Mastering Mobility: Understanding air quality and its role in urban transportation

ovember 16th | 10:00-11:30 CET

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Welcome to this year's Mastering Mobility Series!

- ✓ Learn
- ✓ Exchange
- ✓ Connect

02.11.2021	Data types and data collection methods for an urban mobility diagnosis
10.11.2021	Tramways as sustainable mass-transit systems: Ex-post evaluation of Moroccan tramways
16.11.2021	**Understanding air quality and its role in urban transportation**
23.11.2021	Integrating air quality into sustainable mobility planning
29.11.2021	Reforming paratransit with MobiliseYourCity's newest catalogue of measures
30.11.2021	Getting to know your potential: Conduct a financial assessment of your city
07.12.2021	Reflecting about barriers and co-creating solutions for active and walkable cities

Translation French-English will be provided

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Agenda

10:00	Introduction to today's session Vincent Larondelle
10:05	Wordcloud: Air quality - what does it mean to you? Vincent Larondelle
PART 1	
10:10	Air quality, what does it mean and why does it matter? Marie-Pierre Meillan
10:15	What are the main pollutants and where do they come from? Marie-Pierre Meillan
10:20	Impacts of air pollution Marie-Pierre Meillan
10:30	Transportation and air pollution´: example in Paris region Juliette Laurent
10:40	Break

PART 2	
10:45	Poll Vincent Larondelle
10:50	Air quality and transport: information needed to make a diagnosis Juliette Laurent
11:00	Case study 1: Micro-sensors and mapping of air pollutants in Yaoundé Sandra Monsalve, Arnauld Ndzana
11:20	Q&A, overview of next session, participant feedback Vincent Larondelle

Objectives of the session

- Understand the difference between Greenhouse Gas (GHG) emissions and air pollution
- Identify the main air pollutants, their impact on health and their main sources
- Understand the contribution of transport to air pollution

Meet the speakers and facilitators of today's session

Speaker
Arnauld Ndzana
FASEP Yaoundé
Ville de Yaoundé

Speaker
Juliette Laurent
Partnerships and International Relations Coordinator
Airparif

Speaker
Marie-Pierre Meillan
International project officer at European and International Division
Ademe

Speaker
Sandra Monsalve
FASEP Yaoundé
DVDH

Moderator
Vincent Larondelle
Monitoring and evaluation
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Understanding air quality and its role in urban transportation

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What does air quality mean and why is it important?

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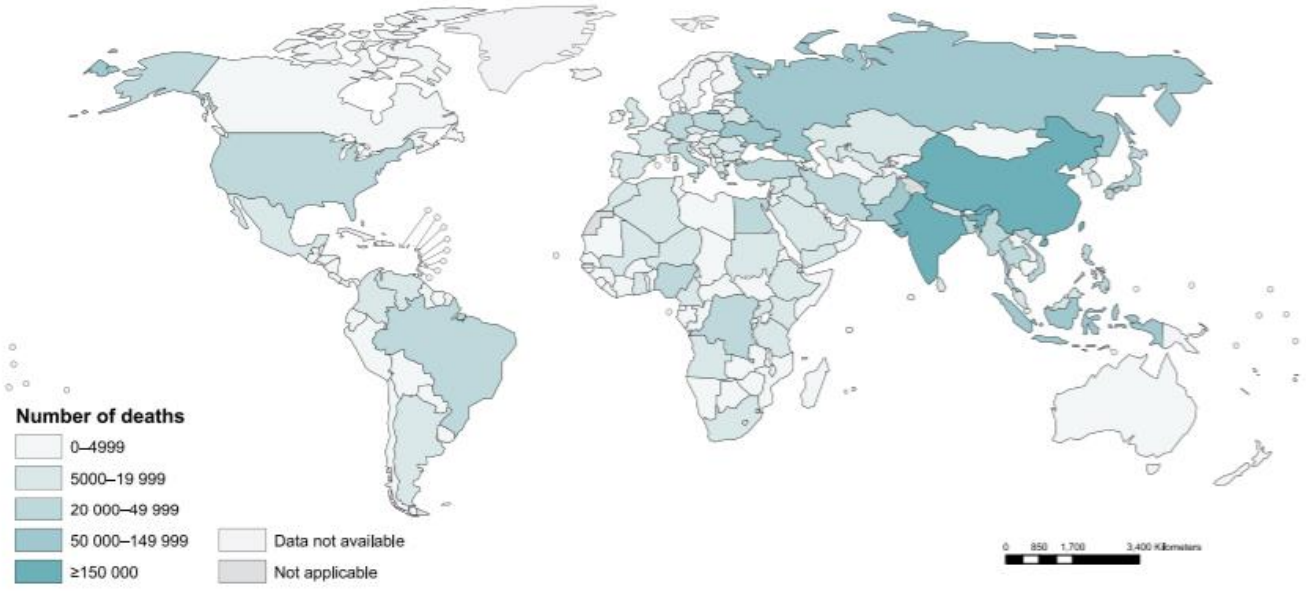
Air pollution, a public health issue

Figure 16: Deaths attributable to AAP in 2012, by country



AAP: Ambient air pollution

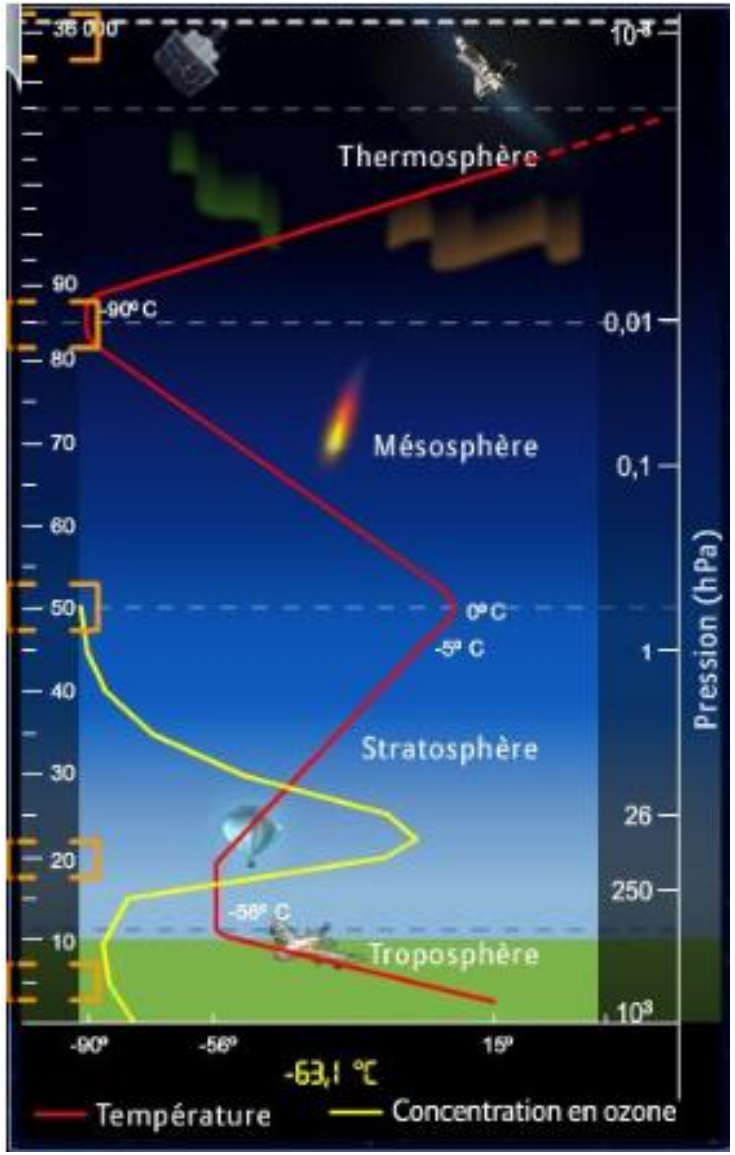
Ambient air pollution: a global assessment of exposure and burden of disease, WHO 2016

ADEME

7 million premature deaths due to the effects of air pollution (WHO)

Air composition and atmospheric structure

Gaz constituants de l'air sec	Pourcentages en volume
Azote (N_2)	78,09
Dioxygène (O_2)	20,95
Argon (A)	0,93
Dioxyde de carbone (CO_2)	0,035
Néon (Ne)	$1,8\ 10^{-3}$
Hélium (He)	$5,24\ 10^{-4}$
Krypton (Kr)	$1,0\ 10^{-4}$
Hydrogène (H_2)	$5,0\ 10^{-5}$
Xénon (Xe)	$8,0\ 10^{-6}$
Ozone (O_3)	$1,0\ 10^{-6}$
Radon (Rn)	$6,0\ 10^{-18}$



http://education.meteofrance.fr/

Emissions / concentrations

Some figures for France (CITEPA, 2020)

- **About 90%** of primary particulate matter and nitrogen oxide emissions from road transport are from diesel vehicles
- **84%** of fine particles emissions from the residential sector are linked to heating

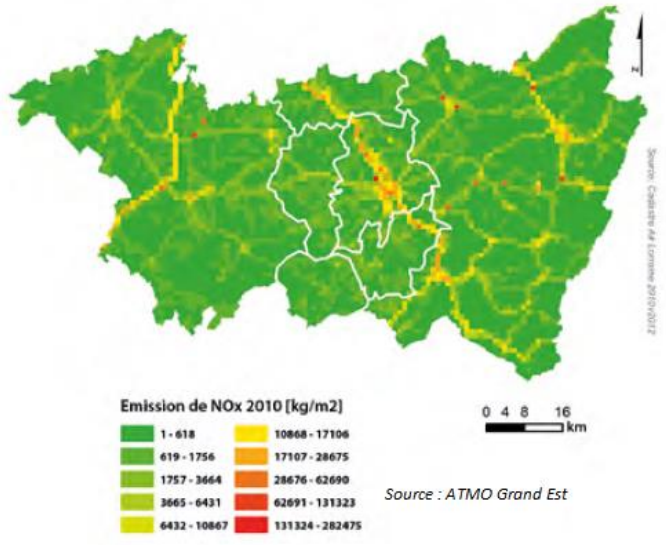
La pollution de l'air en 10 questions, ADEME 2020

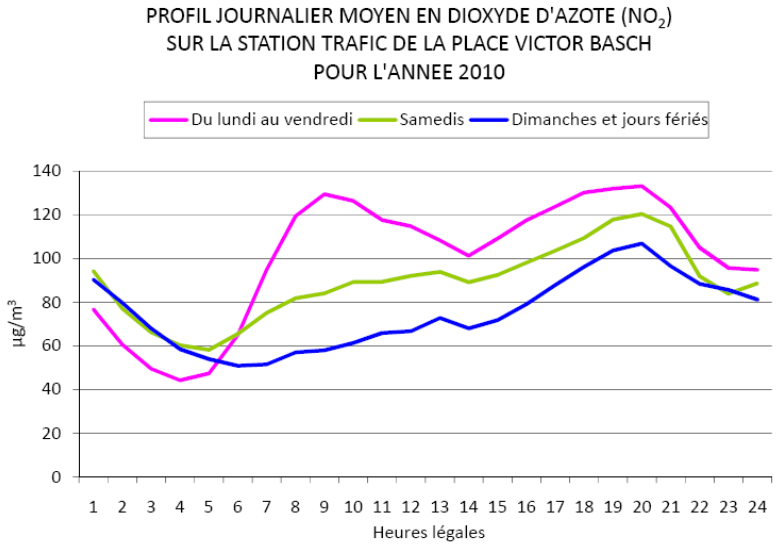
Emissions / concentrations

- **An emission inventory** consists of recording the nature and quantity of **air pollutants emitted by different sources** according to their location and over a given time. When emissions are geographically distributed, it is generally referred to as an emissions register.

- **Concentrations** correspond to the mass of pollutant per volume of air. They can be transformed into an air quality index. These are the local concentrations that we breathe. Assessing these concentrations requires the setting up of measurement network stations.

Cadastre d'émission de NOx sur le périmètre du SCoT et du département des Vosges (source : Air Lorraine)

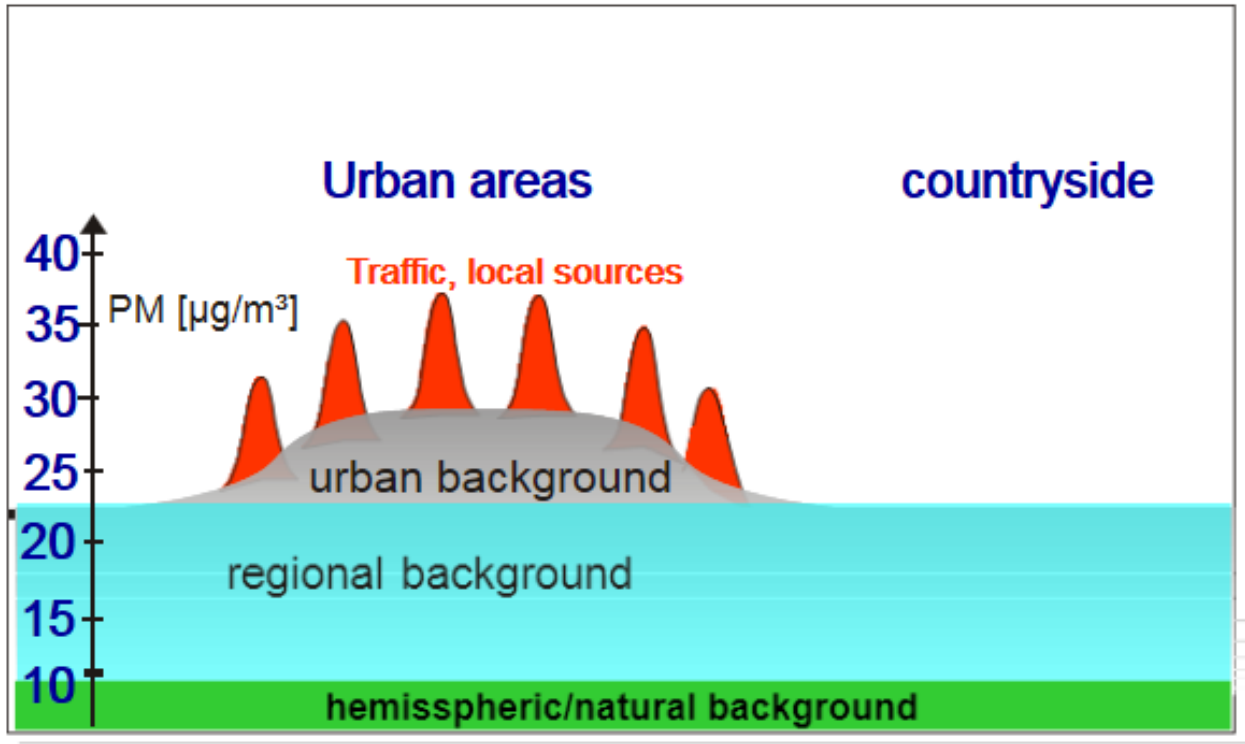




Source : Surveillance et information sur la qualité de l'air en Ile-de-France en 2014, AIRPARIF, mai 2015

Emissions / concentrations

Pollutant concentrations are often broken down into the sum of ***background pollution and pollution of more local origin.***



Source : Martin Lutz, Sénat de Berlin

Inhomogeneous concentrations, varying from day to day

Reactive pollutants

O_3	: a few hours
NO_x	: 1,5 days
SO_2	: 5 days
Particules	: a few days
COV	: 0,5 - 60 days
CO	: 2 months
CH_4	: 7 years
CFC	: 7 - 150 years

Emissions / concentrations : influence of meteorological conditions

- wind

Absence of wind: concentration of pollutants
Moderate wind: good dispersion of pollutants
Strong wind: plume effect and localised pollution

- rain

Raindrops and fog droplets entrap gaseous pollutants and particles and carry them to the ground

- topography

Natural obstacles, buildings or land and sea breeze phenomena on the coast can generate the dispersion of pollutants

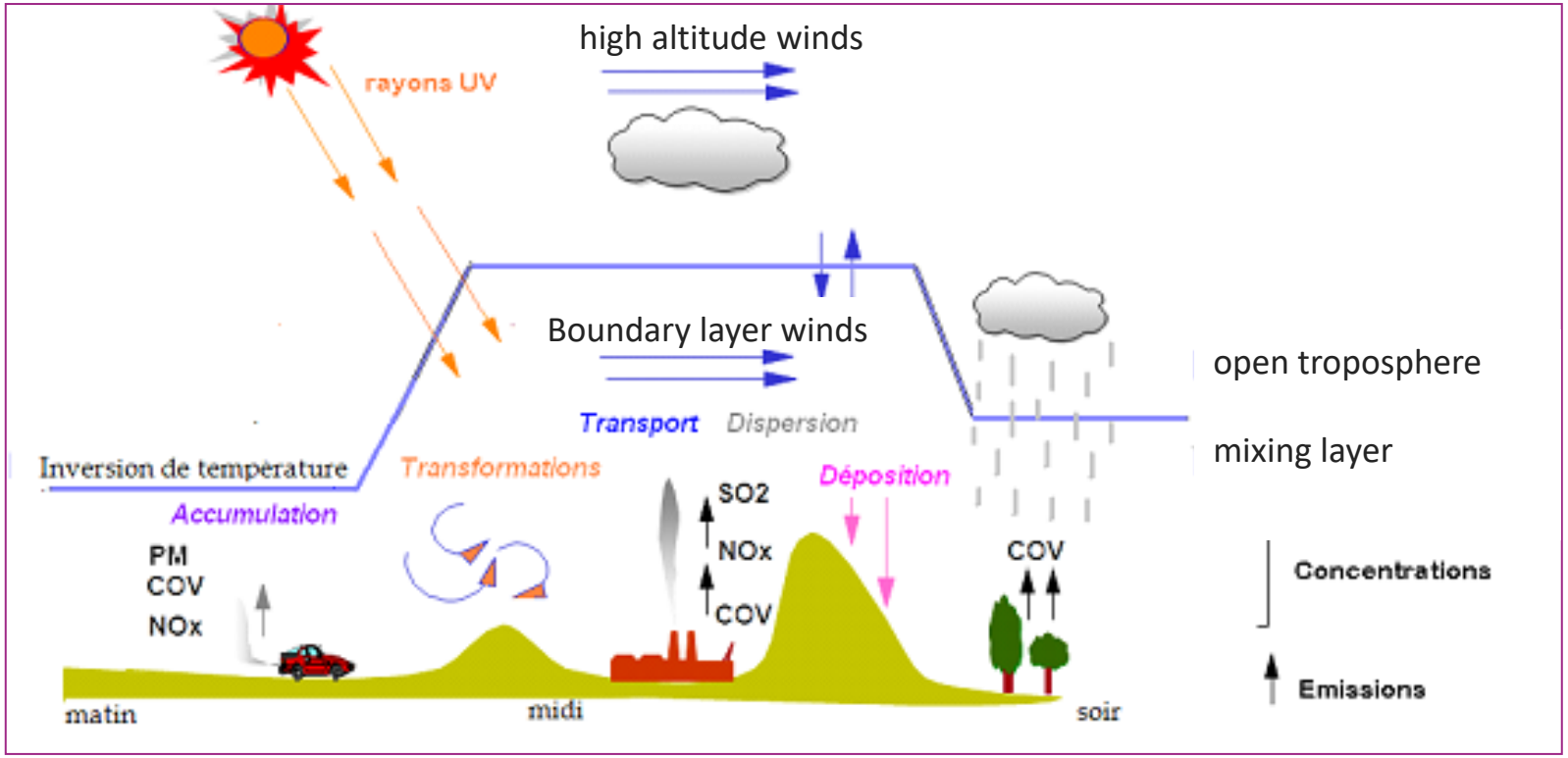


Illustration Airparif

Greenhouse gases/air pollution: how to tell the difference?

