Cascading risks from climate change for infectious diseases in Europe

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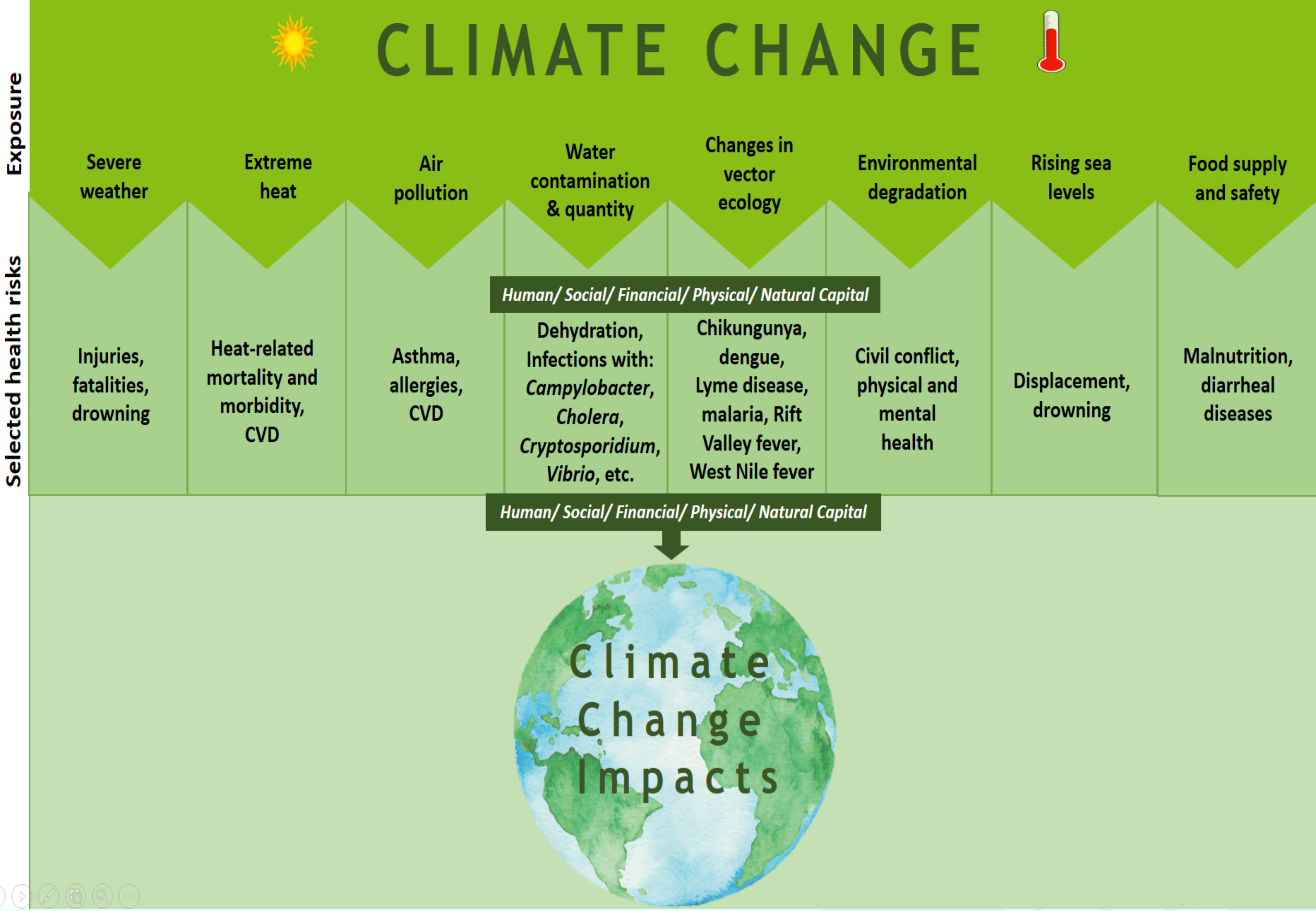
European Centre for Disease Prevention and Control



CLIMATE CHANGE

Exposure	Severe weather	Extreme heat	Air pollution	Water contamination & quantity	Changes in vector ecology	Environmental degradation	Rising sea levels	Food supply and safety
Selected health risks	Injuries, fatalities, drowning	Heat-related mortality and morbidity, CVD	Asthma, allergies, CVD	Dehydration, Infections with: *Campylobacter*, *Cholera*, *Cryptosporidium*, *Vibrio*, etc.	Chikungunya, dengue, Lyme disease, malaria, Rift Valley fever, West Nile fever	Civil conflict, physical and mental health	Displacement, drowning	Malnutrition, diarrheal diseases

Human/ Social/ Financial/ Physical/ Natural Capital

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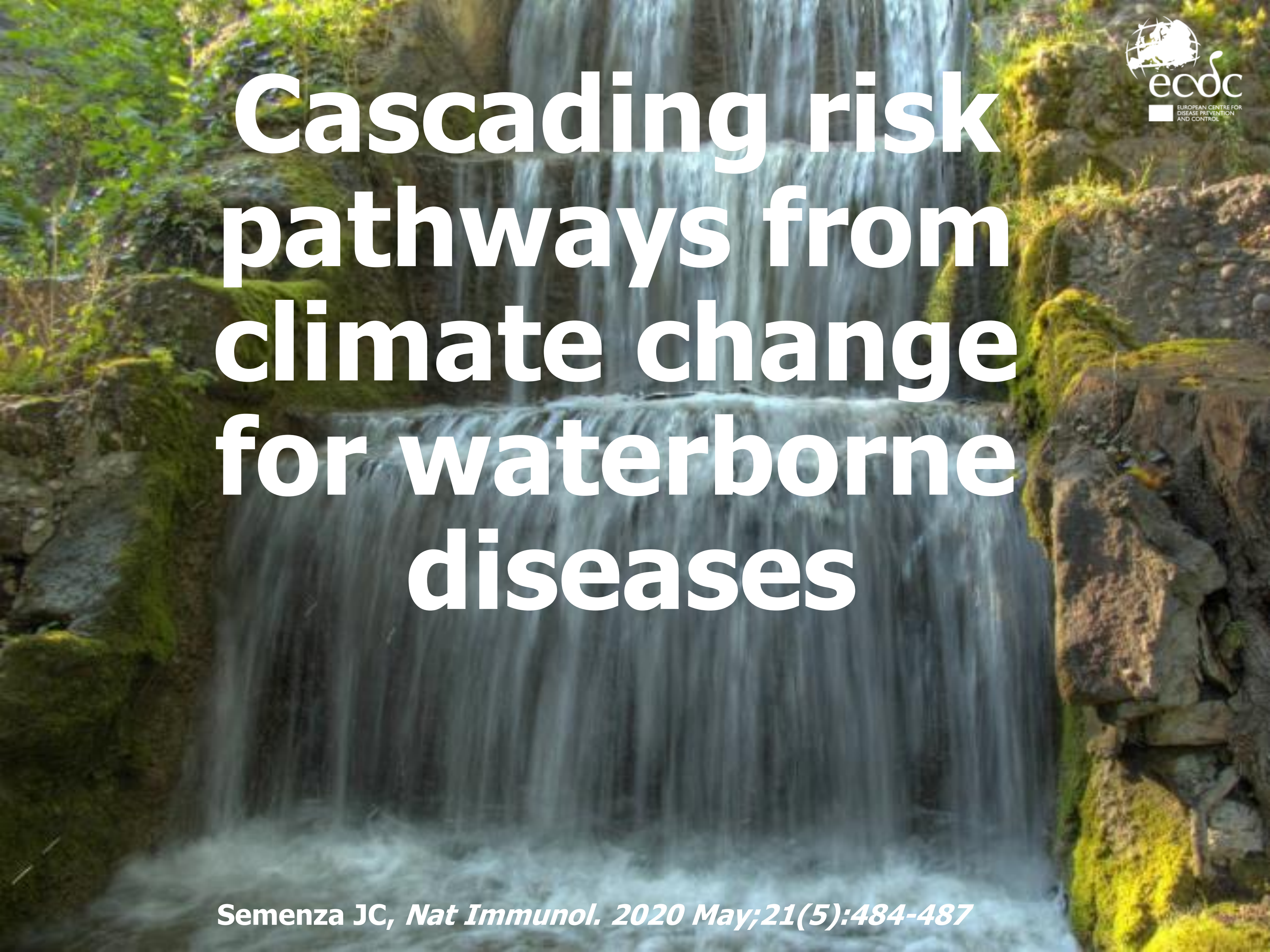
Climate Change Impacts

Semenza JC, Ebi KL. *J Travel Med.* 2019;26(5).



