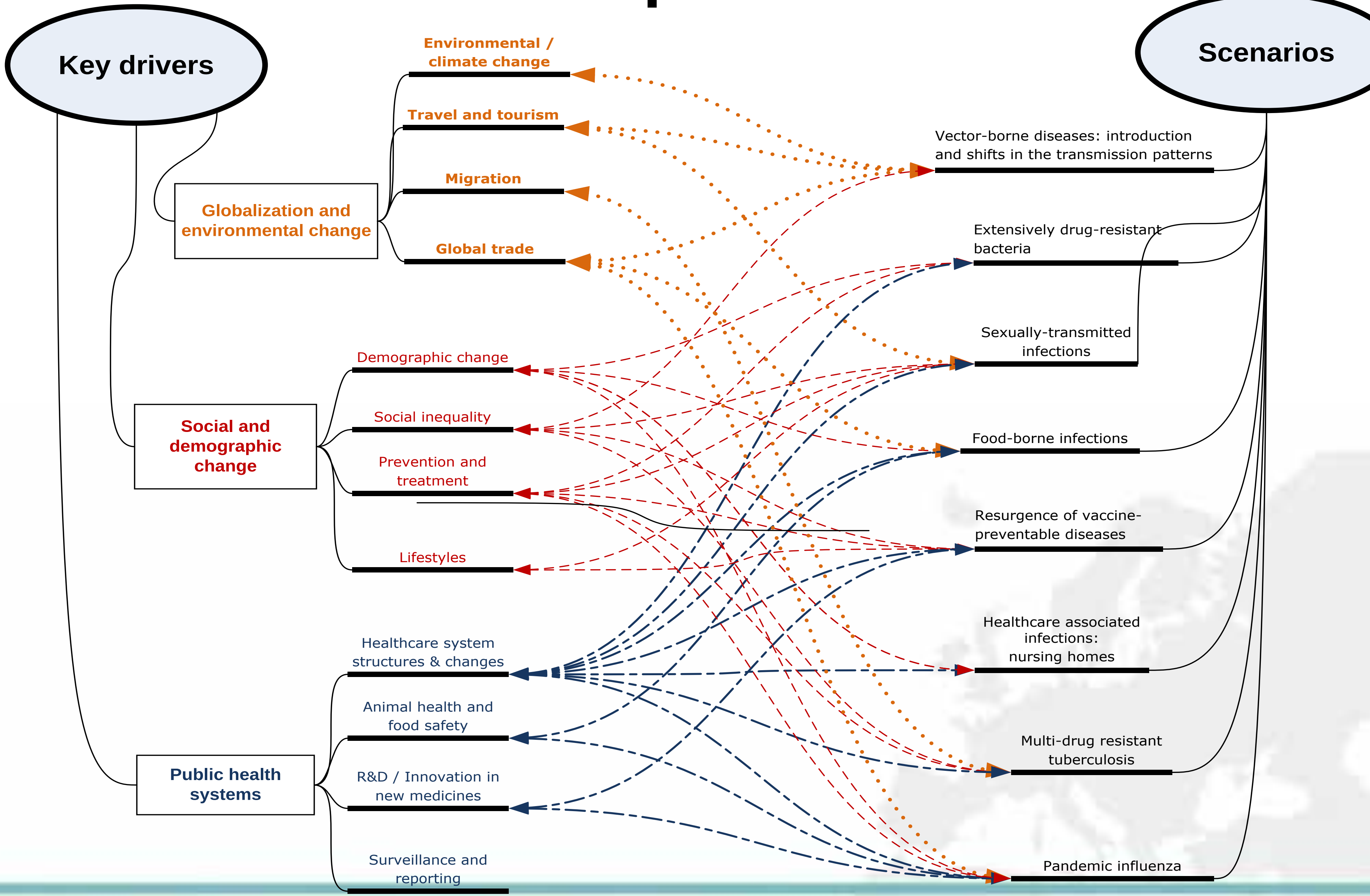
Monitoring epidemic precursors of disease

Jan C. Semenza
European Centre for Disease Prevention and Control

Source: http://earlyworldhistory.blogspot.com/2012/04/delphic-oracle.html

IDTE drivers and plausible scenarios



Suk JE, Semenza JC. *Am J Public Health*. 2011;101(11):2068-79

Disease and event monitoring at ECDC

TESSy[1]
Disease monitoring

Cases

collect, analyse, interpret

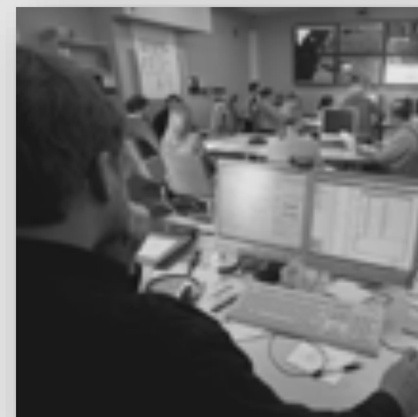
assess

investigate

EWRS[2]
Event monitoring

Events

capture, filter, validate



disseminate

Signal

Alert

Communicate and control

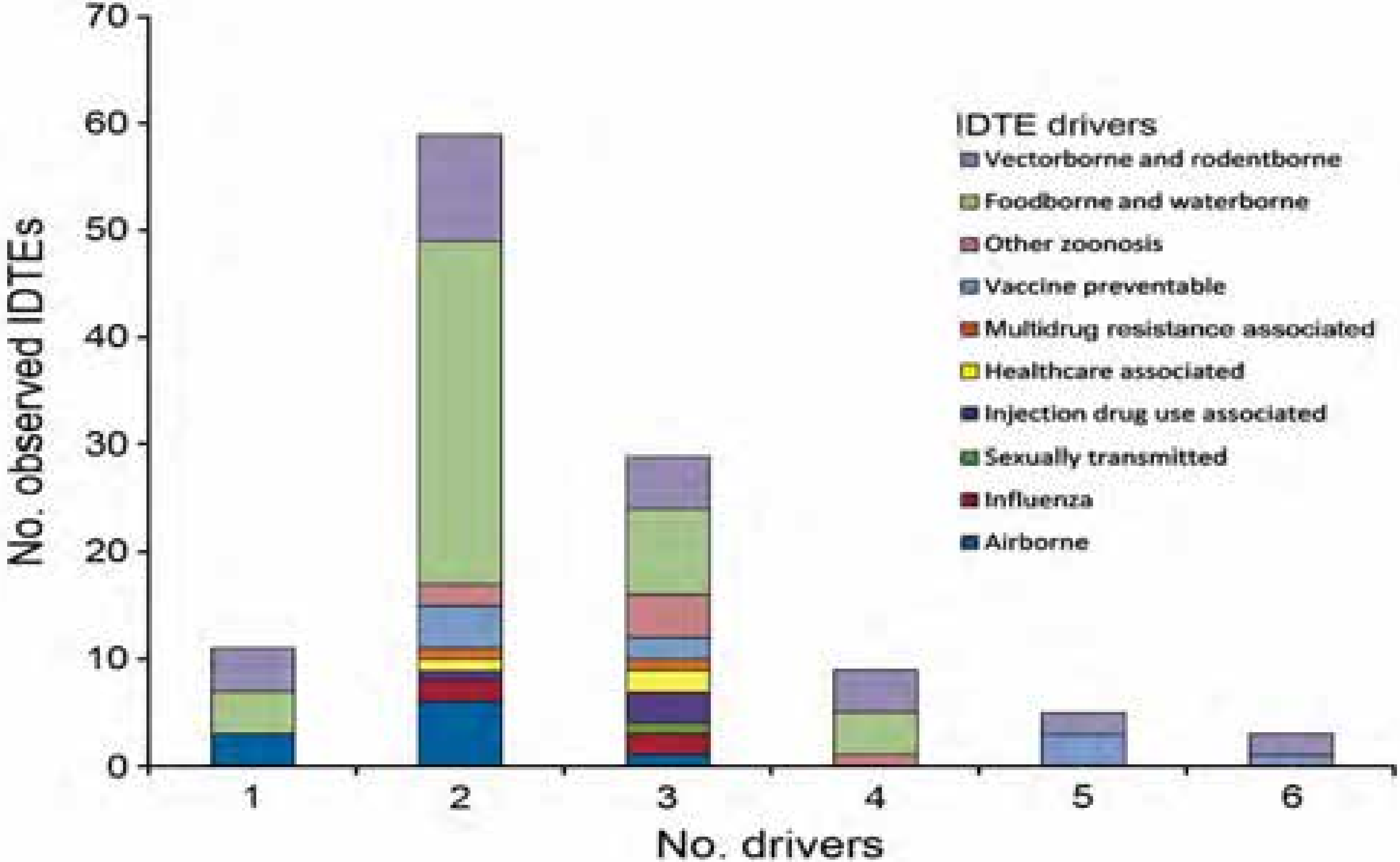
[1] The European Surveillance System – a database system
[2] Early Warning Response System

Emergency Operation Center

Every working day at 11:30, a roundtable meeting in ECDC's Emergency Operations Centre assesses threats, official alerts and epidemic intelligence from around the EU and the world.

Photo: ECDC

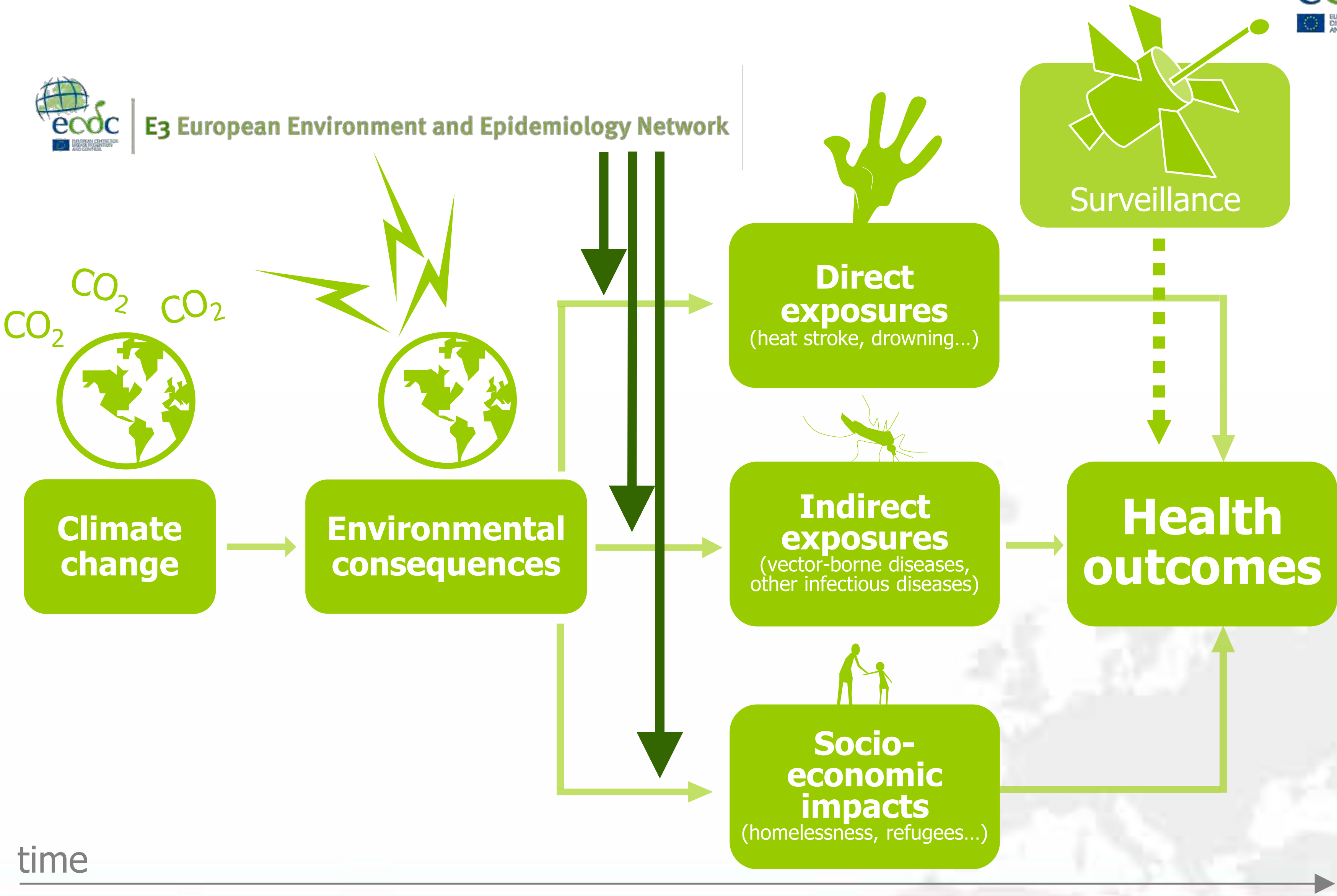
Number of drivers for infectious disease threat events (IDTE), Europe 2008-2013