- **Air pollutants**: composed of toxic gases or harmful particles, have a direct effect on health and ecosystems.

→ **Short term impacts**

- **Greenhouse gases:** are responsible for climate change. They remain in the atmosphere for a very long time but have little direct effect on health (with the notable exception of ozone, which is also an air pollutant).

→ **Long term impact**

Air pollution and climate change

► Pollutants

Main sources of pollution (climate and air):

Short lived compounds (**SLCs**) including soot.

Impact of climate change on air pollution

Increased burden of ozone pollution

Lengthening of the pollen season

► Sources (emissions)

Same origins

With different contributions

https://www.atmo-nouvelleaquitaine.org

► Action plan

Research for synergies

- **Reduction of energy consumption**
- **Behaviour** change **(mobility and sustainable agriculture…)**

Vigilance against **actions with antagonistic effects**:

Energy substitution (diesel, combustion of wood, etc.)

Key role of cities: efficiency of bottom-up actions

- Local action = **Positive local and global impact**
- **Short-term benefits** for health and economy

What are the main pollutants and where do they come from?

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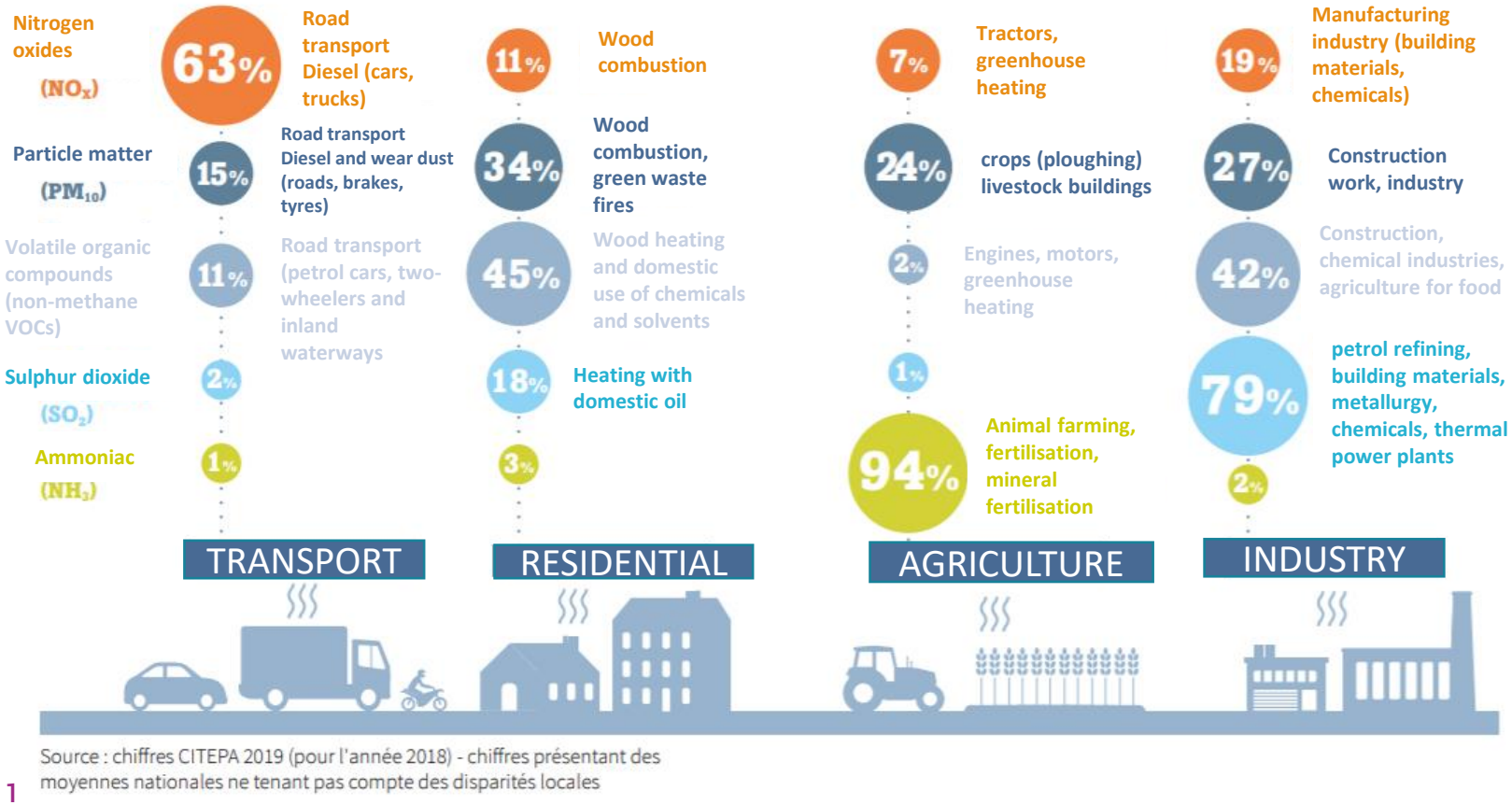
Main sources of pollution

Main pollutants and their sources



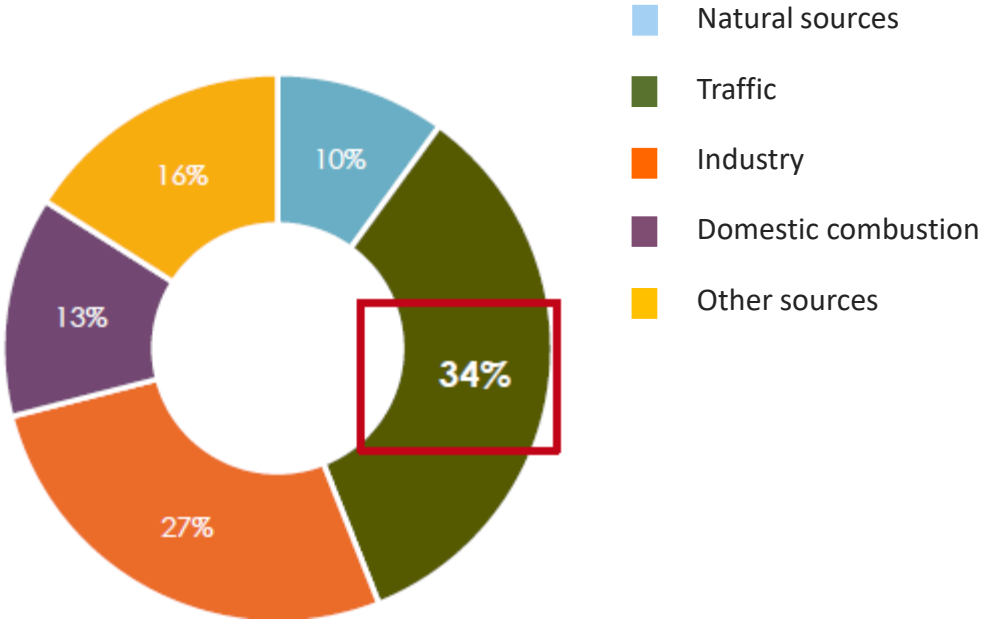
Source : chiffres CITEPA 2019 (pour l'année 2018) - chiffres présentant des moyennes nationales ne tenant pas compte des disparités locales

https://www.ademe.fr/sites/default/files/assets/documents/guide-pratique-pollution-air-en-10-questions.pdf

- **Primary pollutants:**
  - ✓ Combustion
  - ✓ Volatilisation
  - ✓ Mechanical process
- **Secondary pollutants:**
  - ✓ Chemical or photochemical reactions from primary pollutants
  - ✓ Examples: ozone, secondary particles

Main sources of pollution

Contribution of different sectors to PM2,5 emissions



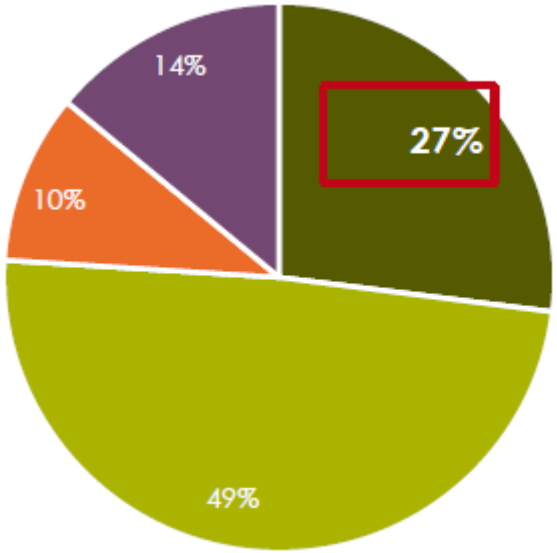
- Natural sources
- Traffic
- Industry
- Domestic combustion
- Other sources

South Asia, 2015

Source : Karagulian et al. 2015

PARIS, 2015

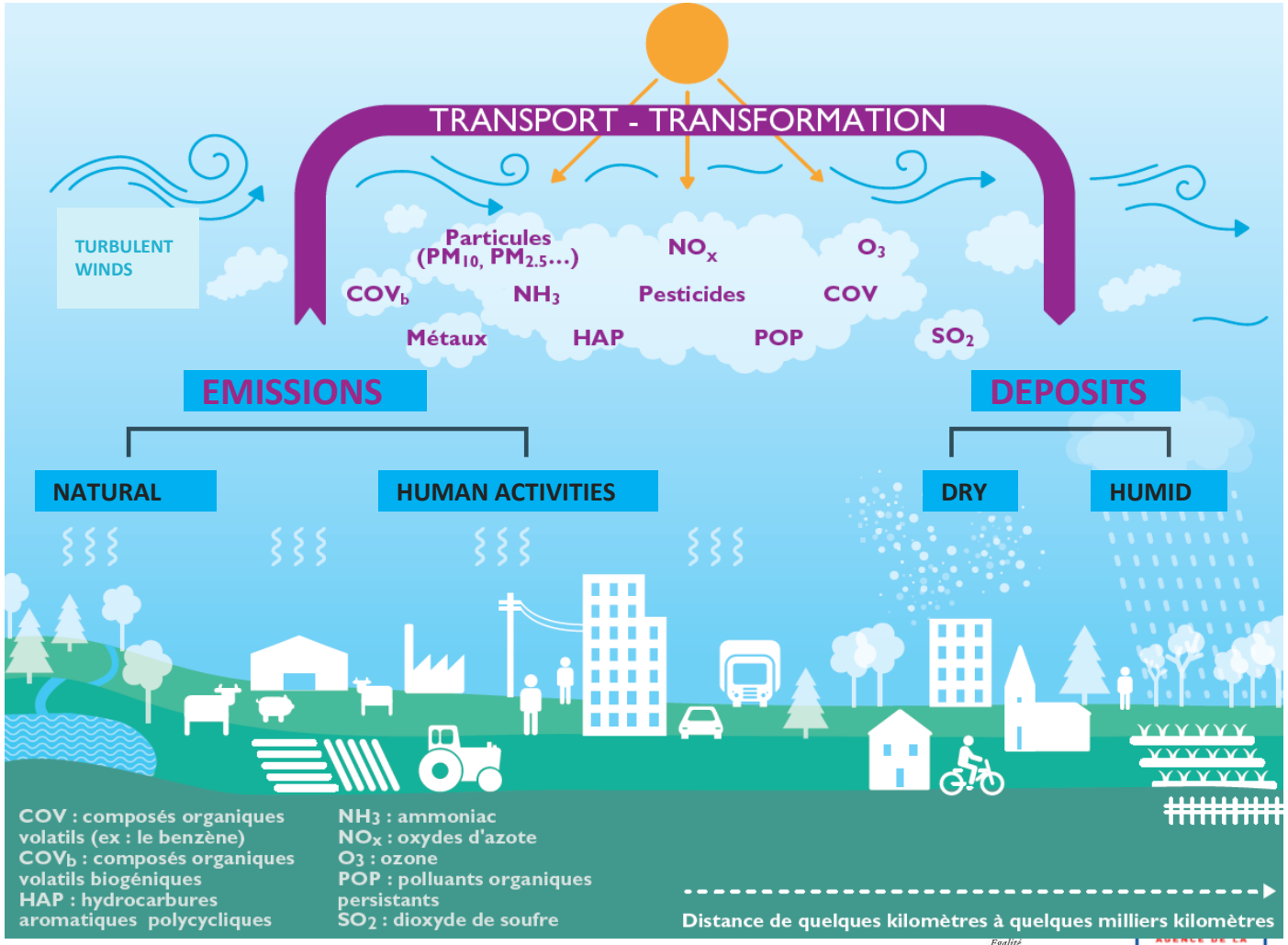
Source : AirParif



- Residential sector
- Traffic
- Construction
- Other

https://www.ademe.fr/sites/default/files/assets/documents/guide-pratique-pollution-air-en-10-questions.pdf

Impact of the environment on pollutants



http://www.ademe.fr/agriculture-pollution-lair

Impact of atmospheric pollution

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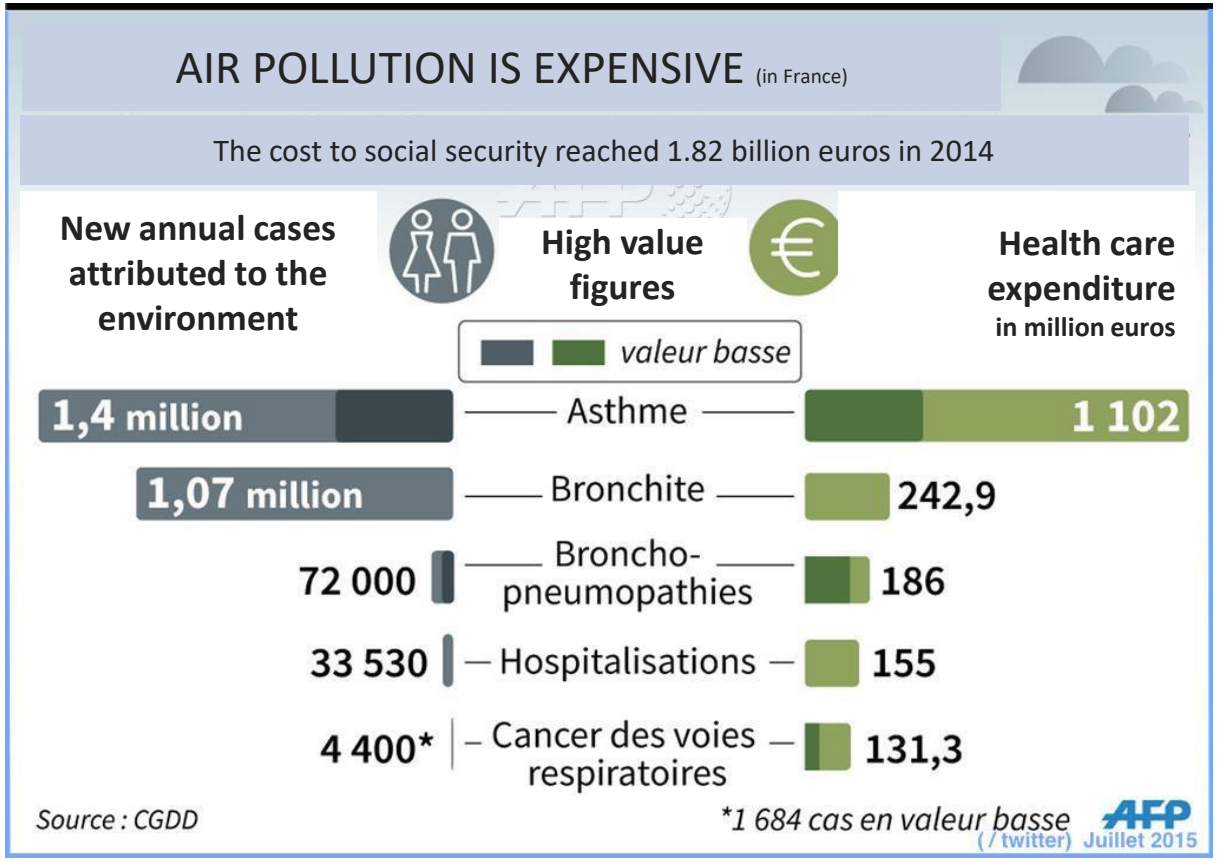
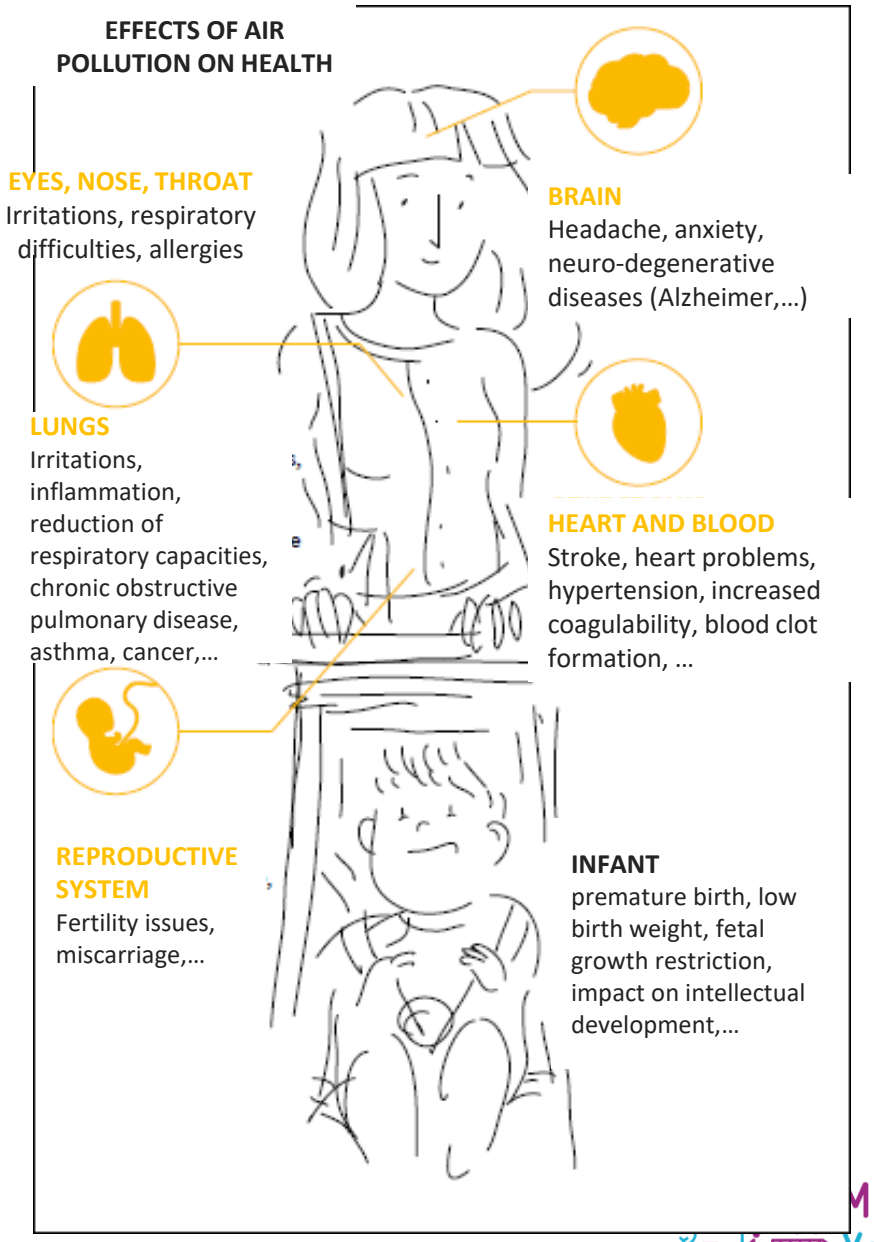
Impact on health





