CITIZEN SCIENCE VOOR LUCHTKWALITEIT: VOORBEELD VAN WETENSCHAPPELIJK ONDERBOUWDE AANPAK

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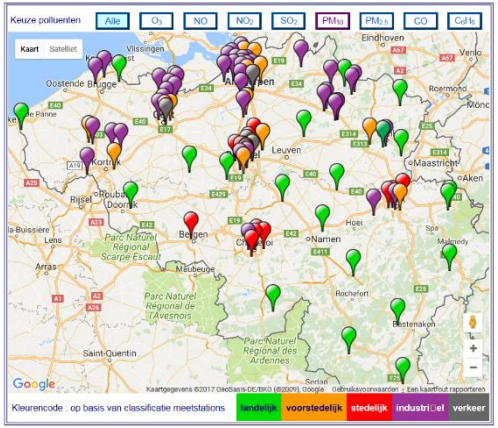
CITIZEN **SCIENCE**

- Wat's in for the scientist? Added value of citizen science data in research questions.
- What's in for citizen science initiatives? The input of scientists in (giving advise on) setting up campaigns, analyzing data and use the right measurement set-up and instruments
- Example of citizen science project in Mechelen and lessons learned
- Sensors: use the right instruments

AIR QUALITY MONITORING BY CITIZEN SCIENCE? **WHY?**

⇒ Traditional measurements (normative)

- Yearly or daily average
- Accurate
- Long time series, time trends
- BUT limited in spatial resolution



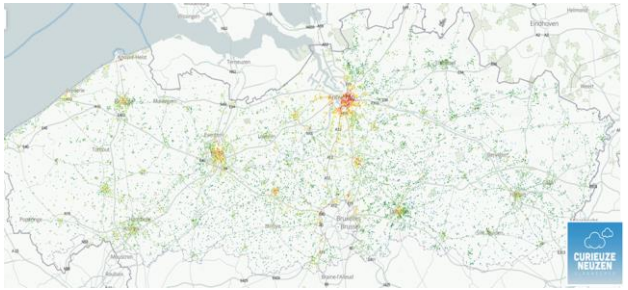
⇒ Air Quality is not uniform over a city, a region

- Insufficient info about exposure
- Source apportionnement
- Measures and impact of measures
- …

airqmap (www.airqmap.com)

⇒ Citizens want to be involved

- Information of their own neighbourhood
- Search info
- Citizen participation
- Ownership
- DIY, availability of sensors



AIR QUALITY MONITORING BY CITIZEN SCIENCE? **HOW?**

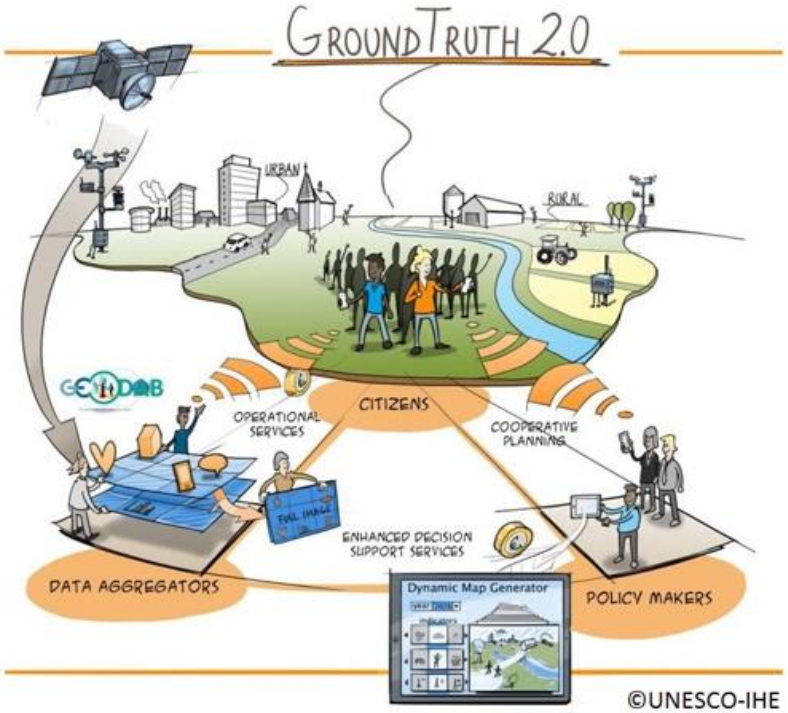
- Set-up of the monitoring campaign and instruments/sensors used need special attention
  - Data quality
  - Fit for purpose

- Results of citizen science projects need to be explained in a comprehensive way to keep citizens engaged

=> Citizens, researchers and policy makers need to work together to make a citizen science observatory successful

