



Meteorology and infectious diseases: a risk for public health?

Jeroen van Leuken Ph.D.

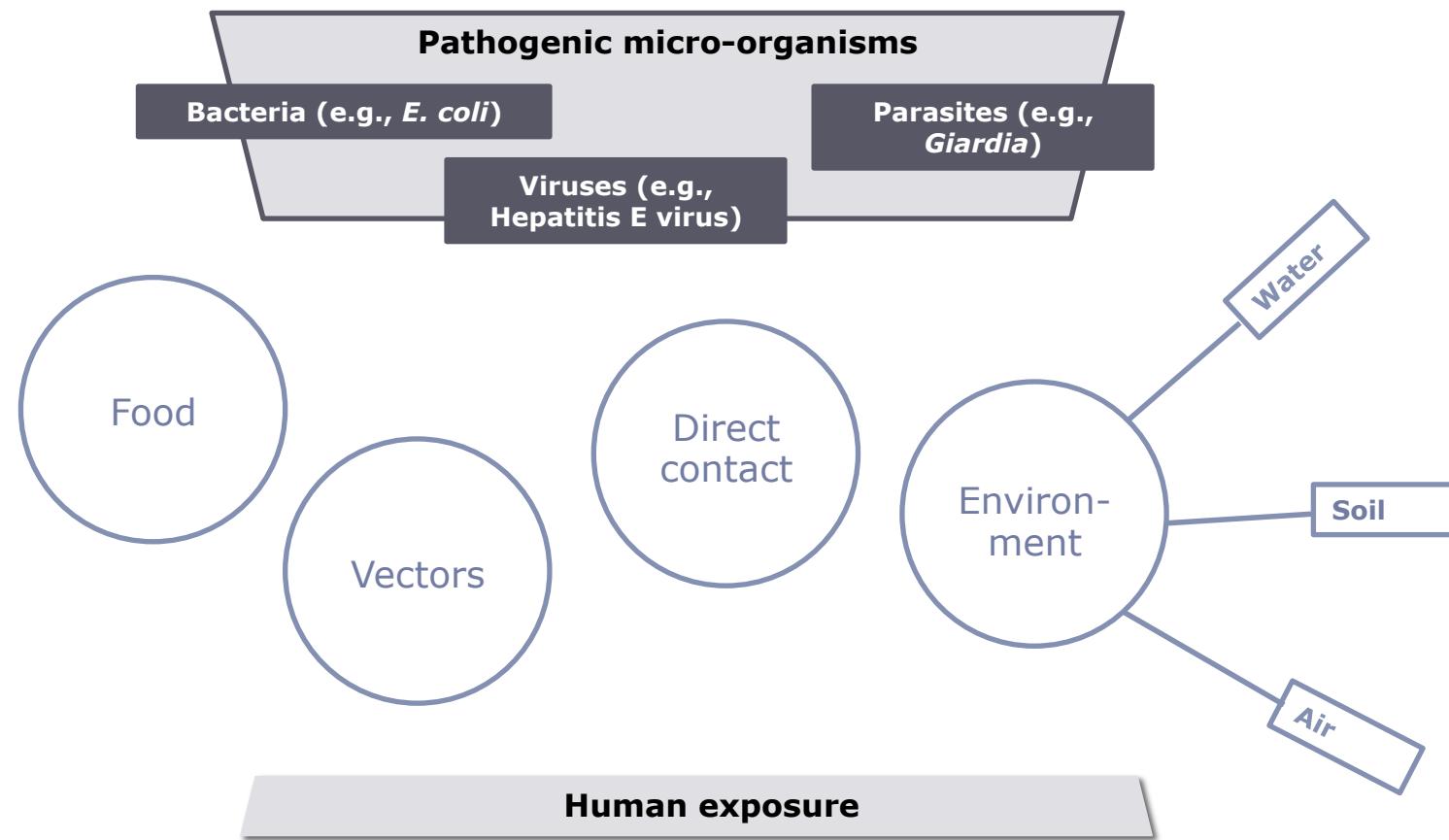
RIVM National Institute for Public Health and the Environment

