biogeografie
uni bayreuth

Dengue in Europe:

Nationale Forschungsplattform für Zoonosen

New approach to integrate the temperature dependent Extrinsic Incubation Period of virus amplification in the hazard assessment

Stephanie Thomas[1], Nils Tjaden[2], Anja Jaeschke[1,2], Lena Muffler[1], Carl Beierkuhnlein[1]

[1]Biogeography, University of Bayreuth, [2]Biogeographical Modelling, University of Bayreuth, Germany

Background

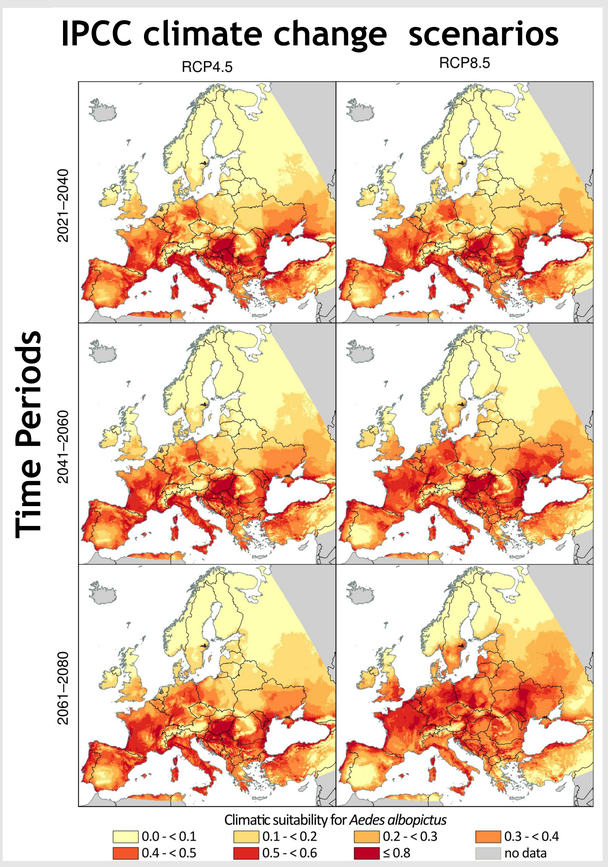
The geographical range of areas where dengue epidemics occur has expanded dramatically during the last decades. Up to now, dengue was generally considered an exclusively travel-related disease. However, first European cases of autochthonous dengue were reported in the Mediterranean; Madeira experienced an epidemic in 2012/2013. As arthropod vectors are ectothermic species, the environmental temperature directly determines the amplification of the virus inside the vector, i.e. the extrinsic incubation period (EIP), which is shortened at warmer temperatures. If minimum temperature thresholds for the EIP are not exceeded, the virus cannot accomplish its amplification and the transmission to humans can be excluded.

Results

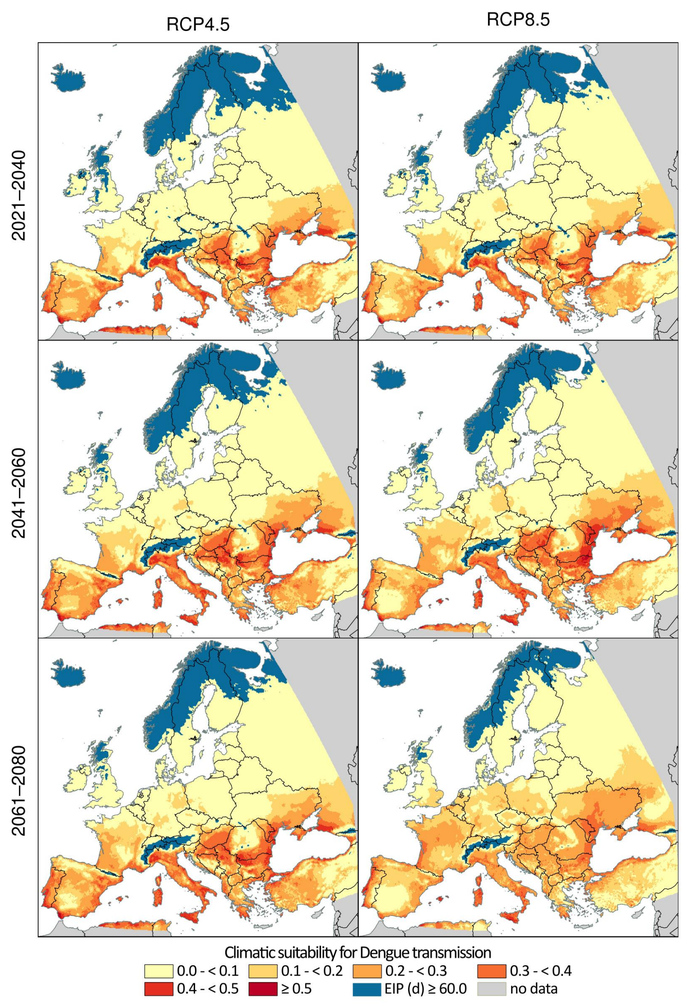
1 Vector: *Aedes albopictus* Climatic Suitability

Climatic Variables
Annual Mean Temperature
Max Temperature of Warmest Month
Min Temperature of Coldest Month
Mean Temperature of Driest Quarter
Mean Temperature of Warmest Quarter
Mean Temperature of Coldest Quarter

High climatic suitability : Parts of Hungary, Croatia, Serbia and the Danube valley along the border of Bulgaria and Romania
Quite high climatic suitability : South-east and central France, Italy, the Italian islands

