

URBAN POPULATION IN EUROPE IS INCREASINGLY EXPOSED TO VECTOR-BORNE DISEASES TRANSMITTED BY THE ASIAN-TIGER MOSQUITO

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Bellini et al. (2020)
Fig. 1. Female Asian tiger mosquito during blood meal (drawing by Elisa Canaglia).



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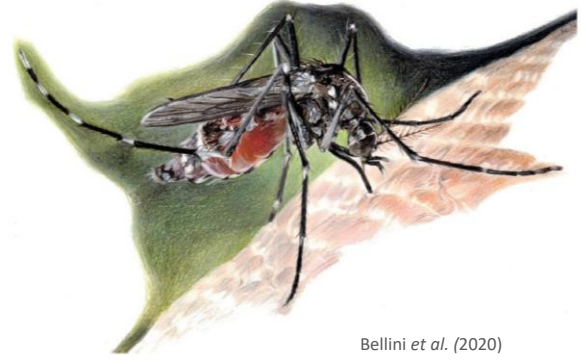
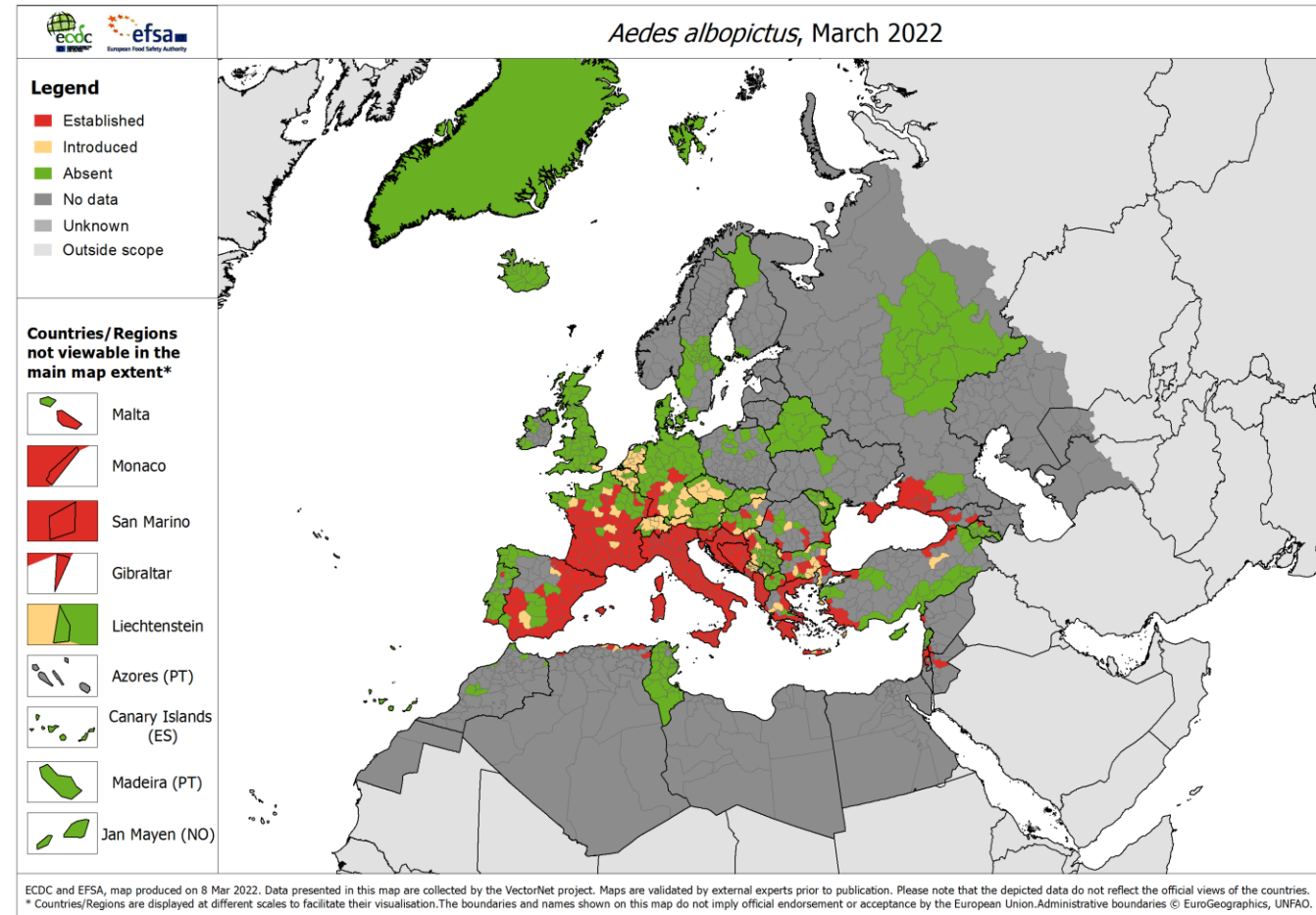
Bellini *et al.* (2020)