Cascading risk pathways from climate change for waterborne diseases

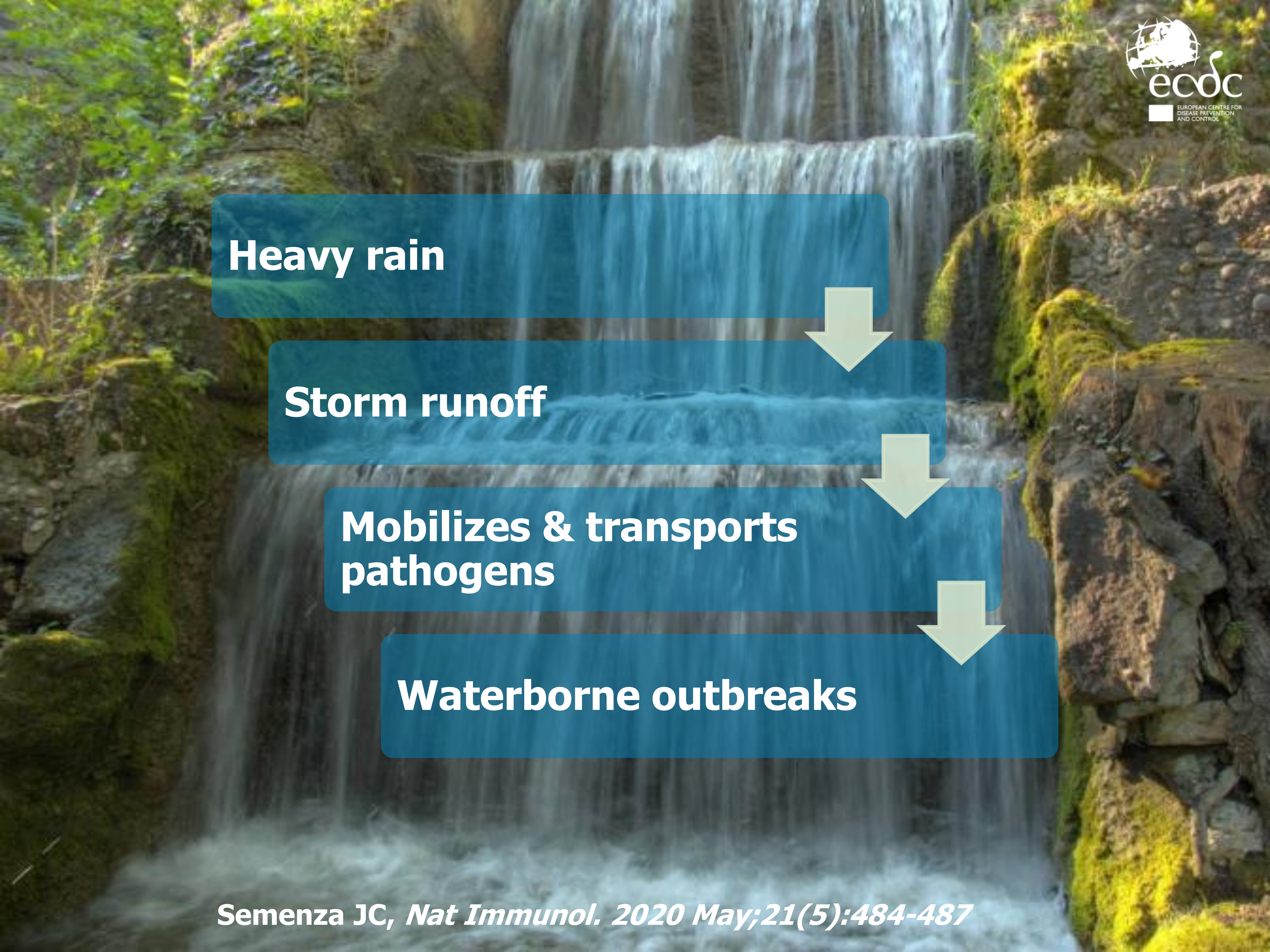
Semenza JC, *Nat Immunol. 2020 May;21(5):484-487*

Cascading risks from climate change for waterborne diseases

- A heavy rain event can potentially trigger a **cascading event** with other consequences of **significant magnitude**, even larger than the initial rain event.

- Such cascading effects are a function of the magnitude of the **existing vulnerabilities** in society rather than of the **initial hazard**.

Semenza JC, *Nat Immunol. 2020 May;21(5):484-487*



Heavy rain

Storm runoff

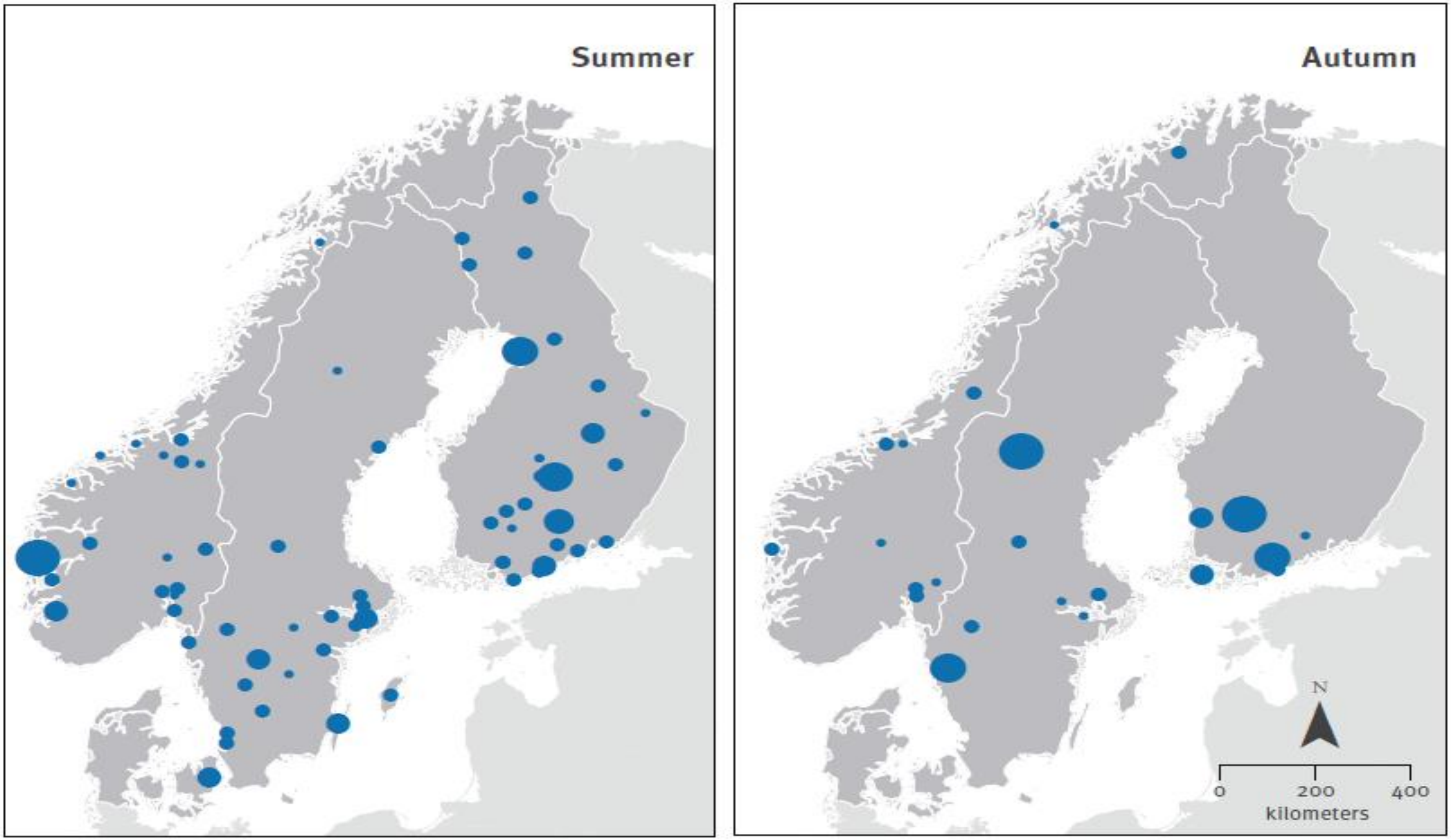
Mobilizes & transports pathogens

Waterborne outbreaks

Semenza JC, *Nat Immunol. 2020 May;21(5):484-487*

Semenza JC, *Nat Immunol. 2020 May;21(5):484-487*

Seasonal distribution of waterborne outbreaks by size of outbreak, Denmark, Finland, Norway and Sweden, 1998–2012



Guzman-Herrador B, *Euro Surveill*. 2015;20(24):pii=21160.

Association between heavy precipitation events and waterborne outbreaks in four Nordic countries, 1992–2012

- Matched case-control study

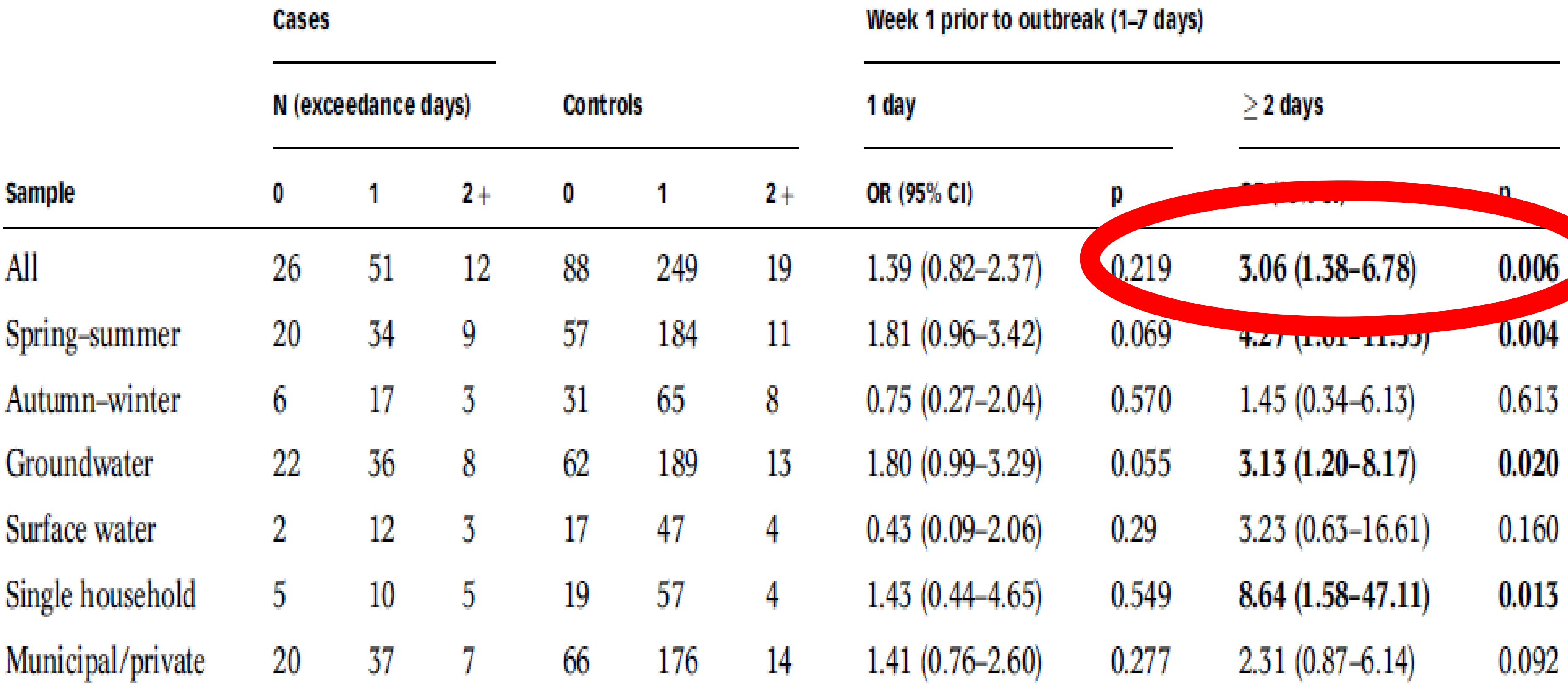
- Epidemiological registries of waterborne **outbreaks**

