

ASSESSING PRESENT AND FUTURE SUITABILITY OF EUROPEAN CITIES TO THE ASIAN TIGER MOSQUITO, A VECTOR OF DENGUE AND ZIKA

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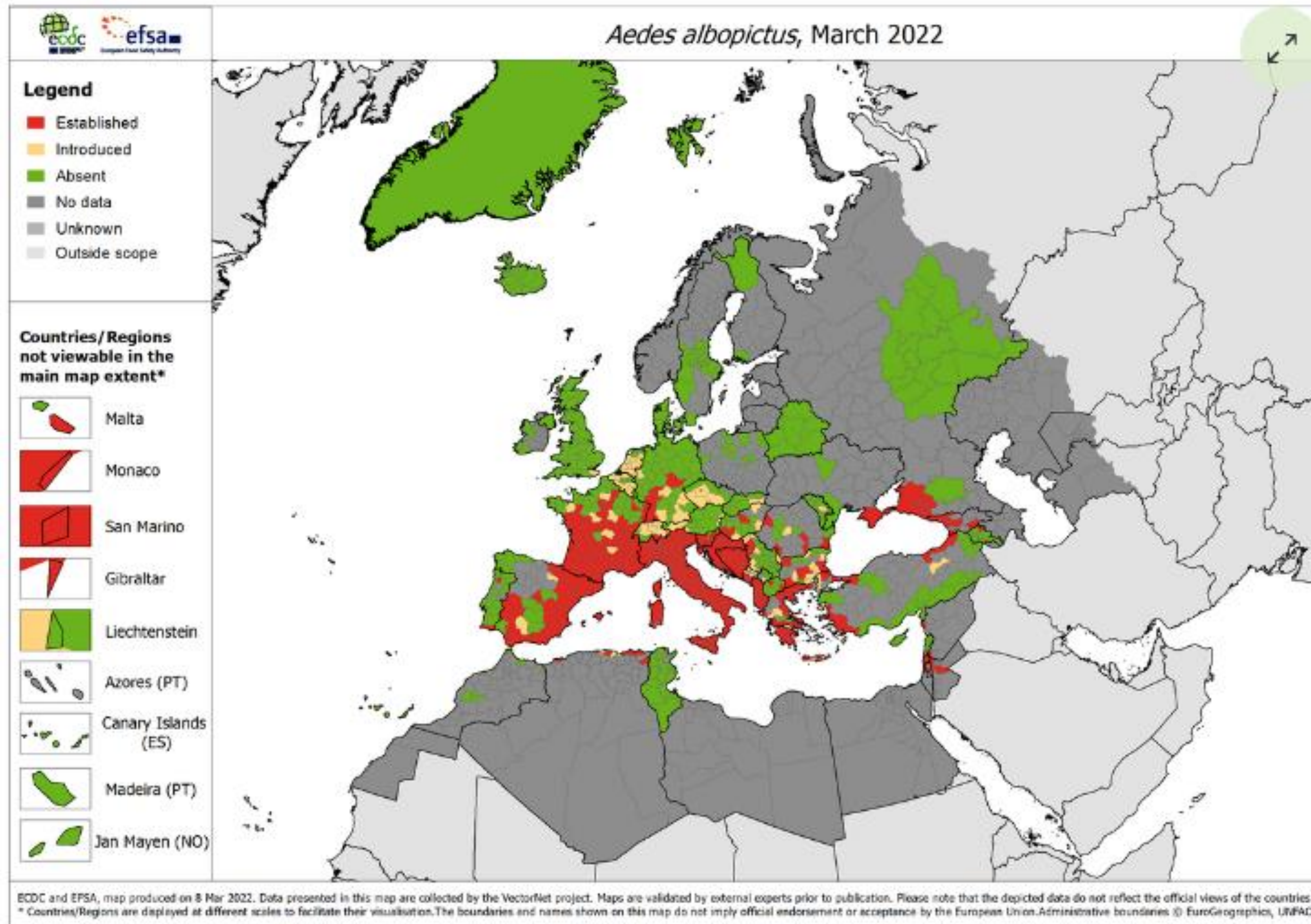
CENTRO EUROPEU DE RISCOS URBANOS

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OUTLINE

- 1. Background
- 2. Objectives
- 3. Methodology
- 4. Results
- 5. Conclusions





- Origin in Southeast Asia
- Albania 1979, Italy 1990
- Competent vector for dengue, Zika and Chikungunya
- Outbreaks in Croatia, France, and Italy
- In Portugal since 2017
- Climate change may increase suitability
- **Urban areas particularly vulnerable:**
 - heat island effect, higher urban temperature amplifies climate change
 - supply of mosquito breeding sites in man-made water containers and through irrigation
 - availability of potential hosts and dynamics of urban movements - increased risk of disease spread

