WHO/PREZODE Working-Group
Indicators for the human exposures to zoonotic pathogens

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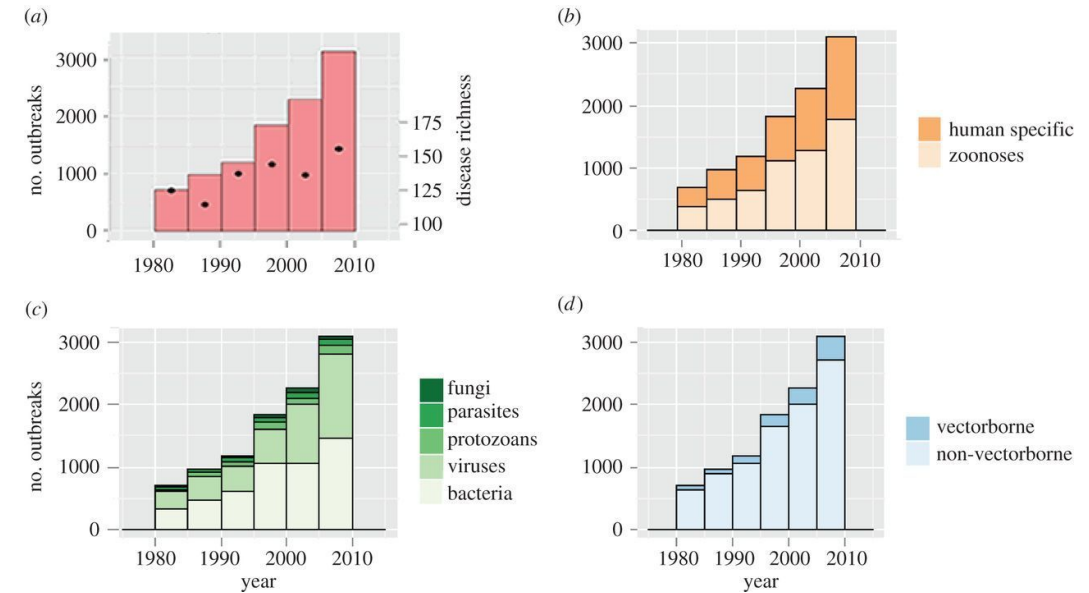
Rico Ancog

