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

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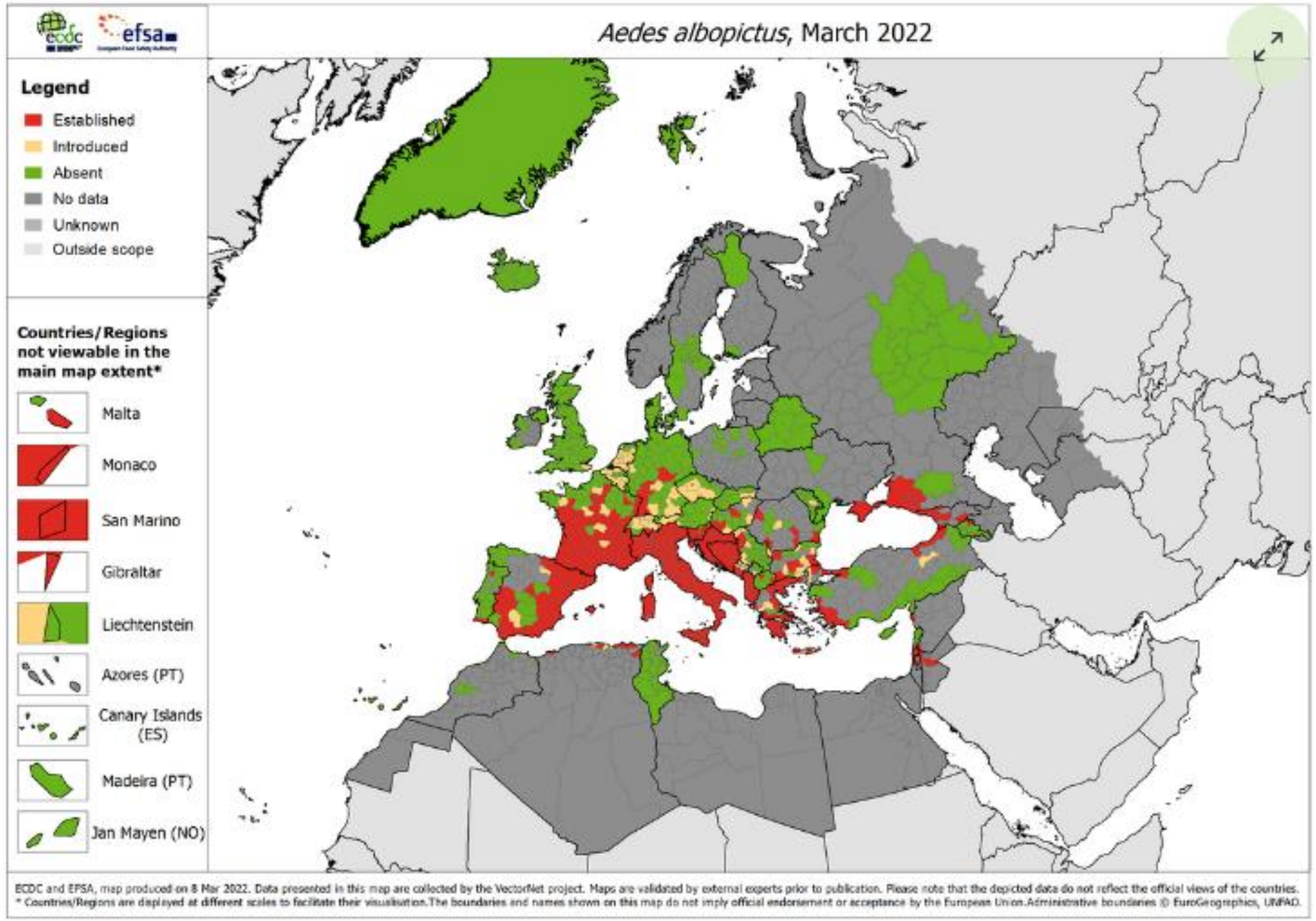
2018-2022

