

# The value of citizen science on air quality monitoring and protection

Leveraging Community Involvement for Better Air Quality

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**The pressure on cities to address urban challenges is overwhelming.**

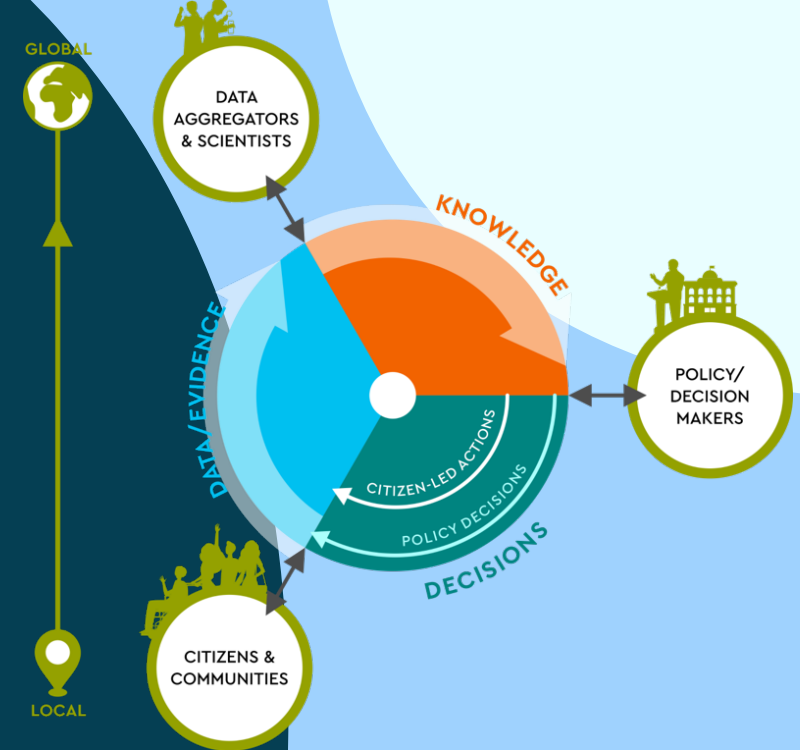
The required measures are likely to be found not only in **technological development** (e.g. monitoring systems, electric mobility, carbon capture) but also in the required **social transformation** (e.g. increasing citizen involvement and engagement with science and policy, awareness raising, societal actions).





# What is Citizen Science?

- Citizen science involves public participation in scientific research<sup>1</sup>. Volunteers collect data, share observations, and help analyze results
- Citizen science has become particularly valuable in environmental monitoring, especially for tracking air pollution where official monitoring is sparse or insufficient
- Allows for data collection at a larger scale, increases public awareness, and empowers local communities



Citizen Science increases awareness, involvement and engagement of citizens from all backgrounds and age with science and policy.

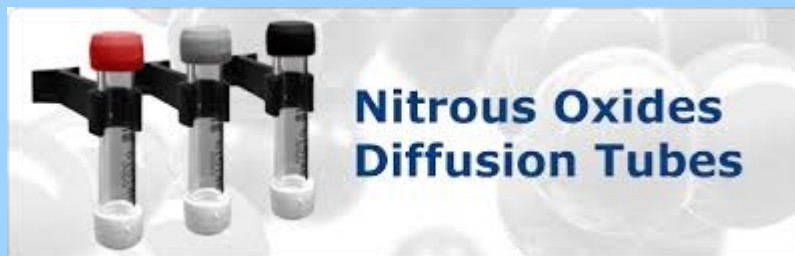


[1] Kruger, L. E. & Shannon, M. A. Getting to know ourselves and our places through participation in civic social assessment. Society & Natural Resources 13, 461-478 (2000).

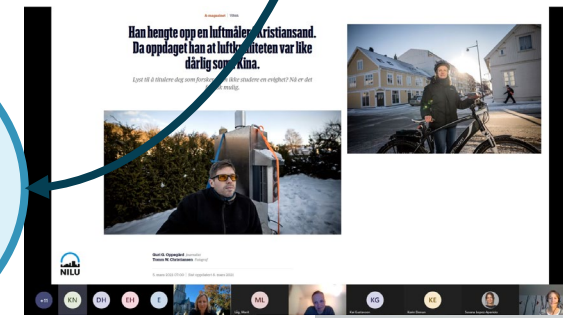
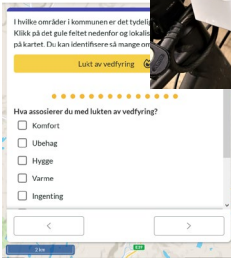
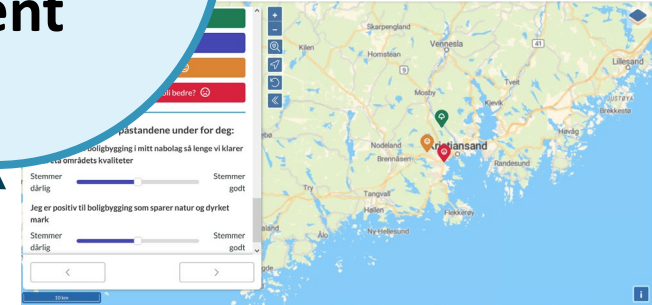
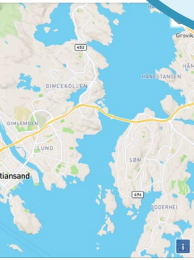
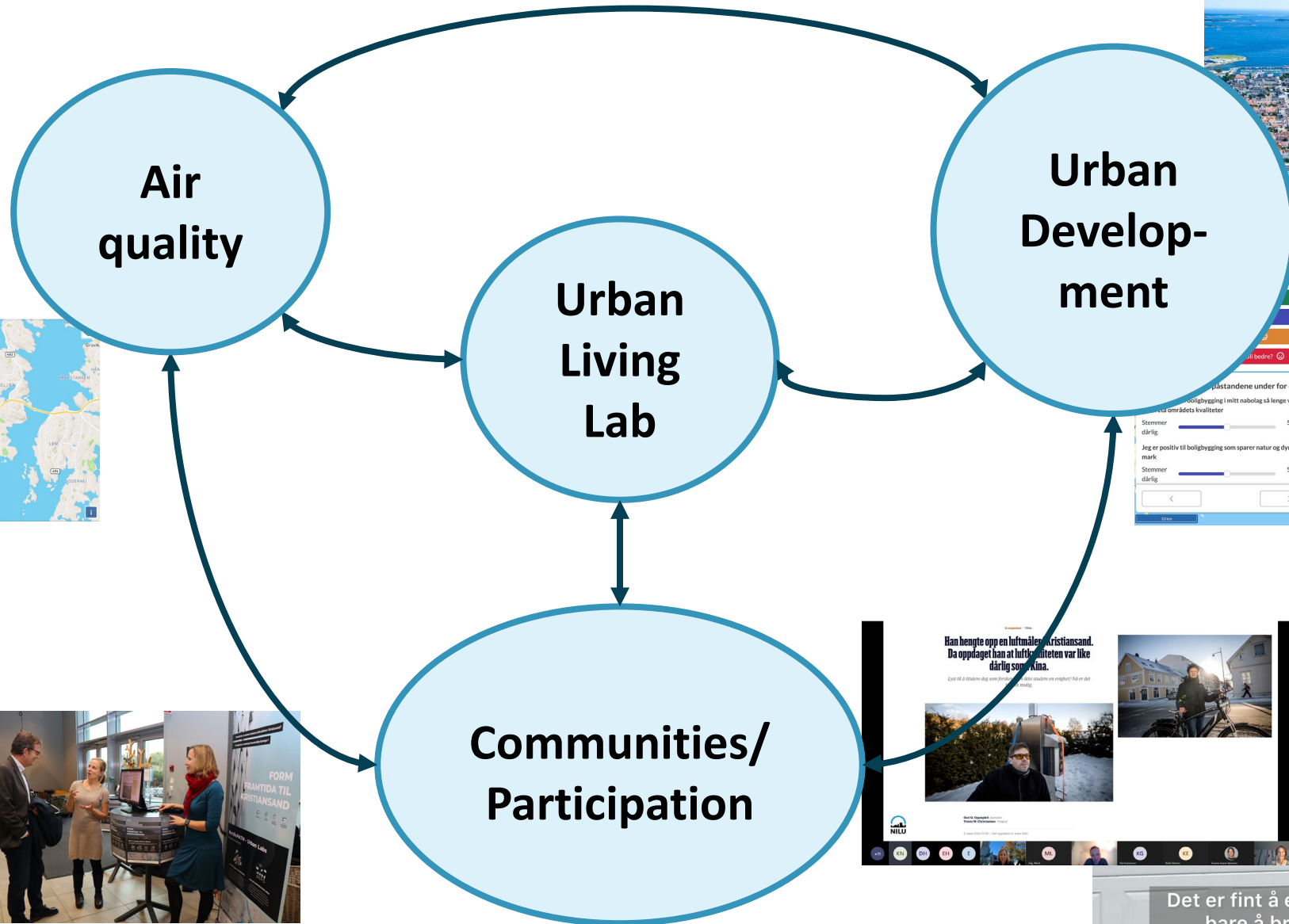
# How Does Citizen Science Work for Air Quality?