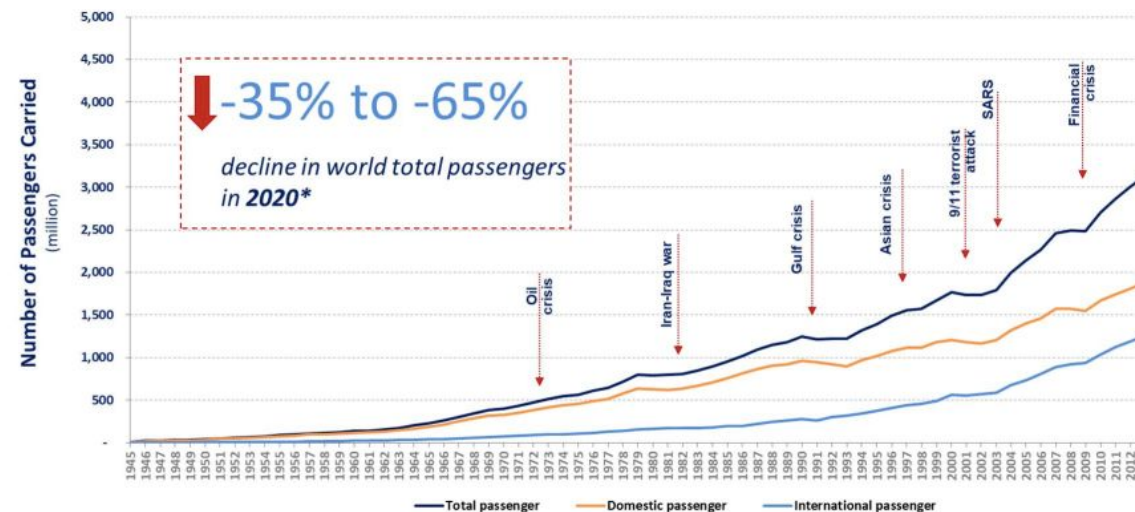Juan Fernando Vesga

Supaporn Wacharapluesadee
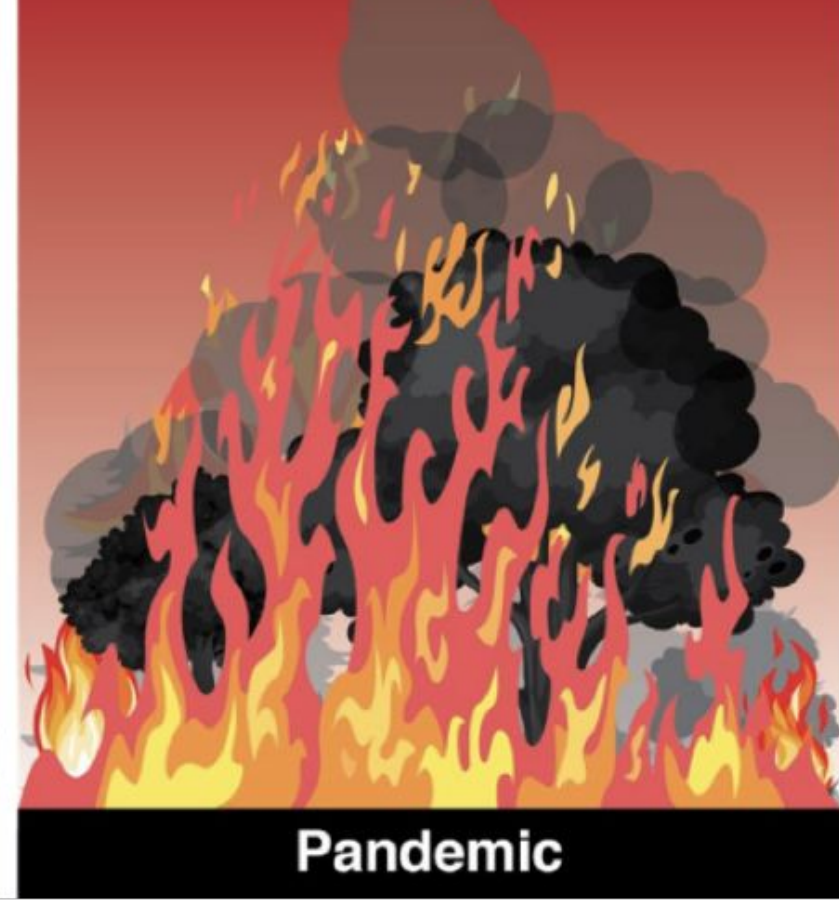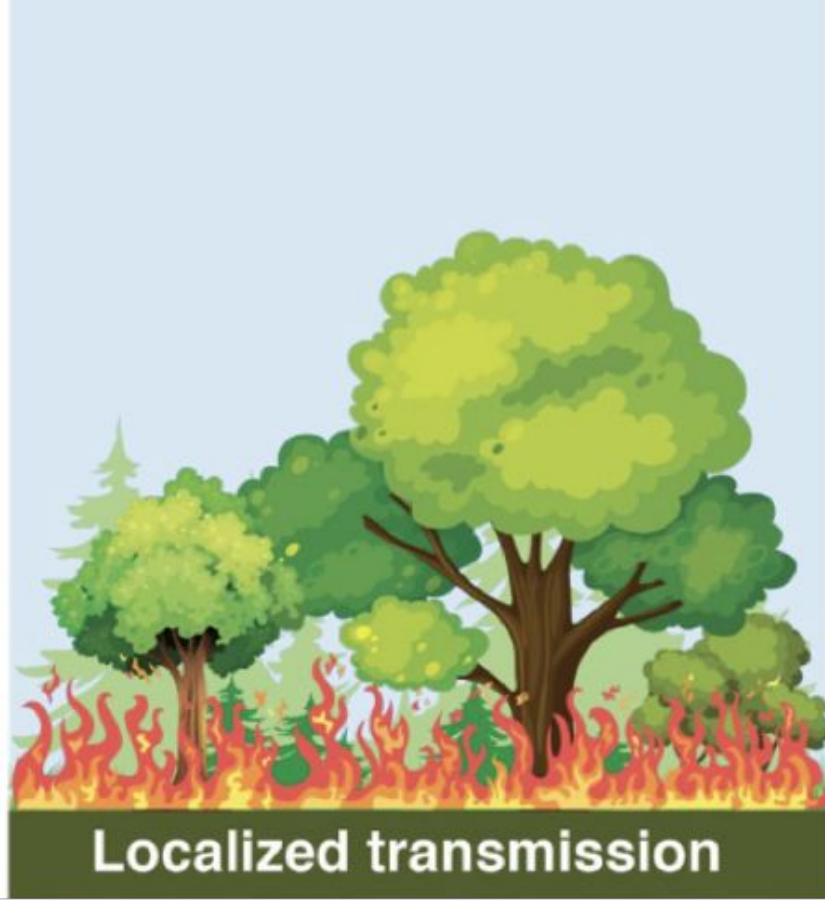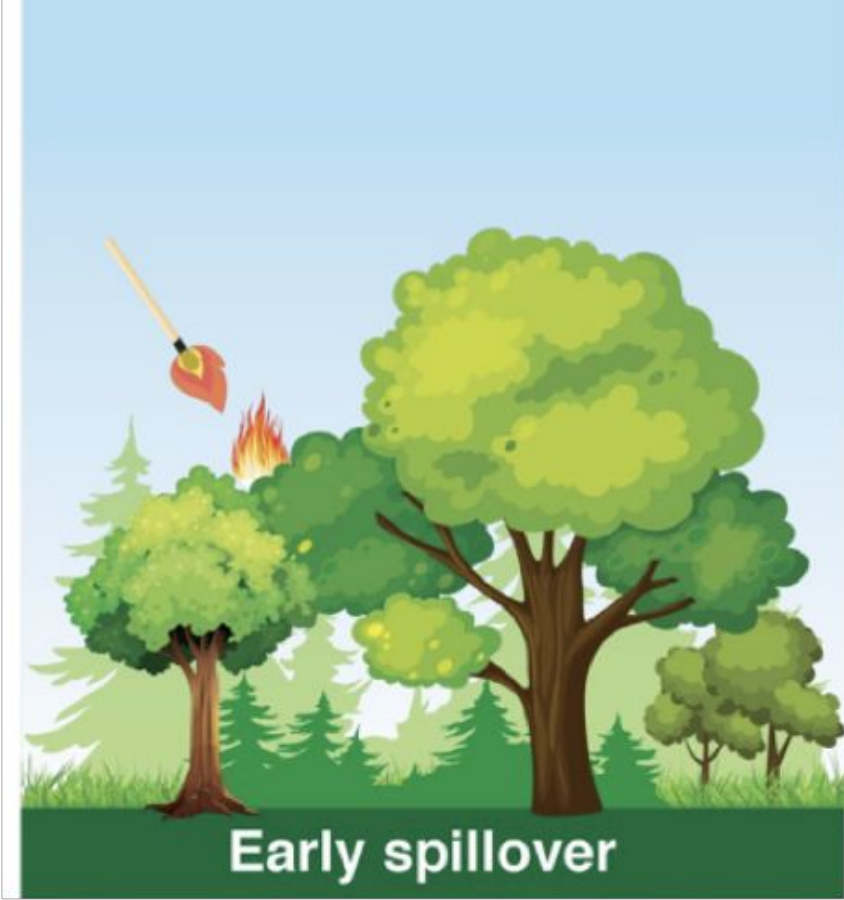
Suzannah, Rihn

Erik Karlsson

The current context

- Number of emerging disease outbreaks is increasing since decades

- Human mobility is also increasing since decades

- All ingredients are here to observe new pandemics during the next years

Early spillover | Localized transmission | Pandemic

Prevention, preparedness and response

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Why indicators?

- Prevention strategies against zoonoses (including improved surveillance for faster response and ecosystem management) are challenging to implement because funders and authorities do not have a visibility on their efficiency

- One way to address this issue is to quantify the risk reduction by prevention strategies

- Goal of this working-group: Defining indicator(s) able to characterize this risk reduction

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Spillover theory

Pre-emergence → **Pathogen spillover** → **Emergence** → **Localized transmission** → **Epidemic** → **Pandemic**

- Pre-emergence: Pathogen circulation in animals
- Pathogen spillover: Primary prevention — Spillover
- Emergence: Early detection
- Localized transmission: Containment
- Epidemic: Control and mitigation — Human amplification
- Pandemic: All prior measures brought to a larger scale — Global spread