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

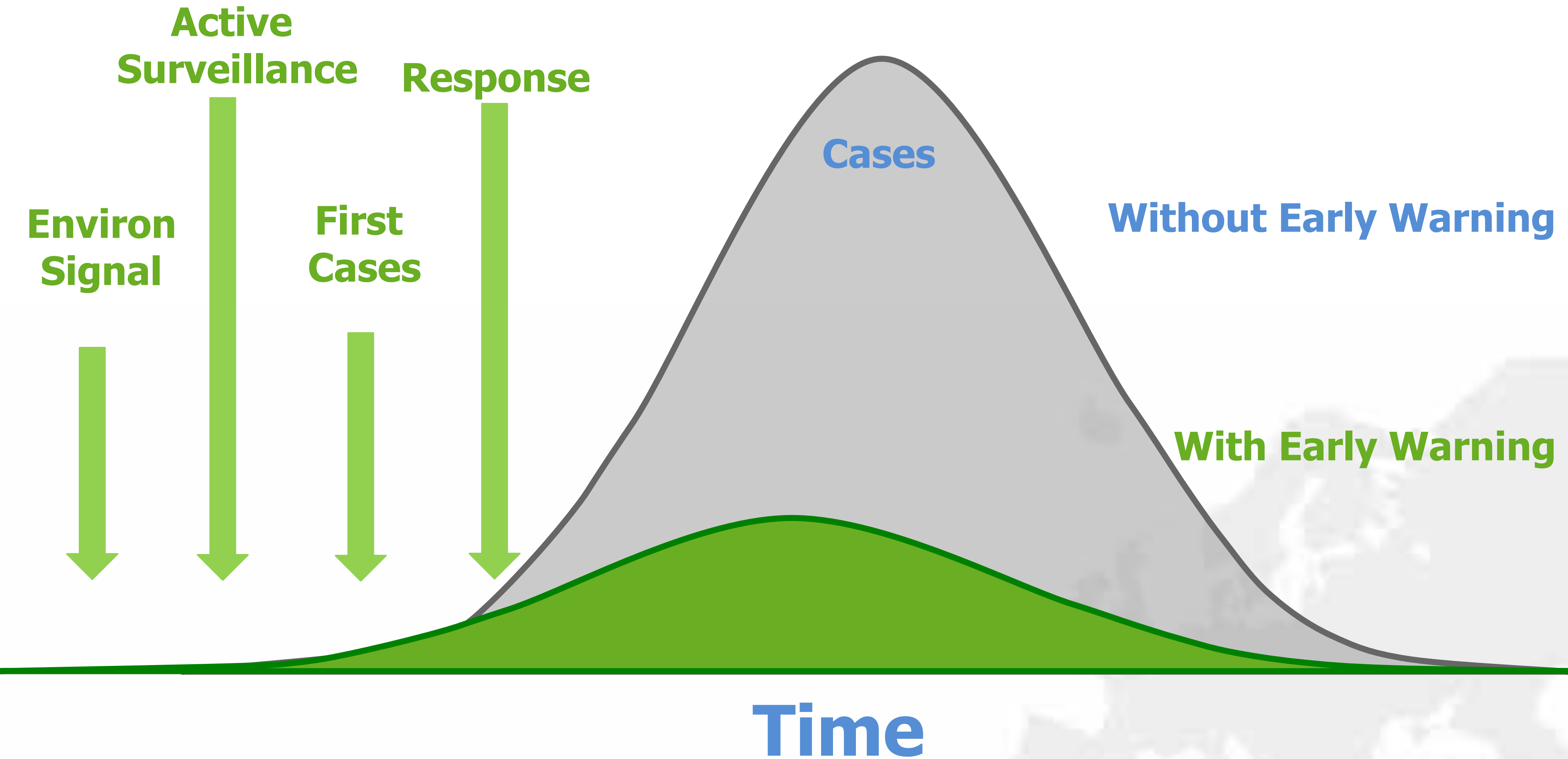
Semenza JC, et al. *Emerging Infectious Diseases*. 2016; 22(4):581-589.

Early warning system



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

Early warning system
Environmental/climatic precursors of disease



E³: European Environment and Epidemiology network

Epidemic intelligence and surveillance
(ECDC, WHO)

Environmental and climatic data
(e.g. EEA, SEIS, EDEN)

Demographic and socio-economic data
(Eurostat)

Merge

Inte-grate

Analyse

Inter-pret

E3

Semenza JC, Menne B. *Lancet ID*. 2009;9:365-75.

E3 Geoportal
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E3 Map Viewer
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DISCOVER METADATA
Basic search
Contains
Search
or advanced search
or browse data
E3 User
What's new?
Near real time global data mining
available a wide range of information for anybody interested in infectious disease epidemiology in Europe.
The objective of E3 Geoportal is to promote geospatial infectious disease modelling in Europe and its integration in Public health. There are many different determinants of infectious disease transmission but they are often highly dispersed and/or difficult to obtain. The E3 Geoportal will facilitate the collection and exchange of these datasets in a user-friendly manner. It is an inventory of information and resources which are collected, maintained, and managed by a collaborative effort under the European Environment and Epidemiology Network.
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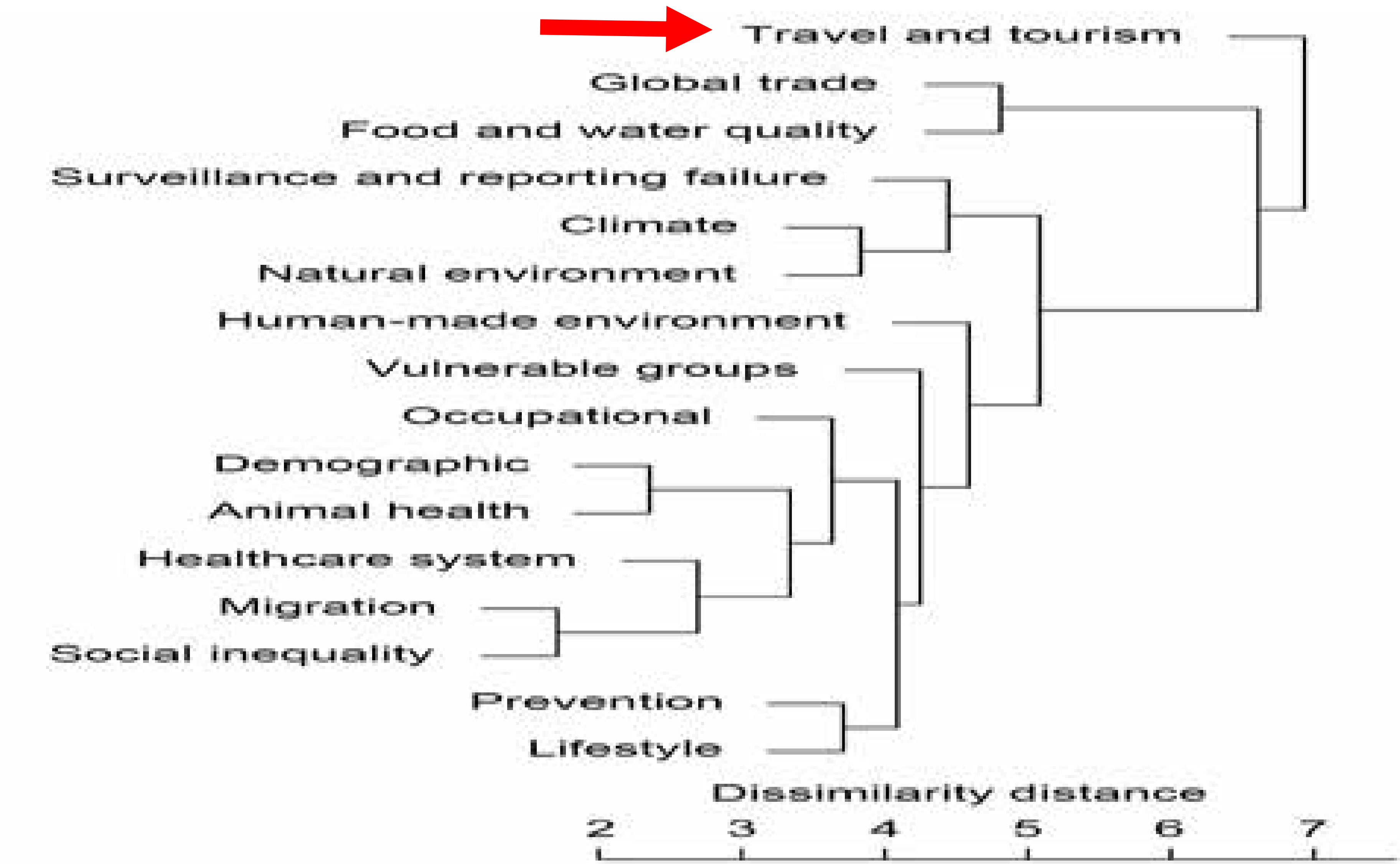
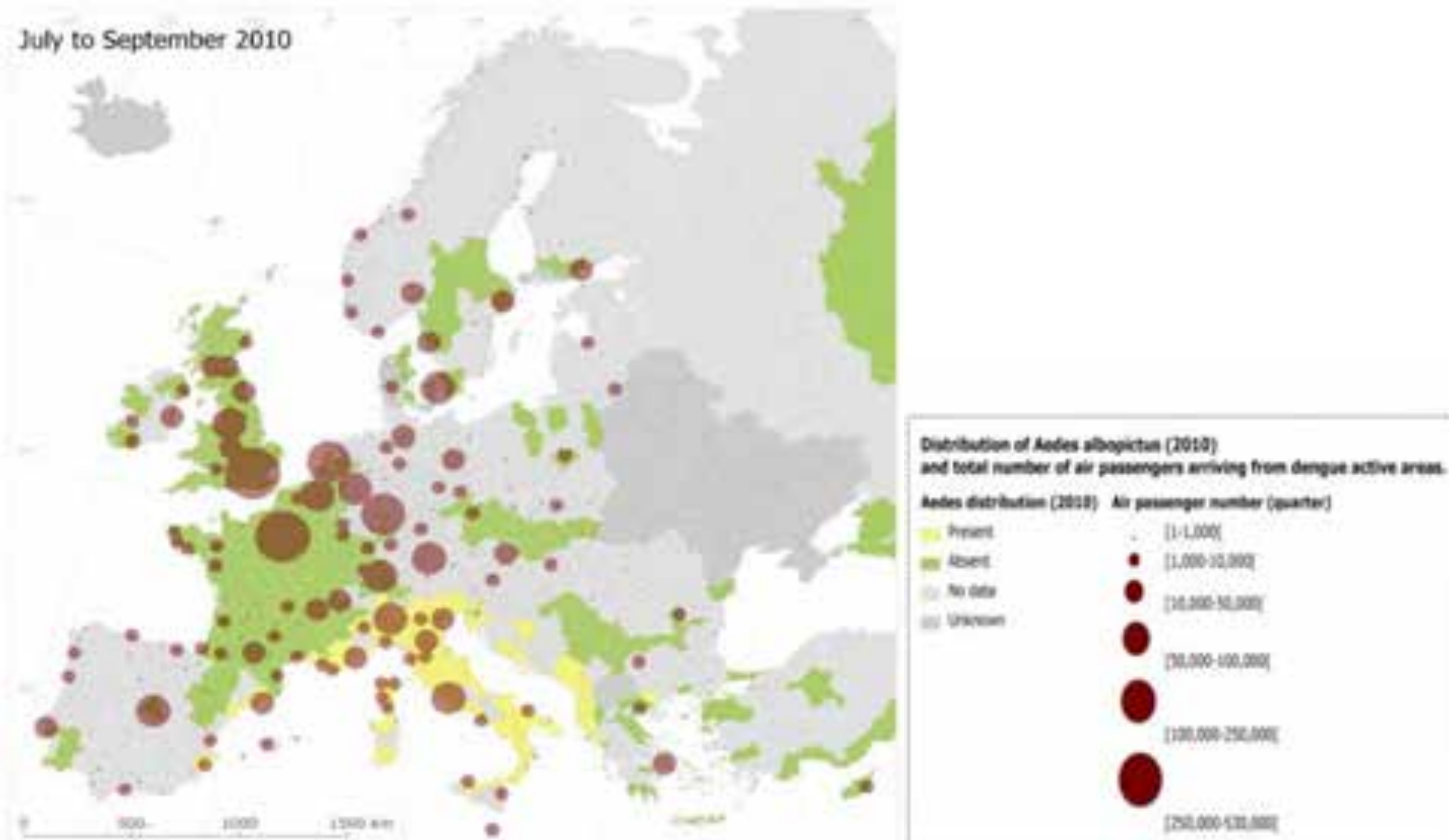