Fig. 1. Female Asian tiger mosquito during blood meal (drawing by Elisa Canaglia).

- Origin in Southeast Asia
- In Europe since 1979 (Albania), Italy in 1990
- Competent vector for dengue, Zika and Chikungunya
- Outbreaks in Croatia, France, and Italy in the last decade
- Increase in environmental suitability due to climate change

Currently established in 30 European countries



Urban areas are particularly vulnerable:

- supply of mosquito breeding sites in man-made water containers and through irrigation
- heat island effect, higher urban temperature amplifies climate change
- availability of potential hosts and dynamics of urban movements - increased risk of disease spread



1. Assess the environmental suitability for the establishment of the species in Europe
 - *Consensus between existing models*
2. Assess the suitability to the mosquito in large urban areas in Europe
 - *Present-day conditions and future climatic scenarios (2050)*
3. Estimate the urban population potentially exposed by 2050
 - *Present-day conditions and future climatic scenarios, with SSP scenario (2050)*

1. Environmental suitability in Europe

Data from existing models in Europe (7 present, 5 future)

Transform in binary scale (absence/presence)

Harmonize spatial resolution (25 km)

Identify common and divergent areas/patterns

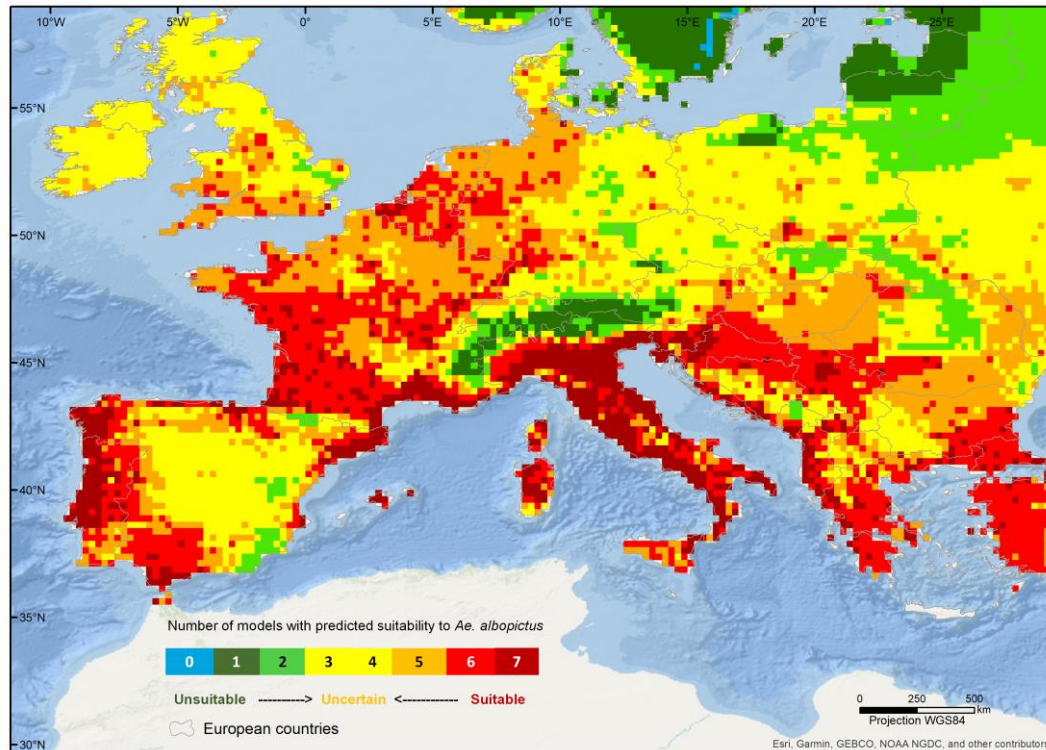
Classify consensus level and uncertainty

