Online personal IAQ monitoring – personal exposure to indoor air pollutants.

B. Hanoune

benjamin.hanoune@univ-lille.fr

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https://www.apolline.science

- Development of small-size, **low-cost, pollutant monitoring system** adapted to indoor and outdoor environments
- U Lille campus-wide sensor network, can be deployed in other environments

- Research objectives : to understand the **drivers of the dynamics of pollution inside buildings** (U Lille and other environments), and to **quantify the exposure of people**

- **Educational and awareness tool** for students, staff, academics and general public

Strategies to monitor personal IAP exposure

Where Do We
Spend Our Time?

- 69% in a home
- 2% in a bar/restaurant
- 5% in a vehicle
- 11% in an outdoor/indoor location
- 5% in an office/factory
- 8% outdoors

Strategy #1 : Personal sensors
- Size, weight, autonomy, communications are critical factors
- Few sensors inside the device
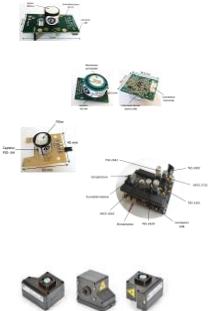- Access to indoor and outdoor personal exposure

Strategy #2 : Fixed indoor air sensors
- Electrical plug and ethernet available
- Sensor box can be somewhat large
- Access to room/building air concentration, not exposure
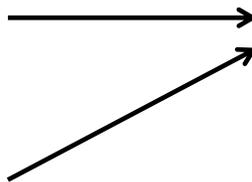
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From sensors to data

Individual sensors

Sensing node

Communication protocol

Server (storage infrastructure)

apisense

Delayed or real-time web-based display

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« Wearable sensors » strategy

Do we really want to have sensors on everyone ? (would be great also, but…)

24 hours with a sensor

Challenges :
- Discrimination indoor/outdoor : jumps in T, RH, number of satellites…
- Metrology of sensors (changes in T, RH, speed)
- Data transfer
- Autonomy
- Time and space variability
- Inter-individual variability
- Are the sensor people-proof ?

Apolline in the subway

Indoor	Outdoor	Metro	Outdoor
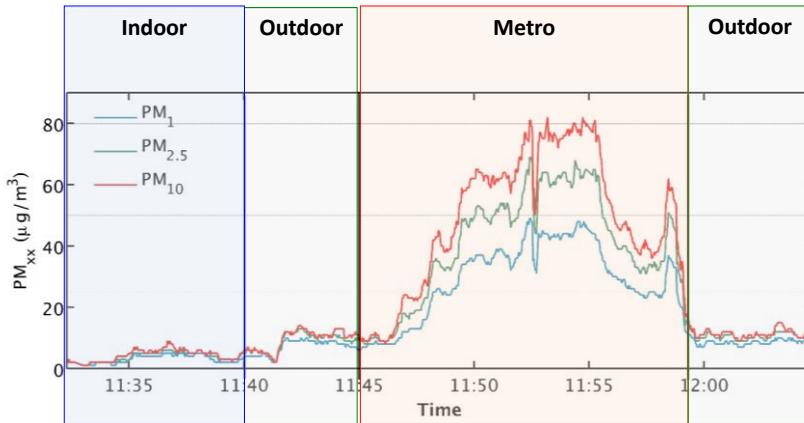
Indoor concentrations ~ 5 µg/m3
Outdoor concentrations ~ 10 µg/m3

PM_{10} Subway concentrations up to 80 µg/m3
PM_1 Subway concentrations up to 50 µg/m3
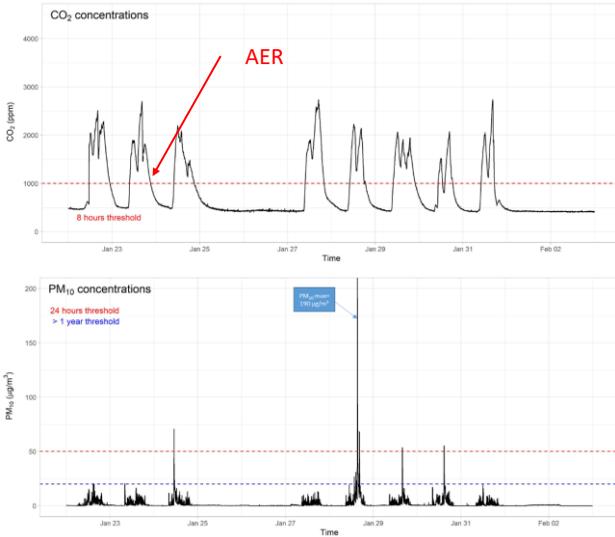
« Fixed sensors » strategy

