VAQUUMS

Layman's report

Various assesments of air quality measurement methods and their policy support

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Rijksinstituut voor Volksgezondheid en Milieu
Ministerie van Volksgezondheid, Welzijn en Sport

TNO innovation for life

VLAAMSE MILIEUMAATSCHAPPIJ

Introduction

Introduction

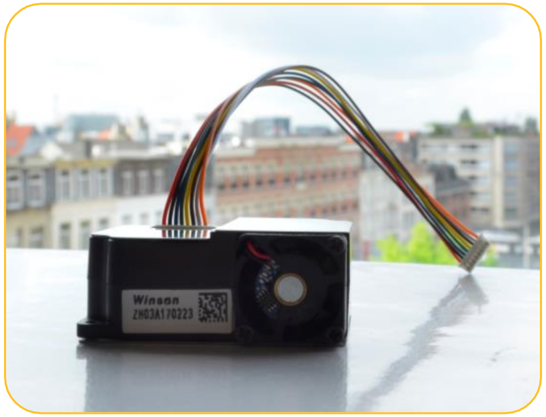
In recent years the awareness on the influence of air quality on human health increased exponentially. This led to the start of many citizen science initiatives which measure air pollution on a local scale. This evolution also lead to the development of vast amounts of low cost devices to measure the air quality. Given the recent update of the WHO Guidelines on ambient air quality an additional surge in interest on the topic is to be expected.

Devices are often mobile and portable enabeling everyone to start measuring air quality in their neighborhoud. This leads to a high spatiotemporal resolution of te measurements, but the quality of these measurements is often unknown. Our literature review learns us that previous projects and studies each followed their own methodology which makes it very hard to compare sensor performance between studies.

The LIFE VAQUUMS-project was started in order to support citizen scientists and local governments that want to start measuring air quality. To be able to give advice on the use of air quality sensors we needed to better understand their performance. Therefore the LIFE VAQUUMS-project did its own large scales tests on 18 different low cost sensors for particulate matter (PM), nitrogen dioxide (NO_2) and ozon (O_3). As it is important to know sensor performance on a fixed location, before mobile measurements are started, the project focused on the tesing of low cost air quality sensors at a fixed location. The results of the tests enabled us to formulate guidelines on the use of low cost air quality sensors and a roadmap on air quality sensor networks.

Project Objectives

- Providing an overview of the state-of-art, applicability & use cases of low cost air quality sensors
- Developing a supporting framework for local & regional air quality monitoring networks to facilitate the uptake of flexible monitoring systems
- Creating building blocks for online platforms for knowledge and experience exchange, data collection and analysis
- Providing input for reviews of the air quality directive
- Informing all stakeholders according to their role in the air quality networks of the future