Centre for Infectious Disease Control

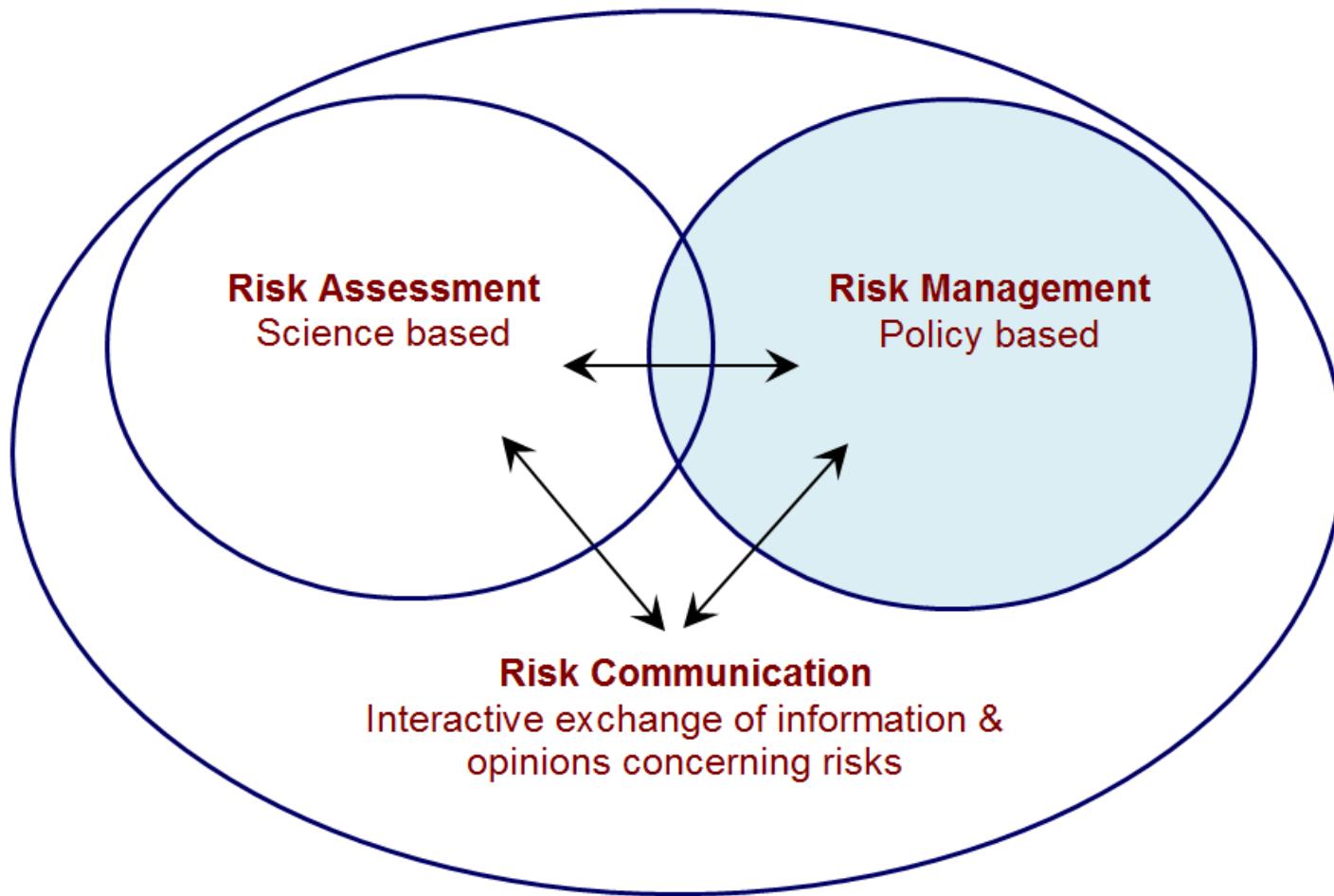
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Exposure to micro-organisms



Risk analysis framework



On lots of topics



One Health



netherlands
centre for
one health

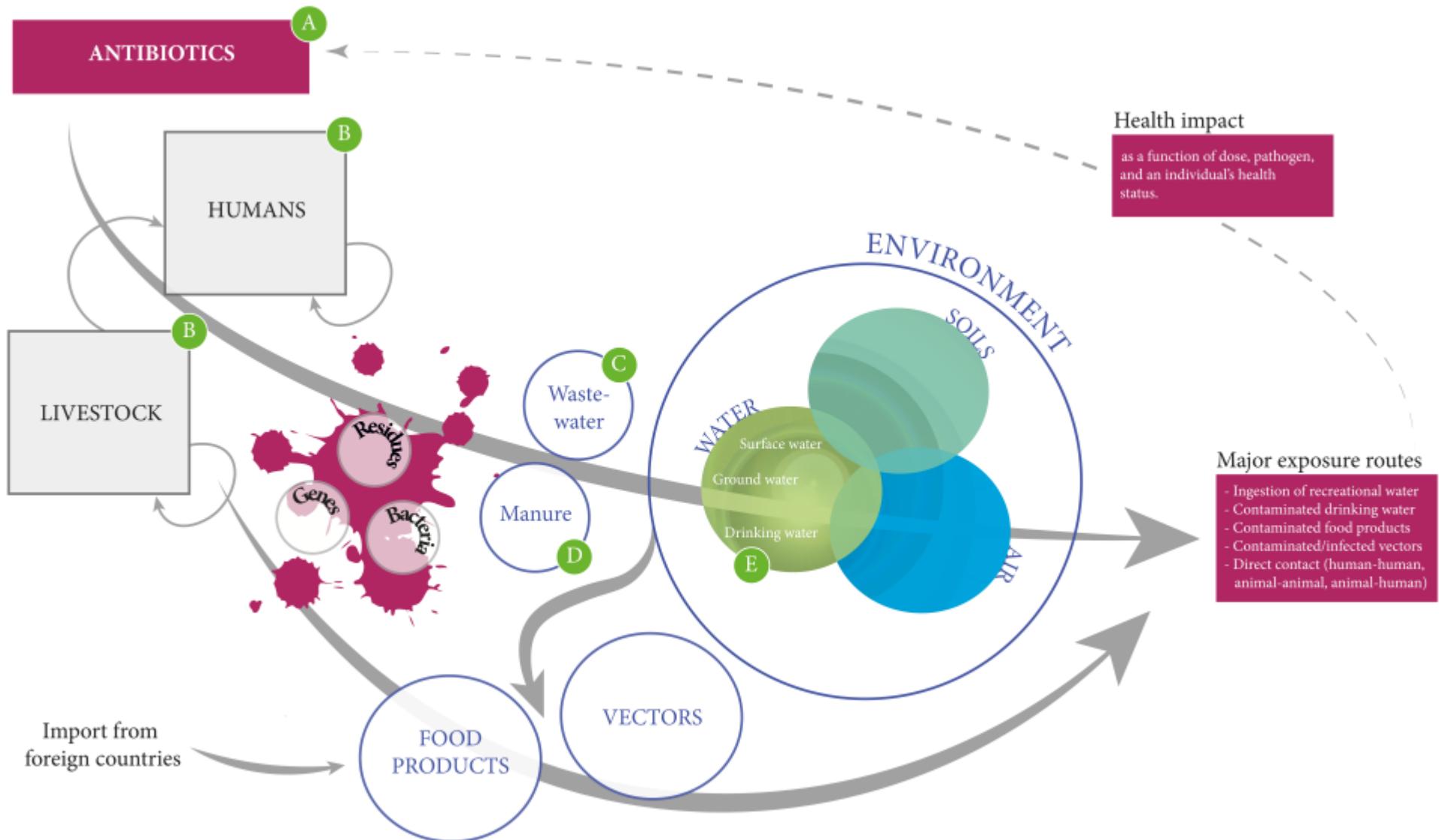
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Solutions
to Global
One Health
Challenges