Identify future trajectories (2 timeframes)

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

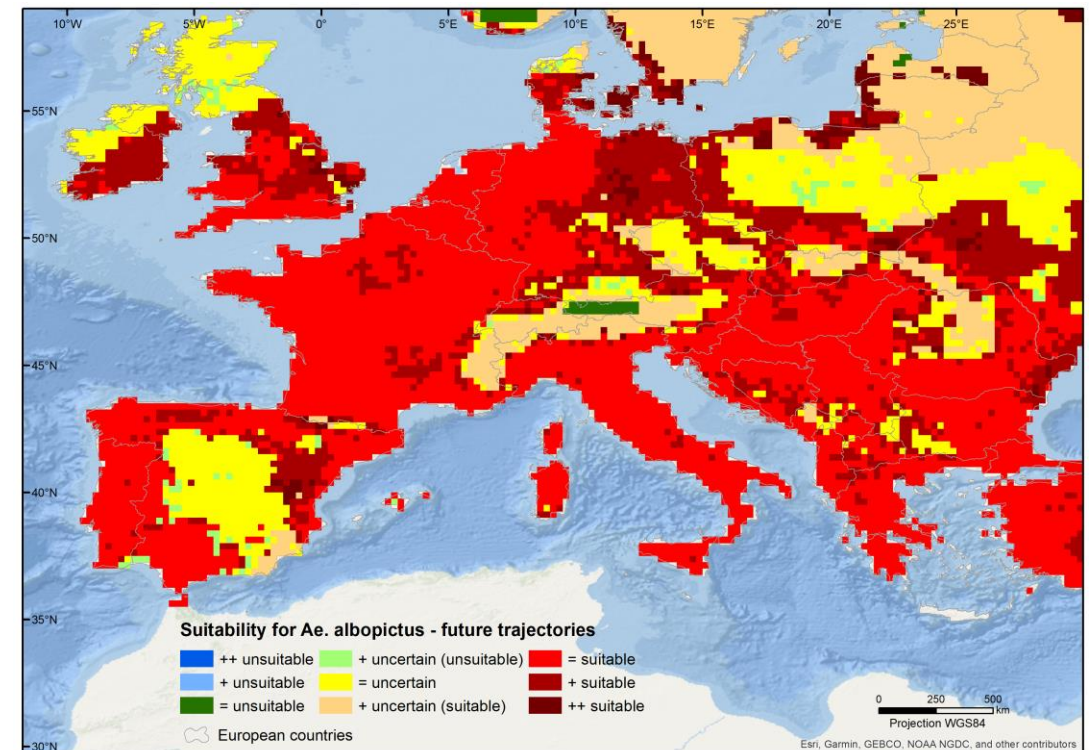
Categories	Present (7 models)	Future (5 models)
Unsuitable, low uncertainty	5 to 7 models agree unsuitable	4 to 5 models agree unsuitable
High uncertainty	Only 3 or 4 models agree	Only 2 or 3 models agree
Suitable, low uncertainty	5 to 7 models agree suitable	4 to 5 models agree suitable

1. Environmental suitability in Europe



Present conditions

Areas of high uncertainty (high disagreement between models) mainly in eastern Europe, northern Britain, Ireland and central Spain.