Project overview

State-of-art

A1: Inventory

- Inventory of initiatives & projects so far
- Lessons learned

A2: Performance

- Establishing performance
- Developing protocols

A5: Data management

- Usefulness of aggregated datasets
- Managing & automating datastreams

Guidance

A3: Guidelines

- Recommendations 2008/50/EC
- Workshops & instructions

A4: Portal

- Portal to interpret data flows
- User friendliness

B: Communication

- Increase awareness
- Capacity build-up
- Involve stakeholders
- Reach public

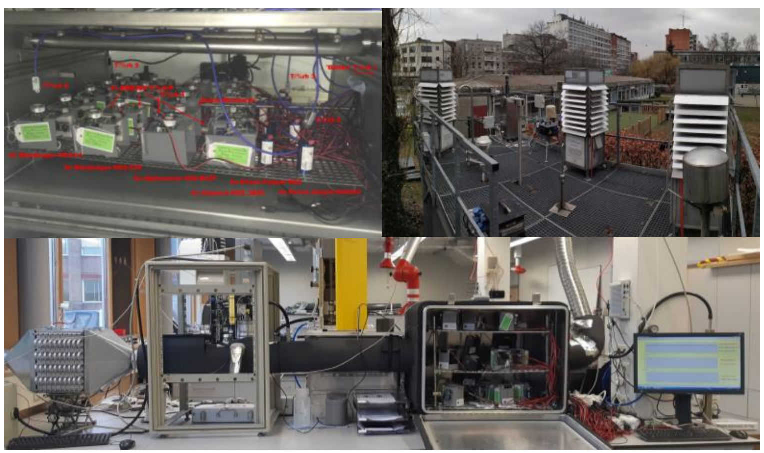
C: Project management

- Project management
- Lessons
- Audits
- Progress & finances
- After-LIFE

Protocol & manual

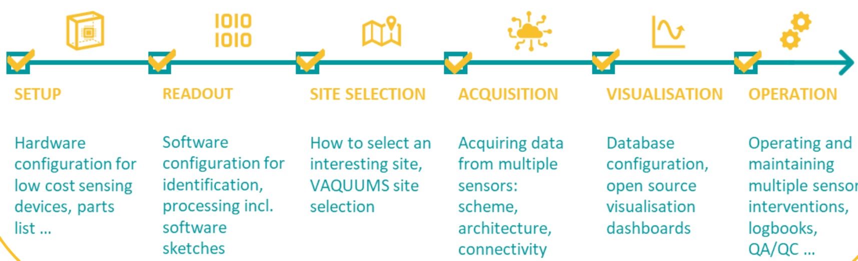
Test protocol

At the onset of the LIFE VAQUUMS-project a test protocol was developed based on previous projects, CEN-drafts and partners' experience. The protocol facilitated uniform testing of all sensors. It describes the experimental setup and procedures both in the laboratory and in the field. In addition, it also defines the sensor evaluation criteria and how to calcurate these criteria.



Technical manual

The technical manual describes how to build working low-cost air quality sensors, how to attain data from these sensors and how to keep multiple sensors operational for over one year. Naturally there are multiple ways to do so, but the LIFE VAQUUMS-project aimed to mimic citizens' approaches when conducting air quality measurements. Sensores were assembled, programmed and calibrated in a simple way. We did not aim to build a professional housing for the sensor, neither did we pursue to develop calibration algorithms to improve the sensor quality. As a result the document provides hands-on recommendations for operating low-cost air quality sensors.



Interesting links

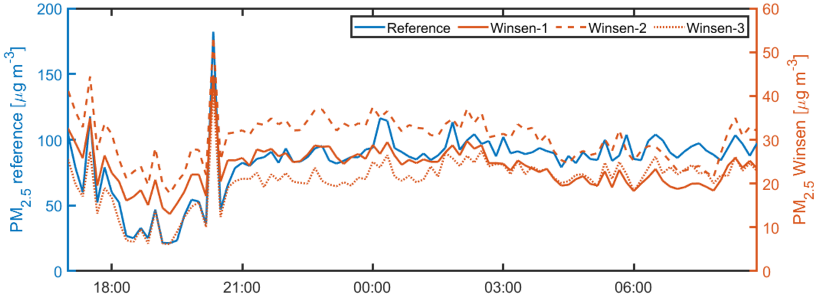
Test protocol – Technical manual – Supporting video's

Test results: lab

PM-sensors

The laboratory tests of the PM-sensors were conducted at TNO from October 2018 until January 2019. the goal of the tests was to evaluate the sensor performance in different concentration ranges at various temperatures and levels of humidity. Results from these experiments were used to calculate performance parameters:

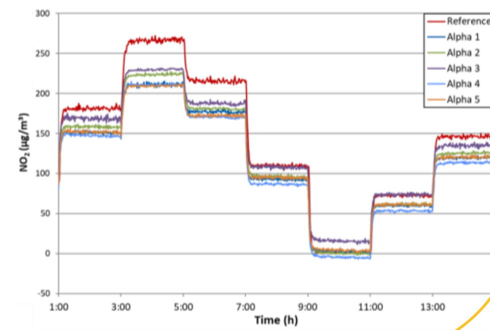
- Linearity of the response compared to reference measurements
- Accuracy
- Data recovery
- Effect of temperature and humidity



Gas sensors (NO_2 & O_3)

The laboratory tests of the gas sensors were conducted from September until November 2018 at RIVM. An essential part of the testing schedule was the ramping experiment at constant temperature and humidity. The performance characteristics of the gas sensors determined in our laboratory study were:

- Accuracy
- Linearity compared to reference
- Sensor stability
- Between-sensor uncertainty
- Influence of temperature and humidity
- Cross-interference



