Citizens, Citizen science and the common quest to improve air quality in Europe

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Abstract

Air quality in Europe is constantly changing along with changes in human activities. The European Union has put in place legislative instruments to ensure that the air we breathe is not harming our health, but latest reviews show that these precautions are not enough, and in addition, even today's legislation is not fully complied with.

This is the backdrop for a rising interest of citizens in their local air quality, accompanied with an increased access to monitoring technologies. While this serves as an excellent basis for a public dialogue on air quality and how to improve it, there are also major challenges related often to data quality and comparability.

I will show examples of European citizen activities, as well as how selected authorities are meeting the information and public involvement challenges, and I will conclude with an example from Norway of a possible collaborative effort that allows to develop synergies between individual activities and citizen science, and the work of authorities, with the aim to co-create better air quality.

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Outline

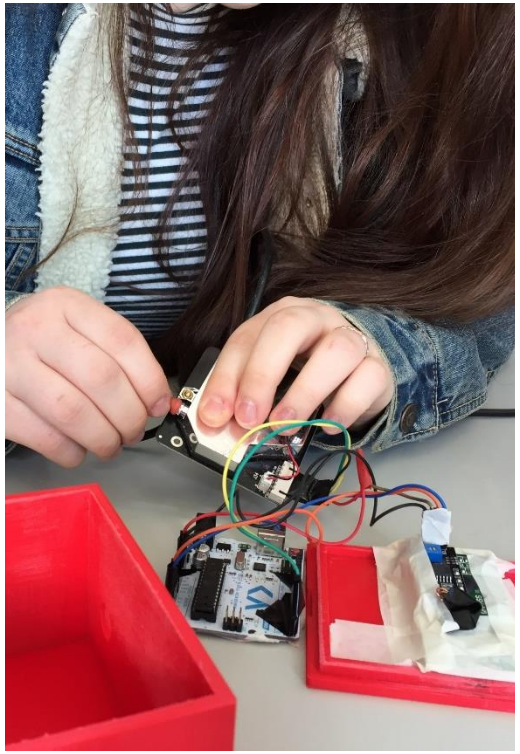
How good is the air quality?

How did we get here?

What does the public think?

Can the public & new technologies help?

What are the next steps?



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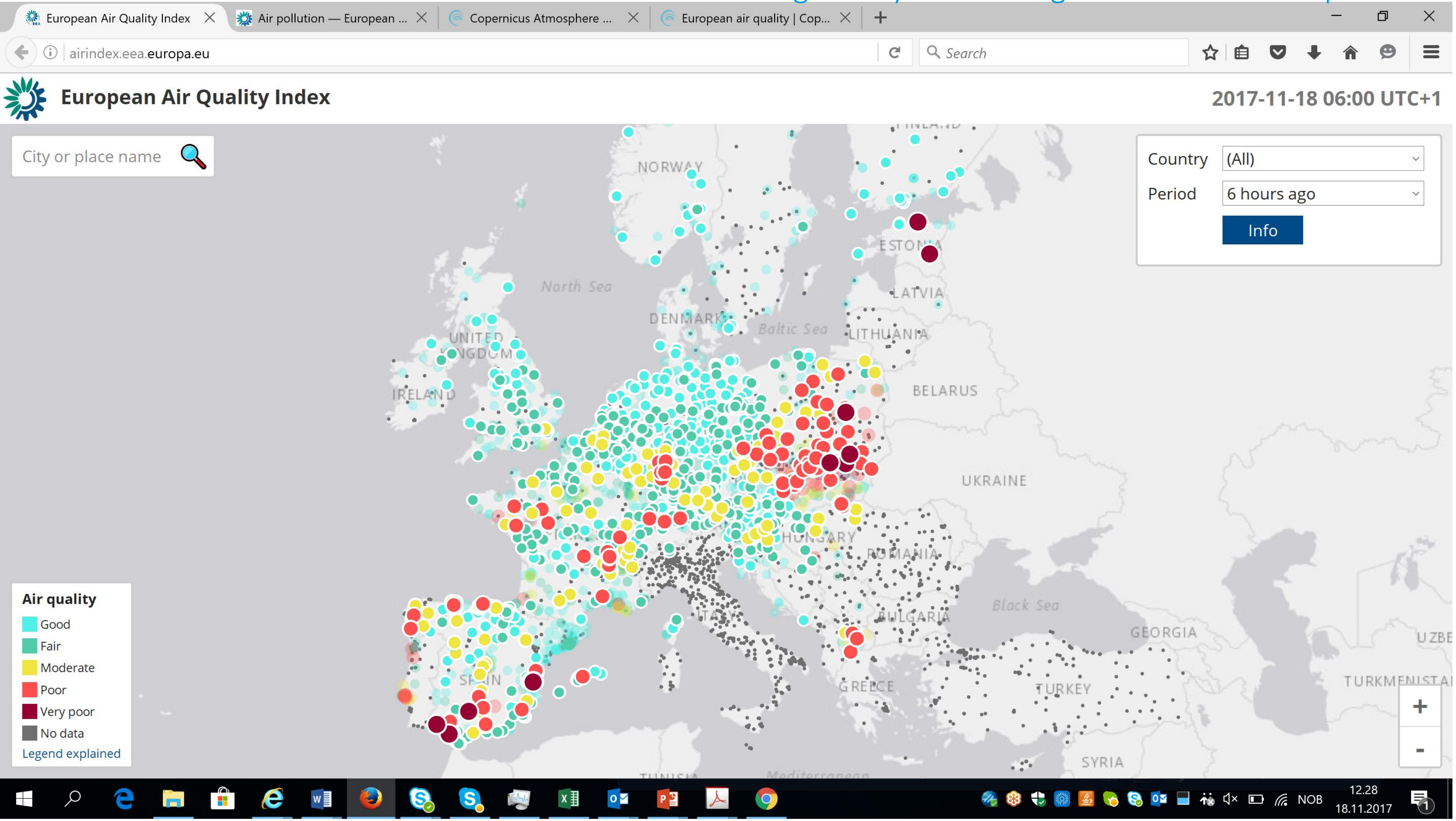
airindex.eea.europa.eu

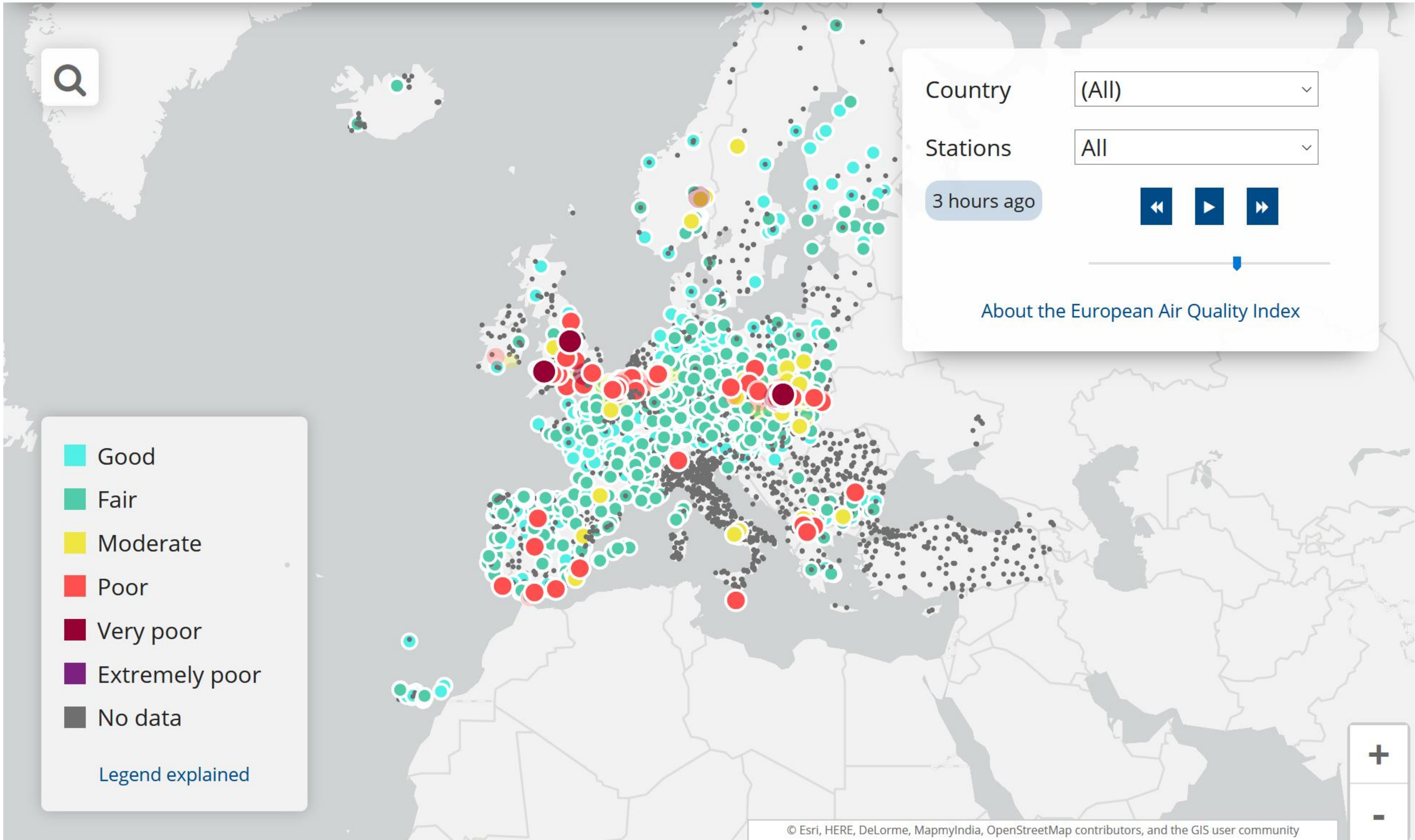
http://www.eea.europa.eu/themes/air/air-quality-index/index