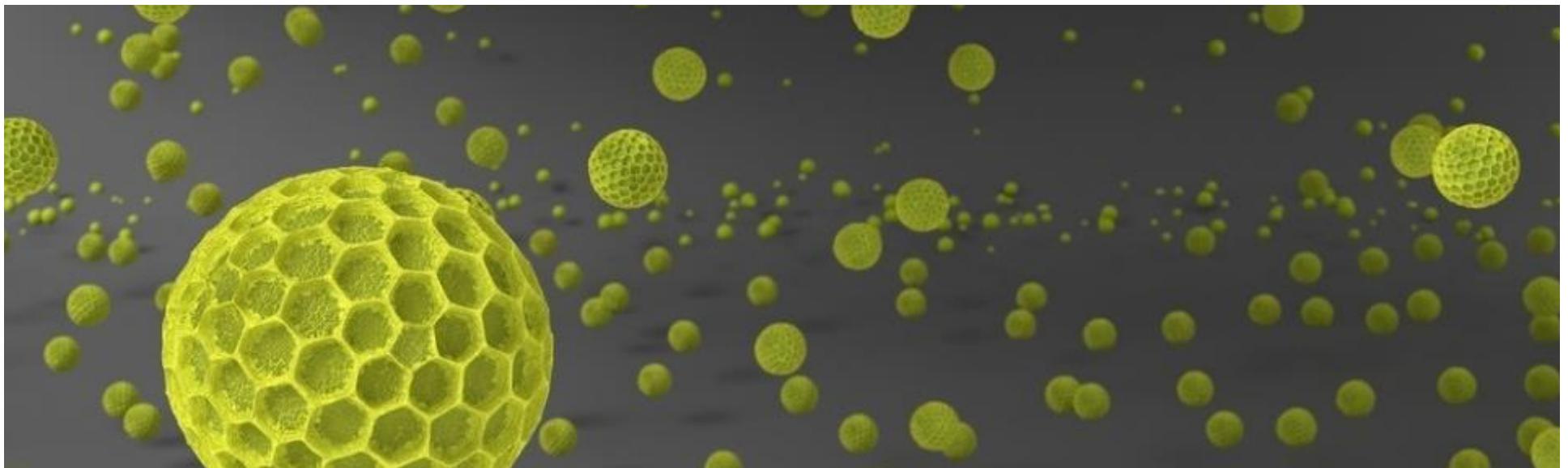


Transmission



Bioaerosols

- ▶ Small, airborne particles of biological material from bacteria, viruses, spores, fungi, algae, protozoa and pollen.
- ▶ Single or attached to particulate matter.
- ▶ Sources: livestock farms, manure, wastewater, compost, nature, ...
- ▶ Question: do bioaerosols pose a significant risk for public health?



Airborne transmission of bioaerosols



Contents lists available at [ScienceDirect](#)

Microbial Risk Analysis

journal homepage: www.elsevier.com/locate/mran



Atmospheric dispersion modelling of bioaerosols that are pathogenic to humans and livestock – A review to inform risk assessment studies



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^d Environment & Safety (MS&V), National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

Major pathogens:

Foot-and-mouth disease virus, *Bacillus anthracis* (anthrax),
Legionella pneumophila (Legionnaires' disease),
avian influenza virus and *Coxiella burnetii* (Q fever)

Conclusions:

- Frequently qualitative conclusions
- Lack of quantitative data, e.g., emission and inactivation rates
- Only few studies applied dose-response models.