Semenza JC, et al. *Emerging Infectious Diseases*. 2016; 22(4):581-589.

Airport-level final destination of international travellers from dengue affected areas, 2010



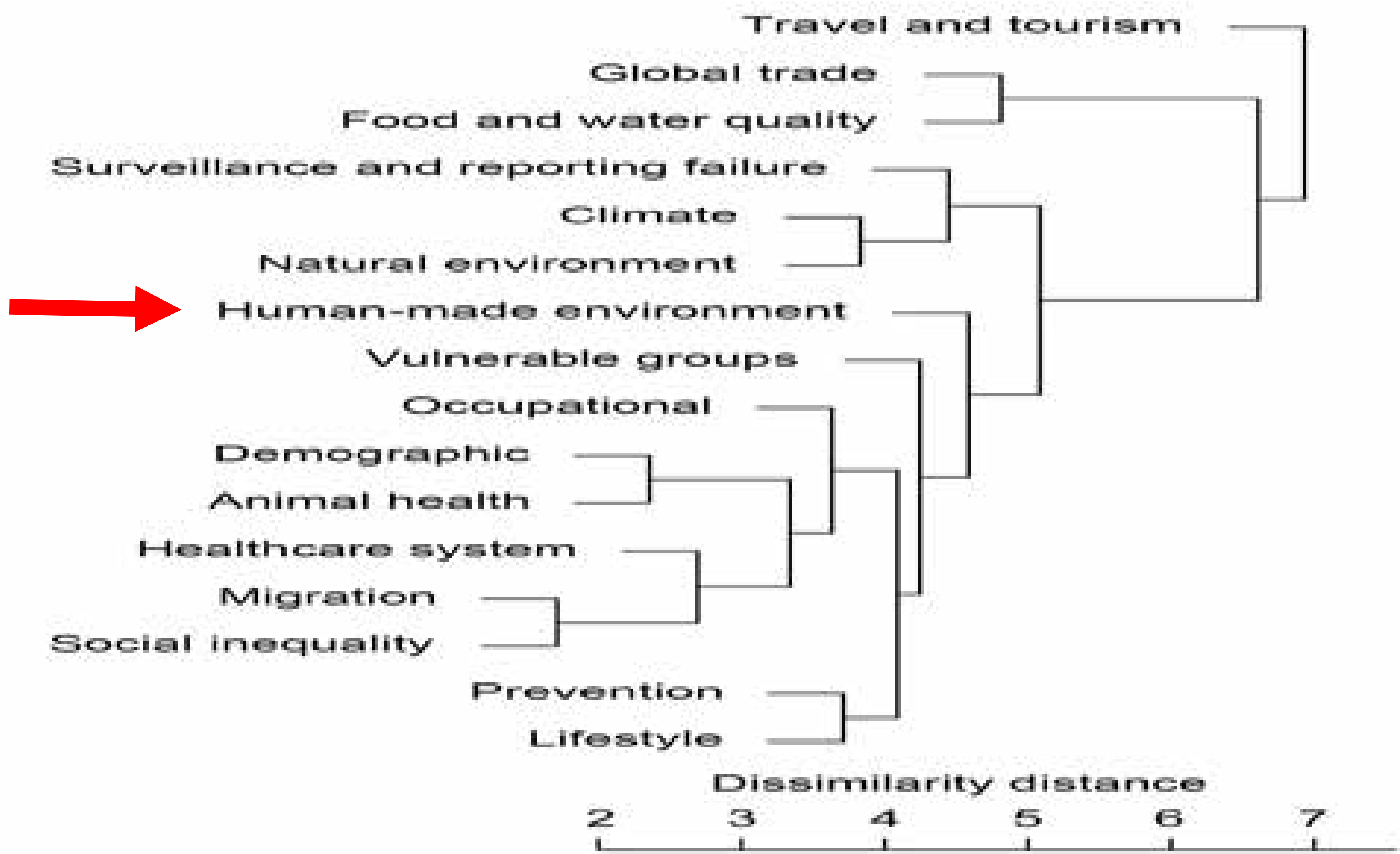
Semenza JC, et al., *PlosNTD* 2014;8(12):e3278

Hierarchical multivariate model: Risk of dengue importation into Europe, by month, 2010

Variables	Incidence rate ratio	P-Value	Confidence Interval (95%)
Travellers from dengue affected areas (per 10,000)	**1.09**	**0.02**	**[1.01-1.17]**
Month			
January*			
February	0.83	0.19	[0.63-1.1]
March	1.15	0.28	[0.89-1.48]
April	0.87	0.30	[0.65-1.14]
May	1.03	0.81	[0.78-1.36]
June	0.85	0.25	[0.64-1.12]
July	0.72	0.07	[0.51-1.02]
August	**1.70**	**0.001**	**[1.23-2.35]**
September	**1.46**	**0.04**	**[1.02-2.1]**
October	**1.35**	**0.04**	**[1.01-1.81]**
November	1.17	0.30	[0.87-1.58]
December	1.06	0.66	[0.82-1.37]

Semenza JC, et al., *PlosNTD* 2014;8(12):e3278

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.

Malaria

Historical malaria foci in Greece

Sudre B, et al. *Emerg Infect Dis*. 2013; 19(5): 784-786.

Environmental suitability for malaria

Area with autochthonous cases 2009-2011

Potential areas of environmental suitability

Significant variables (NLDA):

- **Warmer temperatures**
- **Low elevation** (low-range in DEM)
- Permanently **irrigated** land
- Complex **cultivation pattern**

Sudre B, et al. *Emerg Infect Dis*. 2013; 19(5): 784-786.

Malaria: Public health interventions

- Delineate areas **environmentally suitable** for transmission

- Targeted epidemiological and entomological **surveillance**
- **Indoor residual spraying** and the provision of long-lasting insecticide-treated **nets**
- **Aerial sprayings** over extensive water bodies (difficult access)
- **Active case detection**: house visits for fever screening
- **Mass Drug Administration** (MDA) to immigrants from malaria-endemic regions
- Immediate case **investigation**
- Use of **EU Structural Funds**

- **Transmission interrupted** 2013 and 2014

Tseroni M, et al. *PLoS NTD*. 2015 Nov 19;9(11):e0004215.

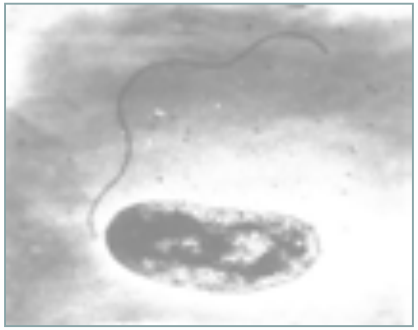
Vibrio infections

With its low salinity and rising water temperatures, the Baltic Sea is becoming prime habitat for Vibrio species. During the exceptionally hot summer of 2006, at least 66 people developed vibrio infections after visiting Baltic beaches. © Kacper Kowalski/Panos Pictures

Levy S. *Environ Health Perspect*. 2015 Apr;123(4):A82-9. doi: 10.1289/ehp.123-A82.

Pathogenic vibrios present in the marine environment

V. vulnificus



V. alginolyticus

Gram negative bacteria – common in marine and estuarine environments.

All these species proliferate in warm (>15 °C) and low salinity (<30 ppt NaCl) seawater.

Complex life cycle: planktonic and attached to marine organisms

V. parahaemolyticus

V. cholerae

Slide courtesy of Jaime Martinez-Urtaza

Different clinical manifestation of vibriosis

1. **Wound infections.** Caused by a range of different *Vibrio* spp. including *V. vulnificus, V. alginolyticus, V. cholerae* – normally caused by exposure of cut, wound or abrasion to contaminated seawater. Seriousness of infection is partly determined by species in question – *V. vulnificus* probably the worst ~25% mortality rate (Oliver 2005).

2. **Gastroenteritis.** Nausea, vomiting, diarrhoea - again, caused by a range of different *Vibrio* spp. – most commonly *V. vulnificus, V. parahaemolyticus* and *V. cholerae* – normally caused by consumption of raw/undercooked seafood and/or exposure to contaminated water sources.

3. **Septicaemia (blood poisoning).** Most serious clinical manifestation associated with vibriosis. Often fatal, depending on pathogen involved (*V. vulnificus* > 50% of cases). 100 *Vibrio* fatalities a year in the USA, mostly septicaemia-associated, numerous recent cases in Europe.