European Centre for Disease Prevention and Control

<https://www.ecdc.europa.eu/en/publications-data/aedes-albopictus-current-known-distribution-march-2022>

- Public health concerns fostered research on the suitability to the establishment of the species in Europe
- Different suitability models have been developed - distinct data sources and methods, equally valid estimates of the potential distribution of the species
 - Do the models agree?
 - Consensus levels differ over Europe?
 - Hotspots of (dis)agreement?
 - **Suitability in urban areas?**
 - **Variations expected in the future?**

eLIFE RESEARCH ARTICLE

The global distribution of the arbovirus vectors *Aedes aegypti* and *Ae. albopictus*
 Moritz UG Kraemer^{1*}, Marianne E Sinka¹, Kirsten A Duda¹, Adrian QN Mylne², Freya M Shearer³, Christopher M Barker³, Chester G Moore⁴, Roberta G Carvalho⁵, Giovanini E Coelho⁵, Wim Van Bortel⁶, Guy Hendrickx⁷

nature microbiology ARTICLES
<https://doi.org/10.1038/n41564-019-0376-y>

Past and future spread of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*
 Moritz U. G. Kraemer^{1,2,3,4,2*}, Robert C. Reiner Jr^{4,2}, Oliver J. Brady^{5,4,2}, Jane P. Messina^{7,4,2}, Marius Gilbert^{8,9,4,2}, David M. Pigott⁴, Dingdong Yi¹⁰, Kimberly Johnson⁴, Lucas Earl⁴, Laurie B. Marczak⁴, Shreya Shirude⁴, Nicole Davis Weaver⁴, Donal Bisanzio^{11,12}, T. Alex Perkins¹⁴, Shenzhi Lai^{15,16,17}, Xin Lu^{18,19,20}

PHILOSOPHICAL TRANSACTIONS B Climate change influences on global distributions of dengue and chikungunya virus vectors
 Lindsay P. Campbell¹, Caylor Luther¹, David Moo-Llanes², Janine M. Ramsey², Rogelio Danis-Lozano² and A. Townsend Peterson¹

PHILOSOPHICAL TRANSACTIONS B Dengue: recent past and future threats
 David J. Rogers¹
 Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK

PHILOSOPHICAL TRANSACTIONS B Present and future projections of habitat suitability of the Asian tiger mosquito, a vector of viral pathogens, from global climate simulation
 Y. Proestos¹, G. K. Christophides², K. Erguler¹, M. Tanarhte³, J. Waldock^{1,2} and J. Lelieveld^{1,3}

JOURNAL OF THE ROYAL SOCIETY Interface Suitability of European climate for the Asian tiger mosquito *Aedes albopictus*: recent trends and future scenarios
 Cyril Caminade^{1*}, Jolyon M. Medlock², Els Ducheyne³, K. Marie McIntyre⁴, Steve Leach², Matthew Baylis⁴
 Global and Planetary Change 78 (2011) 54–64

Global and Planetary Change Projection of climatic suitability for *Aedes albopictus* Skuse (Culicidae) in Europe under climate change conditions
 Dominik Fischer^{1*}, Stephanie Margarete Thomas², Franziska Niemitz³, Björn Reineking¹, Carl Beierkuhnlein⁴

References models	Geog. coverage	Spatial resolution	Present-day period	Future period	Scenario	Modelling technique
Caminade et al. (2012) ¹⁹	Europe	0.25° ~ 25 km	1960–2009	2030–2050	SRES A1B	GIS-based (overwintering and seasonal activity); Multi-criteria decision analysis
Campbell et al. (2015) ⁸	Global	0.16666° ~ 18 km	1950–2000	2041–2060	SRES B1	MaxEnt
Ding et al. (2018) ¹¹	Global	0.05° ~ 5 km	1970–2000			Support vector machine (SVM); Gradient boosting machine (GBM); random Forest (RF)
Kraemer et al. (2015) ¹² , (2019) ⁵	Global	0.04166° ~ 5 km	1960–2014	2050	RCP 6.0	Boosted regression trees (BRT)
Proestos et al. (2015) ⁷	Global	0.46875° ~ 50 km	2000–2009	2045–2054	SRES A2	Fuzzy-logic
Rogers (2015) ⁵²	Global	0.5° ~ 55 km	1961–1990	2080 (estimated for 2050 by linear interpolation)	SRES B1	K-means clustering; Nonlinear discriminant analysis
Santos and Meneses, (2017) ¹³	Global	30 arc-sec ~ 1 km	1950–2000			MaxEnt