Airborne transmission of bioaerosols



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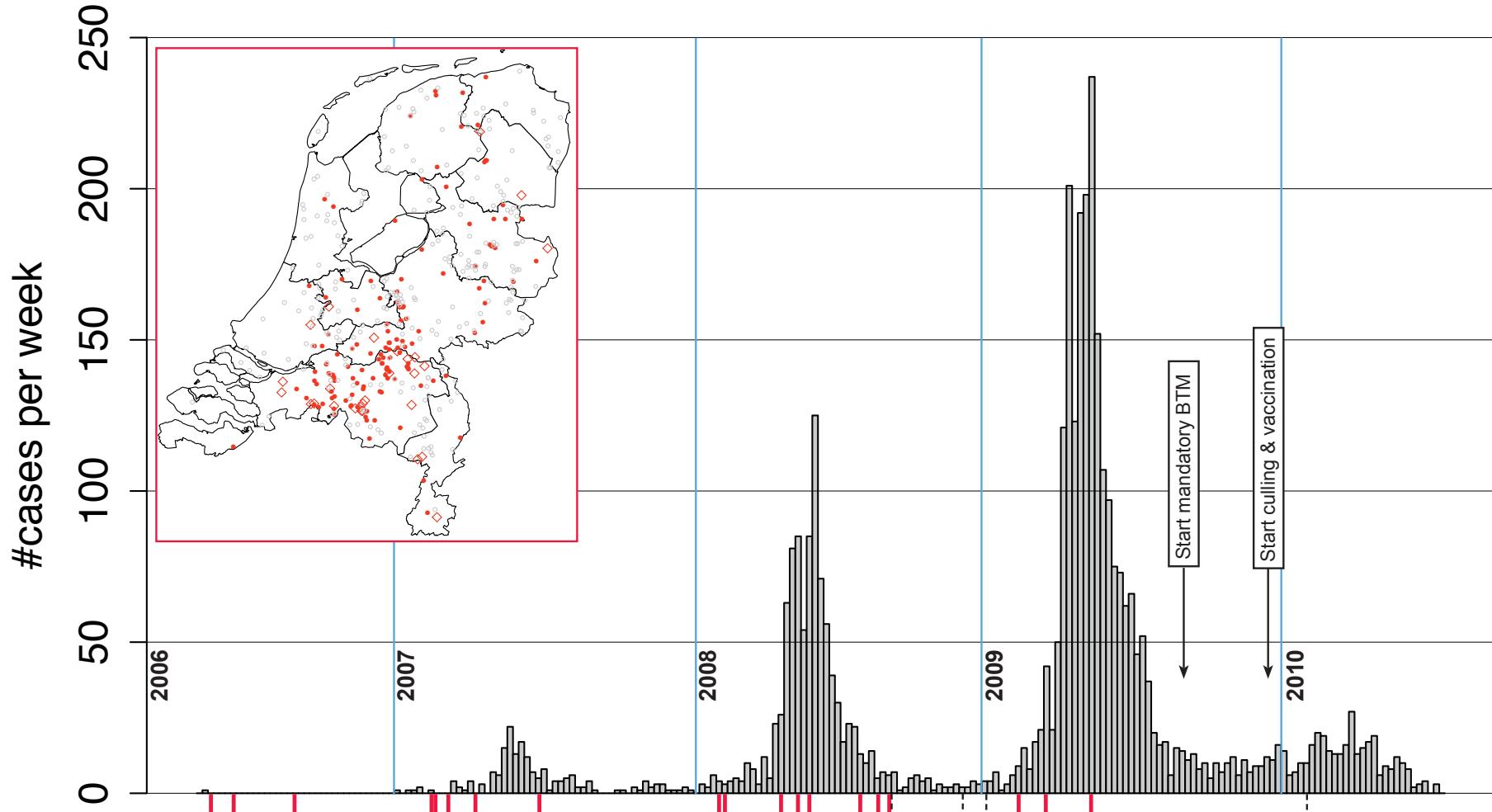
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Q fever epidemic in NL

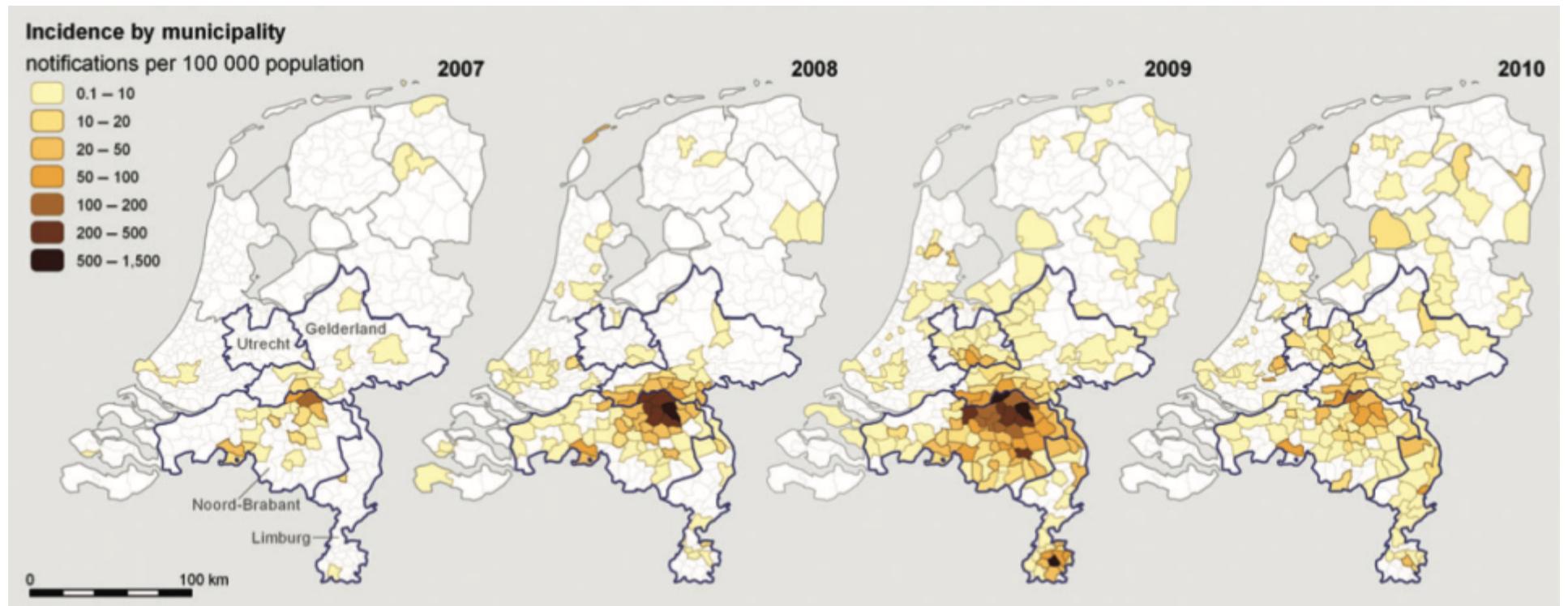


- *Coxiella burnetii* (zoonotic agent)
- 2007–2010, the Netherlands
- > 4000 human cases, incl. 75 fatal
- Approx. 50,000 human infections
- > 100 goat/sheep farms
- Pneumonia, fever, chronic fatigue, fatality

Q fever epidemic in NL



Q fever epidemic in NL



Dijkstra et al., 2012, The 2007–2010 Q fever epidemic in The Netherlands characteristics of notified acute Q fever patients and the association with dairy goat farming

Atmospheric dispersion

Aim: to use an atmospheric dispersion model to estimate exposure levels.

