IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Management and control of vector borne diseases

WOAH Regional Seminar

Vector-Borne Diseases in the European Region

25 - 27 June 2025

Teramo (Italy)

Daria Di Sabatino – Paolo Calistri

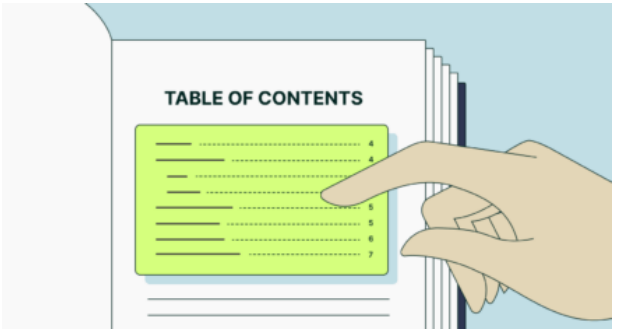
IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Contents

- Some differences between VBD and others disease
- Preparedness and response (example for RVF epidemic phases)
- Vector control
- Control measures for livestock
- Conclusions



IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

VBD – some differences

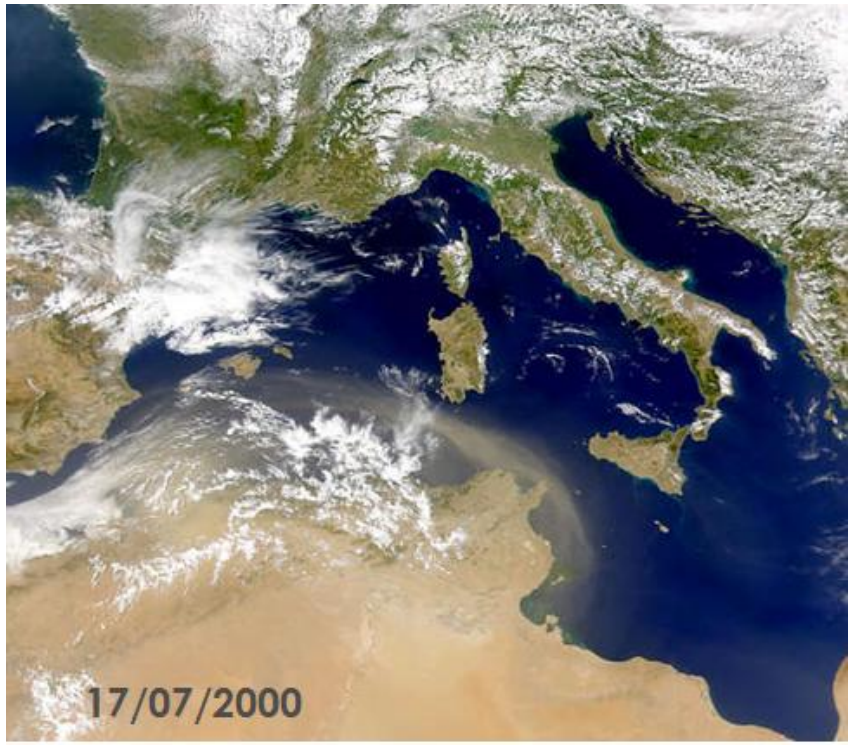
- **Measures against vectors alone** are ineffective for stopping the VBD spread
- **Rapid spread**, especially when flying vectors are implicated
- Need for a **territorial approach** (epi-regions, eco-regions) taking into consideration the spatial distribution of competent vectors and animal hosts
- Need for **early warning systems**

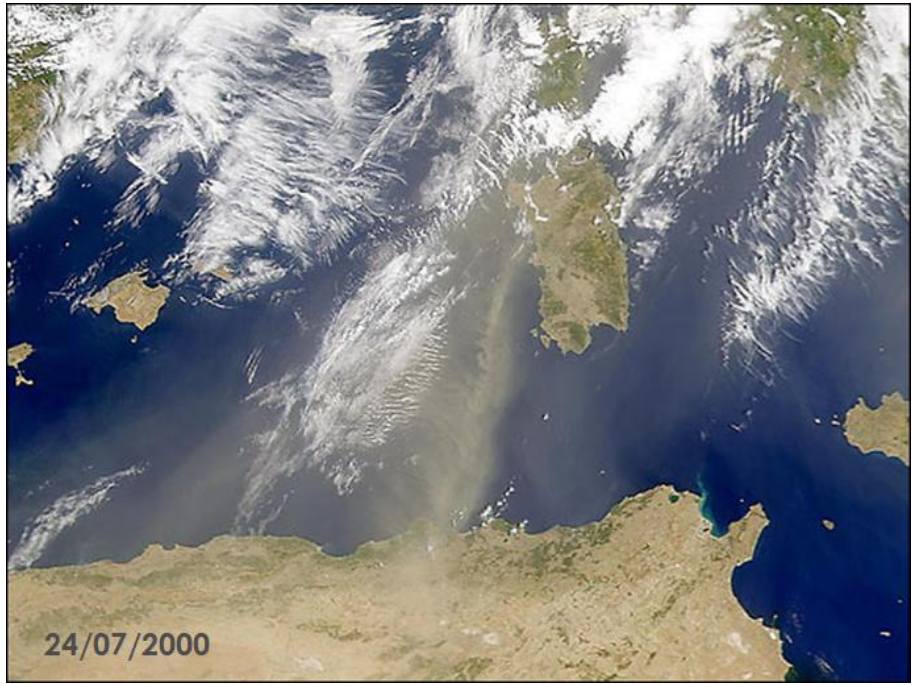
IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Rapid spread





Source:

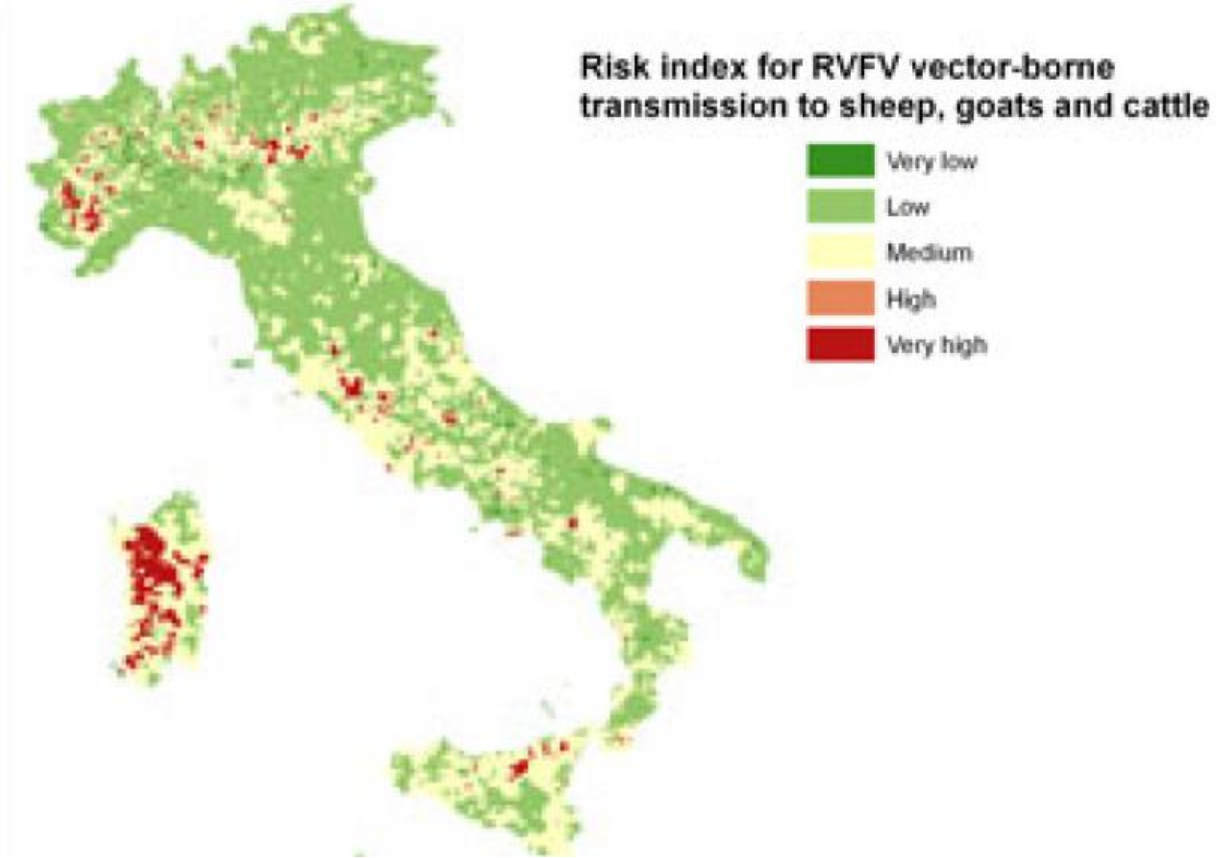
- Images from “SeaWiFS Project”, NASA/Goddard Space Flight Center, and ORBIMAGE
- Satellite: OrbView-2
- Sensor: SeaWiFS

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Territorial approach
Example of suitability maps



Transboundary and Emerging Diseases

Transboundary and Emerging Diseases

ORIGINAL ARTICLE

A Geographical Information System-Based Multicriteria Evaluation to Map Areas at Risk for Rift Valley Fever Vector-Borne Transmission in Italy

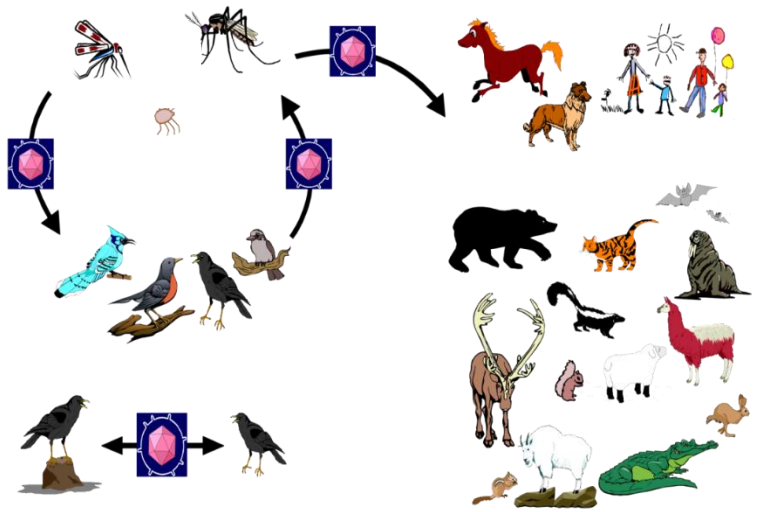
A. Tran[1,2], C. Ippoliti[3], T. Balenghien[4], A. Conte[3], M. Gely[1], P. Calistri[3], M. Goffredo[3], T. Baldet[4] and V. Chevalier[1]