Background



European Centre for Disease Prevention and Control

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

- 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

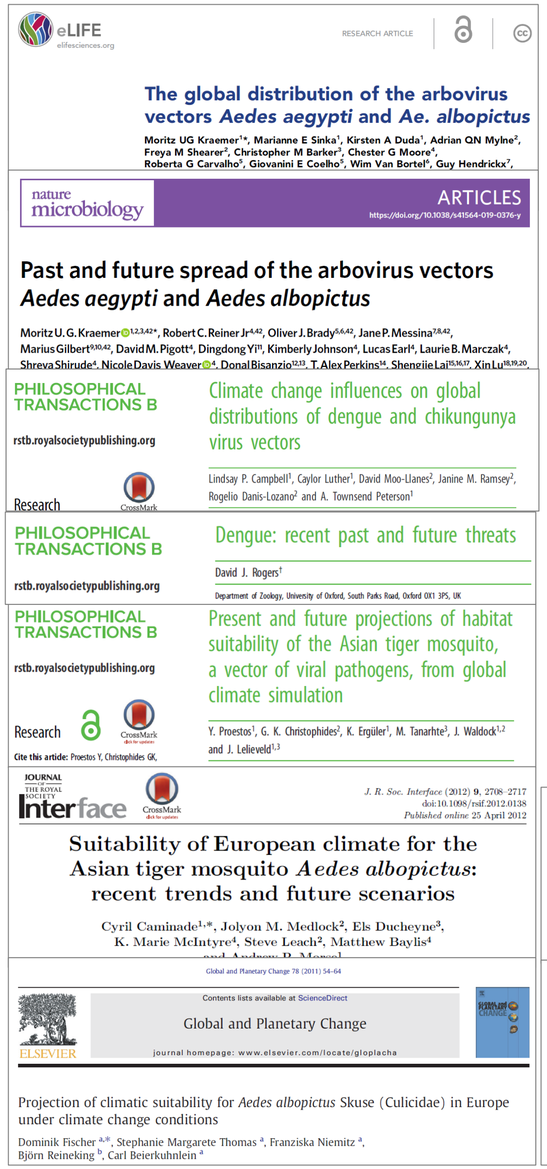
Objectives

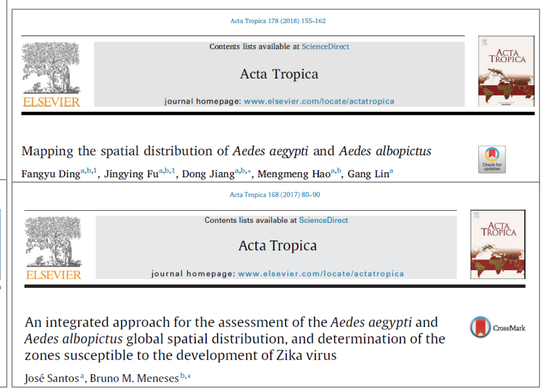
- Public health concerns fostered research on the suitability to the establishment of the species in Europe