regulatory monitoring combined with Copernicus observing system



European Air Quality Index

2020-11-06 06:00 UTC+1



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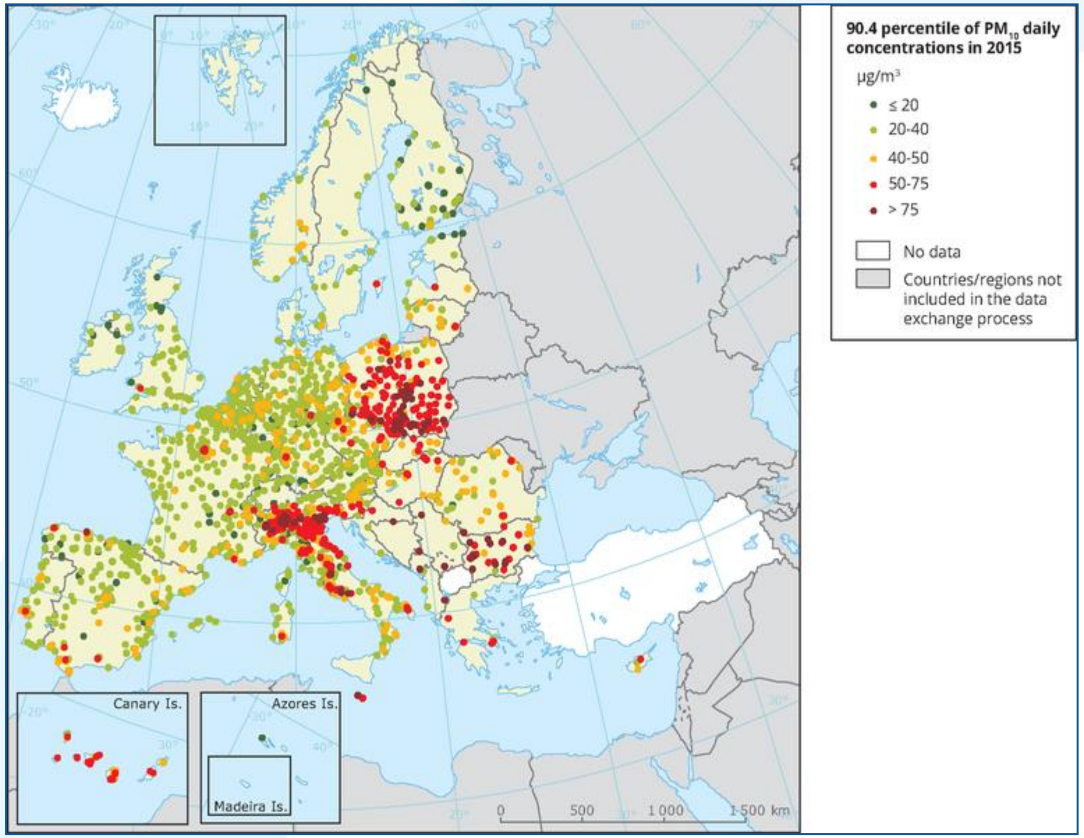
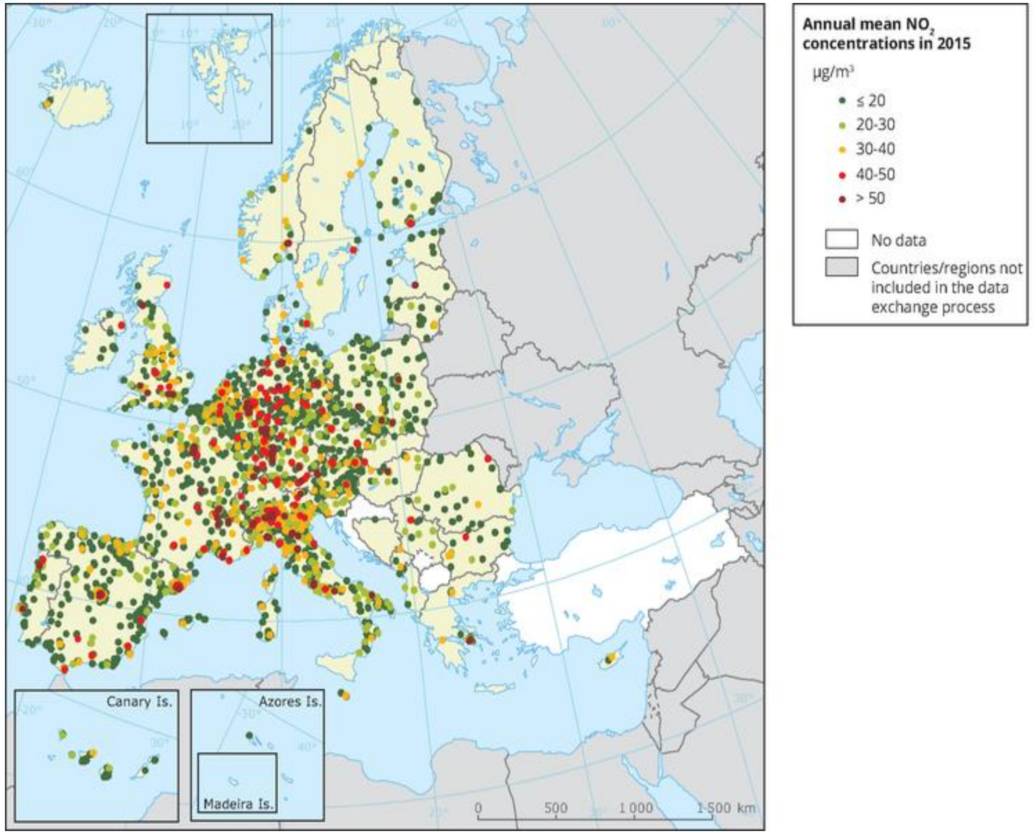
Air pollution in Europe – A widespread issue

PM10 exceedances: often linked to fuel combustion (energy, heating)



NO2 exceedances: often linked to traffic, in more than 130 cities in EU



Source(s): EEA Air Quality in Europe (2017)

Air pollution still a problem?

Table ES.1 Estimated damage costs aggregated by pollutant group, 2008–2012 (2005 prices)

Pollutant group	Aggregated damage cost (billion EUR_{2005})				
	2008	**2009**	**2010**	**2011**	**2012**
Main air pollutants (NH_3, NO_x, PM_{10}, SO_2, NMVOCs)	58–168	47–136	44–129	43–124	40–115
CO_2	20–82	18–73	19–76	18–74	18–73
Heavy metals (As, Cd, Cr, Hg, Ni, Pb)	0.53	0.34	0.43	0.34	0.34
Organic pollutants (benzene, dioxins and furans, PAHs)	0.22	0.11	0.17	0.22	0.10
Sum	**79–251**	**65–209**	**64–206**	**62–199**	**59–189**

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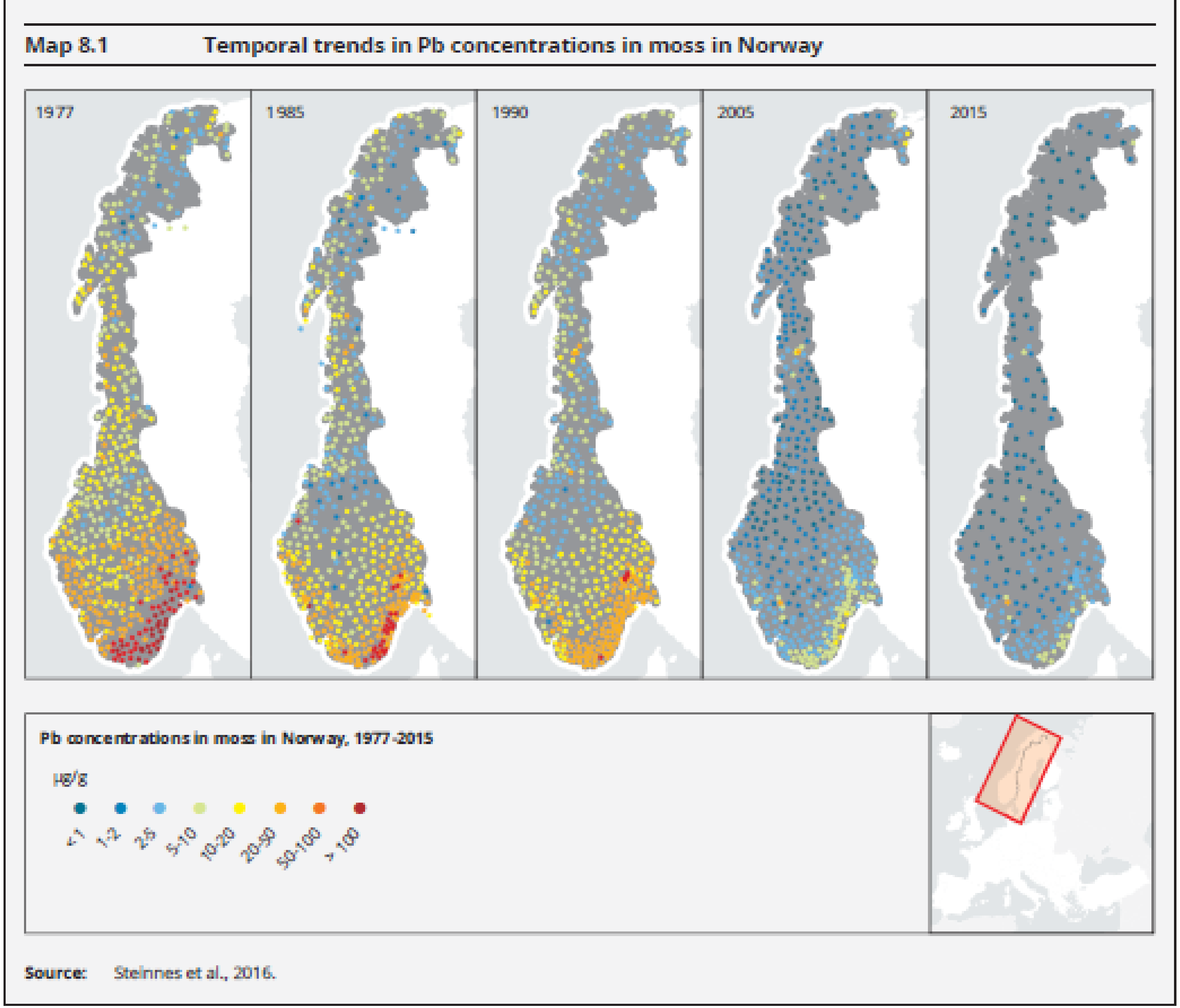
Source: EEA, «Costs of air pollution from industrial facilities «, EEA technical report no. 20/2014, available at https://www.eea.europa.eu/publications/costs-of-air-pollution-2008-2012