- Low-cost sensors (e.g., PurpleAir, AirBeam) measure pollutants like NO<sub>2</sub>, PM<sub>2.5</sub>, and ozone
- Smartphone apps and platforms for easy data submission (e.g., OpenAQ, AirVisual)

Citizens can: Install sensors in homes, schools, or workplaces  
Report real-time data on air quality in their neighborhoods  
Participate in local campaigns and workshops

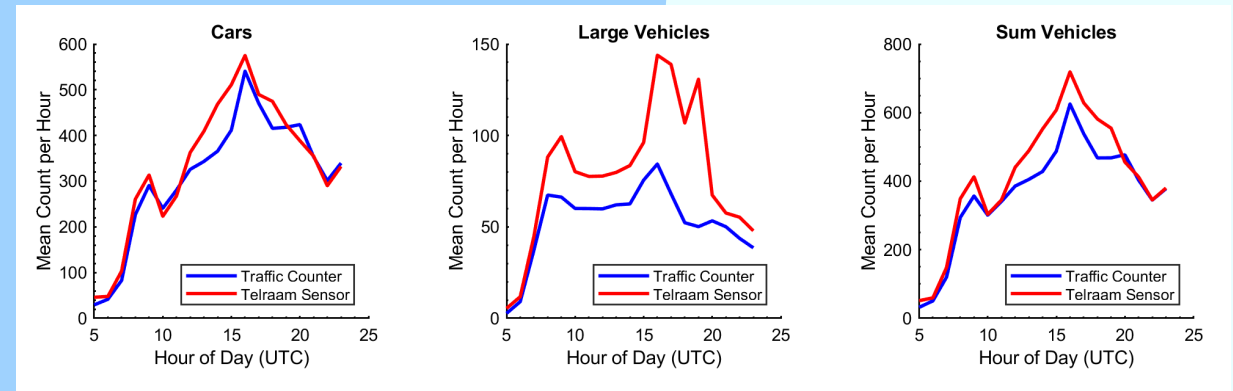


# ULLs – Smart planning for healthy and sustainable cities



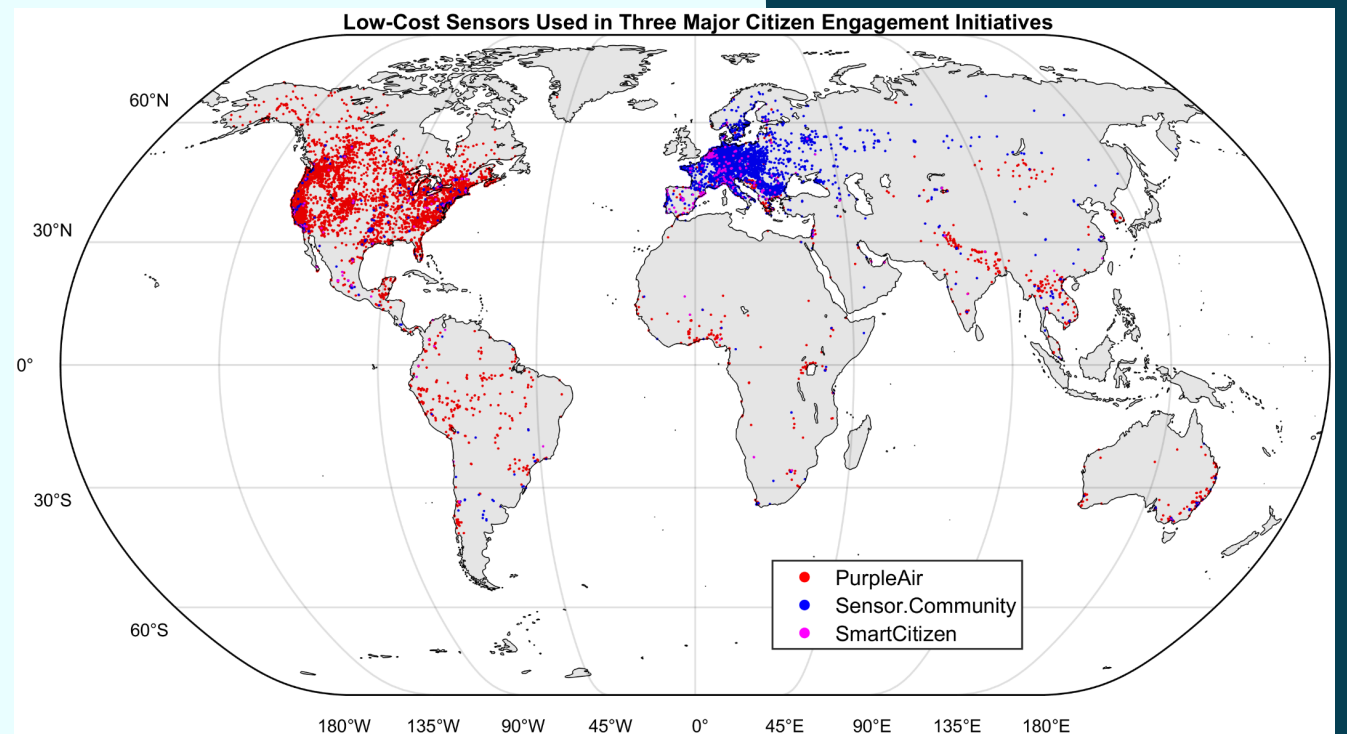
Det er fint å erfare det selv, at det er ikke bare å bruke opp den luften vi har.

