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Combining Climate Projections and Dispersal Mechanisms for the Future Development of Aedes Species in Europe

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Background

***Aedes* in Europe**: Beside native *Aedes* vector species (*Aedes vexans, Ae. cinereus*) in Europe, non native, invasive aedine mosquito species (*Ae. albopictus, Ae. japonicus*) are expected to be of medical importance, too. Both species are in rapid extension of their dispersal area.

Introduction by Humans: The spread of *Ae. albopictus* for instance is strongly driven by human activities, mainly by transport of goods [1]. It is already established in Mediterranean countries (e.g. Albania, Italy) and can hardly be controlled.

Establishment promoted by Climate Change: Introduction my happen by chance, but the establishment of viable populations depends on climatic and further environmental habitat restrictions [2,3].

Fig 1. *Aedes albopictus is an invasive and highly competent vector for various arboviruses.*

Methods

A) **Climatic constraints for Vector and Pathogen**
***Aedes albopictus* and Dengue:** Bioclimatic variables are detected, supported by previous investigations and expert knowledge. (*Aedes*: mean temperature of the warmest and of the coldest quarter, annual mean temperature, annual precipitation, altitude; Dengue: mean temperature between May and October).

B) **Regional Climate Models:** The future suitable climatic conditions are modeled for *Aedes albopictus* and Dengue in Europe based on this bioclimatic variables.

We compare different IPCC scenarios and present here the A1B scenario (very rapid economic growth, global population that peaks mid-century and declines thereafter, and a balance across fossil-intensive and non-fossil energy sources).

C) **Dispersal mechanisms:** Moreover introduction pathways of vector (seaports, containers inward EU form infested countries) and pathogen (airports, incoming passengers from endemic countries) are considered.

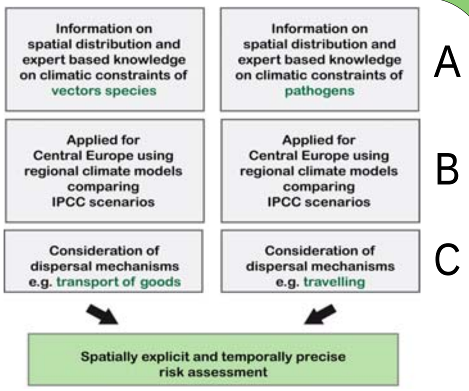

Fig 2. Approach for a spatially explicit and temporally precise risk assessment for vectors and pathogens.

Results

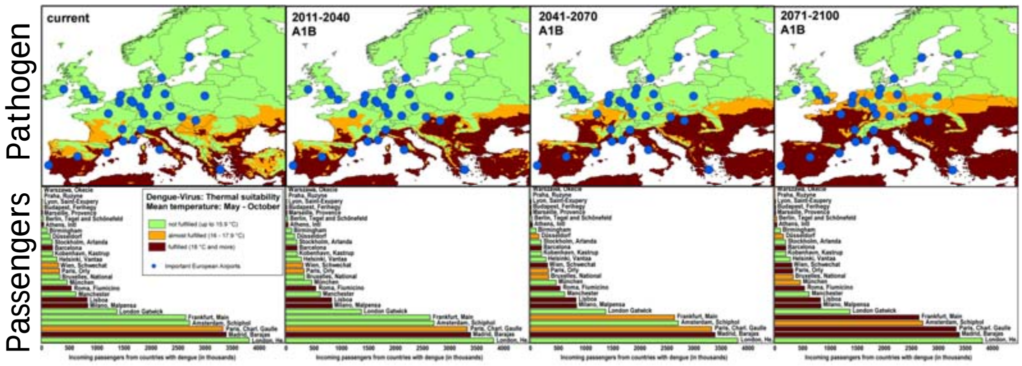

Fig 3. Climatic projection of Dengue and possible dispersal by incoming passengers from endemic countries

Dengue thermal suitability and incoming passengers from endemic countries
Currently, Madrid and Paris fulfill or almost fulfill the required mean temperatures from May to October respectively. Both airports are counted to the biggest airports in Europe, with nearly 3,5 million incoming passengers form endemic countries per year.
Until the end of the century all airport sites without those of the Nordic countries and the United Kingdom will achieve or nearly achieve thermal spring and summer conditions which would allow dengue transmission.

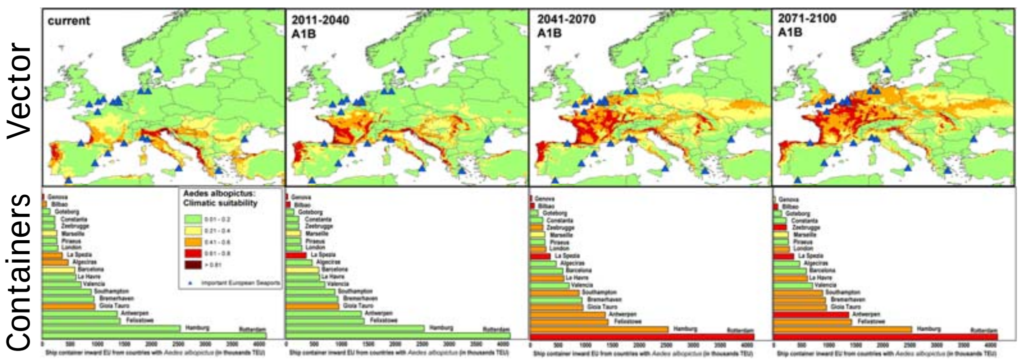

Fig 4. Climatic projection of *Aedes albopictus* and possible dispersal by transport of goods by ship inward EU from infested countries

***Aedes albopictus* climatic suitability and ship containers inward EU from *Aedes albopictus* infested countries**
Rotterdam is by far the most important seaport regarding incoming ship container from countries where *Aedes albopictus* is already established (more than 4 million containers per year). Whereas in the first half of this century the Italian seaports and Bilbao in the North of Spain provide climatic suitable conditions for (further) establishment of *Aedes albopictus*, from mid-century onwards this is true for seaports as far north as Hamburg, which provide highest turnover of containers in the EU.

Conclusions

- Combined analyses of climatic suitability for vectors AND pathogens result in realistic projections for potential establishment of vector-borne diseases
- Combined investigations considering climatic projections AND dispersal mechanisms are needed
- Spatially explicit and temporally precise risk assessment support decision makers in public health sector

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