Validation:

correlation of **observed human Q fever incidence rate data** and
modelled *C. burnetii* exposure data

van Leuken *et al.* International Journal of Health Geographics (2015) 14:14
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RESEARCH

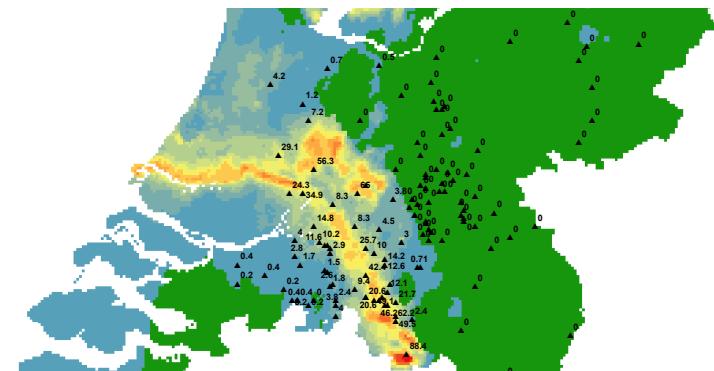
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Improved correlation of human Q fever incidence
to modelled *C. burnetii* concentrations by means
of an atmospheric dispersion model

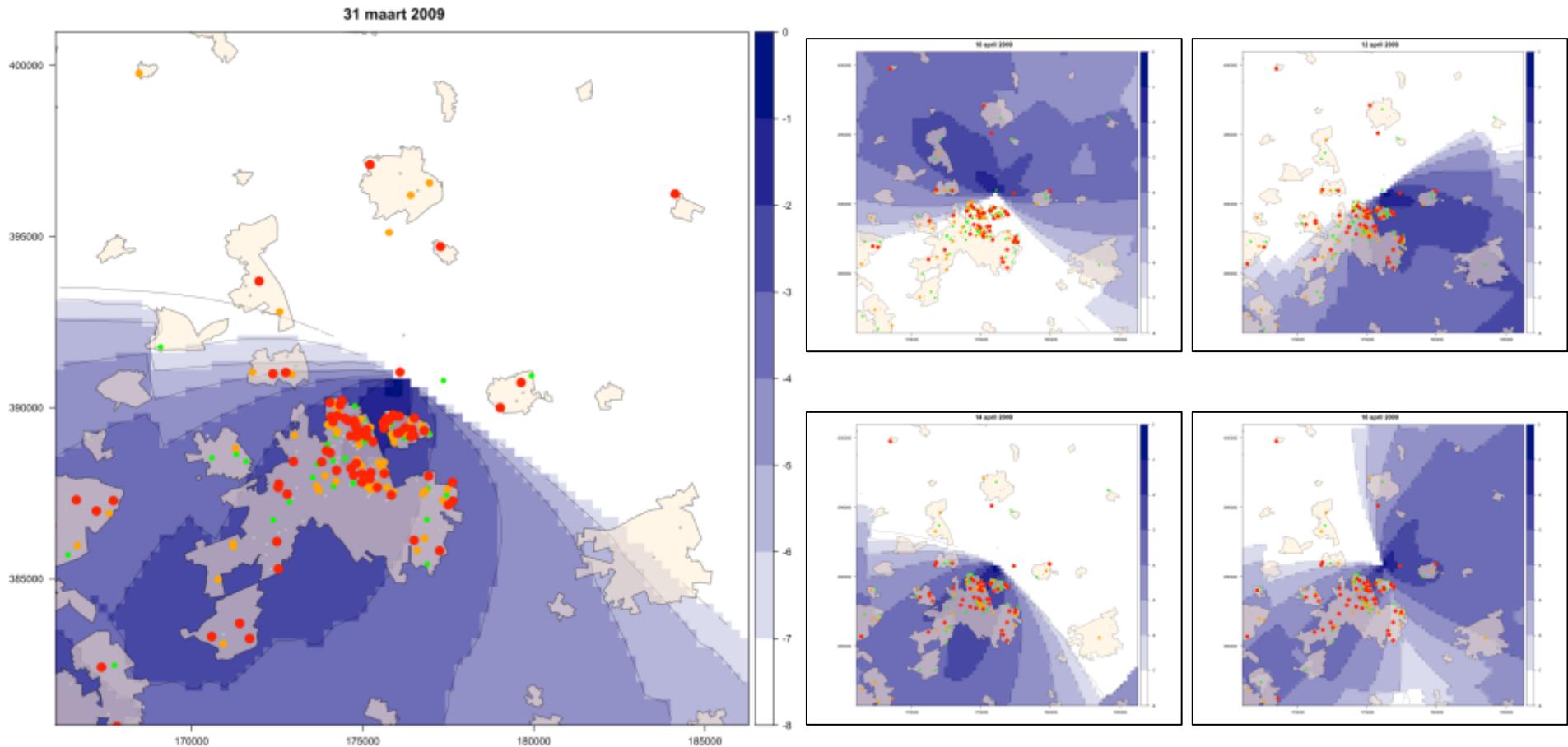
Jeroen PG van Leuken^{1,2*}, Jan van de Kassteele², Ferd J Sauter³, Wim van der Hoek², Dick Heederik¹,
Arie H Havelaar^{1,2,4} and Arno N Swart²

ADM applied to *Coxiella burnetii*

- ▶ Operational Priority Substances Model (OPS-ST), developed by the RIVM National Institute for Public Health and the Environment
- ▶ Proxy: particulate matter (PM_{10})
- ▶ Hourly simulation in 2009
- ▶ KNMI Meteorological data: temperature, global radiation, precipitation, relative humidity, wind speed, wind direction
- ▶ Assumption 1: cases were infected at their home addresses
- ▶ Assumption 2: arbitrary emission profiles