# Traffic Count Monitoring



# Real-World Examples of Citizen Science in Air Quality

- PurpleAir Network (Global): A global network of low-cost air quality sensors deployed by citizens. Data from these sensors can complement official monitoring stations. Benefits: Real-time data, large coverage, engages people in air quality awareness.
- The Sensor.Cimcommunity (Europe): Citizens across Europe build and install low-cost air sensors in their homes, contributing data to open-source platforms.

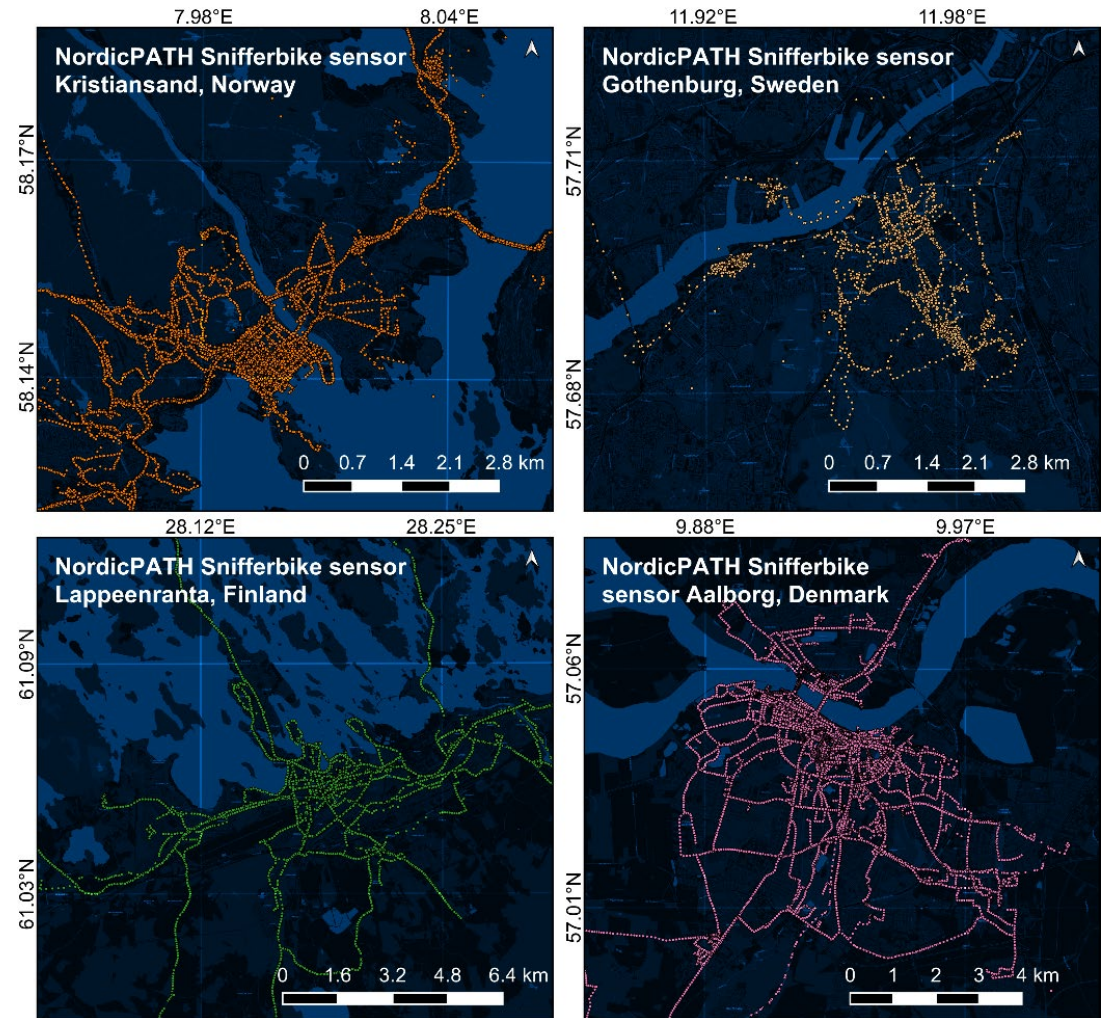
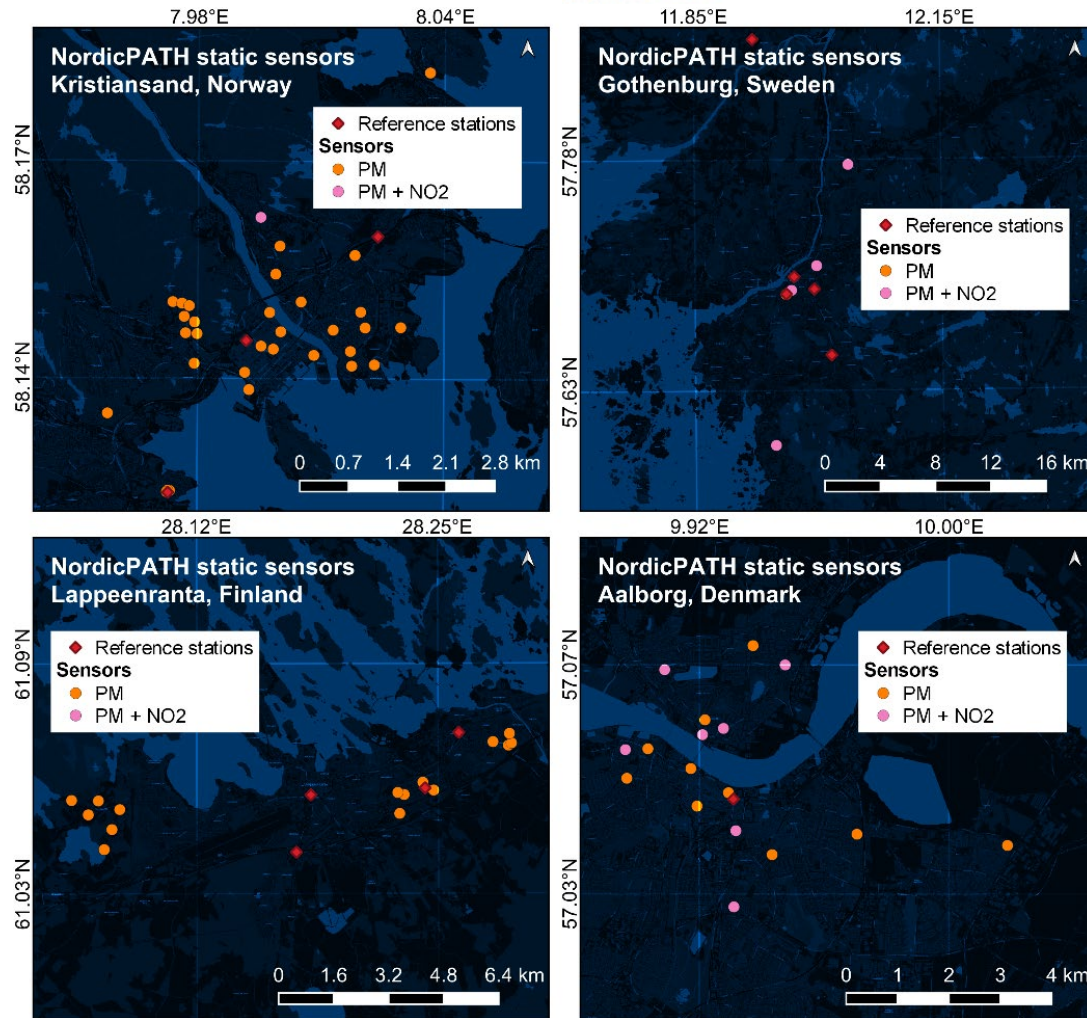