Air Quality in Europe 2019

https://www.eea.europa.eu/publications/air-quality-in-europe-2019



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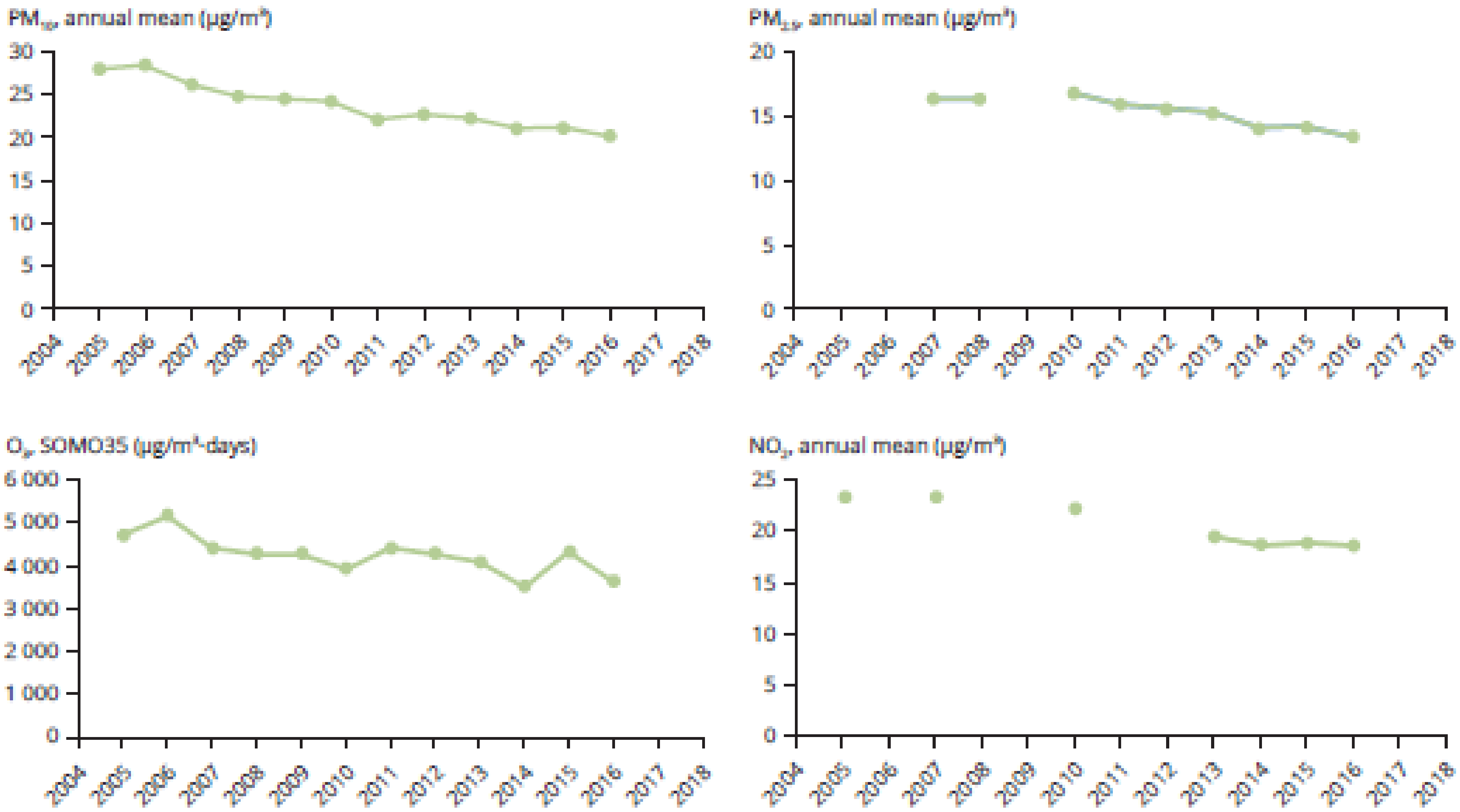
Air Quality in Europe 2019

https://www.eea.europa.eu/publications/air-quality-in-europe-2019

Figure 9.2 Changes in total European population exposure to PM_{10}, $PM_{2.5}$, (annual mean), O_3 (SOMO35) and NO_2 (annual mean) from 2005 to 2016



Note: Exposure is expressed as population averaged concentrations. The total European population does not include Turkey, since, in the years before 2016, it was not included in the interpolated maps.

A short history of European air quality

1970's: Acid Rain (regional), UN ECE CLRTAP

1980's: CLRTAP protocols; local and urban air; persistent pollutants

1990's: European Environment agency (EEA). Arctic, Climate Change

2000's: EU directives on air quality; Antarctic monitoring; integrated assessments

2010's: Low-cost sensor technologies «democratizing» air quality

Living well, within the limits of our planet

7th Environment Action Programme

European Commission

environment

European Commission

Joint Research Centre

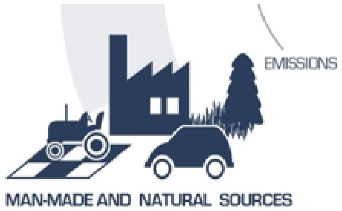
EU Clean Air Policy – The policy framework

Air Quality Directives

Maximum concentrations of air polluting substances

CONCENTRATIONS

EMISSIONS



National Emission Ceilings Directive

National emission totals (SO_2, NO_x, VOC, $PM_{2.5}$, NH_3)

Source-specific emission standards

- IED Directive
- MCP Directive
- Eco-design Directive
- Energy efficiency
- Euro and fuel standards

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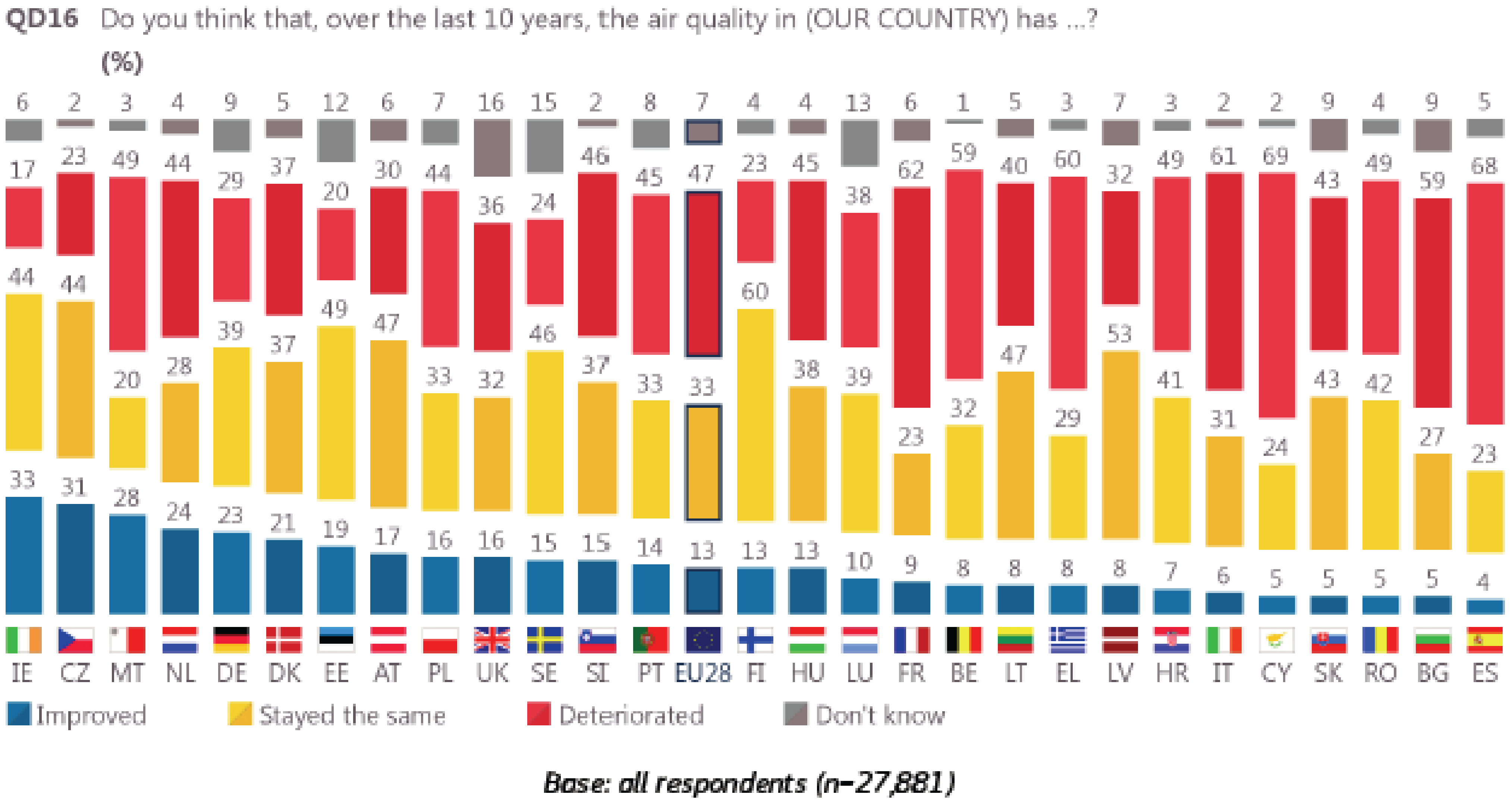
European Environment Agency
European Topic Centre on Air pollution, transport, noise and industrial pollution