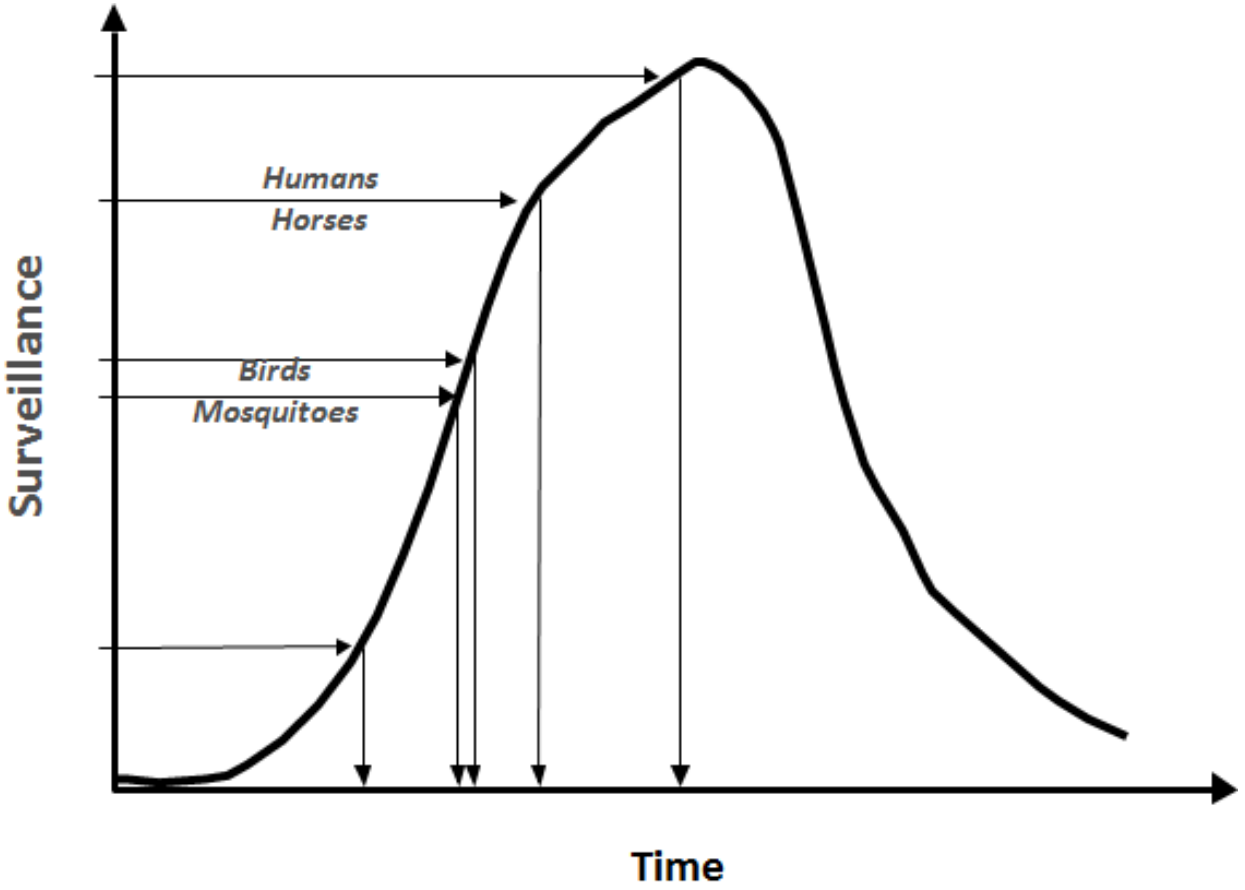
IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Need for early warning systems: Epidemic phases of West Nile Disease



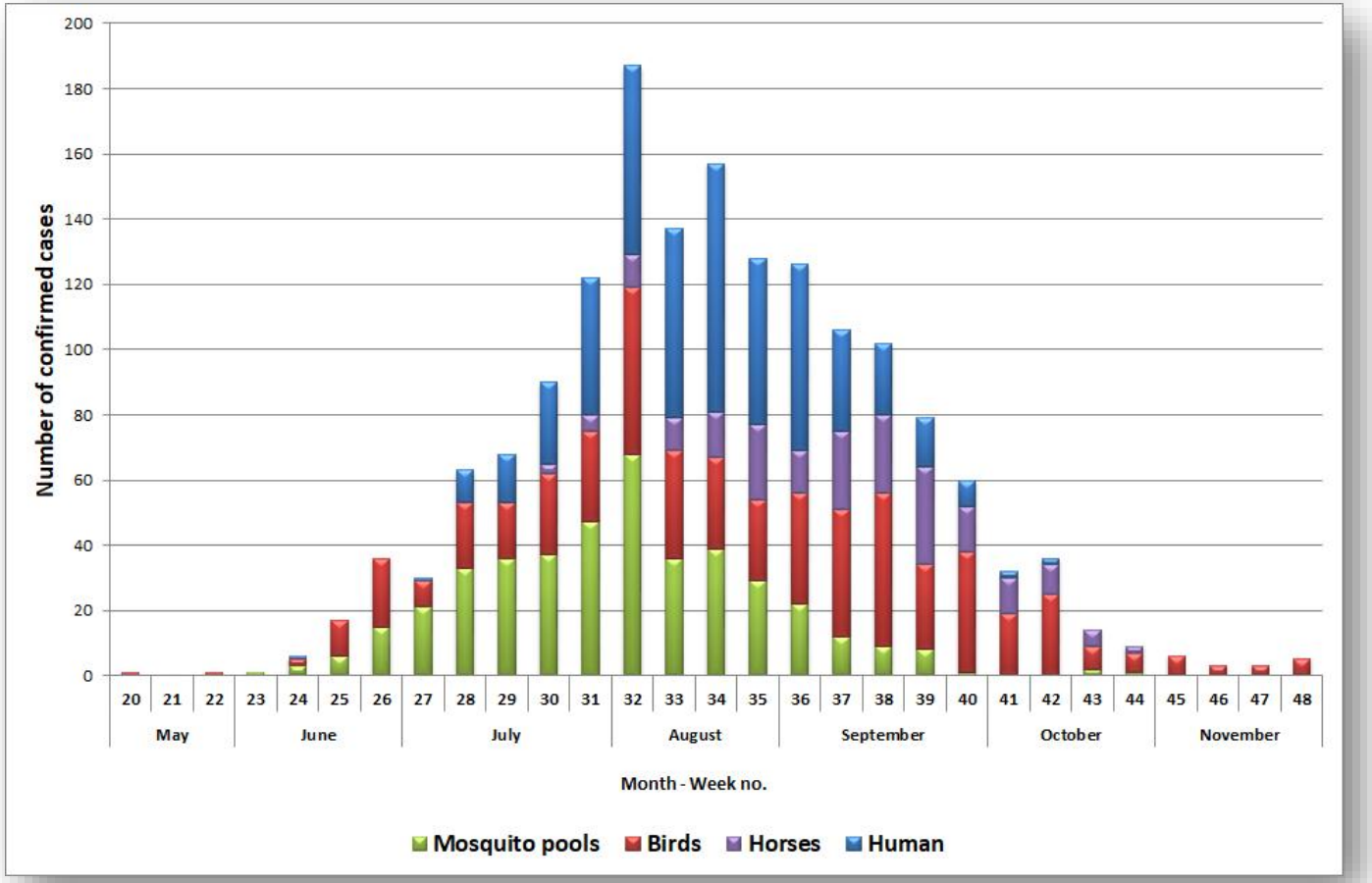


IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Need for early warning systems



