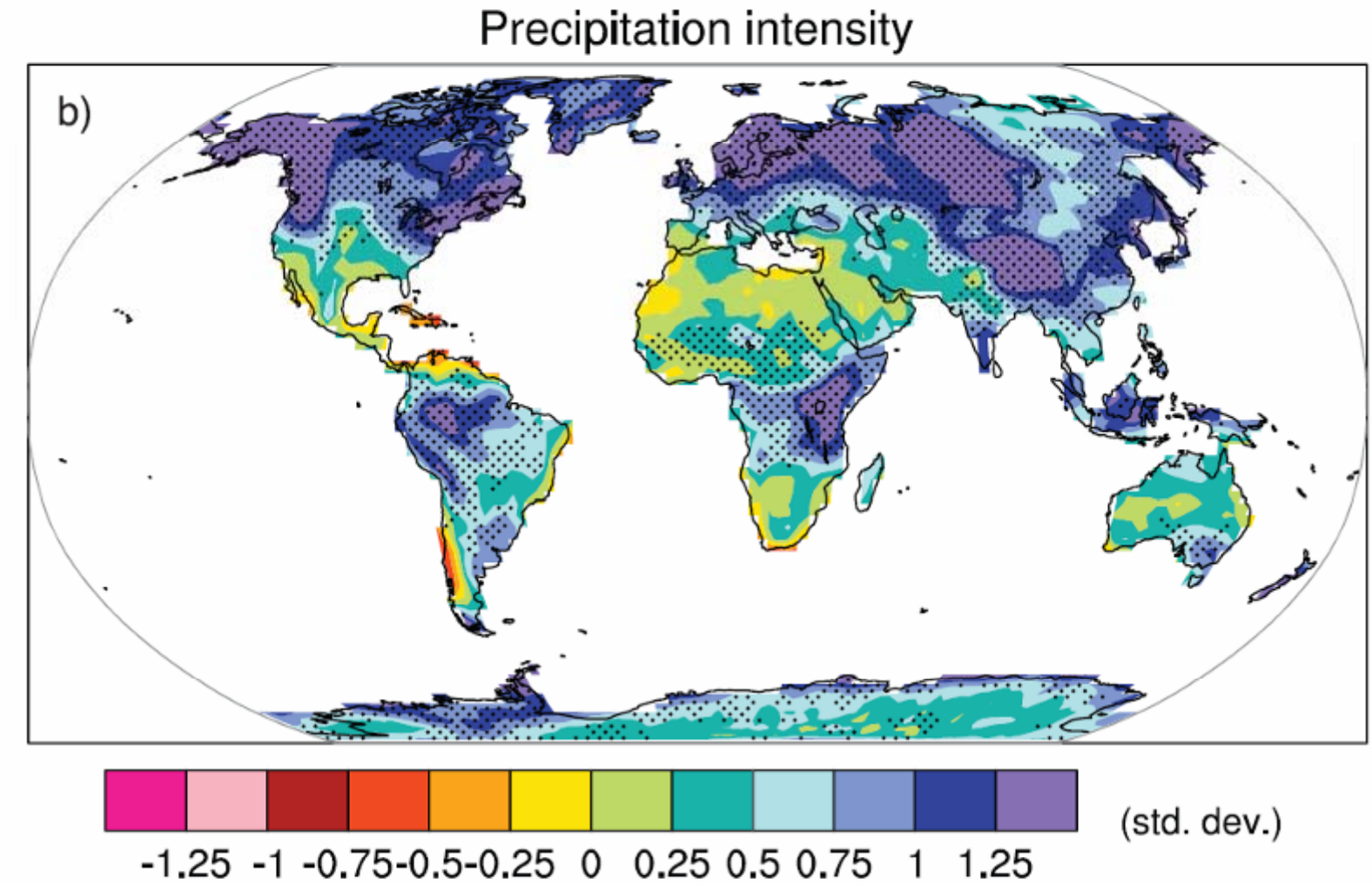
- Surveillance: need a better animal surveillance based on stronger veterinary services, national laboratory capacities
- Animal Vaccination strategy: safe, immune, available before outbreaks. Need Vet Services able to implement mass vaccine campaigns
- New vector control approach?
- Case management and treatment: need for new antiviral drugs

Outbreaks of RVF from forecasting to control

International: at global level OIE FAO and WHO do have a common strategy, from Forecasting to Outbreak response:

- → need for SOPs for RVF from forecasting to outbreak containment: One Health, One Message
- → preparedness guidelines for occupational health (e.g. how to protect slaughtering house personnel in different technology settings)
- → field lab for human + animal health / outbreak response