# Co-monitoring with citizens

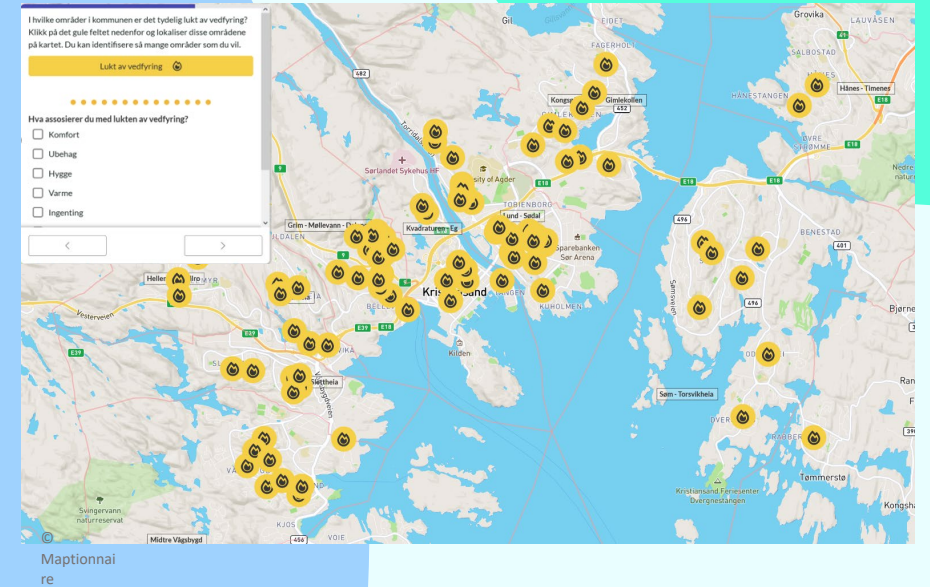
## Static Sensors



## Mobile Sensors



# How Can Citizen Science Benefit in the context Air Quality?



Governance



Individual and  
collective action



Economy  
and finance



Science and  
technology

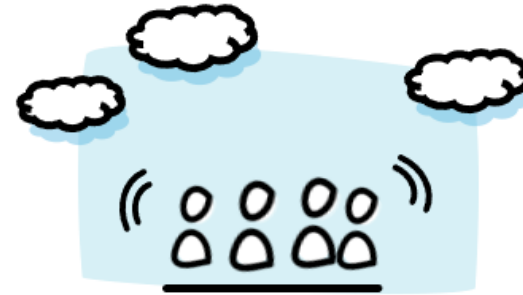


# Governance

Overcoming sectoral silos

- Introduce participatory Air Quality monitoring
- Expanding the traditional dialogues in urban planning
- Learn from and act in concert with Peer cities