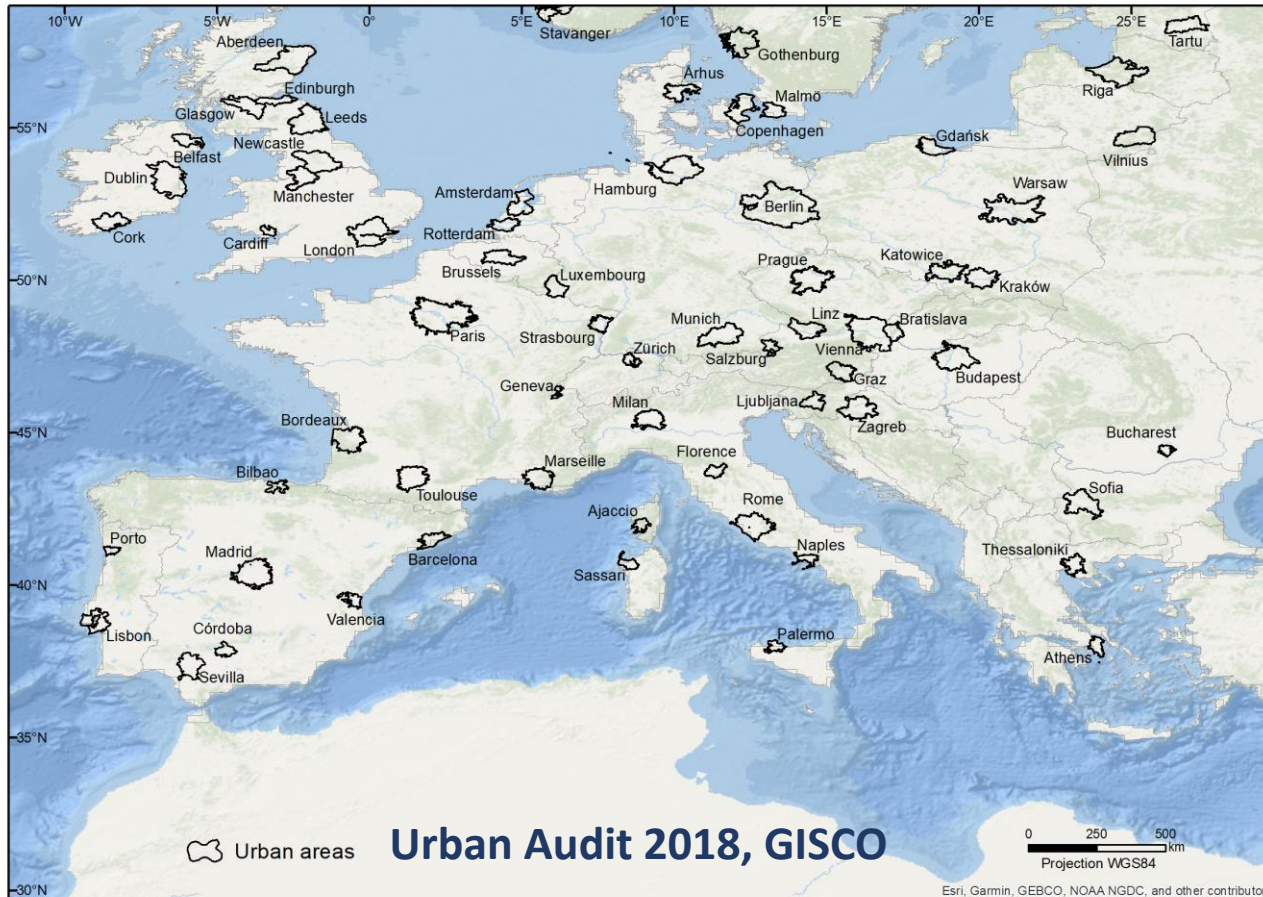


Future trajectories

Suitable regions will encompass 21% more area, adding to the 47% of the continent that is suitable nowadays.

2. Suitability in European 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 metropolitan areas

- Large metropolitan (above 1.5 million people)
- Metropolitan (250.000 to 1.5 million people)

