REVIEW OF THE CITIZEN AIR QUALITY MEASUREMENT EXPERIMENT, USING MICROSENSORS, THAT TOOK PLACE ACROSS CCPMB TERRITORY DURING WINTER 2019

Published by par Atmo Auvergne-Rhône-Alpes 13. 10. 2020

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http://www.alpine-space.eu/projects/bb-clean
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SUMMARY

The Interreg Alpine Space programme "*BB clean - Strategic tools for a sustainable use of biomass for domestic heating*", whose initials signify Biomass Burning Clean, is a European project that brings together partners from 5 countries in the alpine arc: France, Austria, Italy, Slovenia and Germany. The project, as a whole, aims to encourage vast changes in the individual use of wood-fired heating across the European Union in order to limit its polluting emissions. To do so, it relies on the creation of technological, economic and regulatory tools to improve the knowledge of citizens and public authorities on issues concerning the use of wood-energy in alpine valleys. This review presents the results of one of the awareness campaigns conducted in the context of this programme: a citizen experiment to measure air quality using particle microsensors. The experience was conducted across the territory of the CCPMB – Arve Valley using the Atmo Auvergne-Rhône-Alpes Captotheque facility.

Consequently, during the winter of 2019, a fine particle microsensor loan scheme, coupled with a technical and sociological support programme for participating citizens, was set up across CCPMB territory. More than 150 people, of various profiles (age, profession, family status, awareness of and commitment to the theme of pollution...) were able to freely explore air quality monitoring in their area. Numerous participatory workshops, as well as various individual and group discussions were proposed in order to allow participants to share their thoughts, to further understand the phenomena observed using microsensors, and to generally improve their knowledge on the topic.

While each of the participants experienced the measuring process in their own individual way, all volunteers were able to grasp the issue and gain knowledge by experimenting with particle measurements in multiple contexts and situations. From cooking to the waxing of skis, they were able to identify the impact of everyday actions, previously believed to have an insignificant effect on the air quality of their accommodation. Outdoors, they endeavoured to test various traffic or industrial related contexts. Some participants explored further by measuring spatial and temporal variations in fine particle levels, at different altitudes, in different meteorological conditions and at different times of the day. Wood-fired heating was also extensively tested by the participants, whether it be the indoor air around their own appliances or outdoors in their neighbourhood, within the proximity of working chimneys. A discovery for some, a confirmation for others, all participants were able to identify the impact of wood-fired heating and the role of associated good practices with regards to air quality.

Beyond the intellectual enrichment of the individual, this experiment helped to recreate a climate of trust between citizens and local stakeholders involved in the air quality thematic. Discussions between the participants and scientific and territorial experts led to the subsequent resumption of a dialogue that had deteriorated over the past years. This experiment also confirms the interest and the potential in the development of a Captotheque service at regional level, to equip volunteer citizens, enabling them to contribute to discussions concerning the implementation of local actions in favour of air quality.

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INTRODUCTION

Alpine valleys are particularly subject to atmospheric pollution, primarily due to their topography - polluting emissions related to human activities are concentrated in a reduced space. The meteorology in alpine valleys can also limit dispersion, especially in winter, promoting the accumulation of pollutants in the lower layers of the atmosphere. Consequently, alpine valleys across the entire Alpine arc are subject to a high level of particles every winter, regularly exceeding the daily limit values and mainly caused by non-performing wood-fired heating emissions, seconded by transport and industry. Actions are therefore absolutely necessary and must be re-examined regularly to improve air quality, reduce emissions and raise awareness among the various stakeholders in the territories concerned.

The Interreg Alpine Space programme "*BB clean - Strategic tools for a sustainable use of biomass for domestic heating*" is a European project that brings together partners from 5 countries in the alpine arc: France, Austria, Italy, Slovenia and Germany. Through the involvement of partners and a wide network of stakeholders, the programme should enable a massive change in practices, facilitated by the implementation of common regulations concerning the individual use of wood-fired heating throughout the European Union in an effort to limit pollutant emissions. To do this, it relies on interactive approaches and the creation of technological, economic and regulatory tools to improve the knowledge of both citizens and public authorities on the issues concerning the use of wood-energy in alpine valleys.

This review presents the results of the citizen air-quality measurement experiment, conducted with the help of microsensors and the Atmo Auvergne-Rhône-Alpes Captotheque facility, during winter 2019, across the CCPMB (Arve Valley), as part of the BB-Clean programme.

1. PROJECT CONTEXT

1.1. CITIZEN PARTICIPATION IN MEASUREMENTS AND DIALOGUE : THE CAPTOTHEQUE BY ATMO AURA

With the growing awareness of citizens and their involvement in certain air quality issues affecting health and climate, and the increasing distrust of "institutional" representatives, some citizens are seeking to actively contribute to the preservation of their environment and, in particular, to the monitoring of air quality. Monitoring methods must thereby evolve, consider and integrate this new approach, to encourage dialogue and citizen participation.

Currently, in the Auvergne-Rhône-Alpes Region (AuRA Region), air quality monitoring is mainly carried out by Atmo Auvergne-Rhône-Alpes (Atmo AuRA) as part of its regulatory tasks. The existing observatory, a robust proven model, is based on a network of fixed stations, pollutant emission identification tools and digital equipment. Today, the availability of lightweight and inexpensive pollution microsensors, the explosion of digital technology and the emergence of measurement data outside the "institutional" framework (public data), offer an opportunity to rethink the development model of this observatory.

Consequently, in 2016, the Auvergne-Rhône-Alpes monitoring network launched the Mobicit'air project with financial support from the AuRA Region and the metropolis of Grenoble. The objectives were the following:

- The evaluation of the reliability of microsensors in comparison to reference analysers.
- An experimental approach to citizen participation and measurement of individual exposure in the urban district of Grenoble.
- A sociological appraisal of the impact of these measurements and of citizen participation.
- The assessment of data integration, from microsensors to monitoring tools, to improve fine-scale mapping.
- The provision of data for the creation of new services, in particular by coupling air quality data with mobility data.

One of the innovative features of the Mobicit'air project was the sociological approach used to complement technical expertise. With citizens placed at the heart of this study project, it was necessary to fully understand their motivations for participating, to evaluate their initial knowledge, to accompany them while taking measurements, to gather their feedback and to identify possible changes in behaviour.

To do this, Atmo AuRA was accompanied by a sociologist to carry out a screening survey to select participants and conduct semi-structured post-experiment interviews to understand their experience and measure their progress. The selection process was based on different socio-economic criteria. 30 volunteers, representing a diversity of profiles, were finally able to carry out air quality measurements over a period ranging from two weeks to one and a half months.

The Mobicit'air project thus made it possible to highlight several points: a true increase in public competence on the subject of air quality, experimentation as a vehicle for citizen to citizen sharing and the need for technical support.

Based on these conclusions, Atmo AuRA launched the development of a regional Captotheque® project. Designed to use microsensors as a link between local citizens and the air quality reference observatory, the

Captotheque® is a facility that aims, for 2020, to offer all residents of the AuRA region, without conditions of resource, the possibility to measure the air they breathe by borrowing a free microsensor measurement tool. Individuals can thus freely explore their atmospheric environment, develop their knowledge and share their discoveries.

The facility comprises three tools:

- Sensors: a diverse range of tested and graded microsensors
- A digital platform and a smartphone application: storage, recovery and visualisation of all data, exchanges between members of the public on their measurement experiences
- A human support programme: events across the territory, workshops, discussions and exchanges between experts and users

Prior to the launch of this facility, in order to assess its relevance in answer to sociological and political questions on air quality, several citizen experiments, with specific contexts and implications, were initiated across the Auvergne-Rhône-Alpes Region in 2019:

- The PRIMEQUAL CheckBox project focused on the influence of such a facility on the understanding of air quality issues related to wood-fired heating. The first phase ran in parallel with the BB-Clean programme, during winter 2019, to enable inter-project comparisons.
- Citizen workshops in the city of Clermont-Ferrand aimed to evaluate the Captotheque system across a territory with different characteristics (a distinct pollution problem, varied citizen involvement, a specific sociology…).
- The European programme Interreg Alpine Space BB-Clean (2018-2021), the subject of this review, aimed to test the relevance of such a facility to, in addition to the appropriation of air quality issues, encourage inter-stakeholder exchanges in a region where tensions associated with these problems are high.

Figure 1 presents a visual schema of these citizen measurement projects, illustrating the temporal evolution of reflection by Atmo AuRA and the work of the association in integrating this issue.

Figure 1: Progression of studies on public measurement led by Atmo AuRA

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1.2. FRENCH EXPERIMENTATION IN THE ARVE VALLEY : ACROSS CCPMB TERRITORY

The Arve valley, located in the Haute-Savoie region of France, stretches for more than 100 km, between Vallorcine and the Bonnevillian basin, through the various valleys that compose the Pays du Mont-Blanc (Mont-Blanc region). It boasts mountainous terrain and some of the most impressive altitudinal variations in the Alps.

Contrary to collective representation that identifies it as a particularly preserved environment, this region concentrates intense human activity, with a population density of approximately 450 inhabitants per km2. Indeed, with the residential sector in full development, a significant concentration of industries or commercial zones at the bottom of the valley, dense road traffic dictated by international transit and the passage to Italy via the Mont Blanc tunnel, coupled with an undeniable tourist attraction, the Arve Valley is subject to considerable anthropogenic pressure. Farmed areas must also share this reduced amount of space.

1.2.1. AN IMPORTANT HEALTH AND ENVIRONMENTAL ISSUE

The different sectors of activity across the territory each contribute, in their own way, to the air pollution of the valley (Figure 2), whether punctual or continuous, channelled or diffused.

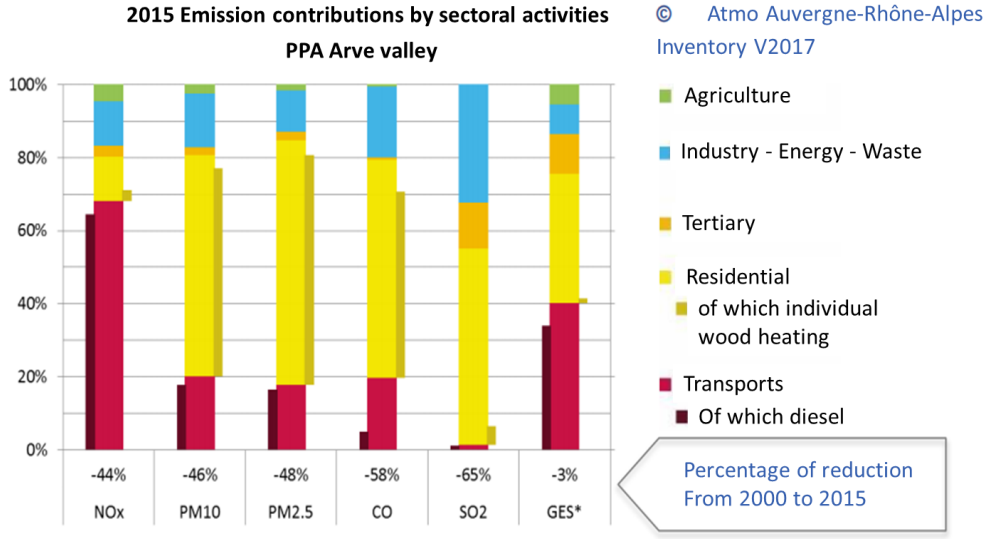

Figure 2: Breakdown of the sources of major pollutants on PPA territory in the Arve Valley (source Atmo AuRA)

Each year, the region is affected by episodes of pollution and generally poor air quality, provoked by the synergy between the presence of numerous and varied sources of pollution and particular weather and topographical conditions. Temperature inversions, common natural phenomena in alpine valleys during winter, promote stagnation and accumulation of pollutants at low altitudes. Suspended dust particles, pollutants caused mainly by combustion, are the main culprits of these winter pollution peaks. Prominent use of wood-fired heating across the territory largely explains the presence of such particles in the ambient air of the valley. Mainly emitted by road transport, nitrogen dioxide (NO_2) is also found on the valley floor, close to road infrastructure, main roads and access roads to the Mont- Blanc Tunnel (more than 22,000 vehicles per day, including 3200 lorries). In summer, the numerous high-altitude zones in this region receive intense solar radiation that promotes the formation of ozone, a secondary pollutant produced by a photochemical reaction between solar radiation and precursor pollutants such as nitrogen dioxide.

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Over the past ten years, the region has regularly exceeded European regulatory values and WHO recommendation thresholds for such pollutants and is, for this reason, one of the five territories in the Auvergne Rhône-Alpes region covered by an Atmospheric Protection Plan (APP). This five-year plan of action, which aims at reducing pollutant emissions to decrease base levels and episodes of pollution, was renewed by the Haute Savoie Regional Prefect in 2019.

In France, tens of thousands of people die prematurely due to air pollution, with the impact of fine particles on the body considered the main contributory factor. In the Arve Valley, according to a study by Public Health France submitted in September 2017 to the Minister of Health, 8% of premature mortality is attributable to fine particulate matter, the equivalent of 85 deaths per year. Certain so-called "sensitive" population groups, such as the elderly and young children, are often more vulnerable to the effects of pollution.

Focus on French experimental territory: The CCPMB

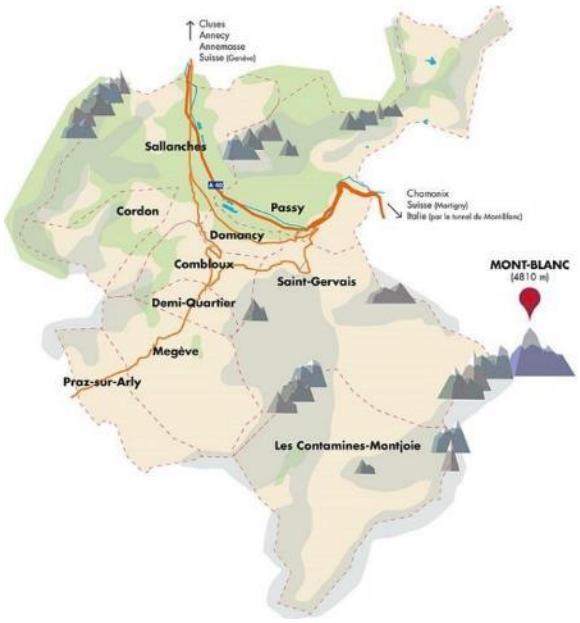

Figure 3: Map of local territory and the different communes within the CCPMB

The CCPMB (Mont- Blanc Community of Municipalities), one of the four groups of municipalities in the Arve Valley, comprises 10 different communes: Combloux, Contamines-Montjoie, Cordon, Demi-Quartier, Domancy, Megève, Passy, Praz-sur-Arly, Saint-Gervais-les-Bains and Sallanches.