Slide courtesy of Jaime Martinez-Urtaza

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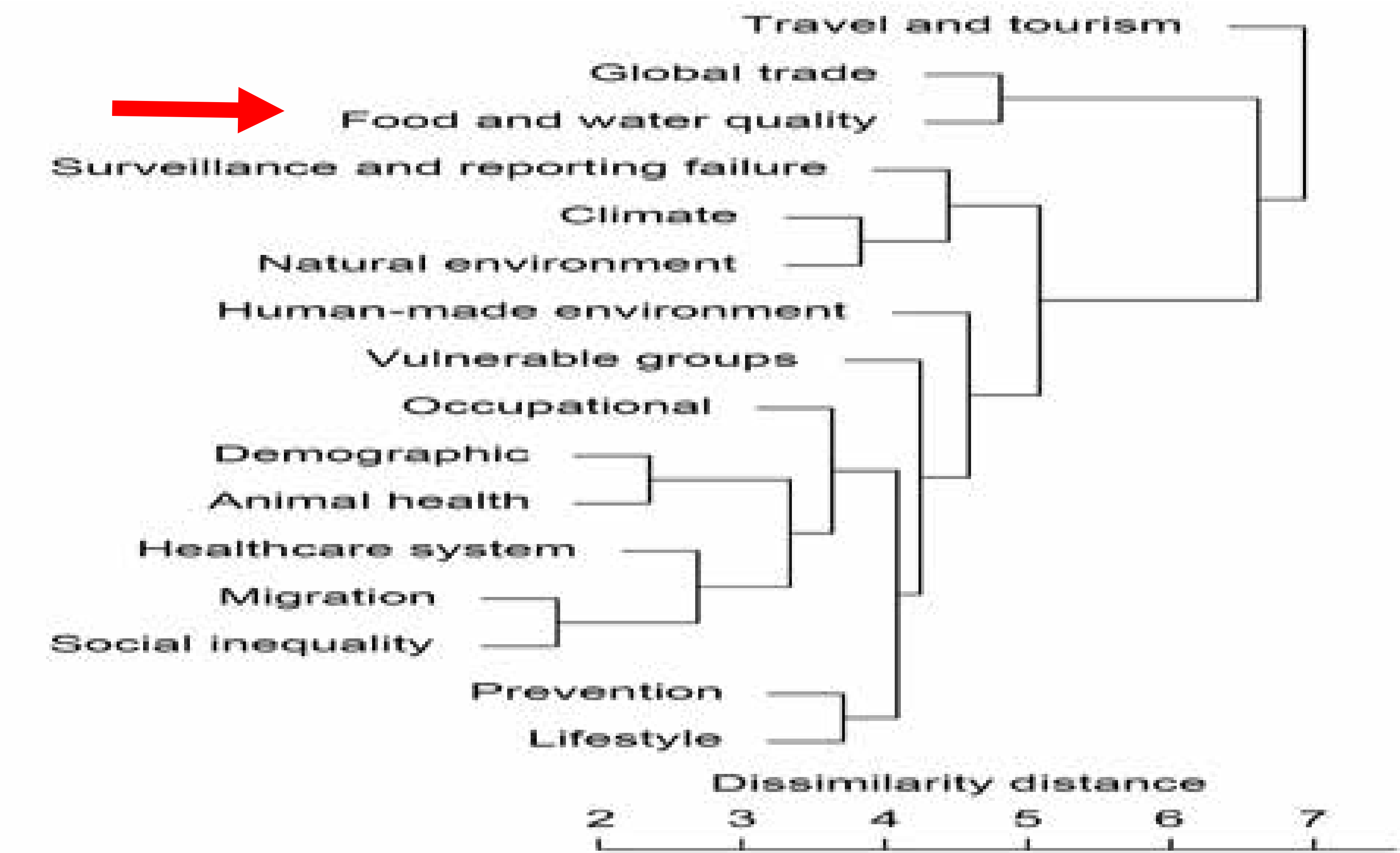

Semenza JC, et al. *Emerging Infectious Diseases*. 2016; 22(4):581-589.

Early warning system: ECDC *Vibrio* map viewer

- Designed to delineate retrospective, current, and short-term forecasts of **environmental suitability** for vibrio growth at a global scale

- Monitor **sea surface temperature** (SST) and **sea surface salinity** (SSS), especially in coastal regions where human exposure is more likely to occur

- Global model data inputs are SST fields from **remote sensing and models**, as well as SSS from models, *in situ* data and climatological data