- **Meteorological** data between 1992 and 2012 from four Nordic countries:
  - Central Weather Station
  - Gridded precipitation data

- **Heavy precipitation** events were defined by above average (exceedance: **95 percentile**) daily rainfall during the preceding week using local references

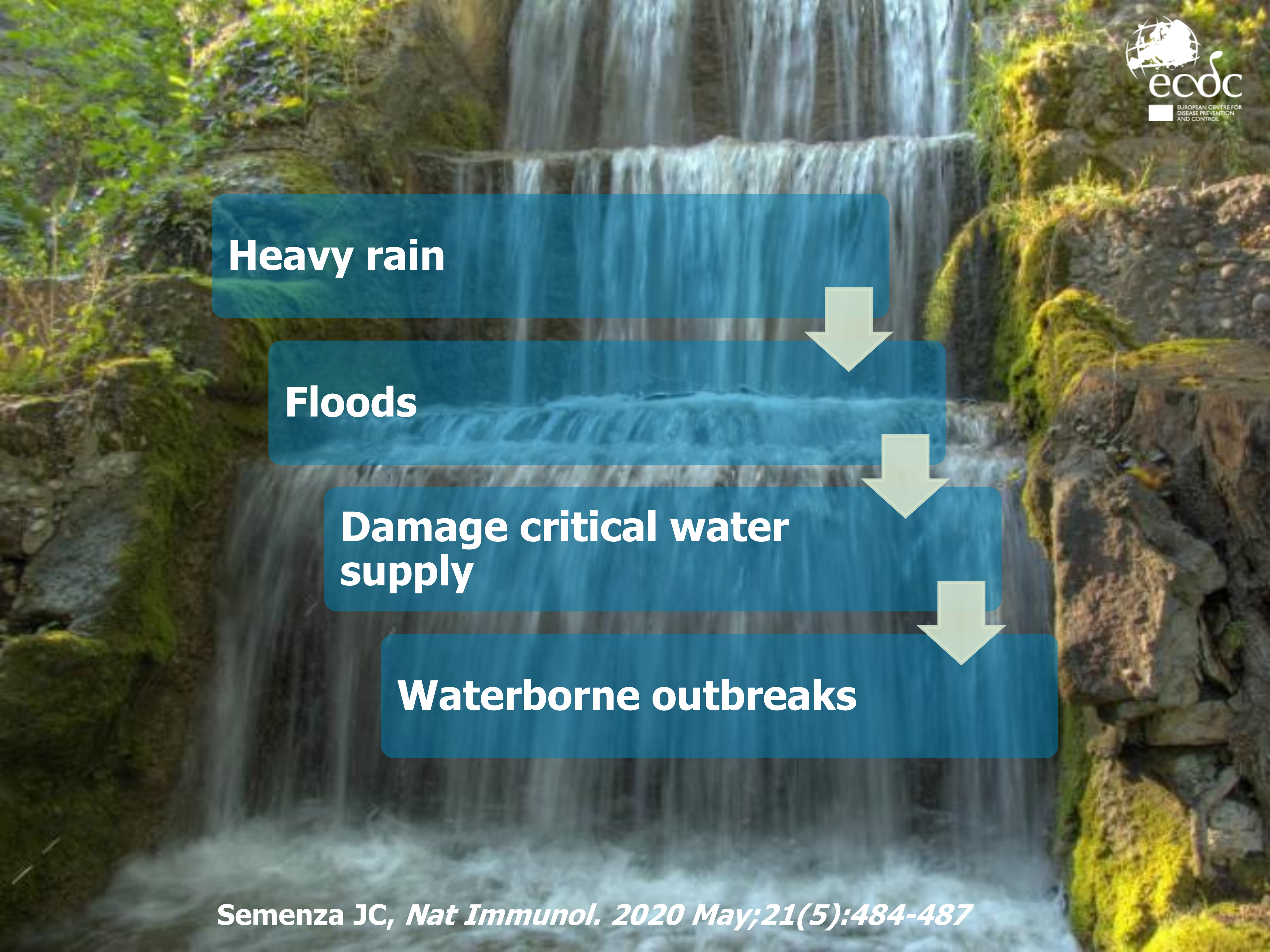
Guzman-Herrador B, ***J of Water and Health*** **2016;14(6):1019-1027**

Association between waterborne outbreaks and exceedance precipitation during the previous week



	Cases						Week 1 prior to outbreak (1–7 days)			
	N (exceedance days)			Controls			1 day		≥ 2 days	
Sample	0	1	2+	0	1	2+	OR (95% CI)	p	OR (95% CI)	p
All	26	51	12	88	249	19	1.39 (0.82–2.37)	0.219	**3.06 (1.38–6.78)**	**0.006**
Spring–summer	20	34	9	57	184	11	1.81 (0.96–3.42)	0.069	**4.27 (1.61–11.33)**	**0.004**
Autumn–winter	6	17	3	31	65	8	0.75 (0.27–2.04)	0.570	1.45 (0.34–6.13)	0.613
Groundwater	22	36	8	62	189	13	1.80 (0.99–3.29)	0.055	**3.13 (1.20–8.17)**	**0.020**
Surface water	2	12	3	17	47	4	0.43 (0.09–2.06)	0.29	3.23 (0.63–16.61)	0.160
Single household	5	10	5	19	57	4	1.43 (0.44–4.65)	0.549	**8.64 (1.58–47.11)**	**0.013**
Municipal/private	20	37	7	66	176	14	1.41 (0.76–2.60)	0.277	2.31 (0.87–6.14)	0.092