Air pollution in 10 questions, ADEME 2020

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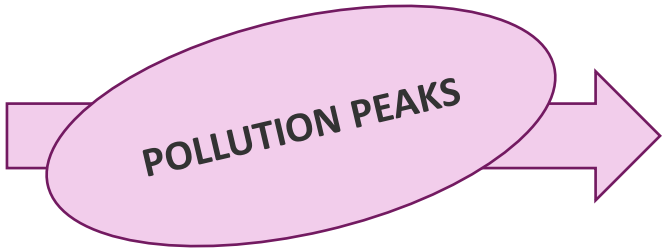
Impact on health

Exposition over several hours to several days



Acute exposure, so-called short-term

An exhibition over several years

Chronic exposure, so-called long-term

Chronic exposure to air pollution leads to the most significant health impacts for the general population

To act in a permanent way and not only in a punctual way (during pollution peaks for example)

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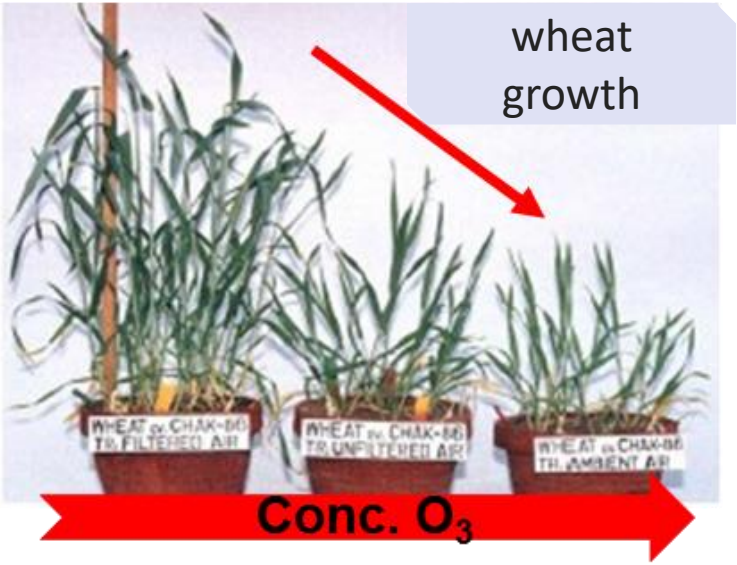
Other impacts

- **Impacts on the environment**
  - ✓ Excessive nitrogen deposition
    - Acidification and eutrophication of environments
    - Nitrophilous species favoured and species vulnerable to excess nitrogen regres
    - Biodiversity
  - ✓ Excess Ozone
    - Decrease in agricultural, forestry and fish farming yields
    - Impacts on the quality of marketed plants
  - ✓ Acid rain: NOx, SO2, NH3
    - Acidification of wet deposits (rain, snow, fog, etc.)
    - Disruption of photosynthesis and mineral salt absorption
    - Acidification and loss of soil fertility
    - Death of trees



- **Impact on buildings**: Air pollution dirties and degrades materials and buildings

✓ Formation of black crusts on facades (particularly by particles linked to the combustion of petroleum products)

✓ Dissolution of stones (especially limestone under the effect of acid rain)

✓ Corrosion (SO2)

The damage is sometimes irreversible.

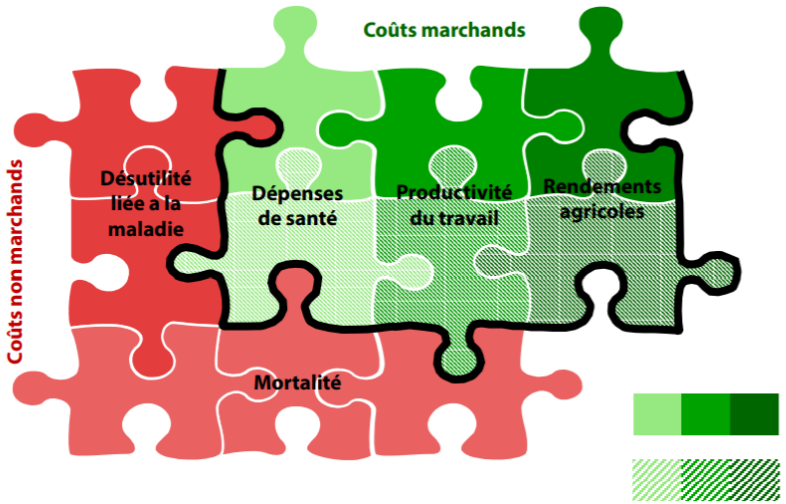
Other impacts

Economic impact :

- €68-97bn in France (Senate, 2015)
- A progressive increase in overall economic costs, projected to reach **1% of global gross domestic product (GDP) by 2060**. (OECD, 2016)

	OECD		World	
	2015	2060	2015	2060
TOTAL market impacts	90	390	330	3 300
En part de revenu (pourcentage)	0.3%	0.5%	0.6%	1.5%
Par habitant (USD par habitant)	70	270	50	330
TOTAL non-market impacts	1 550	3 750 - 3 850	3 440	20 540 - 27 570
En part de revenu (pourcentage)*	5%	5%	6%	9 - 12%
Par habitant (USD par habitant)	1 210	2 610 - 2 680	470	2 060 - 2 770

Consequences-economiques-de-la-pollution-air-exterieur-essentiel-strategique, OCDE, 2016



New WHO guidelines

Table 0.1. Recommended AQG levels and interim targets

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
$PM_{2.5}$, µg/m³	Annual	35	25	15	10	5
	24-hour[a]	75	50	37.5	25	15
PM_{10}, µg/m³	Annual	70	50	30	20	15
	24-hour[a]	150	100	75	50	45
O_3, µg/m³	Peak season[b]	100	70	–	–	60
	8-hour[a]	160	120	–	–	100
NO_2, µg/m³	Annual	40	30	20	–	10
	24-hour[a]	120	50	–	–	25
SO_2, µg/m³	24-hour[a]	125	50	–	–	40
CO, mg/m³	24-hour[a]	7	–	–	–	4

[a] 99th percentile (i.e. 3–4 exceedance days per year).
[b] Average of daily maximum 8-hour mean O_3 concentration in the six consecutive months with the highest six-month running-average O_3 concentration.

WHO global air quality guidelines, 2021

The average level for **PM2.5** (10 µg/m3) is exceeded by **70% of the measuring stations in Europe**

Air quality in Europe - 2020 report

Between 2009 and 2018, for **PM2.5**:

- **22% reduction in annual average concentrations,**
- **13% reduction in premature deaths linked to air pollution**

Air quality in Europe - 2020 report

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

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AGENCE DE LA TRANSITION ÉCOLOGIQUE

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Additionl resources

- **A 20-minute awareness-raising tool on air, climate and energy issues**

- **An online training tool on air quality**

- **An ADEME guide for the general public on air pollution**

- **A reference website: https://www.ccacoalition.org/en**

Thank you for your attention

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L'Observatoire de l'air en Île-de-France

Road transport and air pollution: The example of the Paris metropolitan region.

Mobilise Your City Mastering Mobility Series - Airparif | 16.11.2021

Sources of air pollution

Diverse sources:

Transport : road, rail, river and airport traffic...

Residential / tertiary: heating, cooling, other energy consumption

Industry

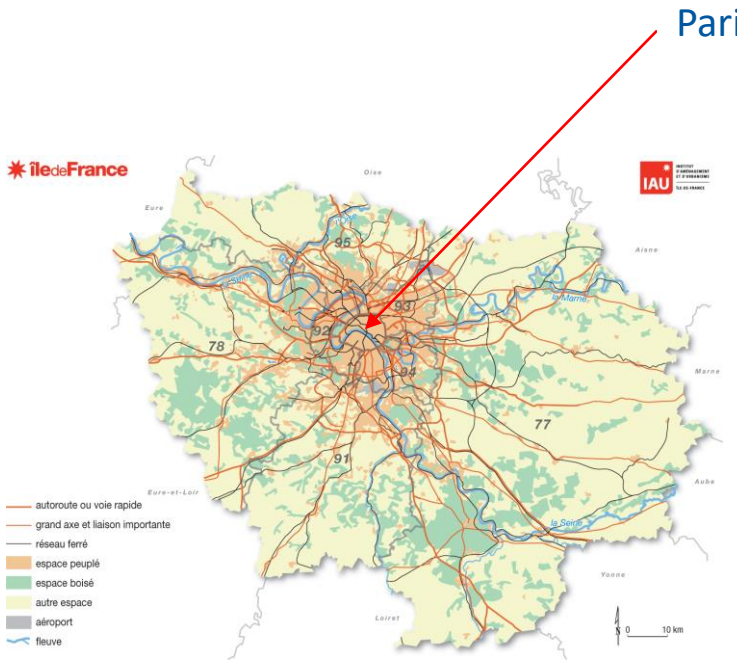
Agriculture

Waste

Construction sites…

Each sector contributes in its own way to air pollutant emissions (particulate matter, nitrogen dioxide, sulphur dioxide, ammonia, volatile organic compounds, etc.). The emission profile depends strongly on the territory considered.

Paris and the Île-de-France region



Paris

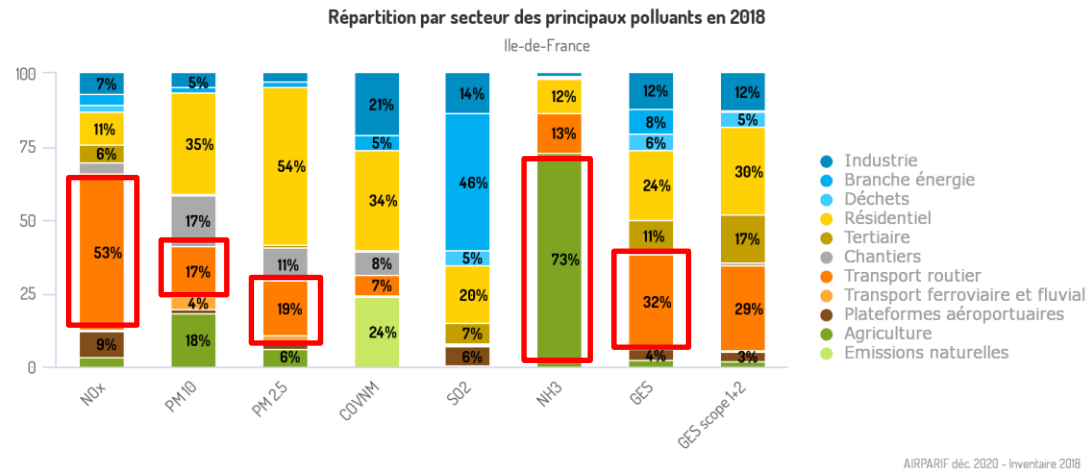
- 1.2 million inhabitants
- 1st European megapolis in terms of **population density** (20,600 inhabitants/km2)
- High concentration of economic activities and **traffic**

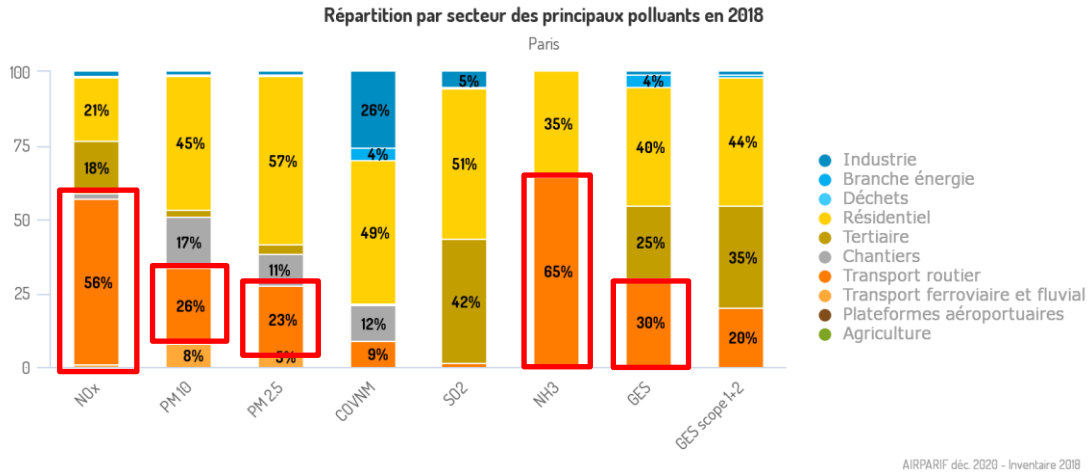
Île-de-France

- 12 million inhabitants
- **Attractive economic centre**
- Increasingly dense **road network** towards the centre of the agglomeration
- **50% agricultural land**, with many forests on the periphery

Emissions from road traffic

Emissions inventory: Paris vs Île-de-France





Transport sector: road traffic is by far the biggest emitter, ahead of rail and waterway transport and airports

Road transport :

- Primary source of NOx
- Secondary source of PM2.5

Different emission profiles depending on the territory:

- PM10: road transport 2nd source in Paris, 3rd in Ile-de-France (behind agriculture)
- Ammonia: 65% emitted by road transport in Paris, but 73% emitted by agriculture in Île-de-France

Links to climate change :

- 30% of GHG emissions from road transport

Evolution of road traffic emissions

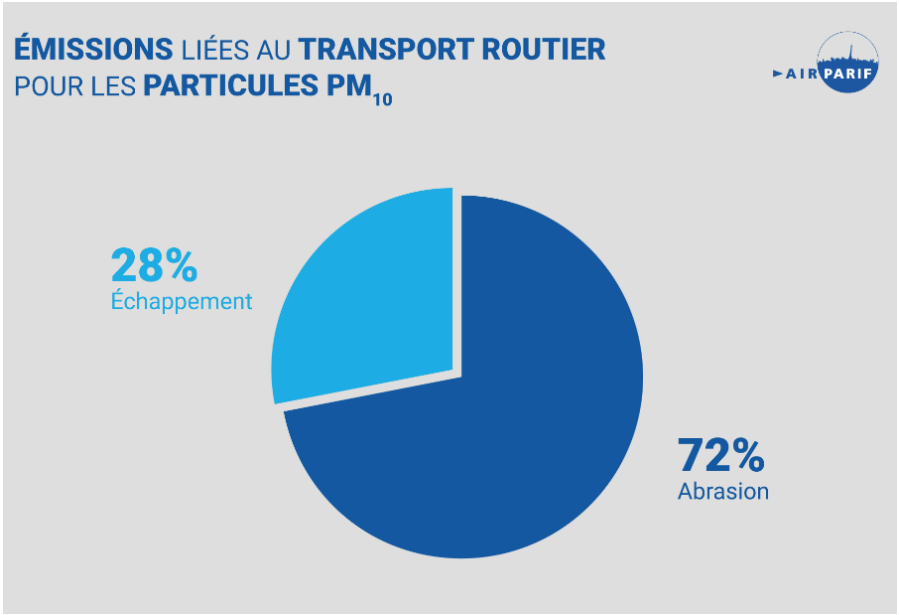
- **Clear downward trend (2005-2018) :**
  - NOx: -46%.
  - NH3: -52
  - PM10: -55%.
  - PM2.5: -65%.

- **Technological improvements and tightening of regulations (EURO standards)**

- **Abrasion particles**
  - With the decline in combustion-related particulate emissions (exhaust), the relative share of **abrasion particles (tyres, brakes, roads) is becoming the majority**.
  - Little impacted by the **renewal** or **electrification** of the fleet
  - Importance of **good** road and vehicle **maintenance** and **eco-driving practices** (to avoid sudden acceleration/deceleration).