Reservoir host distribution

Reservoir host density

Pathogen prevalence

Infection intensity

Pathogen release
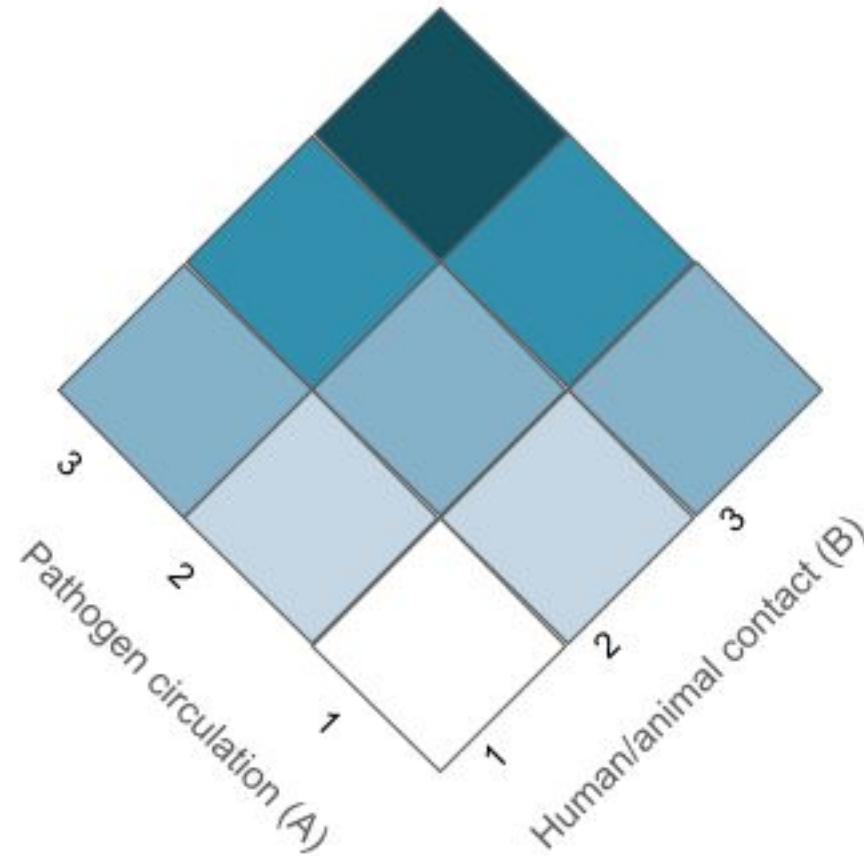
Pathogen survival

Human exposure

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Global framework

Indicator composition

Indicator composition

Pathogen circulation (A)