MEASUREMENT CAMPAIGN IN MECHELEN

- As part of two Citizen science projects GroundTruth 2.0 and Flamenco
  - **GroundTruth 2.0**: design of Citizen Observatory on Air Quality in Mechelen
    http://gt20.eu/
  - **Flamenco**: Design of platforms, tools and good practices for citizen science, case studies
    http://citizen-observatory.be
- Citizen Observatory (CO) “Meet Mee Mechelen”



… from citizen-based data collection to knowledge sharing for **joint decision-making**, **cooperative planning** and **environmental stewardship.**

Development of **generic approach** to **initiate citizen observatories**

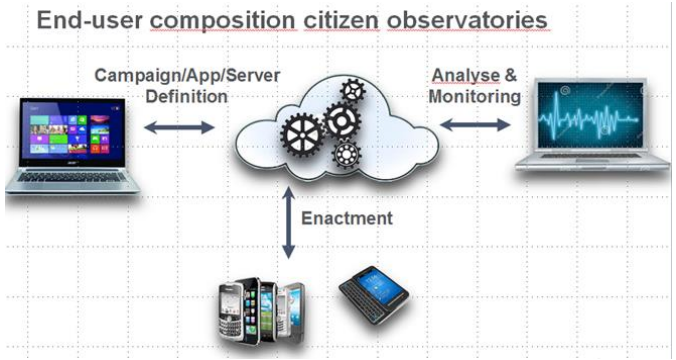
UNESCO IHE DELFT Starlab vito Gavagai akvo.org EARTHWATCH INSTITUTE

CREAF ALTRAN HydroLogic RESEARCH WWF Stockholm University Upande TYGRON TAHMO

Project Director: Dr. Uta Wehn, Associate Professor, IHE Delft

Reconfigurable citizen observatory platform for Flanders

1. stakeholders themselves can **instantiate new citizen observatories** for the particular application area they have in mind (AQ and mobility)
2. open cloud-based software platform: **web services** and **mobile apps** are generated accordingly
3. providing **guidelines** for best practices of citizen initiatives in the field of a.o. AQ
4. **data collection**: case studies



Flemish funded (VLAIO) citizen science project

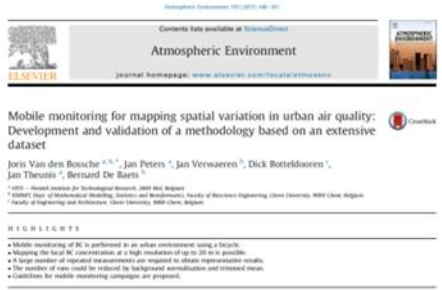
http://citizen-observatory.be/

CHALLENGES, VISION AND AIM OF THE CO "MEET MEE MECHELEN"

- Meet Mee Mechelen = a group of enthusiastic **volunteers**, **local policy makers** and **scientists**
  - Cooperation of different stakeholders in a sustainable and constructive manner
  - Co-design: aim, set-up, training, data-collection, interpretation
- Focus: **improving local air quality** to improve health, quality of life and social cohesion
- Action: **measure local air pollution levels in Mechelen along cycling lanes**
  - identify the impact of road traffic
  - prior to propose or implement specific actions to improve the urban air quality
  - data showing both the spatial as temporal changes in air quality levels

MEASUREMENT APPROACH: **HOW?**

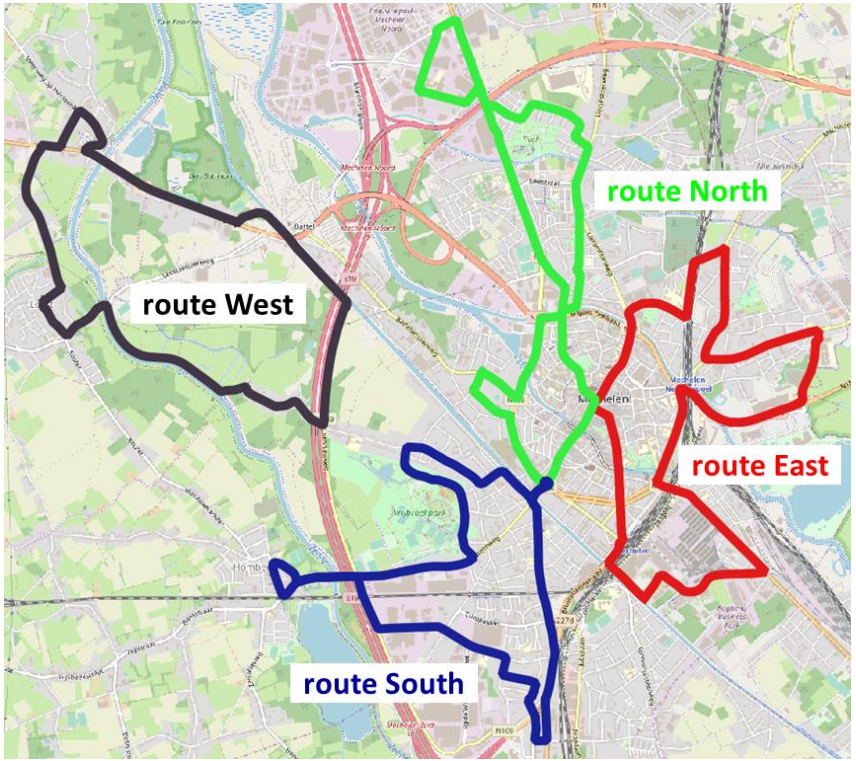
- airqmap
  - Monitoring and visualization tool
  - Mobile measurements of Black Carbon (BC)
  - Easy to use instruments and software
  - Measurement devices: microAeth (AE51) and GPS
  - Validated approach
- Measurement set-up:
  - Repeated measurements (about 25 times)
  - Fixed route
- Results: aggregated maps (20 m resolution)
- www.airqmap.com