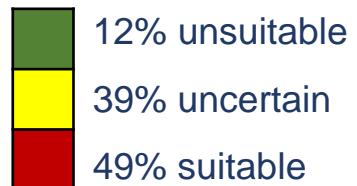
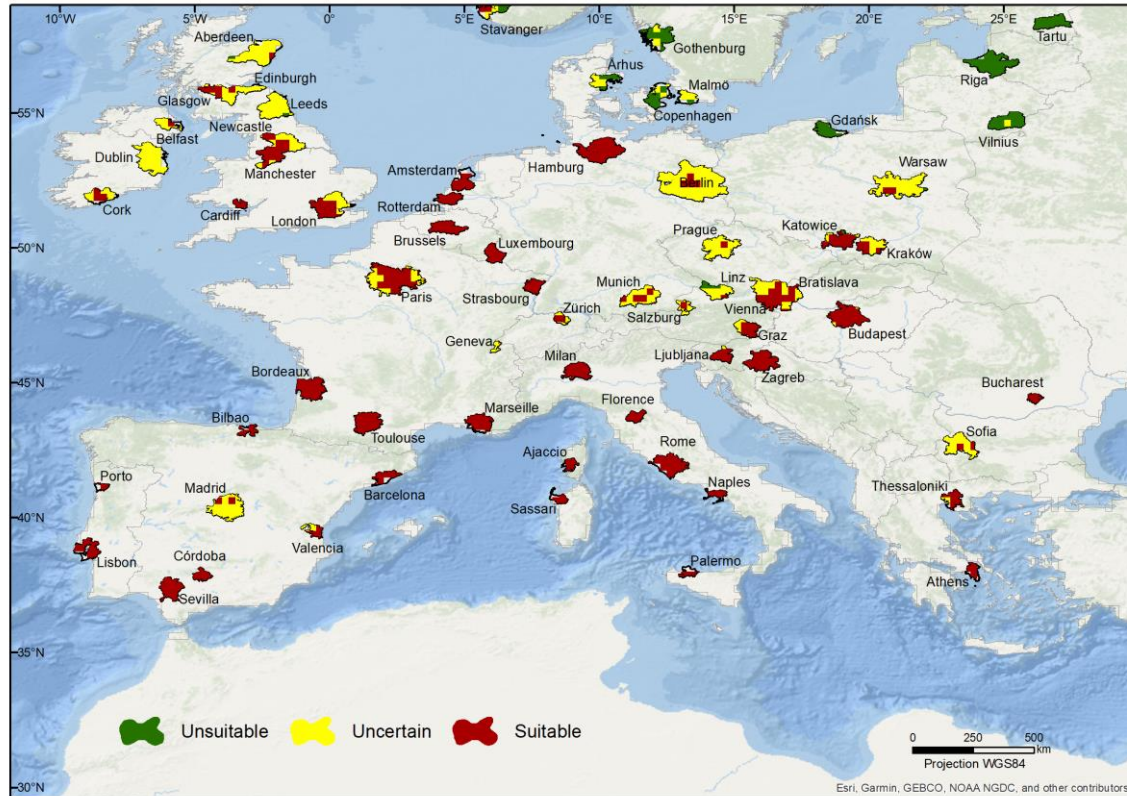
3 medium-size urban areas

- 3 medium areas (100.000 to 250.000 people), in Corsica, Sardinia and Estonia

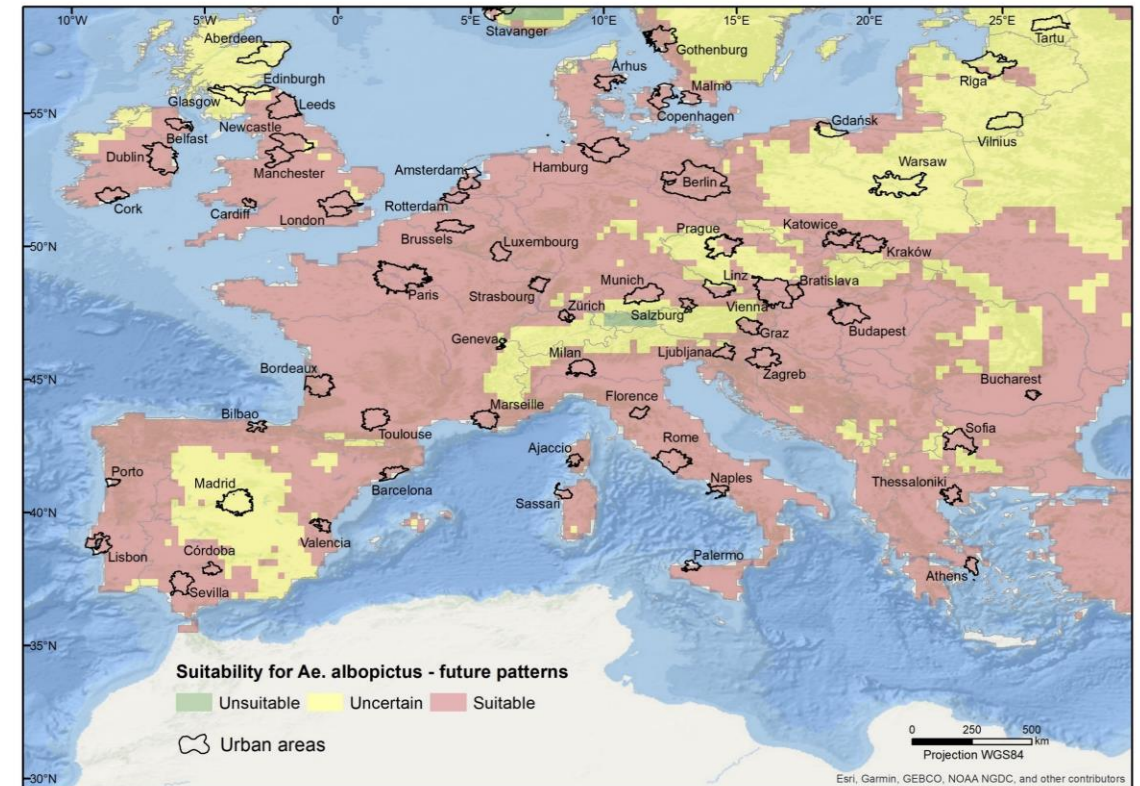
- Predominant class within FUA boundaries
- *Future worst-case scenario* – 1/3 urban area covered by a more unfavorable variation than given by the baseline