Territorial ID:

Population: 44 127 residents
Surface area: 398 km²
Altitude: from 600 to 4 810 meters asl

This territory is distinguished by its industrial and tourist history and by its unique geographical characteristics dictated by the marked relief of the Mont-Blanc mountain range. The traditional use of wood, for construction and as fuel, completes the view of a territory whose economic advantages are also factors that explain poor air quality. This situation is accentuated in the Passy-Chedde area, due to a combination of several aggravating factors: the variety and density of pollution sources (A40 motorway, large factories and wood-fired heating systems) and the presence of a topographical lock that prevents the dispersion of pollutants. The seasonal tourist influx, that marks an increase in road traffic and the use of wood-fired energy for pleasurable reasons, amplifies the problem locally.

The presence of numerous regulatory measurement stations across the territory illustrates the consideration of this particular issue by various stakeholders in air quality monitoring.

1.2.2. A FRACTURED DIALOGUE BETWEEN LOCAL STAKEHOLDERS

The region of the upper Arve Valley has experienced a series of significant events that have led to the development and evolution of local interest in air quality (Figure 4). First and foremost, the installation of a waste energy recovery unit (incinerator) in the Passy area in 1995 and the fire in the Mont-Blanc tunnel in

1999. These events, sometimes dramatic and often anxiety-provoking, rapidly transformed general interest into concern and distrust of the public and economic stakeholders involved.

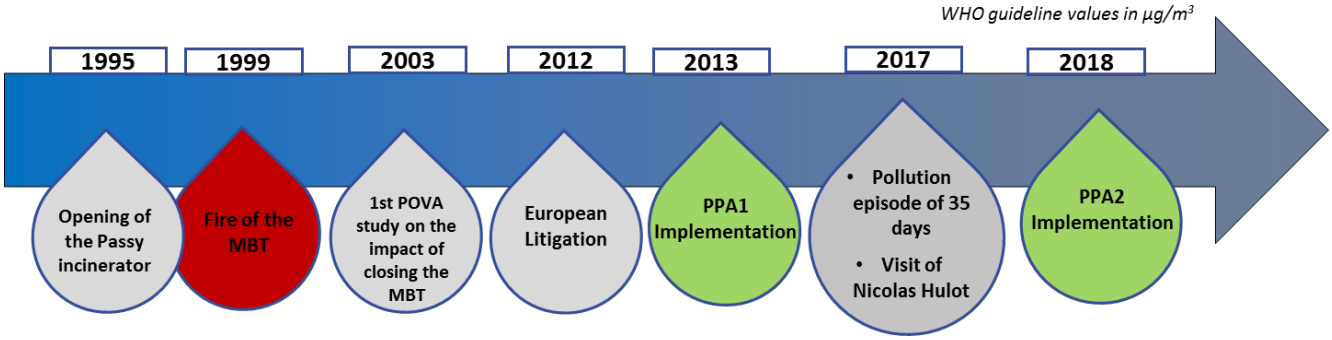

Figure 4: Timeline of events that contributed to the breakdown of dialogue between the different stakeholders

The Pays du Mont-Blanc (Mont Blanc Region), and more broadly the Arve Valley, experienced an unprecedented air pollution crisis in the winter of 2016-2017. Indeed, the region suffered several lengthy episodes of peak fine particulate pollution, a record number of 35 consecutive days between December and January.

The anticyclone locked above the region for several weeks and a phenomenon of temperature reversal that blocks pollutants at the bottom of the valley, greatly contributed to the exceeding of authorised thresholds.

Several years previously, the elected representatives, already aware of the air quality problems in this particularly vulnerable region, established various measures to reduce air pollution and limit its health impacts, including the first Atmospheric Protection Plan (PPA) in 2012. The PPA was accompanied by a multi-sector plan of action: the iconic “Fonds Air Bois” – to fund the change of wood-fired heating appliances.

Despite this, the duration of the pollution peak led some residents, extremely worried for their health, to challenge the public authorities through numerous demonstrations. The involvement of local health partners in these events generated significant media coverage, rapidly crossing valley boundaries. Local and national media widely reported a range of messages.

In addition to this climate of mistrust, came a national expression of anger and unfair punishment, in the absence of measures against the “giant" polluters. Various groups and associations were created to denounce pollution, making violent attacks on public authorities, in particular via social networks.

Lack of knowledge of the correct scientific data combined with the actions taken by residents of the Mont-Blanc region, reinforced this crisis. The situation was tense and consequences on the social climate were partly extended beyond the lifting of the pollution alert. The dialogue between the different parties froze.

Despite numerous studies, in partnership with research laboratories, on the issues this territory faces, Atmo AuRA, part of whose funding comes from industrialists, is accused of truncating its measures to hide the truth from the population. By pointing its finger at individual responsibility it creates a detrimental impact on the responsibility of «bigger polluters". The impact of individual wood-fired heating is regularly challenged, as are the results of measurements carried out around the Passy incinerator, which do not indicate any particular problems related to this installation (compared to other similar sites in the region).

It therefore became necessary to take into account this context of mobilisation which influences, on the one hand, the participation and discourse of participants, and on the other hand, the media coverage of the project. One of the key challenges of the BB-Clean programme is to study how the Captotheque facility improves dialogue between various stakeholders responsible for air quality and the representatives of civil society.

1.3. PROGRAMME OBJECTIVES

Beyond raising awareness on air quality, this project is considered as a means, a tool and a place to exchange. In a tense territorial context, concerning several initiatives, associative and political actions on the subject of atmospheric pollution, the BB-Clean programme coupled with the Atmo AuRA Captotheque (microsensor loan facility), seeks to establish (or restore) a situation of trust between the general public, local stakeholders and politicians.

The primary expectation of this experiment is to encourage the public to take ownership of local air pollution problems by understanding territorial phenomena, pushing them to broader reflection on individual and collective practices that can contribute to improving air quality. The individual experience of air quality measurement also aims to provide residents with concrete observations and measures that will enable them to participate more actively and knowledgably in the various exchanges and debates on the topic.

Citizen ownership of air quality issues

Improving citizens' and actors' knowledge of the issues involved in the use of wood-energy

Recreating a space for dialogue and trust

Atmo Auvergne-Rhône-Alpes pilots the European awareness campaign, « Raising awareness of citizens and political decision-makers in the alpine valleys through the use of innovative tools, for a better understanding of the impact of wood-fired heating", the subject of this report. This experiment, part of Atmo AuRA's various citizen measurement studies, illustrates one of the association's future strategies: to integrate civil society into air quality observation, via deployment of citizen measurement observatories.

The CCPMB participates in the BB-clean programme as a pilot territory for participatory measures on French soil. For the CCPMB, the challenge is first and foremost to recreate a dialogue, through the enhancement of existing actions (environmental education, air and energy ambassadors etc.), but also by promoting the appropriation of knowledge on air pollutant emissions and existing solutions, by its inhabitants.

This action aims to offer an integral service, from measurement taking to existing solutions (for citizens, public and private stakeholders), to reduce emissions related to the use of wood-fired energy and create favourable conditions for a change in behaviour, in the short, medium or long term.

Sociological back-up support was proposed throughout the experiment, with different aims for each of the two project partners. For the territory, the aim was above all to understand the social representations of volunteers with regard to pollution (sources, origins, impacts etc.), their relationship to public action and wood-fired heating (awareness, opinion), and their personal practices. For Atmo AuRA, it was more a question of understanding the participant's relationship to the project, his handling of the technical device, his experience, his logic of interpretation and the impact of the experience on his understanding of pollution-related phenomena.

To achieve these objectives, various elements fuelled the citizen experiment that took place on CCPMB territory during the winter of 2019:

- The establishment of a sensor loan system to enable the individual measurement of fine particles in ambient and indoor air across CCPMB territory.
- The creation of a support programme in collaboration with local partners (air quality and existing solutions) including demonstration workshops, practical workshops, air quality conferences etc.
- The technical and sociological monitoring of all participants in order to accompany them in their measurements, the interpretation of results and to offer general support throughout their experimentation. This review details the results of this experimentation.

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2. METHODOLOGY

The BB-Clean experiment carried out across CCPMB territory during the winter of 2019 took place in several phases, from the choice of microsensors, the different phases of individual measurement and collaborative workshops to the final event (Figure 5).

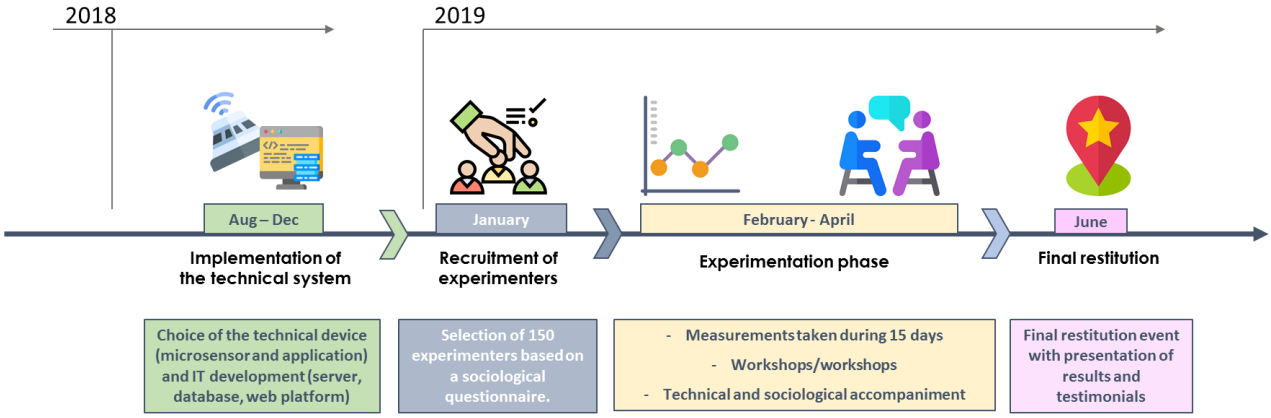


Figure 5: Schema of the course of experimentation

During these different phases, the use of various technical and digital tools as well as the establishment of sociological support and territorial entertainment contributed to the realisation of the said objectives.

2.1. TECHNICAL METHODOLOGY

The technical base constitutes the tools made available to participants by Atmo AuRA, to enable them to participate in a collaborative approach to air quality data collection and, in particular, the assessment of individual exposure to fine particles.

It comprises:

- A fine particle microsensor
- Data visualisation tools (smartphone application and digital platform)
- Digital exchange forums
- Training workshops for the use of the different tools as well as individual technical support
- Expert and territorial support workshops

The purpose of these different elements is to enable each participant to collect air quality data, visualise and share it with the community, discuss measurements and question the atmospheric phenomena observed.

2.1.1. THE MICROSENSOR

2.1.1.1. The choice of equipment

The microsensor was chosen to meet project objectives, the most important being the identification of pollution related to wood-fired heating, in particular through the differentiation of the various fractions of fine particles (PM10, PM2.5 and PM1).

Several selection criteria were defined to enable us to choose the most suitable measurement tool:

- Pollutants to be measured: the microsensor should allow the individual measurement of fine particles (PM10 and PM2.5 at a minimum).
- Measurement mode and environment: the assessment of individual exposure to pollution involves being able to make measurements in everyday life, both in ambient air and indoors. The sensor must therefore be mobile.
- Price: the microsensor must be available at a low cost in order to guarantee a sufficient stock and thus enable the participation of the greatest number.
- Reliability: not all microsensors on the market are equal in terms of accuracy, precision and durability. Local, national and international trials regularly take place to test these different parameters (e.g. LCSQA aptitude tests, Airlab microsensor challenge). Only the sensors evaluated in this context were taken into consideration.
- The Open Source nature of the solution: this criterion is essential because it meets our commitments in terms of legislation (compliance with RPGD regulations on the use of personal data), moral values (a free, fair and independent service) and scientific expertise (access to raw data to verify the relevance of the signal processing carried out by the device and to readjust it if necessary).

Few solutions could meet all of these criteria, resulting in the choice of the Airbeam 2, manufactured by the American NGO Habitat Map. Corresponding to the second version of the sensor used in 2016 during the Mobicit'air campaign, Airbeam 2 enables the measurement of PM10 and PM2.5 particles (suspended particles less than 10 and 2.5 microns), as well as PM1 particles. In operation, this sensor performs measurements in the time step of a second, enabling the precise identification of immediate variations in particle levels. Spatial and temporal measurement precision facilitates the understanding of phenomena related to air pollution but also the identification of sources, particularly interesting in the context of a participatory citizen project.

The experiment was thus enriched by 30 Airbeam2 microsensors, funded by Europe and the AuRA Region as part of the project. The same microsensors were also used during the winter of 2019/20 as part of an experimentation transfer on Austrian and Italian territory.

These microsensors, associated with a continuous mobile human resource and a global scheme designed for a large number of participants, enabled us to propose the experiment to 153 local inhabitants over 15-day periods.

A 15-day loan period was allocated to allow participants to take charge of the various tools and to test, if not all possible contexts, a large portion of the phenomena related to fine particulate pollution. The optimal duration and frequency of this type of loan is featured in a latter part of this report.

A large number of participants, if not a statistical representation of local inhabitants, enables a diversity of profiles, making it possible to evaluate the scheme on types of participants who are sociologically different.

2.1.1.2. Sensor evaluation

Before distributing microsensors to citizens, Atmo AuRA systematically proceeds in an evaluation of the equipment, called cross-comparison, to detect problems. This evaluation is carried out in addition to the national evaluations mentioned above, which aim to test a solution as a whole, in terms of measurement technique, design, ergonomics and consistency, for the uses envisaged. The parameters tested in our inter-comparison are not the same. Firstly, it was necessary to check that each device worked properly (battery, LEDs, fan, connection etc.). Secondly, we wanted to verify the consistency of the measurements between all Airbeam sensors to enable the comparison of the results.