Guzman-Herrador B, *J of Water and Health* 2016;14(6):1019-1027



Heavy rain

↓

Floods

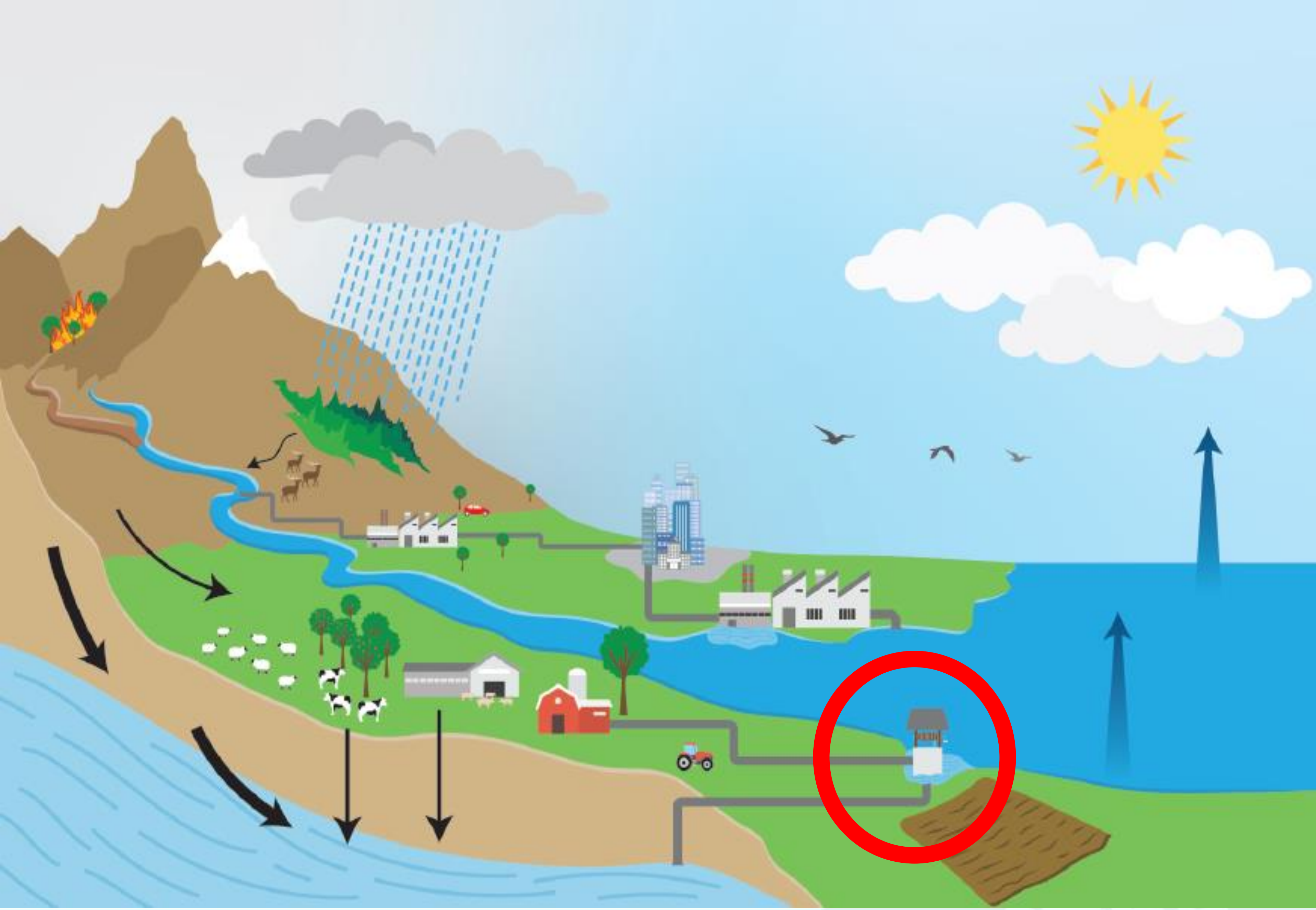
↓

Damage critical water supply

↓

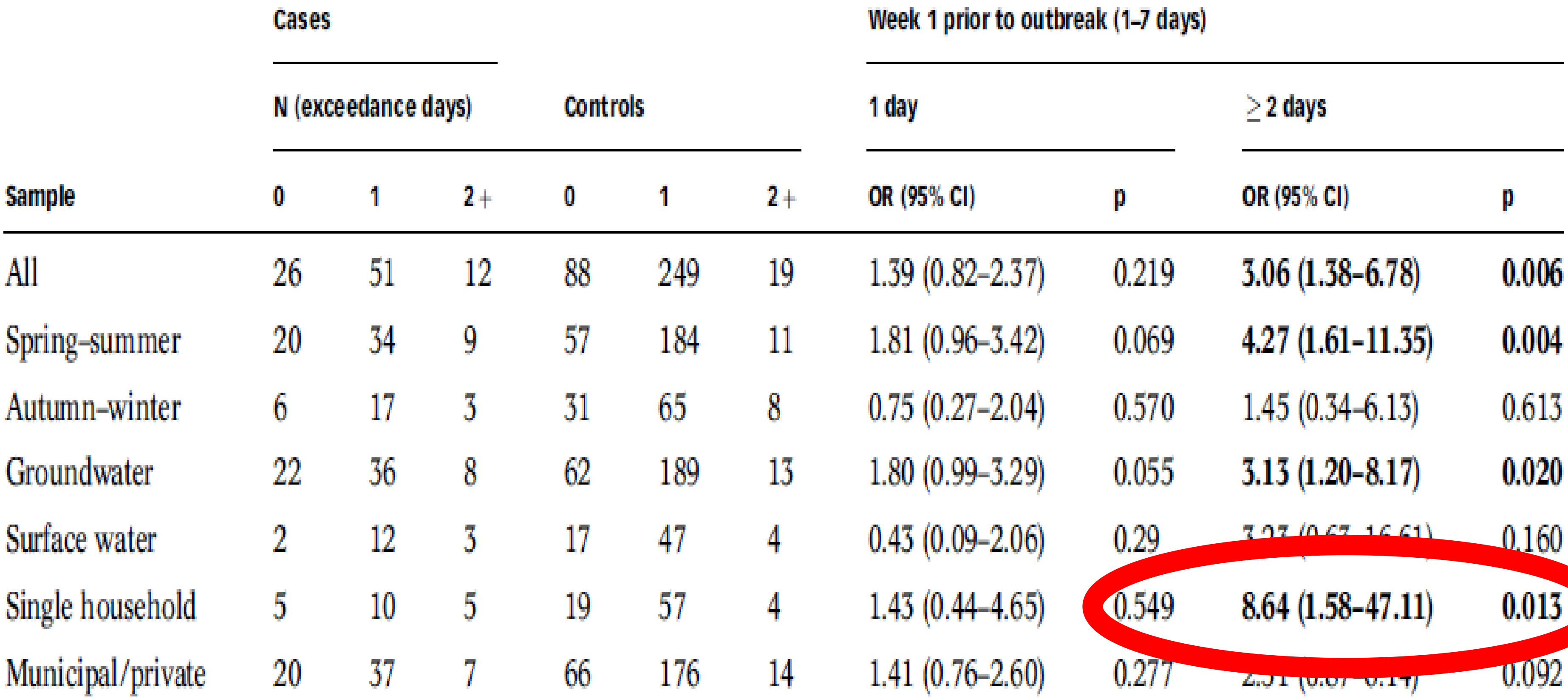
Waterborne outbreaks

Semenza JC, *Nat Immunol. 2020 May;21(5):484-487*



Semenza JC, ***Nat Immunol. 2020 May;21(5):484-487***

Association between waterborne outbreaks and exceedance precipitation during the previous week



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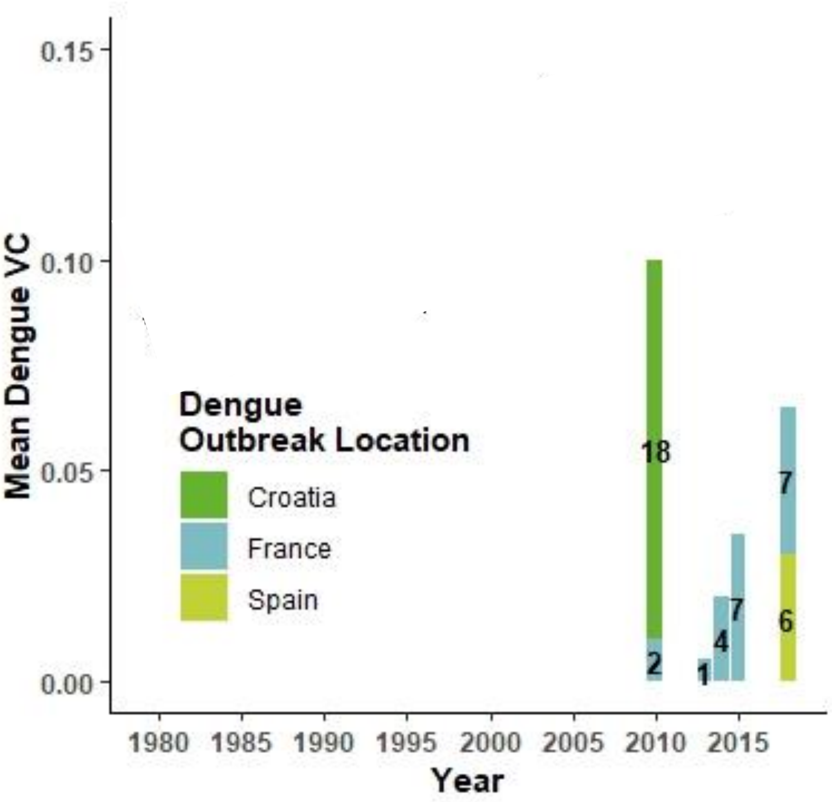
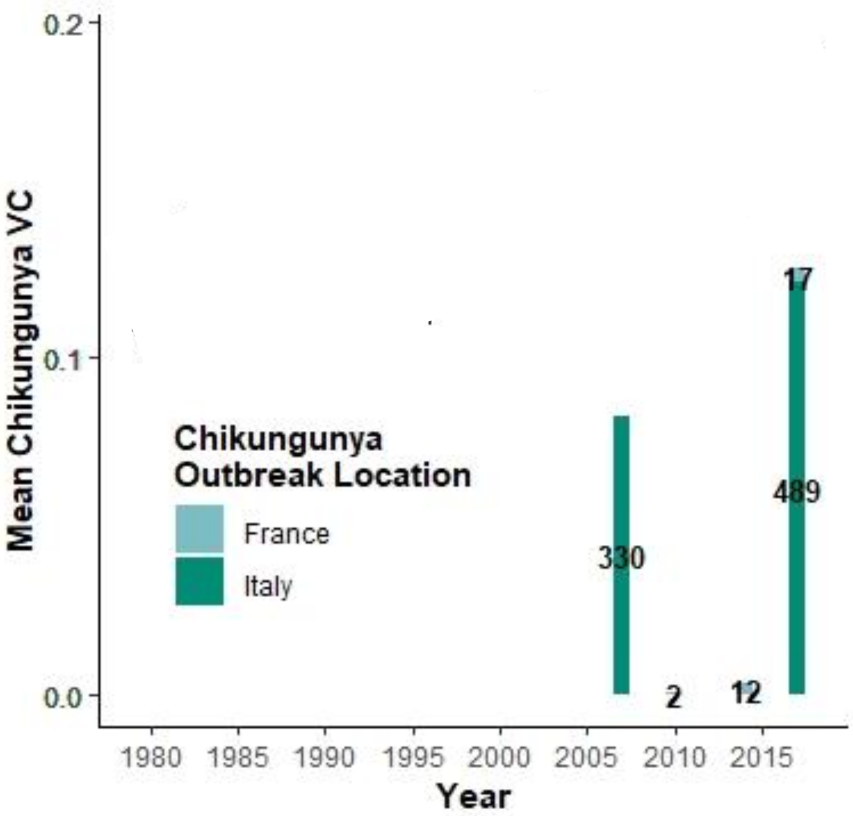
Guzman-Herrador B, *J of Water and Health* 2016;14(6):1019-1027