West Nile Disease 2008-2018 in Italy

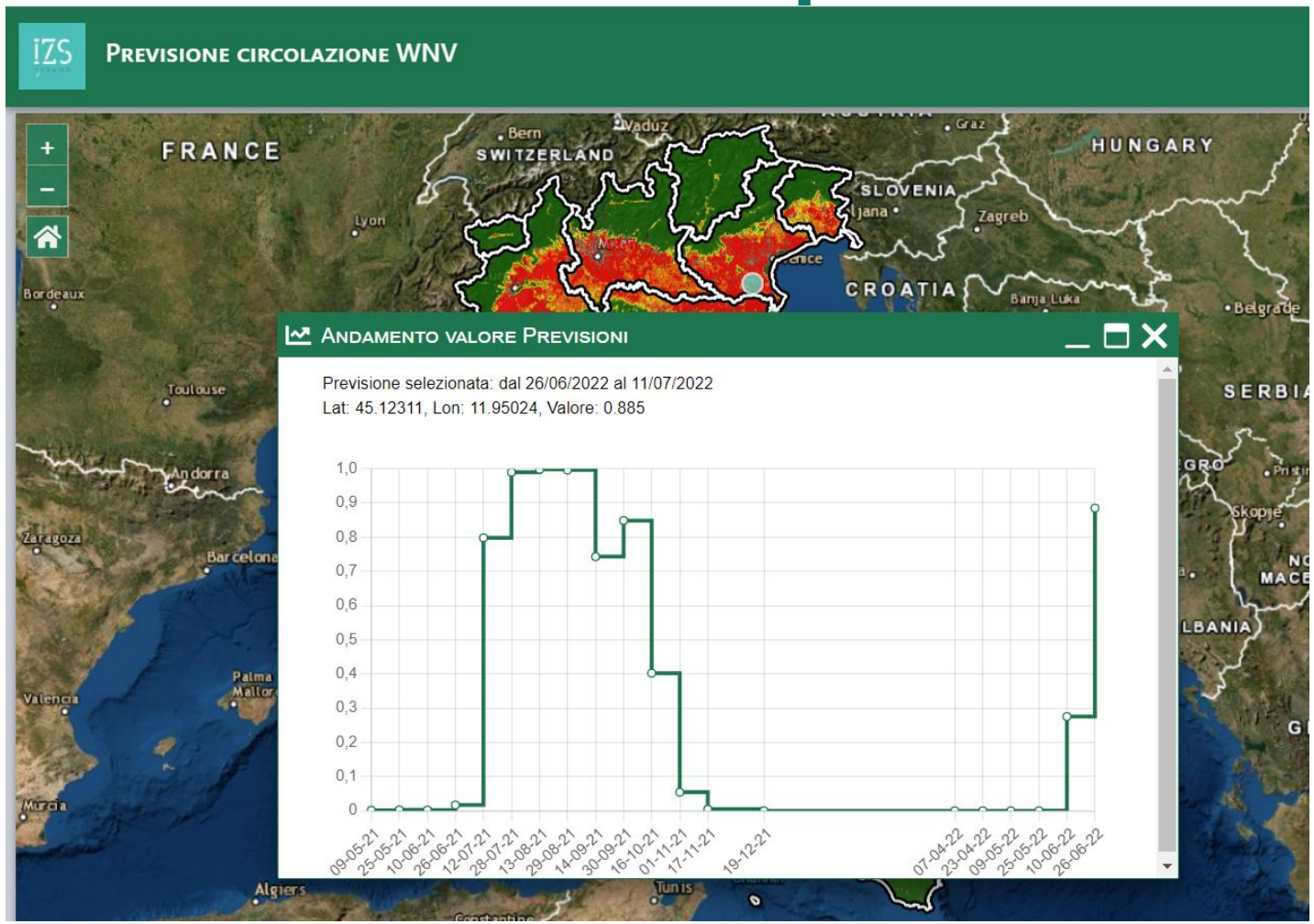
Seasonal distribution of humans, veterinary cases and entomological results

IZS TERAMO

WOAH Collaborating Centre
for epidemiology, modelling
and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Need for early warning systems: WND predictive tool



remote sensing MDPI

Article

Predicting WNV Circulation in Italy Using Earth Observation Data and Extreme Gradient Boosting Model

Luca Candeloro [1,*], Carla Ippoliti [1], Federica Iapaolo [1], Federica Monaco [1], Daniela Morelli [1], Roberto Cuccu [2], Pietro Fronte [2], Simone Calderara [3], Stefano Vincenzi [3], Angelo Porrello [3], Nicola D'Alterio [1], Paolo Calistri [1] and Annamaria Conte [1]

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Elapsed time between events in 2006-2007 RVF outbreak in Kenya

Event	Average elapsed days since previous event
Onset of heavy rains	0
Mosquito swarms	23.6
First case in livestock	16.8
First case in human	17.5

On average, the onset of the first cases in livestock was only 17 days after mosquito swarms and approximately 40 days after heavy rains. Human cases were observed around 18 days after the first livestock cases (Jost et al., 2010).

National contingency / control plan

A National contingency / control plan is a fundamental tools for effective preparation. The plan must include at least:

- Description of the command chain
- Roles and responsibilities
- Components of Crisis Units at the different levels (central / local)
  - In case of VBD, need for a multidisciplinary approach (involvement of entomologists, experts on wildlife, etc.)