Air pollution in Europe: EEA (2017)

https://www.eea.europa.eu/highlights/improving-air-quality-in-european

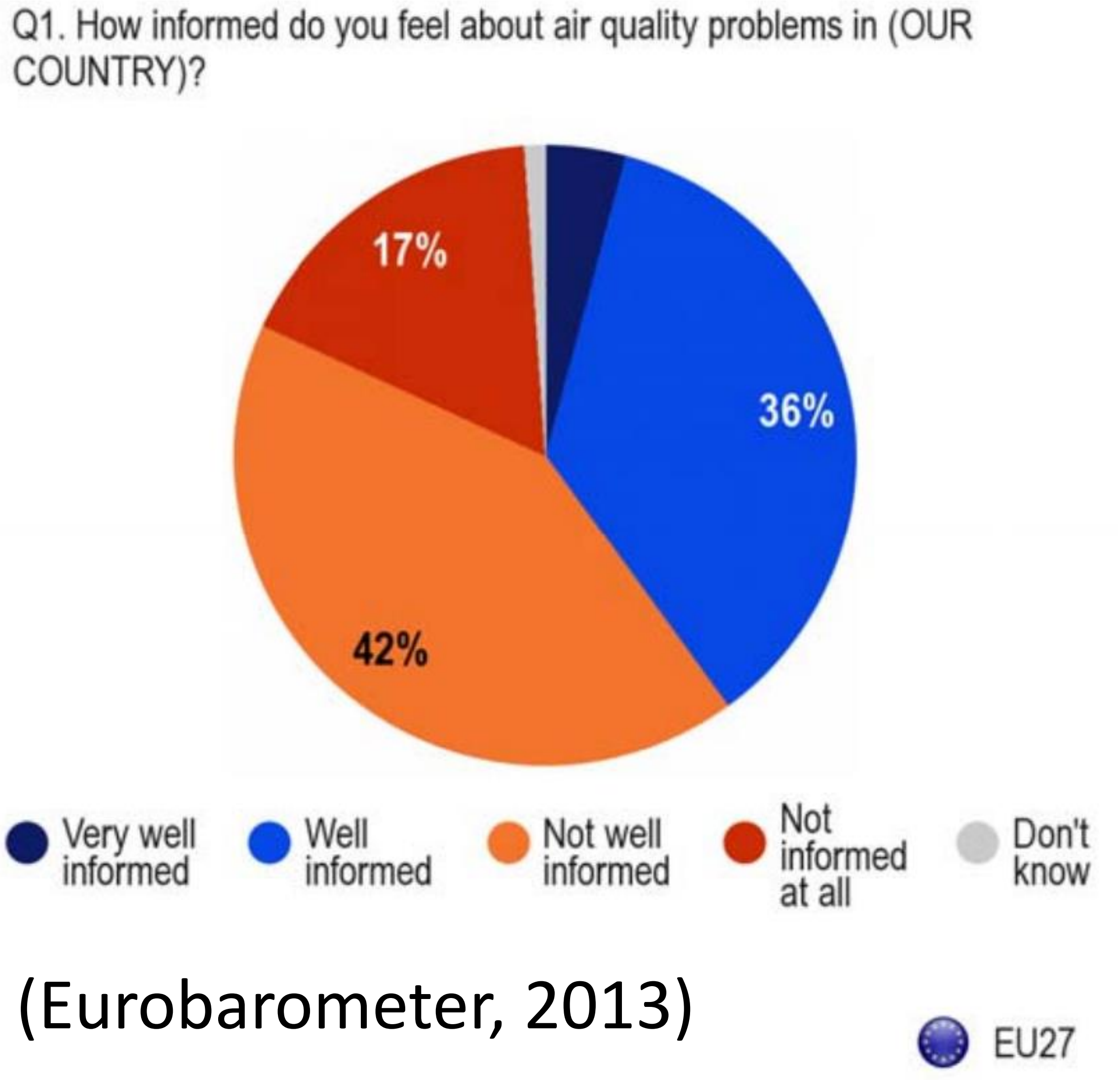
	EU limit/target values	WHO guidelines
$PM_{2.5}$	7–8 %	82–85 %
PM_{10}	16–20 %	50–62 %
O_3	7–30 %	95–98 %
NO_2	7–9 %	7–9 %
BaP	20–25 %	85–91 %
SO_2	<1 %	20–38 %

But perception of change….



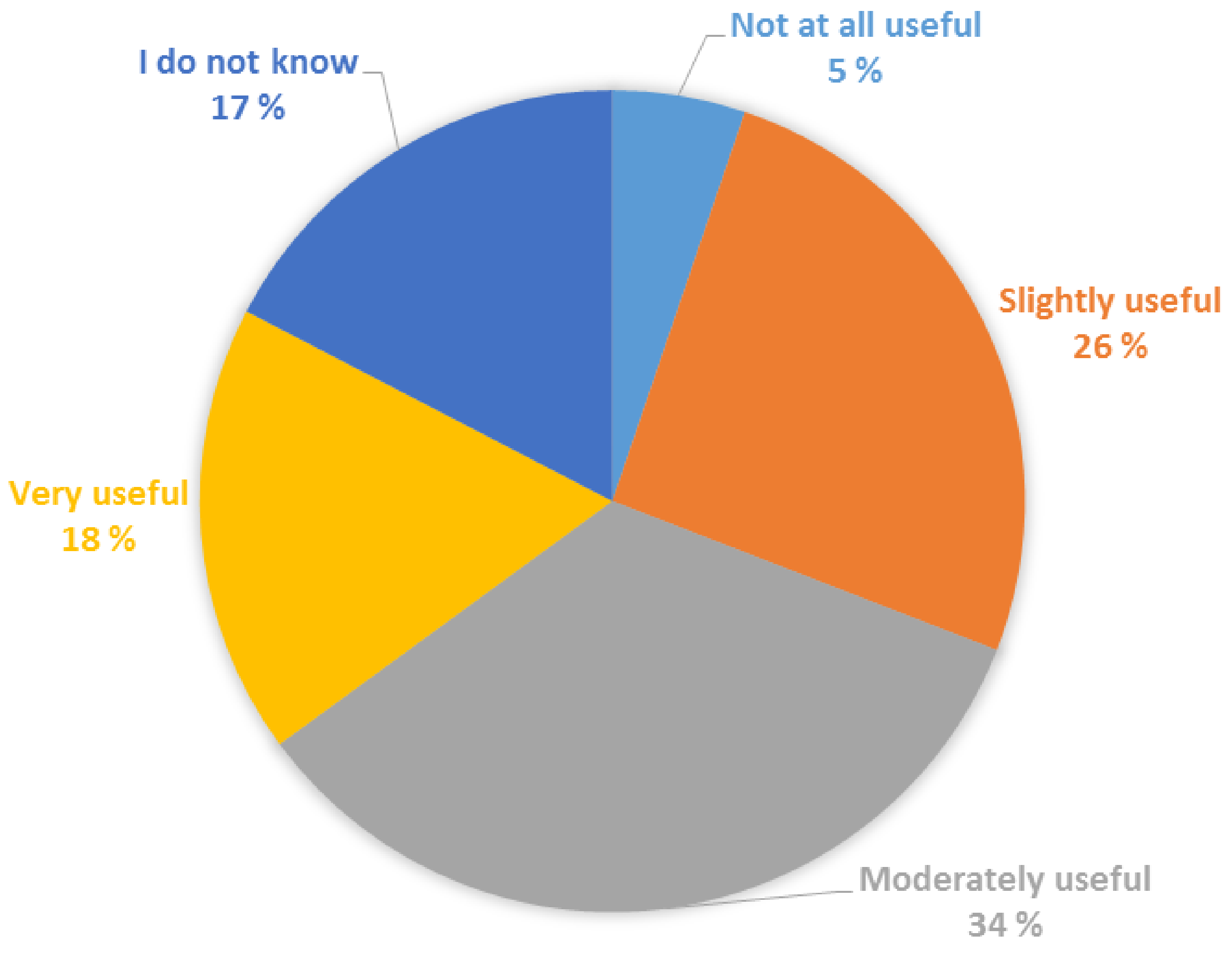
Source: Special Eurobarometer 468/2017

Well informed?