2. Suitability in European urban areas

Present conditions



Future conditions



2. Suitability in European urban areas

Main city (country)	P	F	Main city (country)	P	F	Main city (country)	P	F
Aberdeen (UK)	●	●	Glasgow (UK)	●	●	Prague (CZ)	●	●
Ajaccio (FR)	●	●	Gothenburg (SE)	●	●	Riga (LV)	●	●
Amsterdam (NL)	●	●	Graz (AT)	●	●	Rome (IT)	●	●
Århus (DK)	●	●	Hamburg (DE)	●	●	Rotterdam (NL)	●	●
Athens (EL)	●	●	Katowice (PL)	●	●	Salzburg (AT)	●	●
Barcelona (ES)	●	●	Kraków (PL)	●	●	Sassari (IT)	●	●
Belfast (UK)	●	●	Leeds (UK)	●	●	Sevilla (ES)	●	●
Berlin (DE)	●	●	Linz (AT)	●	●	Sofia (BG)	●	●
Bilbao (ES)	●	●	Lisbon (PT)	●	●	Stavanger (NO)	●	●
Bordeaux (FR)	●	●	Ljubljana (SI)	●	●	Strasbourg (FR)	●	●
Bratislava (SK)	●	●	London (UK)	●	●	Tartu (EE)	●	●
Brussels (BE)	●	●	Luxembourg (LU)	●	●	Thessaloniki (EL)	●	●
Bucharest (RO)	●	●	Madrid (ES)	●	●	Toulouse (FR)	●	●
Budapest (HU)	●	●	Malmö (SE)	●	●	Valencia (ES)	●	●
Cardiff (UK)	●	●	Manchester (UK)	●	●	Vienna (AT)	●	●
Copenhagen	●	●	Marseille (FR)	●	●	Vilnius (LT)	●	●
Cordoba (ES)	●	●	Milan (IT)	●	●	Warsaw (PL)	●	●
Cork (IE)	●	●	Munich (DE)	●	●	Zagreb (HR)	●	●
Dublin (IE)	●	●	Naples (IT)	●	●	Zürich (CH)	●	●
Edinburgh (UK)	●	●	Newcastle	●	●			
Florence (IT)	●	●	Oporto (PT)	●	●			
Gdansk (PL)	●	●	Palermo (IT)	●	●			
Geneva (CH)	●	●	Paris (FR)	●	●			