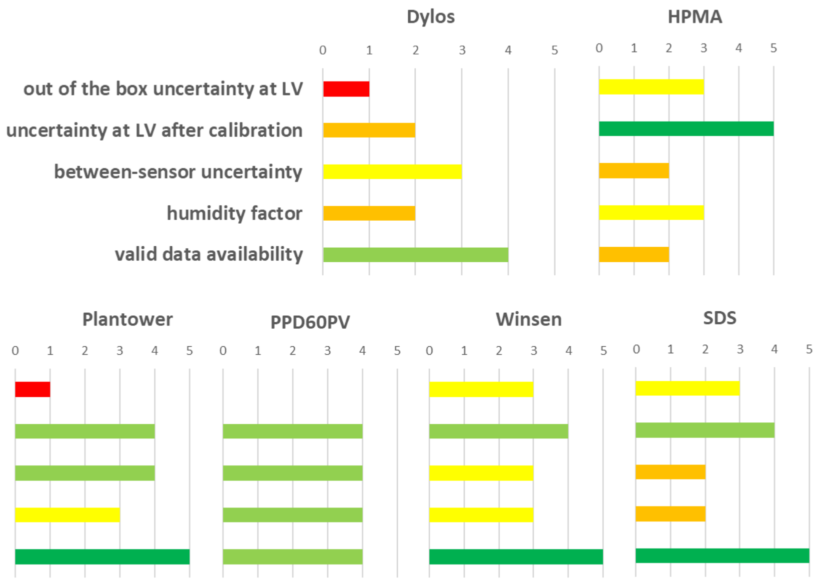
Interesting links

Test protocol – Report lab tests PM - Factsheets lab PM – Report lab tests NO_2 – Factsheets lab NO_2 – Report lab tests O_3 – Factsheets lab O_3 – Supporting video's

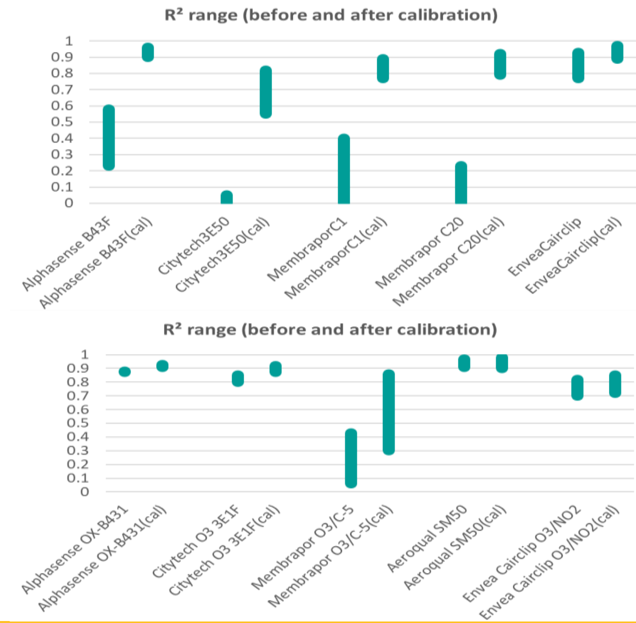
Test results: field

In February 2019, the sensors were transferred from lab to field. The sensors remained in the field for over one year! To place the sensors as close as possible to the reference monitors at the measurement station Antwerp (Belgium) three tailor –made shelters were used. The shelters protect the sensors from rain and sun, air circulation is guaranteed by two fans per shelter.

PM-sensors



Gas sensors (NO_2 & O_3)



Interesting links

Test protocol – Report field tests PM - Factsheets field PM – Report field tests NO_2 – Factsheets field NO_2 – Report field tests O_3 – Factsheets field O_3 – Sensor Quality Index - Supporting video's

Guidelines

Guidelines

We distinguish two elements in our guidelines: a draft air quality sensor charter and a set of key recommendations in support of this charter. The draft charter should be elaborated at the regional, national or European level, providing a base for commitment to harmonious sensor deployments by local communities, cities etc. The set of recommendations stimulates further development of the state-of-art.

Key recommendations

1. Set up a standardised testing protocol
2. Maintain a database of sensor/reference intercomparisons
3. Support local air quality sensor initiatives
4. Encourage further sensor development
5. Relevant Open Data sources
6. QA/QC tools

VAQUUMS Air Quality Sensor Charter

First set of principles – preparing an air quality sensor network

#1 Formulate your goal(s) early on
#2 Maximise the specificity of your use case
#3 Cooperate with regional experts
#4 Consider using sensors in conventional setups

Second set of principles – acquiring air quality sensors

#5 Tailor your approach
#6 Include intercomparison in public tender
#7 Develop the sensor network through experimentation