**Urban air communities**



**Participatory urban planning**



Co-design environmental monitoring stations

Co-monitoring methods

Co-planning solutions

Co-creation of potential solutions

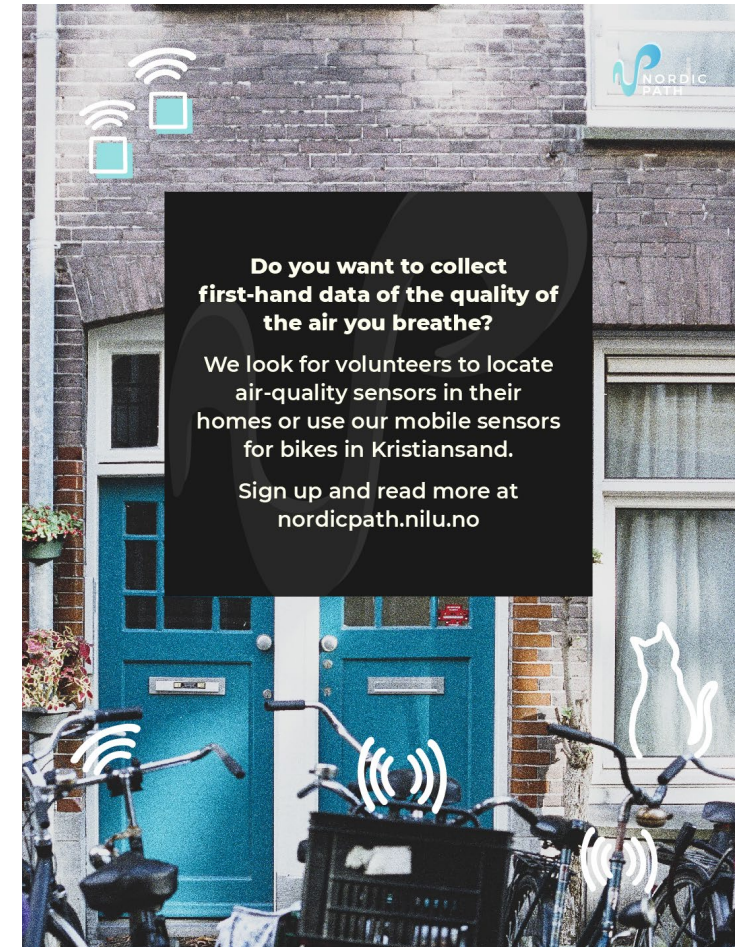
Co-production of knowledge



## Economy and Finance

Eradicating deprivations, building capabilities and opening up for new opportunities

- New partnerships in Urban Laboratories
- Integrating urban development & smart cities
- Integration of diverse stakeholder groups



Co-design environmental monitoring stations

Co-monitoring methods

Co-planning solutions

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Co-production of knowledge



## Individual and collective action

Bottom-up social, technological and institutional innovation

- Identifying key actors, networks, neighbourhoods
- Inclusion
- Green spaces, bicycles



Co-design environmental monitoring stations

Co-monitoring methods

Co-planning solutions

Co-creation of potential solutions

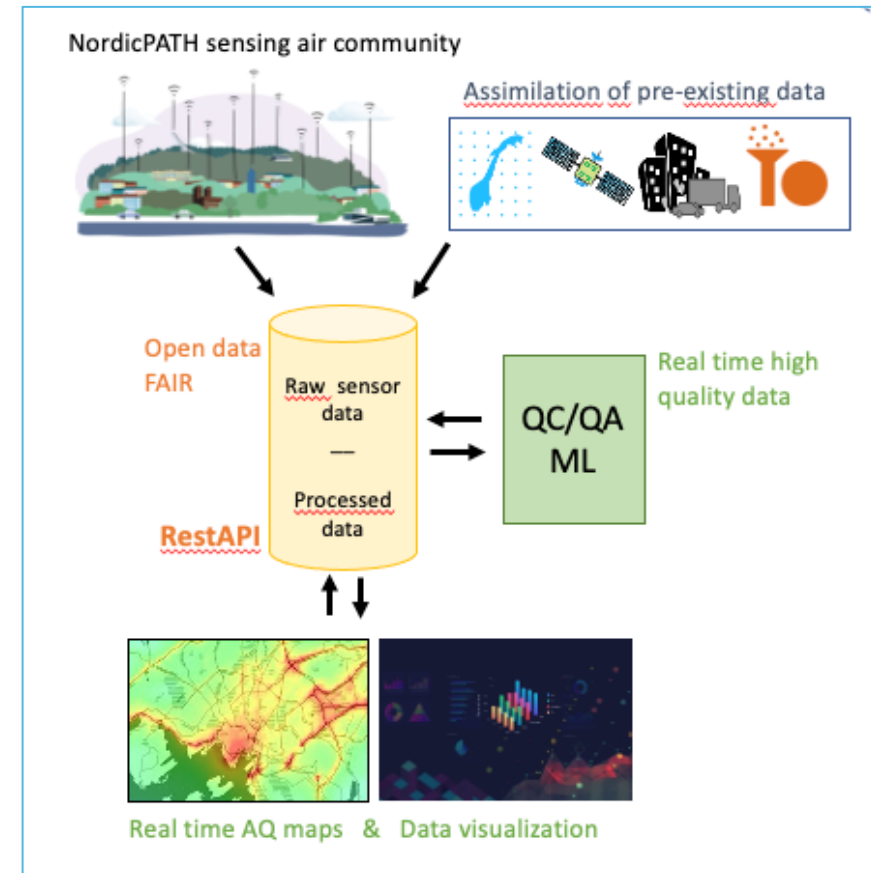
Co-production of knowledge



## Science and technology

### Integrating

- Urban air communities
- Air pollution data and input from citizens
- Multi/intra/trans-disciplinary research



Co-design environmental monitoring stations

Co-monitoring methods

Co-planning solutions

Co-creation of potential solutions

Co-production of knowledge



# Social solutions: insights from residents

## PPGIS surveys

**Places in the park**

Choose the statements that are accurate:

- Kungsparken is near my home
- Kungsparken is near my workplace/school
- Kungsparken is close to where I run errands in central Gothenburg
- Kungsparken is suitable for the activity that I want to do (please name this activity in the text field below)
- Other reason

Om du vill kan du berätta mer här:

Click the buttons below to mark your favourite and least favourite places in the park on the map, as well as development ideas. You can mark several places.

What are your favourite places? ❤️

Which places do you avoid? ☹️

Do you miss something in the park? 🚫

Do you also sometimes just go through the park on your way somewhere else, without spending more time there?

Yes

No / Already answered questions on that.

4 / 9

## Workshops

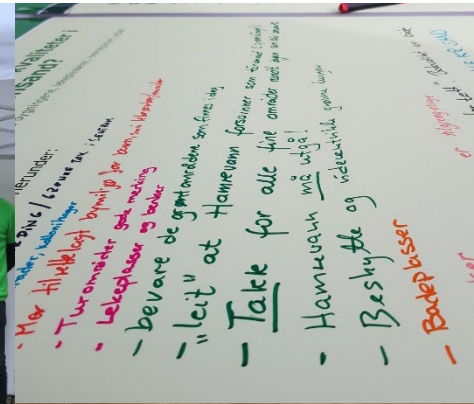
**Han hengte opp en luftmåler i Kristiansand. Da oppdaget han at luftkvaliteten var like dårlig som i Kina.**

Etter 10 år i Stavanger-ålg som prosjektleder, oppdaget Ståle studerte en luftmåler i Kina og det faktisk mer dårlig.

NILU



## Street Activities



How would you prioritize municipal spending on reducing pollution from household heating?