Unsuitable ●
 Uncertain ●
 Suitable ●

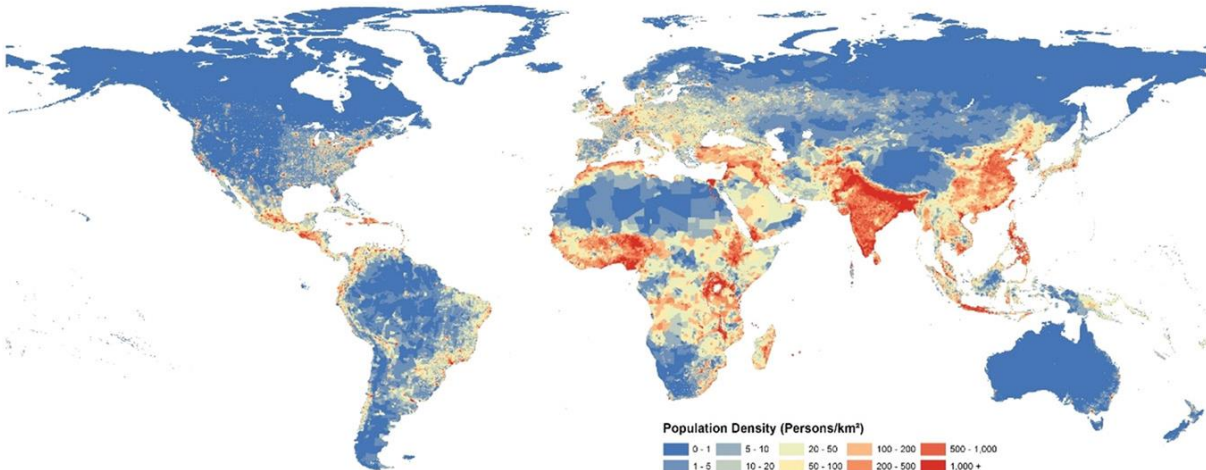
- Cities located in northern Europe expected to undergo the most severe changes (from unsuitable to suitable)
Arhus, Copenhagen, Gothenburg, Stavanger
- Cities of central Europe, Great Britain and Ireland are expected to become suitable (from uncertain today)
Berlin, Dublin, Geneva, London, Prague, Vienna
- Uncertainty remains in the future for cities such as:
Edinburgh, Madrid, Munich, Warsaw

3. Urban population exposed in 2050

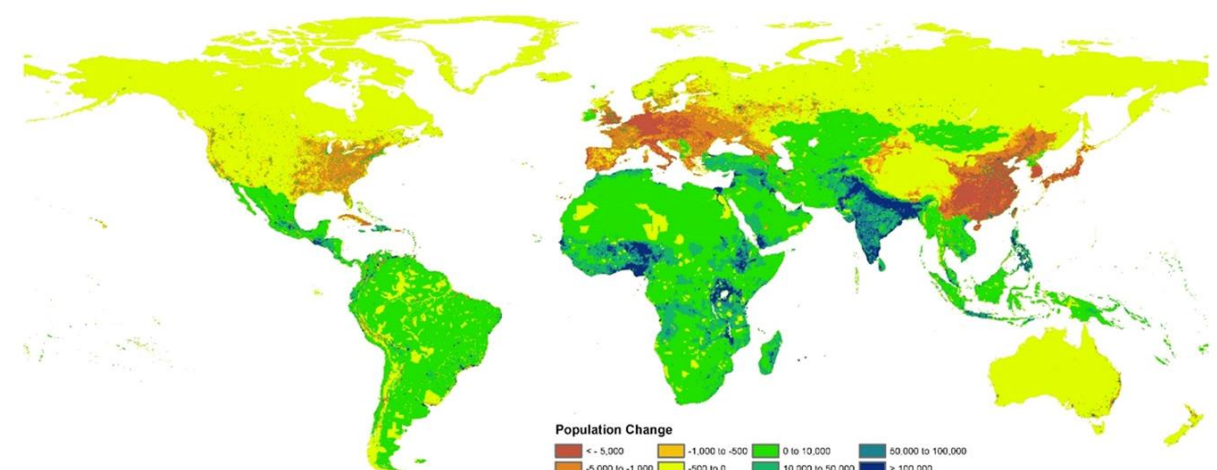
Shared Socioeconomic Pathways (SSP) - Future pathways of societal development

- **5 alternative outcomes** for trends in demographics, economics, technological development, lifestyles, governance...
- Provide **quantitative projections of key elements**, including national level population growth, educational composition, urbanization, and economic growth.