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


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What's new?
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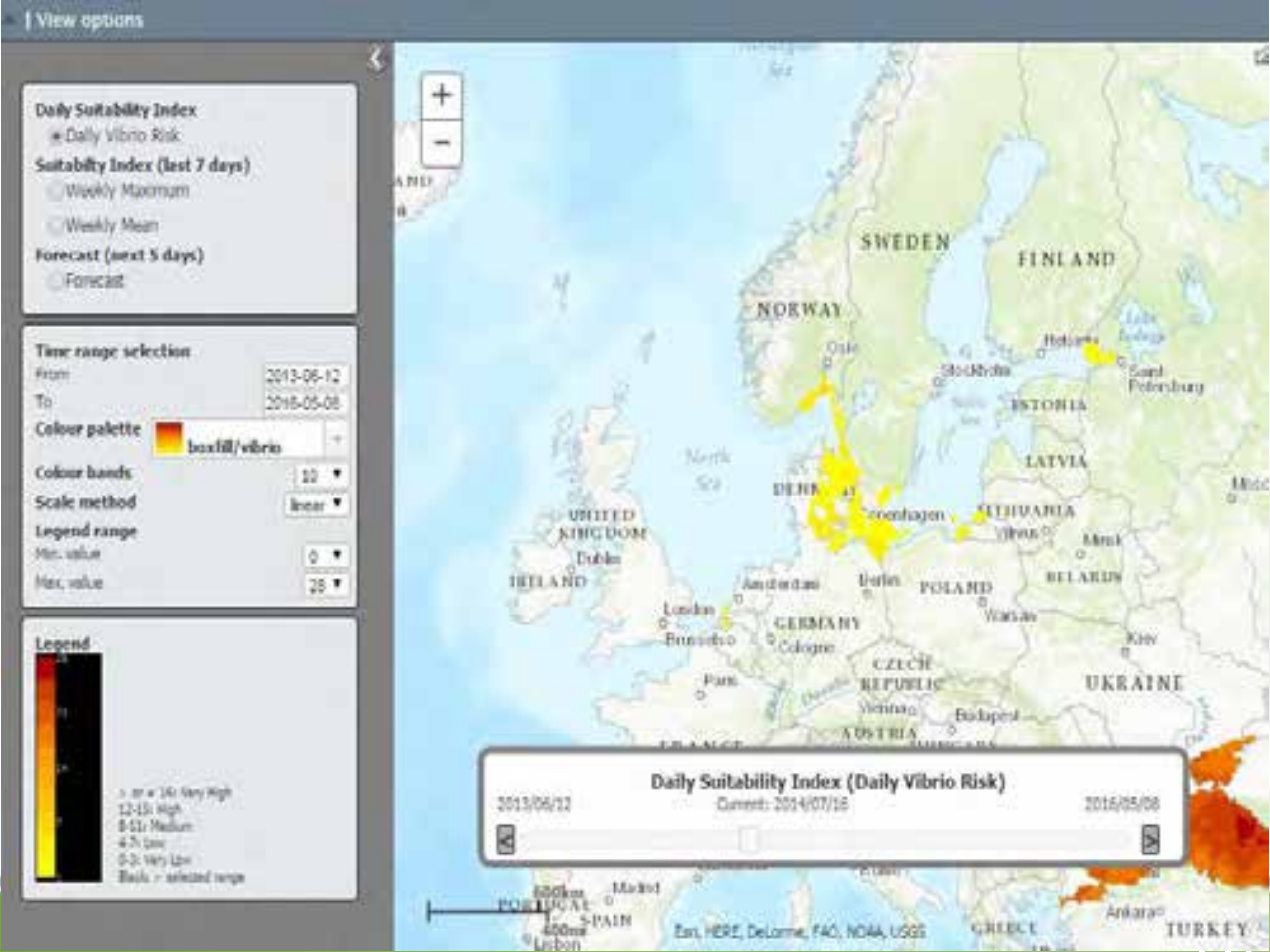
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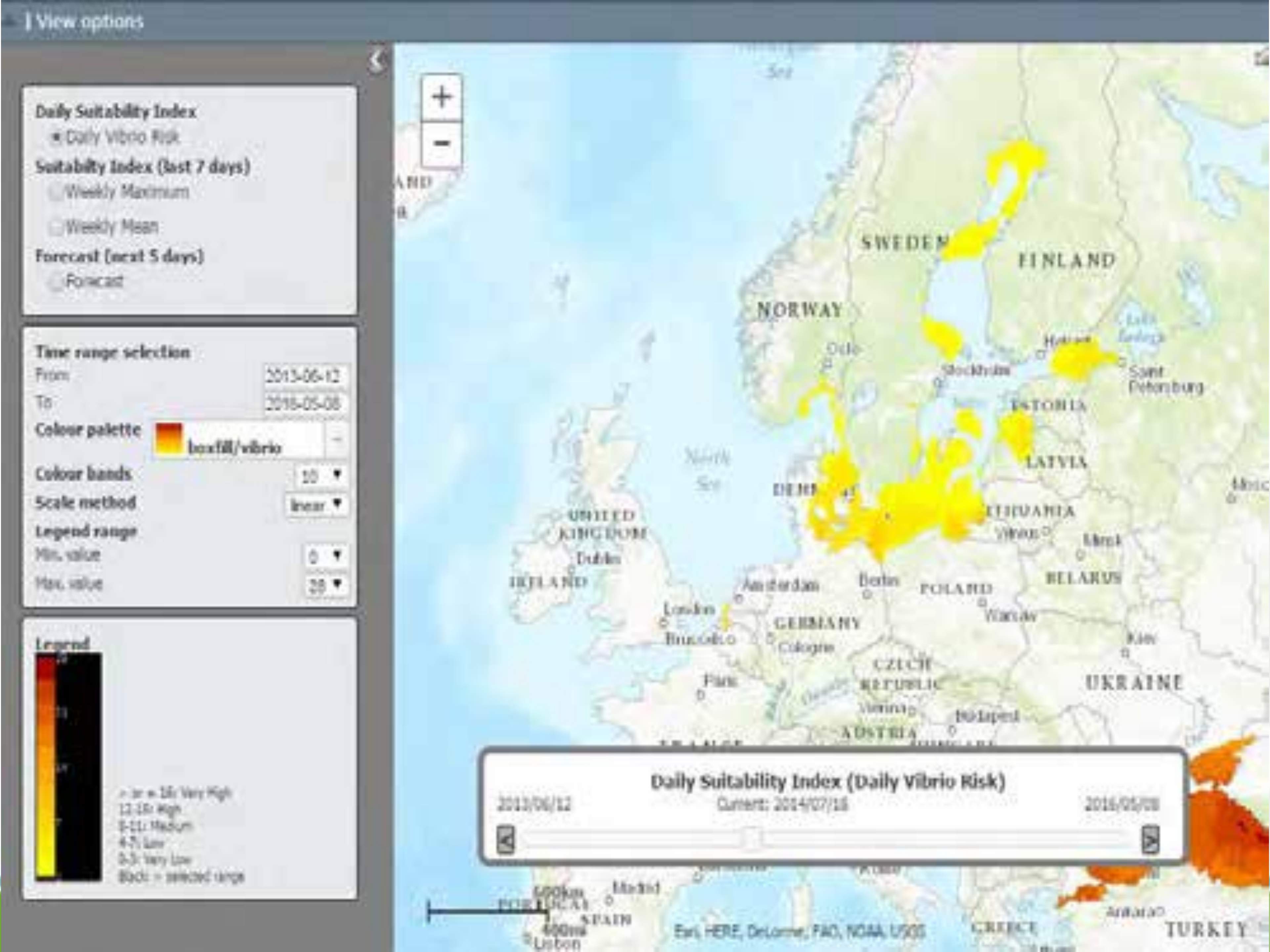
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8-11: Medium
4-7: Low
0-3: Very Low
