Impact of Climate Change on Infectious Diseases of Livestock

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Insel Riems
Celle
Mariensee
Braunschweig
Jena
Worldwide Expansion of Infectious Animal Diseases

- African Swine Fever
- Peste des Petits Ruminants

2005 - 2007

2008 - 2014

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Worldwide Expansion of Vector Borne Diseases

West Nile Fever

1999

2005 - 2007

Rift Valley Fever

2008 - 2014

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Expansion of Population Ranges of Potential Vectors

Hulecoeteomyia japonica
(Aedes japonicus)

Aedes albopictus

Aedes japonicus

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Global Distribution of Aedes albopictus

district map with countries coloured to show distribution status:
- Native
- Introduced
- Intercepted
- Eradicated / Extinct

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Expansion of Vector Species Ranges of VBD (e.g. BT)

- Northward shift of the traditional African-Asian vector *Culicoides imicola*
- Involvement of Palearctic species *C. dewulfi, obsoletus, pulicaris* complex
  - until 2005 already in the Mediterranean area and in 2006 also in NW-Europe
Schmallenberg-Virus
Weekly BTV-8 cases (shifted back by 4 weeks) and altitude-adjusted mean temperature

Extrinsic incubation period
Is Climate Change responsible?

Globally averaged changes in precipitation intensity and dry days for a low (B1), middle (A1B) and high (A2) scenario (Martin et al., 2008; Tebaldi et al., 2006)
Global Climate Suitability Areas for *Culicoides imicola* using Ecological Niche Modeling and Current Climate Data

Guichard et al., 2014
Expansion and Contraction of Suitable Areas for *Culicoides imicola* in 2070 Compared to the Current Climate

Guichard et al., 2014
Introduction of Vector Borne Diseases

  - illegal import or transit of domestic and wild ruminants
  - wind spread
  - indirect import via ruminant-live products, non-ruminant animals (e.g. horses), plants (e.g. flowers), etc.
  - contaminated biologicals (e.g. vaccines)

Bluetongue serotypes

Schmallenberg virus infection
Disease Outbreaks and Climate Anomalies

BT and AHS outbreaks in Europe versus climate driven models $R_0$ (line) and climate data anomalies (Guis et al., 2012)

Discrepancies between outbreak, model and climate data

BT outbreaks in Europe and USA versus Atlantic Multidecadal Oscillation (AMO; Zell et al., 2008)
Climate change would most likely
- alter bird migration
- influence the AIV transmission cycle
- affect directly virus survival outside the host
Risk Map of HPAI H5N1 outbreaks in migratory birds based on the predicted distribution of migratory birds using current climate data

Tian et al., 2015
Risk Map of HPAI H5N1 outbreaks in migratory birds based on the predicted distribution of migratory birds using prediction of the global climate in 2030

Cave!
Lack of broad knowledge regarding the impact of even the current climate (not weather) on migratory bird distribution patterns in relation to habitat suitability, food availability, etc.
(Guillemain et al., 2013)
Tick-borne Encephalitis (TBE) and Climate Change

Temperature dependence of the inter-stadial development of the vector tick *Ixodes ricinus*

Annual mean daily maximum temperature of Latvia

Climate change alone is not sufficient to provide a consistent explanation of the variation and upsurge of TBE in the Baltic countries (Randolph, 2008)
Hypothetical Explanation for the differential upsurge of TBE

Randolph, 2008
Multiple Factors and Changes influencing each Other and the Pathogen, Vector, Host Relationship
Multiple Factors and Changes influencing each Other and the Pathogen, Vector, Host Relationship

- Land use
- Deforestation
- Water availability

- Vector
- Pathogen
- Host

- Climate
  - Temperature
  - Precipitation
  - Wind
  - Climate change

- Population of animals, vectors and humans
- Urbanisation
- Density
- Social status
- Trade
- Travel
- Economy

- Habitat Environment
- Land use
- Deforestation
- Water availability

- Globalization
Conclusions

- Climate has a complex and multifaceted impact on infectious animal diseases
- Expansion of infections and vector populations may coincide (and sometimes correlate) with climate change
- A simple monotonic response to climate change is unlikely due to the complexity of host-pathogen-vector systems
- The impact of macroclimatic changes on animal infectious diseases remains largely enigmatic
- “Climate change is a largely unproven driver of infectious diseases and, at most, one factor among a range of other factors“ (Heffernan et al., 2012)
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