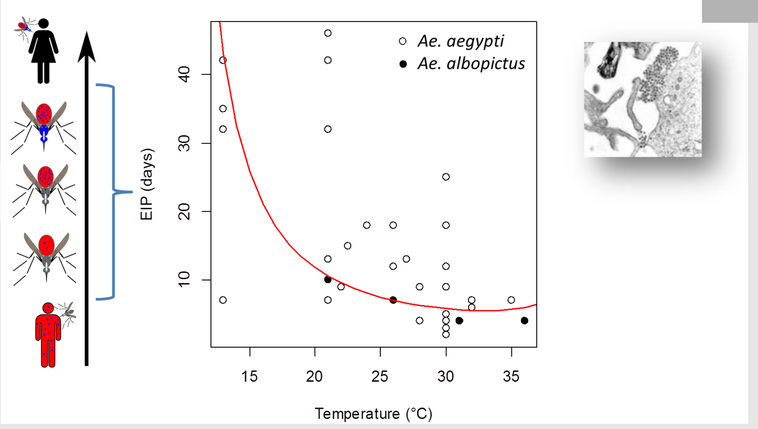


3 Dengue Transmission in Europe

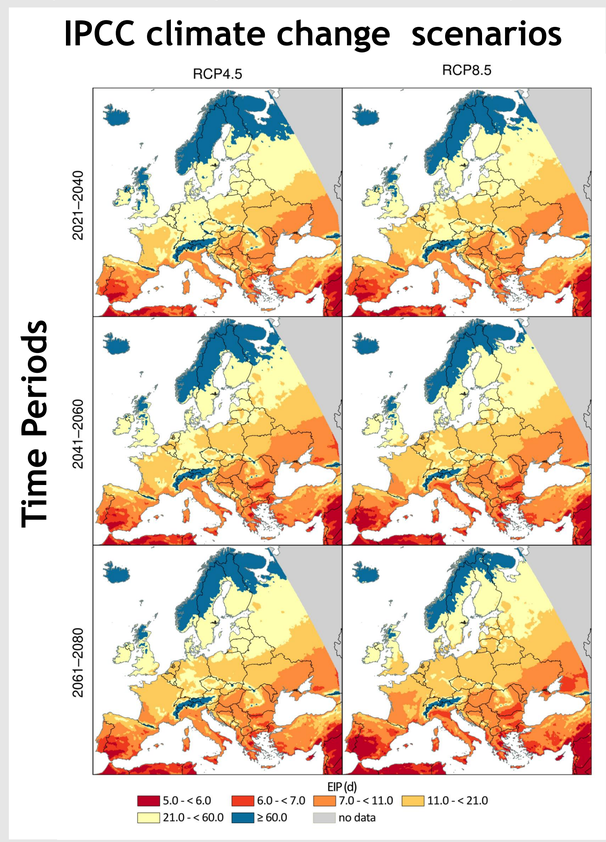


Areas with higher and increasing climatic suitability for dengue transmission with advancing climate change were projected for parts of south-eastern Europe such as Hungary, Croatia, Serbia as well as the Danube valley, and for large parts of Italy, Islands of the Mediterranean Sea as well as for most parts of the coastline of the Mediterranean Sea and Black Sea.

2 Virus: Extrinsic Incubation Period



Short EIP: south-western part of the Iberian Peninsula, Danube valley, parts of Greece and Turkey, for parts of Italy and south-western parts of Russia.



Methods

1. Vector: Development of maps with areas at risk for a long-term establishment of the mosquito species *Aedes albopictus*, a well-known vector for dengue. Species distribution modelling was performed with R and the package biomod2, which allows the use of an ensemble of different modelling algorithms: Generalized Linear Model, Generalized Boosted Regression Model, Random Forest Model, Maximum Entropy Model Maxent. Future maps are based on Global Climate Model MPI-ESM-LR.

2. Virus: Detection of areas where the temperature requirements of dengue EIP are fulfilled by detecting the relationship between EIP (days) and temperature, modelled by applying the left-skewed unimodal function according to Briere et al. (1999), with margins of the function being 9°C and 40°C.

3. Transmission of dengue: Climatic suitable areas for disease transmission were obtained by combining the results for vector and virus. EIP was combined with the climatic suitability *of Ae. albopictus* by multiplication.

All future maps are based on Global Climate Model MPI-ESM-LR and the two representative concentration pathways RCP4.5 and RCP8.5 (IPCC AR5).

Further References

- Thomas, Beierkuhnlein (2013) Predicting ectotherm disease vector spread—benefits from multidisciplinary approaches and directions forward. **Naturwissenschaften** 100:395-405
- Fischer, Thomas et al. (2011) Projection of climatic suitability for Aedes albopictus Skuse (Culicidae) in Europe under climate change conditions. **Global Planetary Change** 78:54-64
- Tjaden, Thomas, Fischer, Beierkuhnlein (2013) Extrinsic incubation period of dengue: Knowledge, backlog and applications of temperature-dependence, **PLoS Neglected Tropical Diseases** 7(6): e2207
- Thomas, Fischer, Fleischmann, Bittner, Beierkuhnlein (2011) Risk assessment of dengue virus amplification in Europe based on spatio-temporal high resolution climate change projections, **Erdkunde** 65(2):137-150

Stephanie.Thomas@uni-bayreuth.de

www.biogeo.uni-bayreuth.de
www.researchgate.net/profile/Stephanie_Thomas4