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

National contingency / control plan

- Procedures for:
  - Suspicions / confirmation and case definition
  - Notification
  - Application of control / eradication measures
  - Zoning
  - Surveillance activities in response of confirmed cases

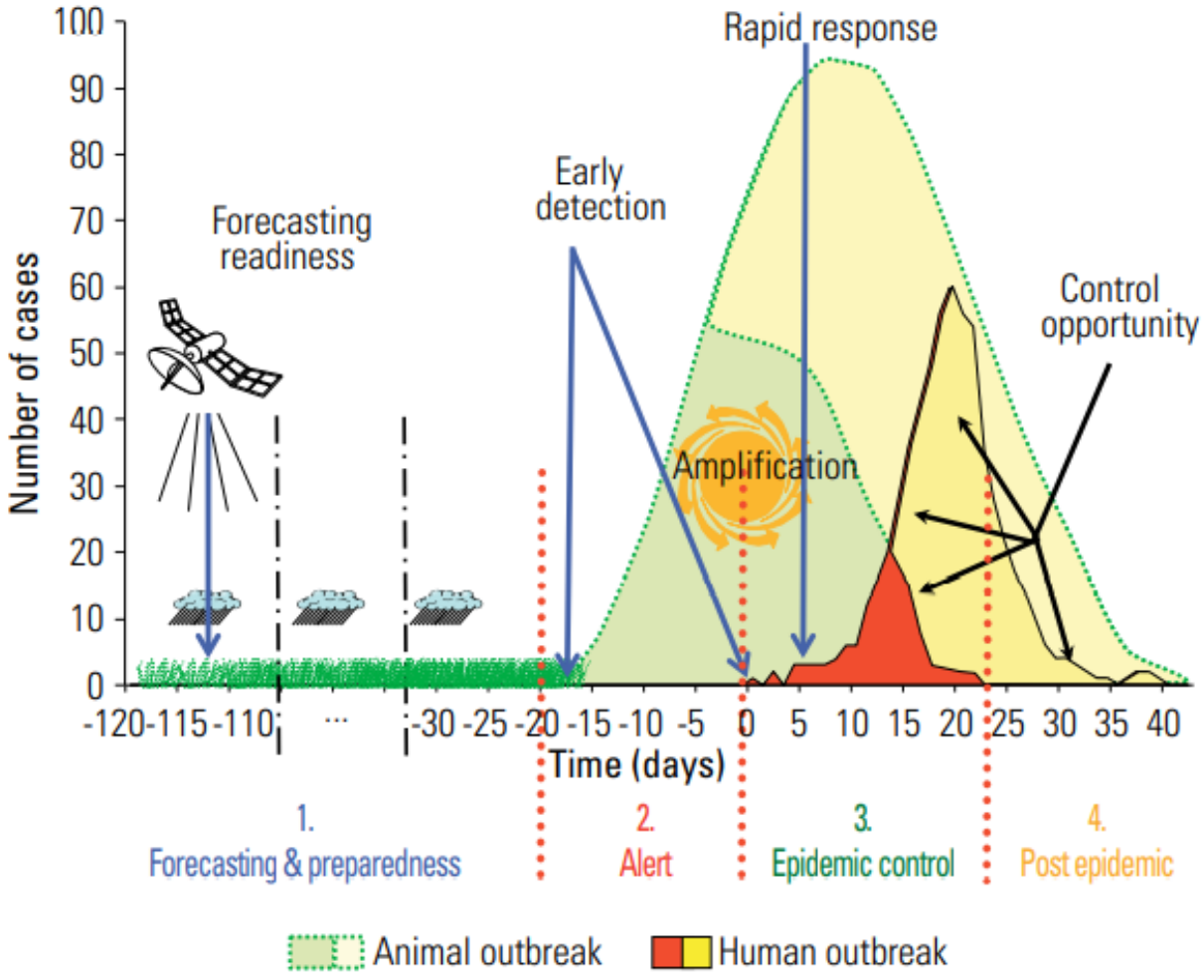
- Definition of training programmes for veterinary services and professionals
- Simulation exercises

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

RVF epidemic phases



It can be applied to the other VBD too…

S. de La Rocque & P. Formenty, 2014. Applying the One Health principles: a trans-sectoral coordination framework for preventing and responding to Rift Valley fever outbreaksRev. sci. tech. Off. int. Epiz., 2014, 33 (2), 555-567

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

INTER-EPIDEMIC PERIOD

The inter-epidemic period is the critical period for building the capacity to respond to new outbreaks.

- One Health coordination
- National action plan
- Surveillance
- Forecasting and early warning systems
- Disease control strategies
- Capacity building

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

PRE-EPIDEMIC PERIOD

The pre-epidemic period starts when forecasts of future weather conditions or alerts are indicating the presence of conditions consistent with the possible occurrence of VBD

- Mobilization of resources
- Activation of logistics for sample collection
- Verification of laboratory and health system capacities
- Surveillance intensification
- Reinforcement of animal movement control and vaccination activities
- Risk communication

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

EPIDEMIC PERIOD

- Surveillance and notification system
- Disease control
- Palliative and supportive care
- Risk communication and social mobilization

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

EPIDEMIC PERIOD
Outbreak control

- **Animal culling** is generally not a preventive measure (it can be considered only for animal welfare reasons)
- Control of **animal movements** is needed although it is not able to stop the spread due to the dissemination of infected vectors
- Identification of **infected area** by:
  - Clinical surveillance
  - Laboratory surveillance
  - Entomological surveillance

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

EPIDEMIC PERIOD
Clinical surveillance

- The efficacy in identifying the infected area depends on the clinical features of the disease
- The incubation period must be considered
- Repeated clinical visits by veterinarians may be not feasible due to the number of heads under surveillance
- A syndromic approach may help (e.g. abortion monitoring)
- Good communication with farmers

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Laboratory surveillance

- ***Ad hoc* surveys**
  - Effective when target population is large or dispersed across a wide territory. It gives a picture. Need to be repeated regularly
  - Vector-borne diseases are not homogeneously distributed in the territory or during time and biotic/abiotic variables must be taken into account

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Laboratory surveillance

- **Sentinel animals**
  - It can give precise information about place and time of pathogen circulation
  - Sentinels may be tested for various pathogens / infections
  - Difficulties in selecting the right sites in lack of entomological information
  - Need for a individual animal identification system
  - Relevant load of field activities

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Entomological surveillance

- To map of the spatial distribution of vectors -> moving trapping device across the area under investigation
- To monitor vector population dynamics -> regular catches in selected sites along seasons
- To detect the virus circulation in vectors -> depending on the vector infection rate. In general difficult due to the pathogen dilution in vector population

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

POST-EPIDEMIC PERIOD

- Surveillance
  - serosurvey to measure herd immunity
- Study and impact assessment
- Economic and social impact mitigation