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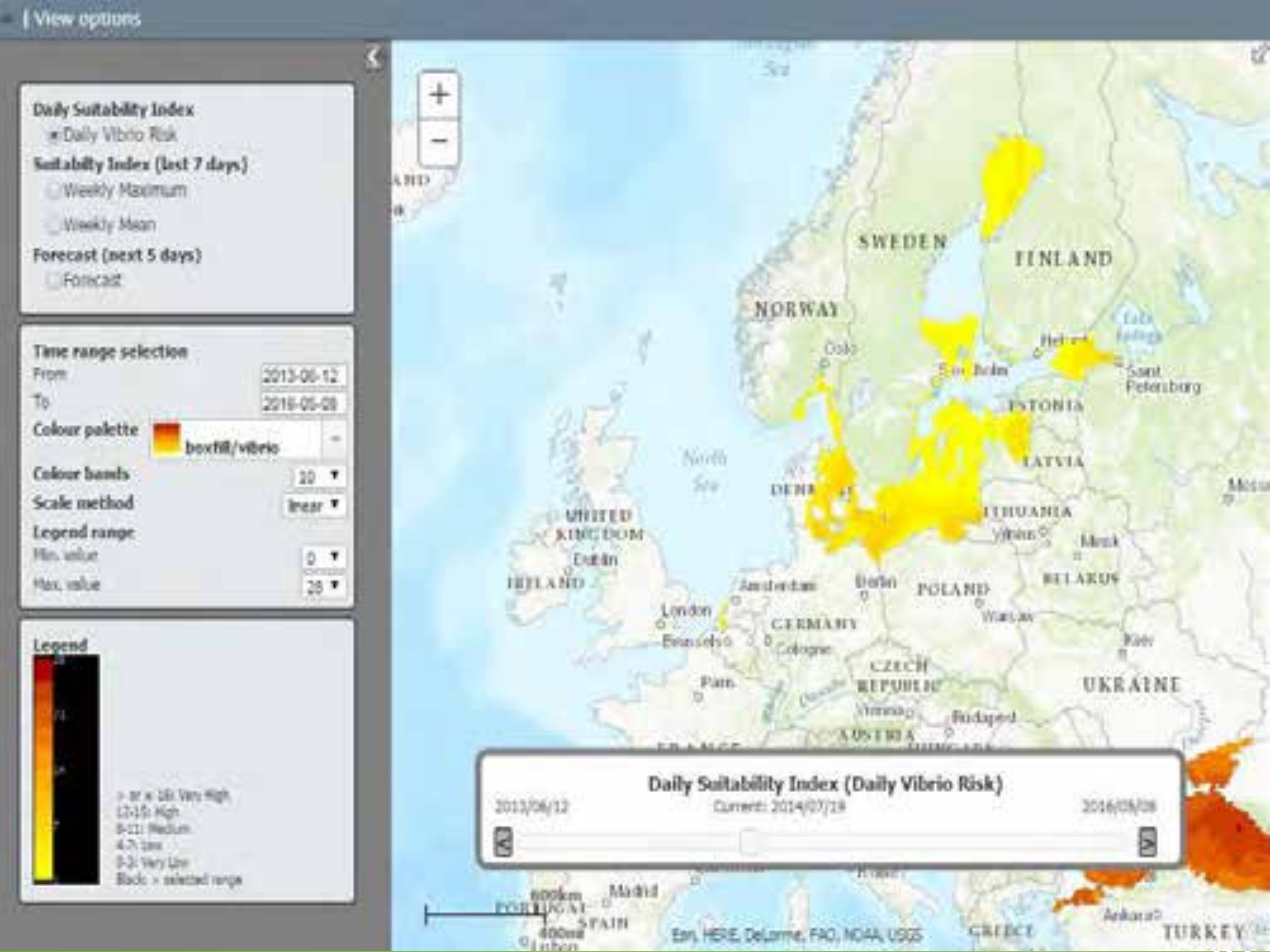
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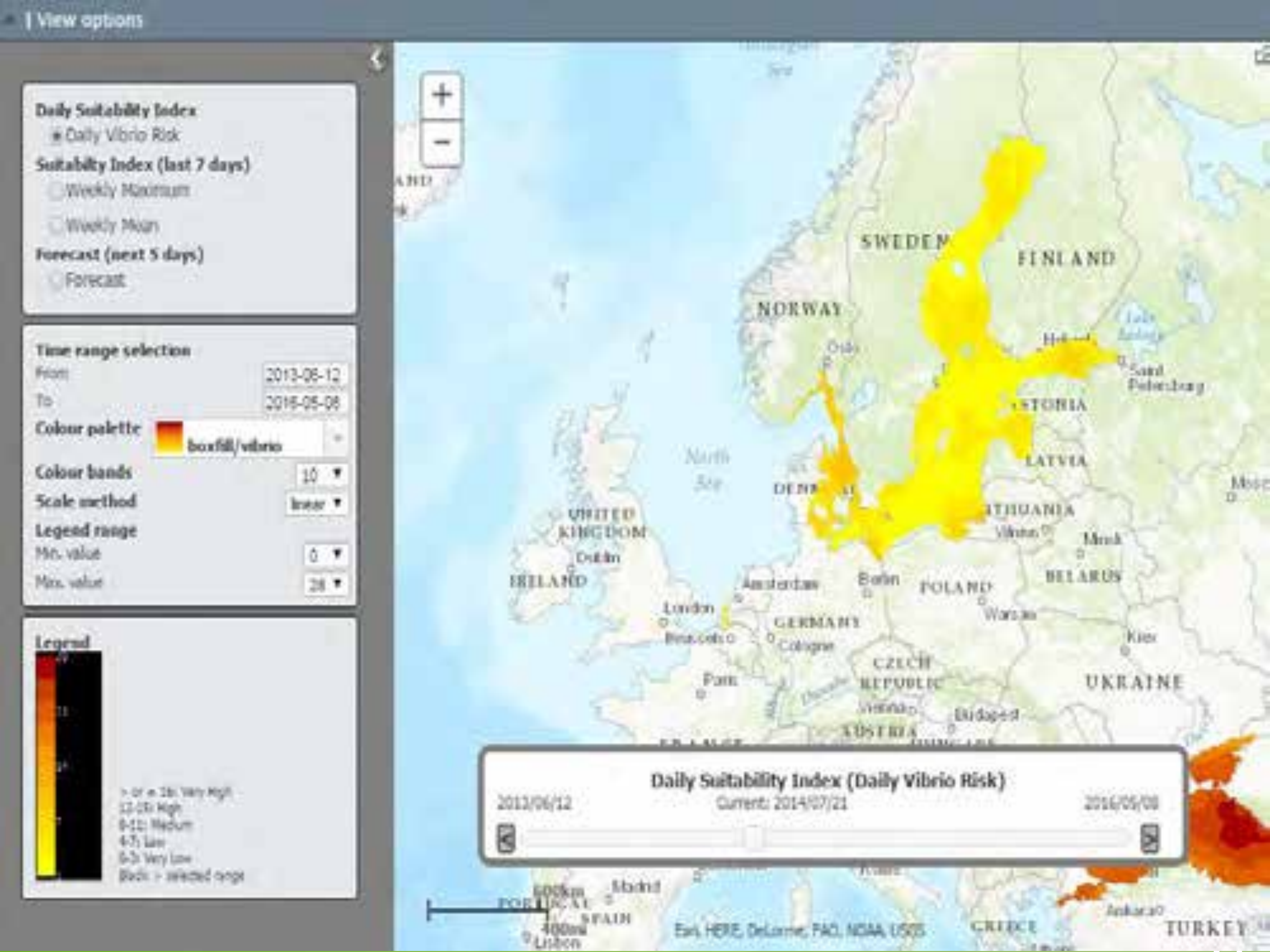
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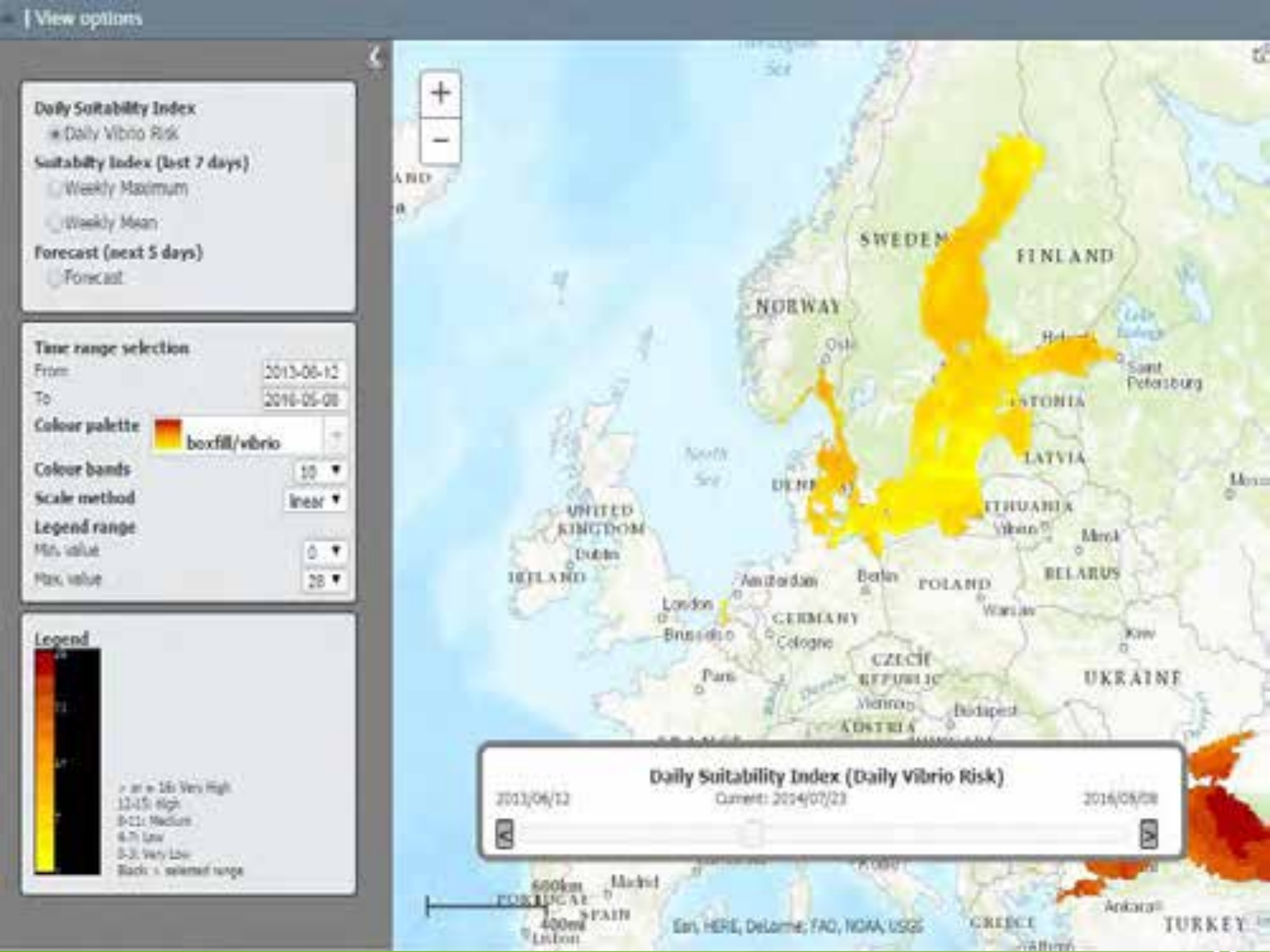
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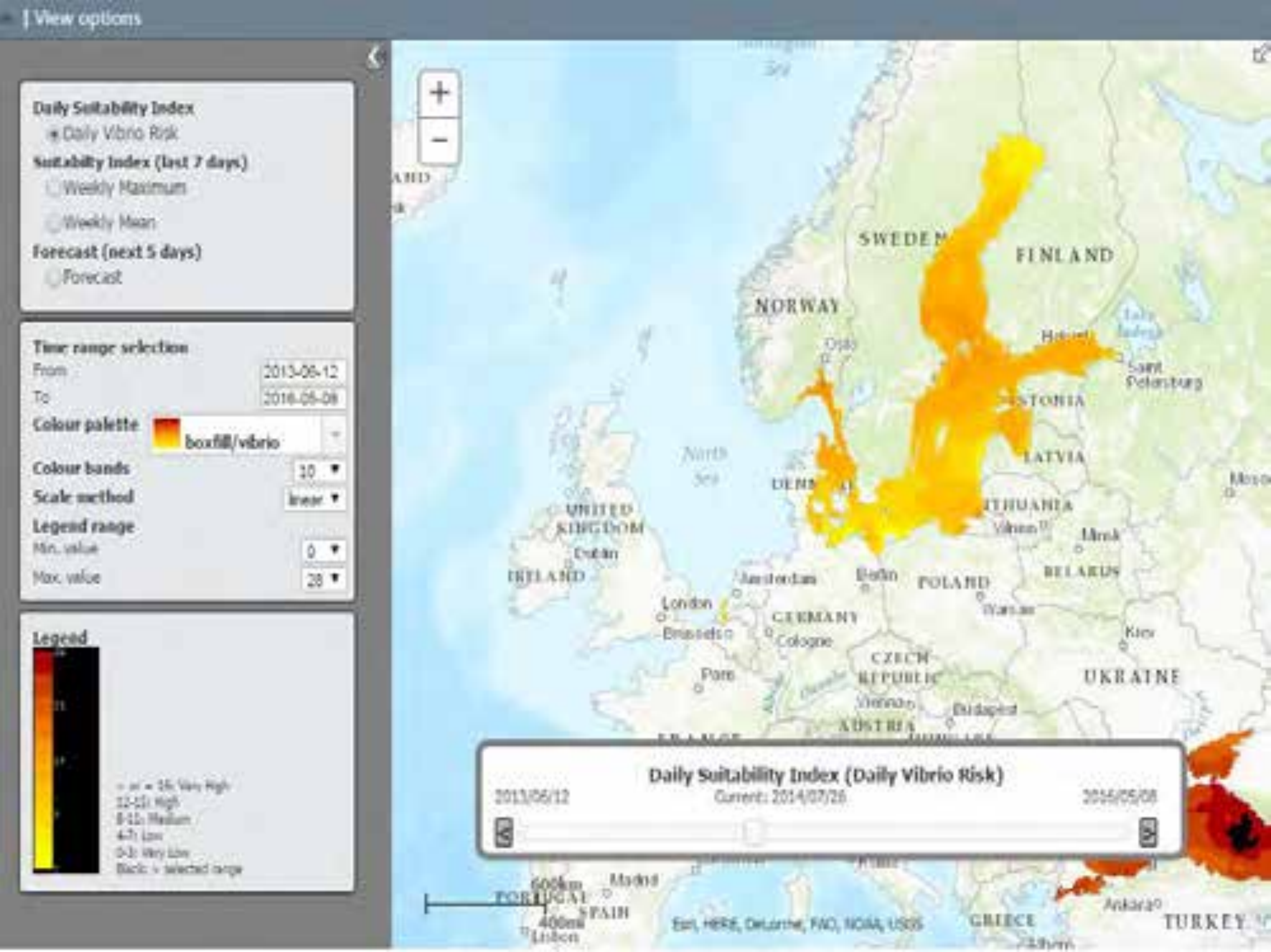