Cascading risk pathways from climate change for vector-borne diseases

ecdc
EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

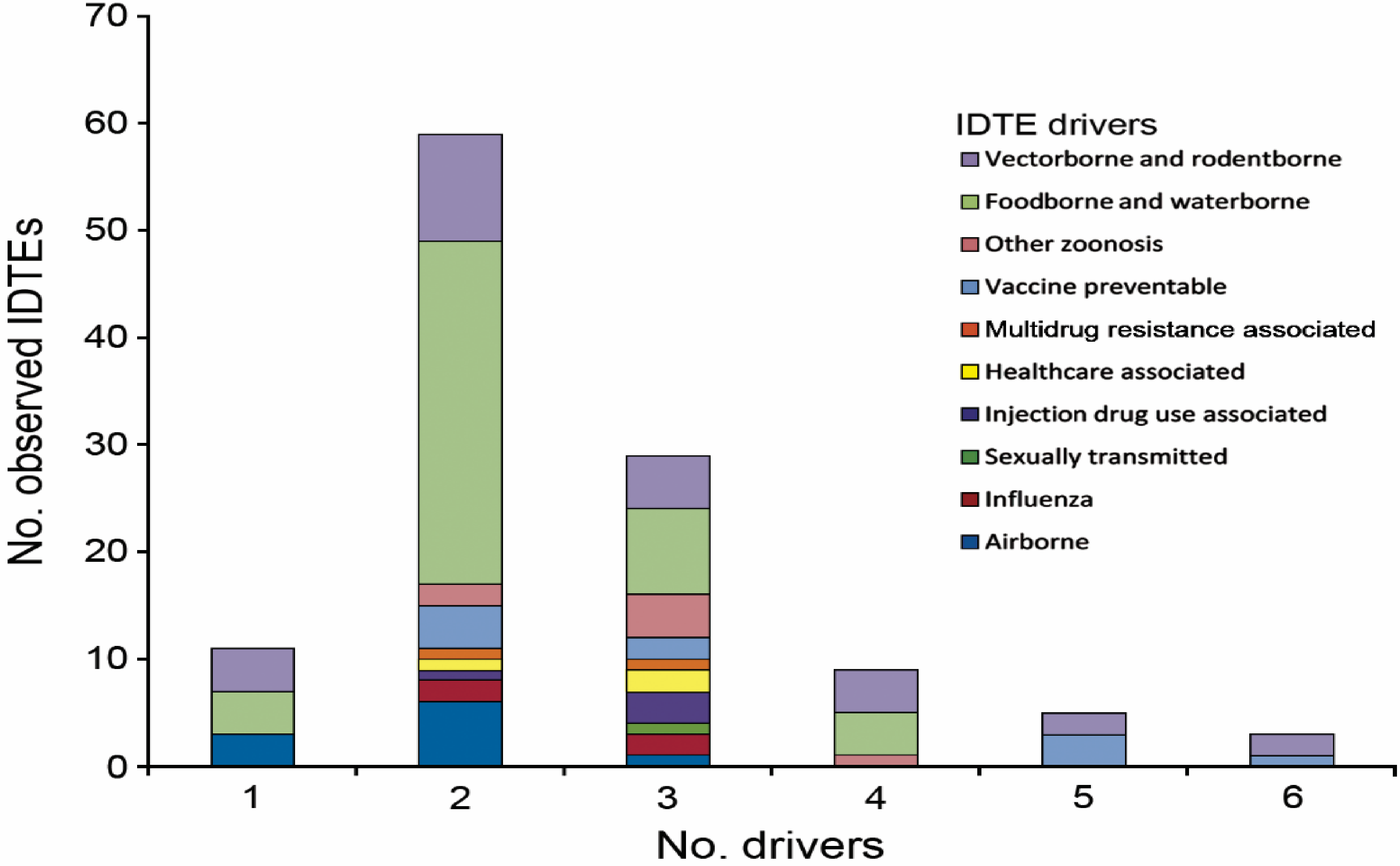
Have dengue and chikungunya outbreaks in Europe increased due to the warming climate?





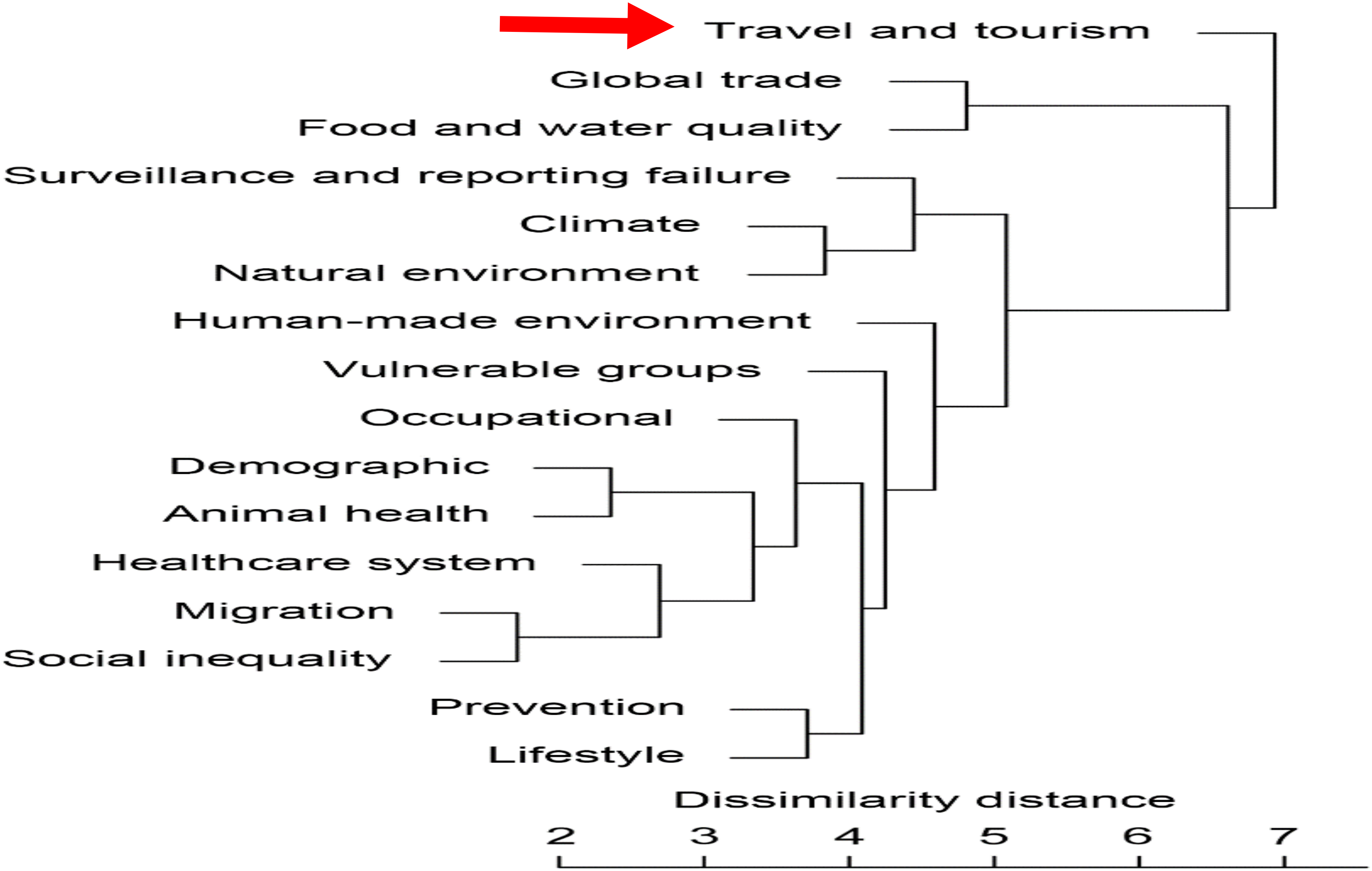
Lillepold K, et al., *J Travel Med.* 2019 Jun 11;26(5).