Population density



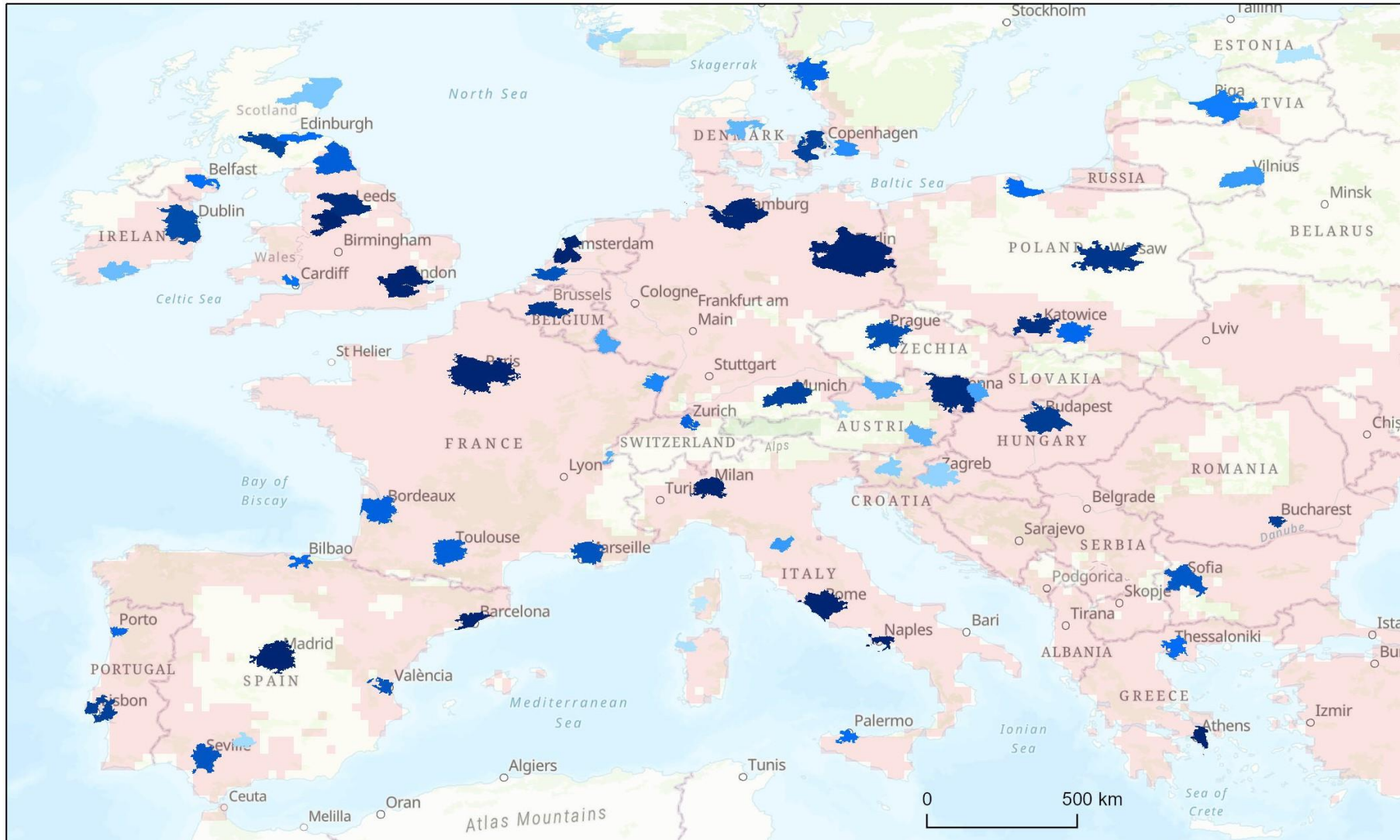
Population change



SSP3 - intermediate level of growth regarding demographics, economics, technology, governance (Gao, 2020; Jones & O'Neill, 2016).

Data from **Global Population Grid (1 km)** - <https://sedac.ciesin.columbia.edu/data/set/popdynamics-1-km-downscaled-pop-base-year-projection-ssp-2000-2100-rev01>

3. Urban population exposed in 2050



Suitable cities present
~60 million

Suitable cities future (2050)
~110 million

- Paris - 14 million
- London – 12 million
- Barcelona – 4.8 million
- Berlin – 4.7 million
- Milan – 4.6 million
- Valencia – 1.7 million
- Porto – 1.2 million

2020 – 60 million

2050 – 110 million

In Europe, the increase in exposure is caused by changes in environmental suitability, it's not due to population growth.

What can we do to protect our cities and urban dwellers?

- ✓ Surveillance and monitoring of the species (ports, ground transport, airports)
- ✓ Integrate vector-borne diseases in public health policies
- ✓ Improve community awareness for potential exposure
- ✓ Adapt urban areas (reshape water reservoirs, control microhabitats, larvae control)

Gracias!
Thank you!