NOx

NH3

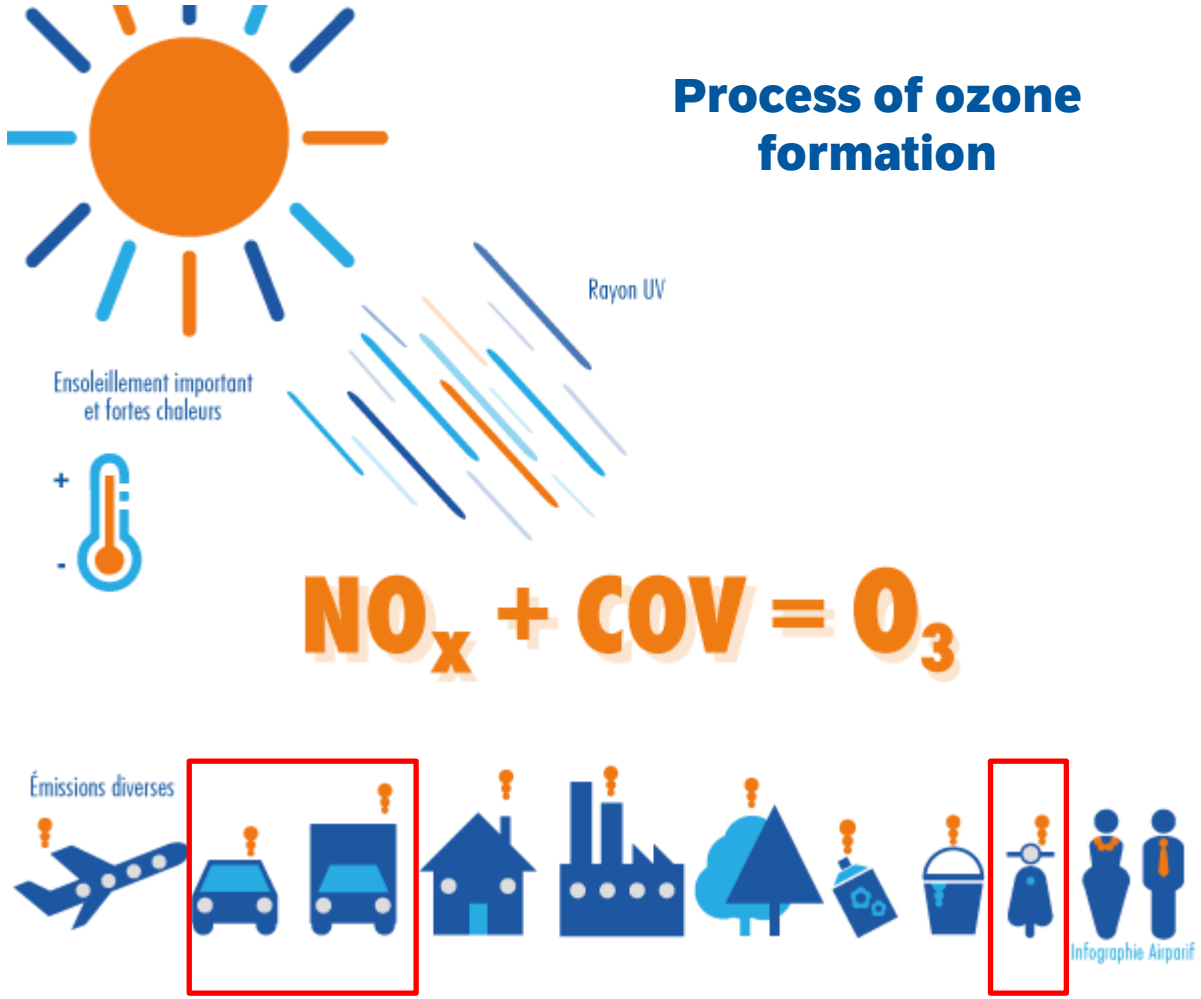


Ozone formation

Nitrogen oxides and volatile organic compounds from road traffic:

- **Precursors of ozone that contribute to its formation in the atmosphere.**
- Only pollutant **on the rise** in Île-de-France

Process of ozone formation



Conclusion on traffic emissions in Île-de-France

- **Emissions have fallen sharply** thanks to **technological developments** and increasingly strict **regulations** on vehicle emission standards.
- Traffic remains a **major source** of air pollution.

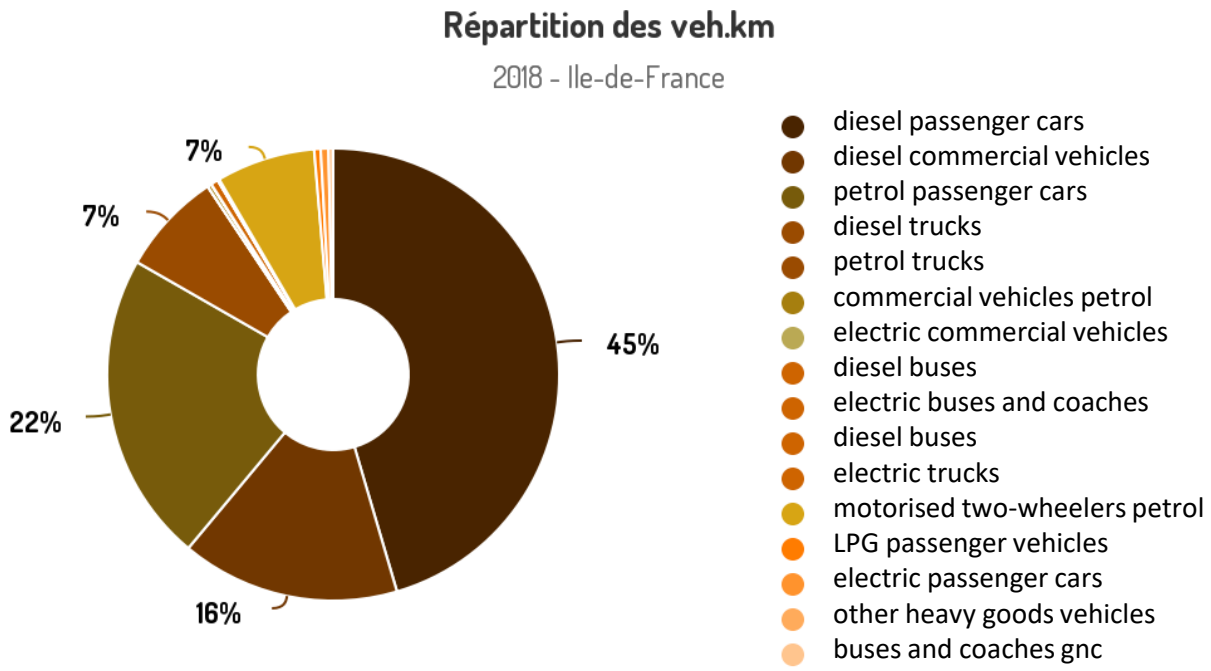
- **Health issues** *(IARC: particles and gases from diesel vehicles are classified as definite carcinogens; particles and gases from petrol vehicles as probable carcinogens).*

- And **climate** *(technological improvements in vehicles having little impact on their CO2 emissions).*

Factors affecting traffic emissions: fleet composition, speed, congestion

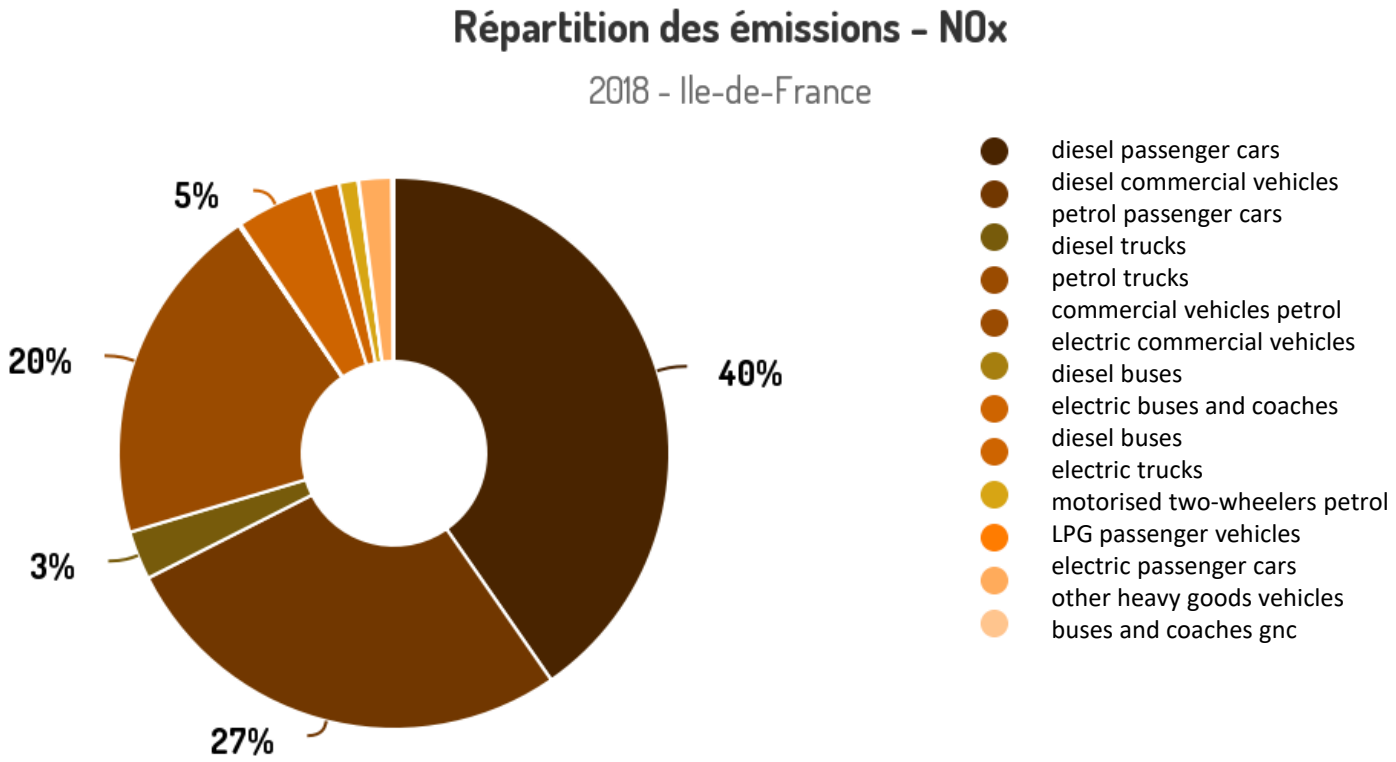
Composition of the fleet

- **Static fleet:** number plate file
- **Rolling stock:** kilometres travelled by vehicles according to their type
  - ➢ Necessary to determine actual road traffic emissions



Nitrogen oxide (NOx) emissions

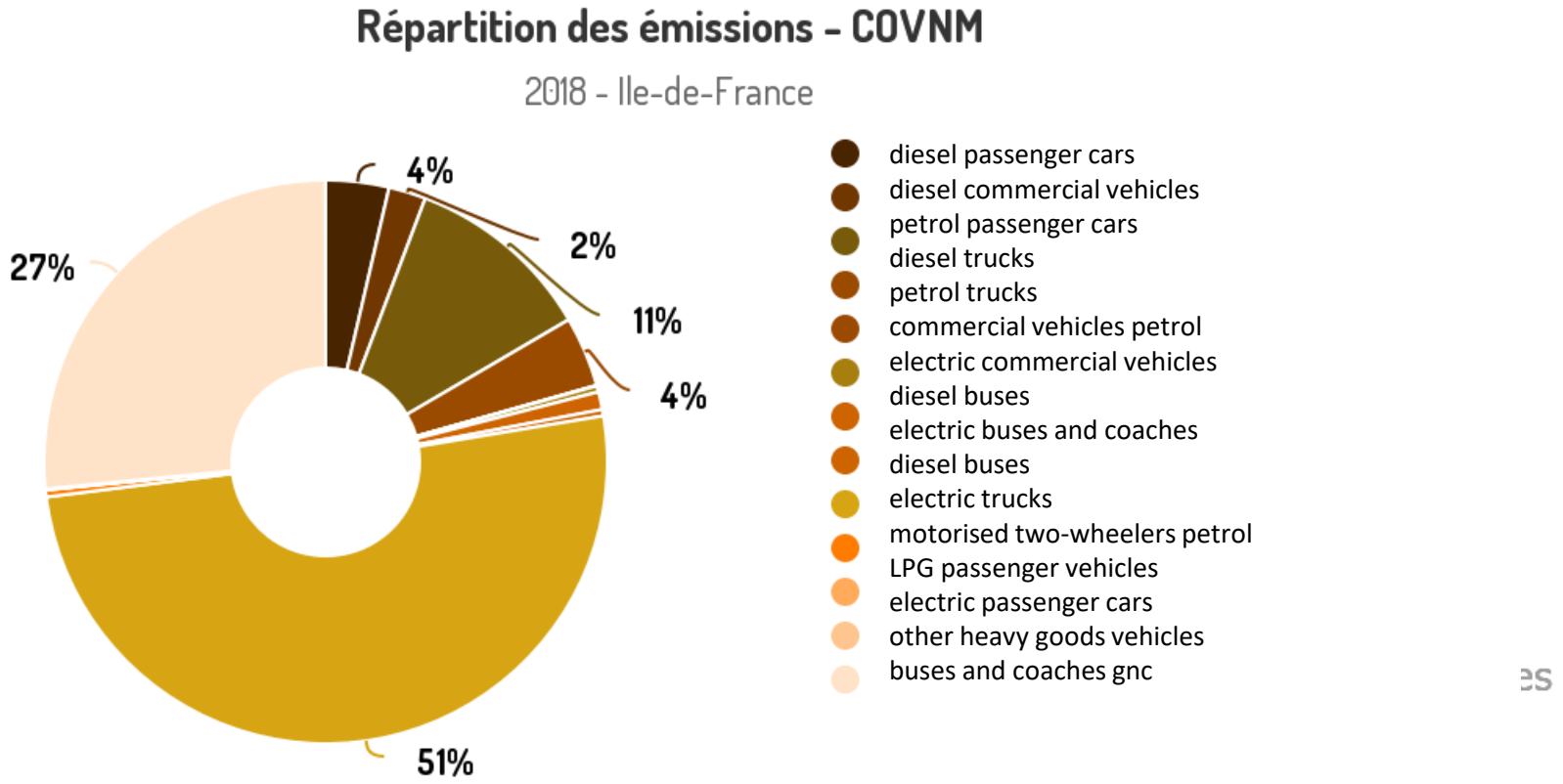
- **Diesel vehicles** (VP + VUL + PUL) :
  - 68% of the fleet
  - 87% of Nox emissions



AIRPARIF déc. 2020 - Inventaire 2018

Emissions of Volatile Organic Compounds

- **Motorised two-wheelers** :
  - 7% of the vehicle fleet
  - 51% of NMVOC emissions (excluding evaporation)



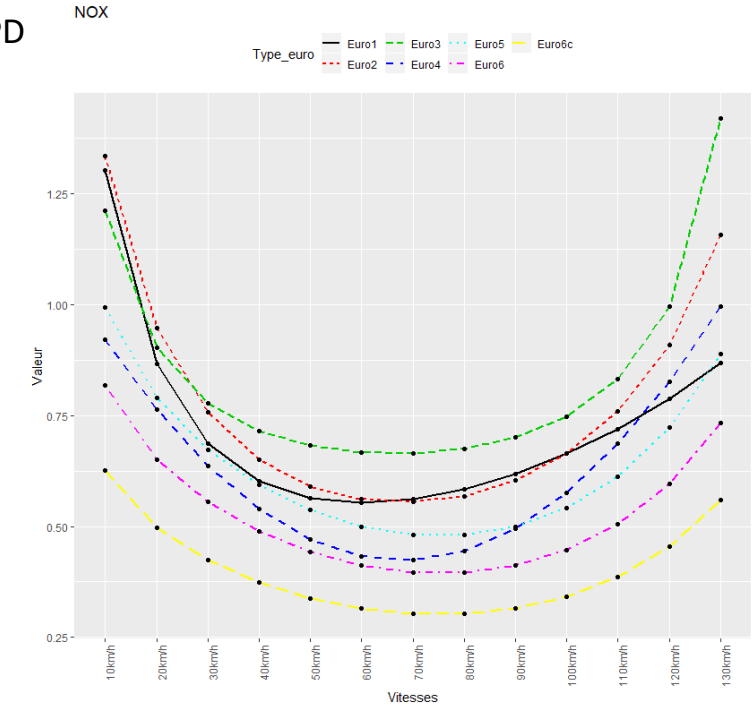
Impact of speed on emissions (NOx)

For diesel cars, speed impacts emissions in a bell-shaped pattern, with an optimum around 75km/h :
Between 130km/h and 70km/h, a decrease in speed leads to a decrease in emissions

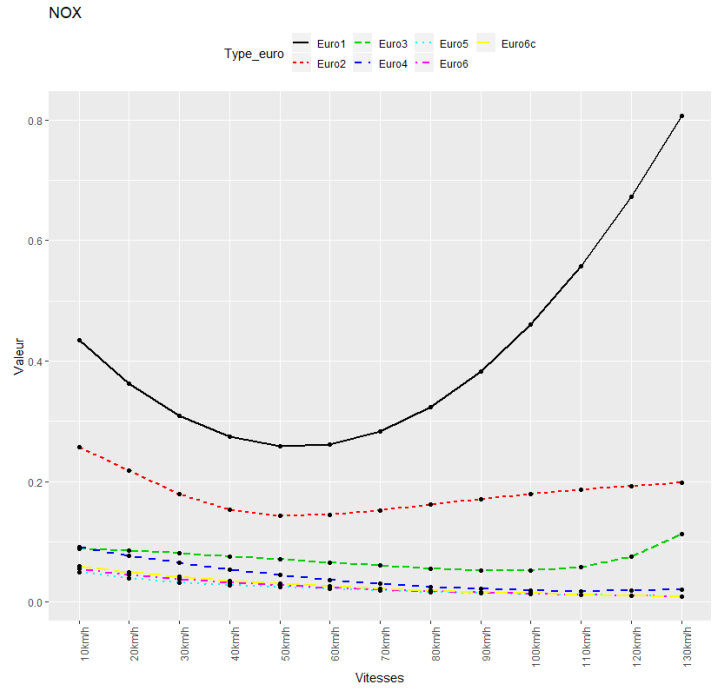
- Below 70km/h, a decrease in speed leads to an increase in emissions

For petrol cars, the bell-shaped profile is only found for the oldest vehicles (Euro 1); emissions from more recent vehicles are less affected by speed.

VPD



VPE



Impact of congestion on emissions

- **Less traffic flow leads to higher emissions** of air pollutants (and GHG):
  - **Decreased speed** (from 75 km/h)
  - Increased **deceleration and acceleration** cycles
  - **Cooling** of engines...

- All these phenomena combine and it is therefore **difficult to quantify precisely** the excess emissions linked to congestion.

Source : ADEME 2014

Conclusion sur les facteurs influençant les émissions

Traffic emissions in urban areas depend directly on the number and type of **vehicles on the road**, but also, in a more complex way:

- The **average speed**
  - This impact is different depending on the **type** of vehicle, the **fuel** used and the **pollutants** considered.