MEASUREMENT APPROACH: **WHEN AND WHERE?**

- Along **4 routes** in Mechelen: **40 km**
- During morning and evening rush hour
- In **4 campaigns** of 2 weeks: **280 h**
- Simultaneous measurements (except route South in Campaign 1)
- 50 volunteers/2800 km!

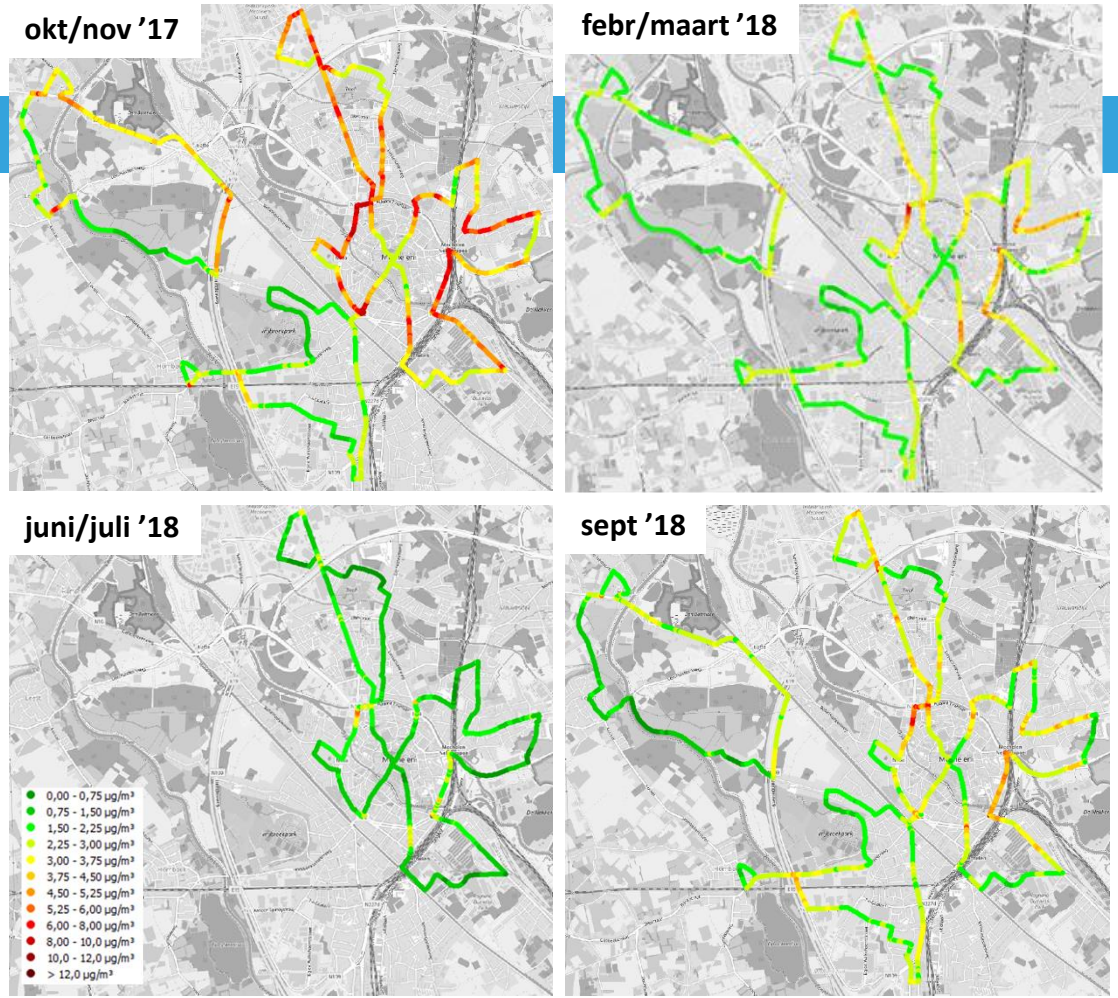
Campaign	Wind direction	Wind speed	Temperature
23/10/17 – 05/11/17	SW	3.5 m/s	10.5 °C
06/11/17 – 19/11/17	NW	2.8 m/s	5.9 °C
21/02/18 – 06/03/18	NE	4.9 m/s	-0.6 C
25/06/18 – 08/07/18	NE	3.9 m/s	22.7 °C
17/09/18 – 30/09/18	SW	3.1 m/s	13.6 °C