Number of drivers for infectious disease threat events (IDTE), Europe 2008-2013



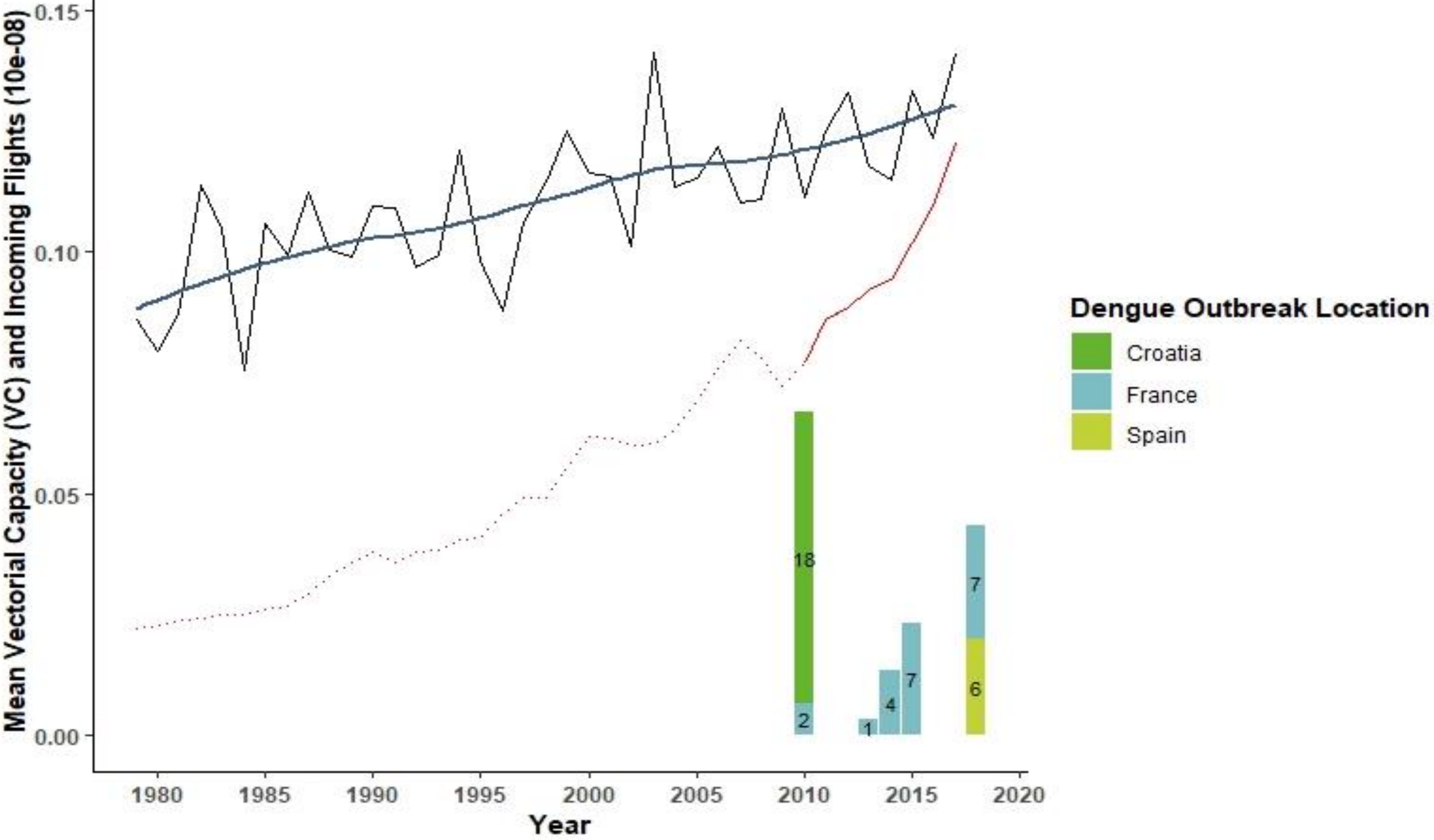
Semenza JC, et al. *Emerging Infectious Diseases*. 2016; 22(4):581-589.

Cluster dendrogram from hierarchical cluster analysis of drivers of IDTE, Europe 2008-2013



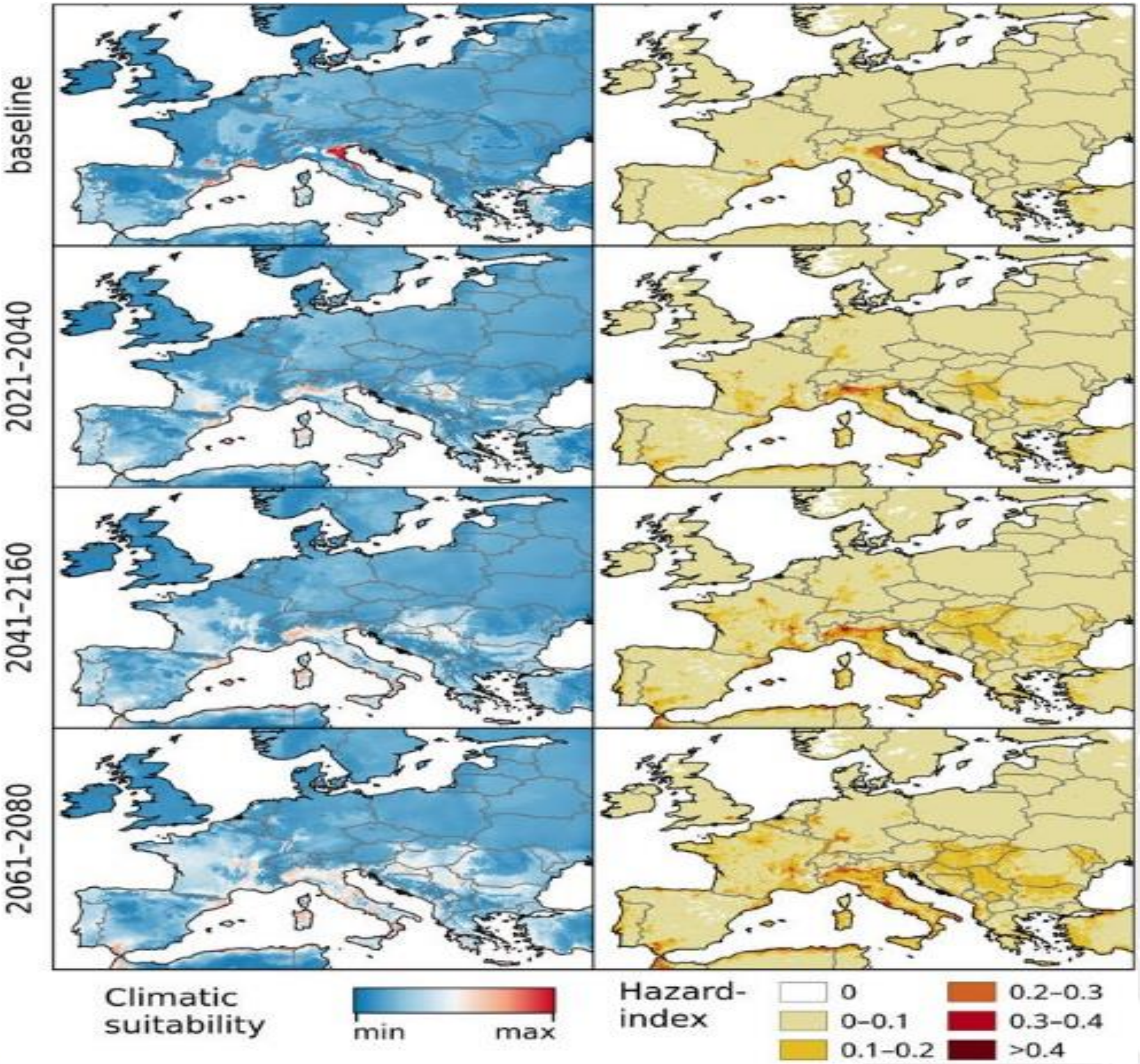
Semenza JC, et al. *Emerging Infectious Diseases*. 2016; 22(4):581-589.

Air passenger volume from dengue active areas internationally



Lillepold K, et al., *J Travel Med.* 2019 Jun 11;26(5).

Chikungunya under the baseline and RCP 8.5 climate change scenarios in Europe



Tjaden NB et al., *Sci Rep*. 2017 Jun 19;7(1):3813

Mosquito-borne diseases
Future projections

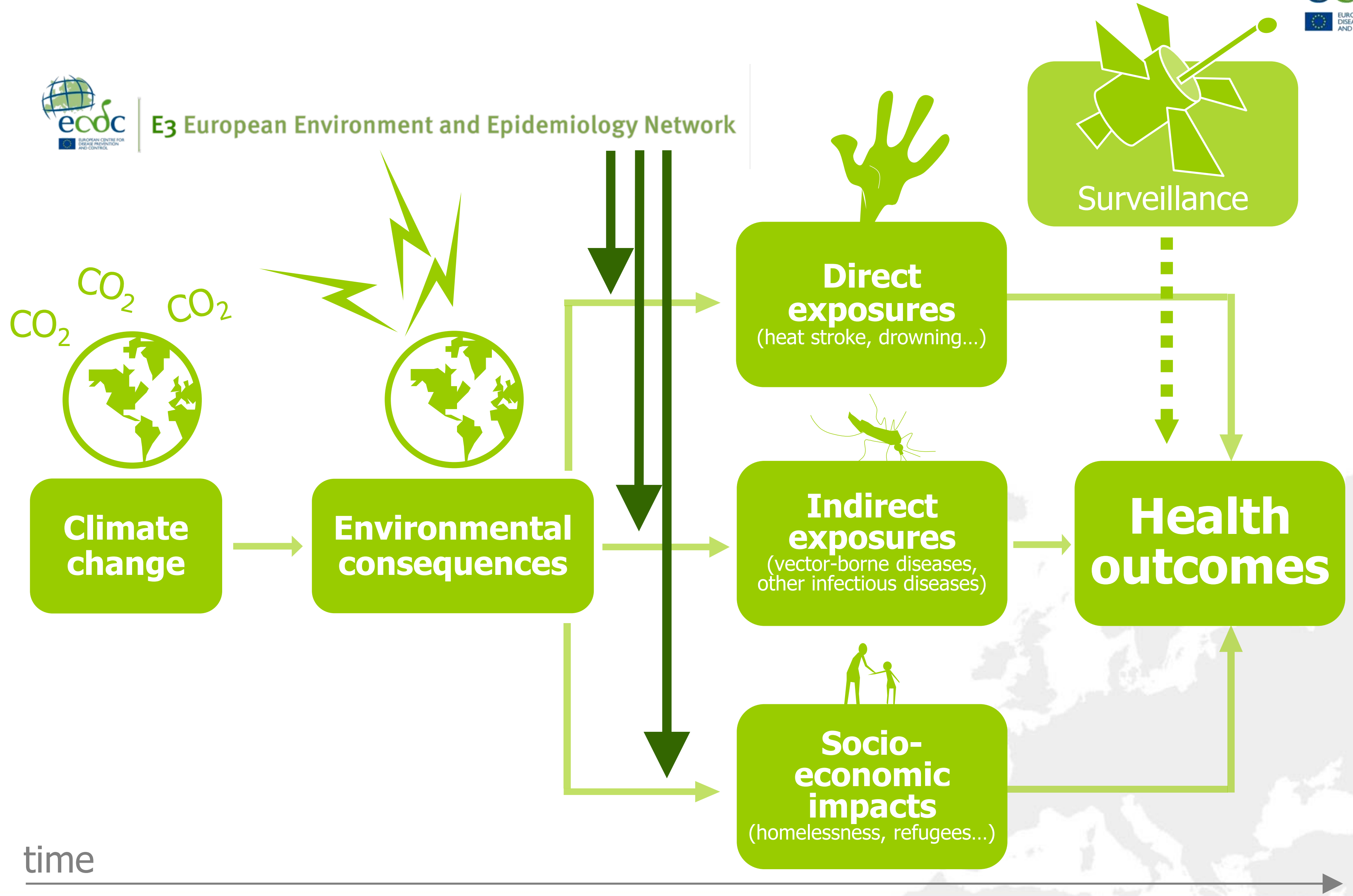
Models have generally projected a **moderate climatic suitability** for chikungunya transmission, notably across France, Spain, Germany and Italy, with increased suitability projected for large areas by the Rhine and Rhone rivers

