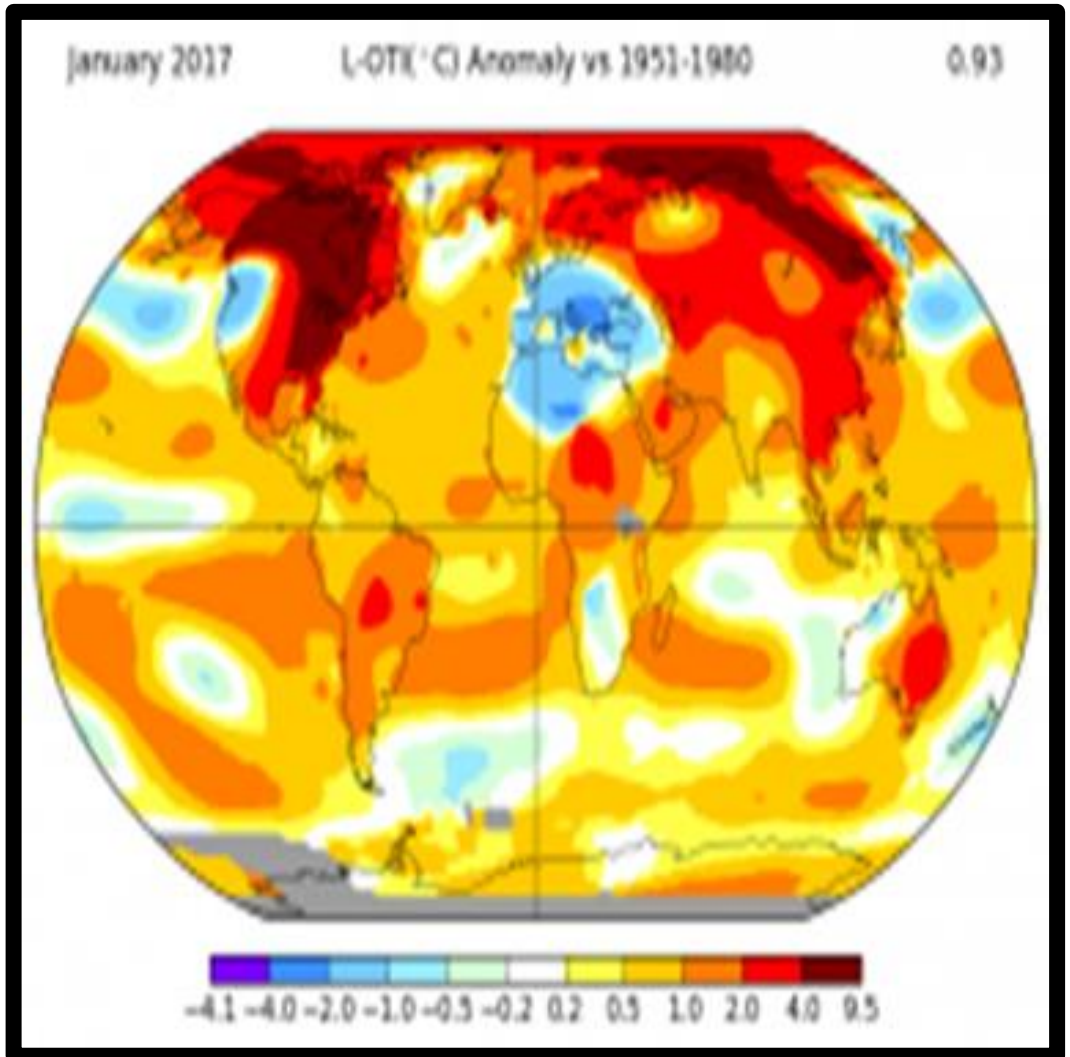
Biology and control of some exotic, emerging and transboundary vector-borne and zoonotic diseases in Bulgaria and Germany with emphasis of veterinary and public health importance

Risk Assessment Centre on Food Chain

Project link to the Delphi priorities / EFSA Strategy topics

Temperature distributions in January 2017 (Report on NASA's global warming)



Delphi study priority 3:

Environmental issues impacting on human health through the food chain

Objectives:

1 To investigate the biological, ecological and epidemiological components of some vector-borne diseases (VBD), their introduction & spread, phenology of the competent vectors and the importance for animal and human health (zoonoses);

2. To develop models of different ecological niches of LSDV and identify the epidemic progression patterns during the course of the LSD epidemics on the Balkans, focusing on the spatial and temporal epidemiology parameters;

3. To propose some innovative tools and increase the capacity building for effective and adequate disease prevention & control.