OVERVIEW RESULTS

Large differences

- ✓ Between locations
- ✓ Between seasons
- ✓ Same hot spots and similar spatial pattern



COMPARISON WITH FIXED MONITORING STATIONS

- Summary statistics per campaign and BC concentrations at fixed monitoring stations (VMM)

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	VMM virtual Traffic station
Campaign 1	1.0	2.4	3.3	3.7	4.7	12.4	3.3
Campaign 2	1.3	2.0	2.3	2.5	2.9	10.5	2.4
Campaign 3	0.5	0.9	1.2	1.4	1.7	6.2	1.4
Campaign 4	0.5	1.8	2.5	2.5	3.1	8.3	2.5
						Yearly average 2017: 1.9	

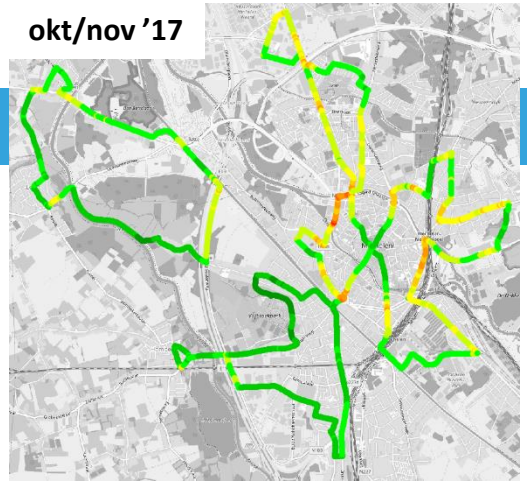
→ Max concentration

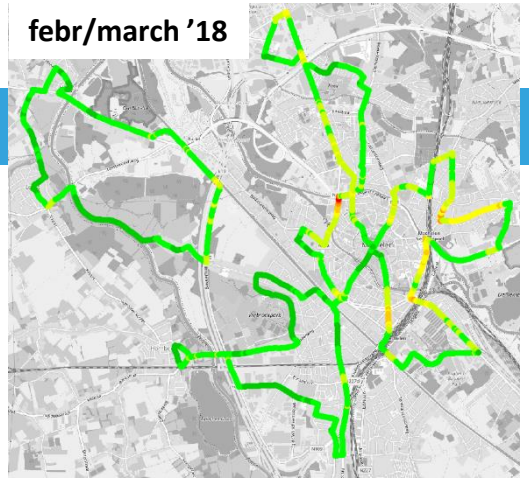
→ Min concentration

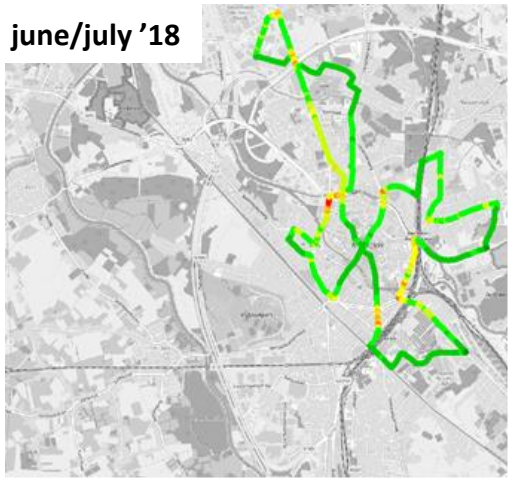
=> Rescaling the legend of the map/**comparison** with fixed monitoring stations to analyse different campaigns or **aggregation** of different campaigns

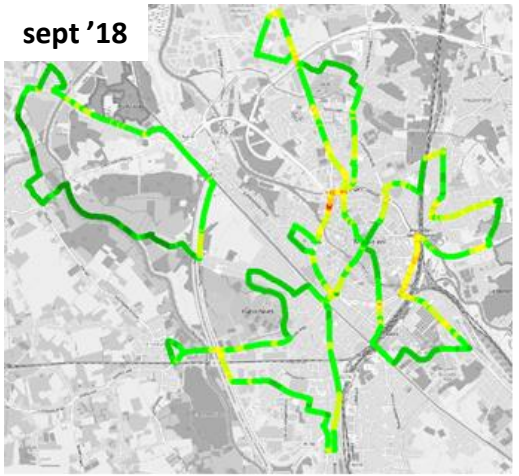
RESCALED MAPS

- ✓ Factors
  yearly av/campaign av:
  0,57 – 1,37
- ✓ More similar pattern
- ✓ Holiday season is less suitable to assess impact of traffic
- ✓ Cold season can be impacted by other sources