- 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?**

Methods – data collection





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

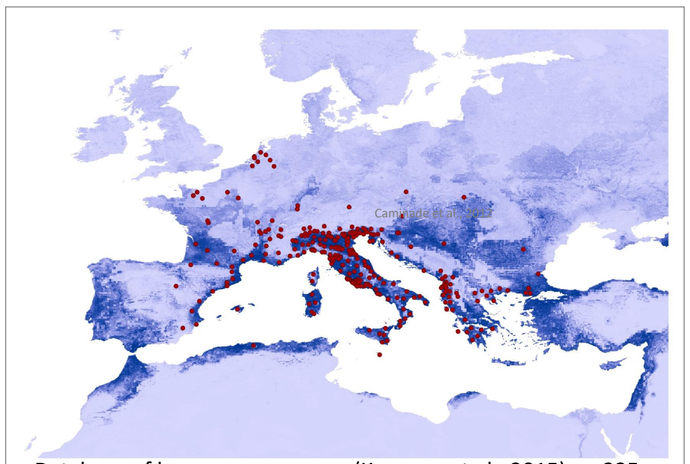
25 km resolution

Present-day 7 models

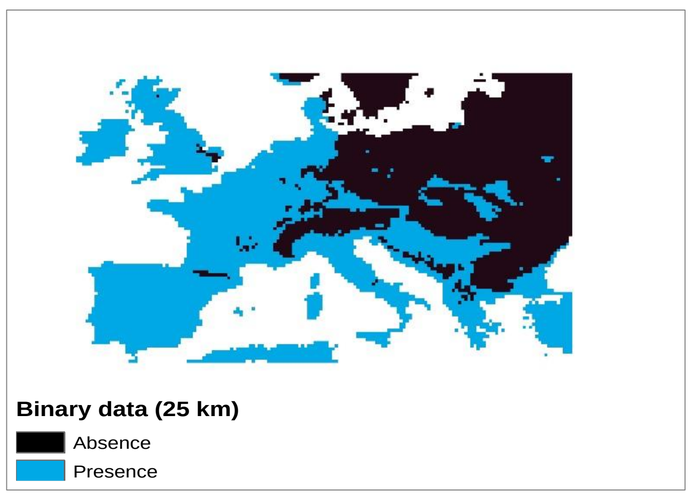
Future 5 models

Methods – consensus analysis

Transform continuous data in presence/absence	Harmonise spatial resolution	Identify patterns of common and divergent areas	Identify future trajectories	Functional Urban Areas (GISCO)
Identify thresholds based on percentiles of known occurrences (fixed omission)	Up/downscale values to 25 km resolution	Nr. matching cells Classify level of consensus	Difference between major categories among two timeframes	Spatial overlap with classes distribution, present and future conditions



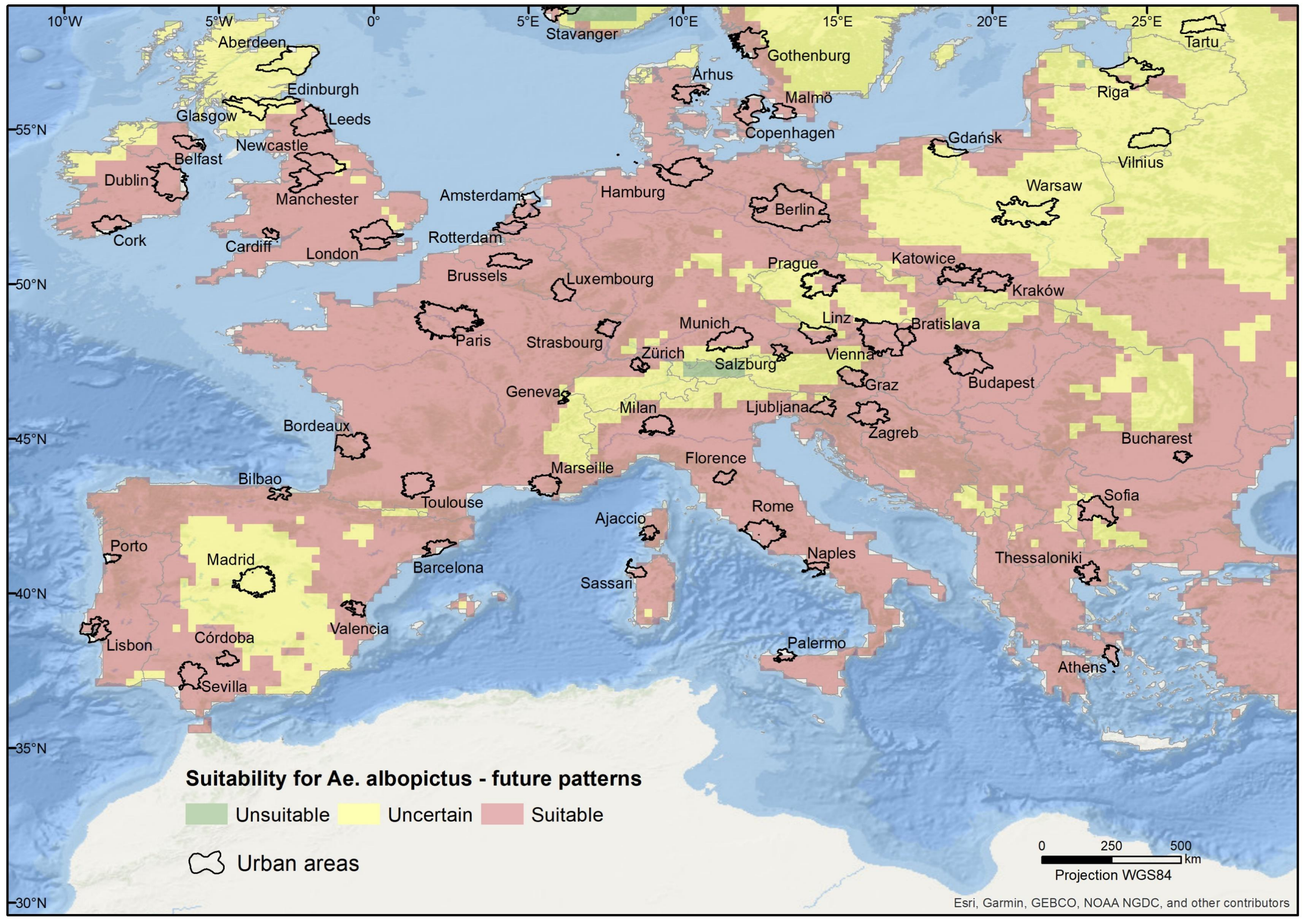
Database of known occurrences (Kraemer et al., 2015). n=335