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Vector control

Any control strategy for vectors must be:

- Knowledge-based
- Surveillance-driven

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Knowledge-based

- Which/where breeding sites are
- Activity peaks (nocturnal, diurnal)
- Flight ranges, flight patterns, active host-seeking
- Flight ranges
- Wind dispersal
- Host preferences and behaviours
- Temperature and humidity requirements for each stage
- ……

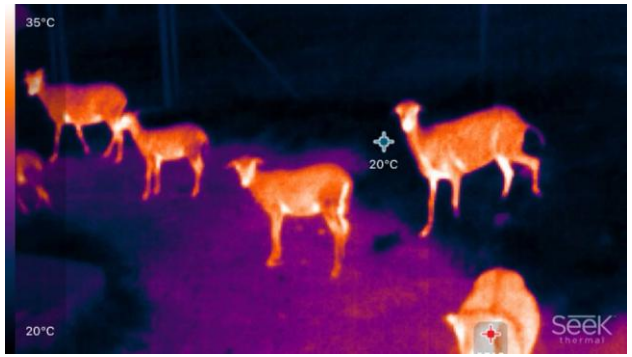
IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Knowledge-based

Need for research studies on the biology of vectors and their behavior



IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Surveillance-driven

- Needed for targeting control activities, to increase the efficacy, reduce the environmental impact and avoid to stimulate resistances
- It must govern the control activities, giving indications on:
  - Which actions
  - When
  - Where
  - How to monitor the efficacy

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Surveillance-driven

Need to develop:

- Surveillance methods
- Surveillance protocols
- Entomology skills
- Laboratory capabilities
- ….

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Preventive and control actions

- Preventive
  - Reduction/treatment of breeding sites
  - Reduction of animal exposure (physical/chemical barrier)

- Control
  - Treatments against larvae/adults in the environment, in the stables, over the animals

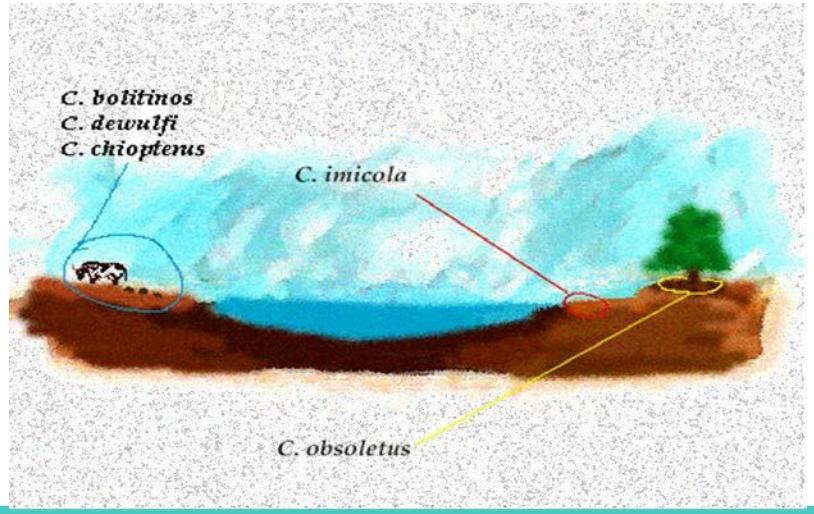
IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Preventive measures – breeding sites

- For some vectors (for example some *Culicoides* species) breeding sites are not well known
- Difficult to perform effective interventions (need for landscape modification!)
- In-farm hygienic measures could be more feasible



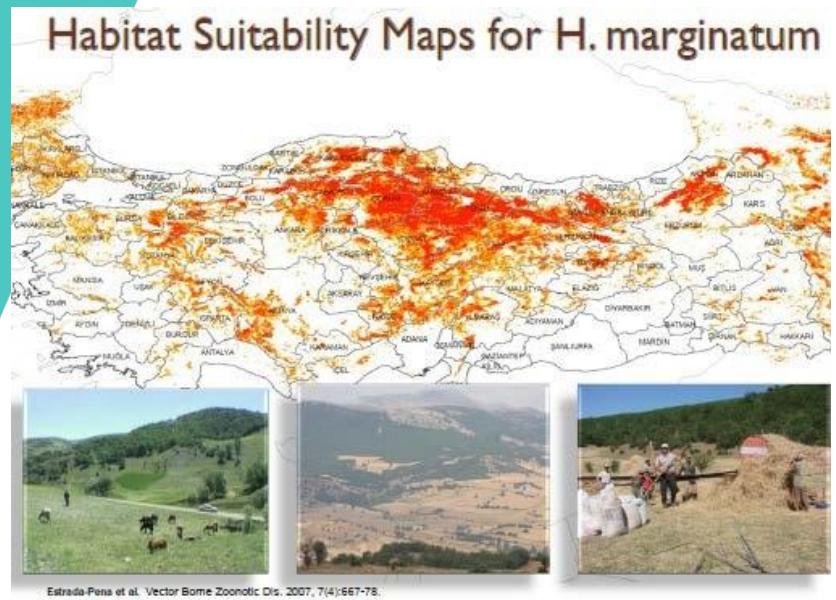
IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Preventive measures – breeding sites

- Some conditions are known to create a suitable larval habitat
- Effective measures need for community involvement