Human/animal contact (B)
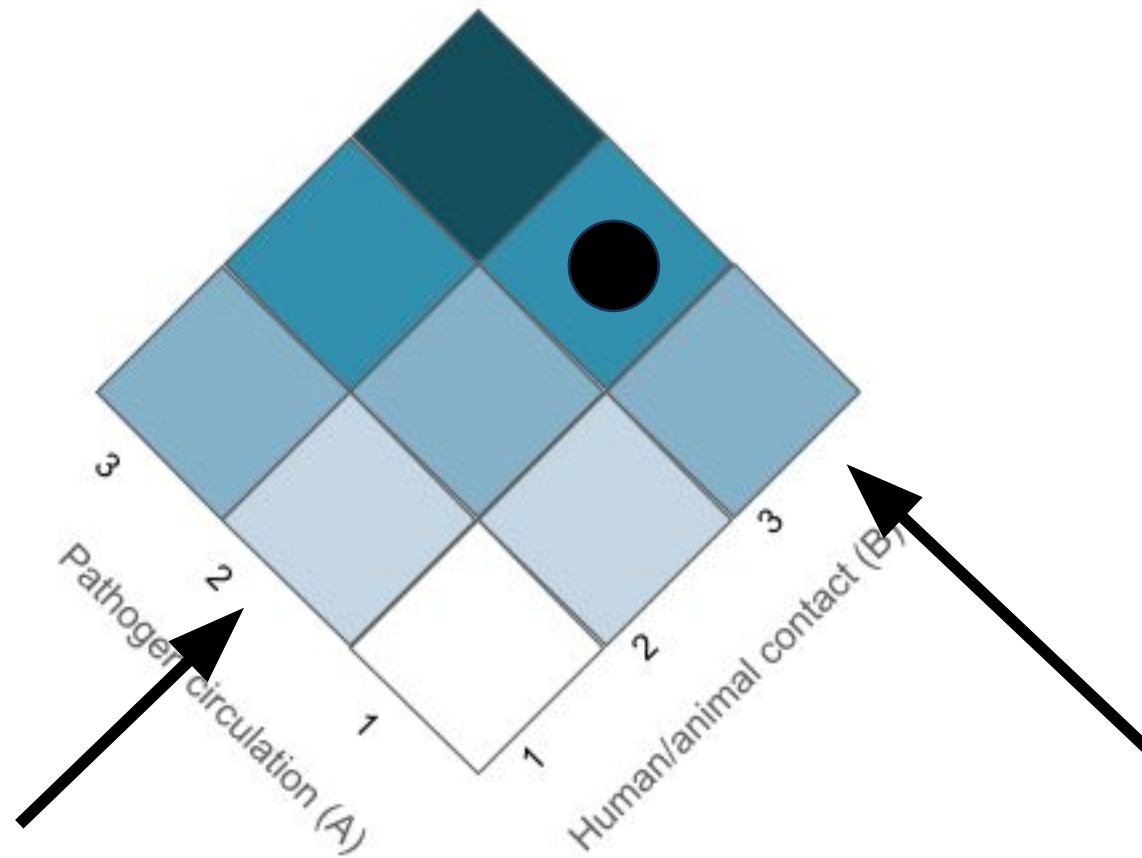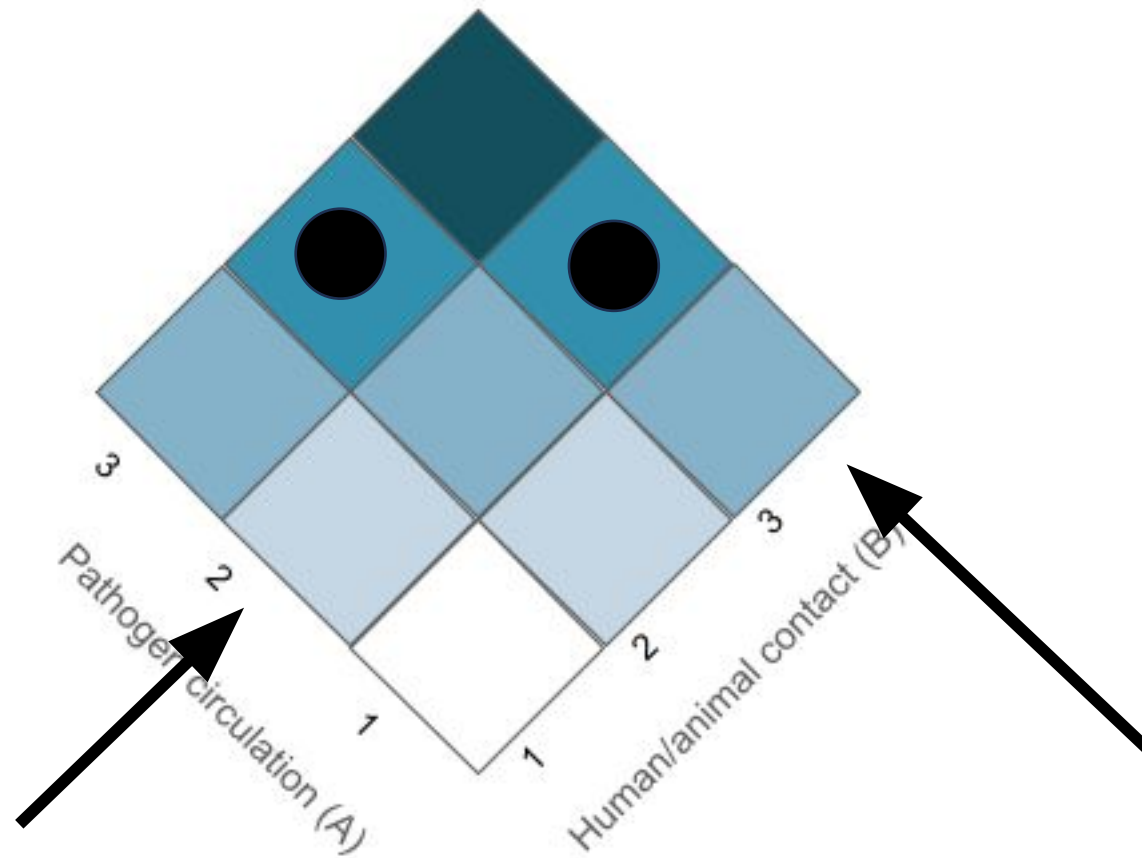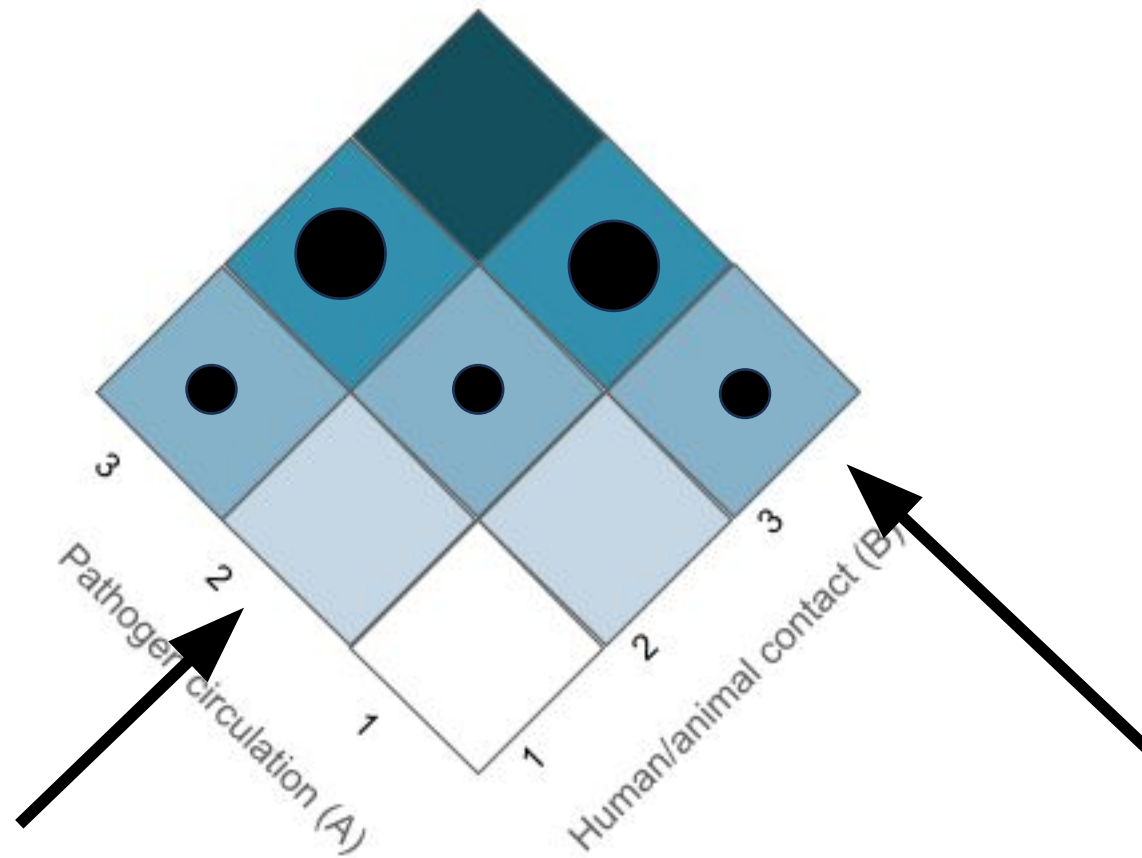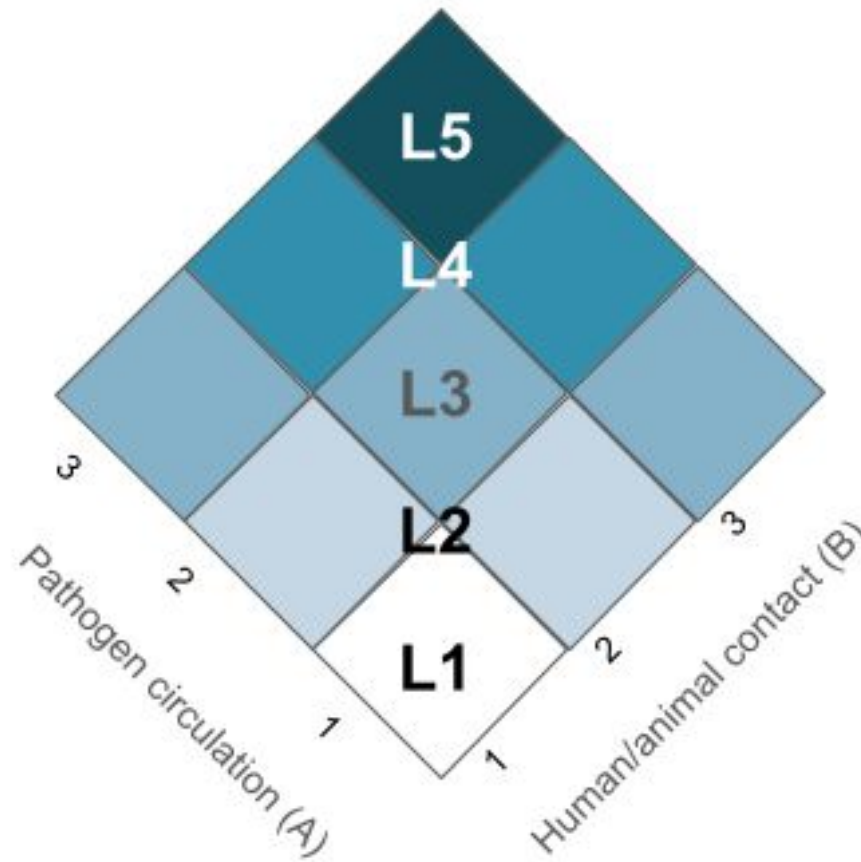
Indicator composition