Some areas by the Adriatic coast in Italy are projected to experience a **decline in suitability** due to the increased probability of summer droughts

Tjaden NB et al., *Sci Rep*. 2017 Jun 19;7(1):3813

Early warning system

E3 European Environment and Epidemiology Network



CO_2 CO_2 CO_2

Climate change

Environmental consequences

Direct exposures
(heat stroke, drowning…)

Indirect exposures
(vector-borne diseases, other infectious diseases)

Socio-economic impacts
(homelessness, refugees…)

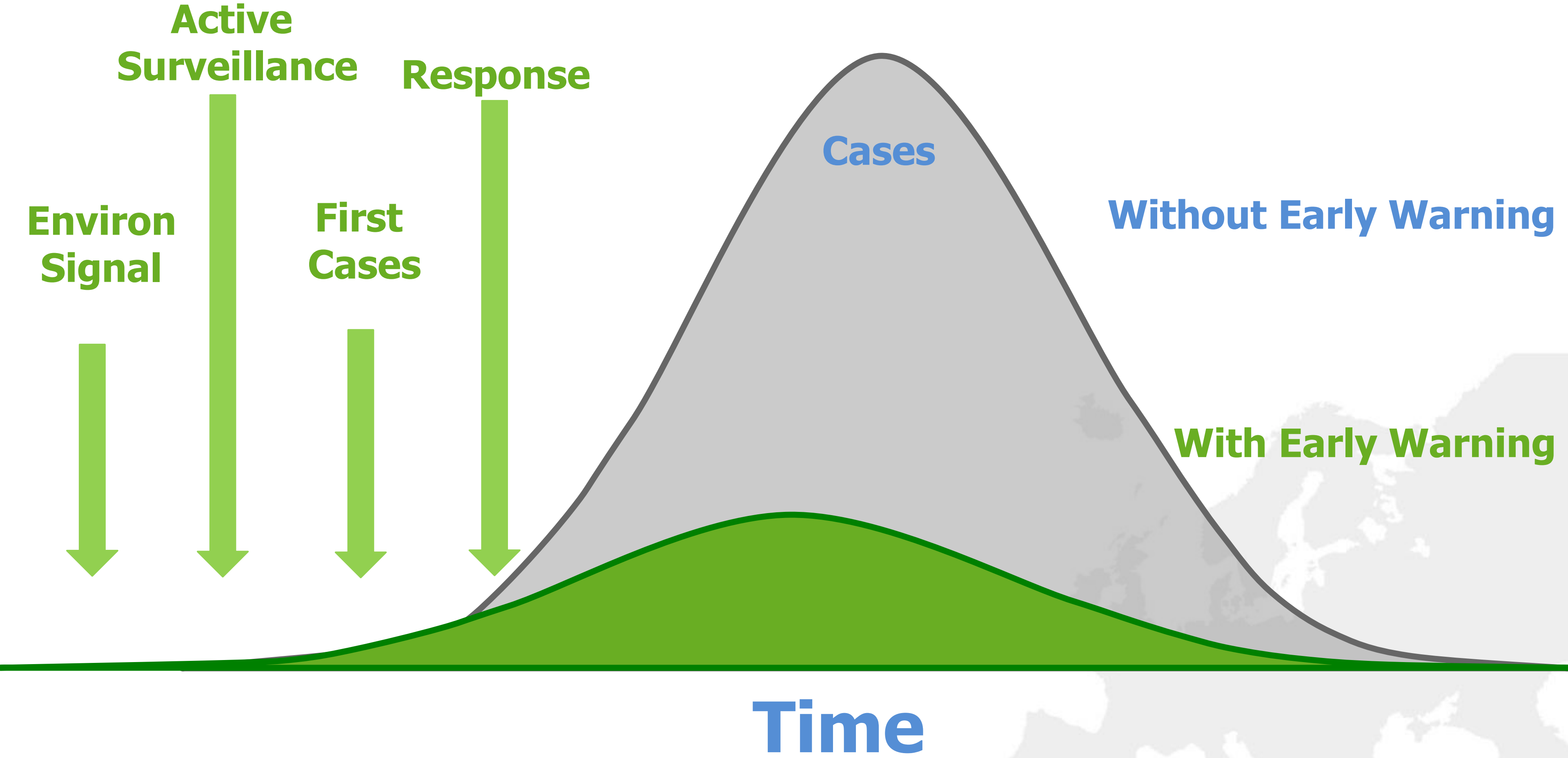
Surveillance

Health outcomes

time

Semenza JC. *Int. J. Environ. Res. Public Health*. 2015;12(6):6333-51

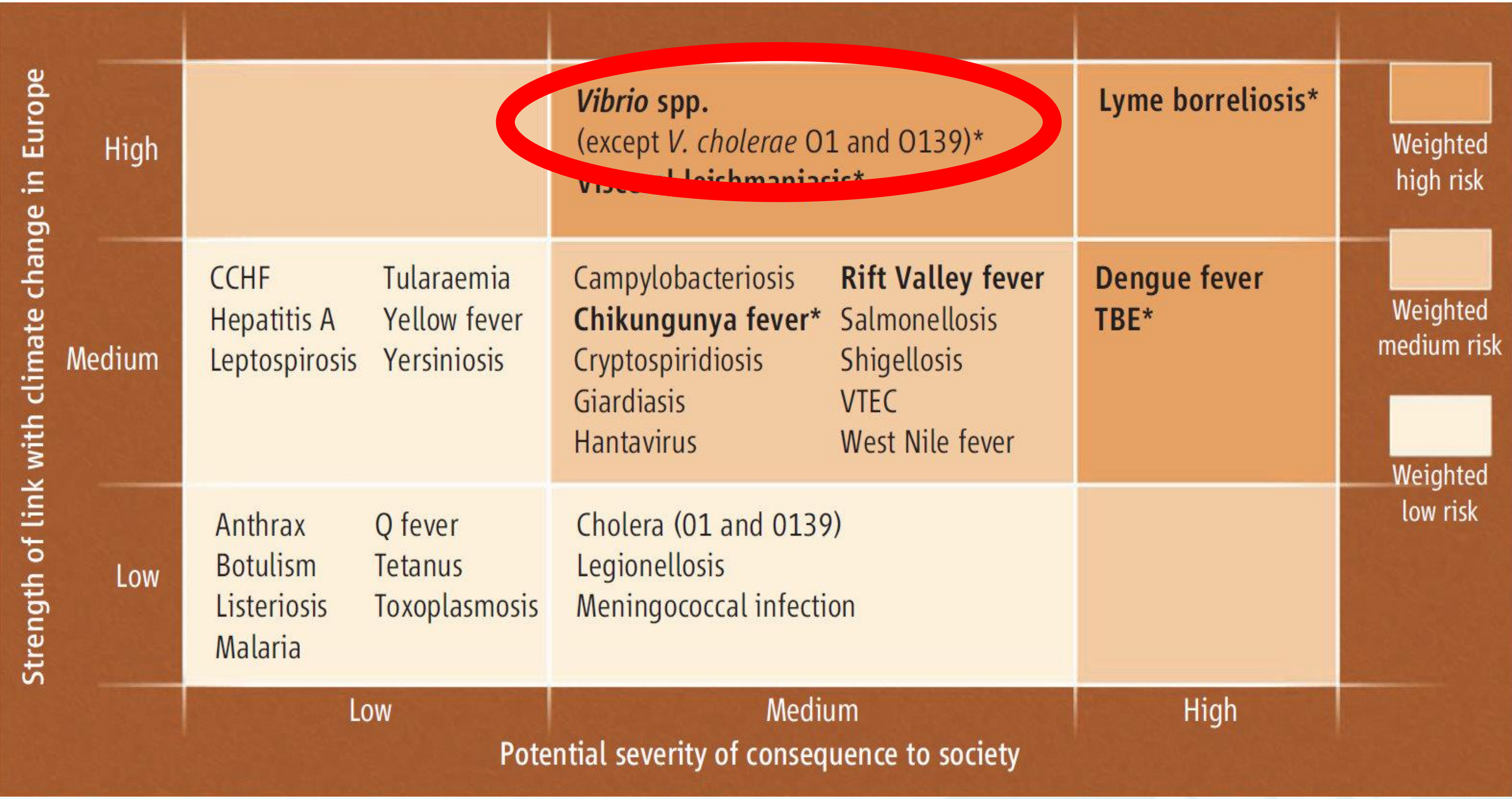
Early warning system
Environmental/climatic precursors of disease



Semenza JC, *Nat Immunol. 2020 May;21(5):484-487*

Weighted risk analysis of climate change impacts on infectious disease risks in Europe

IDs for suggested changes to disease-specific surveillance are in bold.
Asterisks indicate diseases currently notifiable in some EU Member States