25 km resolution

Present-day
7 models

Future
5 models

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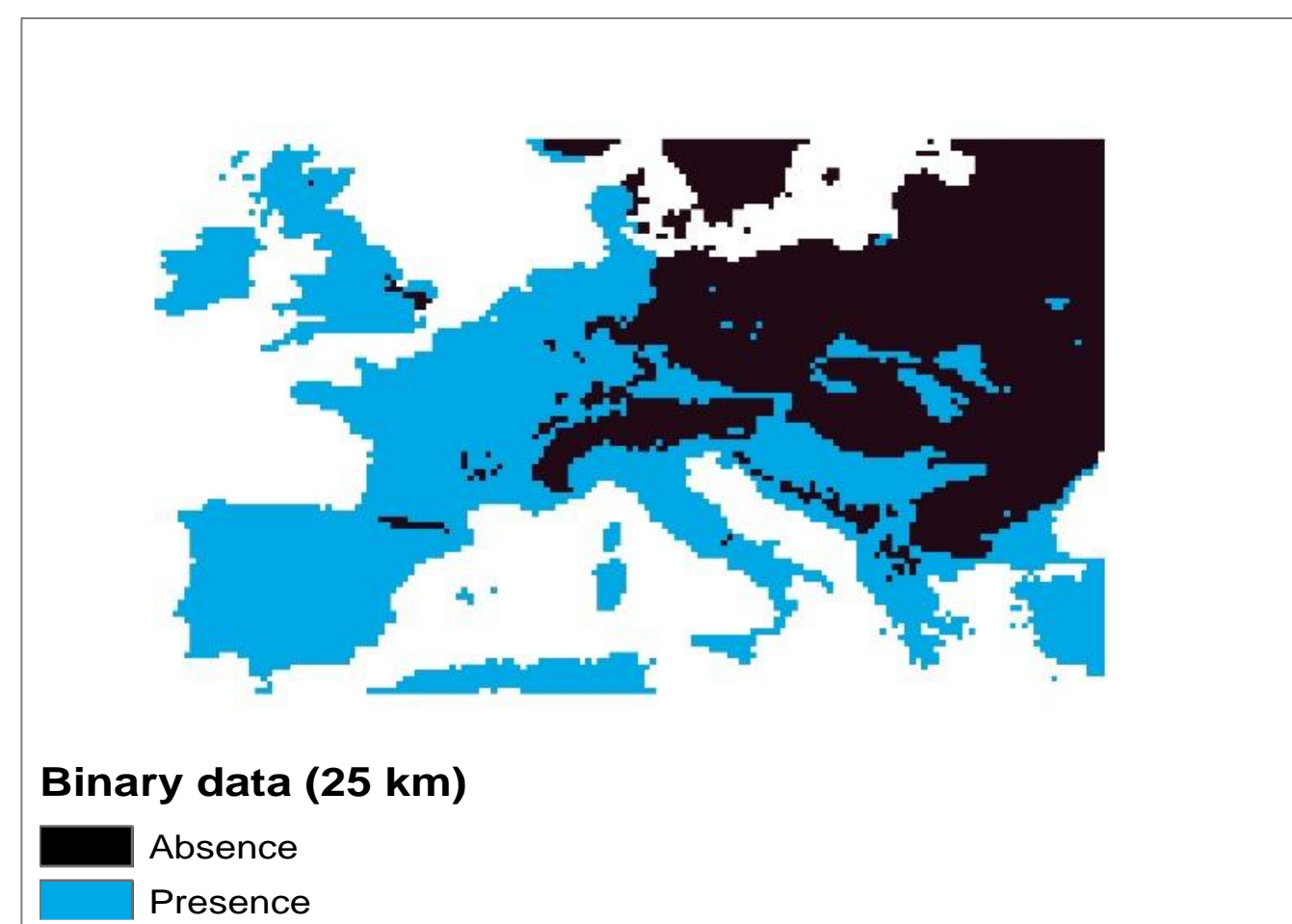
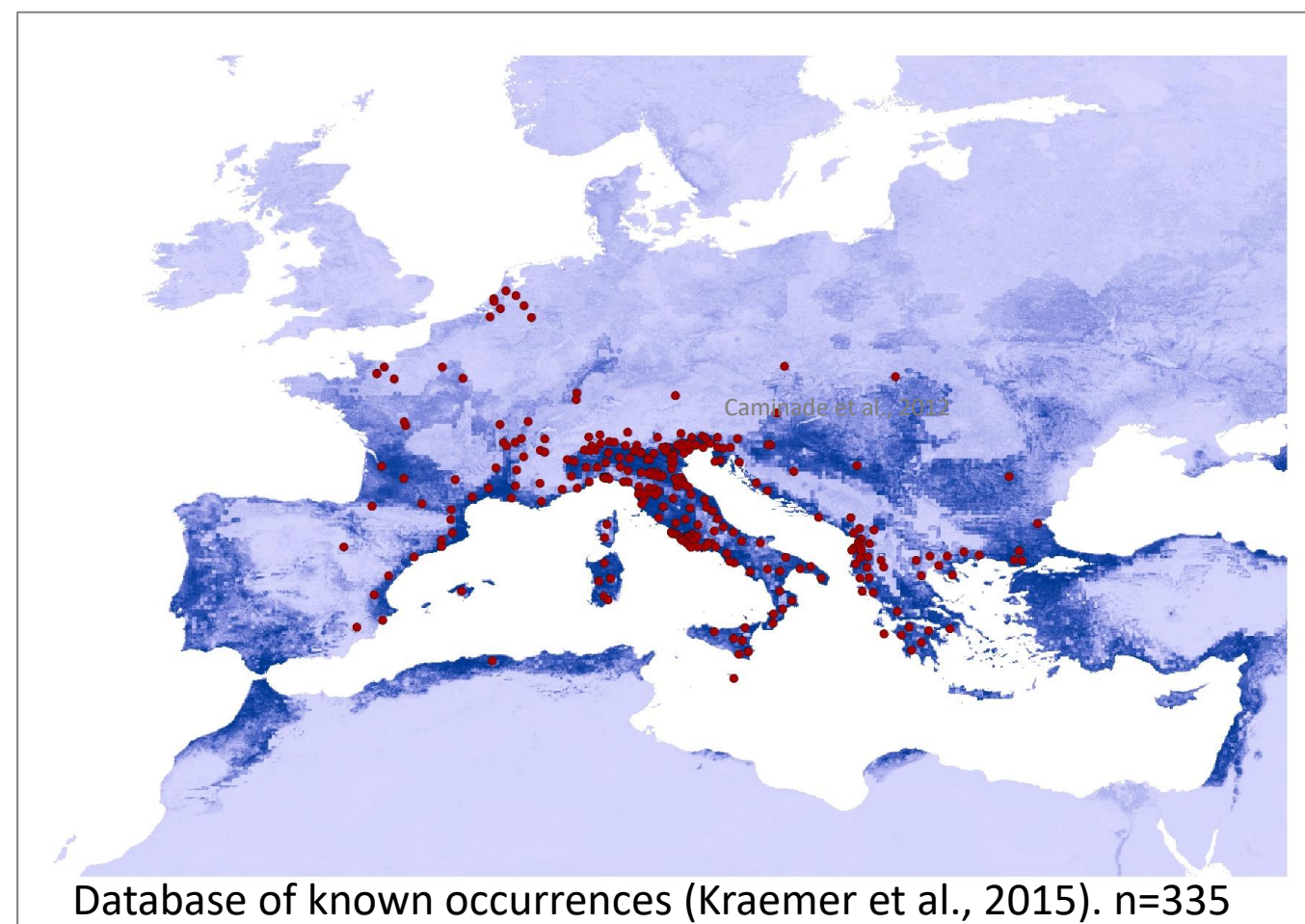