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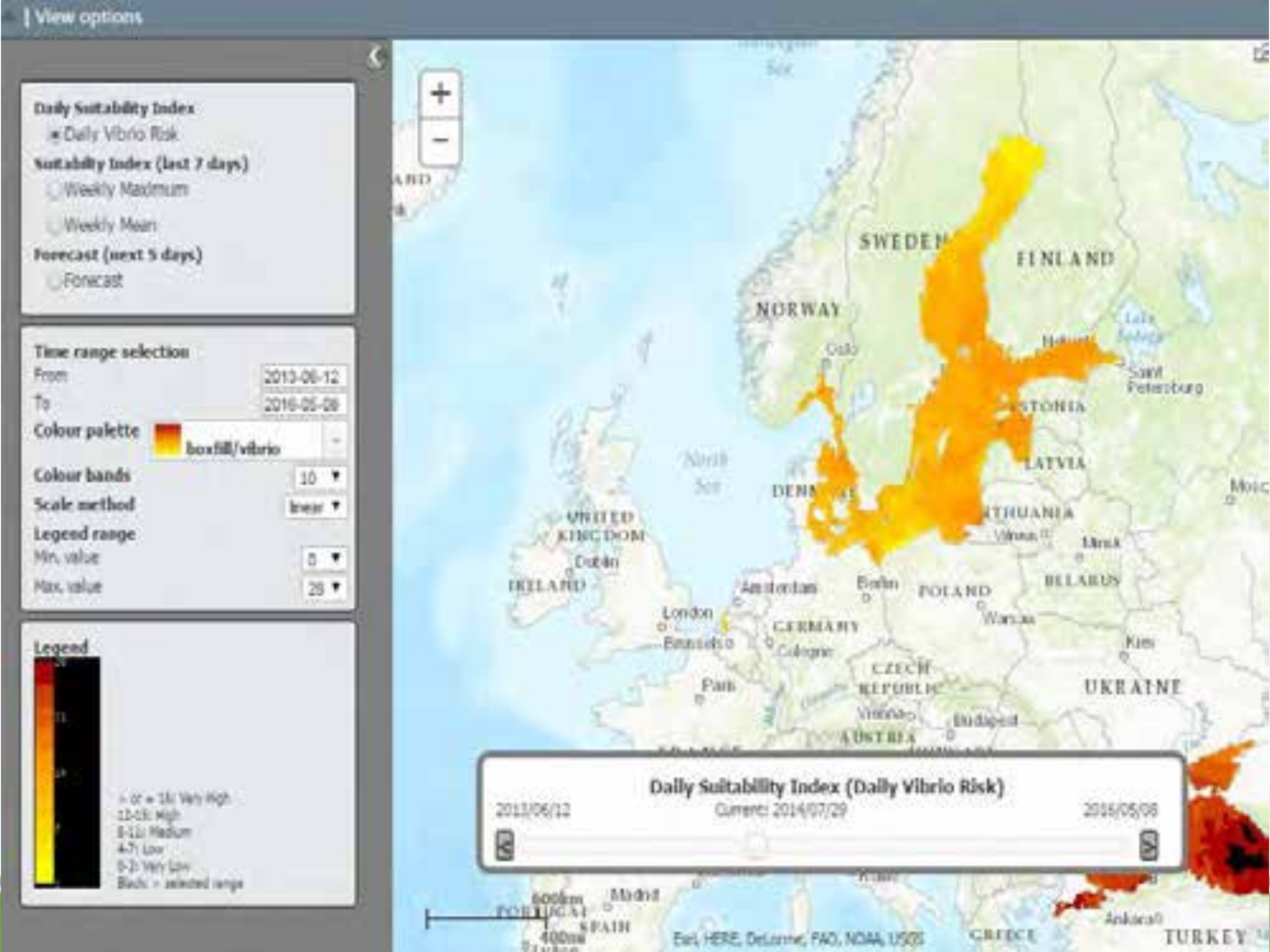
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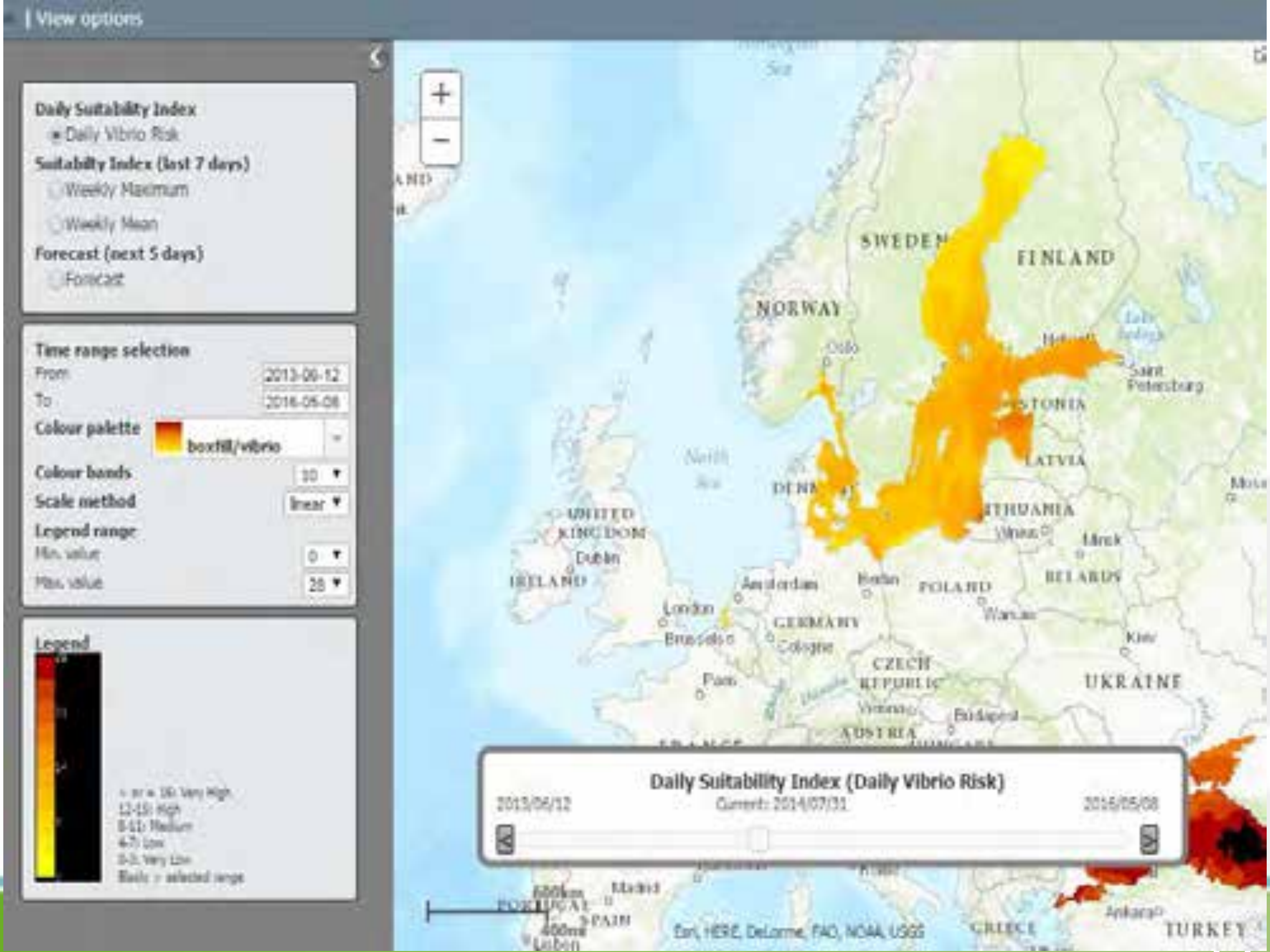
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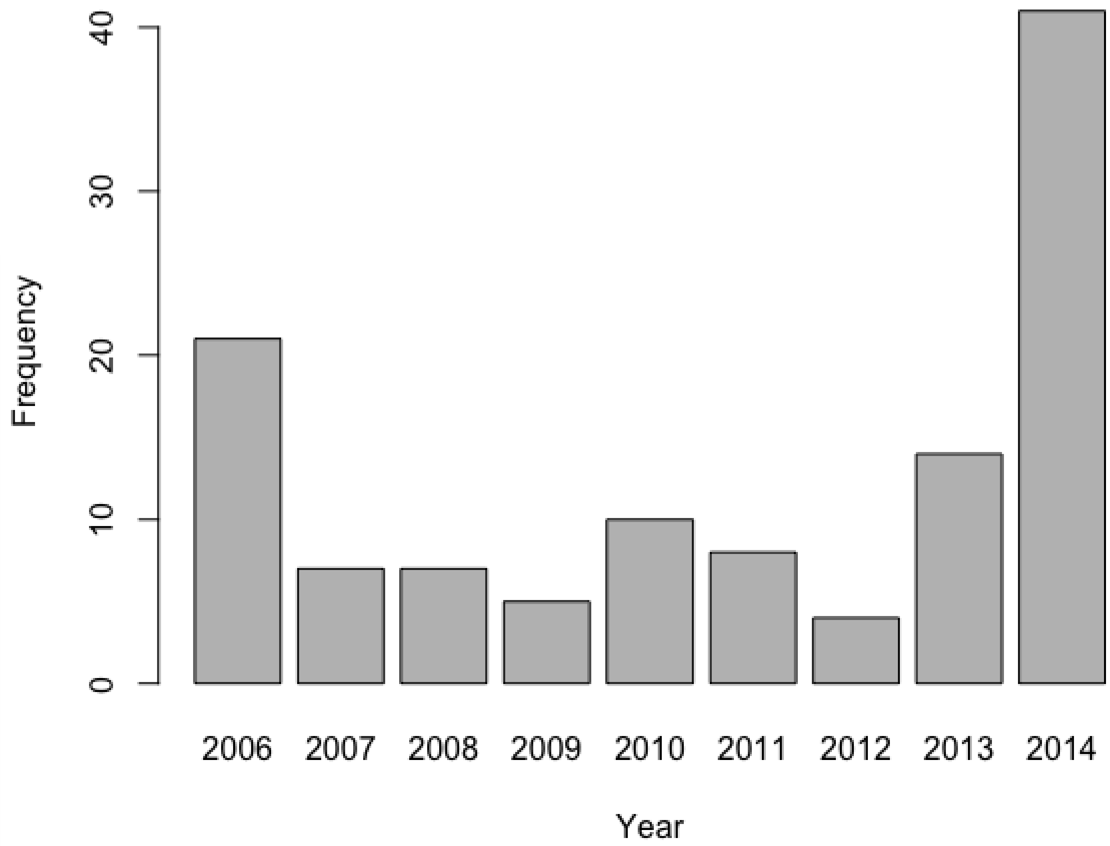
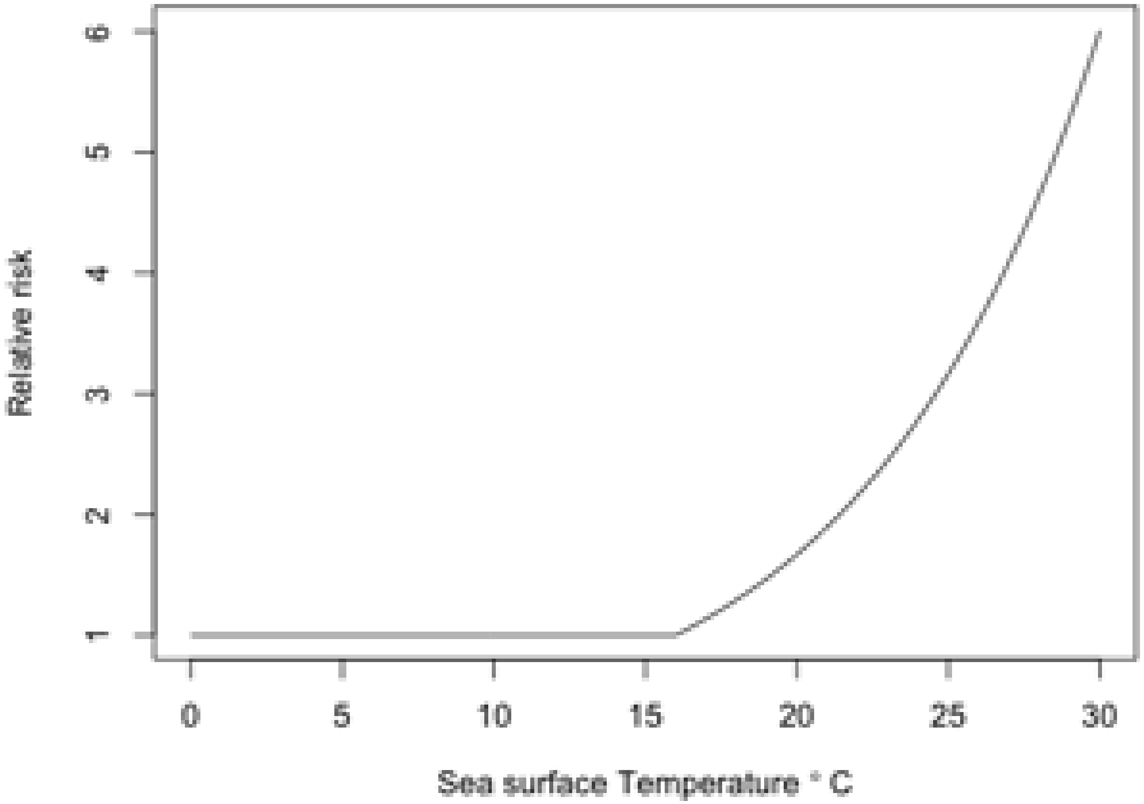
Annual frequency of total *Vibrio* infections notified in Sweden from 2006-2014