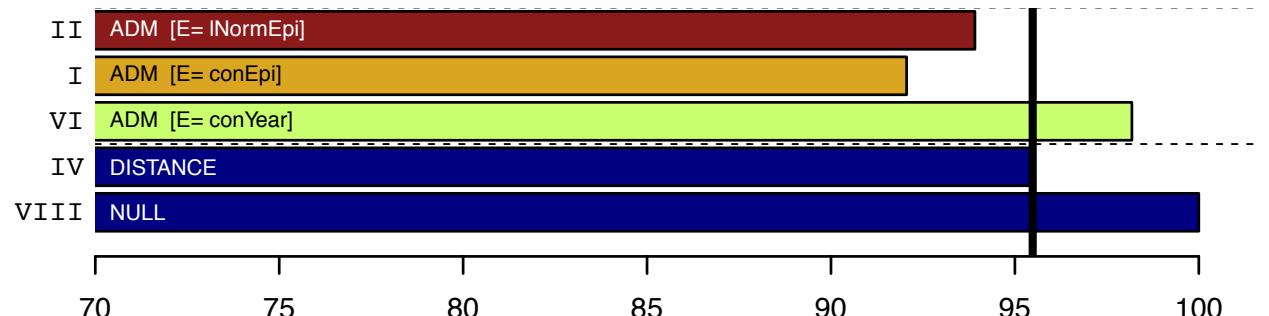


Q fever

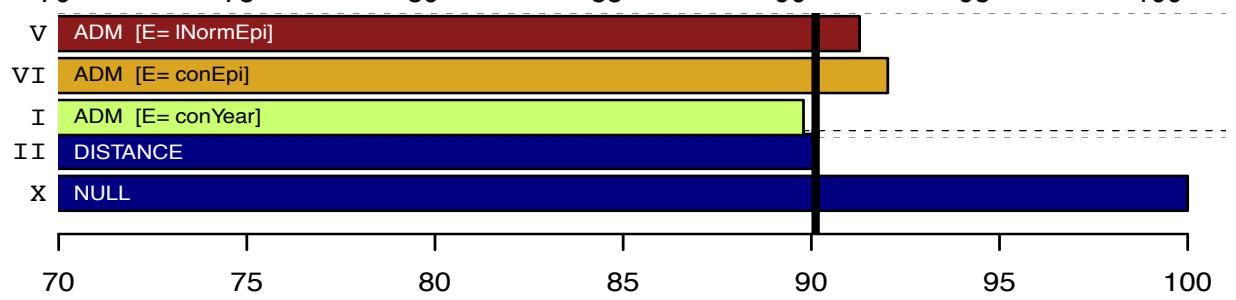


Q fever

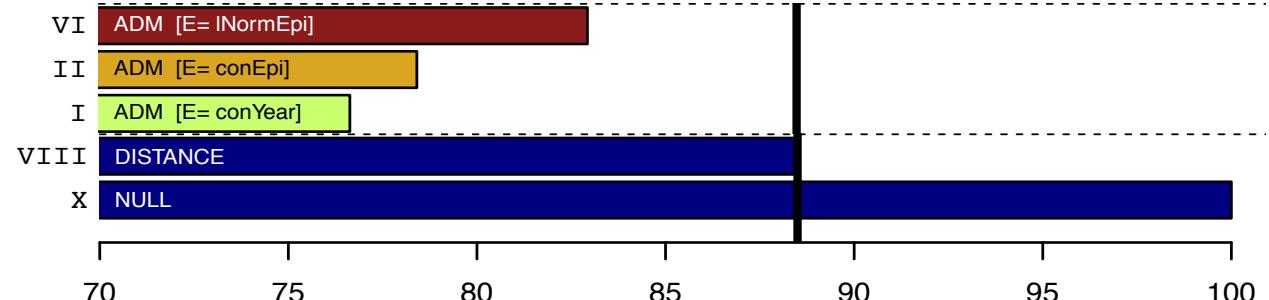
area A:



area B

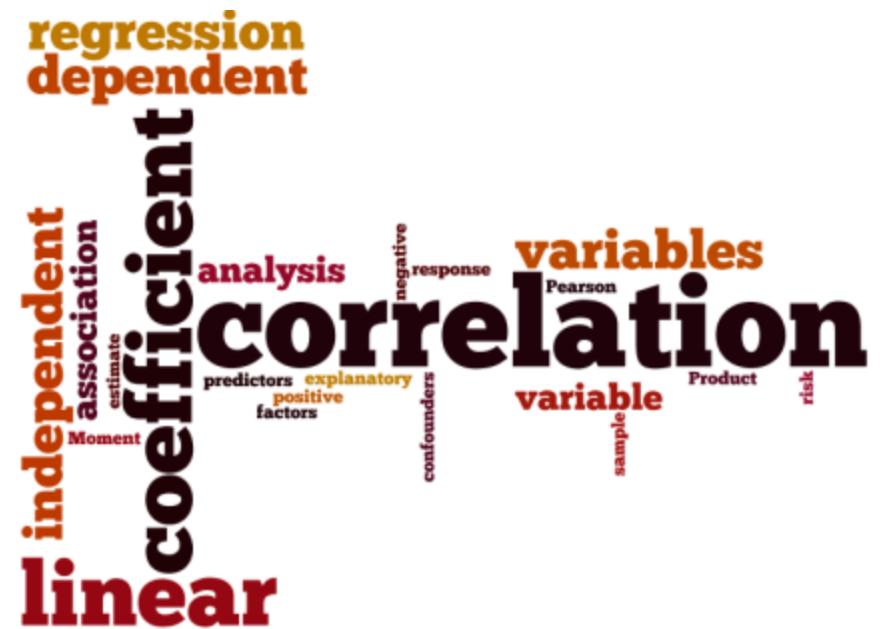


area C



Conclusions

- ▶ Cases were not randomly distributed in space
- ▶ Distance-dependent pattern.
- ▶ Adding meteorological data significantly improves the correlation.
- ▶ Deviances might be explained by:
 - ▶ Mobility patterns of humans
 - ▶ Mismatch between cumulative dose and actual dose
 - ▶ Emission data in arbitrary units