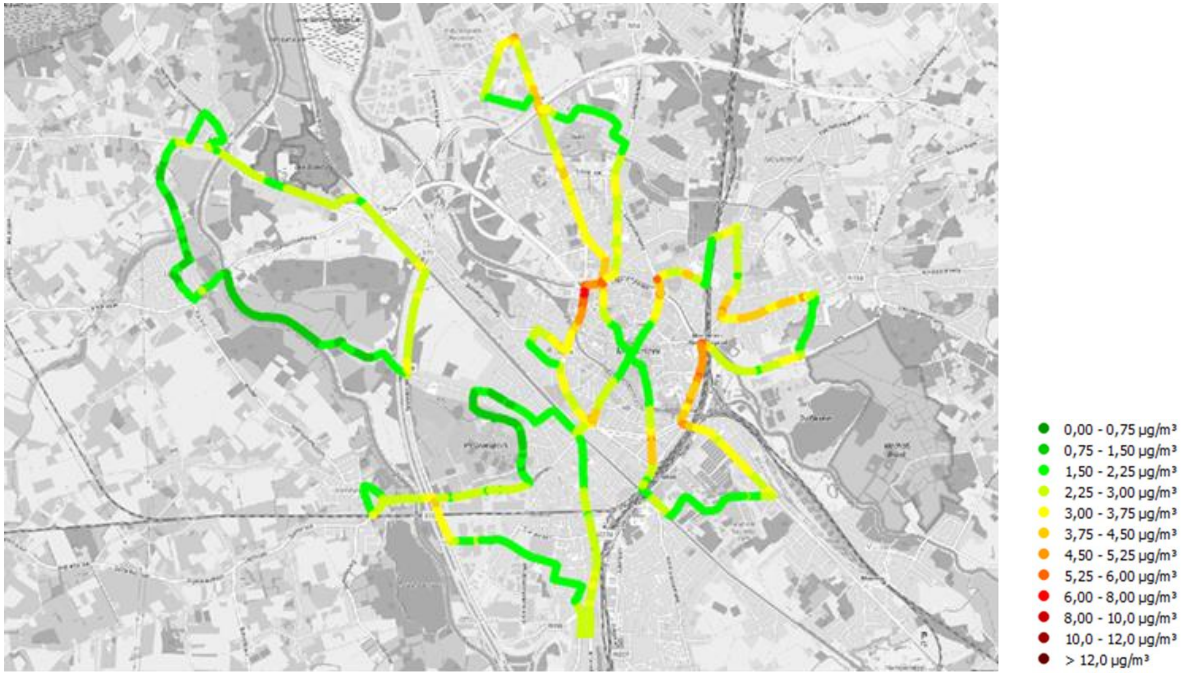




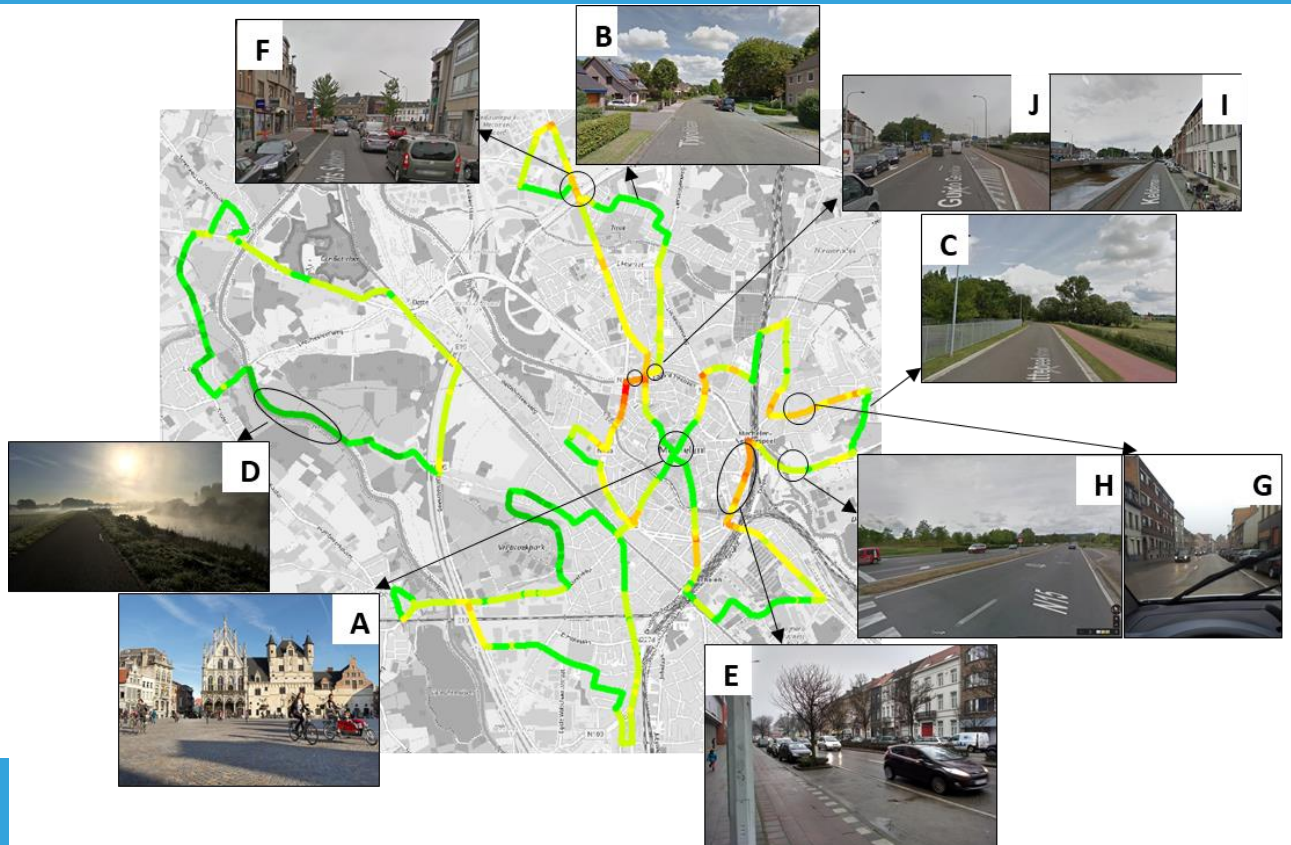




AGGREGATED MAP



INTERPRETATION OF RESULTS IN FUNCTION OF MOBILITY PLANNING



COMPARISON WITH AIRBEAM

- AirBeam: a PM sensor developed by HabitatMap (US non-profit environmental health justice organization) connected to AirCasting
- AirBeam was used on some trips
- Results:
  - BC visualizes better the impact of traffic: localized variation of this pollutant
  - Two different metrics!