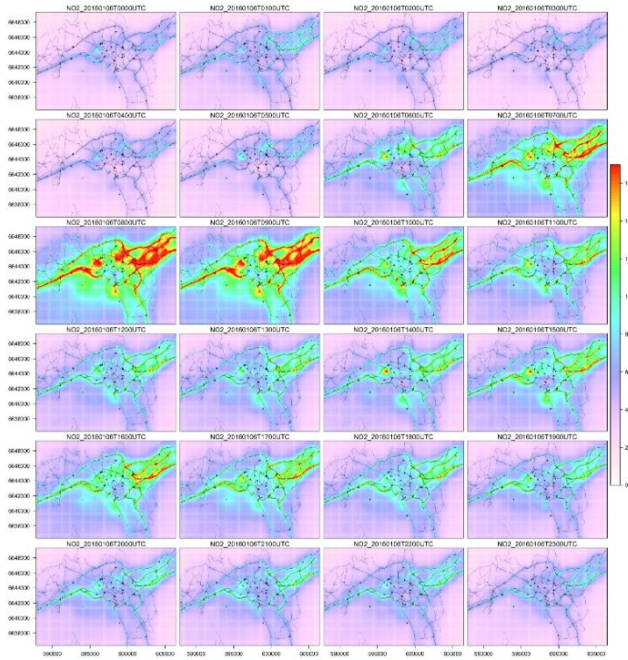
(Eurobarometer, 2013)

Public info on AQ in Oslo



Source: unpublished results for Oslo, CITI-SENSE project.

New technologies – new applications



CITI-SENSE

Citi-Sense-MOB

hackAIR

InnoSense

LEOPARD

IFLINK

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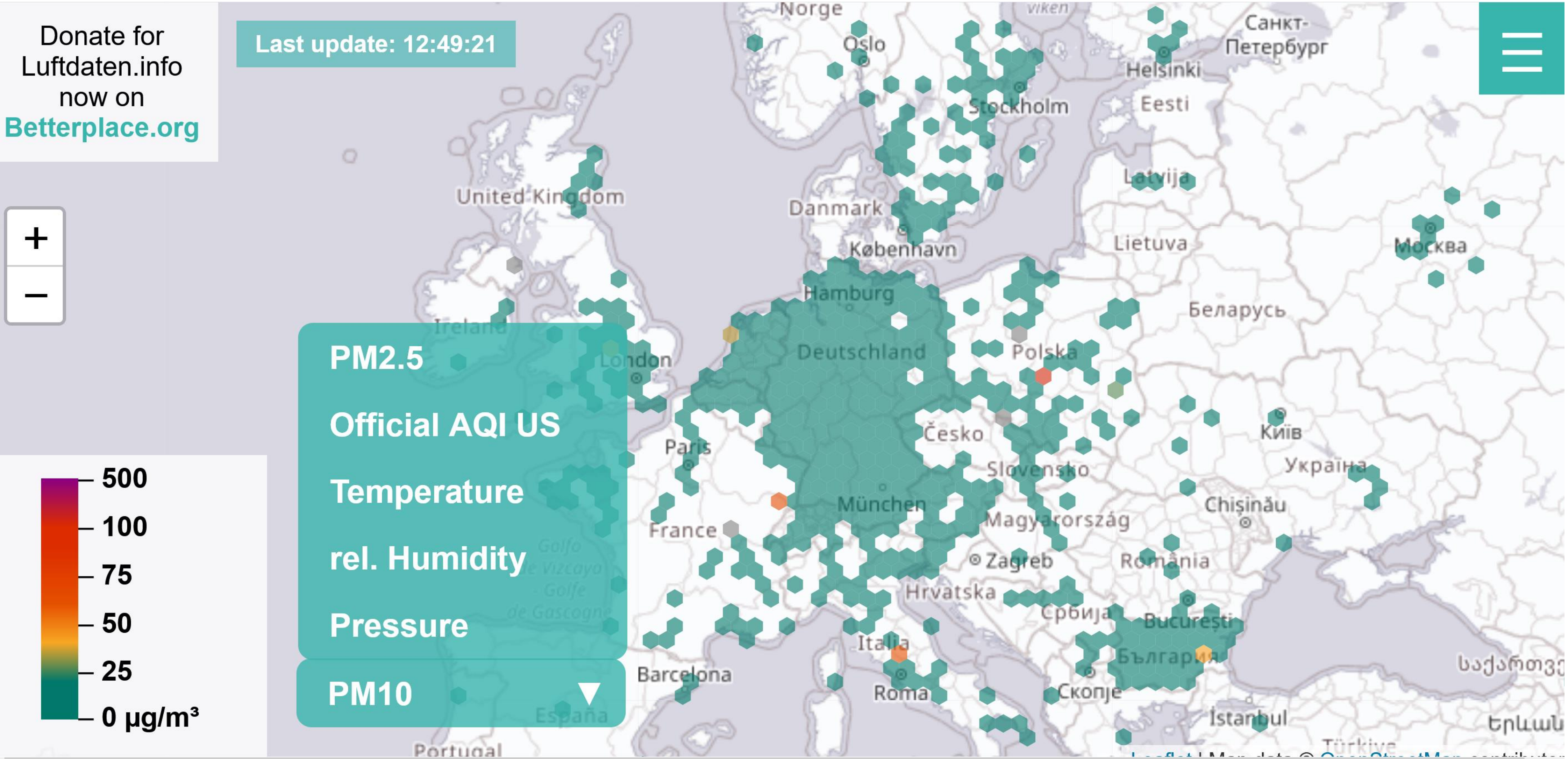
2012

2020

https://deutschland.maps.luftdaten.info/#4/51.18/6.96

Heightened interest in AQ

https://luftdaten.info/en/home-en/



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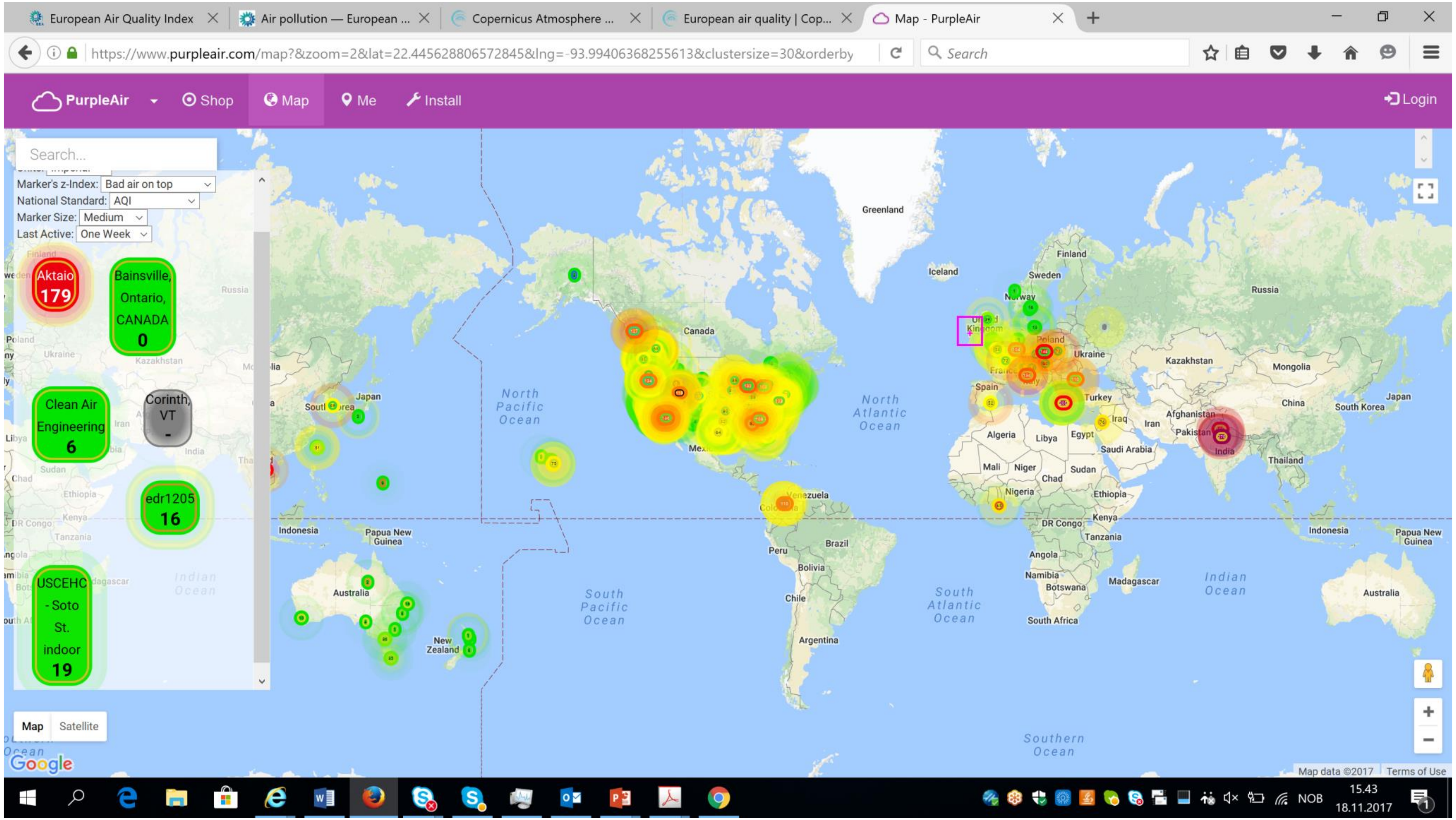
PM sensors Purple Air: https://www.purpleair.com/map