The cross-comparison of the Airbeams used in this project was carried out immediately prior to the start of the participative experimentation, in winter, when the range of ambient air particle concentrations is at its greatest. The 30 Airbeams (+ 6 replacement microsensors) used in BB-Clean were simultaneously put into operation, from 18/12/2018 to 26/12/2018, at the Atmo AuRA station in Passy.

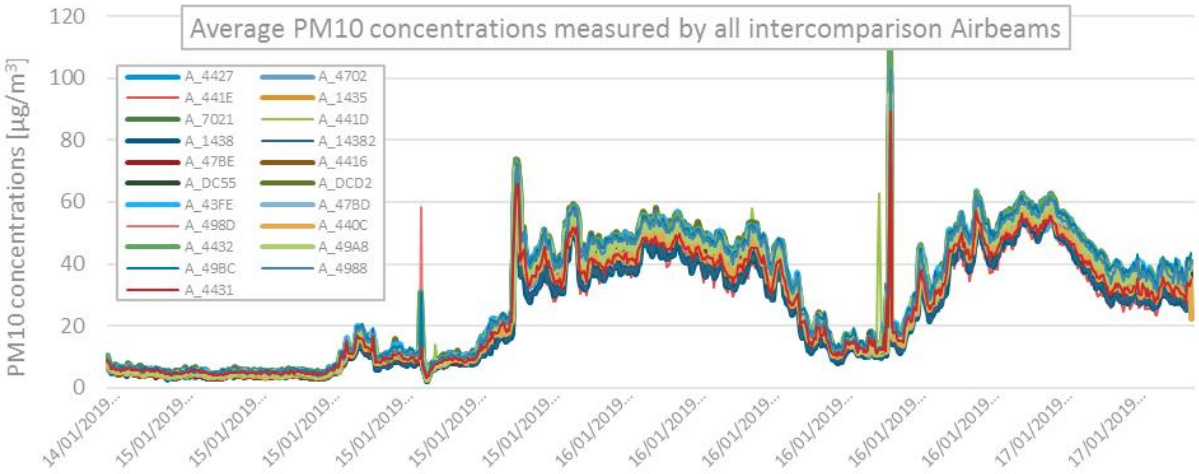
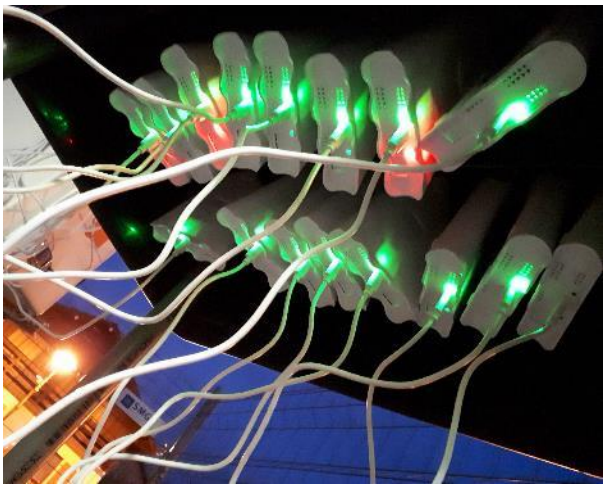


Figure 6: PM10 levels measured by Airbeams during cross-comparison



The results of this cross-comparison were analysed by the classic statistical method of linear regression, taking one of the microsensors as a reference. With determination coefficients (R2) greater than 0.99 for all sensors, the measurements show a low dispersion, illustrating a good correlation between the Airbeams. However, three sensors presenting poorer results (R2 somewhere between 0.95 and 0.99) were replaced. The results of this cross-comparison for the measurement of fine particles were considered satisfactory, confirming our choice as regards Airbeam.

Figure 7: Photo of the cross-comparison of Airbeam sensors at the Atmo AuRA station in Passy

2.1.1.3. The recording of measurements via a Smartphone application

Since the Airbeam2 does not possess a visualisation interface or a means of data storage, it cannot be used independently of a smartphone (reception of real-time measurements via Bluetooth).In addition to the microsensor itself, the Habitat Map solution includes a Smartphone app, Aircasting, which enables one to view real-time measurements and record them as sessions, as well as a web platform (www.aircasting.org) to view and share the data with other Airbeam users. The Aircasting app, available in English only and on Android phones, enables simple measurements to be viewed in different and complementary formats: average per minute for the three fractions of fine particles, detailed graphs for each setting and user mapping (colour chart according to the levels encountered, from left to right in Figure 8).

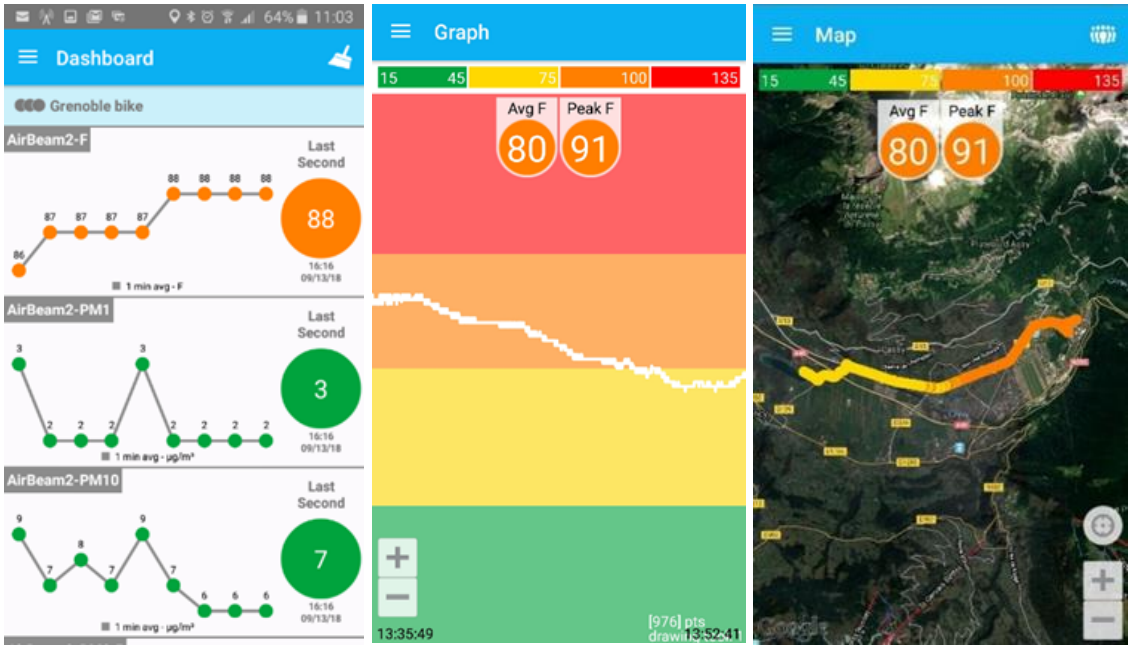


Figure 8: Visual display of measurements on the Aircasting app

2.1.2. SHARING AND EXCHANGE TOOLS

2.1.2.1. The web platform

To enable participants to engage in an enriched collaborative project (visualisation of individual and collective data, guaranteed anonymity, session sorting according to the measurement context), the BB-Clean programme relied on the first version of the Captotheque facility developed by Atmo Auvergne-Rhône-Alpes with the support of the Auvergne-Rhône-Alpes region. The Captotheque web platform, the development of which is based on the Mobicit'air experiment conducted in 2016, was therefore the one used.

The first version of the Captotheque web platform (https://www.captotheque.fr) consisted in the integration of the visualisation map developed by the NGO Habitat Map, allowing adequate data visualisation while securing the anonymity of the participants to meet the regulations of personal data protection. This platform also enabled total independence in terms of features and content.

Figure 9: Screenshot of the Captotheque home page

The Captotheque web platform thereby enabled each person to obtain general information on the various collaborative measurement programmes run by Atmo AuRA, to register on the platform using a pseudonym and to apply for the various experimental campaigns underway by completing an online sociological questionnaire. For the participants in experiments, the platform made it possible to share measurement sessions with others and access online technical assistance as well as other useful information (air quality index, current pollution episode, workshop dates etc.).

The application phase, which also takes place on the web platform, was based, for this particular project, on a sociological questionnaire. This questionnaire is an important part of the general methodology. It allows the inhabitants of the territories under experiment to apply to participate and also enables the collection of sociological data of interest. This questionnaire is presented in further detail in the following section of this review.

2.1.2.2. The Facebook Group

To complete the Captotheque service, a Facebook group called "Captotheque Exchange" was created to enable discussions between participants - beyond planned discussions during workshops. In order to promote a certain freedom of expression on this sensitive topic, sometimes a source of violent verbal opposition on social networks, as well as to strengthen the sense of belonging to a community, we chose to make this group private, exclusively accessible to the organisers and participants. Like the Captotheque web platform, this exchange forum was shared by participants in the different territories under observation.

2.1.3. TRAINING AND RESTITUTION WORKSHOPS

During the course of the winter, more than 150 people were able to participate in the BB-Clean experiment across CCPMB territory. With 30 microsensors, six groups of thirty people were trained during the winter, each member disposing of 15 days to use the microsensor to effectuate their own measurements. Beyond this individual measurement period, participants had the opportunity to access the different platforms and participate in the proposed workshops.

In the first experiment conducted by Atmo AuRA in 2016, Mobicit'air, the reception and training of the participants was carried out individually, with sessions varying between 1 to 3 hours depending on the technical skills of those taking part, or their knowledge of air quality.

The BB-Clean project, on a larger scale, enabled to assess how the Captotheque service can be made more operational, in order to reach as many citizens as possible, regardless of their means, social stratum or technical skills. It therefore seemed necessary and relevant to set up collective training sessions which, beyond the optimisation of time, also help to foster a collaborative spirit.

Figure 10: Photo taken at one of the training sessions

From 15th January until the end of April, 6 phases of individual measurement were completed, each of which began with a collective training session in groups of 15 (2 sessions of 15 people on the same day). During these group sessions, representatives of Atmo AuRA and the CCPMB, responsible for the mission, presented the project, its various objectives and the agenda. It was also during these group sessions that the participants took charge of their sensor, making their first measurements with the help of a tutorial. Each participant then benefited from the use of the sensor for 15 days, during which time telephone, online and/or physical assistance was available. This assistance responded to technical problems but also primary questions concerning the levels of pollution measured.

The restitution of equipment, at the end of the 15-day monitoring period, took place individually. These individual exchanges with an Atmo AuRA research analyst enabled us to gather primary feedback from the participants, their feelings, their opinions on the different tools and their use. More importantly, they enabled us to answer some of the questions concerning the measurements taken. These individual interviews are addressed in more detail in the results section of this review.

2.1.4. EXPERT & TERRITORIAL ASSISTANCE

One of the lessons learnt from the first Citizen Mobicit'air project was that the assistance of participants in their monitoring activities is absolutely essential to their understanding of the topic, to help them comprehend a number of phenomena. In addition, in order to facilitate the dialogue between citizens and institutional representatives (Atmo AuRA and local elected officials), we wanted to propose regular moments of exchange (in person) via the creation of sessions dedicated to the presentation of existing territorial actions as well as to discussion and debates between these different stakeholders. In addition to loan

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sessions, one-on-one restitution interviews and web platform exchange forums (Captotheque and Facebook), we proposed a number of workshops for participants throughout the winter period. Attendance at these workshops was optional although highly recommended for those who had the possibility to attend (availability in the evening, distance from CCPMB premises etc.).

In total, 9 workshops, divided into three main themes, were proposed to the 153 participants:

2.1.4.1. DIALOGUE workshops

These sessions, lasting approximately 2 hours, were designed to allow each person to share their experience, discuss their monitoring and the results obtained, to exchange and debate positively on major local themes and ask the Atmo AuRA representative any questions specific to local territory. Three DIALOGUE workshops were proposed during the course of the experiment, at a rate of one per month. Each session began with a presentation of the principal measurements made by the participants. This was the perfect opportunity to observe the different themes addressed, the preferential measurement contexts chosen and to highlight the more interesting measurements taken.

Figure 11: Photo taken at the 3rd DIALOGUE workshop

Secondly, participants had the opportunity to exchange in a more intimate manner, in small groups/ roundtables dedicated to the major themes of this experiment. The different themes, chosen according to main topics and questions addressed by all participants, who moved from one table to another, were:

- **Indoor air:** Particularly important for most participants, the assessment of air quality in their homes was often one of the first measurements taken. Since the phenomena encountered in indoor air were significantly different to those present in the ambient air, it seemed necessary to provide certain precisions in order for the conclusions drawn to be as accurate as possible (e.g. only fine particles are measured by microsensors, other pollutants may be present in the ambient air).

- **Outdoor air:** In the broadest sense, this theme allowed us to address numerous topics, such as the global levels registered during the measurement period, the identification of the sources at the origin of this pollution, variations in space and time etc.
- **Weather, topography & altitude:** This theme allowed for further investigation of topics related to variations in fine particulate matter levels according to environmental criteria. It led the debate on the complexity of phenomena related to air pollution, taking into account various physical and environmental factors such as meteorology, topography, altitude or proximity to rivers or bodies of water.
- **Air quality within the territory:** The presence of Atmo AuRA's territorial representative enabled to focus the discussion on local issues and the present situation with regards to air quality in the Arve valley. Direct exchanges with an expert made it possible to clarify the changing and sometimes contradictory information perceived, on a daily basis, via numerous media sources addressing the issue in question.
- **The Captotheque:** The purpose of this roundtable was to communicate directly with users concerning the Captotheque facility made available to them throughout the experiment. It was thus possible to gain feedback in terms of use (practicality, ergonomics, design, and technical problems), the relevance of the various features, and ideas for future improvements. The aim was to involve participants in a think tank, led by Atmo AuRA, on the development and deployment of this key tool throughout the region.

Figure 12: Photos of the roundtable discussions held during DIALOGUE workshops

2.1.4.2. COMPREHENSION workshops

These workshops aimed to enable participants to discover the different air quality monitoring professions via a presentation and direct exchanges with the Atmo AuRA experts concerned. Among the many professions represented within the association, we chose three main themes, which enabled us to address the principal elements of air quality monitoring (as carried out at a regional level by Atmo AuRA) and answer the most commonly posed questions.