- **Congestion**
  - It is difficult to quantify this impact because **many factors** come into play

Exposure of the inhabitants

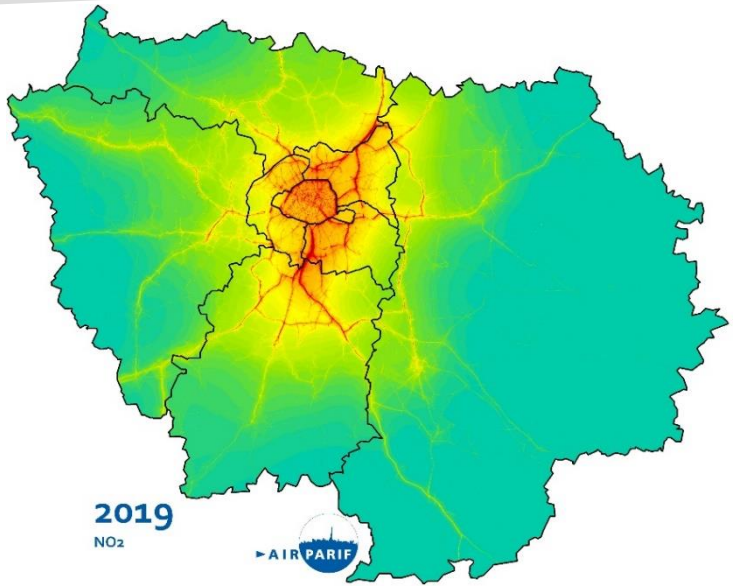
Exposure of the inhabitants

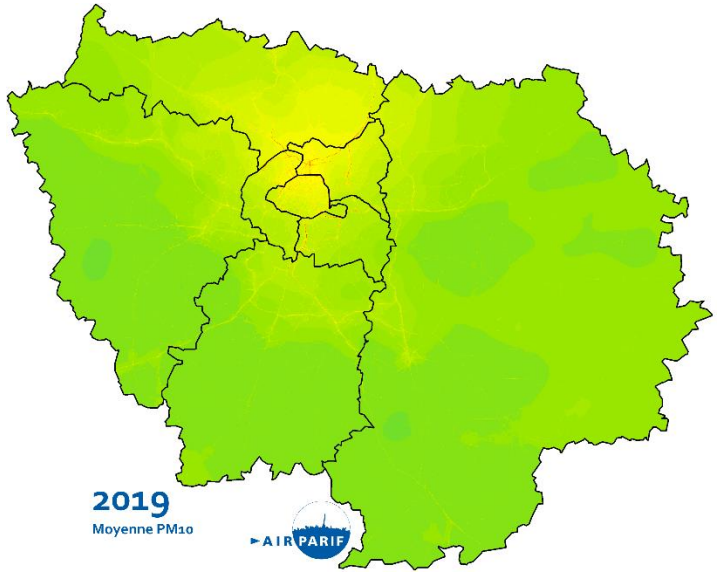
The road network stands out on the pollution maps:

- **NO2** (tracer of road traffic)
- **PM10** (even though there are many sources)

Near major roads, **NO2** concentrations are **5 to 6 times higher than WHO recommendations.**

Some areas near traffic exceed the **binding limit values** (EU litigation).

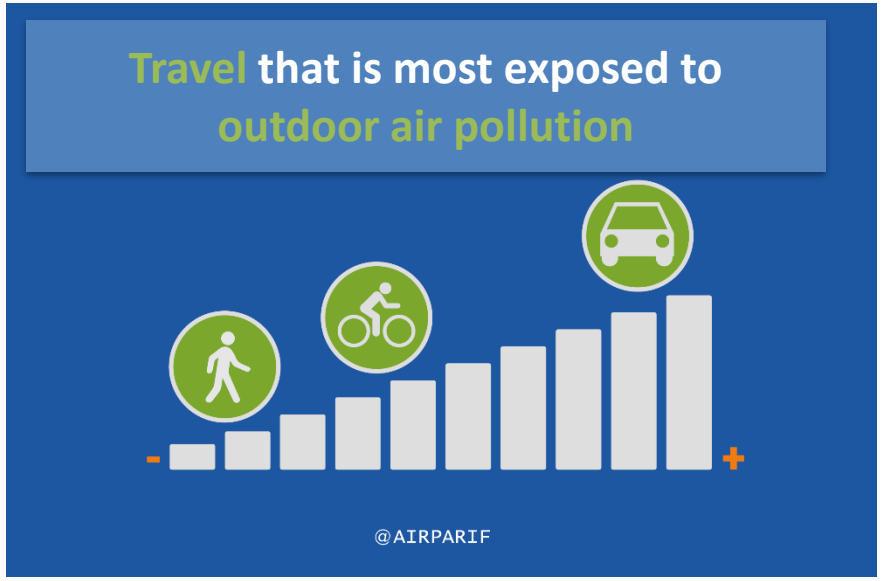


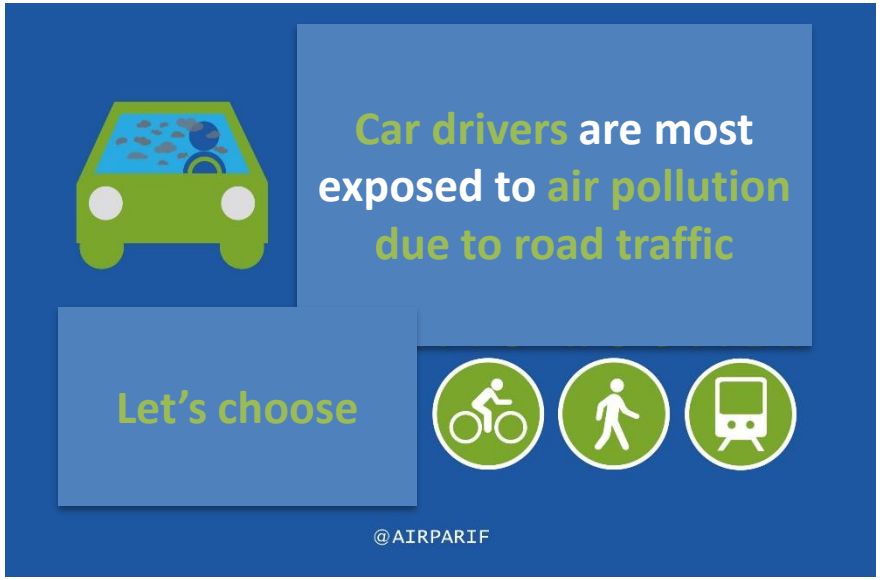


Exposure of the inhabitants

Individual exposure varies according to **where people live**, but also according to the **modes of transport used:**

- **Car drivers** are most exposed to both PM and NOx
- **Pedestrians** and **cyclists** are more protected as they move away from the traffic flow
- Particulate pollution issue in underground rail networks (**metro**)





Conclusion

Conclusion

- The contribution of road traffic to air pollution depends strongly on
  - The **number of vehicles** on the road
  - The **composition of the vehicle fleet** (type, fuel, age, etc.)
  - **Traffic conditions** (speed, congestion, etc.)

- The composition of the vehicle fleet leads to specific problems from one territory to another:

- Large proportion of **2RM**: issues related to **VOC** emissions
- Older vehicles, use of **sulphurous petrol**: issues related to **SO2, CO, benzene emissions...**

- **Accordingly adapt air quality monitoring**

L'Observatoire au service de la Santé et de l'Action

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L'Observatoire de l'air en Île-de-France

Air quality and transport: data and tools for diagnosis

Mobilise Your City Mastering Mobility Series - Airparif | 16.11.2021

Data and tools to be mobilised

Données et outils à mobiliser pour établir un diagnostic

To establish a diagnosis of air quality, different tools can be used with different advantages/disadvantages and degrees of reliability:

- **Concentration data** (pollution levels): spatial and temporal variability, hot spots, problematic pollutants...
  - **Measuring stations**
  - **Modelling**
  - **Micro-sensors**
  - **Satellite data...**

- **Emissions data** (discharges into the atmosphere): main emitting sectors -> which levers to use to improve air quality
  - **Emissions inventory**

To know precisely the contribution of transport to pollution :

- Data on **concentrations in the vicinity of roads**
- **Input data** for the transport emissions inventory :
  - Fleet composition
  - Travel survey
  - Counting loops...

Monitoring air quality

Monitoring air quality

High temporal and spatial **variability** of pollution levels and sources.

A monitoring scheme should be able to characterise air pollution for :

- Different **environments**
  - Background pollution (far from sources) / proximity pollution (around roads)
  - Hot spots (transport infrastructures, industries, airports...)
  - Individual exposure

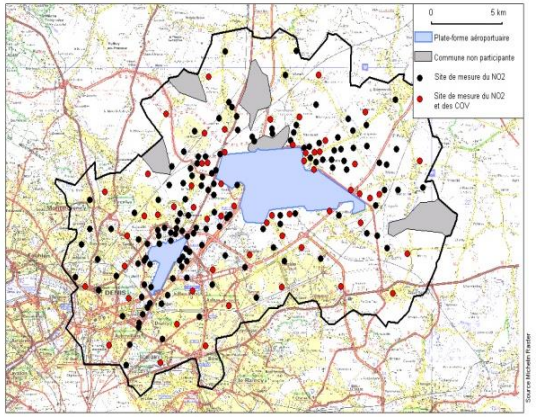
- Different **pollutants**
  - Pollutants regulated for their effects on health and the environment
  - Emerging pollutants (ultrafine particles, pesticides, etc.)

Monitoring system

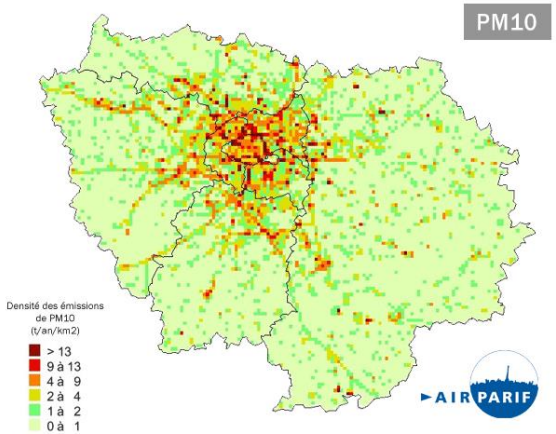
3 **complementary** tools for different environments and pollutants

Measure stations

Modelling and emission inventory

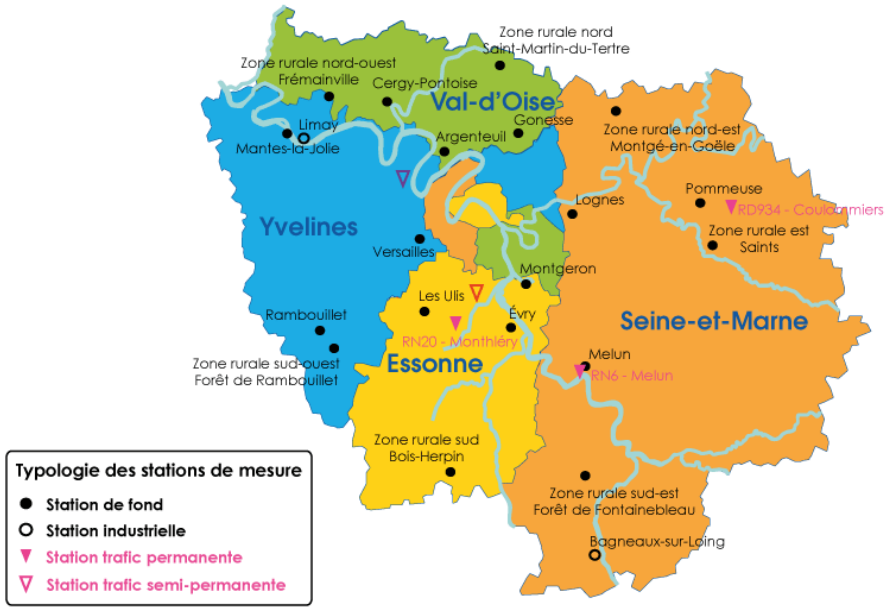


Measurement campaigns



Network of fixed stations

- Produce **baseline data** on pollution levels
- Monitor **pollutants of concern** in the territory
- **Several typologies** to characterise different environments:
  - **Background stations*** (urban, suburban or rural)
  - **Proximity stations*** (near road traffic)
  - **Industrial stations*** (near industrial/artisanal activities)



Network of Airparif stations

70 stations spread out over 12 000 km2

* European classification. Other classifications exist.

Monitoring system

Tailoring a measurement network according to the objective

- The Airparif network is 40 years old... and has been built up little by little.
- A few reference stations can constitute a solid base for a measurement network:
- **Representativeness** of sites and typologies
- Attention paid to equipment **maintenance** and **data processing**
- Possibility of **coupling fixed stations to other tools:**
  - Passive tubes (NO2, SO2): low-tech, low-cost and reliable tool
  - Micro-sensors: in full development; not so low-cost, reliability issues (see below)

Always using station data as reference data.

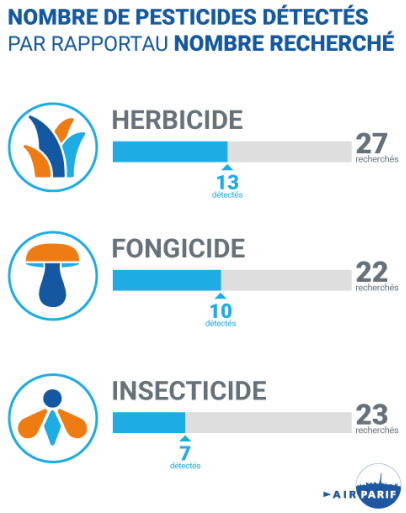
Passive tubes

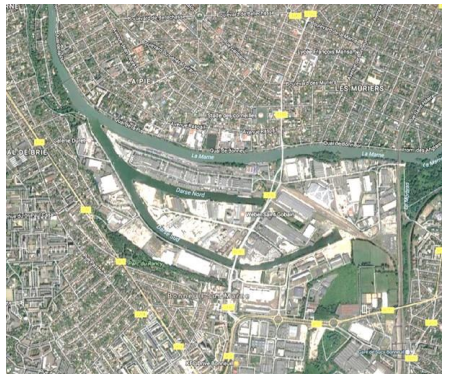
Mini-stations

Micro-sensors

Measuring campaigns

- Measuring **non-regulated pollutants** (e.g. pesticides)
- Assessing **individual exposure** (e.g. cycling)
- Assessing the impact of a road **infrastructure**, an **industrial site**, an airport platform, etc.
- Consolidate **models**
- Prior to the creation / extension of a network of stations to **validate the location of sites.**

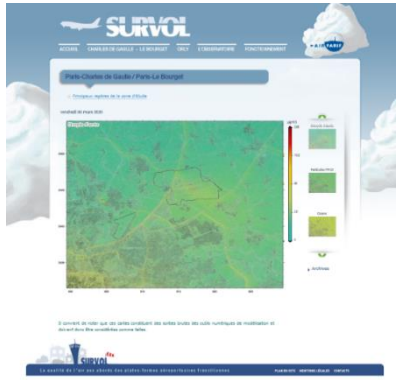


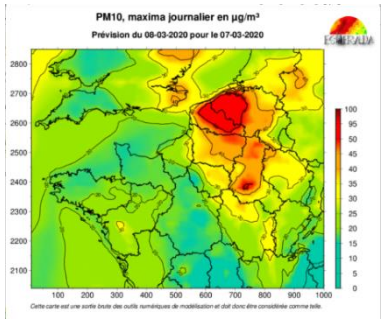


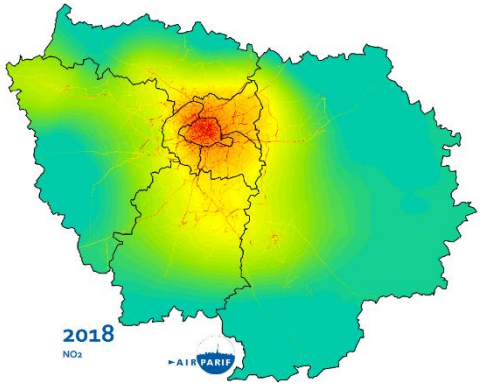
Modeling tools

- Produce air quality **maps**
- **Forecasting** air quality (pollution episodes)
- **Assessing the impact** of projects or action plans
- Test **scenarios**

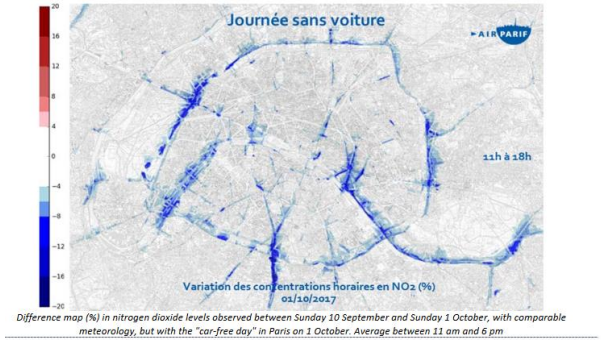
- **Different tools, scales, degree of accuracy, depending on the needs**







Hourly mapping of concentrations
25 x 50m grid



Difference map (%) in nitrogen dioxide levels observed between Sunday 10 September and Sunday 1 October, with comparable meteorology, but with the "car-free day" in Paris on 1 October. Average between 11 am and 6 pm

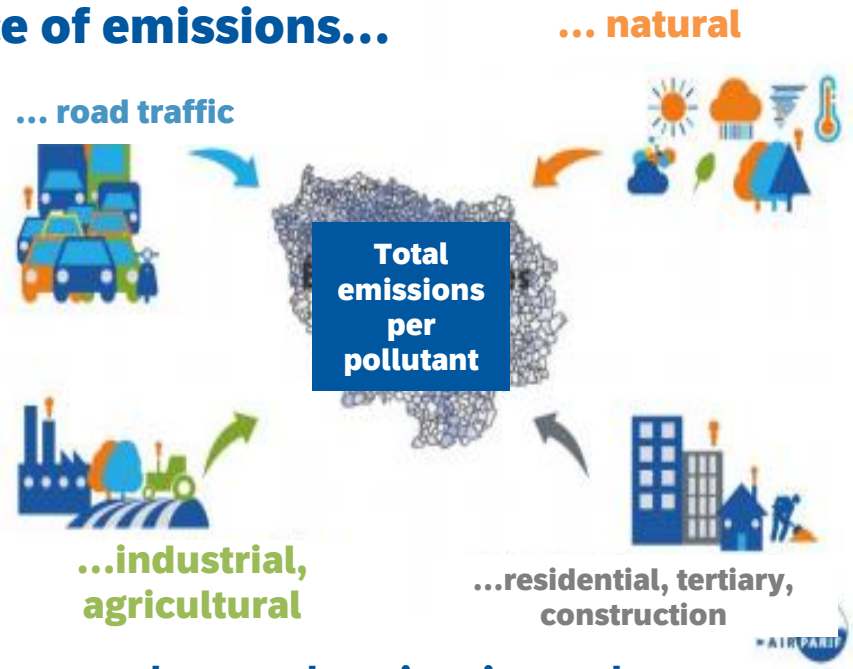
Impact of Car Free Day on NO2 concentrations

Emissions inventory

- Determine the respective **contribution** of the sectors to pollutant / GHG **emissions**
- Identify priority **levers for action**
- **Evaluate the effectiveness** of public policies / regulations / action plans (e.g. fuel regulations, fleet renewal)

NB: the emissions inventory is an essential input data for modelling.