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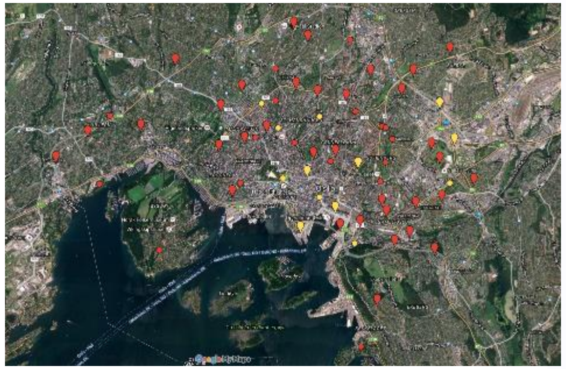
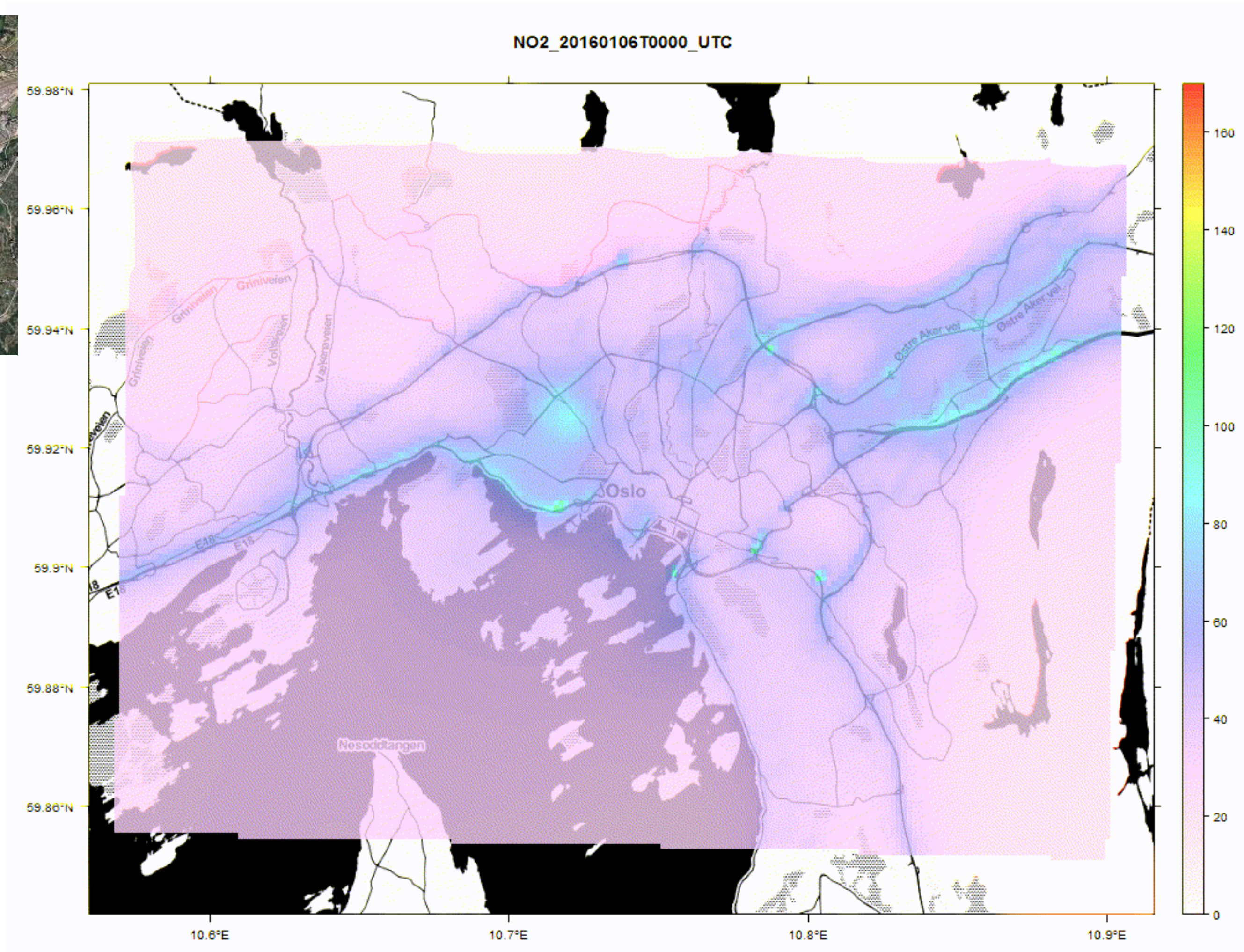
Real time air quality map





Source: Schneider, P., Castell, N., Vogt, M., Dauge, F. R., Lahoz, W. A., & Bartonova, A. (2017). Mapping urban air quality in near real-time using observations from low-cost sensors and model information. *Environment International*, *106*, 234-247. doi:10.1016/j.envint.2017.05.005

Information on air quality

- Up-to-date, near-real-time situation (limited QA/QC) **(the public)**
- Historical situation (excellent QA/QC) **(all users, a baseline)**
- Short-term prediction of air quality (usually, national level; no rules on what is acceptable QA/QC) **(authorities, the public)**
- What-if: scenarios related to implementing of measures to improve air quality (no general QA/QC requirements, other than related to eventual hypotheses) **(authorities, corporate users)**

Today, all four kinds of information are generated as a combination of data from multiple sources, see e.g.,

- FAIRMODE Forum for air quality modeling, https://fairmode.jrc.ec.europa.eu/
- Copernicus Atmosphere Monitoring Services

Technologies: fit for purpose

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Atmosphere **2019**, *10*(2), 41; https://doi.org/10.3390/atmos10020041

Open Access Article

Performance Assessment of a Low-Cost $PM_{2.5}$ Sensor for a near Four-Month Period in Oslo, Norway

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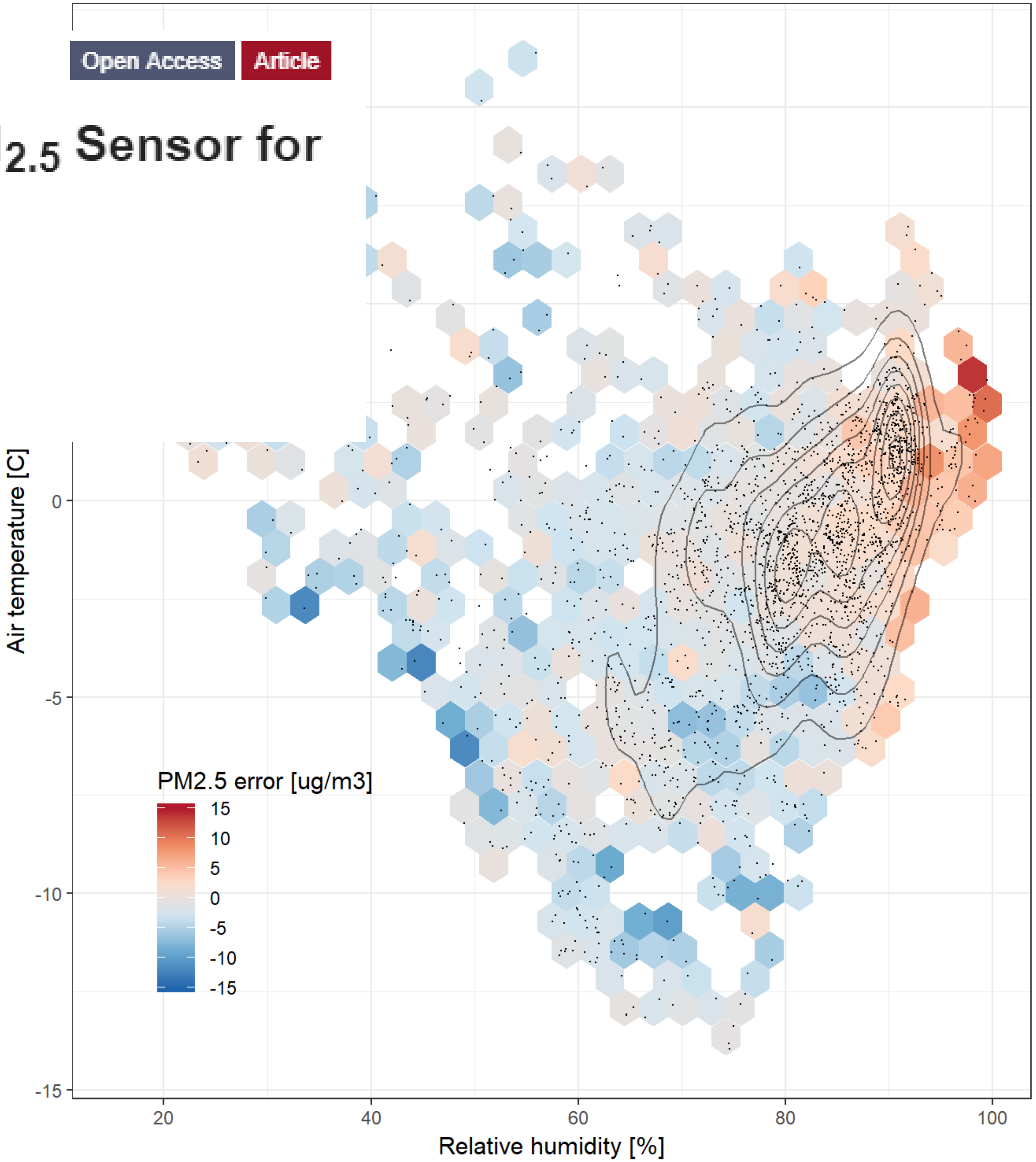

Strong error dependence on relative humidity, particularly at RH over ca. 80%. No significant dependence on air temperature.