Workshop 1: Air Quality monitoring

This first workshop was intended to be fairly general, presenting the context of regional air quality monitoring from a regulatory point of view (presentation of the various legislating regulations within the territory), a strategic point of view (organisation of monitoring and the measurement network), and a technical point of view (human and technological means deployed). Participants discovered the diversity of the pollutants measured, the allocation of monitoring stations throughout the region concerned, the different devices and the techniques used to validate data collected on a daily basis.

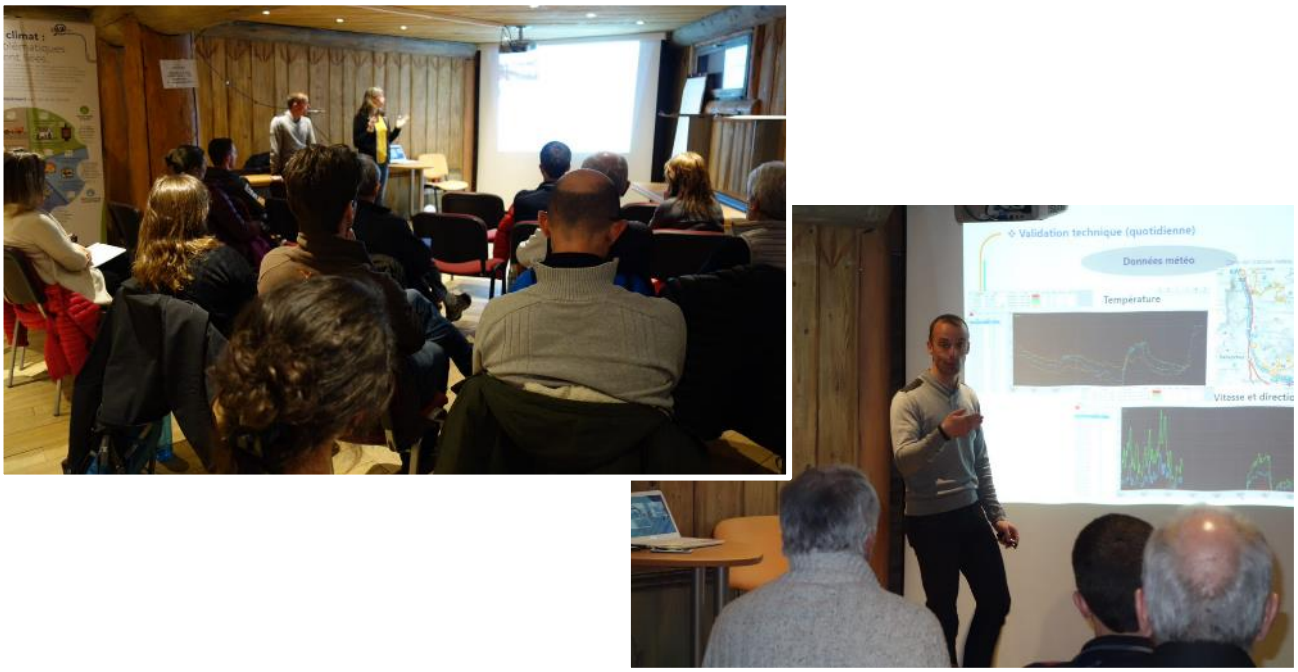

Figure 13: Photos taken at the "Measurement comprehension" workshop on CCPMB premises

The most knowledgeable could examine these topics in more detail by asking their most pointed questions to the two Atmo AuRA experts present: the head of the observatory and the technician in charge of operations at the monitoring stations in the Arve Valley. The session ended with a visit of the regulatory facility in Passy, usually closed to the public, and a detailed presentation of the various elements that comprise it (analysers, manual samplers, central data collection units etc.).

Workshop 2: Emissions and modelling

A fairly technical session, the aim here was to address the important (and sometimes sensitive) topics of regional air pollutant emissions and the modelling tools used by Atmo AuRA to simulate concentrations

across the territory. An emissions specialist presented the tool, called a register, that permits the collection, census and analysis of air pollutant emissions produced by various sectors of activity (industry, transport, residential, agriculture, energy etc.) and their division into squares (defined in a spatial grid). This workshop was also an opportunity to present the limits of the data available.

A fellow modeller was also present to explain how, from this register of emissions, meteorological data, models of chemistry and atmospheric transport and other socio-economic information (population density, car population, road traffic, use of different energy modes etc.), it is possible to model (to extrapolate) air pollutant concentrations in all territories across the region, regardless of whether or not effective measures exist in the various sectors.

Figure 14: Photo taken at the workshop "Emissions and modelling"

Workshop 3: Managing an episode of pollution

This workshop was intended to illustrate the complexity of managing an episode of pollution, to explain the order of discussion in times of crisis and the actions that can then be introduced on a territorial level to recover, as best possible, from the said crisis. Organised in the form of a "serious game", this workshop enabled participants to step into the shoes of the decision-makers (Regional Prefect, Atmo AuRA forecaster, business manager, Mayor of a town in the valley...) and to understand the complexity of the issues to be taken into account by each person concerned.

Figure 15: Photo taken at the workshop "Understanding the management of an episode of pollution"

All these workshops aimed to enable local citizens to discover, rediscover or deepen their knowledge of the main professions related to air quality monitoring and to understand the complexity of the issues managed daily by the various people involved. Such sessions were also an opportunity to exchange directly with members of the association, to improve dialogue and highlight transparency, integrity and an open approach to civil society.

2.1.4.3. ACTION workshops

This third series of workshops aimed to move from words to actions. For participants, it was no longer a question of debating but of proposing actions in favour of improving air quality. Again, three workshops were proposed, all on different themes.

Workshop 1: The hunt for fine particles

The initial idea of this workshop was to propose a collective measurement session, using particle microsensors distributed among participants, to establish a series of monitoring measurements, achievable over a relatively short period of time (1 hour – 1 hour 30), enabling participants to encounter various particle concentrations and to identify the sources. The main sources of fine particulate pollution in the valley (wood-fired heating, road transport and industry) were the key stages of this measurement session. The aim was to accompany the participants in interesting measurements, essential to the comprehension of local phenomena, that they did not necessarily have the opportunity or the idea of experimenting individually.

Workshop 2: The best practices for a cleaner use of wood-fired heating

Focused on wood-fired heating, this workshop aimed to educate participants on how to correctly use a wood-fired heating device and thus reduce its fine particle emissions. Firstly, a representative of SM3A, in charge of the Air Bois Fund, presented participants with a list of good practices: choice and drying of wood, ignition from above, air inflow management and the regular maintenance of equipment. In a second phase, the participants were invited to think about how best to educate the inhabitants of the valley on these good practices. A debate on the most relevant communication tools was thus conducted in small groups and then

presented to all participants. This occasion was an excellent opportunity to highlight the existence of financial aid for the replacement of old wood-fired installations by more efficient ones.

Figure 16: Photo taken during the workshop "Wood Heating and Good Practices"

Workshop 3: How to talk to children about air quality?

The child theme was regularly highlighted by participants, both in their initial motivations to participate in the programme, and in all further discussions. In particular, they questioned how best to talk to children about air quality, a worrying and complex subject, omnipresent across the territory. We created this particular workshop to try to provide answers to these questions. This session aimed to provide parents, or adults in general, with elements of language and specific tools to approach the topic with young children in a fun and simple way.

Figure 17: Photos taken during the workshop "How to talk to children about air quality?"

The CCPMB's nature & entertainment officers ran the session for adults, presenting them with ideas for small experiments that could be easily carried out at home with children, as well evoking the subject of air pollution with the language elements used in their school interventions. At the same time, children, who were also invited to participate in the workshop, stepped into the shoes of scientists by carrying out small experiments to learn to consider the air as an object and to discover its properties (volume, density, strength etc.).

These events, announced progressively on the Captotheque Facebook group and by email, complimented the measuring experience itself, providing participants and air quality professionals with the opportunity to debate on the subject and to engage in fun and informative participatory sessions.

2.1.4.4. The final restitution

To complete this citizen experimentation across CCPMB territory, a final event took place a short time after the end of the loan period. In June 2019, participants and local elected representatives were invited to participate in a final friendly and festive meeting. Participants, who regularly questioned the programme's objectives, and the results and lessons that could be drawn from it, were presented with the primary results and elements of analysis. The presence of local elected representatives was an opportunity to emphasize their involvement in the project and their desire to renew the dialogue with their constituents.

The primary analysis were carried out jointly between Atmo AuRA and the sociologist Louise Michelin, in order to present a shared vision of the participants' experience, from a technical point of view (control and use of the tools, summary of the measurements carried out and the phenomena encountered, participation in the various workshops proposed etc.) but also from a sociological angle (sociological profiles of participants, feelings and emotions when confronted with the measurements, opinions and perception of the project, awareness on the subject and consequent changes of behaviour).

An analysis of this type, and its presentation, enabled to put the citizen experimentation into context: an experiment aimed at better understanding how a citizen participation tool, focused on individual measurement but also on expert and territorial accompaniment, can help to improve the general public's knowledge of air quality and promote dialogue in a territory where this issue is at the heart of the debate.

Figure 18: Photo taken at the final event

2.2. SOCIOLOGICAL METHODOLOGY

The experiment as a whole was the subject of sociological accompaniment. The main objective being to assist our partners in their understanding of the participants' social representations and their relationship to pollution (perception, source, origin, impact etc.), to public action and more specifically to wood-fired heating and its use. It enabled a more in-depth analysis of the participants' relationship to the project, their handling of the sensor, their experience, and their logic of interpretation and the impact of the experience on their way of thinking and general behaviour. Sociology was therefore an integral part of the project, from the introduction of a recruitment questionnaire and the selection of participants to debates, workshops and the organisation of the final event.

Executed by the research consultants MyUsages, this sociological support consisted of the following missions:

- Participation in the creation of a recruitment questionnaire for candidate participants
- Methodology of the volunteer selection process
- Assistance in the format creation of workshops, loan and restitution sessions (observation at dialogue workshops, initial loan session and primary restitution sessions)
- Creation and analysis of the experiment evaluation questionnaire to be completed by participants
- The performance of 15 individual semi-structured sociological interviews
- The listening to, and analysis of, volunteer recordings made during various workshops (132 recordings made available)

The methodology of participant selection and the design of the recruitment questionnaire were crucial to both the success of the programme and the analysis thereafter.

2.2.1. THE SOCIOLOGICAL QUESTIONNAIRE

With the platform and recruitment being open to all adult residents across the CCPMB territory, it was necessary to set up a system of selection. Indeed, as expected, there were almost three times as many applicants as there were places on the programme.

Comprising a total of 50 questions, a sociological questionnaire for applicants was created to enable, on the one hand, the collection of socio-economic data useful to the analysis of the project and, on the other hand, to enable the selection of a panel of participants, with diverse profiles, based on certain criteria (to be detailed later). The questionnaire used for the BB-Clean project was based on the one used for the Mobicit'Air project and enriched with specifically defined questions to address the three experimental territories of the Captotheque® (the Interreg Alpine Space BB-Clean programme, the PIMEQUAL CheckBox project and different workshops in the city of Clermont-Ferrand). Additional questions related to wood-fire heating and new technologies, as well as issues related to general knowledge and citizen commitment, further enhance the applications (the following section on selection methodology will further detail these additional issues). The information was destined to provide Atmo AuRA with a better vision of the people interested in the project and hence reflect on how to reach more varied and representative profiles of residents in the Auvergne-Rhône-Alpes region.

This project is co-financed by the European Regional Development Fund through the Interreg Alpine Space programme

2.2.2. THE SELECTION OF PARTICIPANTS

Unable to ensure territorial representativity (representative sample too small) but nevertheless wishing to guarantee a variety of profiles among the participants, we decided to create a panel representative of the diverse points of view while ensuring communal representativity and a diversity of socio-economic characteristics. In a territory such as the Arve Valley, where civil society is particularly concerned by the subject of air quality, we reflected on how to involve the most committed and active people whilst also leaving the project open to newcomers and those curious to participate in a new experience (to prevent over-representation of an "expert" profile within the panels, the aim being to increase competence and raise awareness for all).

For this reason, a selection based on simple socio-economic data (sex, age, occupation, family composition, geographical position etc.) and heating practices, was insufficient to capture an applicant's knowledge of air quality and his/her commitment to the topic, to be able to ensure a good combination of expertise. Hence, to assess (subjectively, but according to a well-established protocol) the attitudes of applicants from the online registration questionnaire, and select them according to their diversity, it was necessary to establish a response rating system in order to build profiles. We therefore proposed a candidate rating procedure that allows for profiling based on a level of knowledge and commitment. This method of selection aims to mix opinions and thereby ensure that all points of view on the subject emerge. The idea here, is not to be representative of the source population, but to obtain a diversity of profiles in order to acquire a mixed sample of representations and opinions on local atmospheric pollution.

To assess the level of knowledge and commitment, we asked specific questions that enabled us to create a scoring system by expanding on the following themes:

- Knowledge on the topic of air quality (self-rating by the volunteer of his/her level of expertise)
- Assessment of public action in the field of air quality - of citizen eco-awareness and the actions in place
- The expectations of participants concerning this collective experience
- The motivations to participate (anxiety, curiosity, expertise, etc.)

Several questions were added to the registration questionnaire to assess a candidate's level of knowledge and commitment on the topic of air quality and to establish a profile score that we called: knowledge/commitment score.

Candidate profile scoring is based on the answers provided to the questions on these topics. Response terms are then recoded in digital format to establish a profile score by criterion. This score is established from the sum of these terms, converted on a scale of 1 to 3 per criterion.

This scoring system thus creates 9 profiles based on knowledge and commitment criteria: one person can have a level of knowledge at 1 and a level of commitment at 1, another can have a level of knowledge at 1 and a level of commitment at 2 etc.

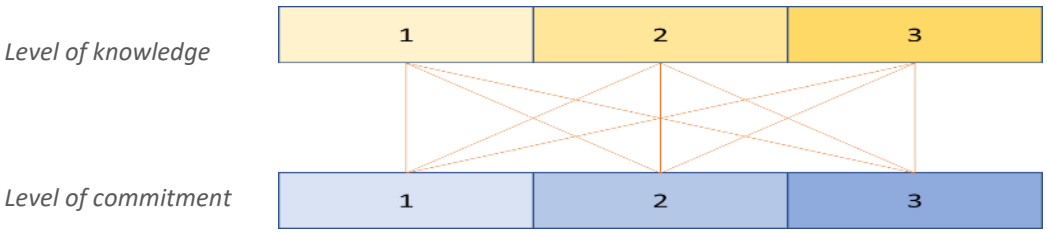

Figure 19: Combination of the different ratings possible

Example of profiles:

- ✓ PROFIL 1/1: a person new to the subject, whose involvement in collective and/or associative projects is non-existent and who only informs himself through the press, television or local websites.
- ✓ PROFIL 3/3: a person with a high level of knowledge, an active member in the associative field, who only informs himself through associations, who believes that the actions carried out in the area are insufficient or inadequate or who does not believe in the effectiveness of actions taken.