Health and Intensive Livestock Farming

Partners:

- RIVM
- Utrecht University,
Institute for Risk
Assessment Sciences
- Wageningen Bioveterinary
Research
- Wageningen Livestock
Research
- NIVEL



Measurements

Indicator micro-organisms:

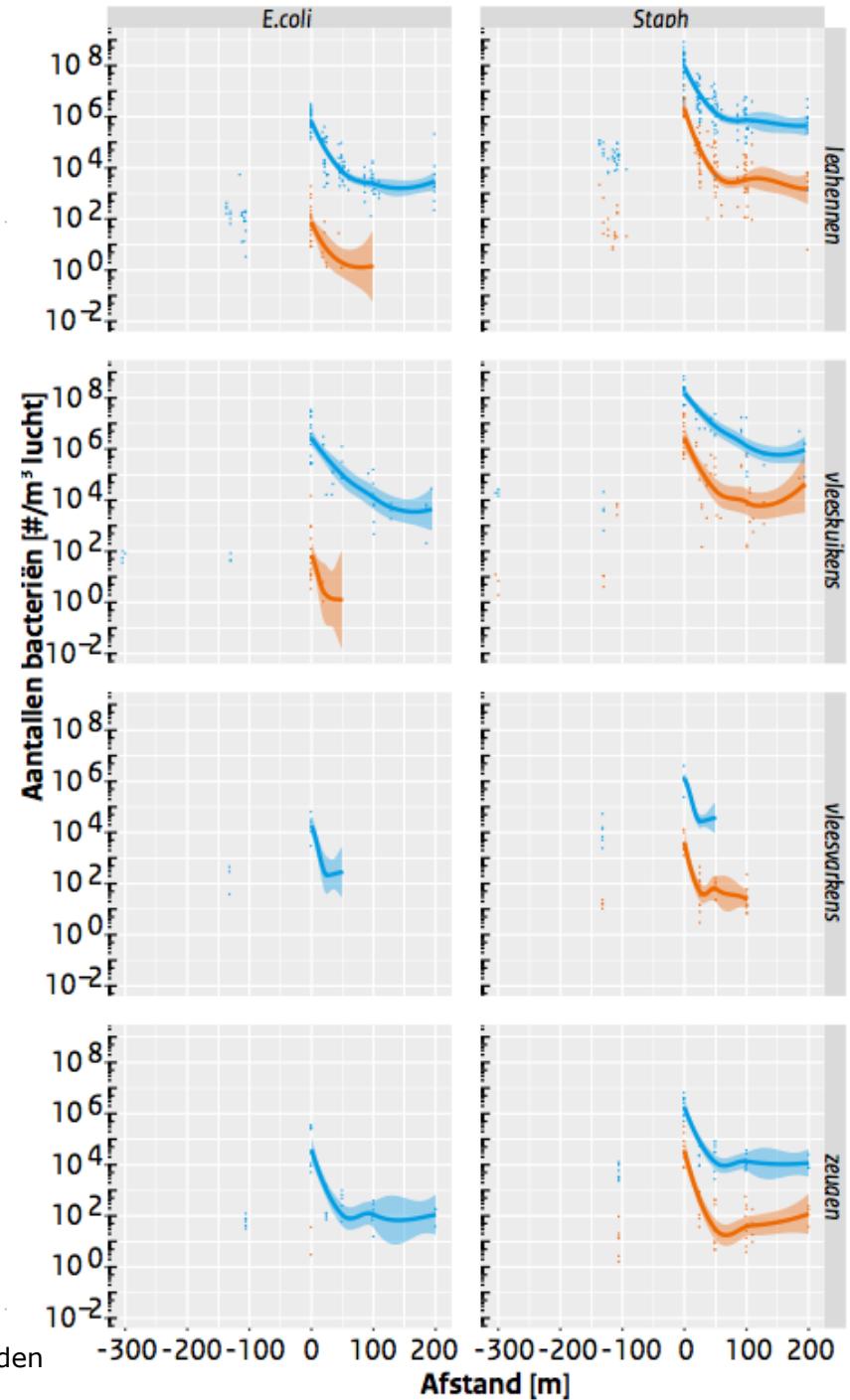
- *Escherichia coli, Staphylococcus* spp.
- Blue: living & dead DNA;
Orange: living cells
- Highest emissions from poultry

Pathogens positive (DNA):