  - Volunteers found it more difficult to use

AirCasting App

Co-designing Meet Mee Mechelen: Lessons learned

Value of co-design starts *before* delivery of platforms, apps, tools

Space for **continuous dialogue** and exposure to the other stakeholders' views

Community building as important as co-designing platform & tools

COs ≠ plug & play solutions for data collection

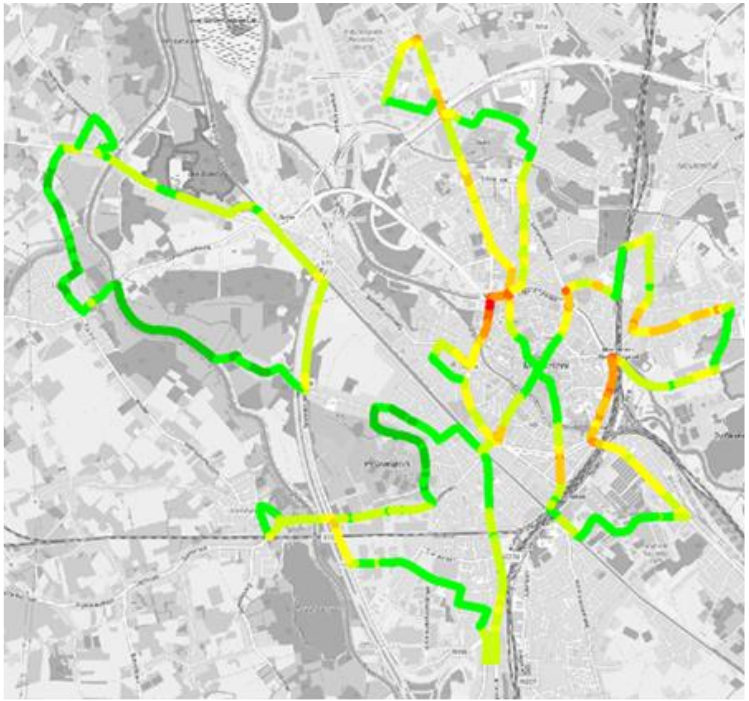
Framing COs: more than just *more data* and not *just* about science!