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

Methods – suitability of urban areas

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

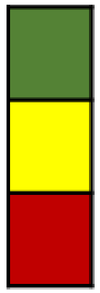
Majority of class within FUA boundaries

AND

Worst-case scenario

(1/3 territory with most negative transition)

Present-day



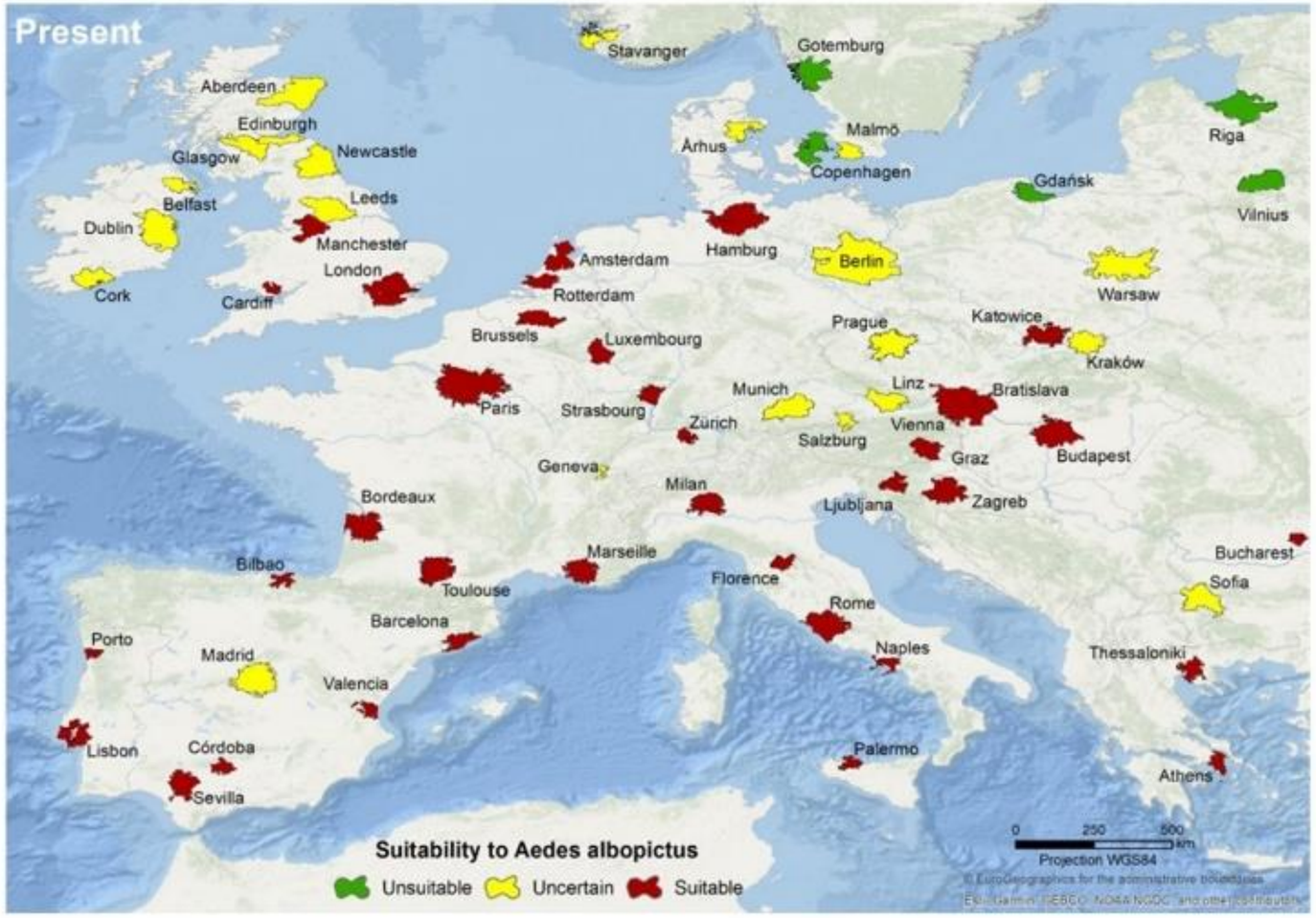