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

Exposure–response relationship of *Vibrio* infections in response to sea surface temperature (SST), Sweden 2006 - 2014



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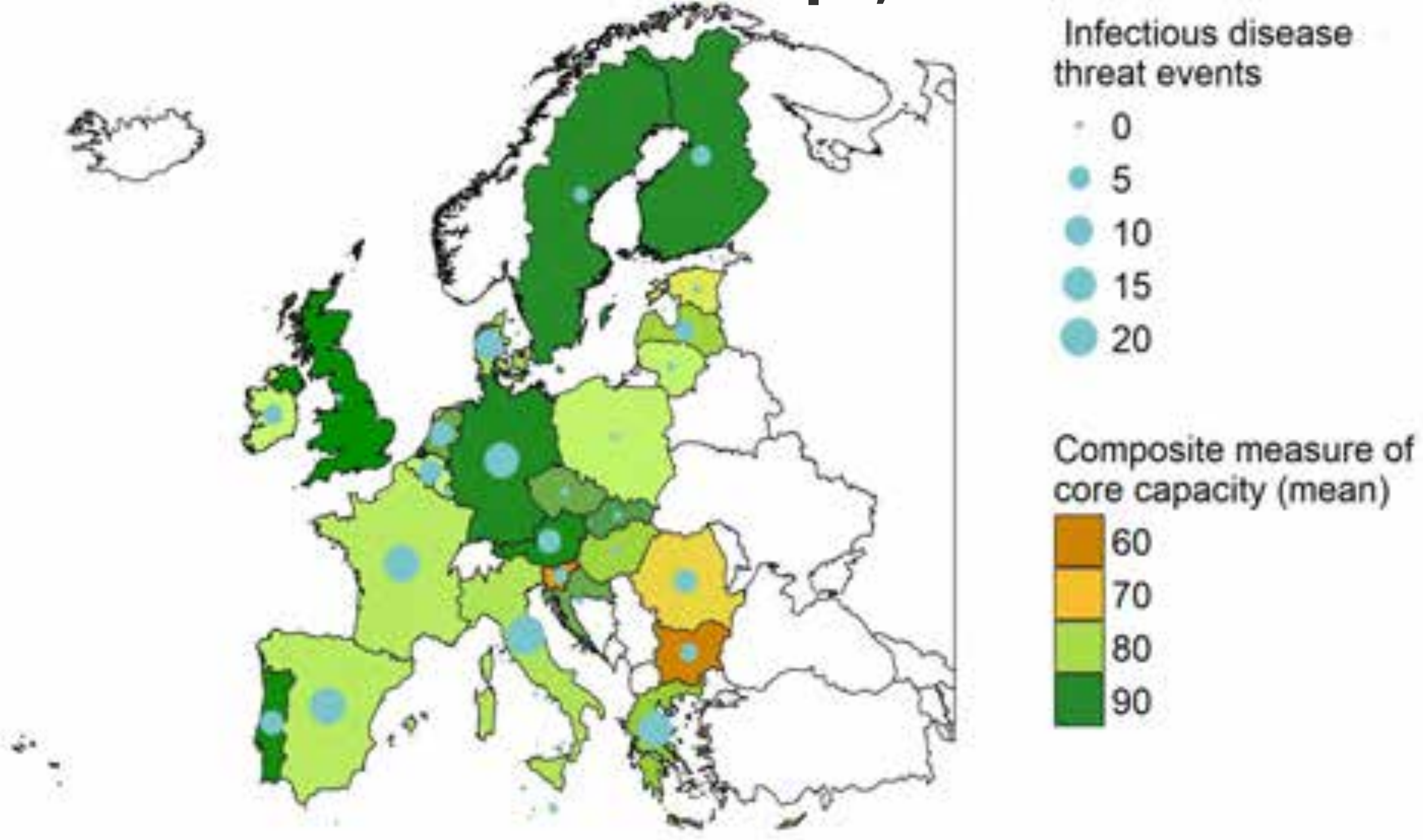
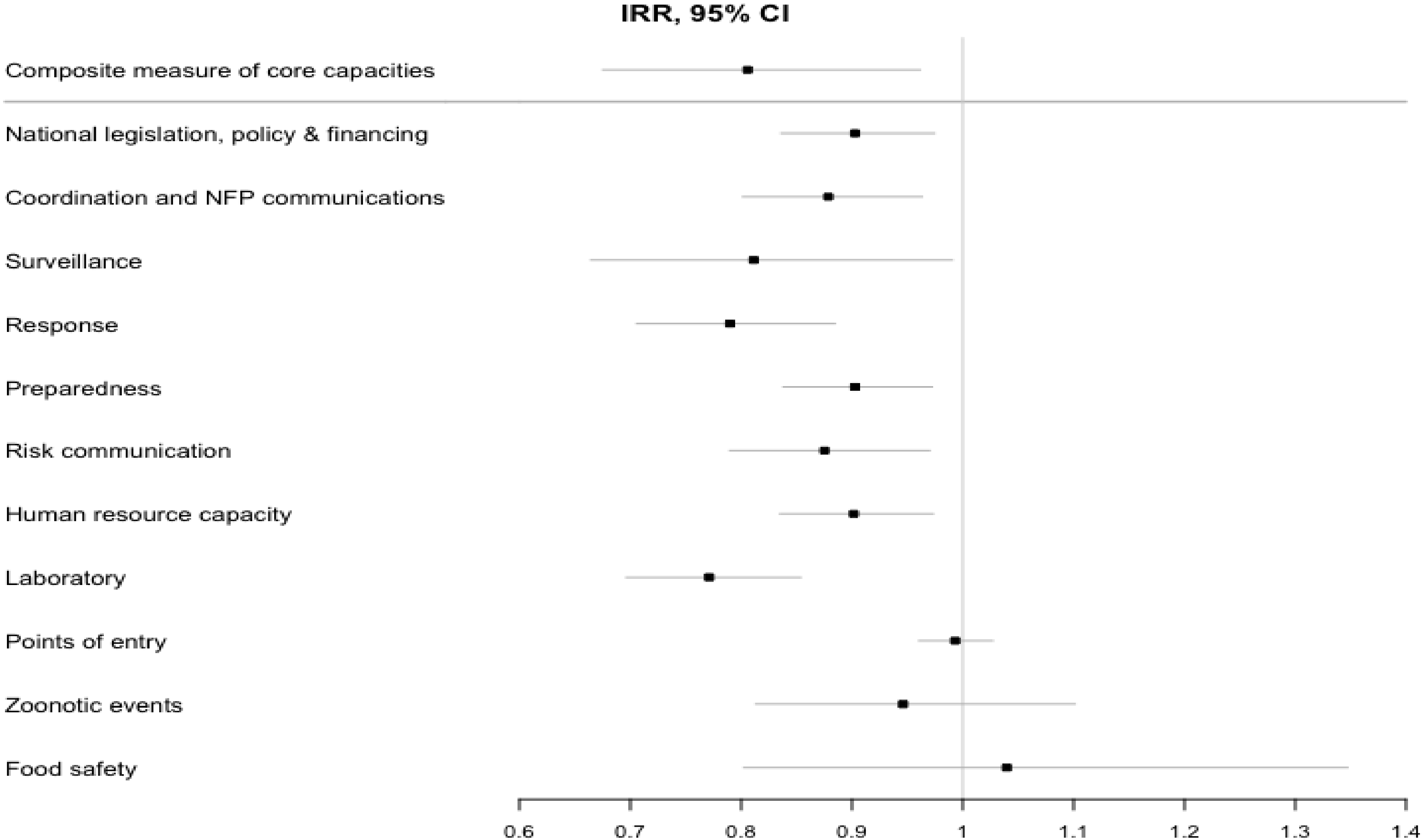
Mean IHR core capacities and infectious disease threat events in Europe, 2010–2016



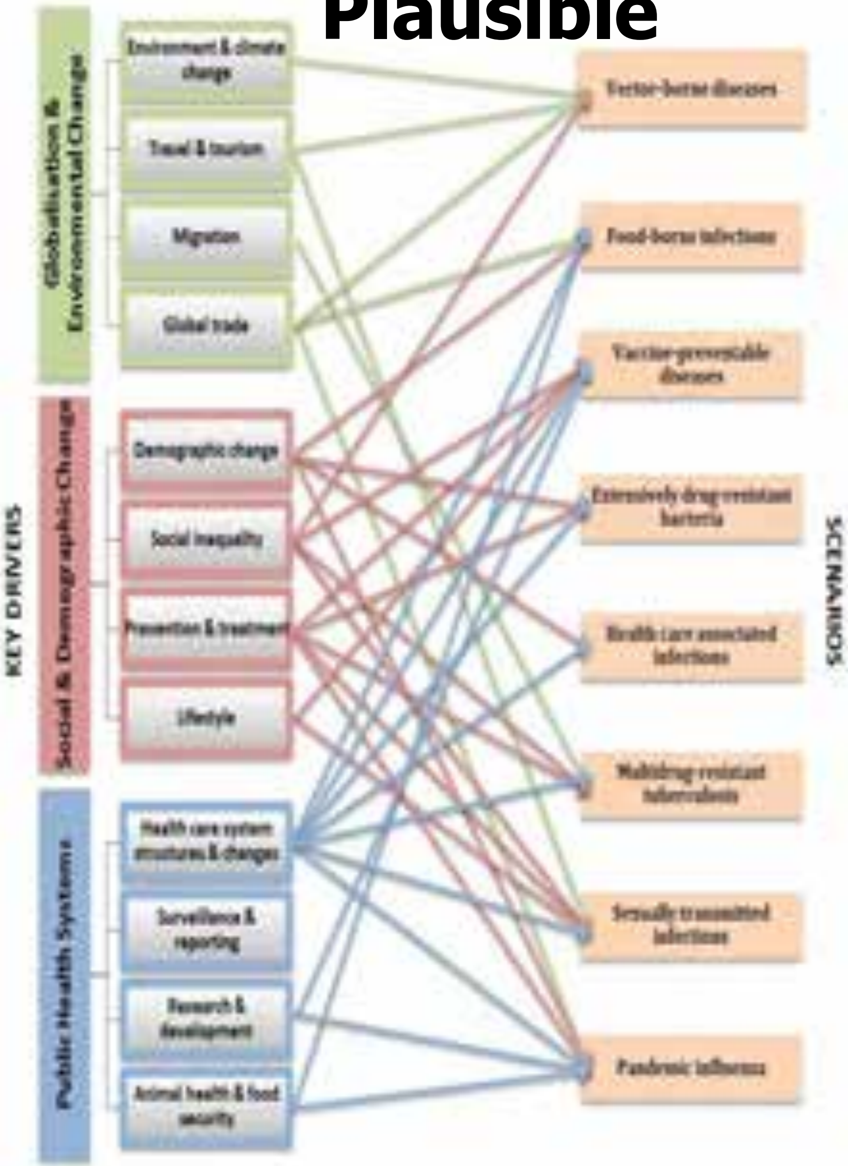
Association of IHR core capacities with infectious disease threat events, Europe, 2010–2016.



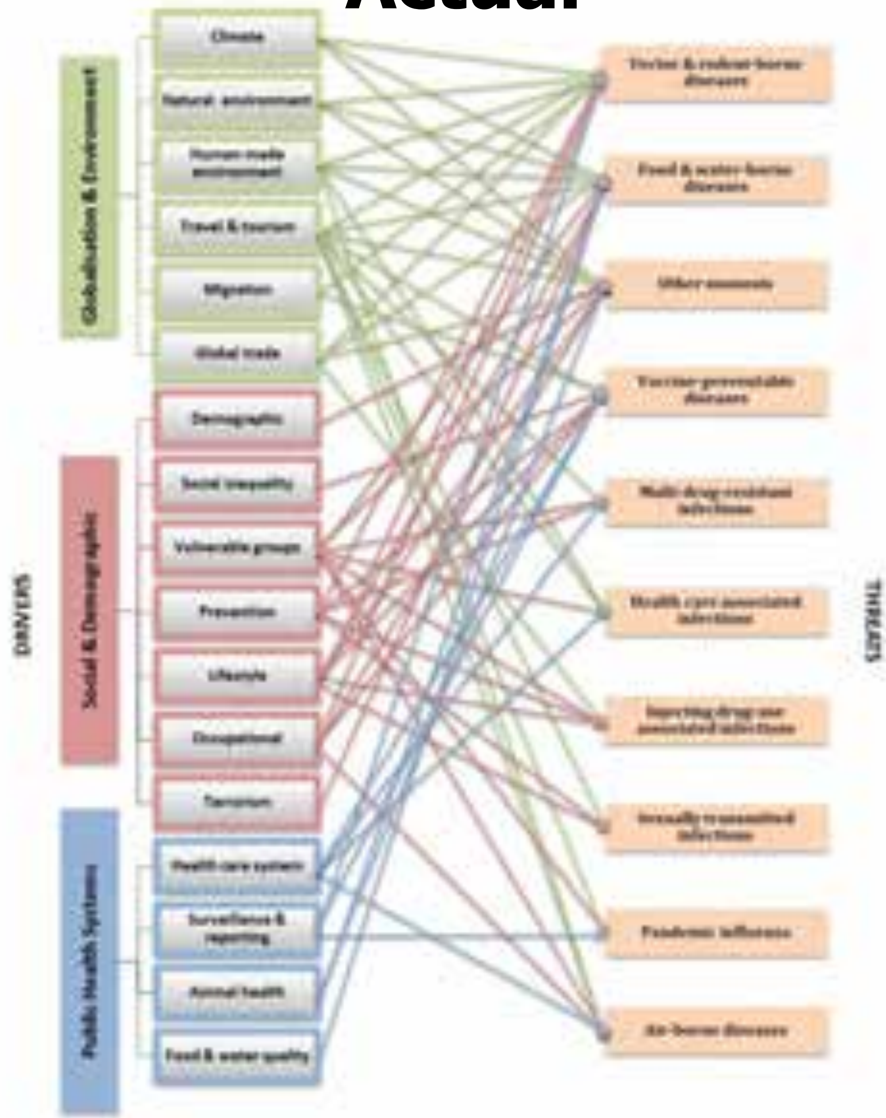
Semenza JC et al., *Transbound Emerg Dis*. 2019 Apr 25. doi: 10.1111/tbed.13211.

IDTE drivers with plausible and actual scenarios

Plausible



Actual



Semenza JC, et al., *Ann N Y Acad Sci* . 2016;1382(1):73-83.

Conclusion

- The most important **category** of drivers of Infectious Disease Threat Events (IDTE) was **global environmental change**, contributing to 61% of all IDTE in Europe

- **Trade and travel** was the most important single driver of IDTE in Europe but climate is also an important driver

- By **monitoring** these climatic and environmental **precursors of disease** it might be possible to **predict** and **intercept** outbreaks

- Improvements in IHR **core capacities** can help reduce the incidence of cross-border IDTE in Europe

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IDTE

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