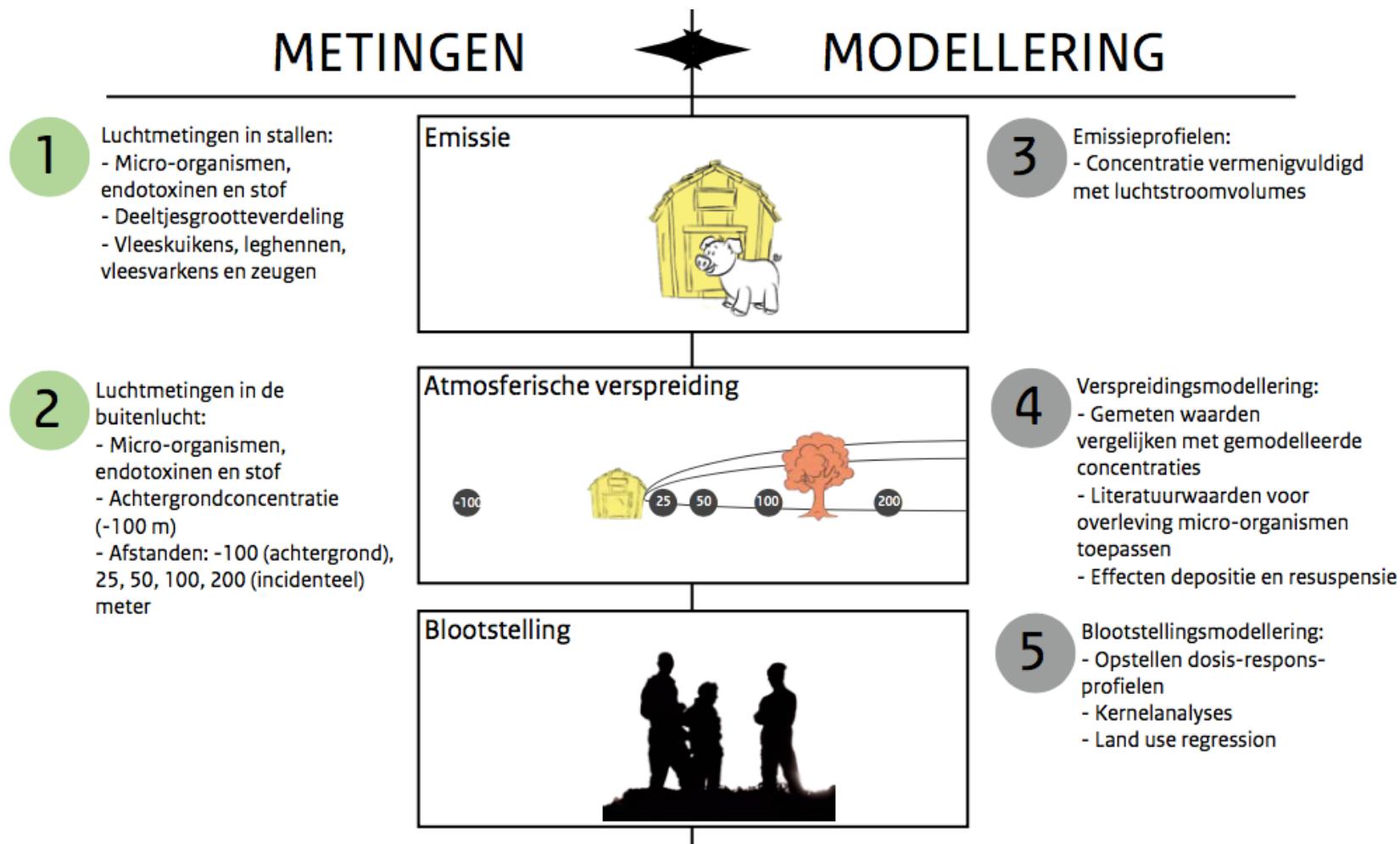
- *Campylobacter coli/jejuni*
- Hepatitis E-virus
- *Clostridium difficile*

Pathogens negative (DNA):

- *Legionella pneumophila*
- *Chlamydophila psittaci*



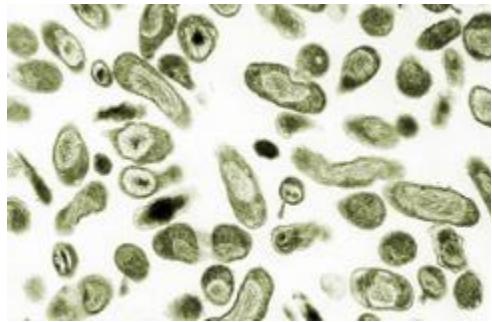
Regional exposure model



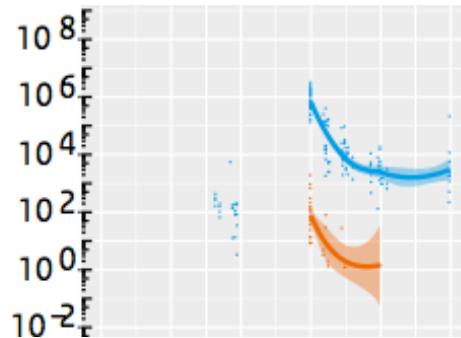
Conclusions

Do bioaerosols pose a significant risk for public health?

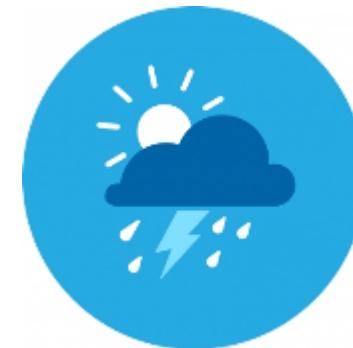
Yes, although the actual exposure and risk depend on:



The micro-organism



Emission strength
and distance



Weather



Person at risk

Many thanks to

RIVM National Institute for Public Health and the Environment

Arno Swart, Wim van der Hoek, Addo van Pul, Marina Sterk, Kitty Maassen, Ana Maria de Roda Husman, Ingmar Janse, Arie Havelaar, and many other people.

Institute for Risk Assessment Sciences, Utrecht University

Dick Heederik

Future Water, Wageningen

Peter Droogers, Wilco Terink, Jaïrus Brandsma

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Volker Hackert, Ronald Ter Schegget

Animal Health Service (GD)

Piet Vellema, René van den Brom

KNMI Royal Netherlands Meteorological Institute

Raymond Sluiter, Andrew Stepek, Ine Wijnant, Frank Lantsheer

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