8% unsuitable

32% uncertain

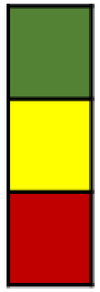
60% suitable

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)*



0% unsuitable

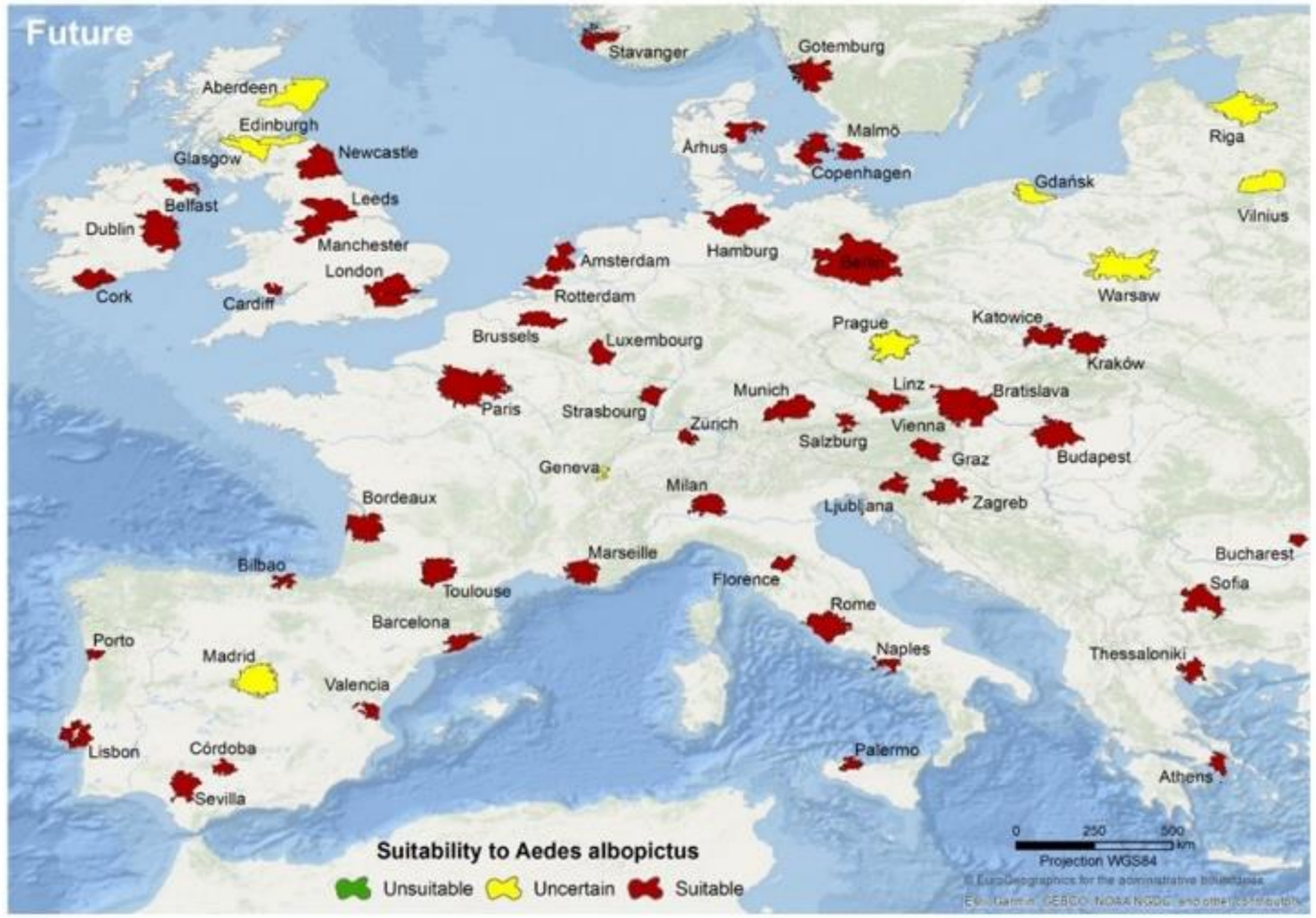
13% uncertain

87% suitable

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*).



Conclusions

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.