0 / 100

Replacement of old wood stoves for modern and more efficient ones

Installation of solar panels at the housing associations (borettslag)

Extension of district heating to other areas

Better household isolation

Educational and awareness raising campaigns

My own suggestion

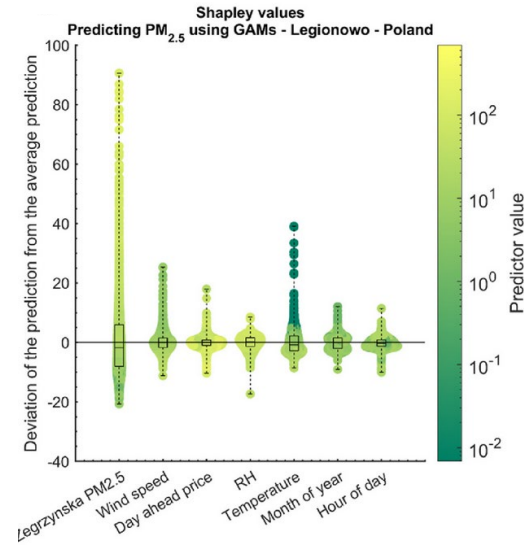
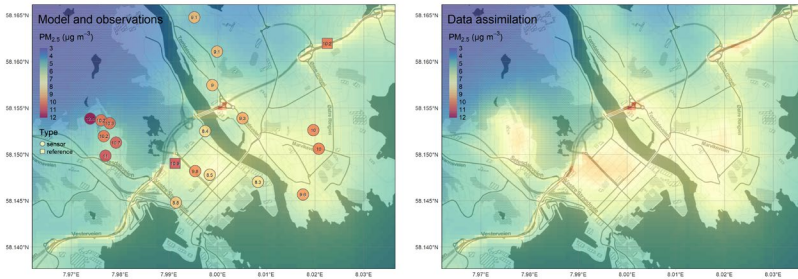
My own suggestion

Please specify



Residents are invited to discuss new incentives and policies towards healthier cities

# NILU's examples of applications



## Low-Cost Particulate Matter Sensors for Monitoring Residential Wood Burning

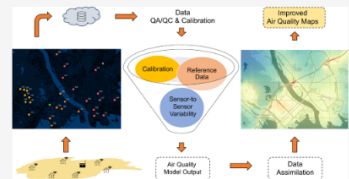
Amirhossein Hassani,<sup>\*</sup> Philipp Schneider, Matthias Vogt, and Núria Castell<sup>\*</sup>

Cite This: <https://doi.org/10.1021/acs.est.3c03661>

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**ABSTRACT:** Conventional monitoring systems for air quality, such as reference stations, provide reliable pollution data in urban settings but only at relatively low spatial density. This study explores the potential of low-cost sensor systems (LCSs) deployed at homes of residents to enhance the monitoring of urban air pollution caused by residential wood burning. We established a network of 28 Airly (Airly-GSM-1, SP. Z o.o., Poland) LCSs in Kristiansand, Norway, over two winters (2021–2022). To assess performance, a gravimetric Kleinfiltergerät measured the fine particle mass concentration (PM<sub>2.5</sub>) in the garden of one participant's house for 4 weeks. Results showed a sensor-to-reference correlation equal to 0.86 for raw PM<sub>2.5</sub> measurements at daily resolution (bias/RMSE: 9.45/11.65 µg m<sup>-3</sup>). High-resolution air quality maps at a 100 m resolution were produced by



Atmospheric Environment

Available online 23 September 2023, 120108

In Press, Journal Pre-proof [What's this?](#)



## Low-cost sensors and Machine Learning aid in identifying environmental factors affecting particulate matter emitted by household heating

Amirhossein Hassani<sup>a</sup>, Sebastian Bykuć<sup>b</sup>, Philipp Schneider<sup>a</sup>, Paweł Zawadzki<sup>b</sup>, Patryk Chaja<sup>b</sup>, Núria Castell<sup>a</sup>



Sustainable Cities and Society

Volume 95, August 2023, 104607



## Citizen-operated mobile low-cost sensors for urban PM<sub>2.5</sub> monitoring: field calibration, uncertainty estimation, and application

Amirhossein Hassani<sup>a</sup>, Núria Castell<sup>a</sup>, Ågot K. Watne<sup>b</sup>, Philipp Schneider<sup>a</sup>

# However, the uptake of sensor data for policy and research is hindered

- By the lack of metadata
- Limited validated standard test to evaluate the performance of sensor systems
- Open and standard data quality processing techniques, interoperability and accessibility of sensor data stored in multiple databases
- And a lack of common semantics for the integration of sensor data in larger datasets
- Low citizen participation among vulnerable and marginalized communities. Reinforces inequities and inequalities in observations.

# EU Air Quality Directive

Low-cost sensors have gained significant attention in recent years among cities in Europe.