Indicator composition

Indicator composition

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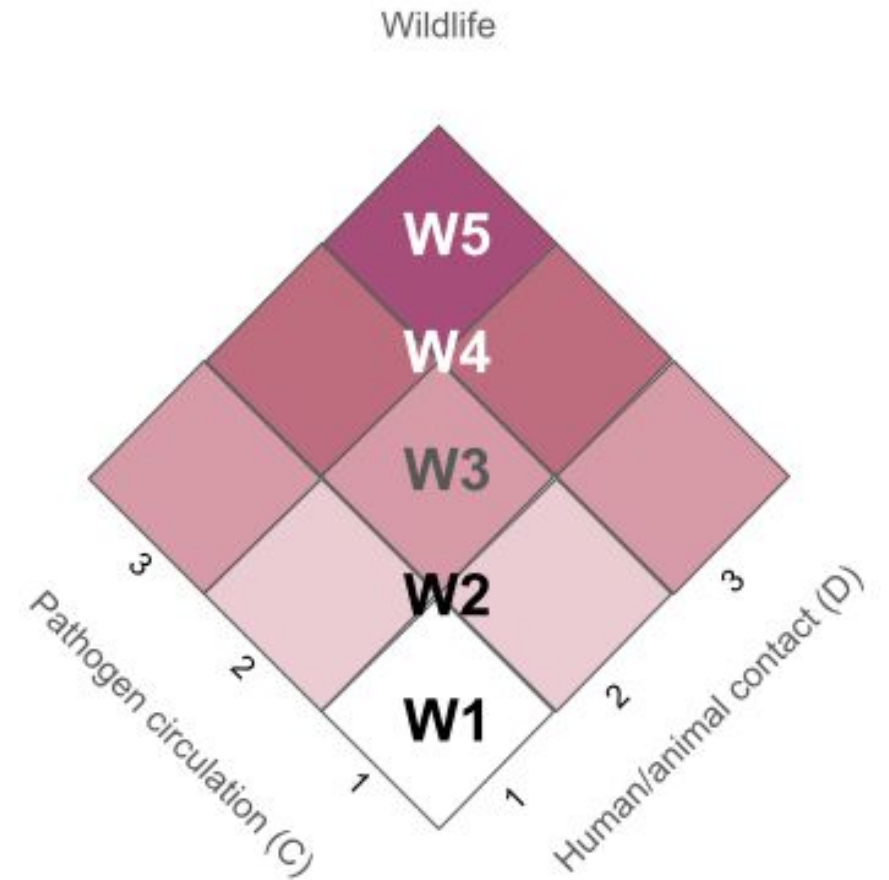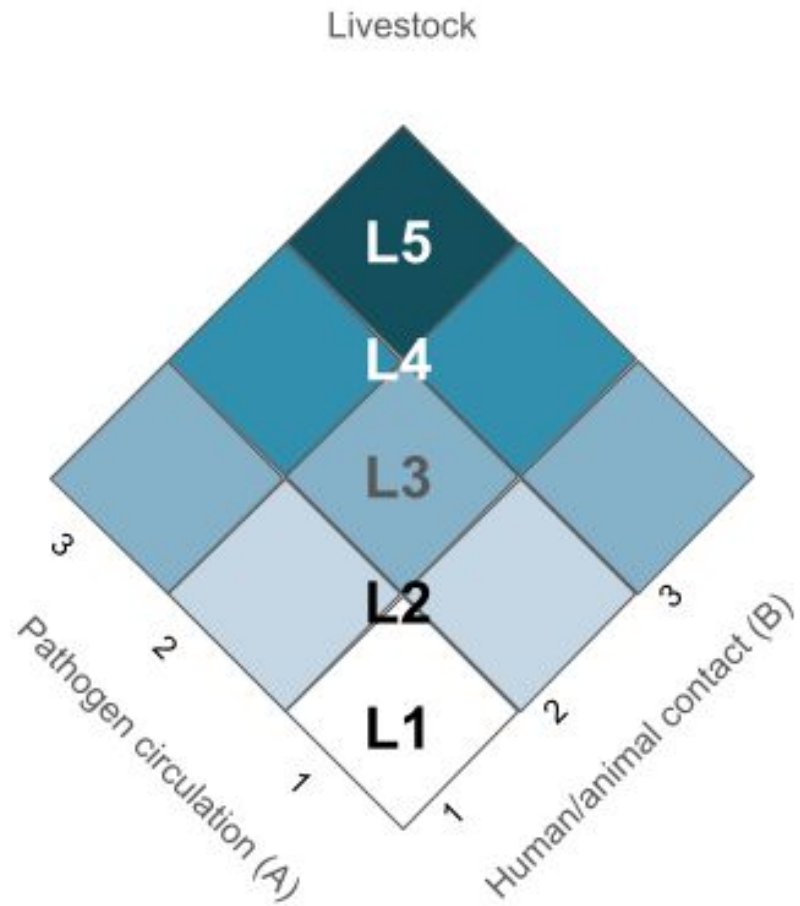
Indicator of human exposure to zoonotic pathogens
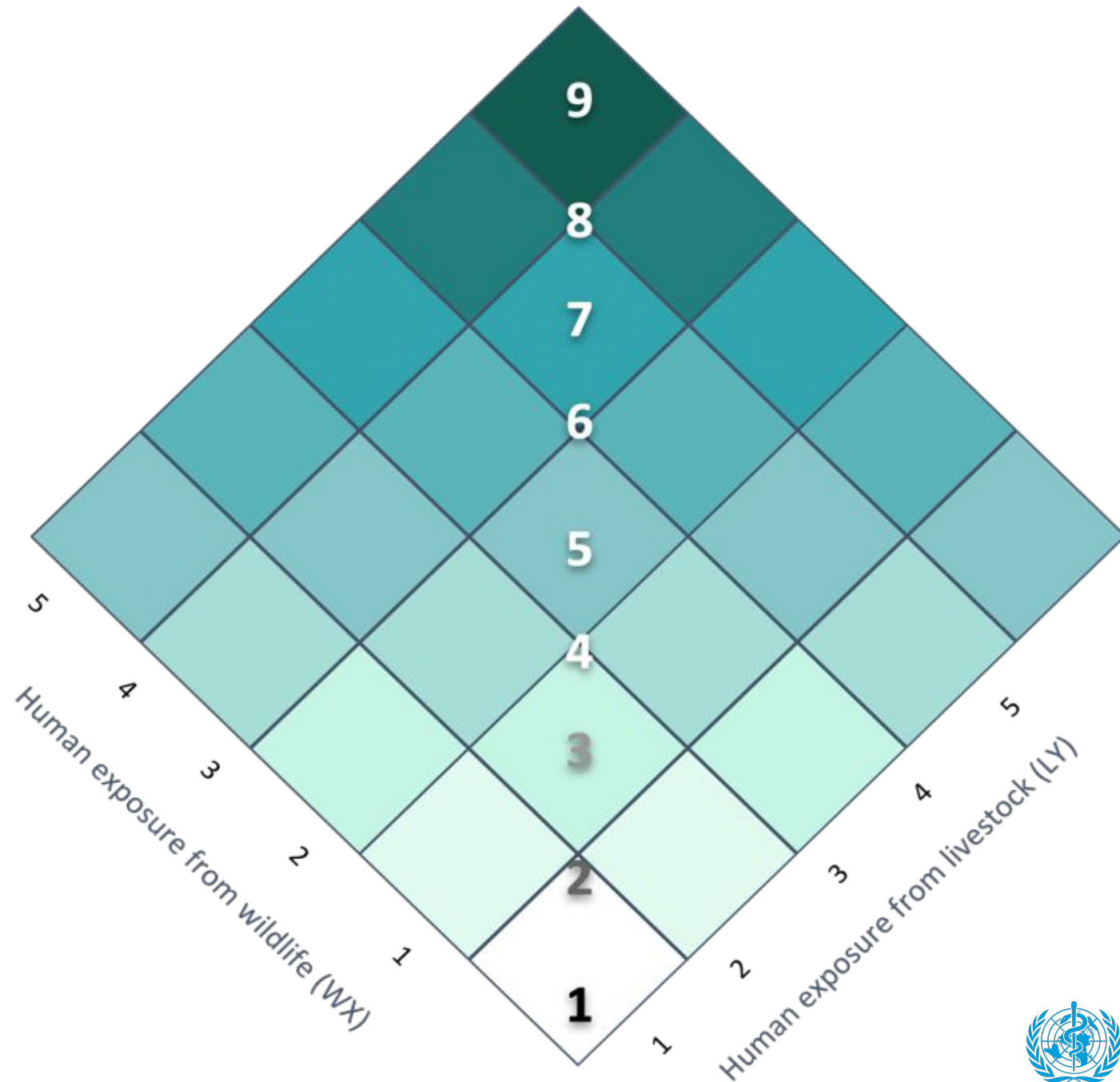
First application of the indicator