Inputs:

- ***Selecting the main groups of arthropod vectors*** involved in the transmission of some vector-borne diseases in common interest: ticks, mosquitoes, sandflies, blood suckling flies (*Horne fly, Stomoxis, Thabanidae*) and biting midges (*Culicoides*).

- ***Selectiing the main actual diseases*** of common interest to veterinary and public health, both for their direct importance for livectock sector and for public health (for both countries – BG and DE).

Inputs:

- Further ***justification of their role as vectors and hosts*** for many pathogens, focussing on vector-disease quantitative livecycle modelling.

- The acquired ***predictive results & predictive models will be used to assess the climate or environmental change scenarios and risk of disease emergences***, as well vectors or diseases control strategies. Perception of the risk assessment level will be an important component of their model of spread.

1. Lumpy Skin Disease (LSD)

The aim:

- ***To model ecological niches of LSDV and identify epidemic progression patterns over the course of the emerging and reeemerging epidemics on the Balkans focusing on spatial and temporal epidemiology by mathematical modelling of transmission routes***

Transmission of LSDV

- **The transmission of lumpy skin disease virus is not yet clear** (Weiss 1968; Kitching and Mellor 1986; Carn and Kitching 1995).
- **LSDV is mechanically transmitted** by different types of biting and blood-feeding arthropods. The important role of the vectors in the transmission of the virus in field conditions it is still not fully understood.
- The mechanical spread of the LSDV is **mainly associated with the flying insects.** Evidence for this are the field observations on coincidence between the time of LSD epidemics and the seasonal insect activity.

Transmission of LSDV

- Most LSD cases are considered to be associated with transmission by arthropod vectors. The attack rates varies between different vectors from 10-15% to nearly 100%, which determines **the differences in their vector capacity.**
- It was found that ***Aedes aegypti*** successfully transmits the virus between cattle up to 6 days after feeding upon infected animals. However it was absent in Israel, where during the last 3 LSD epidemics (1989, 2006, 2012-13) the data for the vectors were well documented.

Transmission of LSDV

- *Stomoxys, Tabanides* and *Tse-tse flies*, are less likely to be leading vectors in dry conditions related to **lower levels of transmission.**
- **LSD virus has been isolated from *Stomoxys calcitrans* and *Musca confiscata* and transmitted experimentally using *S. Calcitrans.***
- Other vectors such as: *Biomyia, Culicoides, Glossina* and *Musca spp*., are also **suspected.**
- Despite the detection of virus in **mosquitoes** (*Anopheles stephensi, Culex quinquefascuatus),* the ***Stable fly*** and a biting midge (***Culicoides nubeculosis***) after they had fed on cattle with lumpy skin disease, **the infection was not transmitted successfully** to susceptible cattle.

List of knowledge gaps on role of arthropods for LSDV transmission

- **Lack of knowledge for vector capacity** of the European or Middle Eastern insect and tick species;
- Effect of **climatic and environmental changes** to insect and tick populations and to the spread of LSDV;
- **Presence of viremic sub-clinical animals in affected herds –**

  Yes or No!
- How much virus is present in the **“left over”** blood?
- **Susceptibility** of European and Middle-Eastern **wild ruminants** and potential **role of wildlife as a reservoirs**;
- How much virus is needed to initiate infection into susceptible animals (**minimum infectious dose**)?

Transmission of LSDV

- The ticks act also as **'reservoirs' for the LSDV between the epidemics because they can shed the virus;**
- The global warming enables **tick's survival during winter** (overwintering);
- The virus has been found to persists in tick saliva and organs;
- Animals infested with ticks **can spread LSD for long distances by moving. (E.g.** "jumping" from Evros – Xanti - Greece 2015).

Mathematical modelling

- We are planning to use mathematical modelling to understand the relative role of each mode of transmission (direct and indirect) by analyzing data collected during the investigation and from LSD outbreaks in Bulgaria.
- Segregation of the groups and preventing contacts between susceptible animals will elucidate the role of the vectors in disease transmission.
- We will use a **back-calculation method** which was previously used for predicting incidence of human Immunodeficiency virus (HIV) and Bovine Spongiform Encephalopathy (BSE).