Source of emissions…



More or less extensive inventory:

- Spatial resolution
- Temporal resolution
- Sectors considered
- Pollutants considered
- Methodology used (tier 1/2/3, bottom-up / top-down)

Micro-sesnsors

- Advantages: **cost of purchase**, **portability**, ...
- Attention to: **data reliability**, maintenance costs, lifetime, **skills** needed (metrology, IT...), ACT...
- **AIRLAB challenge**: test the performance of micro-sensors for different uses and environments.
  - Metrology tests (accuracy and reproducibility of data)
  - Field deployments
  - Results available online (http://www.airlab.solutions/fr/actualites/r%C3%A9sultats-du-challenge-airlab-microcapteurs-2021)

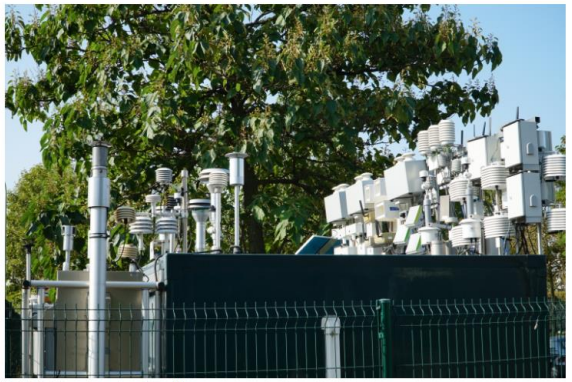
ADEME AGENCE DE LA TRANSITION ÉCOLOGIQUE

AFD

AIRLAB SOLUTIONS POUR NOTRE AIR

MICROSENSOR CHALLENGE EDITION 2021

To challenge and to compare different microsensors to help the choice for users, in complete independence



Test of microsensors in real conditions

Integrating microsensors into a monitoring network: recommendations

- First question: **What use** and **what purpose**?
- Choose the sensor according to its **performance by use and by pollutant**
- Do not disseminate data in real time (except for public awareness projects): **data processing** is necessary before use and publication
- Always have **reference measurements** (fixed stations, passive tubes) for functional tests

  NB: in the current state, micro-sensors cannot replace a regulatory measurement network.
- Perform **pre- and post-deployment tests** (reference station, calibration laboratory):
  - **Performance** tests (at least on a sample) and identification of faulty devices
  - **Calibration** of the devices
  - Control of **deviation** over time
  - Access to **raw data** (for correction)

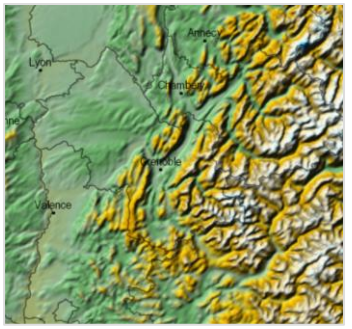
Satellite data

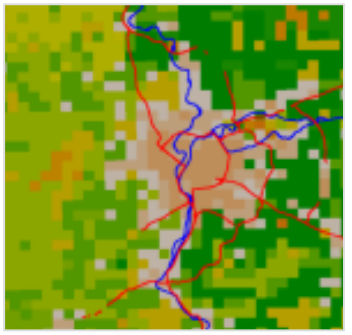
Available data:

- Input data (modelling): **weather, topography, land use**
- **Monitoring of smoke plumes** (volcanoes, forest fires...) and **specific sources** (shipping)
- Macro data: pollution **transport**, temporal **evolution**

Limits :

- **Spatial resolution** too large for urban application (several km)
- No **temporal continuity**
- Lack of **precision** (data integrates the whole atmospheric column)
- Problem of **cloud cover**
- **Cost** of data





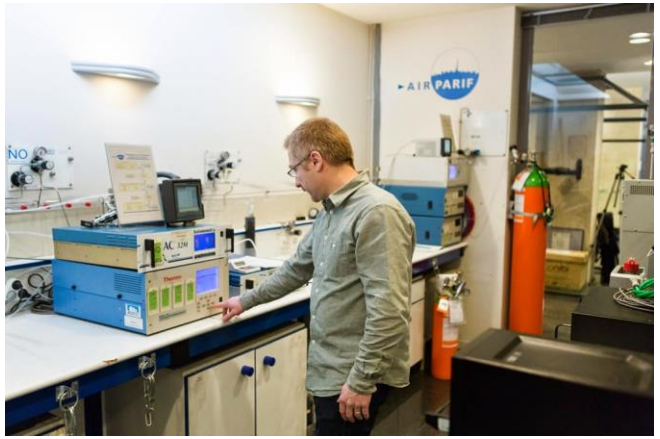
Data processing

The **reliability of the data** is crucial because it is used by all:

- **Decision-makers** (regulation, action plans, litigation...)
- **Media**
- **Citizens**
- **Companies...**

To guarantee reliable data:

- **Calibration laboratory**
- **QA/QC procedures & certifications**
- **Model evaluation**

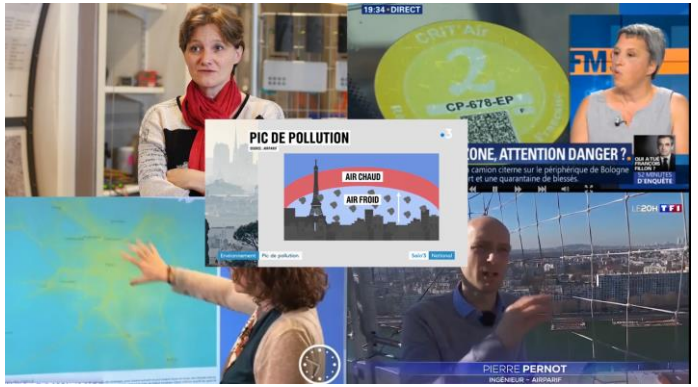


Communication and public information

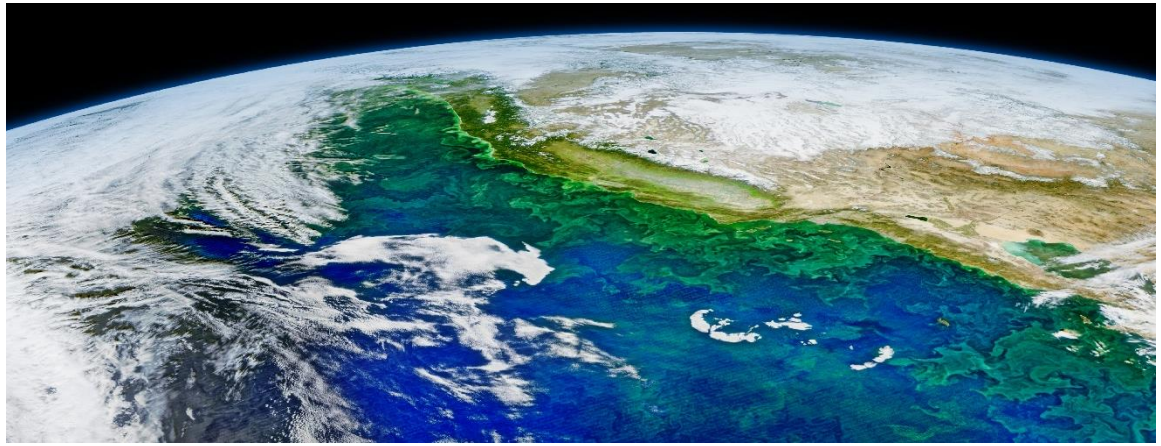
Multiply the channels to make the data easily accessible to all:

- **Media** (TV, radio, press...)
- **Social networks**
- **Website + mobile application**
- **Local relays** (municipal notice boards)

Educate and **raise awareness** of air quality issues **among residents** to change behaviour.



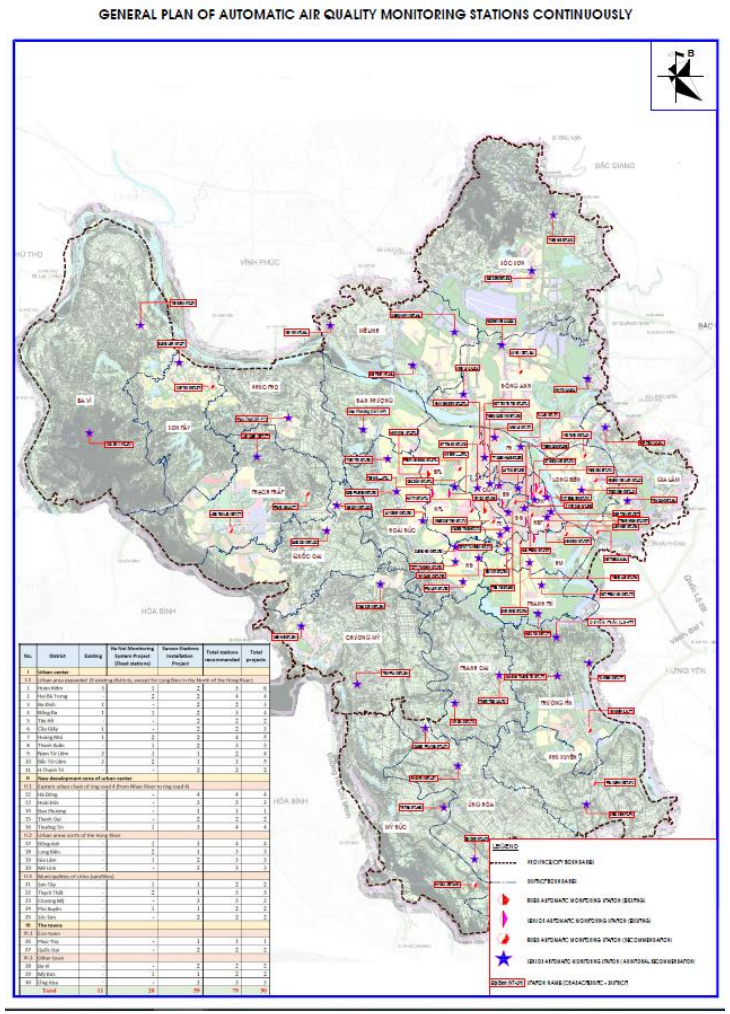
Some examples from abroad



Supporting municipal authorities

Developing local skills in the management of a measurement network:

- **Sampling plan**
- **Typology of stations**
- **Pollutants measured**
- **Improvement of maintenance**



Increasing the competence of the Air Quality Management Centre (AQMC)

Support the improvement / extension of the existing measurement network:

- **Maintenance of equipment**
- **Validation of future station sites**
- **Integration of micro-sensors with calibration on reference stations**

Technical Assistance for the Ministry of the Environment

AFD
AGENCE FRANÇAISE
DE DÉVELOPPEMENT

Supporting the development of the Ministry's air quality management teams

- **Deployment of a measurement campaign to prepare the extension of the network**
- **Training in data maintenance and management**
- **Support for communication on air quality data**
- **Support for the construction of an emissions inventory (Tier 1)**

Conclusion

An air quality monitoring network is built step by step.

Several building blocks are essential:

- One/**reference stations**, to produce reliable data and calibrate the rest of the network;
- A reproducible methodology to select **representative sites**;
- Solid procedures for equipment **maintenance** and **data validation/correction.**

Once these building blocks are in place, the network can be completed by additional tools depending on the objectives pursued:

- **Modelling** tools (mapping, forecasting, assessment)
- Emissions **inventory**
- **Micro-sensors…**

L'Observatoire au service de la Santé et de l'Action

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Implementation of tools for air pollution control in Yaoundé, Cameroon

16th November 2021

Arnauld NDZANA (Yaoundé Urban Community)
Sandra MONSALVE (DVDH)

Mobilise Your City

Contents

Speakers

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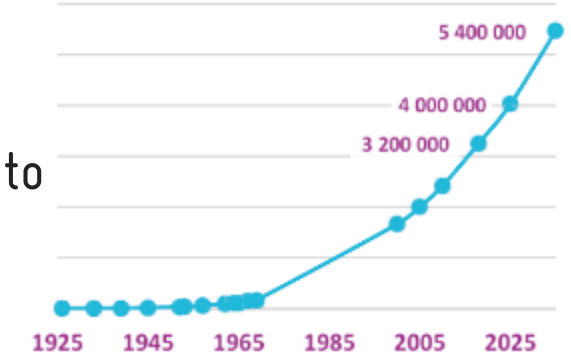
1

Yaoundé, a forward-looking metropolis

Mobilise Your City

Yaoundé, political capital of Cameroon

- Rapid population growth from 3.2 million in 2017 to 5.6 million in 2035



- At the crossroads of the country's main highways
- Mainly tertiary economic activities (central administration, headquarters, shops)

The Sustainable Urban Mobility Plan (Diagnostic 2018)

An alarming observation…

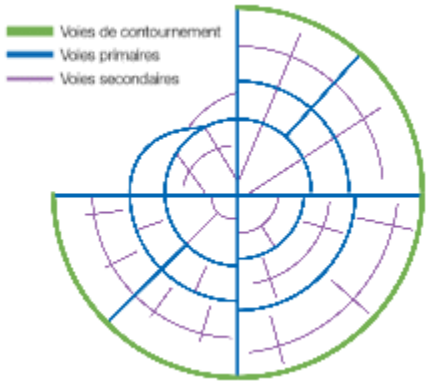
①
- The mobility system is **inefficient**:
  - the majority of people travel by collective taxis or motorbike taxis, which are slow, unreliable, and more or less comfortable;
  - private car and motorbike users are stuck in congestion;
  - many people are forced to make long daily journeys on foot on uncomfortable (or no) pavements.

②
- Mobility is **expensive** for the user and the government,
  - and is not efficient from an economic point of view:
  - trips in collective taxis cost 200 to 300 FCFA, in motorbikes 100 to 500 FCFA;
  - STECY is loss-making, with very few buses to impact mobility;
  - cars stuck in congestion consume a lot of fuel unnecessarily.

③
- The mobility system is **polluting and dangerous:**
  - it consumes a lot of energy and produces greenhouse gases (GHG)
  - it pollutes the atmosphere and makes the inhabitants sick;
  - It is not safe, especially for pedestrians and motorbikes.

… which determines the strategy of the SUMP

- **Develop the road system, treat certain crossroads and create bus lanes** to improve traffic conditions, particularly
  - taxis, which are the main mode of transport in Yaoundé, with more than 2 million trips per day
  - walking, with the creation of safe pavements.



- **Reduce the cost of mobility borne** by households:
  - redefine the public transport offer and achieve a small balance with a unit cost of the bus ticket at 200 FCFA;
  - modernise the collective taxi sector by encouraging a switch to large taxis with greater capacity, greater comfort and less energy consumption per person transported;

- This new mobility system will **improve the quality of life in the city,** with less dangerous roads, fewer accidents and less air pollution.

The Sustainable Urban Mobility Plan (Outlook 2035)

Action plan

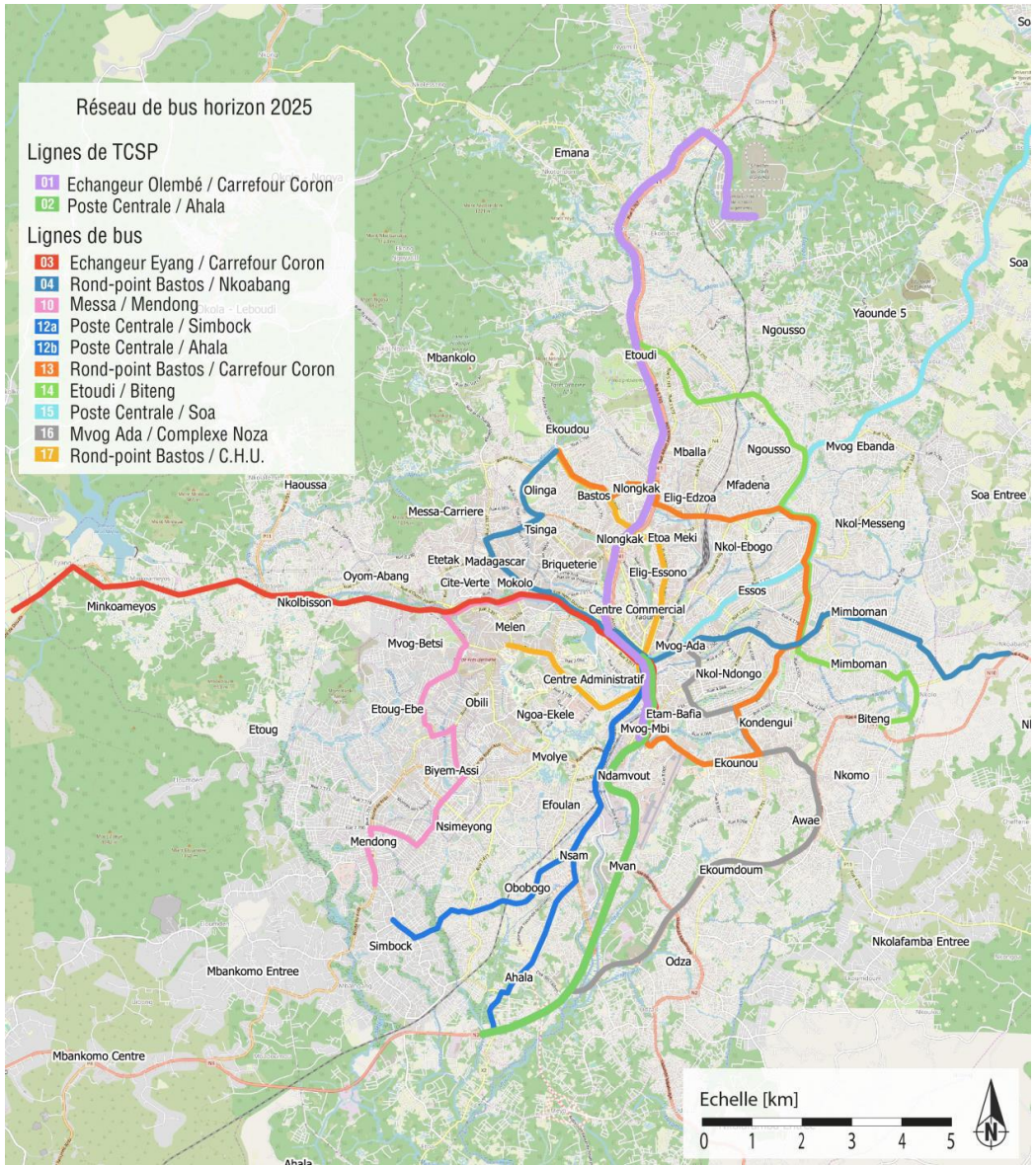
Business-as-usual scenario: foreseeable degradation

Alternative scenario: road development, hierarchical public transport network, improvement of junctions, professionalisation of small-scale transport, strengthening of governance

→ 340,000 daily public transport journeys (compared to 140 without reinforcing the network)

→ 25 min reduction in travel time compared to the run-of-river scenario

→ 11% reduction in GHG emissions compared to the business-as-usual scenario



The Sustainable Urban Mobility Plan

7 major projects underway with 4 objectives

Improve traffic conditions

- Development of crossroads and bus stations (Yaoundé Cœur de Ville)
- Studies of the bypass road
- Project for the Development of Inclusive and Resilient Cities (PDVIR)