- Elicitation study to identify at a national scale:
  - Pathogen circulation within each animal populations (wildlife and livestock)
  - Contact intensity between animal populations (wildlife and livestock) and humans

- Tested on four pathogens
  - Avian Influenza Viruses (AIV)
  - Middle East Respiratory Syndrome Coronavirus (MERS-Cov)
  - Crimean Congo Hemorrhagic Fever (CCHF)
  - West Nile Virus (WNV)

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Elicitation study

- For each pathogen and each country, experts are invited to select:
  - Pathogen circulation in each animal population
    - Level 0: Absence of circulation
    - Level 1: No cases detected currently (may have been detected in the past) or low level of seroprevalence
    - Level 2: Sporadic detection suggesting a low maintenance of the pathogen with an intermediate level of seroprevalence
   - Level 3: Frequent detection illustrating a strong pathogen circulation with a high level of seroprevalence
  - Contact intensity between humans and animals (one estimate for wildlife and one for livestock)
    - Level 0: Absence of contact
    - Level 1: Low frequency of contact with animal populations that are not located near human populations OR transmission modes are very indirect (i.e., require a bridge host)
    - Level 2: Moderate frequency of contact with animal populations that can be easily accessible OR transmission modes are direct, but not high (e.g., sustained contact)
    - Level 3: High frequency of contact with animal populations that are located close to human populations OR highly efficient transmission modes (e.g., aerosols)

Elicitation study - Responses

- 275 expert contacted

- 60 provided estimations
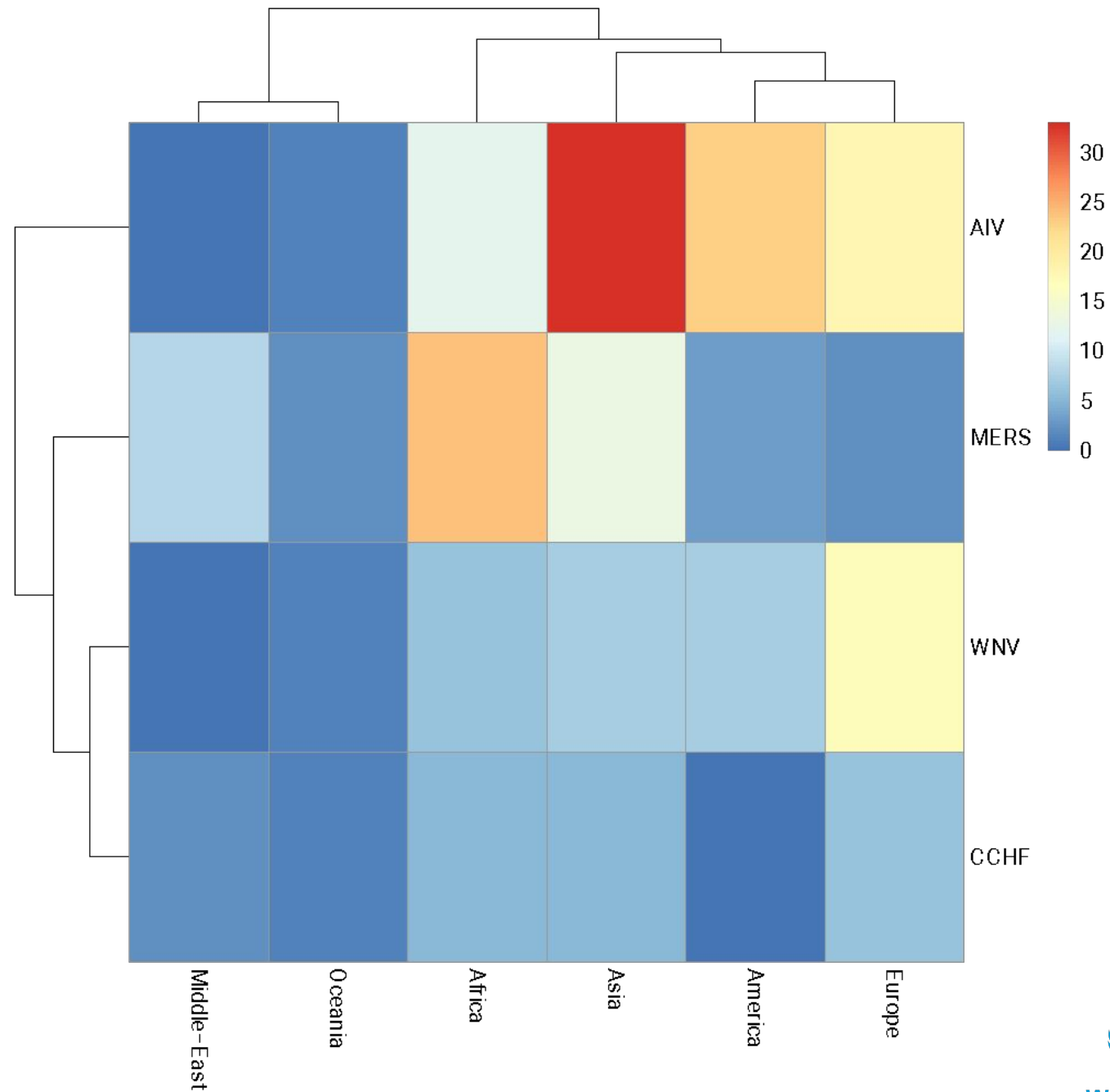
Mapping the indicator from the elicitation study
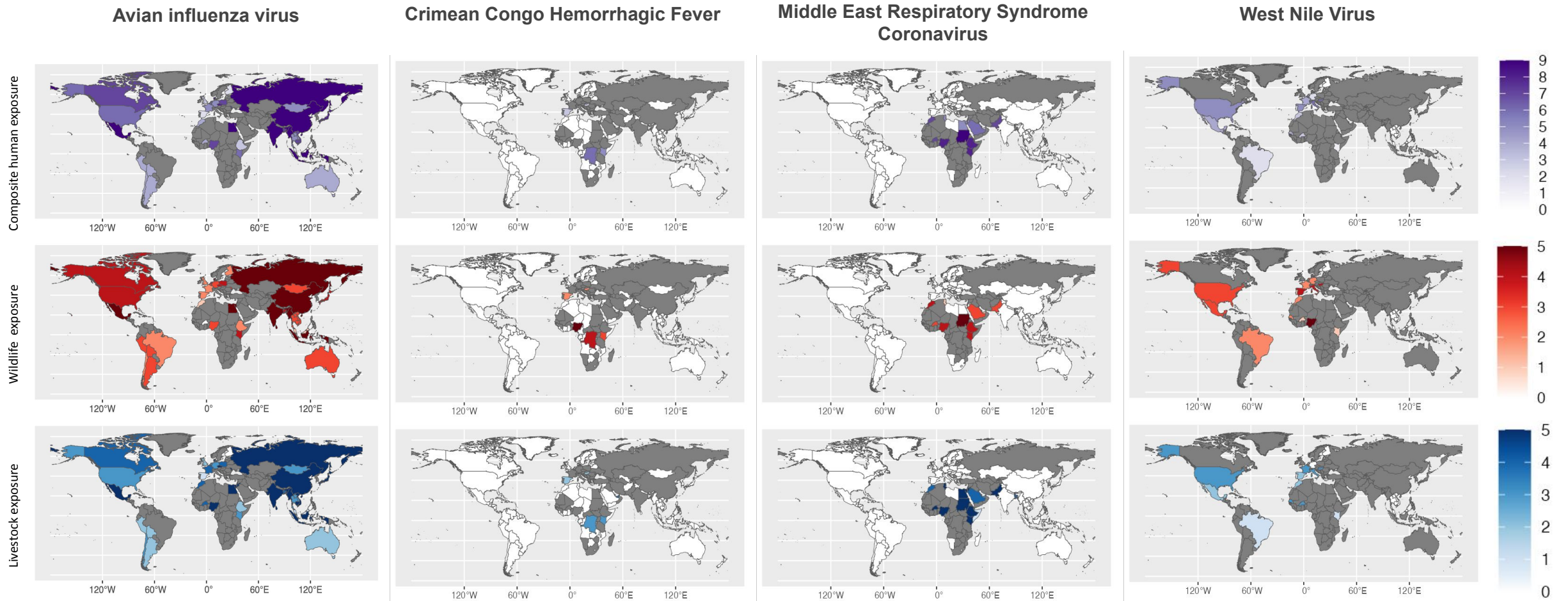
Composite indicator – First validation