Legislation & AQ policy

International — **European Directives** + **International Conventions**

National — **Norwegian Law**

Local — **AQ policies**
- National level
- Municipality level

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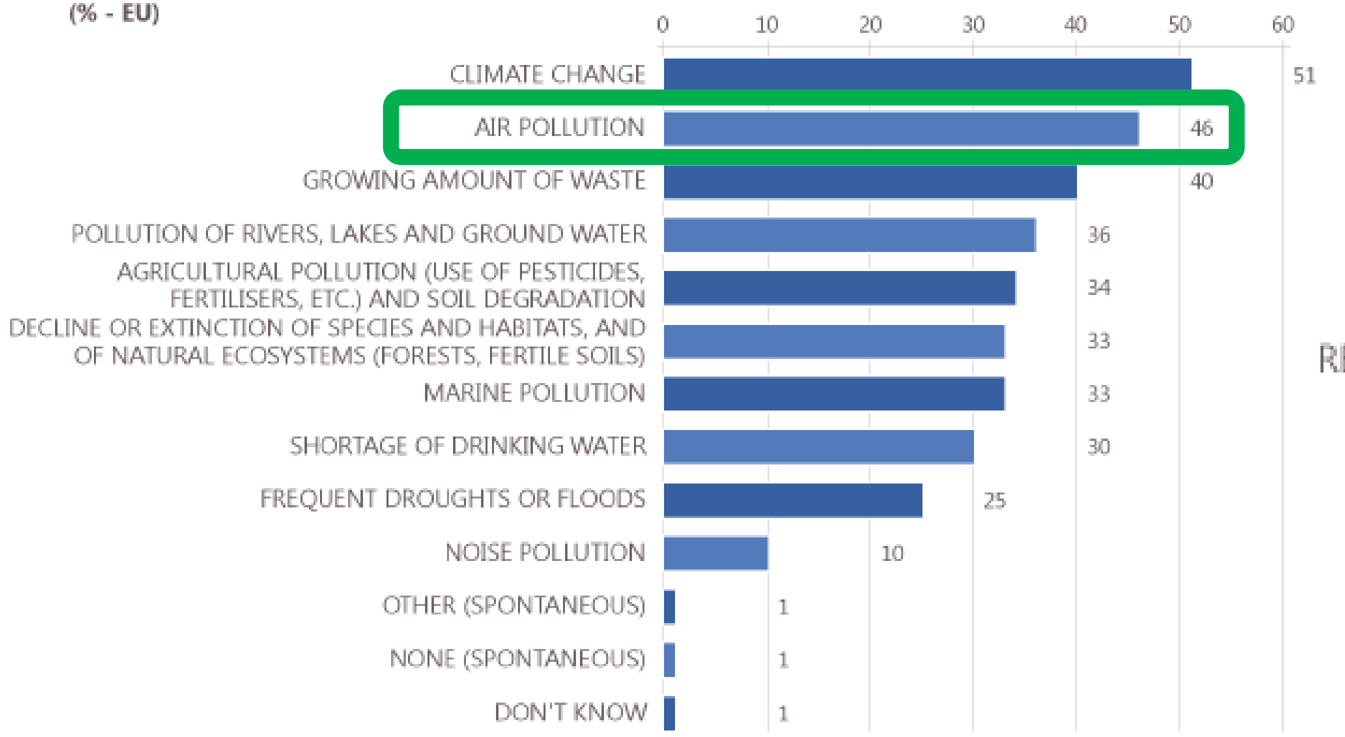
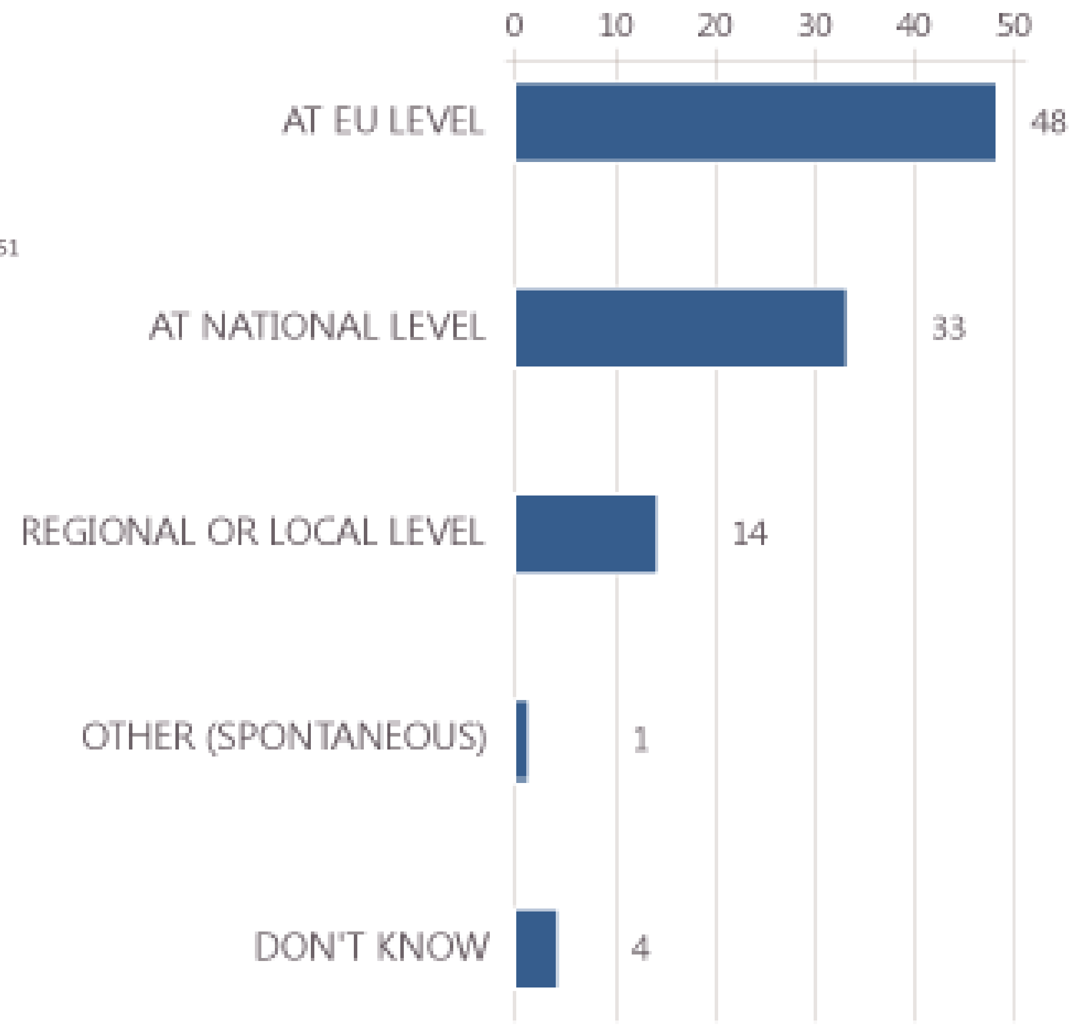
Responsibilities?

QD2 From the following list, please pick the four environmental issues which you consider the most important.
(MAX. 4 ANSWERS)
(% - EU)



Base: all respondents (n=27,881)

QD18 In your opinion, at what level can the issue of air pollution best be addressed?
(% - EU)



Base: all respondents (n=27,881)

Source:
Special Eurobarometer
468/2017

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Who should take care of AQ? (first choice)

Inhabitants & occupants	6
Researchers	1
Everybody	1
Industy, commerce &oth	161
Municipality & others	112
Other	14
DN	1