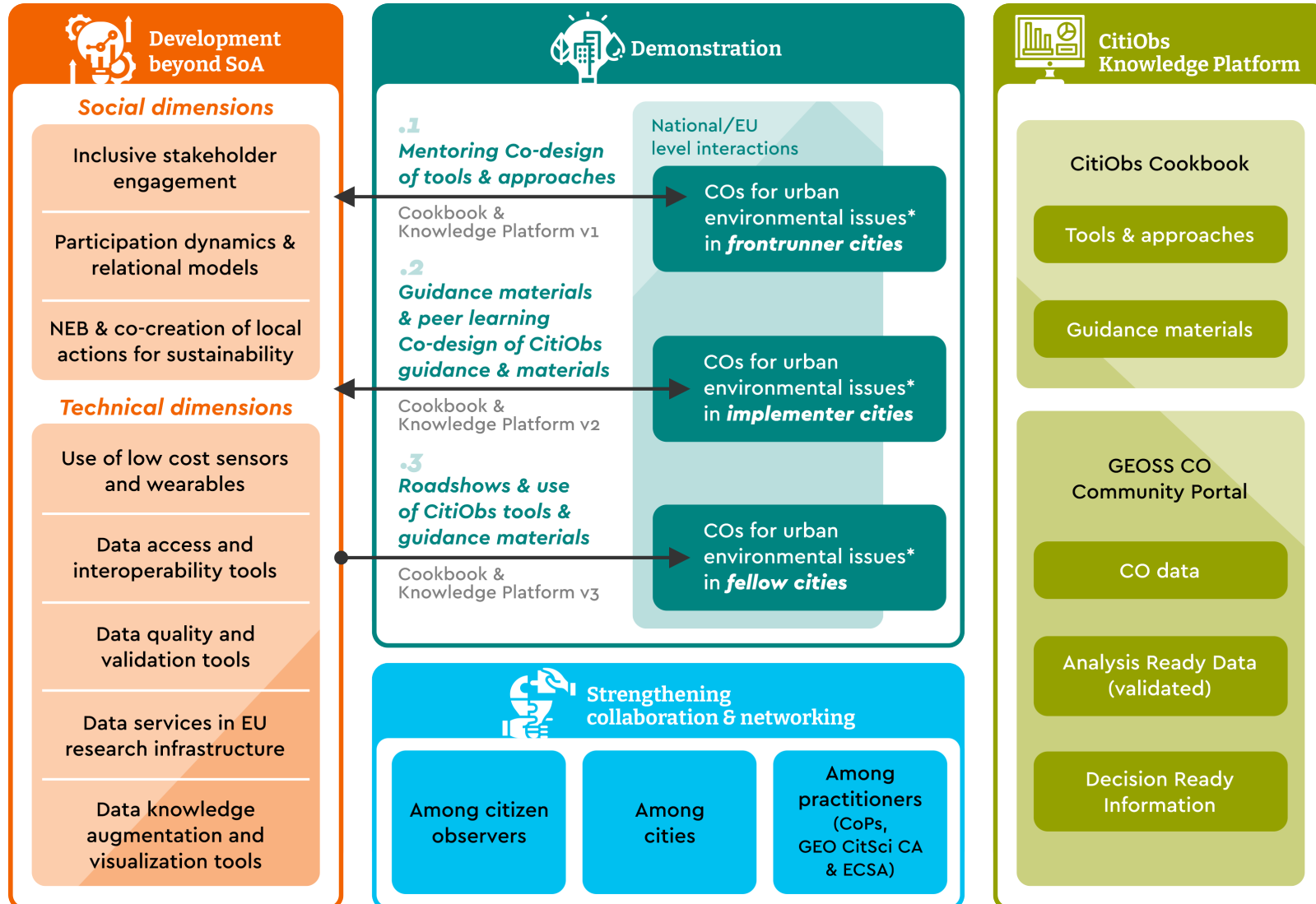
The **European Committee for Standardization (CEN)** is working on creating standards that ensure the quality, accuracy, and reliability of sensors and the data they produce. These standards are crucial for promoting consistency and interoperability among different sensor devices.

Gases – Published December 2022

Particulate matter – Work in progress, soon to be published

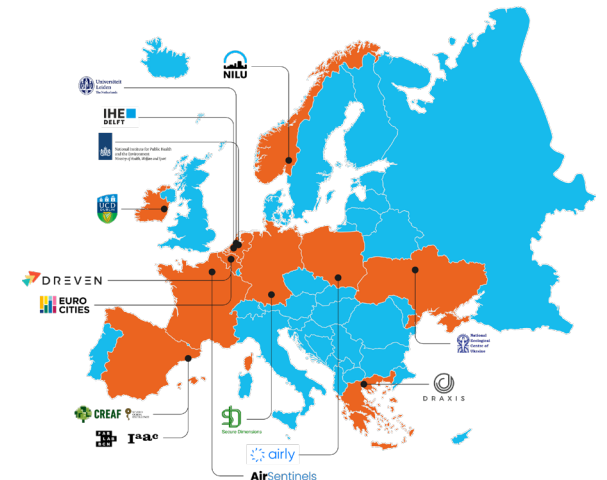
The **European Air Quality Directive** is currently being reviewed, and low-cost sensors are making their way in. Sensor systems will need to indicate their uncertainty level.

# Citizen Observatories for Air Quality



# CitiObs

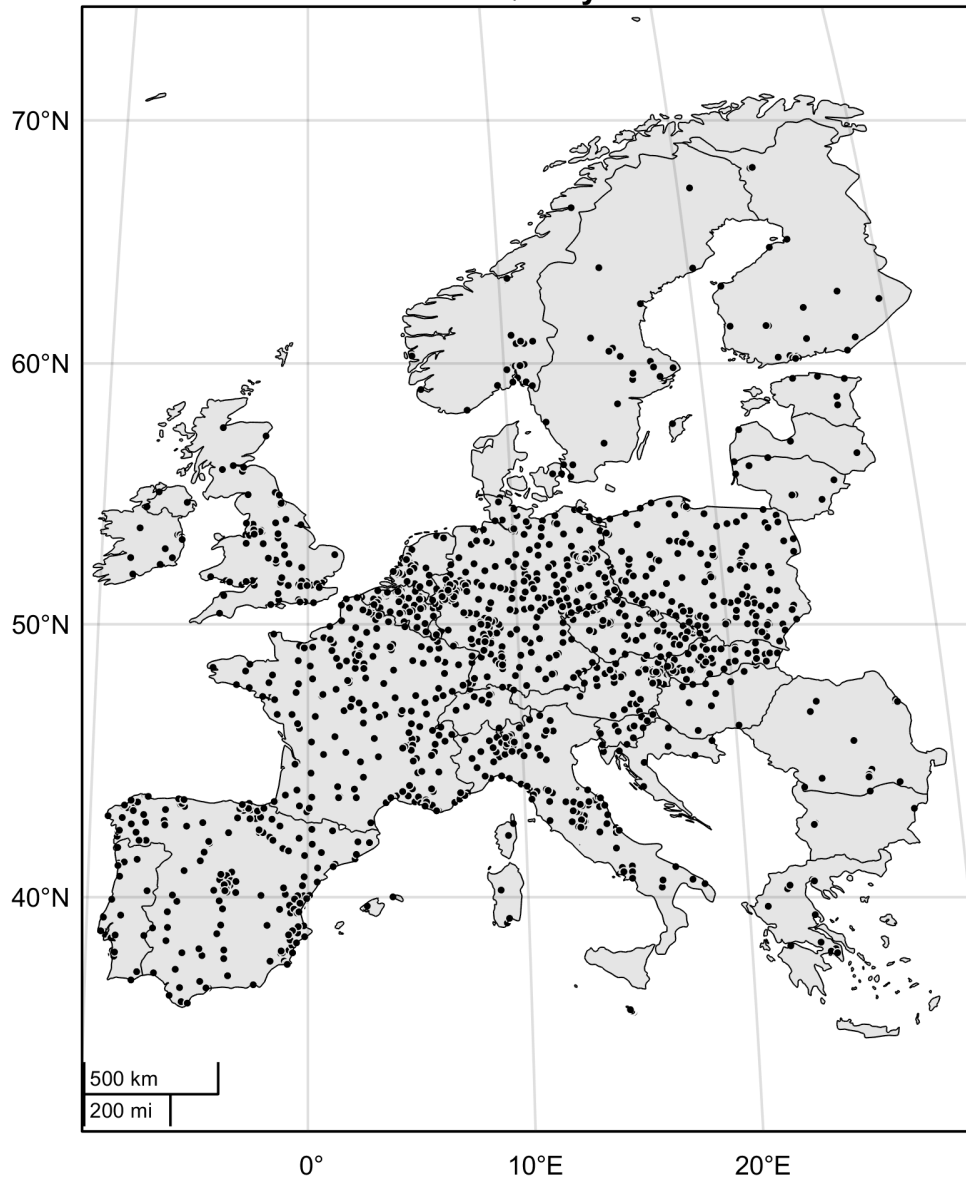
<https://citiobs.eu/>



\* Air quality is the central theme of the COs engaged in CitiObs but other relevant thematic datasets, knowledge and local actions are also being generated