Third set of principles – using air quality sensors

#8 Monitor relative humidity and temperature concurrently and reliably
#9 Monitor cross sensitivities
#10 Set up a well thought out QA/QC procedure
#11 Focus on complementarity to other data sources
#12 Encourage further sensor development

Interesting links

Guidelines on applying (low-cost) air quality sensors – Supporting video's

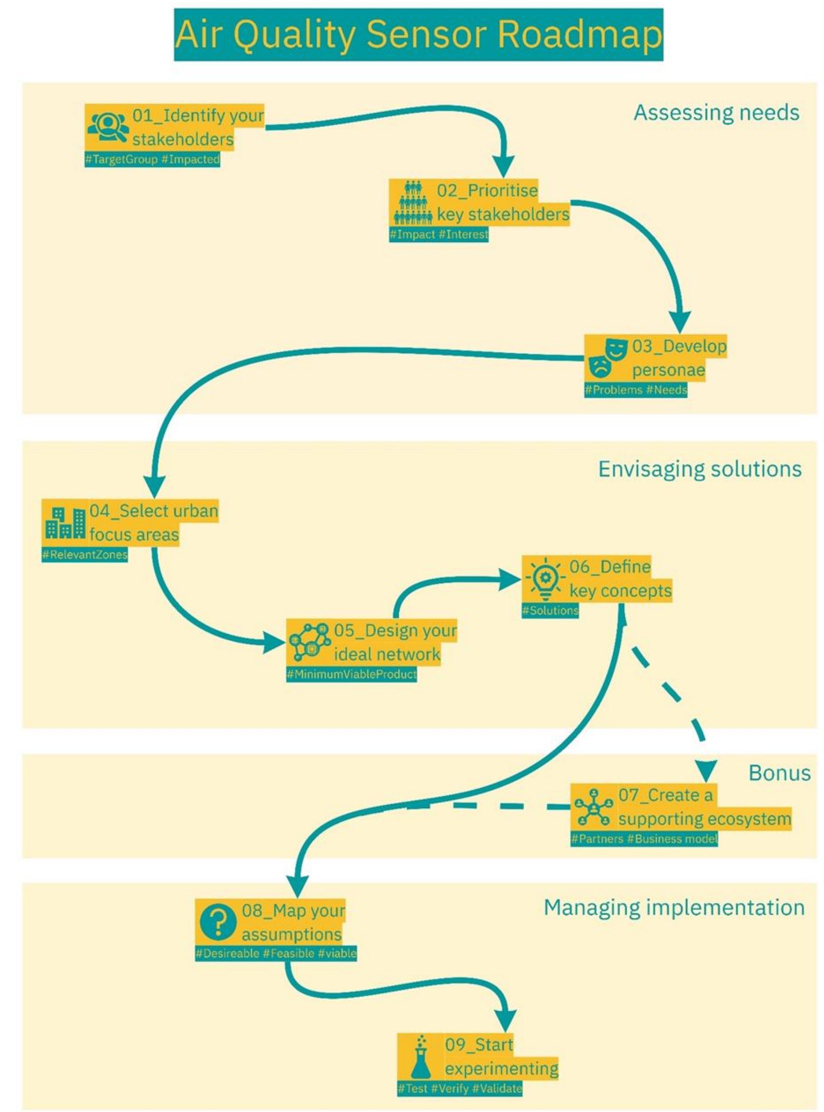
Roadmap

Air Quality Sensor Roadmap

The roadmap is a step-by-step guide for local authorities in planning an air quality sensor network. It can obviously also be used by any organisation supporting them in this development. It will take into account any strategic considerations such as participation, scale, exposure …

The roadmap provides a hands-on and trialed approach to get started with an air quality sensor network. As a user you'll be guided through 3 distinct journeys derived from the basic design thinking process.