Mathematical modelling

- This method uses incidence data, together with an estimate of the incubation period and information about past infection rates.
- Knowing actual incidence of the disease for every group we will try to evaluate the probability of infection by each animal herds depending of the transmission modes.

2. Bluetongue (BT)

The aim:

- ***To generate mathematical models for Risk assessment of emergence and spread of Bluetongue in Bulgaria and Neighboring Countries***

Wind spread patterns model + Risk assessment

- The potential introduction of BT into new areas by directly wind-borne spread of infected midges from Southern (Greek islands) or North Africa territories and livestock movements has been recently assessed by **spatio-temporal and risk analyses**.
- Infected *Culicoides (Diptera: Ceratopogonidae*) species can be transmitted by winds and spillover to long distances.
- Midge's pattern movements were inferred indirectly from the patterns of bluetongue spread between farms (using outbreak data from 1999-2001 for Greece, Bulgaria and Turkey) then matched to the recorded wind patterns.

Wind spread patterns model + Risk assessment

- We will try to integrate the accumulated data with other data about key potential routes of entry such as trade, contaminated biological materials (incl. the use of live attenuated vaccines), transport of infected *Culicoides* with livestock or other commodities, cargos and import of exotic hosts.
- The risk for orbiviruses to adapt in different conditions (climate, landscape, hosts, vectors) in Europe depends on the *Culicoides* vector competence, their abundance, phenologyy and habitats.
- Up to 2005 the role of different vector species in BTV epidemics in Europe has been assessed mainly by virus isolation from adult *Cullicoides spp*., captured in outbreak areas.

Climate and environmental factors influencing the seasonal abundance of Culicoides

- We will directly examine the temperature and humidity impact on *Culicoides spp.* in the affected areas by using existing surveillance datasets to evaluate the climate, host, and landscape drivers of geographical variation in their seasonal abundance, dynamics and phenology.
- As a result, the defined vector model framework will contribute to define the 'vector-free period', related to livestock movements in affected areas during the winter, which is currently based only on the temperature dropping below 10°C inhibiting viral replication.

The vector competence of Culicoides spp., their susceptibility to orbiviruses depends of climatic change and their evolution

- We will use SOPs for RT-PCR to assess the vector competence and levels of infection in wild adult midges: *C. obsoletus* and *C. pulicaris* captured in different climatic and geographyc areas for South and North Bulgaria.

Mathematical modelling

- ***We will use models for assessing Ro (basic reproductive number) to quantify the risk of BTV transmission.***
- *We will assess the likelihood of outbreak occurrence in the presence of BTV in the Culicoides spp. and the presence of a potential link between the environmental conditions and the biological factors, as well as their impact on the efficiency of transmission of the virus;*
- *Safety inactivated BT vaccines already exist. Bulgaria has 3-year vaccination plan, approved by the EC for the use BTV-4 inactivated vaccine to control and finally eradicate the disease.*

Mathematical modelling

- *BT as a transboundary disease requires the same or similar approach and disease control strategy by the neighboring countries.*
- *Unfortunately most of them are not applying the same approach for mandatory mass vaccinations of the whole susceptible ruminant population. BTV-4 continue to circulate in Serbia, Kosovo, Montenegro, Croatia, Greece last 2016 and we expect new BTV-4 wave during the active vector season 2017.*
- ***Field estimates of population reduction will be integrated into vector population and transmission model frameworks to evaluate impacts of different scenarios of vector control on Culicoides population sizes and disease transmission.***

Benefits:

- ***The consequences,*** *triggered by the proposed platform "Biology and control of some exotic, emerging and trans boundary vector-borne and zoonotic diseases in Bulgaria and Germany" for veterinary and public health in both countries* ***will directly influence the veterinary and public health competent authorities for enhance and capacity building for effective control and reaction.***
- ***The couple of innovative research methods, tools and knowledges obtained during the project will be a step forward to generate new approaches of VBD control and will reinforce the general framework of common diseases management and control systems.***
- ***For all these aspects, the both countries will benefit and amplify the scientific results, capacity building, and establishment of research networks by focusing on exotic, emerging, communicable and trans-boundary, vector-borne diseases in face of changing European environmental and climate conditions****.*

MS organisation(s) involved:

- ***As interested party**:*
- *Risk Assessment Center on Food Chain, Bulgaria in collaboration with High Veterinary School in Hannover, Germany, other potential partner organizations at national or EU level: TBD*
- Veterinary Medicine Faculty – University of Forestry – Sofia?

Thank you for the attention!