Out of 370 candidates, 153 participants were selected and divided into 6 groups, each group comprising 30 people. In the aim to achieve the best possible combination in terms of profile, we endeavoured, for each of the 6 groups and therefore for each loan session, to allocate the 9 profiles equally. The equitable division of profiles for each session thus ensured that no group takes precedence, in the aim to encourage fair and constructive dialogue. A computer programme (composed of algorithms) was created to effectively establish a selection from the questionnaires received.

Profile selection was made via random draw from the list of registered candidates. The programme randomly and anonymously selects 30 people corresponding to the 9 profiles previously established. These profiles, based on criteria of knowledge and commitment, are consequently distributed according to a mathematical model of equitable distribution. Within the same sensor loan session, one type of profile is represented as many times as another. In addition to the criterion of equitable profile distribution we added a further condition: the commune of residence, aimed at ensuring representation of the 10 municipalities across the territory in question.

This particular methodology, used to select participants, enabled us to form homogeneously diverse groups: we wanted the different sociological profiles to be present as equitably as possible within each of the six groups, thus encouraging a diversity of opinion, points of view and representation during the different debates and exchanges.

2.2.3. SEMI-STRUCTURED INTERVIEWS

Individual interviews between 15 participants and the sociologist Louise Michelin were conducted during the course of experimentation. These interviews enabled us to review, in more depth than the technical interviews conducted on the delivery of equipment, the perception of the interviewees, their relationship to the experience and the impact of the experience on their behaviour, and thus carry out a truly qualitative analysis.

The selection of the 15 participants for semi-structured interviews was also made randomly using the same selection criteria as those created for the mix of participant groups: profiles and place of residence. A letter explaining the sociological survey and information on individual interviews was distributed to each

participant on delivery of the equipment. Hence, all participants were informed of the contents of the survey and a potential telephone call to fix an appointment.

The selection was easy, as a great majority of participants contacted by telephone immediately agreed to the interview. At the home of the interviewees, at their workplace or on CCPMB premises, the interviews were conducted according to a comprehensive model with a biographical perspective (residential, professional and personal history of the respondents). The interview was not limited to the issue of air quality, but broadened to cover the participant's representation of public action and their behaviour towards their environment, while constantly questioning their relation to the BB-Clean experiment. The topics discussed during the interview are listed below:

- ✓ Residential history (opening subject)
- ✓ Perception and representation of air quality
- ✓ Knowledge and sources of information
- ✓ Practices and usage
- ✓ BB- Clean experiment: motivations, measurements and contributions

The key results from these 15 interviews, non-representative of the local inhabitants but representative of the participants (themselves representing a diversity of opinions and positions on the subject), will serve to feed the results, particularly in terms of participant characteristics.

3. KEY RESULTS

This experience, extremely rich from a technical, sociological and territorial point of view, is a considerable source of learning for the participants but also for those partners involved in the organisation of the project. As part of this review, we have chosen to focus the project's analysis on the technical and operational aspects, with results mainly centred around user behaviour in relation to the various tools provided. This section of the report presents the results of the entire project, by adopting the different methodologies presented above and integrating the results of the sociological analysis when necessary and relevant. We hereby discuss the characterisation of participant sociological profiles, taking into consideration their opinion on the experimentation by way of a general analysis of the measurements carried out and their participation in the various workshops.

3.1. THE PARTICIPANTS

With the past experience of participants, and their feelings when faced with the experiment of individual measurements, placed at the heart of project evaluation, from a technical and sociological angle, it is important to begin by analysing and characterising this participation. The following part of the review presents the profiles of people who manifested interest in the project, through a candidate application made via the Captotheque platform, and a further analysis of those candidates who actually participated in the project. The quantitative analysis of the recruitment questionnaire, as well as the more qualitative analysis of the various individual and collective exchanges that took place throughout the experiment, supplied and supported the participant profile presentation proposed below.

3.1.1. CANDIDATE & PARTICIPANT PROFILES

From the second half of December onwards and during the course of winter 2019, more than 370 applications were completed on the Captotheque platform.

Of the total number of applicants, 30% were non-CCPMB residents (mostly inhabitants of other towns and villages in the Arve Valley), a fundamental condition of participation in this experimentation. Although a clear demonstration of the general interest of citizens in a civil monitoring project, these applications were not taken into account in the profiling work presented here.
The socio-economic characteristics presented below are those of candidates residing within the CCPMB, amounting to 263 applicants from which the participants were selected.

3.1.1.1. Socio-economic characteristics

The socio-economic qualification of participants was achieved with regard to three classical criteria: gender, age and employment status.

With a percentage of male and female candidates amounting to 49.7 and 47.4% respectively, gender parity was achieved naturally.

Regarding the age of the participants, one remarks an average age of 44 with more than 80% aged between 26 and 59 years old. This age group is hereby over-represented in relation to CCPMB territory where it represents just 51.2% of the population (source INSEE 2015).

Hence, there is a very low representation of people over the age of 60 (contrary to the sociology of commitment and participation which shows that retirees are often in the majority) and young people under

the age of 25. While the low proportion of retiree candidates and participants could be explained by the fear of participating in a project involving new technologies and the mastery of digital tools, the absence of the under-25s is more difficult to explain.

Finally, with regard to socio-professional categories, one remarks a diversity of profiles and a representation of all social classes among both candidates and participants. Nonetheless, one observes an over-representation of managers and a very low representation of blue-collar workers, despite their strong presence across CCPMB territory (source INSEE 2015).

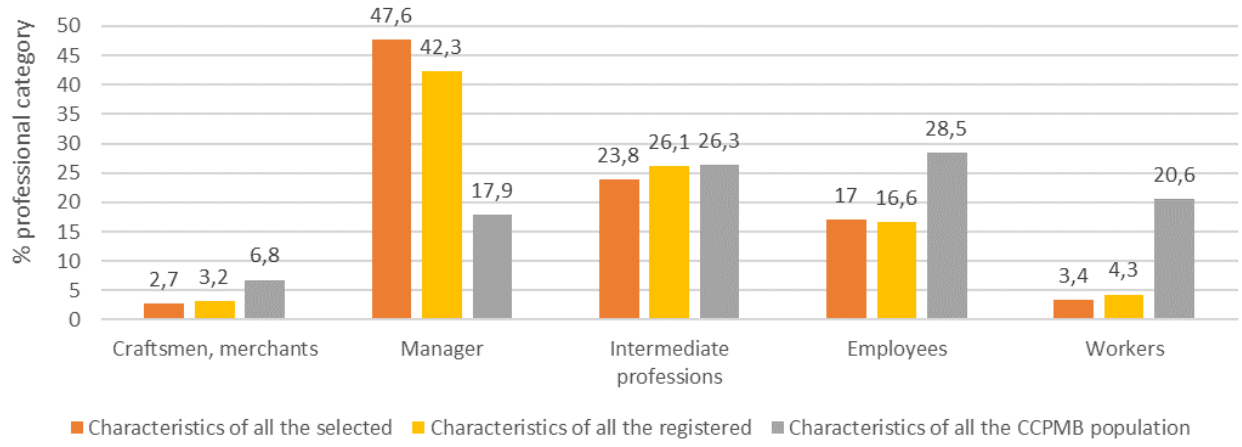

Figure 20: Breakdown of socio-professional categories among applicants, those selected and resident in the CCPMB

The middle classes (managers and intermediate professions) remain dominant throughout the project, as is common in this type of citizen survey to which higher education graduates adhere more openly.

3.1.1.2. Place of residence

The analysis of candidate and participant place of residence shows us that all municipalities within the CCPMB were represented in both categories. However, one remarks an over-representation of residents in Passy and an under-representation of residents in Megève, in relation to the entire territorial population.

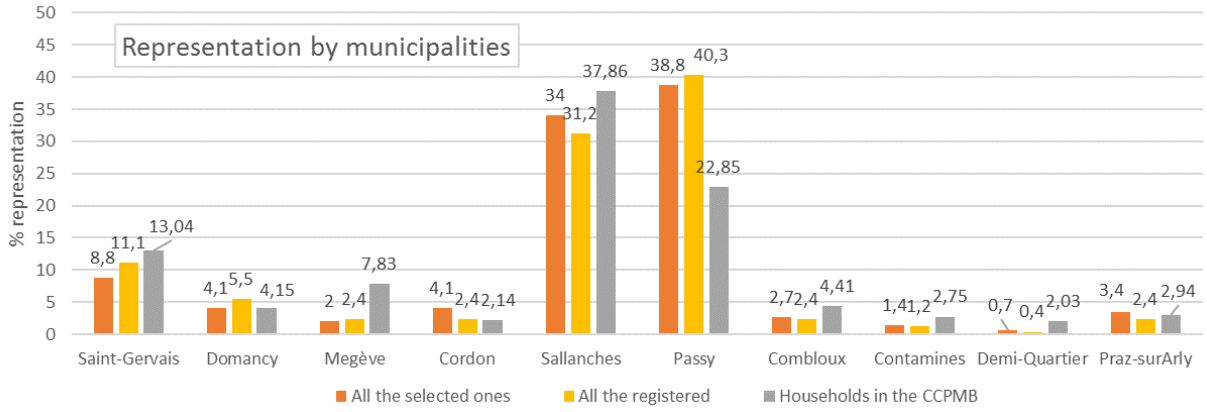

Figure 21: CCPMB residents (in blue), candidates (in yellow) and selected participants (in orange) per commune of residence

The over-representation of the municipality of Passy can be explained by the collective representation of this area as being the most polluted in the valley, hence the motivation and desire of the residents of this sector to analyse and materialise this pollution using sensors.
For example, numerous Passy residents applied to participate for the opportunity to verify data provided by the media, the associations and their personal entourage. One hypothesis that may explain Megève's under-representation is that, residents of Megève, living at altitude, consider themselves protected from pollution at the bottom of the valley and are therefore less concerned by the problem.

3.1.2. PERCEPTION & KNOWLEDGE

From the application questionnaire, backed by different exchanges and debates during the project, we were able to identify the main representations of air pollution in the Arve Valley in terms of overall perception, prioritisation of sources, identification and quantification.
The sociological analysis, dealing with many other components that we will not present here, has also made it possible to understand their opinion and perception of public action prior to the experiment. We will later review if their participation in the project had an impact on their perception and knowledge.

3.1.2.1. Global perception of air quality within the territory

By primarily analysing the results of the following question in the registration questionnaire, "On a scale of 1 to 8 (1 meaning 'not at all' and 8 meaning 'very'), would you say that your territory is polluted? “ one notices a very high percentage of responses beyond the score of 6, thus relating vast negative perception of pollution here.
It is interesting to note that concerning 3/3 profiles (the more knowledgeable and committed) that the perception of a polluted territory is the highest: 59% allocate the score of 8.

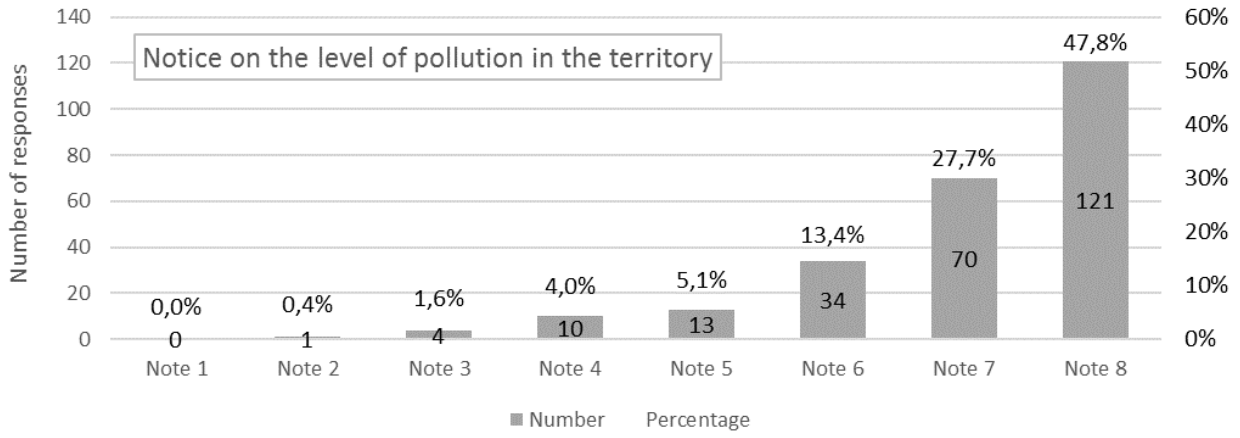

Figure 22: Scores concerning the perception of territorial pollution by applicants (application questionnaire)

This quasi general perception, by both applicants and participants, of a highly polluted territory, can be explained by the composition of the sample. The people who apply to participate in this experiment are already aware of the pollution. They share the same ecological sensitivity and the same interest in understanding reality. Let us also consider that people who respond to online questionnaires tend to be more assertive and thus slightly overestimate their opinions on sensitive topics.

The lowest scores are mostly attributed by people living at altitude (55% of those who allocate a score of 1 to 4 live at altitude, regardless of the level) who automatically feel less impacted; pollution being imagined as a mass characteristic of the valley floor.

In addition to feeling less impacted, they do not consider themselves to be pollution emitters, neither personally nor locally: mainly associating sources of pollution with traffic and industry.
This geographical distinction explains the broadly shared feeling of strong territorial inequality in the face of pollution: there are two distinct groups of citizens in the valley, those who live on the heights, generally belonging to a more affluent social class and considering themselves to be spared from pollution and the inhabitants of the valley floor, more modest and subject to the impact of poor air quality on a daily basis. We will see later how the experience was able to change this perception amongst participants.

3.1.2.2. Prioritisation of Pollution Sources

This section focuses on describing the perception of pollution sources in the Arve Valley, for all candidates, and their relative importance.