- Assessing needs
- Envisaging solutions
- Managing implementation



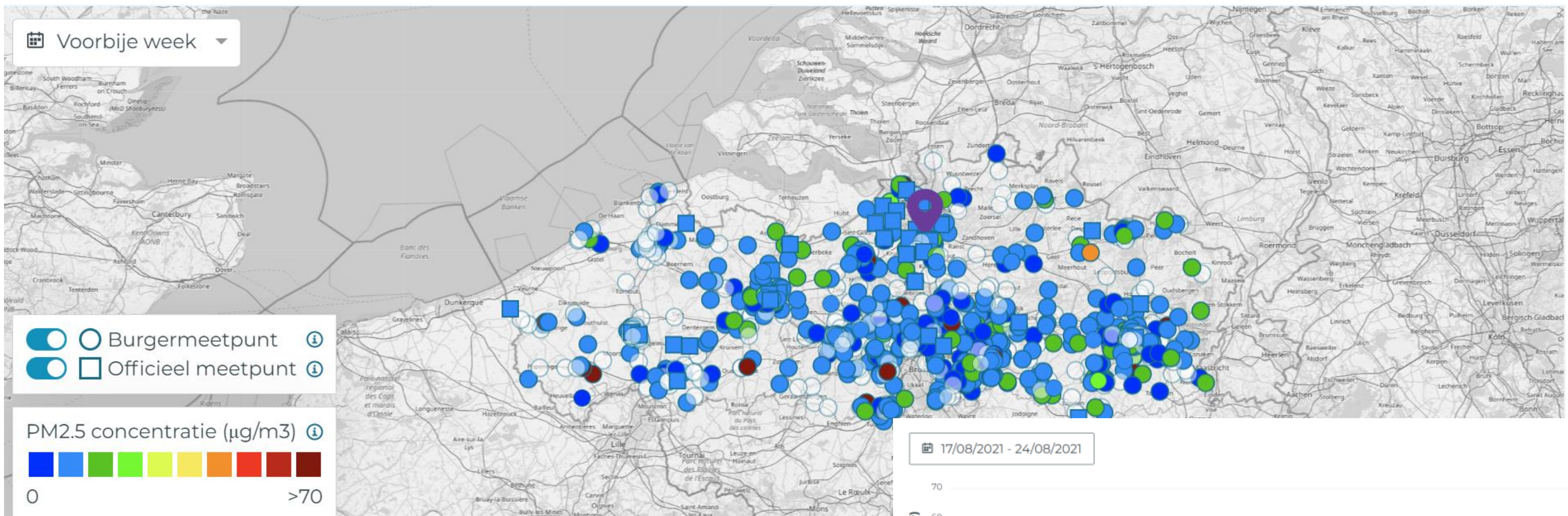
Interesting links

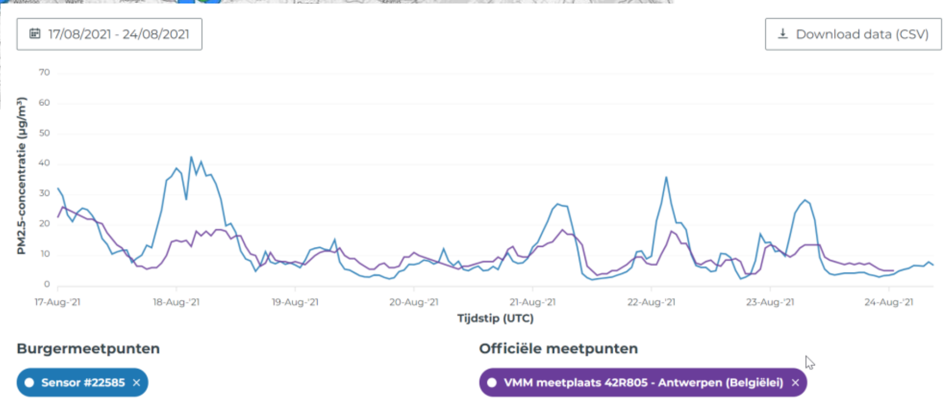
Air Quality Sensor Roadmap – Supporting video's

Data portal

Data portal

On the LIFE VAQUUMS data portal citzens (in Flanders) can compare their $PM_{2.5}$ measurements with the official reference stations of the Flanders Environment Agency. The portal has been incorporated in the SamenvoorZuivereLucht (ToghetherForCleanAir) website, where information on how to measure air quality and a toolbox with measures to imporve air quality are available. The portal is build according to the same principles as the Dutch portal samenmeten.rivm.nl.





Interesting links

Data portal – Supporting video's – SamenVoorZuivereLucht – samenmeten.rivm.nl

Project information

LIFE16 PRE/BE/000003

Various assesments of air quality measurement methods and their policy support

Project location:	Belgium (Flanders), The Netherlands
Project start date:	01/05/2017
Project end date:	30/04/2021
Total budget:	€ 854,210.00
EU contribution:	€ 488,526.00
(%) of eligible costs:	60 %

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