Develop the different transport offers

- TCSP TransYaoundé
- Informal transport reform

Improving the governance of mobility

- Capacity building of CUY agents in the framework of Yaoundé Cour de Ville
- ATCUDY: Setting up a Mobility Organising Authority, a mobility observatory and an urban planning agency

Reducing air pollution

- **Implementation of air pollution control tools**

Partners: French Development Agency, World Bank, French Ministry of Economy, European Union

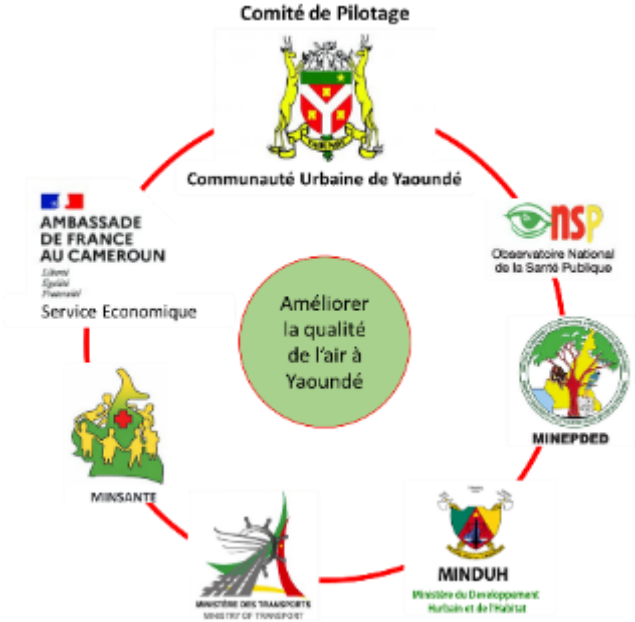
Air quality study in Yaoundé

Mobilise Your City

Organisation of the air quality project

One initiative

- From the **Communauté Urbaine de Yaoundé** (CUY),
- Financed by **French Ministry of Economy, Finance and Recovery (FASEP),**
- Piloted by an **interministerial committee** involving the Cameroonian ministries of health, environment, transport and urban development
- Implemented by a **group of French and Cameroonian experts**



DVDH
Consultancy firm specialising in advising local authorities on sustainable land use and urban mobility

AtmoTrack
Supplier of air pollutant microsensors and air quality monitoring systems

INSERM
French public institute dedicated to biological, medical and human health research

3-step Methodology

Diagnosis of the air pollution and health situation

- Deployment of sensors
- Interpretation of pollution measurements
- Identification of pollutant sources
- Health surveys

Action plan

- Development of an action plan
- Development of a decision-making tool
- Development of an information and awareness-raising tool for the general public

Implementation of the f actions and evaluation

- Tactical planning operation
- Evaluation of effects
- Sustainability
- Practical guide to replicability

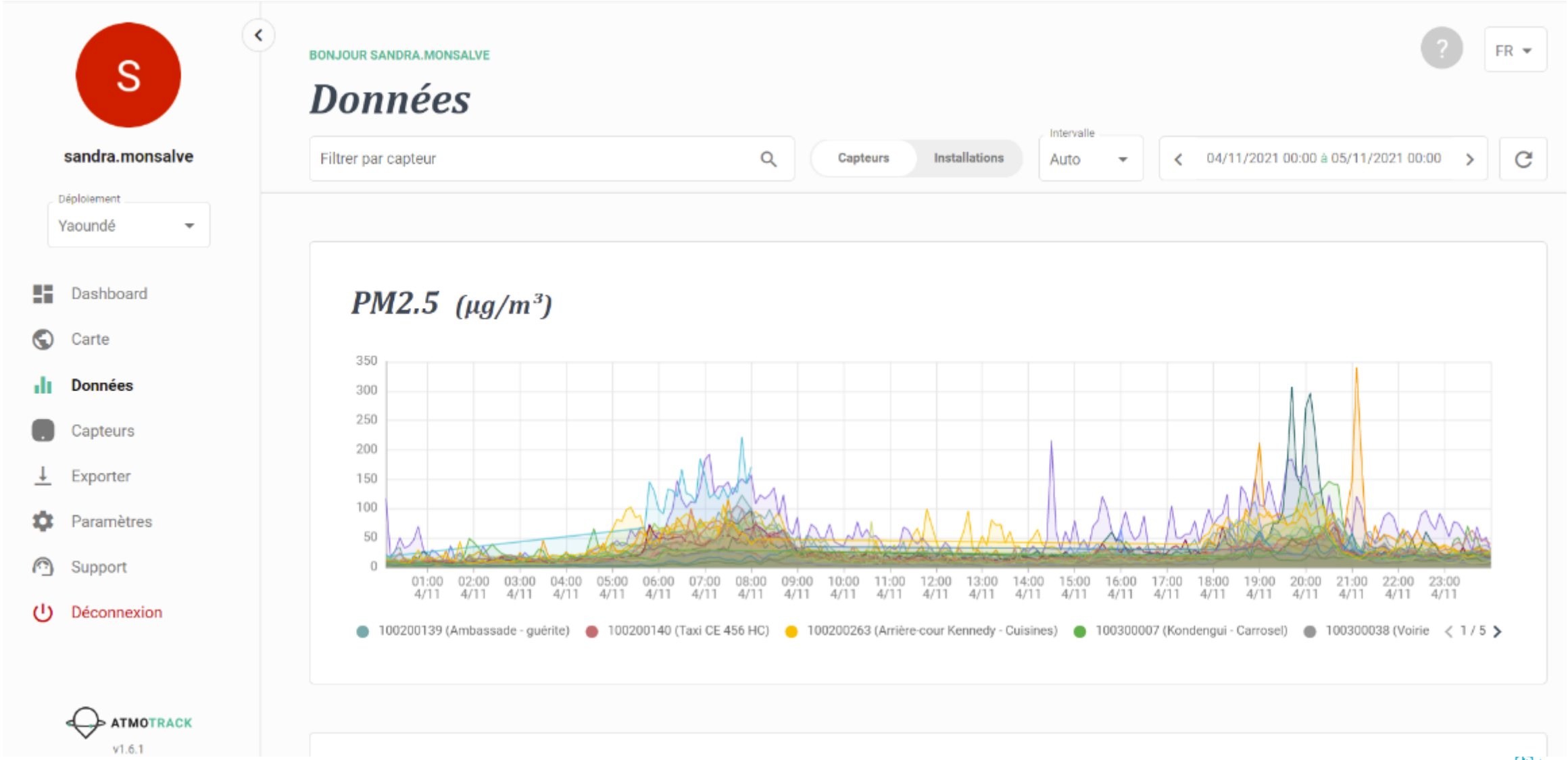
Equipment deployed in the field

Innovative fixed and mobile micro-sensors to form the city's first air quality measurement network:

- 29 Atmo01 (on buildings, taxis and minibuses) measuring PM2.5 and PM10
- 8 Atmo02 (on lampposts) measuring PM2.5, PM10, NO2 and SO2

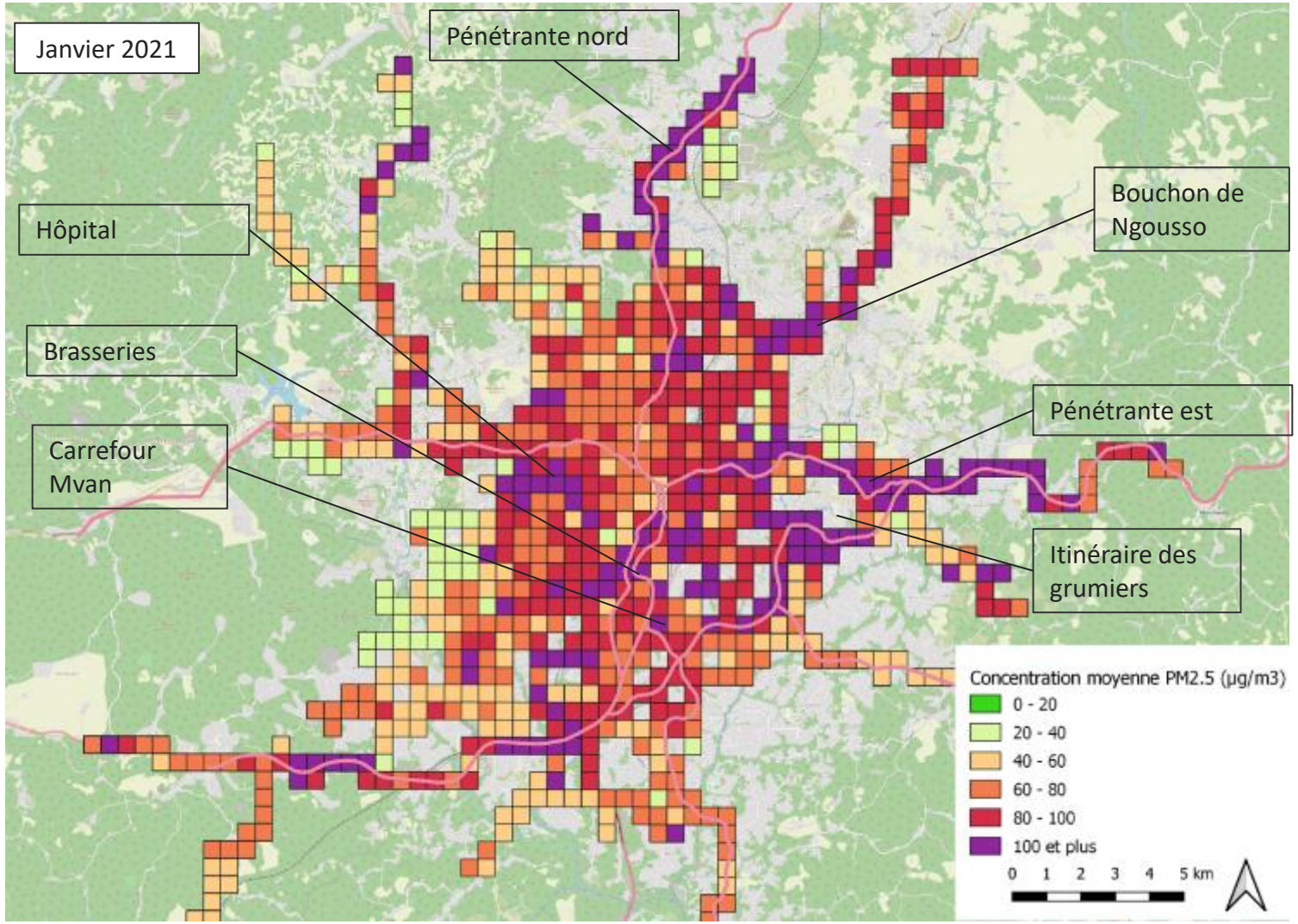
+ a speciation study to determine the composition of the particles

Computer interfaces

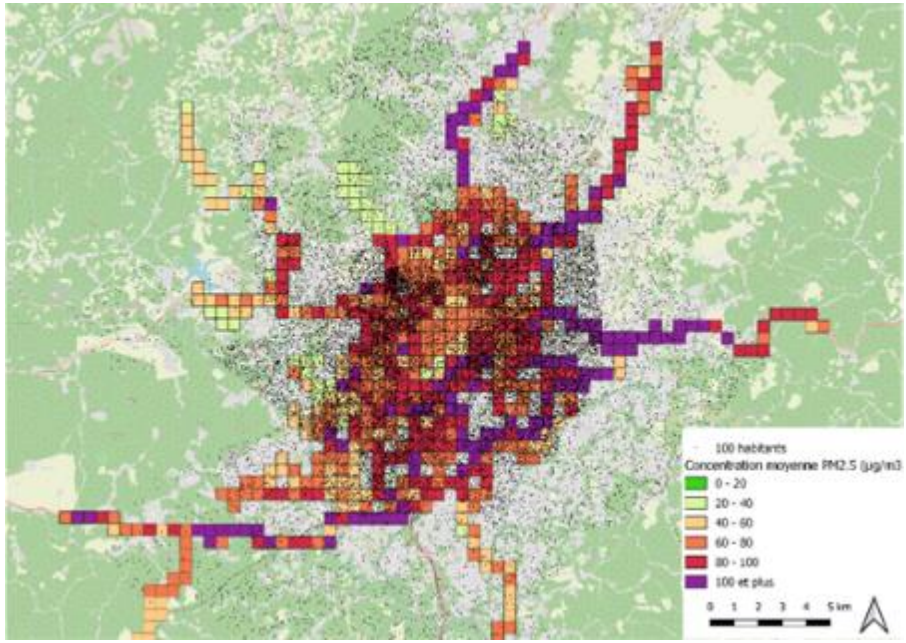


Data interpretation

Mapping of results averaged by period (month, week, etc.)

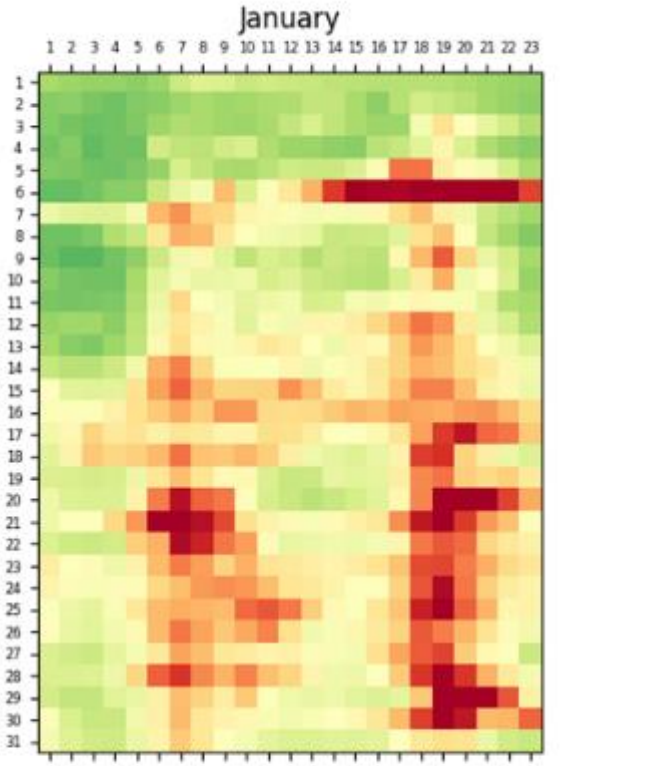


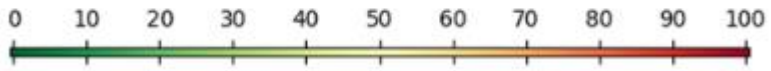
Cross analysis with other information such as road network, population density, waste collection, etc.

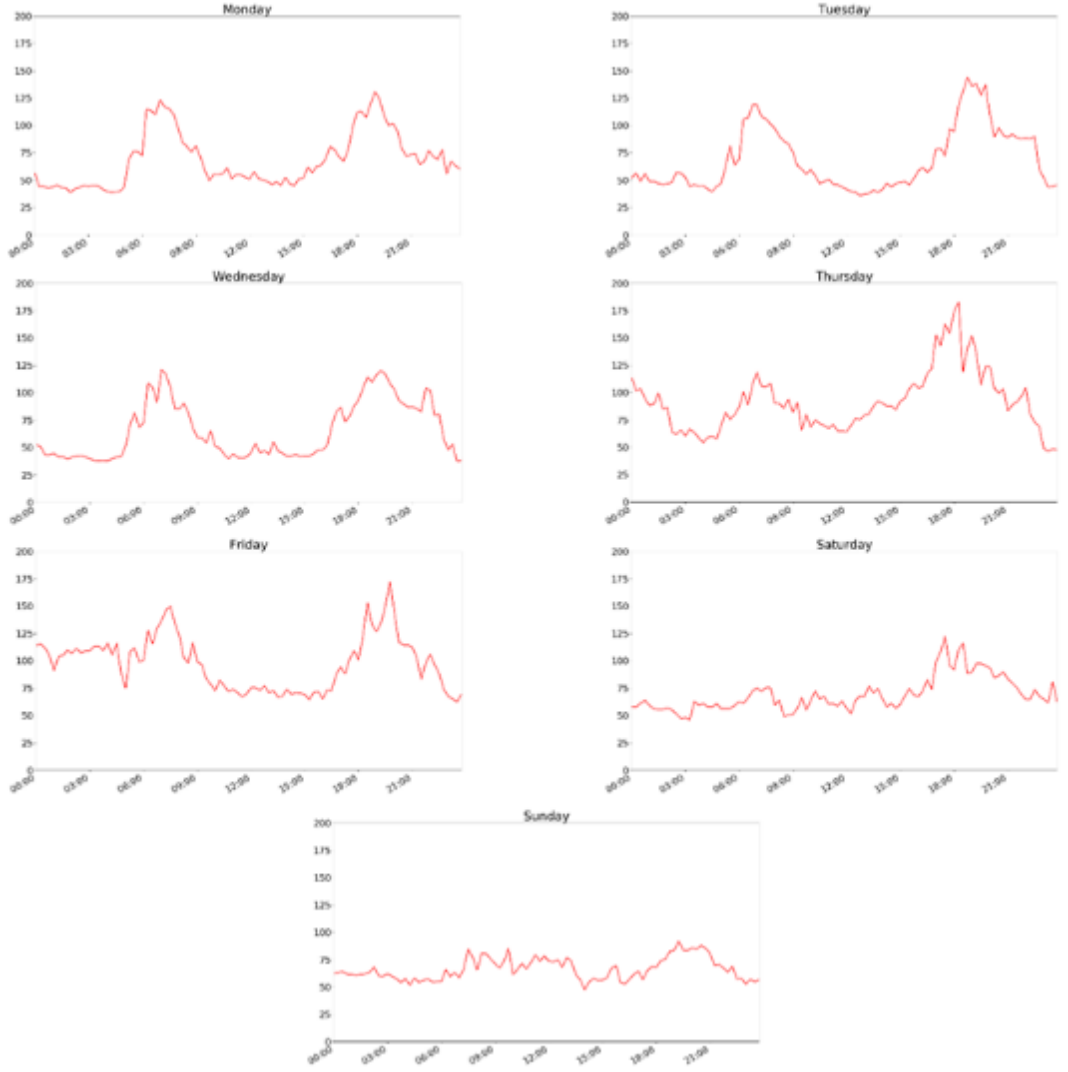


Data interpretation

Strong correlation between peak traffic hours and the average fine particle level in the city