The vast majority of the said candidates, already aware of the problem, positioned wood-fired heating as the primary source of pollution, followed on an equal level by individual transport and industry.

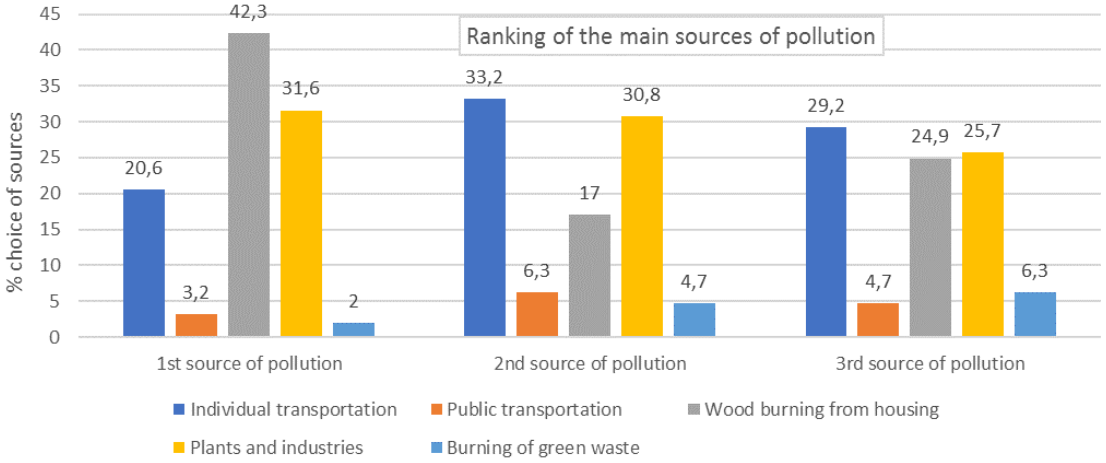

Figure 23: Sources of pollution in the Arve Valley ranked in order of importance by the candidates (in response to the application questionnaire)

These results indicate a real difference when compared to the reference study PR2EA - Monitoring the change of equipment and the evolution of biomass combustion practices in the case of the "Prime Air Bois de la Vallée de l'Arve", Arve PRE2A project: Perception, Representation, Attitude, Adhesion, carried out by E. Cassagne, A. Pottier, S. Martin and C. Ségala - in which more than 80% of respondents positioned transport and traffic as the main source of pollution in the region, ahead of industries and domestic heating.

The difference in the composition of the two samples, especially in terms of the proportion of elderly people, could support the common hypothesis: a refusal of the older generation to position wood-fired heating as the main source of pollution.

While it is highly likely that the positioning of wood-fired heating as the main source of pollution is consequently linked to the profiles of the candidates (potentially aware and much younger), it can be

underlined (and this is confirmed in individual interviews) that local communication on the subject of biomass combustion is important and can contribute to changing the perceptions of the inhabitants.

The analysis of pollution source classification, by the knowledge/commitment candidate profile, shows that it is within 3/3 profiles (the most knowledgeable and committed) that wood-fired heating is placed in last position (a group in which the majority are homeowners, possessing the most wood-fired heating devices).

3.1.2.3. Identification and quantification of pollutants

To begin with, one notes that the primary source of perception and identification of pollution for the majority of participants is identical to that described in the reference studies: the first identification is primarily sensory, mainly by sight and smell, but also by physical manifestations such as allergies, stinging eyes and itchy throats.

Apart from the presence of smoke or a sea of cloud, quasi systematically identified as pollution, the importance of the visual impact may explain how certain structures across the territory could be automatically associated with a significant production of pollution. Consequently, the Egratz viaduct, the industrial platform on the valley floor or the high chimney of the incinerator, in addition to being perceived as deplorable territorial changes (to social, urban and landscape structure), are inevitably responsible for the pollution of the territory.

It appears that, through incidence on and intrusion of an activity that affects one's living conditions, both landscape and society, that an inhabitant develops a perception of pollution. The construction of the Mont-Blanc Tunnel and the motorway are also associated with a tourist influx, or «intrusion".

Tourism thus plays a paradoxical role in the respondents' discourse: whilst generating a dynamic economy, it contributes to the degradation of the local environment. Pollution is introduced by others, "because it did not exist before."

In addition to being associated with intrusion, road traffic is perceived as the main travel constraint, increasing from year to year. The increase in traffic jams, especially during high season periods, highlights traffic as a source of pollution: air pollution and daily pollution.

Beside this visual and sensory perception, the media, and especially local media sources, play a vital role in the perception and awareness of pollution. A quantitative analysis of the answers to questions concerning the sources of information used by the candidates shows that the majority rely on official sources, namely the Atmo Auvergne-Rhône-Alpes or CCPMB websites, followed by social networks and associations.

Figure 24 shows the diverse sources of information that people use and the in-depth analysis of discussions during interviews that enable us to identify the pros and cons that respondents associate with each source.

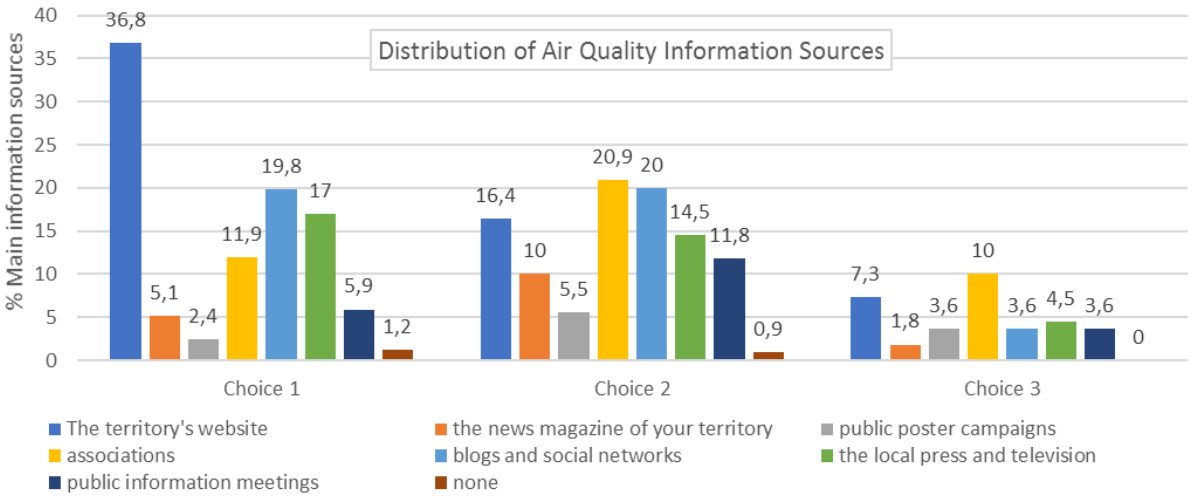

Figure 24: Breakdown of air quality information sources used by candidates (responses to the application questionnaire)

If the web is described by participants as the first source of quick information during an episode of pollution, it is also used as part of a longer-term learning process and understanding of the topic (I search, I classify, I compare and I review).

Paradoxically, they increasingly use this particular tool while becoming more and more suspicious of its content: confidence is declining, even if practices increase. Associations also use the internet, mainly social networks, to diffuse information and opinions.

Although internet was widely popular during public demonstrations in 2016, the people we met are now moving away from the web due to the vast amounts of information present there (sometimes contradictory) and a divergence in the demands made and the actions taken. While associations are sometimes criticised in terms of their organisation, the participants support them in their approach to political questioning, essential to the progression of discussion. On the other hand, newspapers and the local press, considered too general and simplistic in the light of the scientific articles referenced, are gradually neglected by the participants that we met.

Finally, it is through school, professional and sports circles that both candidates and participants remain informed on air quality. For example, parents are aware of peaks in pollution via communal schemes. They share the knowledge acquired by their children at school, especially during the specific interventions by CCPMB facilitators.

Many participants also report that they enrolled on the advice of their colleagues or bosses who had heard of or who had already participated in the experiment. Without this dynamic, many of them would not have had access to information, or felt the urge to participate in such an experience. Sports clubs are also seen to transmit information. Indeed, since many sports are dependent on the weather and areological conditions, the people who practice them are aware of any news concerning pollution.

While they appear satisfied with the information received, criticisms focus on the excessive amount of information available, the multiplicity of sources and their discordance. The people we met demand more qualitative information concerning pollution peaks, sources of pollution and the health impacts of pollutants. Since most of them are unaware of the information and data provided daily by Atmo Auvergne-Rhône-Alpes, they also demand greater access to scientific data. These arguments are reflected in their motivations to participate in the project, in which they have great expectations.

3.1.2.4. Opinion on public action

Overall, one can note, from response to the questionnaire and through the analysis of interviews, that knowledge of public actions remains extremely low among participants, who have certain difficulties in quoting political actions and regulatory measures that contribute to the improvement of air quality.

Among those that are mentioned are the speed limit and the ban on wood-fired heating during peaks in pollution. Only 36.7% of candidates are aware of the “Fond Air Bois”. The most knowledgeable and committed profiles are aware of two additional actions concerning industrial sites and road traffic: the installation of coal filters by the company SGL Carbon and a lorry ban on EURO 3 traffic during pollution peaks.

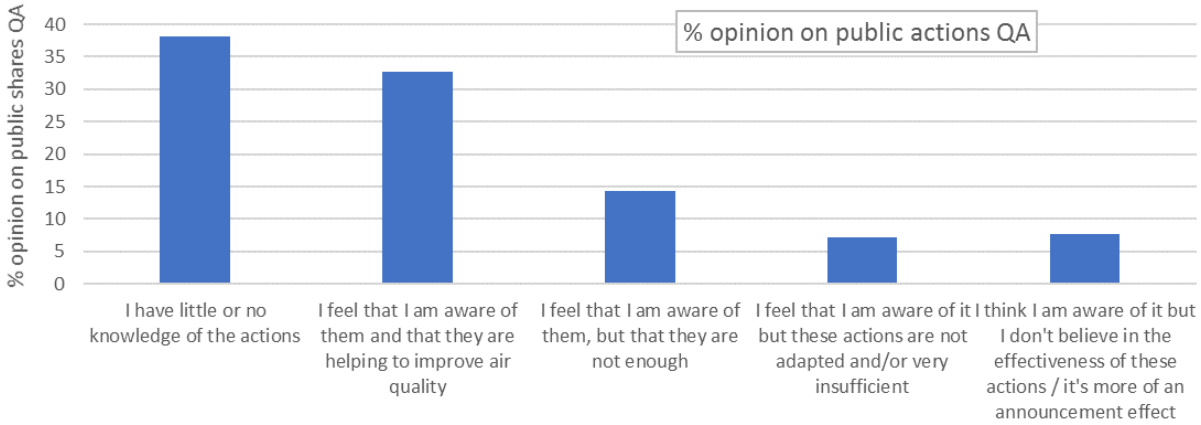

Figure 25: Opinions of candidates on actions across the territory (in response to the application questionnaire)

As many as 85.2% of candidates consider themselves aware of the actions and are relatively negative about their effectiveness and relevance. Opinions differ according to their profile (knowledge and commitment). Only 18.5 % of more novice and less committed profiles (1/1) judge actions unsuitable and/or very inadequate compared to 56.4% among expert-committed citizens (3/3). Among these same people, the lack of control concerning measures put in place during episodes of pollution also arouses strong criticism and a great sense of incomprehension and inconsistency. While some of the rhetoric is relatively radical and advocates stricter punitive measures for those who do not comply with the guidelines, others accuse politicians of being too lax. According to those asked, inaction can be explained by their blind confidence in technical progress and their long-term vision only, preventing them from taking more concrete and immediate action.

3.1.2.5. The use and perception of wood-fired heating

The BB-Clean programme aims to raise awareness of the impact of wood-fired heating. It is therefore interesting to know the position and relationship of participants towards this particular mode of heating.

The percentage of wood-fired heating users among candidates and participants, respectively 41.5 and 44.27%, is slightly higher when compared to the percentage of wood-fired heating users in the Arve Valley, which, according to ADEME, corresponds to 31% of this region’s population.

This over-representation of wood-fired heating users can be explained by important inter-communal communication concerning sources of pollution and "good practices". Hence, a certain percentage of those with wood-burning equipment have the motivation to check that it functions correctly and to discover its impact on the indoor air quality of their dwelling, during the course of this experiment.

When asked about the reason for choosing this particular mode of energy, the economic question prevails. The comfort and leisure aspect are also highlighted by those participants interviewed: a "soft and strong" warmth combining comfort, pleasure and moments of sociability around the fire. Aesthetic reasons are also mentioned. The beauty of the flame, or the equipment itself (fireplace, wood-burning stove etc.) are evoked as part of the decor and layout of the house. The fireplace is considered a feature that enhances the home. The weight of the collective imagination, systematically associating wood-fired heating with the environment of mountain chalets, is also very pronounced.

It should be noted that among the different types of wood-fired heating, the pellet stove is chosen by interviewees for its better energy performance, its lower emissions and practicality compared with more traditional appliances, its easy ignition and storage. Those asked are thus well aware of the impact of the choice of device on pollutant emissions produced during the use of wood-fired heating.

Several people talk about the difficulty in mastering specific gestures to obtain optimum combustion. Less than half of those questioned knew about the technique of ignition from above. They were awaiting information on this topic during practical case workshops.

It should also be noted that for other parameters inherent to the installation or the quality of the fuel (species and humidity of wood, drying time, installation and maintenance of the equipment...), the interviewees entirely trust their wood supplier and their installation technician. This illustrates the importance of the role of professionals in improving the use and behaviour of the consumer.

When asked about the impact of wood-fired heating on air quality, the majority of participants indicated that they were aware of the polluting nature of biomass prior to their participation in the experiment. These observations confirm the ranking as the main source of pollution in the valley, derived from the recruitment questionnaire. Nevertheless, a significant proportion of participants were sceptical of this finding.

Some of them, users of this mode of heating, are aware of the impact within the interior environment of the dwelling but do not pursue their train of thought towards the chimney breast and the ambient air.

Again, the role of geographical location can be found in this representation. One of the five wood-fired heating users interviewed pointed at the low impact of his device located at altitude. For others, it is the ancestral and traditional character of this object that make it difficult to identify as a major source of pollution. These sceptical representations nevertheless remain a minority among our participants, who represent an aware and informed sample of the population.