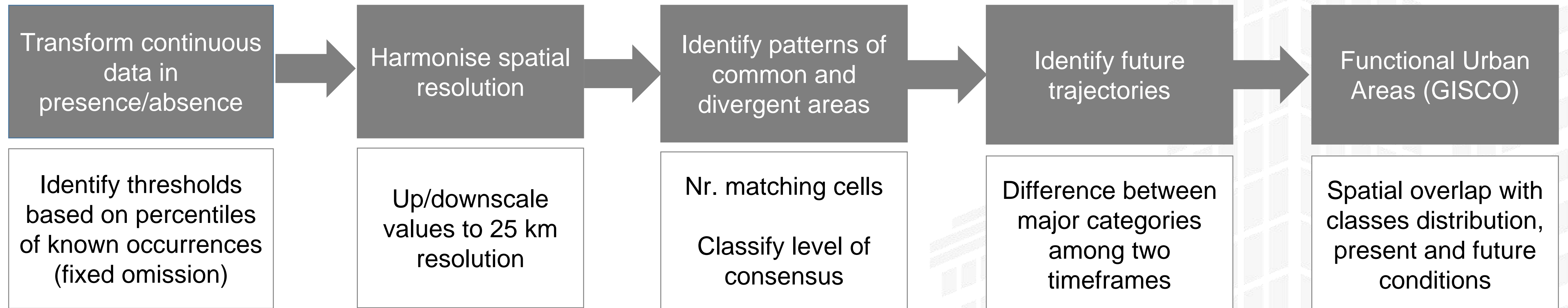
Mapping the spatial distribution of *Aedes aegypti* and *Aedes albopictus*
 Fangyu Ding^{1,2}, Jingying Fu^{1,2}, Dong Jiang^{1,2}, Mengmeng Hao^{1,2}, Gang Lin³