Bedrooms
Dust and dust mites, bacteria and viruses, pet dander, VOCs from personal care products

Bathroom
Mould and mildew, bacteria, VOCs and other chemicals from cleaning products

Kitchen
CO, NO_2 and particulates from gas cookers/stoves, VOCs from household cleaning products

Attic
Man-made mineral fibres, asbestos, formaldehyde, dust

Living areas
Radon from soil/bedrock, CO and NO_2 from fires and wood-burning stoves, VOCs and formaldehyde from carpets, paints, glues, furniture and air fresheners, tobacco smoke, pet dander

Garage
CO from car exhaust, mould and VOCs from paints and pesticides, herbicides

Do we really want to have sensors in every room of every building ? (would be great, but…)

What inter-dwellings variability ?

All investigated environments behave similarly.

Main difference is T and RH, driven by behavior, not by pollution sources.

The « statistical » outliers correspond to pollution episodes driven by activities.

Identification of patterns associated to activities

Self-reported activities : cooking (various methods), some cleaning.

Some events detected but not reported.

« Chemical signature » of activities. Need to construct a database for such signatures.

Sensors and ventilation

Students in their office at the University

CO2 as a proxy to trigger ventilation only when necessary.

From sensors to usable information

Sensing node

Server (storage infrastructure)

apisense

Can we / should we analyze the data before transmission ?
- **Partial information**
- **Computation power**
- **Less transmissions**
- **Energy efficiency**

Data analysis :
ongoing work, and the key to putting sensors everywhere

Take home messages

- Wearable and fixed sensors allow to monitor or evaluate personal exposure.

- Provided you can fix all technical issues : sensor response, size, weight, autonomy, cost, communication protocols, storage infrastructure…

- Not that much low cost, if you consider putting sensors everywhere, framework infrastructure, calibration and operation, environmental cost

- For exposure, recommandation for a network of wearable sensors / fixed sensors / reference monitoring stations

- Issue #1 : make sure what the goal is : exposure characterization, building-related pollution, activity-related pollution, building management, alerting system…

- Issue #2 : what are we looking for ? Environmental parameters, particles, (speciated) gases, exposure duration, pre-identified events, unexpected events…

- Issue #3 : how and when to analyze ? Delayed/real-time. Server/on-board sensor. Time-series, classification, artificial intelligence…

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https://annex86.iea-ebc.org/

IEA EBC HOME   LINKS   SEARCH   SITE MAP   EBC-LOGIN

EBC
Energy in Buildings and Communities Programme

HOME   ABOUT   SUBTASKS   PUBLICATIONS   PARTICIPANTS   NEWS   MEETINGS   MEMBER AREA

IEA EBC - Annex 86 - Energy Efficient Indoor Air Quality Management in Residential Buildings

From the overview of the state of the art, it is clear that the issues raised in the previous section can't be solved directly from existing knowledge. Partial answers to each of these issues are available, but a new annex is needed to address the gaps and integrate the available solutions in a coherent and operable rating method.

International collaboration is a prerequisite for this effort since market access for innovative IAQ management strategies is currently blocked in many countries due to all kinds of prescriptive regulatory constraints. With the methods developed in the annex, we will be able to generate the necessary body of evidence to take regulatory action to overcome these barriers, generate consensus, open these markets and create a level playing field, which today is limited by very sparse and inconsistent approaches in the different member states.

ANNEX INFO & CONTACT
Status: Ongoing (2020 - 2025)
OPERATING AGENT
Dr Jelle Laverge
Assistant Professor
Ghent University
Department of Architecture &
Urban Planning, Building Physics
Campus UFO T4, St-
Pietersnieuwstraat 41
9000 Ghent
BELGIUM
Tel: +32 9 264 37 49
Email

Subtask 5 Energy savings and IAQ: improvements and validation through cloud data and IoT connected devices
Subtask Leader: Belgium (UGent, Marc Delghust)
Co-Lead: France (ULille, Benjamin Hanoune)

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• the AIVC Webinar organizers

• the audience

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