3.1.3. LEVELS OF KNOWLEDGE AND COMMITMENT

Across the board of applicants, the allocation of Knowledge/Commitment profiles happened naturally, in a fair and therefore diversified manner, with a percentage of lay/novice people (profiles 1/1), almost identical to that of expert/committed persons (profiles 3/3) and more intermediate profiles. This same diversity is found among the selected participants

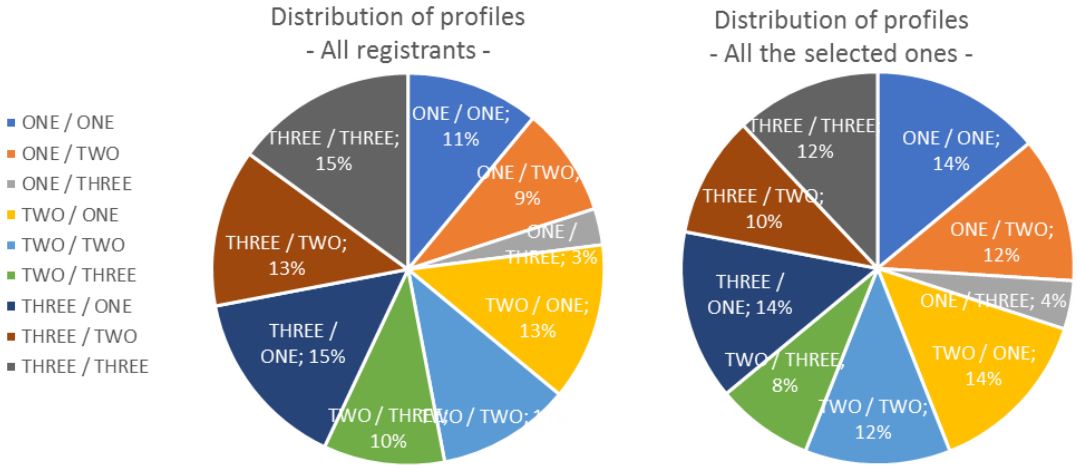

Figure 26: Breakdown of Knowledge/Commitment profiles among candidates and participants

In the context of strong public and associative mobilisation, we expected an over-representation of expert/committed citizens with an intention to use sensors to claim, denounce and/or demonstrate. The analysis of the answers to the questions related to associative engagement also shows that, although 32% of the candidates adhere to an association, they are mainly associations related to sports or leisure, the environmental associations are not represented here in their majority.

The sociological analysis proposes certain hypotheses, still to be verified, regarding the lack of over-representation of expert/committed citizens:

1) A lack of willingness to participate in this pollution awareness experiment, considering themselves already informed and knowledgeable;
2) The refusal to "work for Atmo Auvergne-Rhône-Alpes" as evoked at a workshop by a participant who left the room in the middle of the session. This illustrates a desire to counter official stakeholders, represented as passive and corrupt;
3) A lack of confidence in the impartiality and neutrality of the proposed sensors (one of the first questions asked following the announcement of the project on the CCPMB Facebook page concerned the availability of the sensor code).

NB: Certain candidates may have omitted to indicate that they belong to an association when filling out the questionnaire.

It is interesting to note that the over-representation of certain profiles for each of the criteria assessed (age, place of residence and socio-professional characteristics) converges in terms of knowledge and commitment criterion: it is within profiles classified 3/3 that one finds the highest number of wood-fired heating users (mostly home owners), the highest number of people living in Passy and the most managerial and intermediate professions.

This illustrates sociological theories that describe socio-demographic variables such as gender, age, occupation and diploma, as determining factors on the likelihood of participating in associative life, with the middle classes (management and intermediate professions) adhering more to this type of citizen and scientific project than blue-collar workers, who feel less legitimate to participate and perceive such projects as distant from reality and material constraints.

3.1.4. MOTIVATIONS TO PARTICIPATE

A qualitative analysis of the questionnaire and individual sociological interviews enabled a synthesis of the motivations and expectations of both the candidates and the participants.

Motivations evoking cognitive enrichment (precise knowledge of the sources and measuring of pollution, the impact of different pollutants and the actions in favour of reducing air pollution) are shared by the majority of candidates, illustrating their common interest in the topic. People who are disinterested or totally distant from this topic are logically not affected by this type of approach.

Nevertheless, the panel of participants is diverse in terms of level of knowledge and position (commitment) in relation to the subject. Even if motivations to participate in the project are shared, expectations in terms of education and learning content are different, depending on the level of knowledge and commitment of each and every person but also according to the health condition of the participant. The 4 main expectations mentioned by the candidates are:

- **To develop expertise, learn or strengthen one's knowledge on air pollution and the actions to be put in place.** More than 85% of the applicants wish to enrich their knowledge concerning the origin of pollution, its geographical distribution and concrete actions to be put in place at an individual level. Whether in an introductory context or one of knowledge enhancement, the volunteers wish to deconstruct hearsay and prejudices with the help of professionals. They desire to sort through the mass of given information and expect this experience to reinforce or negate their own knowledge and prejudices. They also participate to be involved, to contribute to a citizen project and to participate in a collective dynamic.
- **To receive scientific explanations on the environmental and health impact of pollution.** Although this demand concerns everyone, with greater or lesser intensity, 15% of candidates integrate this approach solely for the purpose of obtaining scientific data concerning the impacts of pollution on general health. Living in a context of illness, or in one of concern for the health impact in the home, these particular candidates seek above all to obtain precise information in an effort to protect their family (mainly their children) and change their behaviour in order to improve health conditions. They expect explanations concerning molecules, particles and the associated risks and wish to take advantage of this experiment to diagnose the indoor air quality of their dwelling. In this category, motivations are more related to an individual dimension derived from a specific health condition.
- **To verify official information by comparing sensor measurements with measurements from other sources.** These candidates emphasise a desire to measure and verify official information. More than learning, their aim is to check official measures and personally confirm whether official sources can be trusted or not. Characterised by a high knowledge profile, they desire to obtain "exact", "accurate" and "true" measurements. Aware of the position of stations and sensors belonging to Atmo Auvergne-Rhône-Alpes, they are sometimes known users of environmental sensors.
- **To obtain measures to demonstrate to their private and public entourage the presence of pollution**. These candidates wish to participate in the experiment in order to obtain measures that prove to their private or public entourage that the air in their region is polluted. They also expect this experience to be the impetus for wider mobilisation, to be seen and understood as an example of civic action. According to our classification method, these people present profiles that are relatively unfamiliar with the subject and are not particularly involved in the associative world.

Beyond the expressed motivation, the profiles of participants, although diverse in view of the different sociological criteria analysed, showed a common factor that appears to stand out in a rather remarkable way: a very pronounced interest in nature and their living environment. More or less advanced in an active approach, ecological awareness is pervasive. This analysis is based on the 15 semi-structured interviews but can be generalised to all candidates in light of the discussions that took place during the different debates and in their motivations to participate. Through a broader reflective approach to the ecological footprint (outside the specific theme of air pollution), they freely address pollution problems and risks associated with environmental degradation, and implement a number of actions in favour of its preservation in their daily lives, including: the promotion of local and organic produce, sorting, recycling and composting waste, various sports and alpine activities, use of bicycles and electric cars, support and participation in local projects and politics, development of public transport. Concern for the environment and nature was, therefore, one of the reasons that incited them to learn more about air pollution in their homes and daily lives.

3.1.5. THE CONTEXT OF ENVISAGED MEASUREMENTS

When asked about the measurements they plan to take in order to meet their different expectations, the candidates generally had in mind a series of measurement contexts primarily focused on their indoor home environment, the outdoor environment close to home and their daily journeys (to work, school, etc.). Next come more specific but quite recurrent ideas of measurements at different altitudes in order to understand the spatial distribution of pollution within the valley. Coming mainly from people living at altitude, these measurements are necessary to confirm or disprove the idea of "protection" felt by the inhabitants of the heights. A past move or the intention to do so (shared only during semi-structured interviews) also encourages this type of "geographic" measurement. Finally, the attraction for nature and sport being shared by all participants, there is apparent desire to take measurements in sports contexts, in order to adapt ones activity to the air quality.

3.2. THE MEASUREMENTS

The BB-Clean programme aims in particular to help to understand how individual measurement using microsensors can enable a general enhancement of citizen expertise on the subject of air quality, combined with increased awareness of the more specific impact of wood-fired heating.

In order to ensure that the behaviour of the participants is not biased by the knowledge of these objectives, we deliberately chose to leave them autonomous and spontaneous in the realisation of their measurements and in the choice of situations and phenomena investigated. Apart from the processes related to the use of the sensor and the various technical tools, no measurement protocol was imposed.

It is important to remember that the microsensor chosen for this project must enable everyone to take measurements of particulate pollution and to experiment with it in various contexts. The mobile nature of the sensor, which is essential for such use, incurs a limit in terms of the analytical qualification of the data produced: measurements can be carried out anywhere, both in indoor air and ambient air, recording concentrations of particles that can come from a multitude of different sources and situations.

As a consequence, a detailed scientific analysis of the results of these measurements in terms of air quality across a territory (as performed daily by Atmo Auvergne-Rhône-Alpes with data from its network of regulatory stations) was neither conceivable nor of any real interest to the project. This decision comes after

the completion of initial analytical work that sought to highlight statistical and quantitative results, but which was non-conclusive.

Consequently, the analysis of the measurements carried out by the participants focuses more on the use of the various technical tools available to them, on their individual and collective appropriation of the measurements and on the mass of data collected as a whole.

3.2.1. GENERAL STATISTICS

During the winter of 2019, 153 inhabitants of the region CCPMB participated in a citizen experiment to measure air quality. Over a two-week period, each of the participants was able to use the Airbeam microsensor to freely measure the fine particles in the air. In this relatively limited time, they produced a considerable amount of data with more than 4 million measurements collected. This figure corresponds to measurements carried out at a time step of one second for only one of the parameters measured.

Multiplied by three to represent the three fractions of particles, this substantial number illustrates the potential of citizen measurements in terms of data collection in the case of a citizen observatory. However, it should be noted, that data collected during this project is to be considered as citizen discovery measurements and not as official air quality measurements, such as those collected by the fixed stations - Atmo Auvergne-Rhône-Alpes. Additional work to implement data measurement and validation protocols would be necessary for further exploration.

These several million measurement points were achieved in the form of measurement sessions, corresponding to a time-capture delimited in duration by the start and stopping of the recording.

Indeed, the microsensor chosen here is more suited to taking punctual measurements (within a limited duration of time) than to the continuous measurement of ambient air particle levels. During training, it was also specified to participants that the maximum recommended duration of a session was 1 hour, beyond which one could be confronted with technical problems, such as sensor shutdown due to lack of battery, Bluetooth disconnection or the crashing of the mobile application. However, this did not prevent certain participants from testing these technical constraints during sessions of several hours. One volunteer even managed to complete a 14-hour session without any technical problems.

In total, more than 3,500 measurement sessions for more than 2,000 hours of cumulative measurements were carried out by participants. Whether it was voluntary on the part of participants deeming their measurements intimate or uninteresting, or as a result of technical difficulties, additional sessions were carried out but were never recovered on our data server. We estimate this data loss at 10% of the total number of sessions.

The analysis and quantification of the sessions performed individually is intended to illustrate the measurement effort that each participant consented in his/her daily life whilst in possession of the sensor. From figure 27 (breakdown of the number of sessions performed by each participant), one can conclude great variability in measurement efforts, ranging from a few sessions for the minimum to more than a hundred for the maximum.

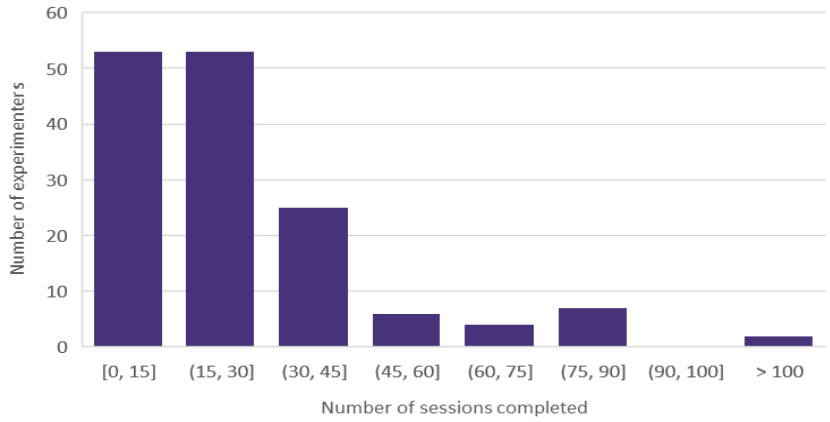

Figure 27: Breakdown of the number of sessions performed by each participant

Overall the participants were relatively active, with an average of 25 sessions per person, which corresponds to several sessions per day. One may note the particular efforts of two participants who completed more than 100 sessions, the record being 138 sessions. Although 3 participants failed to share any measurements on the server, our exchanges with them during the individual restitution sessions allowed us to see that each of them had performed at least two sessions during their two-week period in possession of the sensor.

Certain participants were fully committed, taking numerous measurements. This can be explained by the motivation necessary to register on the site, to apply for the experimentation and to participate in the training session, justifying the desire to invest oneself considerably in order to accomplish the "mission" for which the participant is in charge. The fun of taking measurements, the app and the colour code generally enticed the volunteers and encouraged their implication.

Conversely, the sociological analysis demonstrates that the small amount of measurements made by certain volunteers was due to the complexity of the protocol. For some, turning on the sensor, opening the app, waiting for the sensor to get used to its atmospheric environment, taking the measurement, tagging the measurement, sending the measurement, recharging the sensor, are all discouraging steps, sources of demotivation.

The lack of "spontaneity" in measurement taking, in the busy routine of daily life, prevented some participants from fully embracing the experience. Semi-structured interviews revealed that some participants felt a certain disappointment in the purpose of the project. While the volunteers were unaware of the specific objectives of this experiment at the time of their registration on the platform, some of them imagined participating, via this project, in a "citizen observatory", a participatory scientific experiment useful to the territory and to improving air quality monitoring. The discovery of a narrower objective than the one initially envisaged, focused on awareness and individual discovery of measurement techniques, may have hindered some participants in their overall experience. For these participants, fixed sensors with a lightweight measurement launch protocol appear to be favoured, although such tools would not allow them to understand the same phenomena and sources of pollution but instead enable them to evaluate the ambient air in their homes on a long-term basis.