Acta Tropica 168 (2017) 80–90
 Contents lists available at ScienceDirect
 journal homepage: www.elsevier.com/locate/actatropica

An integrated approach for the assessment of the *Aedes aegypti* and *Aedes albopictus* global spatial distribution, and determination of the zones susceptible to the development of Zika virus
 José Santos¹, Bruno M. Meneses^{1,2}

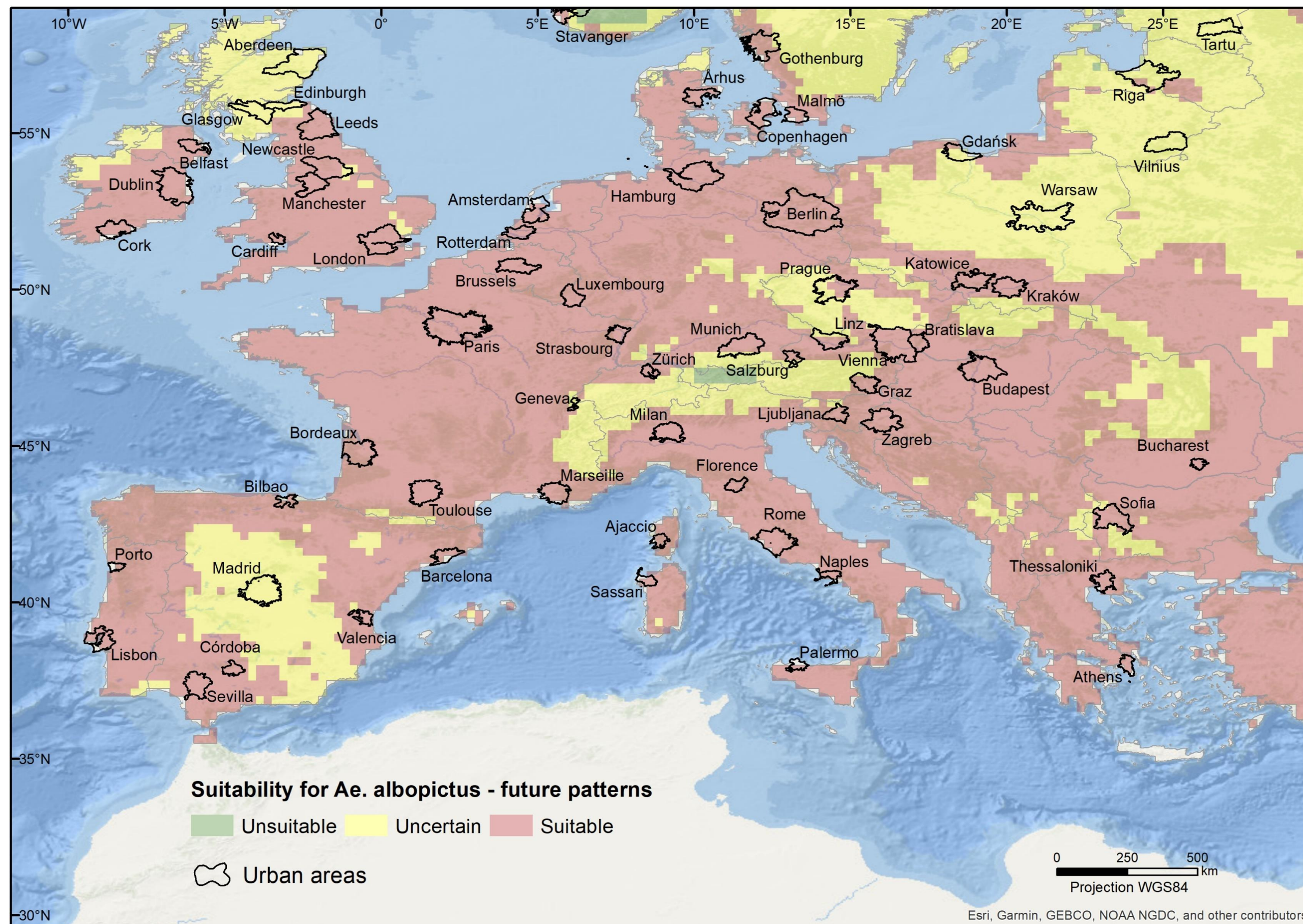


Methods – consensus analysis



Categories	Present (7 models)	Future (5 models)
Unsuitable, low uncertainty	5 to 7 models agree unsuitable	4 to 5 models agree unsuitable
High uncertainty	Only 3 or 4 models agree	Only 2 or 3 models agree
Suitable, low uncertainty	5 to 7 models agree suitable	4 to 5 models agree suitable

Functional urban area (FUA) - a city and its commuting zone. A densely inhabited city and a less densely populated commuting zone whose labor market is highly integrated with the city (*OECD, 2012*).