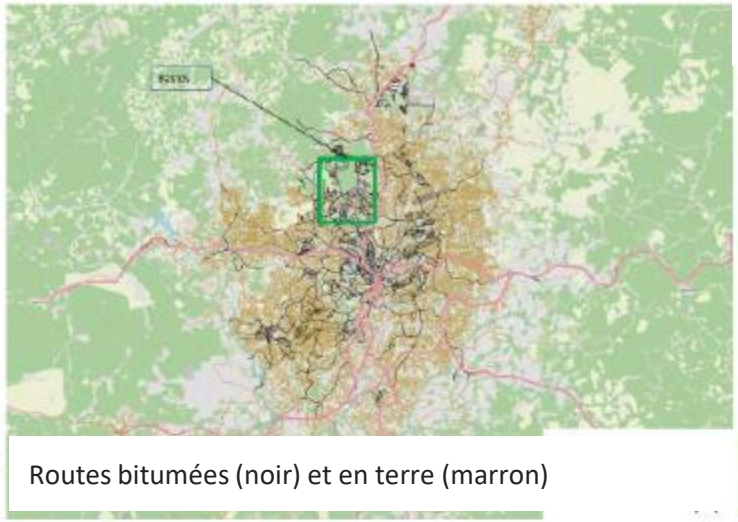






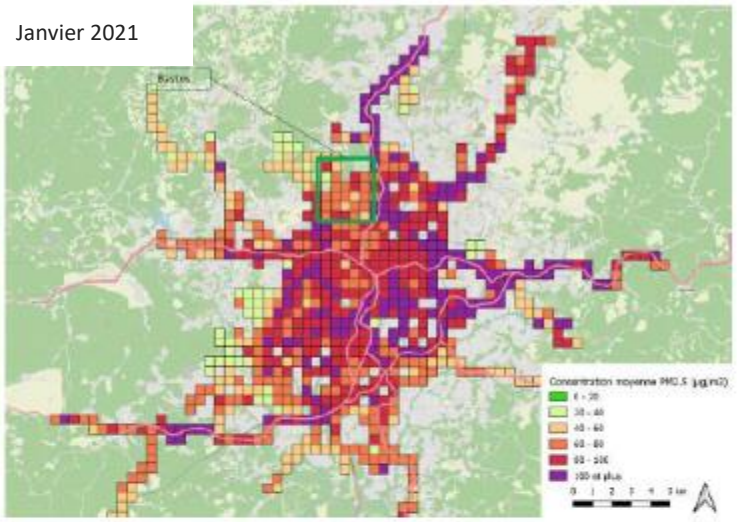
Data interpretation

Correlation between road type (dirt road or asphalt) and concentration of fine suspended particles

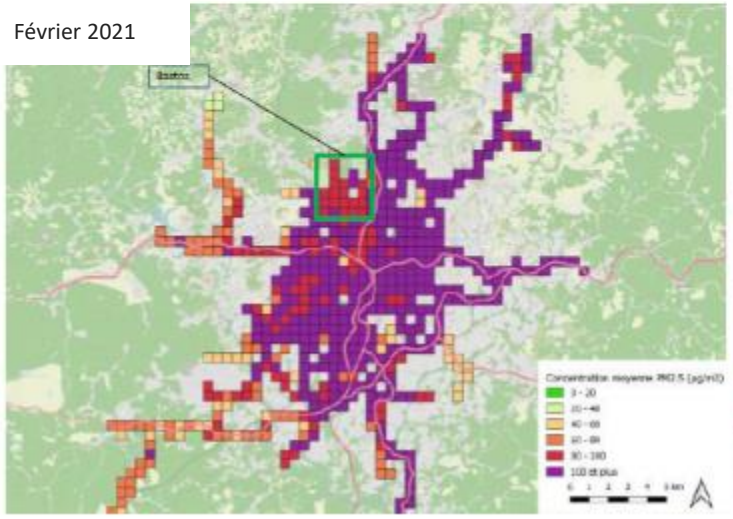


Routes bitumées (noir) et en terre (marron)

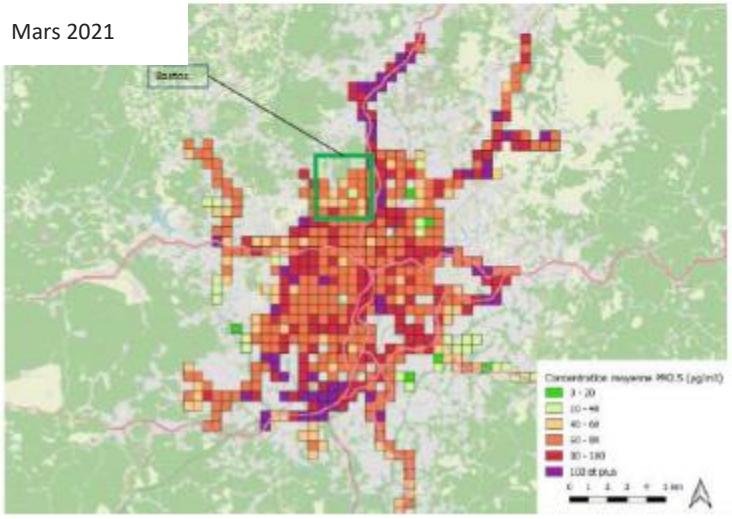
Janvier 2021



Février 2021



Mars 2021



Identified pollution sources and action plan

Traffic (emissions, wear and tear and resuspension)

Other human activities: cooking, waste burning, industrial activities, weeding, slash and burn

Regional natural phenomena: desert storms

Regulatory, fiscal and governance measures

- Improving fuel quality
- Measure vehicle emissions during roadworthiness testing
- Promote fleet renewal/retrofitting
- Traffic calming in the most vulnerable sites
- Invest in asphalt and road sweeping
- Implement the PMUS action plan

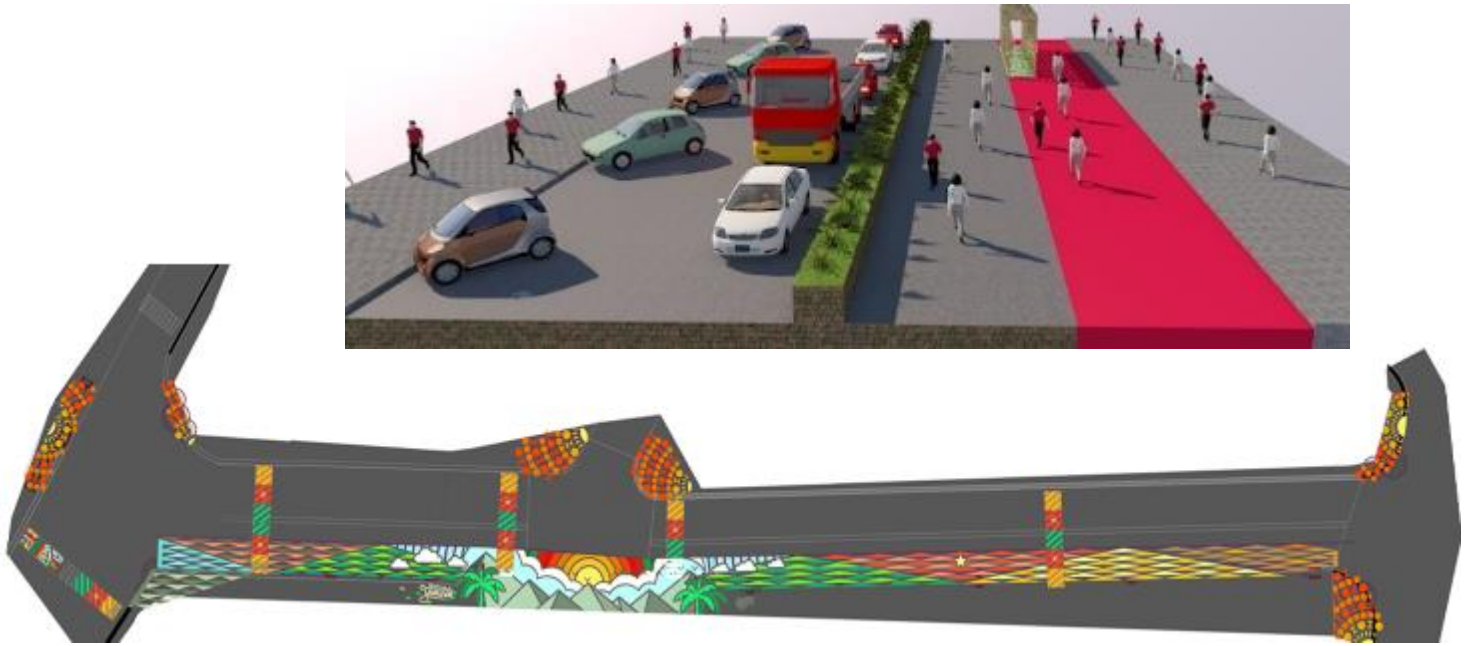
- Promote less polluting cooking techniques
- Support recycling and improve waste collection
- Establish sectoral standards and monitor their implementation. Promote best practice.

- Create an air quality management unit
- Raise awareness and inform the population

Actors: CUY, ministries, prefecture, boroughs, residents' associations, etc.

Semaines de la qualité de l'air

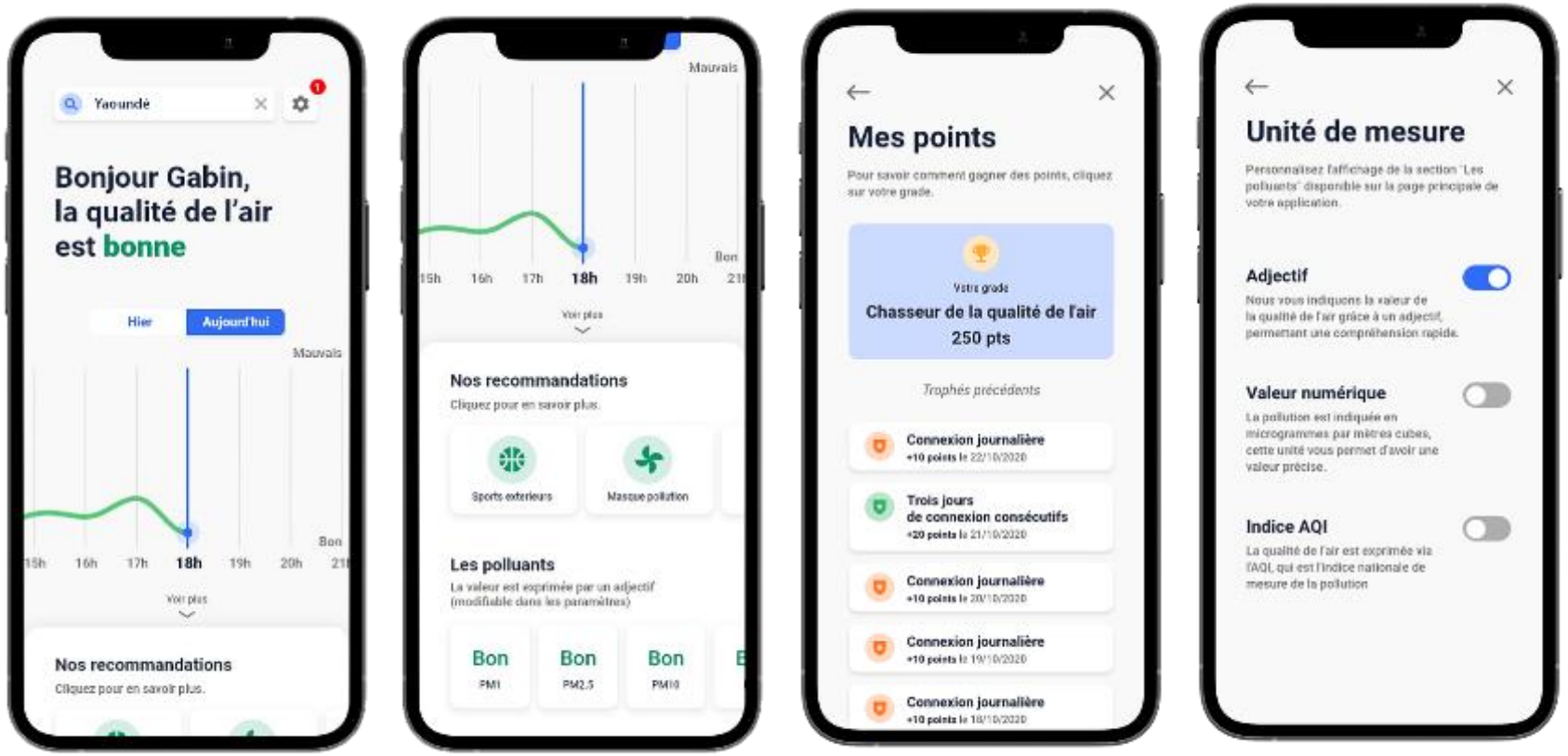
Piétonnisation et embellissement de l'avenue Kennedy (centre-ville), communication, sensibilisation, consultations médicales



Sensibilisation grand public

Application smartphone Caeli

- indicateurs basés sur les mesures en temps réel
- conseils pour ajuster son comportement en fonction du niveau de pollution
- valeurs globales pour la ville, et par quartier



Objectifs : susciter une prise de conscience de la part des citoyens des enjeux de la qualité de l'air sur la santé

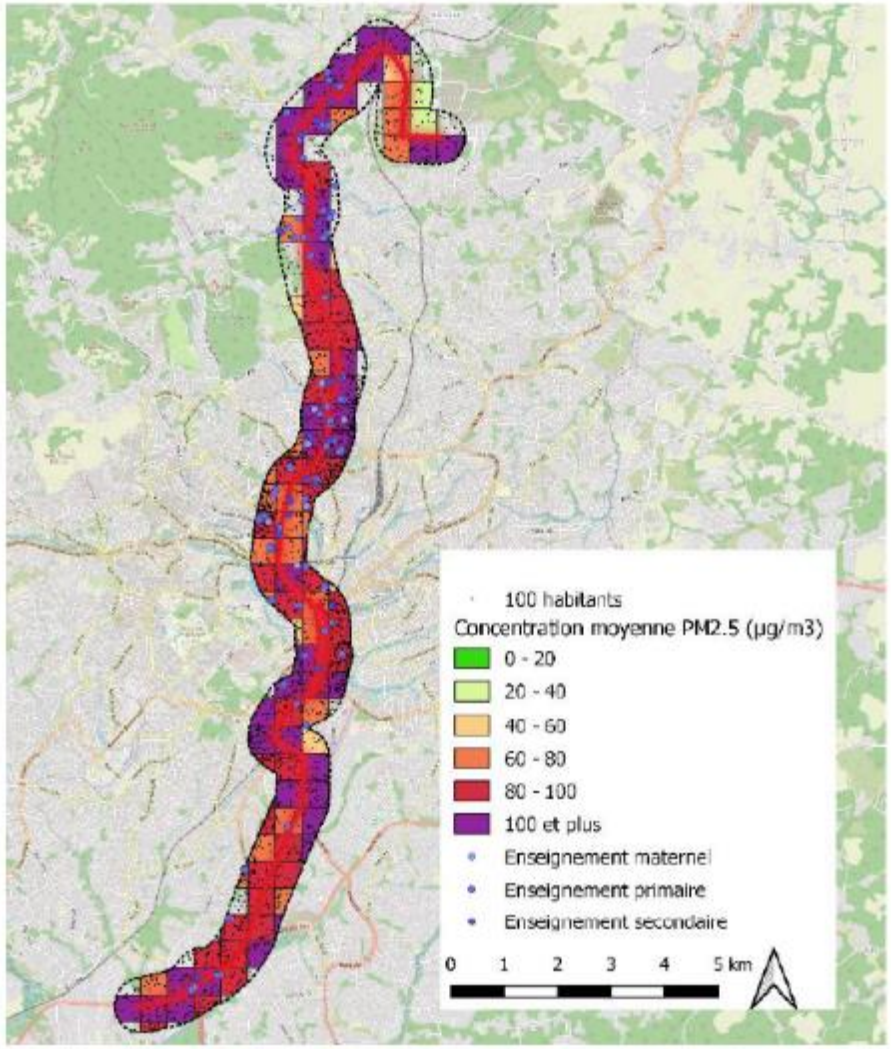
3

Perspectives

Mobilise Your City

Decision support: case study

Analysis of the current pollution level on the future BRT corridor



110,000 passengers per day in old-fashioned taxis -> one of the most congested and polluted roads

The system deployed made it possible to estimate that between January and February 2021, 80% of the population living within 500m of the future BRT was exposed to chronic fine particle pollution (PM2.5) greater than 80µg/m3.

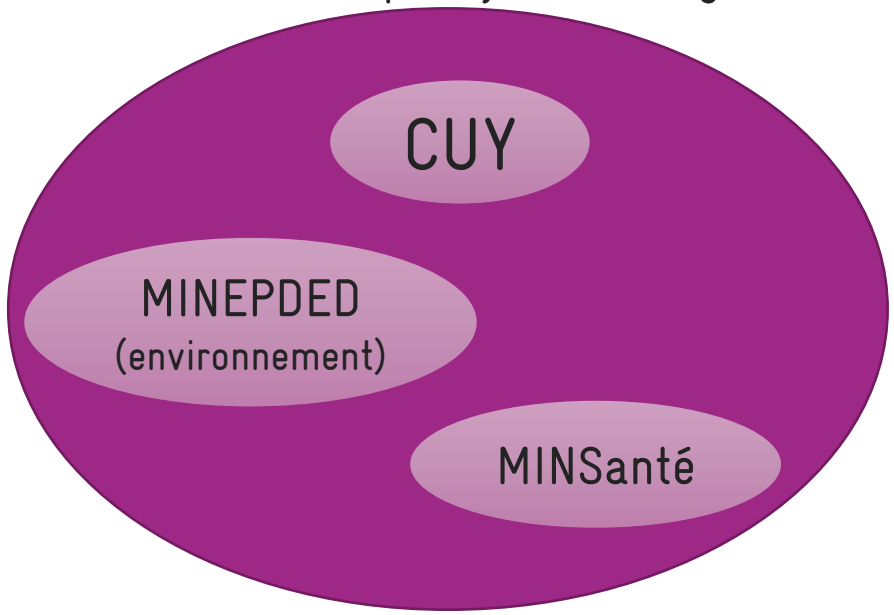
100% of the schools within this perimeter were exposed to PM2.5 pollution above 60µg/m3.

The BRT project will help improve air quality by

- **Reducing congestion,**
- **Providing users with a less polluting transport alternative,**
- **Contributing to infrastructure improvements along the corridor.**

Interministerial Committee for the monitoring of air quality in Yaoundé

- Committee being created to ensure sustainability of the initiative at the end of the project (January 2022)
- Local staff trained in air quality monitoring tools and methods



- General public
- Scientific and academic community
- Actors of the action plan
- National and international peer network

Tasks

- Manage the sensor network
- Produce and disseminate data (monitoring the evolution of air quality indicators over time)
- Supervise the implementation of the action plan

Thank you for your attention!

Keep in touch

Mobiliseyourcity.net

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