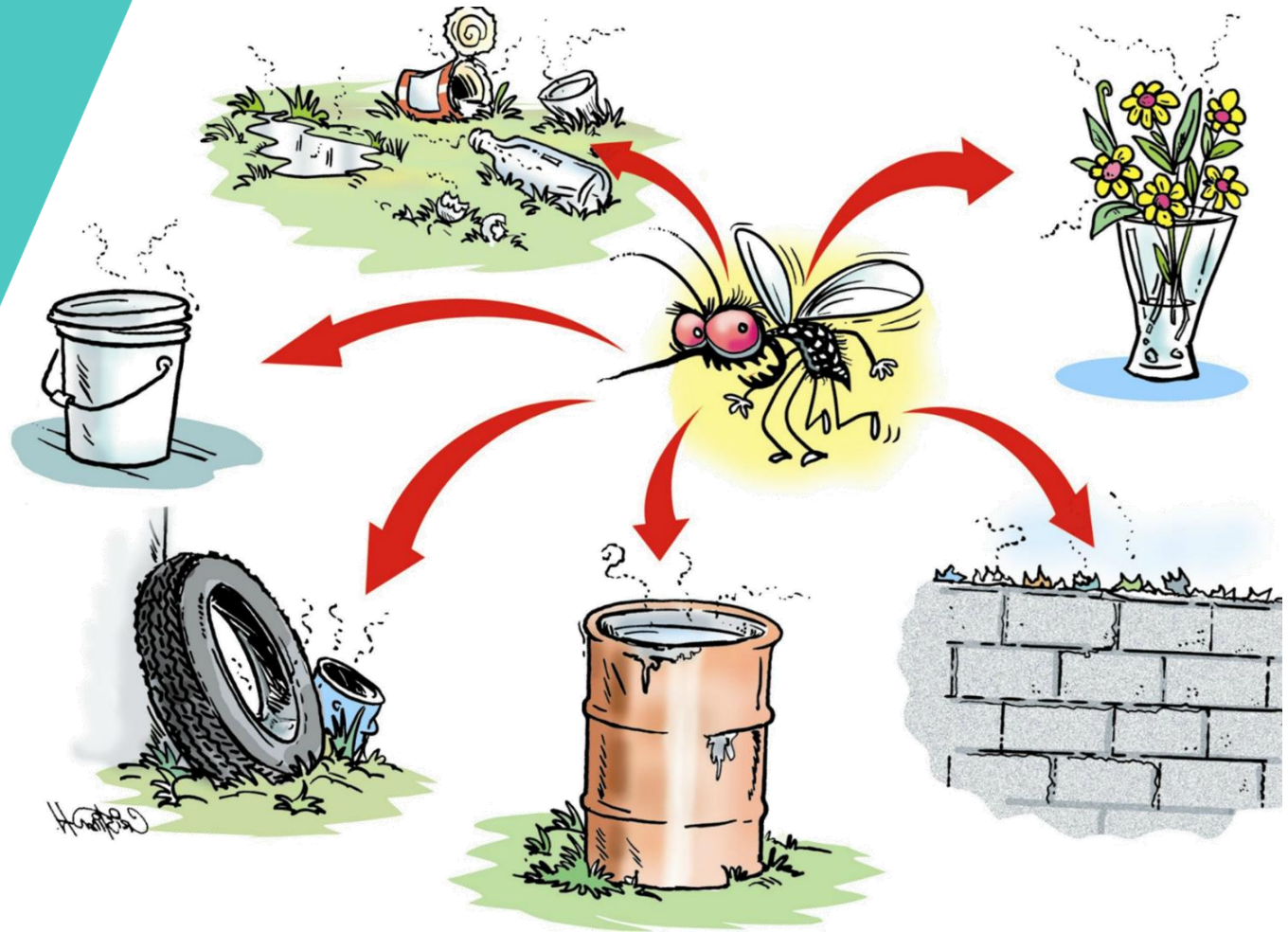


IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Preventive measures – breeding sites



Also at small scale…..

Examples of human activities influencing the presence and abundance of mosquitoes

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

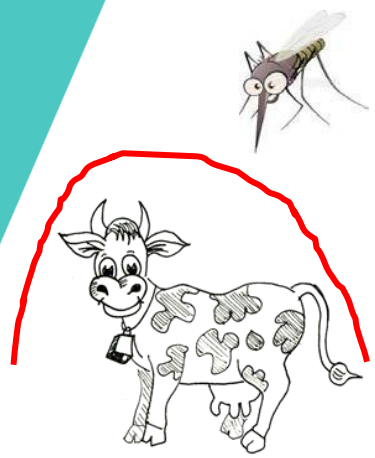
Preventive measures
Reduction of animal exposure

Physical barrier

- Use of nets is not feasible for livestock under field conditions
- To stable animals during night (effective only for nocturnal and not endophilic insects)

Chemical barrier

- Repellents
  - Correct application (reach all parts of the body, particularly the legs and belly)
  - Effects duration under field conditions (rain, animal licking, …)
  - Respect of waiting periods for milk and meat
  - Species-specific (some substances are not allowed in some species for toxicity, residue problems)
  - Costs !!



IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Control methods

Treatments against larval stages

- Biological:
  - *Bacillus thuringiensis israelensis*
  - *Bacillus sphaericus* (against *Anopheles* and *Culex* larvae. Ineffective on *Aedes*)
  - Predators: *Gambusia* fish

Control methods

Treatments against larval stages

- Chemical:
  - Insect growth regulator substances that interrupts the growth cycle of insect larvae
  - Careful and very targeted use to avoid accidental contamination of water bodies and effects on other insects

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Control methods

Treatments against adults

- Biological:
  - Spinosad, compounds found in the bacterial species *Saccharopolyspora spinosa*
- Chemical:
  - Many compounds. Pyrethroids most commonly used

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Control methods

Chemical treatments against adults

- Environment: Ultra low volume spraying
- Animals: Dipping
- In the stables: fly traps and other solutions

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Anti-ticks vaccines

- Vaccines addressing tick antigens (midgut, salivary and others). They are able to reduce the number, weight and reproductive capacity of engorging female ticks, thus indirectly reducing the transmission rate of some tick-borne diseases.
- A commercially available anti-tick vaccine was produced in the early 1990's against *Rhipicephalus* (*Boophilus*) *microplus* and marketed in Australia and Latin America.
- Researches are ongoing for the production of a commercially suitable vaccine.