Stakeholder participation & knowledge co-production

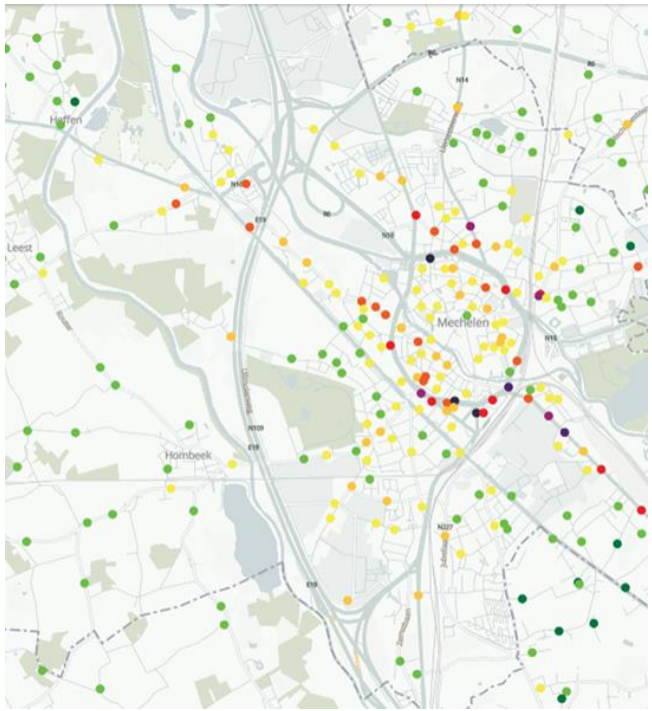
Photo: Luigi Ceccaroni

groundtruth2.0
Environmental knowledge discovery of human sensed data

DIFFERENT MEASUREMENT APPROACH, SIMILAR OVERALL CONCLUSIONS:
MEETMEEMECHELEN AND CURIEUZENEUZEN



BC



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QUALITY OF SENSORS

COMMENT

Validate personal air-pollution sensors

Alastair Lewis and **Peter Edwards** call on researchers to test the accuracy of low-cost monitoring devices before regulators are flooded with questionable air-quality data.

All this excitement presumes that these low-cost air-pollution sensors are fit for purpose. For regulatory applications, governments and scientists use the most accurate, but expensive, detectors. And although the interpretation of the data is a subject of lively debate, the quality of readings is rarely questioned. By contrast, few of these low-cost devices have been rigorously tested and most researchers view the buzz as being beyond the serious business of academia.

The research and regulatory communities are behind the curve. The penetration of these devices into the public domain, generating large volumes of untested and questionable data available to all, is inevitable and will increasingly become a headache for those who are responsible for managing air quality. And opportunities beckon. Atmospheric chemists must engage so that these technologies can realize their huge potential.

NEXT STEPS

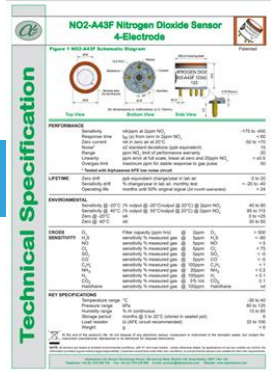
The academic air-pollution community must do the hard yards in the lab and field on calibration and testing. It must also find ways to overcome some measurement challenges. Researchers should take the lead on evaluating sensor performance, creating better devices and designing research applications that are suited to the quantified capabilities of sensors.

More creativity is needed in experimental design. If the long-term performance of sensors is a problem, as is likely, then we need

Lewis A. and Edwards P. (2016). Nature 'News and Comment', 535, 29-31.

QUALITY OF SENSORS

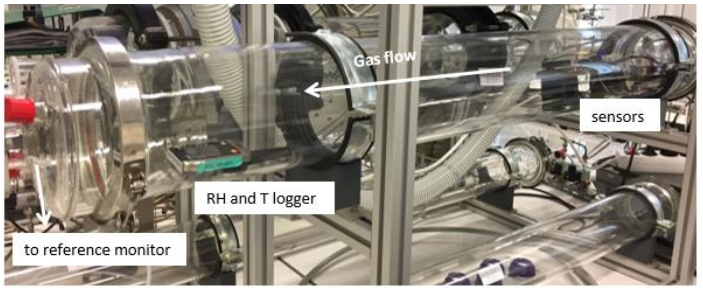
- Reports and info available
  - Sensor suppliers, independent reports
  - Different test conditions (lab, real life)
  - Sensor test in EU projects: e.g. MSP, VAQUUMS (VMM), …
- Requirements
  - Accuracy, intercomparison, response, interfering compounds, detection limit, drift
  - Easy-to use, power, data acquisition,…
- VITO as reference lab Flanders for sensor test (2019-2020):
  - set up a test protocol (lab) as part of reference task
  - WG 42 : A common test protocol for EU by JRC