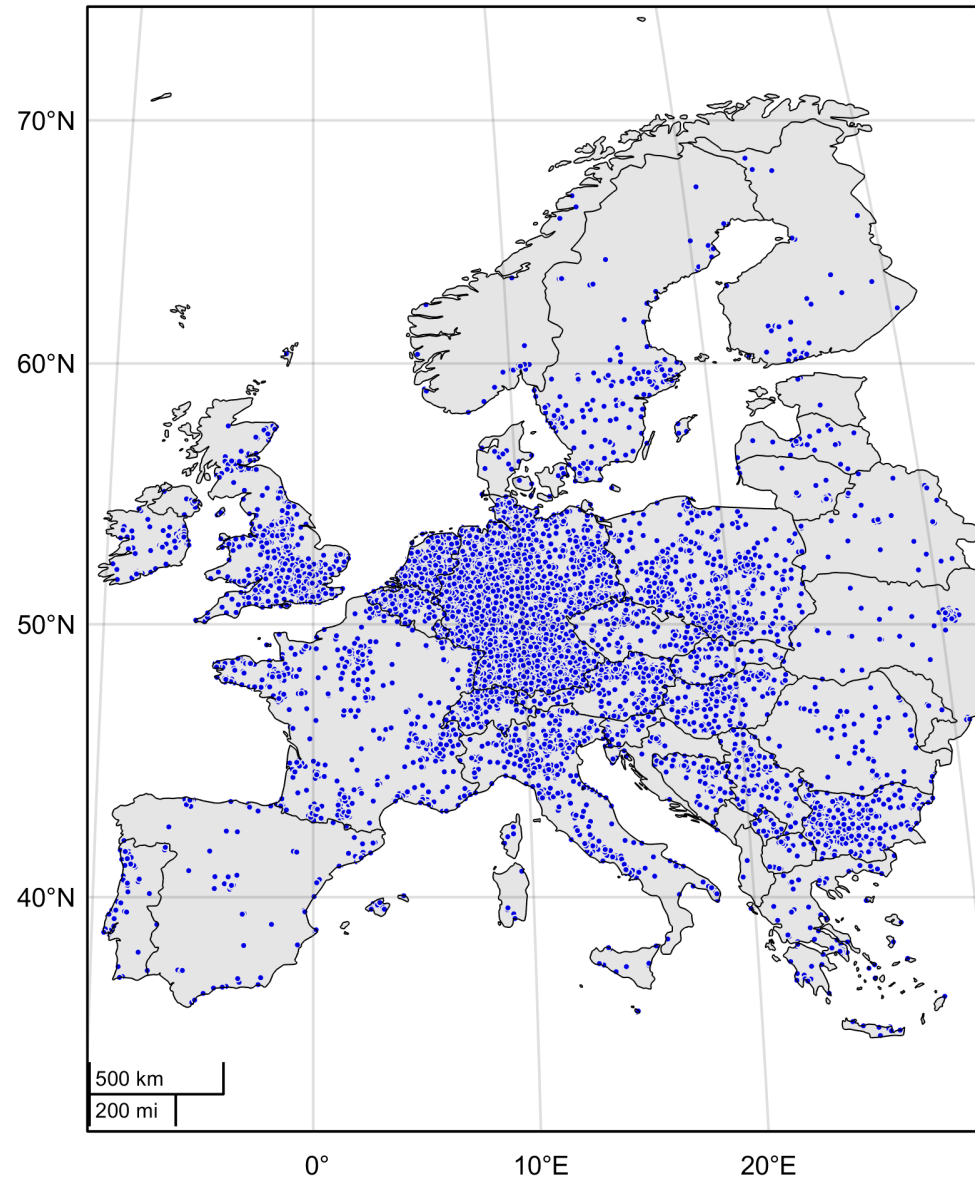
**a**

### Official Air Quality Stations

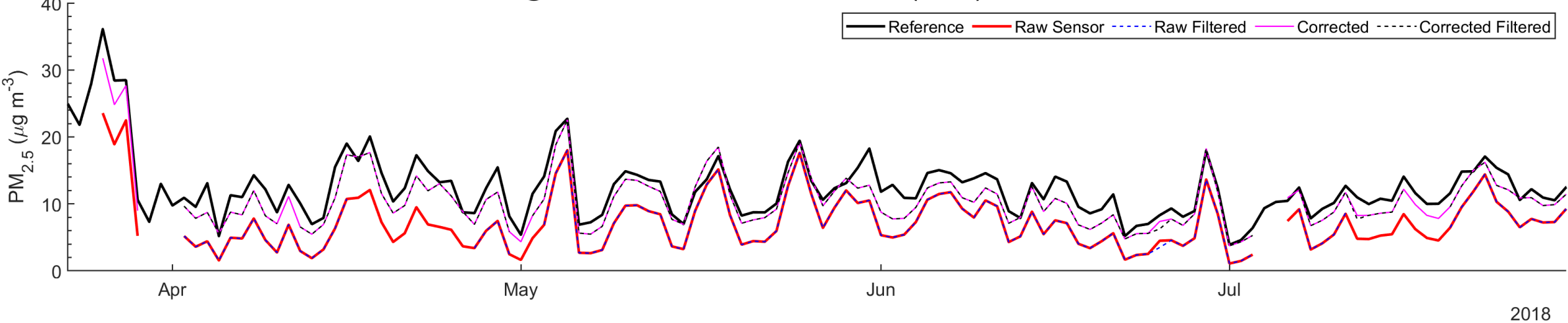


**b**

### Low-Cost Sensors



at4s431 @ AUSTRIA - traffic - urban vs SC8946 (11147) with 55.9 m Distance





# Thank you

The climate and environmental research institute NILU  
A part of the research alliance NORIN