62 urban areas

- Large metropolitan (above 1.5 million people)
- Metropolitan (250,000 to 1.5 million people)

Overlap with classes

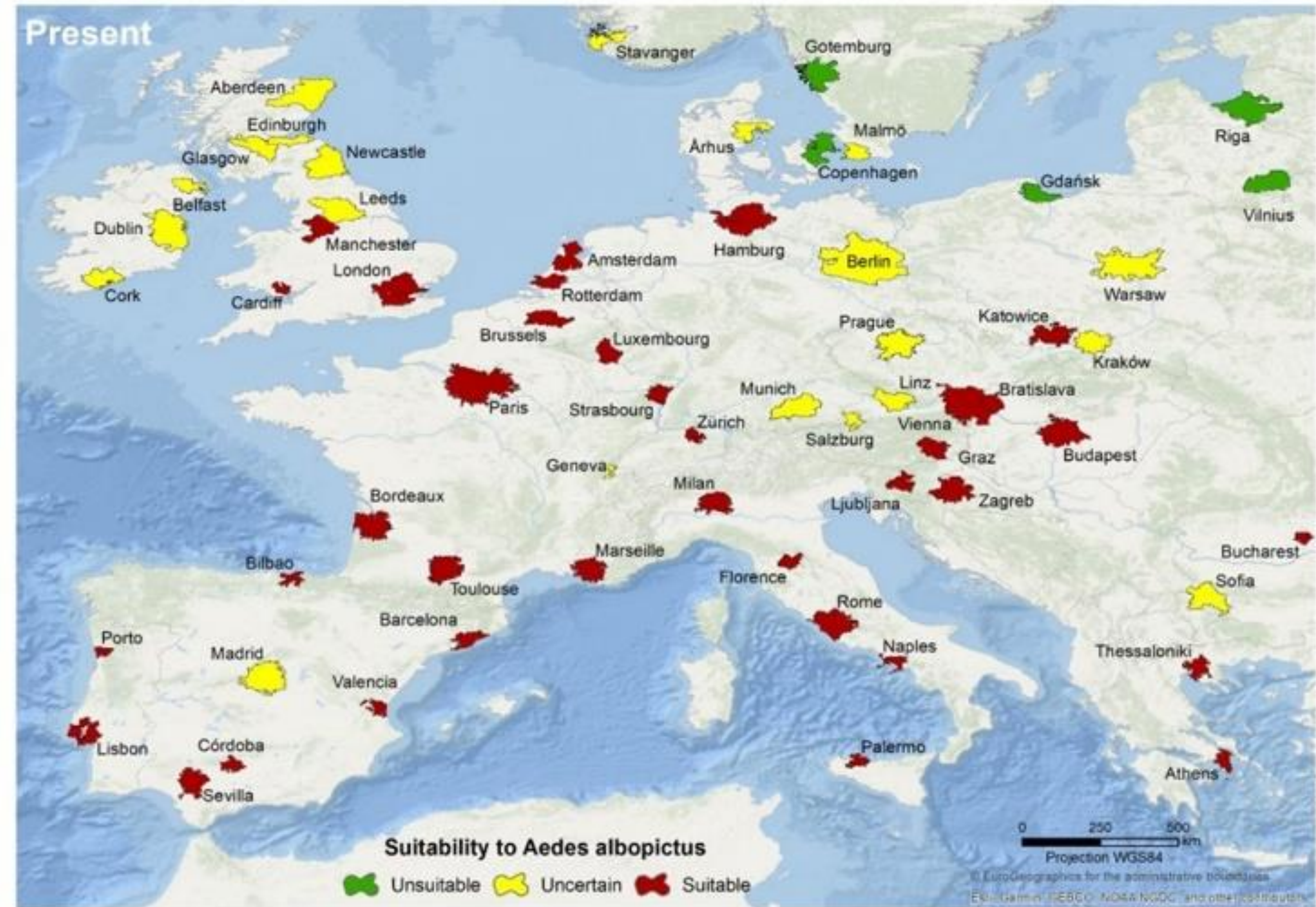
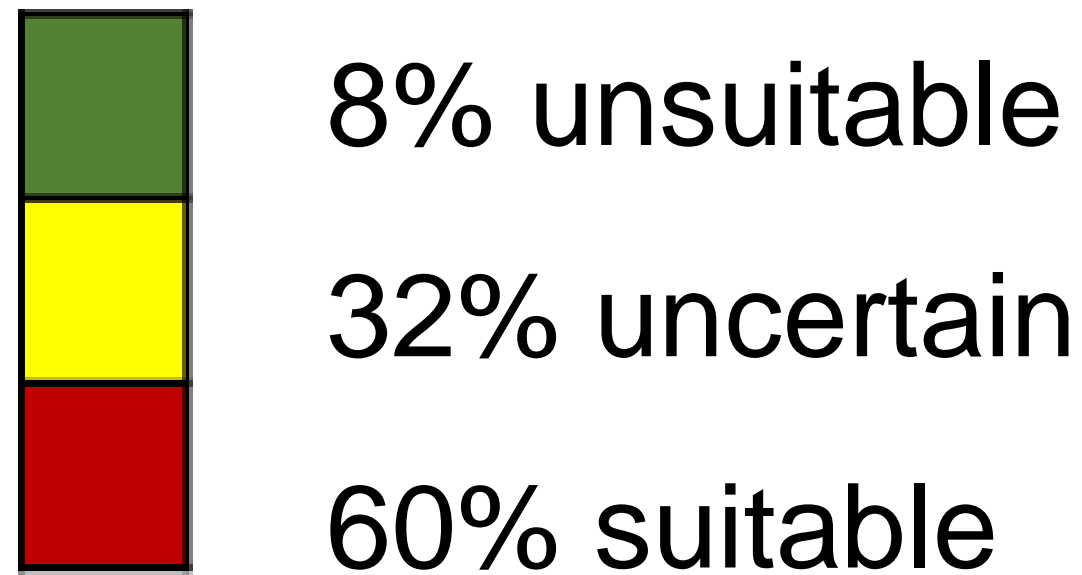
Majority of class within FUA boundaries