AIV distribution

MERS distribution

Probability of spillover + 15%

Probability of spillover + 30%
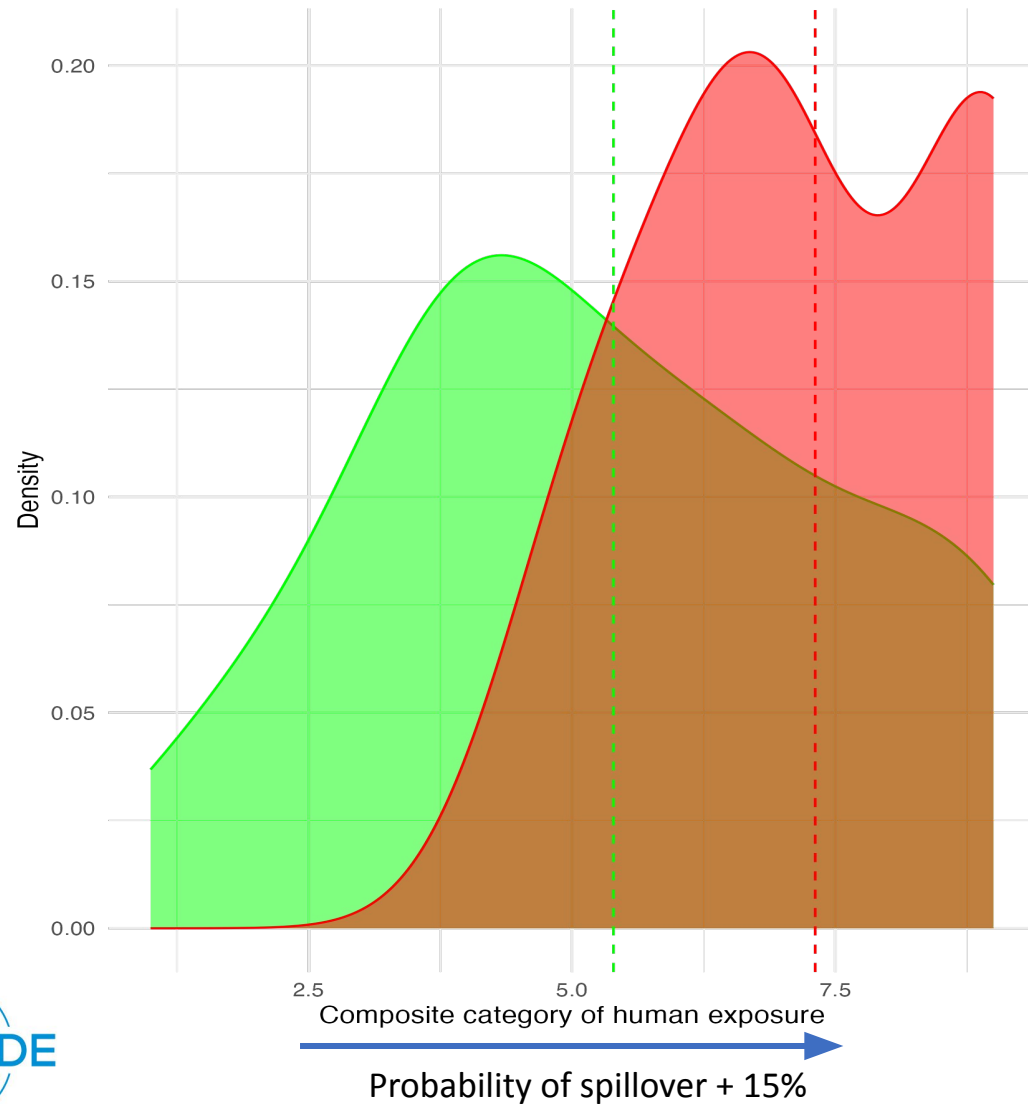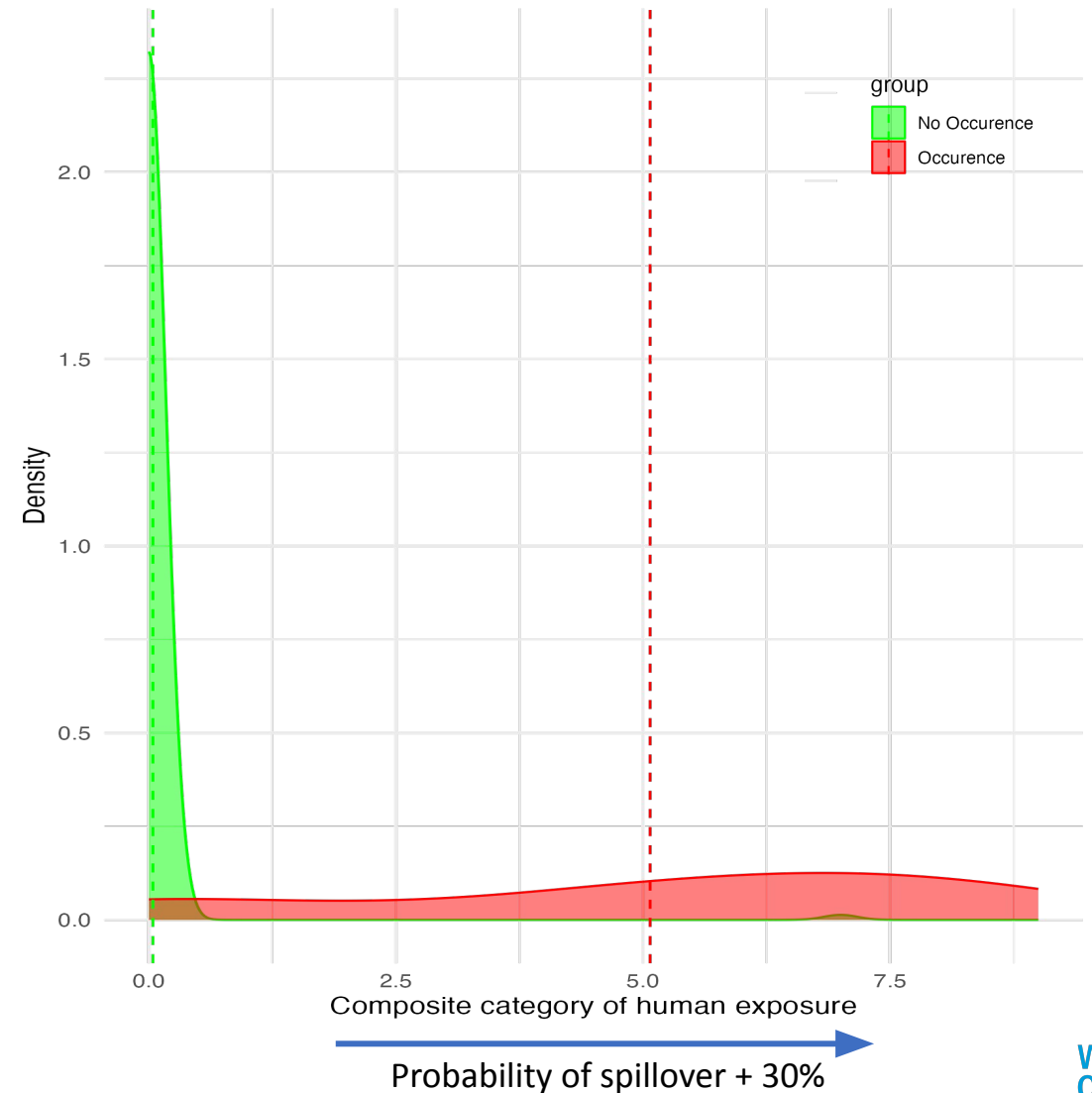
Conclusions and perspectives