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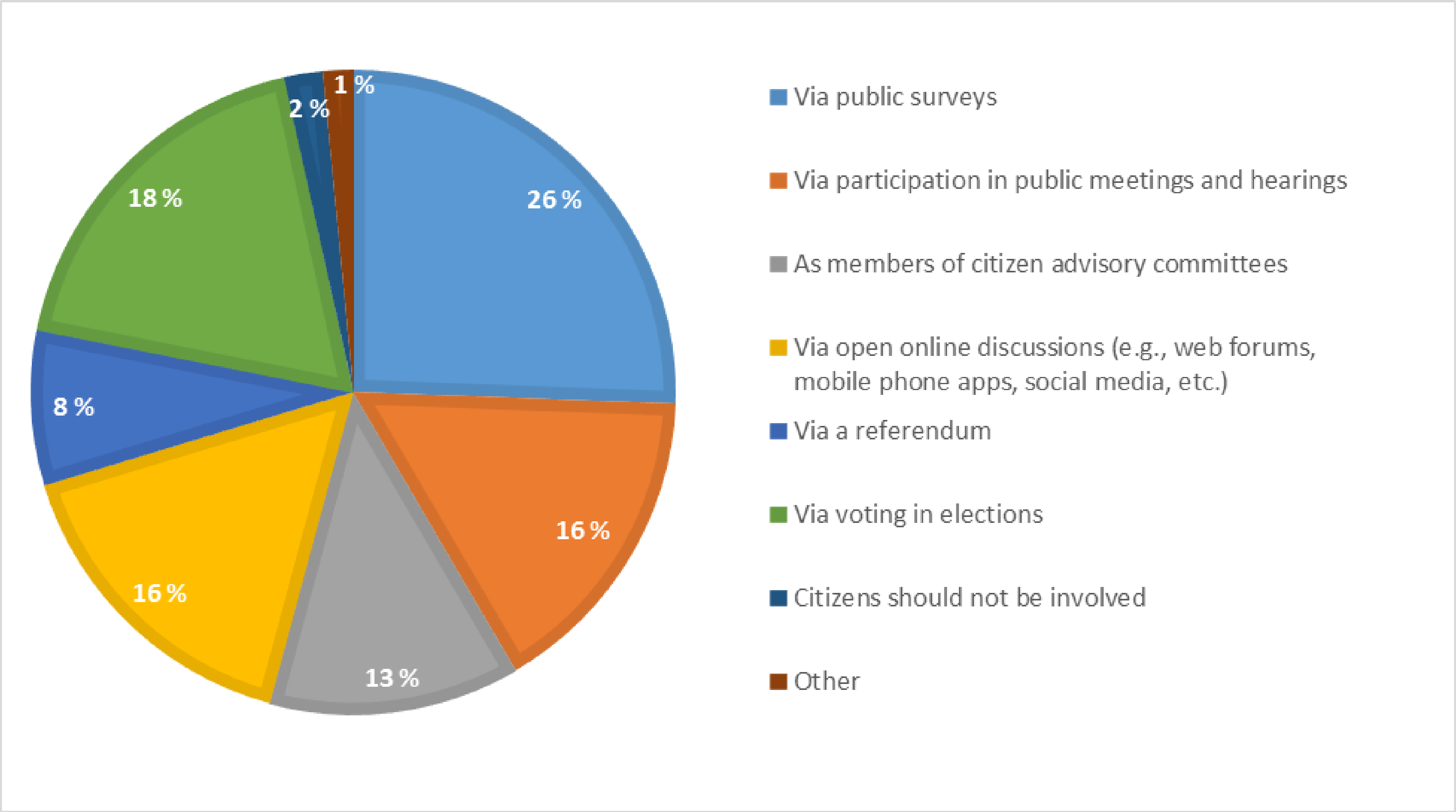
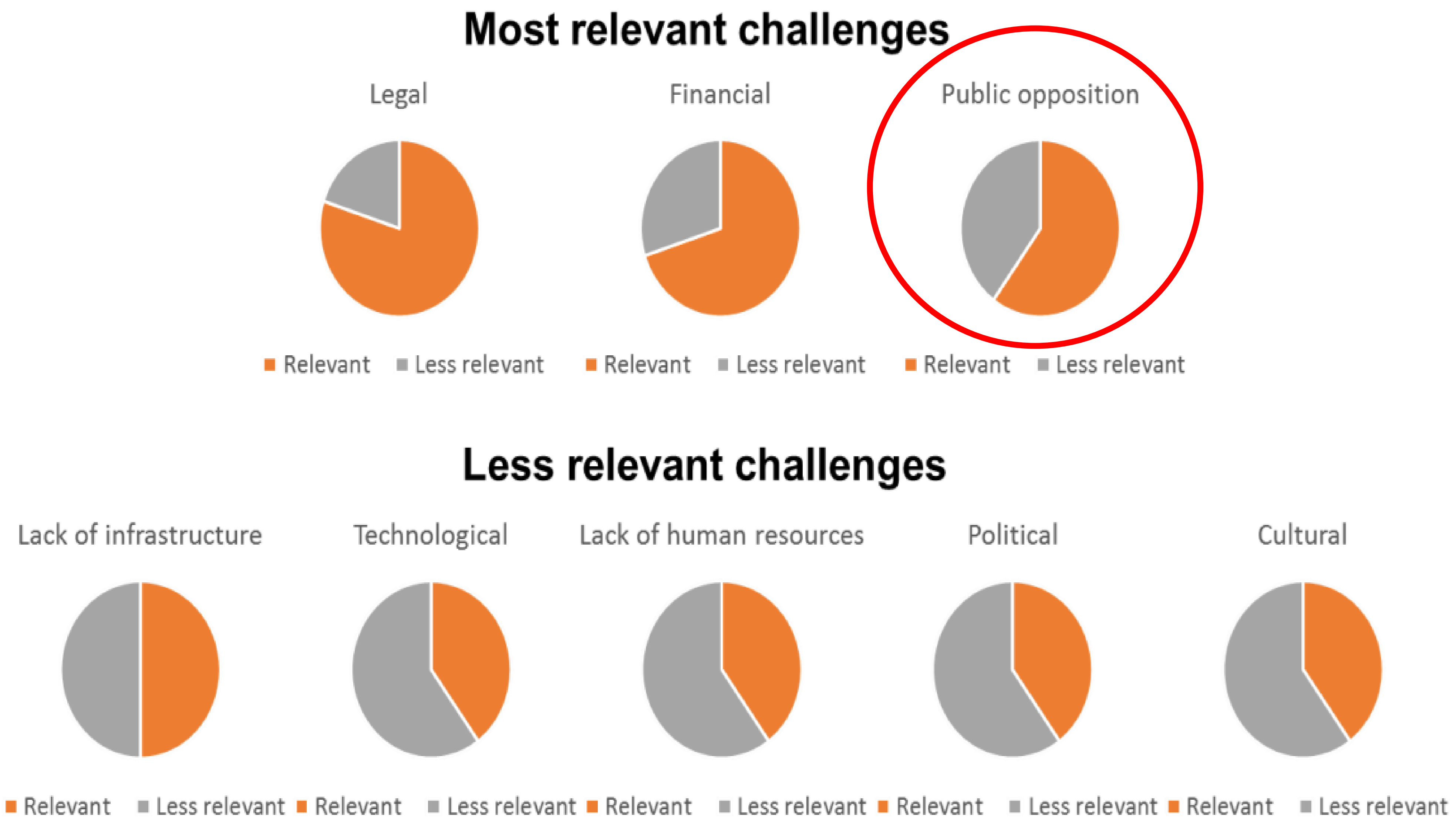
Source: unpublished results for Oslo, CITI-SENSE project.

How should citizens get involved?



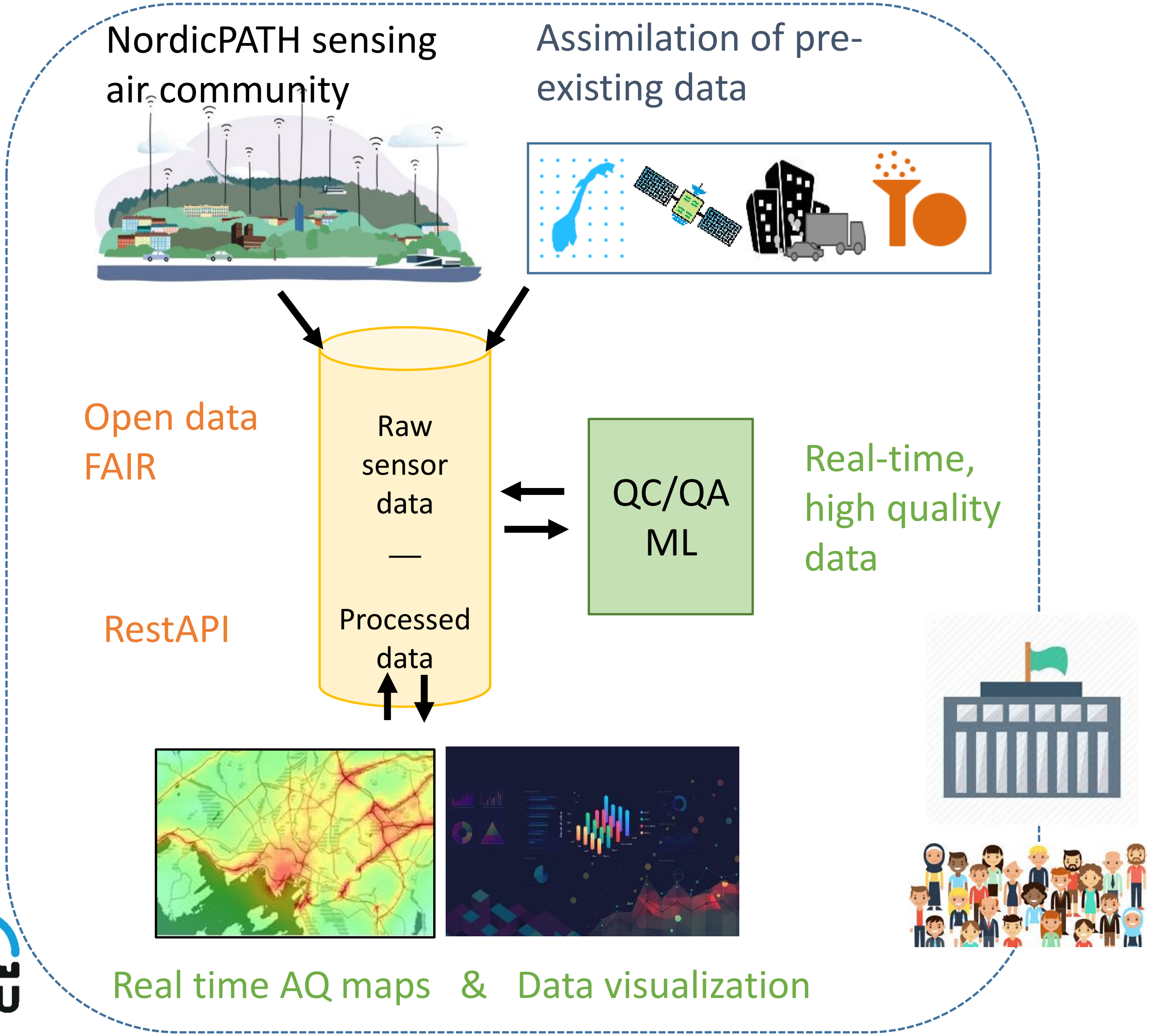
Source: unpublished results for Oslo, CITI-SENSE project.

Municipalities: challenges in combatting AQ



Source: Viana, M., et al **Europes urban air quality - re-assessing implementation challenges in cities** EEA report no. 24/2018

A solution: Environmental co-monitoring?



Co-design of low-cost environmental sensors with citizens will lead to the co-creation of new **urban air monitoring communities** with an impact on urban sustainability.

Citizen collected data is often of questionable quality and possibilities to include them in decision-making is therefore limited.

Research needs: algorithms for calibration and validation of the sensor systems and on new methods to make use of low-quality data, derived from low-cost sensors.

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Source: Nuria Castell, project NordicPath, ncb@nilu.no

Municipalities' challenges

- Technologies
  - How do we use the new technologies?
  - How do we relate to data by citizens?
- Procurement
- Governance
  - How do we create a system that will allow to bring in the citizen's views, citizen science results, and citizen involvement into co-decisions?
  - Are the existing processess good enough? How do we change e.g., urban planning, to allow for (real) co-decisions?

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Acknowledgements

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Thank you!
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