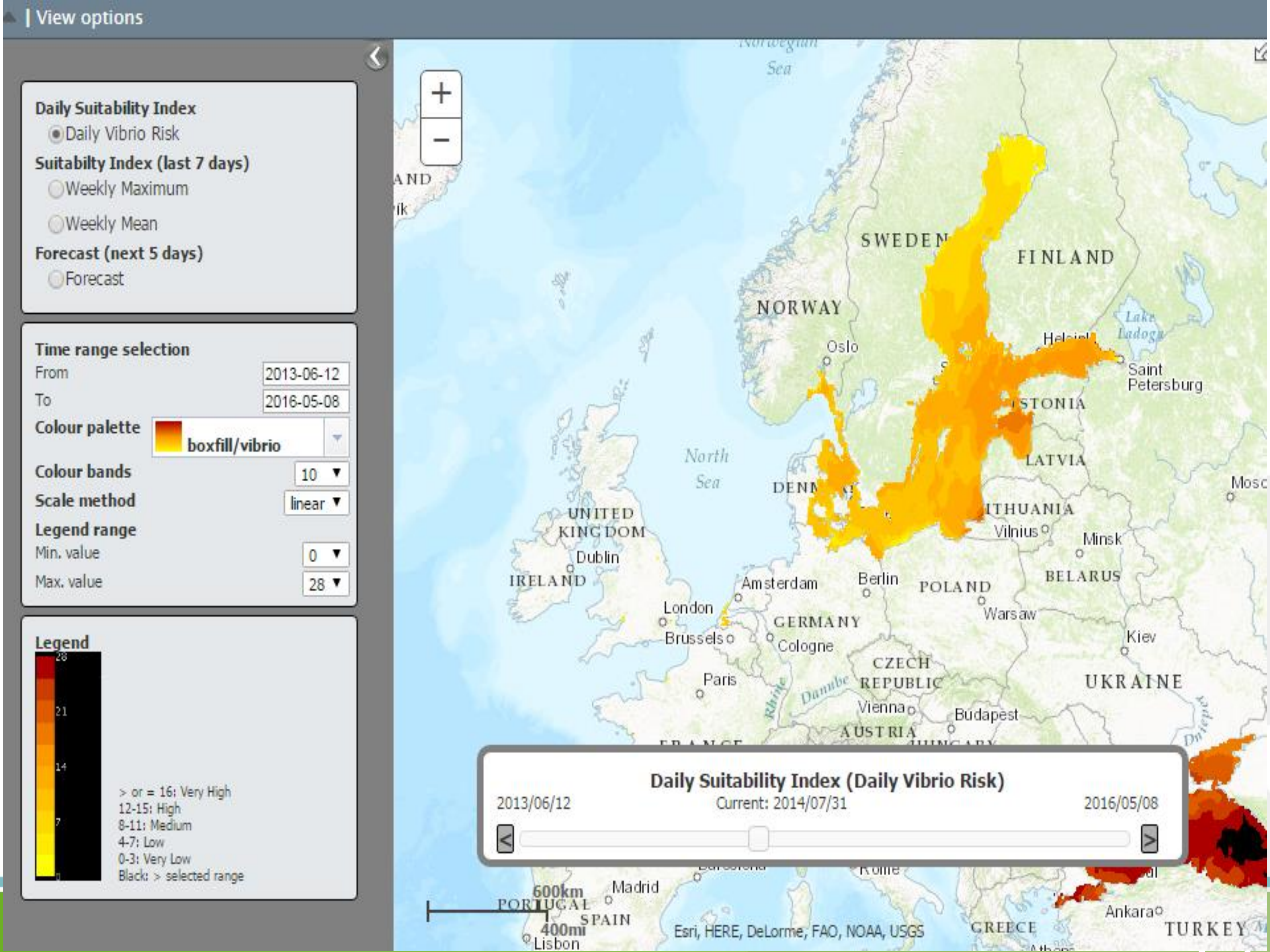
Strength of link with climate change in Europe

	Low	Medium	High
High		***Vibrio* spp.** (except *V. cholerae* 01 and 0139)* **Visceral leishmaniasis***	**Lyme borreliosis***
Medium	CCHF Hepatitis A Leptospirosis Tularaemia Yellow fever Yersiniosis	Campylobacteriosis **Chikungunya fever*** Cryptospiridiosis Giardiasis Hantavirus **Rift Valley fever** Salmonellosis Shigellosis VTEC West Nile fever	**Dengue fever** **TBE***
Low	Anthrax Botulism Listeriosis Malaria Q fever Tetanus Toxoplasmosis	Cholera (01 and 0139) Legionellosis Meningococcal infection	

Potential severity of consequence to society

🟧 Weighted high risk
🟫 Weighted medium risk
⬜ Weighted low risk

Lindgren E et al., *Science*. 2012;336(6080):418-9.



View options

Daily Suitability Index

● Daily Vibrio Risk

Suitabilty Index (last 7 days)

○ Weekly Maximum

○ Weekly Mean

Forecast (next 5 days)

○ Forecast

Time range selection

From 2013-06-12

To 2016-05-08

Colour palette boxfill/vibrio

Colour bands 10

Scale method linear

Legend range

Min. value 0

Max. value 28

Legend

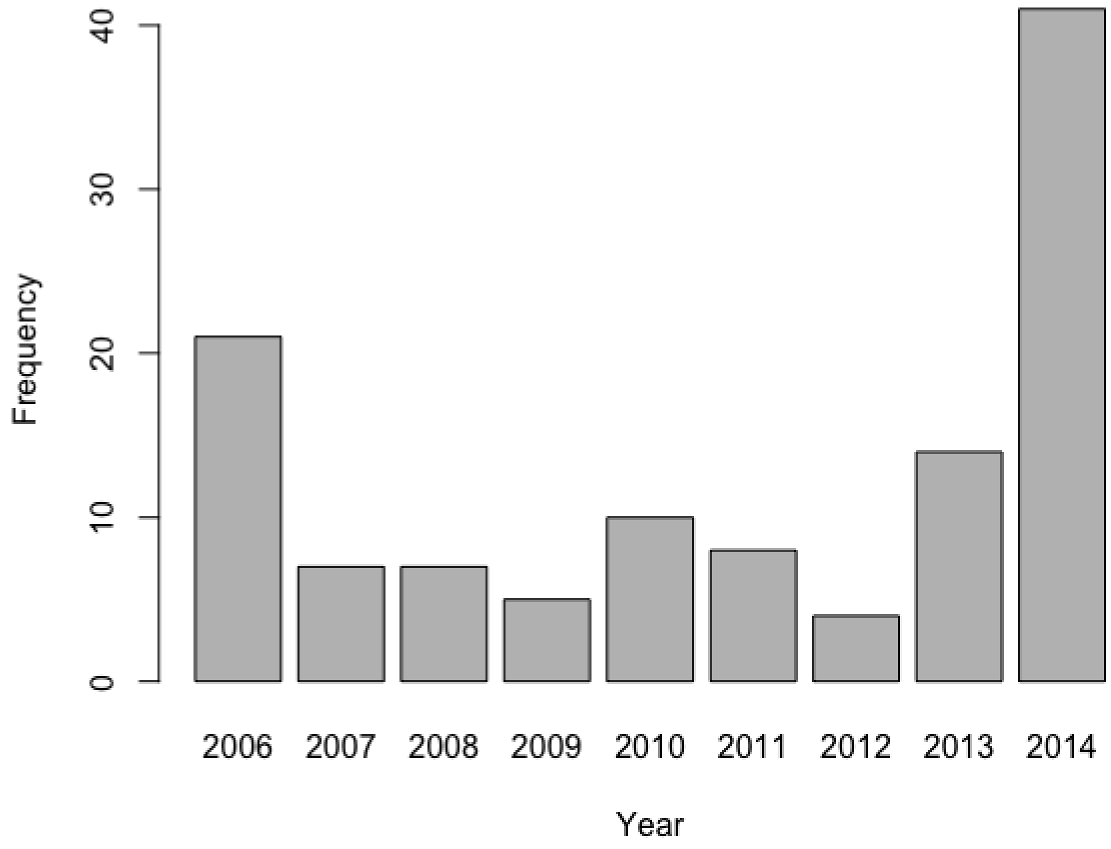
> or = 16: Very High
12-15: High
8-11: Medium
4-7: Low
0-3: Very Low
Black: > selected range

Daily Suitability Index (Daily Vibrio Risk)

2013/06/12 Current: 2014/07/31 2016/05/08

Esri, HERE, DeLorme, FAO, NOAA, USGS

Annual frequency of total *Vibrio* infections notified in Sweden from 2006-2014



Semenza JC, et al. ***Environ Health Perspect*****. 2017;125(10):107004**

Conclusion

- Climate change can trigger a **sequence of events** of significant magnitude with consequences for infectious diseases

- The most important driver of Infectious Disease Threat Events (IDTE) in Europe is **travel and tourism** but **climate** is also an important driver of IDTE

- Climate change has **already** impacted the transmission of a wide-range of water-borne and vector-borne diseases in Europe, and it will **continue** to do so in the coming decades

- **Early warning systems** could intercept these cascading risks

Acknowledgements

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B. Sudre
J. Garrido
CB. de Saint Lary
W. Lohr
K. Lillepold

ID Threat Events

MO. Sewe
E. Lindgren
S. Brusin
KK. Aaslav
T. Mollet
J. Rocklöv

Waterborne outbreaks

B. Guzman
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S. Ethelberg
H. Hygen
M. Kuusi
V. Lund
M. Löfdahl
E. MacDonald
J. Martinez-Urtaza
G. Nichols
C. Schönning
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L. Trönnberg
L. Vold
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