AND

Worst-case scenario

(1/3 territory with most negative transition)

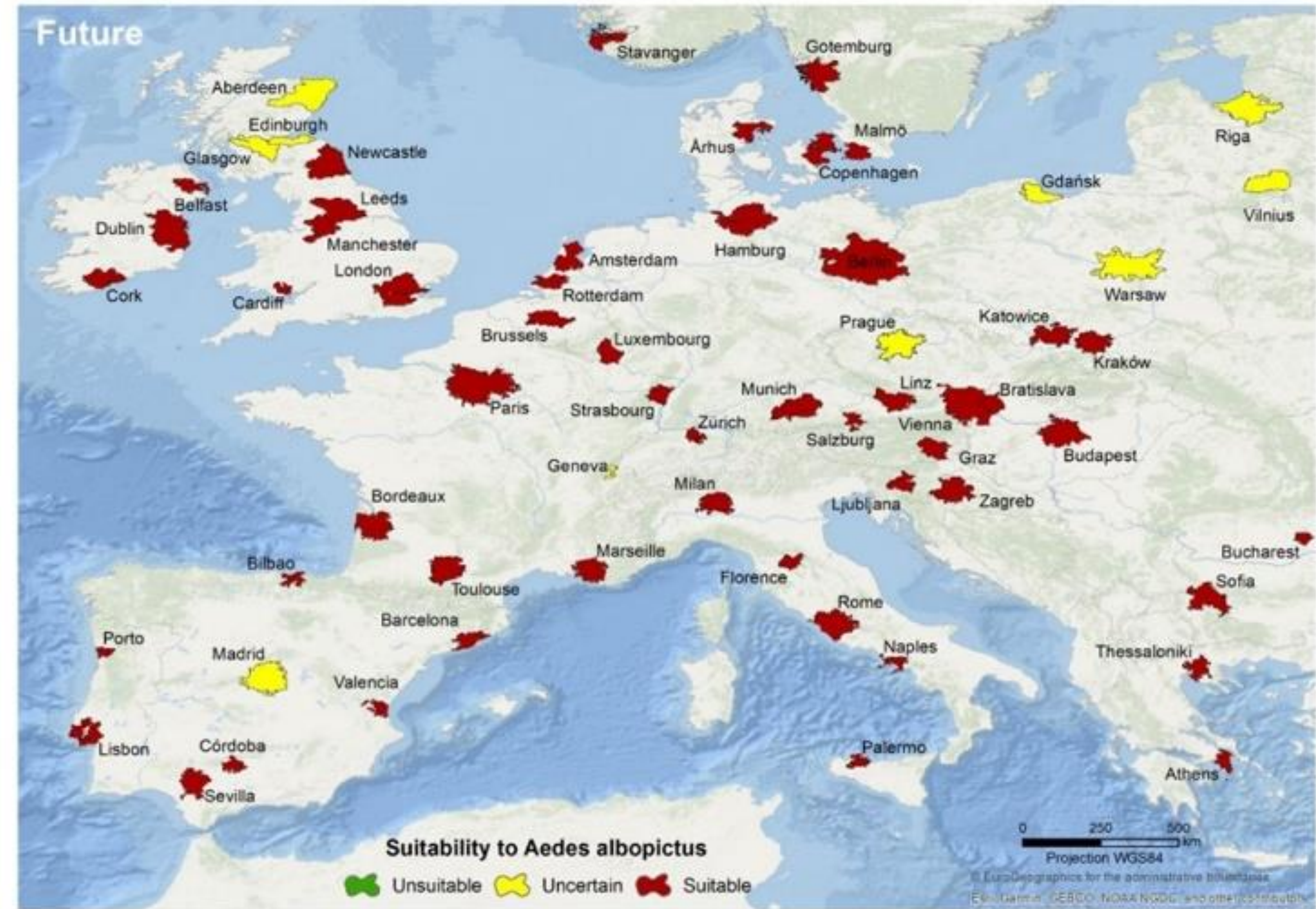
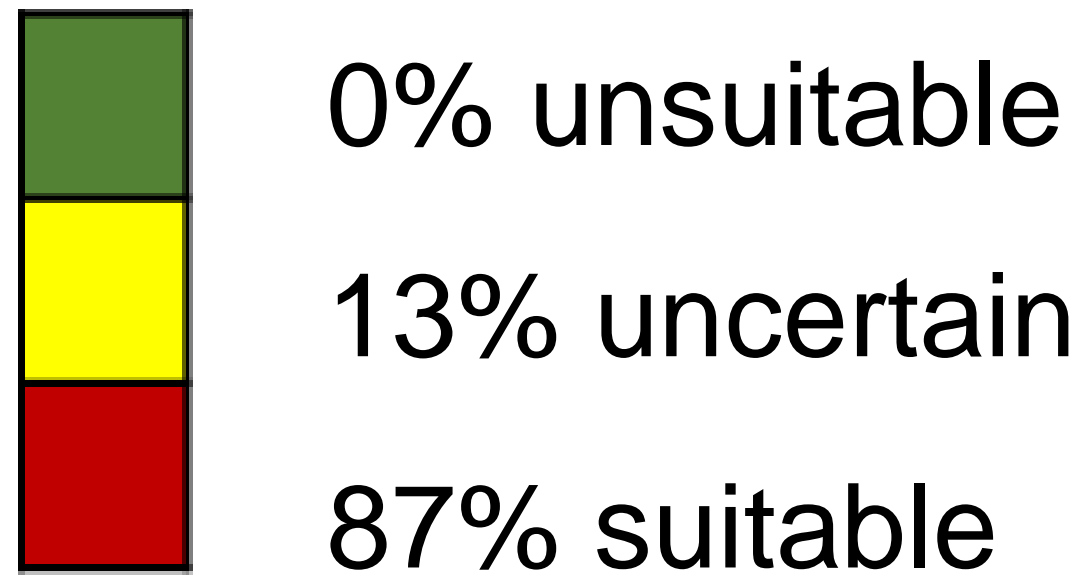
Present-day



Unsuitable cities located in the northeast of the continent, in Scandinavia and the Baltic region (Copenhagen, Goteborg, Riga and Vilnius).

High disagreement (uncertainty) in cities located in the British Isles and Central Europe (Leeds, Edinburgh, Berlin and Prague).

Future (*worst-case scenario*)



Strongest variation (**unsuitable** to **suitable**) seen in Scandinavian cities (Goteborg and Copenhagen).

Most cities in Ireland, UK and central Europe become suitable (Dublin, Berlin and Krakow).

High disagreement (uncertainty) remains in cities located in Eastern Europe, north British Isles and central Iberia (*drought*).

Suitability to Aedes albopictus:

- ❑ Nowadays, 60% of large urban areas (out of 62 analyzed) are suitable to the establishment of the Asian Tiger mosquito. Only 8% are unsuitable.
- ❑ In the future (around 2050), none will be unsuitable and 87% will be suitable
- ❑ *SSP3 population prediction* - people potentially exposed is estimated to be over **100 million**
- ❑ Suitability to *Aedes albopictus* raises public health concerns, need to integrate monitoring and control measures of vectors

Consensus analysis of existing models:

- ✓ Transformation of the original data. Details specific to each model were lost
- ✓ Able to identify hotspots of high and low suitability for *Ae. albopictus*, and areas with high inter-model mismatch (uncertainty)
- ✓ Contribute to transfer scientific outputs (numerous and divergent) into tangible and consensual policies

Thank you!

Oliveira, S., Rocha, J., Sousa, C. A., & Capinha, C. (2021). Wide and increasing suitability for *Aedes albopictus* in Europe is congruent across distribution models. *Scientific reports*, 11(1), 1-9.