MULTI SENSOR PLATFORM
MSP
Multi Sensor Platform for Smart Building Management

VAQUUMS

AQ-SPEC
Air Quality Sensor Performance Evaluation Center



SELECTION OF SENSORS AND APPROACH AS FUNCTION OF AIM

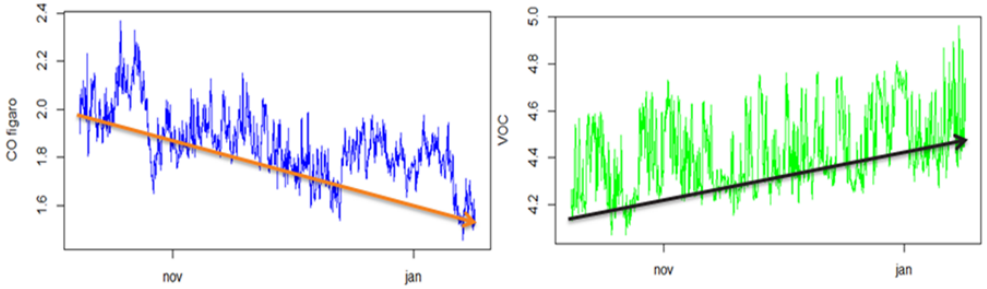
- **Fit for purpose!** Selection of sensor as part of :
  - Research question
  - Experimental design (before analysis!)
  - Environmental conditions (e.g. indoor vs outdoor)

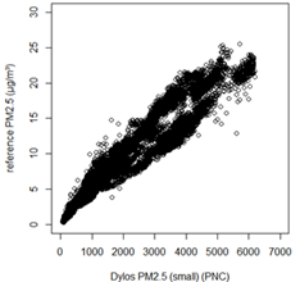
- Expectation management to stakeholders

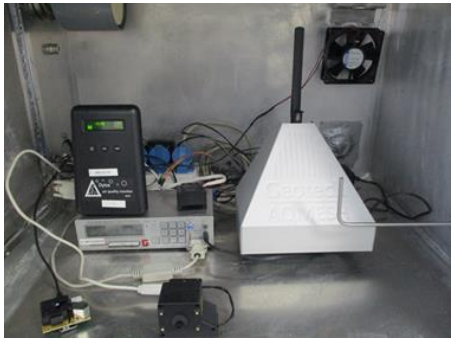
- Some info (VMM):

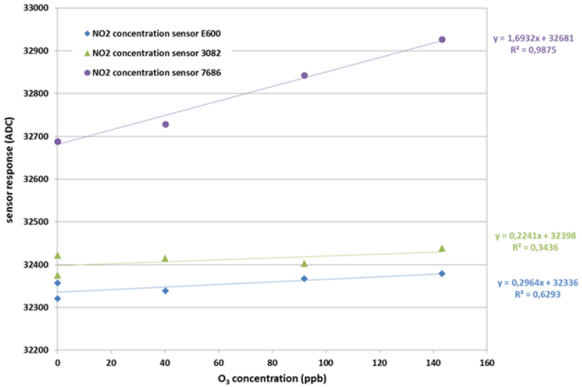
https://hoemeetiklucht.eu/ontdek-de-meetmethoden

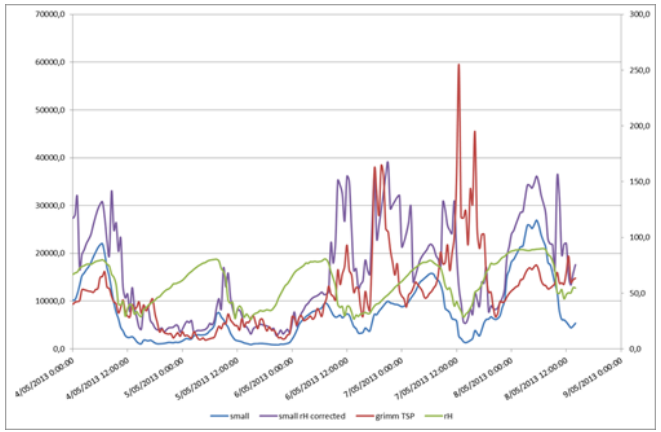
SOME EXAMPLES











CONCLUSIONS

- A mobile measurement approach using airQmap was used to assess local differences in air quality in the city of Mechelen
- The measurement platform engaged people from the CO Meet Mee Mechelen and they were able to set the agenda, perform the measurements and discuss about the results
- Repeated measurements are needed to get representative results
  - On different days (25) in one campaign
  - Campaigns in different seasons show different results BUT similar conclusions
- The current approach was compared to other tools and CS projects:
  - Airbeam: other metrics (BC versus $PM_{2.5}$) shows slightly different results
  - Curieuzeneuzen: similar hot spots, in depth analysis to be performed

CONCLUSIONS

- The results are used to assess the current mobility plans in relation to exposure of cyclists
  - BC concentrations at street level are highly impacted by traffic intensity, stop and go traffic, but also proximity to traffic and the building environment (open versus street canyon)
  - Results show how exposure of cyclists (and pedestrians) can be reduced
- Selection of sensors
  - Different sensors with different performance
  - Selection is part of experimental design

When designing a CS campaign it is important to align the measurement method and data-collection to the addressed question or concern

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More info:
http://www.airqmap.com/
https://mechelen.meetmee.be/