Outbreaks of RVF from forecasting to control

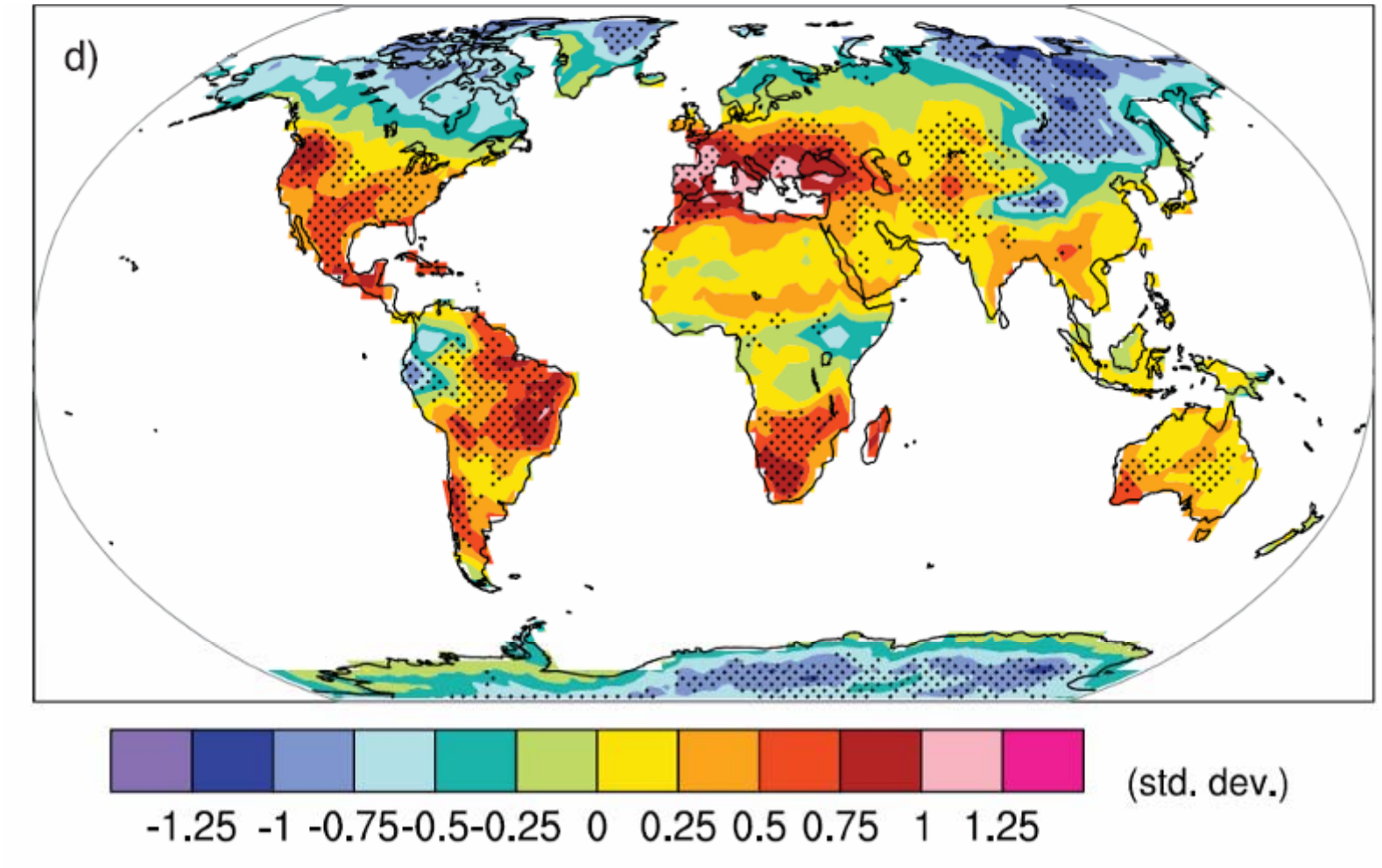


Adapted from Tebaldi et al. (2006), in Bilan des changements climatiques, groupe d'Expert intergouvernemental sur l'évolution du climat (GIEC), Rapport 2007, groupe de travail 1

World Health Organization

Outbreaks of RVF from forecasting to control

Precipitation increase + dry days increase = RVF epidemiology may change



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World Health Organization

Thank You

Ministry of Health and Ministry of Agriculture Kenya

Ministry of Health and Ministry of Agriculture Madagascar

Ministry of Health and Ministry of Agriculture Somalia

Ministry of Health and Ministry of Agriculture Senegal

Ministry of Health and Ministry of Agriculture South Africa

Ministry of Health and Ministry of Agriculture Sudan

Ministry of Health and Ministry of Agriculture Tanzania

Bob Swanepoel, NICD; Assaf Anyamba, NASA/GFSC; Tom Ksiazeck and Pierre Rollin, CDC Atlanta; Nilesh Buddha WHO Sudan, Maalim Dabar WHO Kenya, H El Bushra EMRO, JM Reynes IP Madagascar,...

KEMRI-CDC in Nairobi, Kenya; NAMRU-3 in Cairo, Egypt; Institut Pasteur Sénégal; Institut Pasteur Madagascar; NICD South Africa;

Médecins Sans Frontières

World Animal Health Organization (OIE), Paris, France.