- **Match the expectations:**
  - actionable, synthetic and deal with the inherent complexity of zoonoses emergence

- **Short-term perspectives:**
  - Extending elicitation study (more diverse in terms of experts geography and pathogens)
  - Creation of a Global Network of Zoonotic Disease Experts to update regularly knowledge and estimation on this indicator

- **Middle-term perspectives:**
  - Shifting to a quantitative approach (identifying circulation and contact levels from routine data rather than from experts)
  - Improving animal health surveillance (quantitatively and qualitatively)

- **Long-term perspectives:**
  - Generalizing the framework to allow a pathogen-agnostic approach

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Supplementary materials

Wildlife

Species of interest	XXX
Variables needed to estimate pathogen incidence in the species of interest	XXX
Available data to estimate pathogen incidence and validate estimation	XXX
Variables to estimate abundance of the target population (if indirect measures are needed, i.e., no abundance data studies exists)	XXX
Available data to estimate abundance	XXX

Bridge host

Species of interest	XXX
Variables needed to estimate pathogen incidence in the species of interest	XXX
Available data to estimate pathogen incidence and validate estimation	XXX
Variables to estimate abundance of the target population (if indirect measures are needed, i.e., no abundance data studies exists)	XXX
Available data to estimate abundance	XXX

Livestock

Species of interest	XXX
Variables needed to estimate pathogen incidence in the species of interest	XXX
Available data to estimate pathogen incidence and validate estimation	XXX
Variables to estimate abundance of the target population (if indirect measures are needed, i.e., no abundance data studies exists)	XXX
Available data to estimate abundance	XXX

Human exposure

Variables needed to estimate transmission route intensity with wildlife (W1)	XXX
Available data to estimate W1	XXX
Variables needed to estimate transmission route intensity with bridge host (W2)	XXX
Available data to estimate W2	XXX
Variables needed to estimate transmission route intensity with livestock (W3)	XXX
Available data to estimate W3	XXX

AIV – To consider

Wildlife:
- Species of interest: Waterbirds (especially mallards)
- Drivers to consider: Temperature, land use, density of waterbodies, migratory routes, prevalence in other places along the migratory routes
- Contact with humans: proximity of water bodies

Livestock:
- Species of interest: Poultry
- Drivers to consider: Poultry density, poultry trade routes, proximity with waterbodies, type of husbandry
- Contact with humans: Number of workers inside pig/poultry livestock facility

CCHF – To consider

Wildlife:
- <u>Species of interest:</u> Potentially hares
- <u>Drivers to consider:</u> Mostly host diversity
- <u>Contact with humans:</u> Factors driving tick abundance (mostly temperature, relative humidity, saturation deficit). Human behavior regarding outdoor activities

Livestock:
- <u>Species of interest:</u> Cattle, goat sheep
- <u>Drivers to consider:</u> Livestock density

- <u>Contact with humans:</u> Factors driving tick abundance (mostly temperature, relative humidity, saturation deficit). Human behavior regarding outdoor activities

WNV – To consider

Wildlife:
- <u>Species of interest:</u> Wild birds
- <u>Drivers to consider:</u> Bird density, migratory routes
- <u>Contact with humans:</u> Environmental factors driving mosquito abundance (temperature, rainfall, …)

Livestock:
- <u>Species of interest:</u> Horses
- <u>Drivers to consider:</u> Horse density

- <u>Contact with humans:</u> Environmental factors driving mosquito abundance (temperature, rainfall, …)

MERS-Cov – To consider

Wildlife:
- Species of interest: Vespertilionid (insectivorous) bats
- Drivers to consider: bat fly length and environmental variables affecting food abundance
- Contact with humans: bat/human interaction through deforestation

Livestock:
- Species of interest: Dromedary camels, Bactrian camels, llamas, alpacas
- Drivers to consider: Species densities, husbandry systems, interaction between camelid populations

- Contact with humans: Existence of camel markets, camel gatherings, nomadic communities reliant on and living with camels, competitions involving camels (races, beauty pageants)