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Stimulating RNA Interference (RNAi) in infected vectors

- Arboviruses require vectors for transmission and there is evolutionary pressure on keeping the right balance between virus replication and vector survival
- Research on mosquito-arbovirus interactions indicates that innate immune responses such as RNA interference (RNAi) are key factors in reducing arbovirus replication
- RNAi has been shown to be an important antiviral response in mosquitoes
- This approach for controlling arboviruses is valid for biological vectors

Effectiveness of vector control for reducing VBD spread

- It can reduce the VB-pathogen circulation and transmission
- It cannot stop an epidemic without the application of other control measures

Culex pipiens agilis

Culex pipiens femina

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Disease control

- Livestock
  - Vaccination
  - Movement control

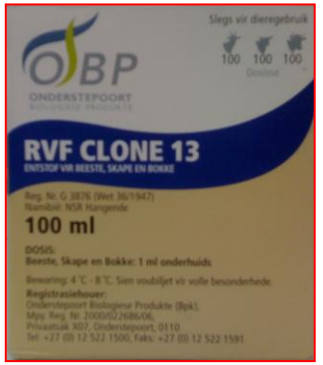
IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

RVF vaccines

- Formalinised Rift Valley fever virus with aluminium hydroxide gel as adjuvant. Susceptible animals can be immunised at any age (> 6 months) irrespective of the stage of pregnancy and lactation. Annual vaccination is recommended.
- Freeze-dried, live attenuated Rift Valley fever virus (Smithburn strain). Animals can be vaccinated at any age (>6 months) but risks for pregnant animals. A single inoculation usually produces a life long immunity.
- Freeze-dried, live attenuated Rift Valley fever virus (Clone 13 strain). Young animals immunised >2 months; >6 months if from vaccinated mother. Annual vaccination.



IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

LSD vaccines

- Available vaccines: live-attenuated vaccines, homologous (Neethling strain) or using sheep pox virus vaccine (10x sheep dose)
- Vaccination must repeated annually

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Bluetongue vaccines

Immunity is serotype-specific:

- Live-attenuated vaccines for all serotypes
- Inactivated vaccines available only for some serotypes

Possible side-effects of live vaccines on animals and circulation of attenuated strains

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

Movement control

- Very effective for direct contact disease, but not so effective for VBDs
- Impossible to maintain for long period or when movements are needed for grazing purposes
- Testing animal subjected to movement may be very expensive and risk cannot be reduced significantly when large numbers of animals are involved

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE

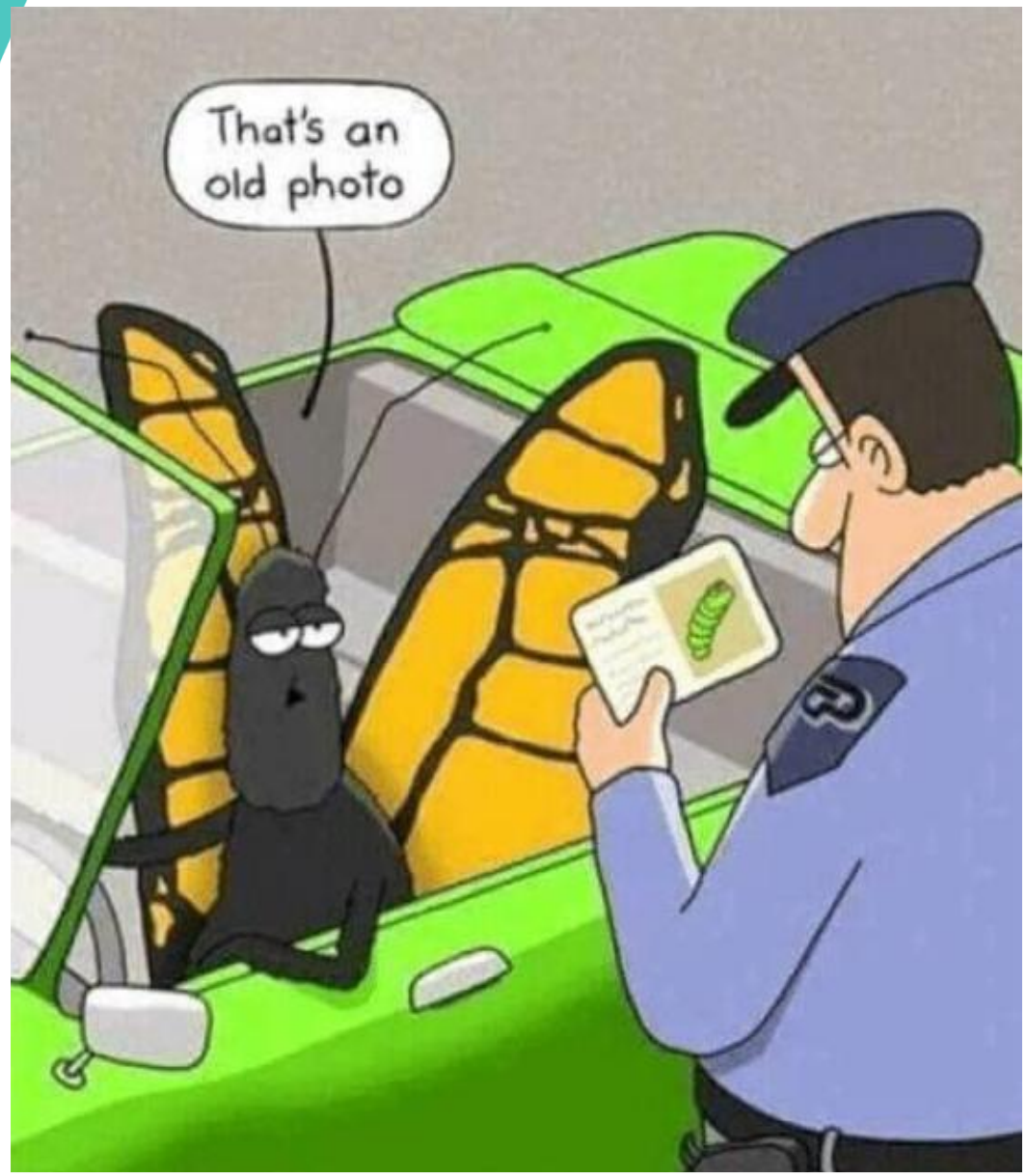
Conclusions

- Any action during “war” must be carefully planned during “peace” to be effective
- Rapid and efficient data / information exchange between actors and clear command chain are the cornerstones for the success of control measures
- Establishing a continuous and good communication with stakeholders is a pre-requisite for the early detection and control of VBDs

IZS TERAMO

WOAH Collaborating Centre for epidemiology, modelling and surveillance

Reference Centre World Organisation for Animal Health Founded as OIE



Thank you