During the quantitative analysis of the number of sessions carried out, we also questioned the existence of a link between the number of measurements taken and the different profiles of the volunteers:

- Do the more knowledgeable and committed participants take more measurements?
- Are people who are inactive or retired, as well as young people who are more inclined to new technologies, more involved in taking measurements?

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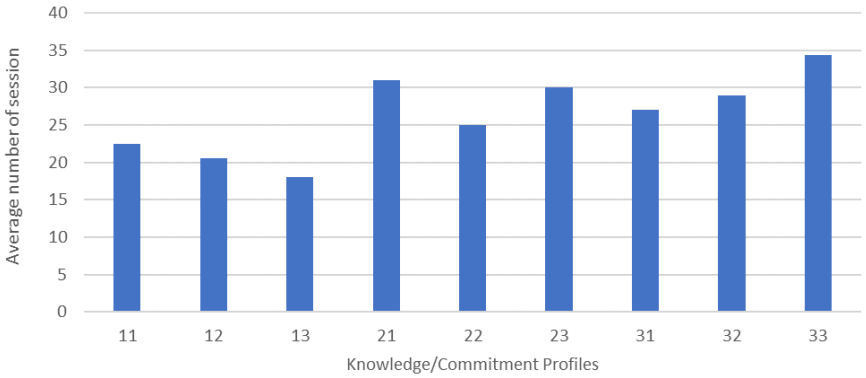

Figure 28: Average number of sessions according to Knowledge/Commitment profiles

With regard to the relationship between the profile [knowledge and commitment] and the number of sessions, there is indeed a tendency increase in the average number of sessions, the higher the profile, even if this factor is less marked than we expected. Hence, one finds the highest average, in terms of the number of sessions performed, amidst the group 3/3 (expert/committed).

On the other hand, it is neither the pensioners, nor the younger generation, who carry out the most measurements but the active population, aged between 26 and 59 years. This is mainly because their goal is to measure their daily lives - an active daily life that offers countless measurement contexts: home, workplace, school runs, leisure activities, measures to be taken with children to raise awareness, etc.

It is also interesting to observe the geographical perimeter covered by the participants as shown in Figure 29. Although all the participants reside within the CCPMB, they carried out measurements over a much larger area, spanning the entire Auvergne-Rhône-Alpes region. Some participants travelled elsewhere in France, on holiday or on business trips. The two maps below show the geographic distribution of all the measurements taken by the 153 BB-Clean participants during the winter of 2019. Nevertheless, one notes that the majority of sessions took place in the Arve Valley.

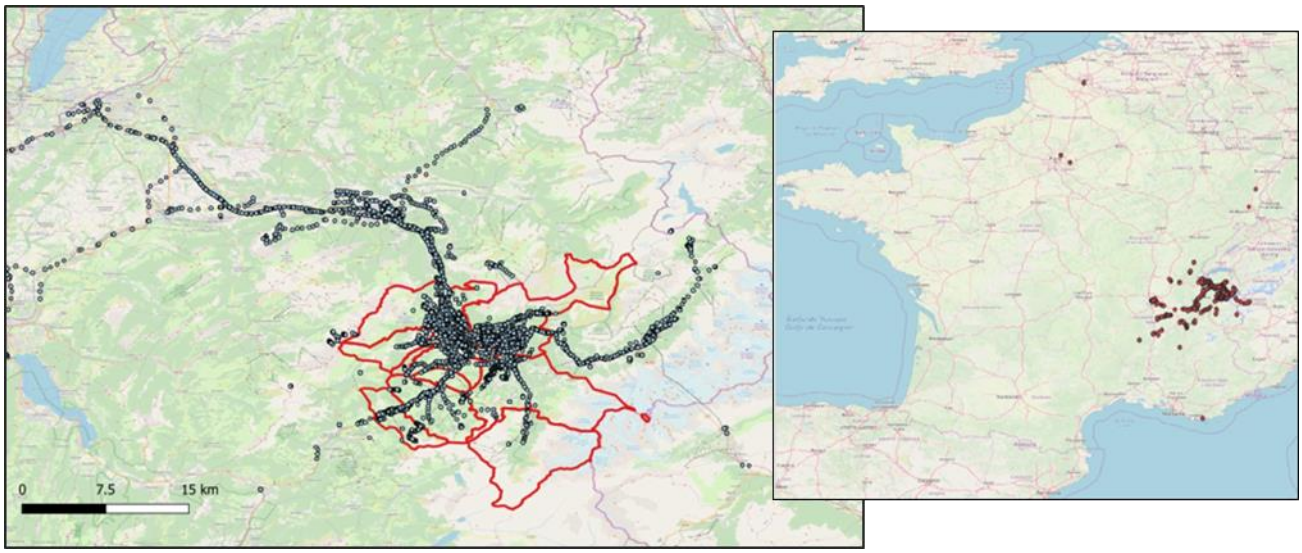

Figure 29: Mapping of all measurement sessions

These results illustrate the interest of the participants in measurements but also in the measurement tool itself. The sociological analysis reports that some participants clearly expressed their attachment to this object, a source of response to their anxieties or questions and to their understanding of previously confusing phenomena. The measurement tool, digital and scientific, appears to have become part of their daily lives, initiating an emotional relationship similar to one that may exist with a mobile phone.

The endearing shape of the sensor, its small size and its portable character have certainly contributed to the appropriation and integration of this tool in the daily life of participants, allowing them to transform the air that surrounds them (a vital and imperceptible element), into something visible and concrete. If 4 of the 15 participants interviewed gave the sensor a name, testifying this attachment (tool, ghost, jewel, Captotheque, Airbeam, detector, my precious, my companion ...), even more evoke a sense of loss once the sensor returned: being unable to identify a phenomenon of interest or a particular smell, or simply being unable to check if the air inside their home is healthy.

3.2.2. MEASUREMENT CONTEXTS

Now, let us take a closer look at the measurements taken by the participants, their context, their objective, their roles in understanding certain phenomena and how they proceeded.

One may recall that it was recommended for participants to make short and specific sessions, concentrating on a particular context (for example, by not mixing a measure of incense with that of an exhaust pipe) in order to promote the understanding of the purpose of the measurement and the interpretation of its results by the participant concerned, but also by others.

Overall, rigour and motivation accompanied the volunteers in their measurements: few extravagant measures, no danger to oneself or the sensor, no creation of a source of diverted pollution (as specified during the training session). Driven by the feeling of having «the chance" and "exclusivity" to participate in the experiment, the participants were also aware of possessing a specific and fragile measuring device and felt responsible for its proper use. They even held back on their measurements as a precaution: not taking the tool skiing, out in the rain or abroad.

Beside the shared feelings of excitement and responsibility, the measures themselves have a different sense for each participant. As specified during the training session, the microsensor was mainly used by the participants to test particular phenomena delimited in time (meal preparation, a weekend hike, home-to-work route). The purpose and the finality of the measurement associated is observed during individual interviews but also in the way participants characterise their measurement sessions through the tags and session titles that they are invited to complete at the start of each session.

3.2.2.1. Tags

If the title of a session was not subject to any particular format, the "tag" field was intended to offer a primary classification and standardisation of the measurements made by all volunteers.

The proposed tagging system, which consisted of manually adding a word characteristic to a particular measurement context at the start of each session, facilitated the characterisation of the measurement sessions and consequently the understanding of the phenomena encountered.

These tags also enabled session sorting on the Captotheque web platform, making it possible to visualise and compare the levels of fine particles measured in similar situations (e.g. to compare levels when using wood-

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burning appliances) or, on the contrary, in very different contexts (to compare exposure on a bicycle to that in a car).

It was therefore necessary for each participant to choose from a list of tags (predefined by Atmo AuRA on the basis of previous experience in the Mobicit'Air project), one that corresponded to their measurement, hence anticipating a specific objective to their session. During the training workshops, the predefined tags were presented by category. This classification aimed at introducing the participants to the different elements that may impact the levels of fine particles encountered (the environment of indoor or outdoor measurements, mode of travel, identified sources of pollution or even weather conditions).

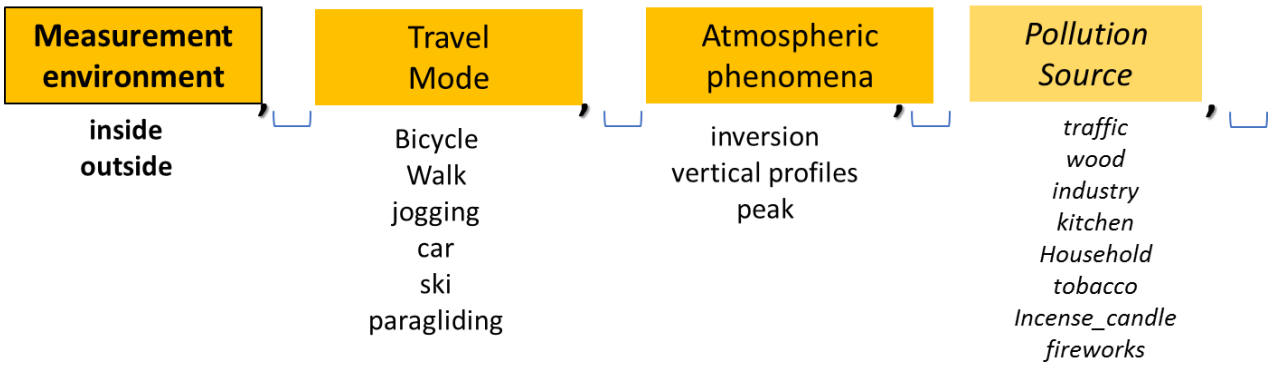

Figure 30: List of proposed tags

It should be noted, however, that participants remained free to use other tags if they considered those proposed unsuitable (not used for the classification of sessions shared on the platform but nevertheless used to identify preferred themes and contexts and adapt the future Captotheque accordingly).

The analysis of the use of these tags enabled us to carry out a primary quantitative study of the measurement contexts chosen by the participants.

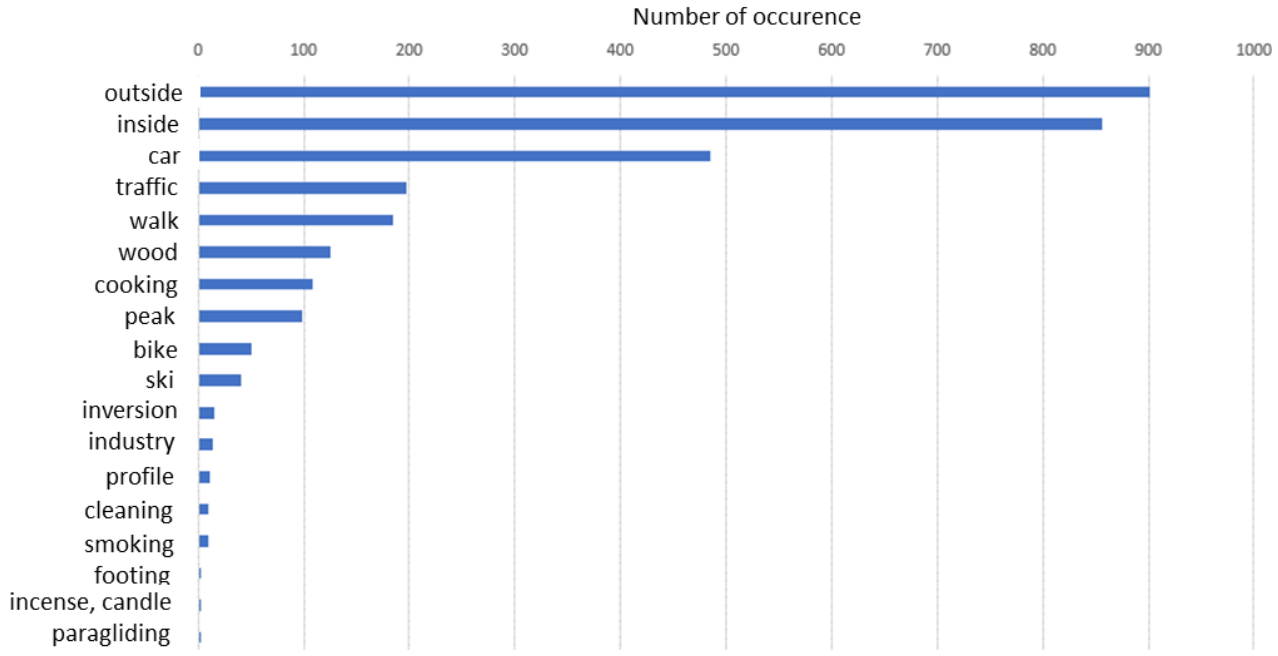

Figure 31: Breakdown of the use of different tags by all participants (total number)

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As requested during the training session, in order to improve the characterisation of the measurement environment, the tags "outside" and "inside" were mentioned the most by the participants. The equal distribution of the number of indoor and ambient air sessions shows that the participants were able to appropriate the theme of measurement in these two distinct environments.

Although this primary characterisation of the measurement environment is essential, the unique mention of these tags does not identify a specific context, often associated with a measurement objective that the participant fixes him/herself beforehand.

By mentioning the other tag themes, participants endeavoured to characterise the objective of their measurement sequence, for themselves and for others. One remarks that the theme of road transport, associated with the tags "car" and "traffic", has been widely addressed, as has the measurement of ambient air in the broadest sense, indicated by the tag "walking". Next come more specific measures related to wood-fired heating or to cooking as well as the practice of sports activities such as skiing or cycling. Some of the tags proposed in the list were never mentioned, most probably too specific or misunderstood by the participants.

One should note that Tags are not the only way to assign a particular context to a measurement session. The majority of the participants qualified their session further, through its "title". As a quantitative analysis of these titles (subject to no formatting) proved to be too tedious, we have focused more on describing the various measurement contexts to which the participants were more committed and illustrating them using some of the most representative sessions.

3.2.2.2. Indoor air

A great quantity of indoor air measurements illustrates relatively well the collective dynamics of this experiment, oriented for the majority of volunteers around the characterisation of daily life, in the aim to assess their home. The qualitative sociological analysis confirms that factors of daily life - the indoor air of the dwelling, the nearby outdoor air (garden, window, neighbourhood), places of life (market, school, sports halls) as well as daily journeys by car or on foot - were the principal subjects of measurement.

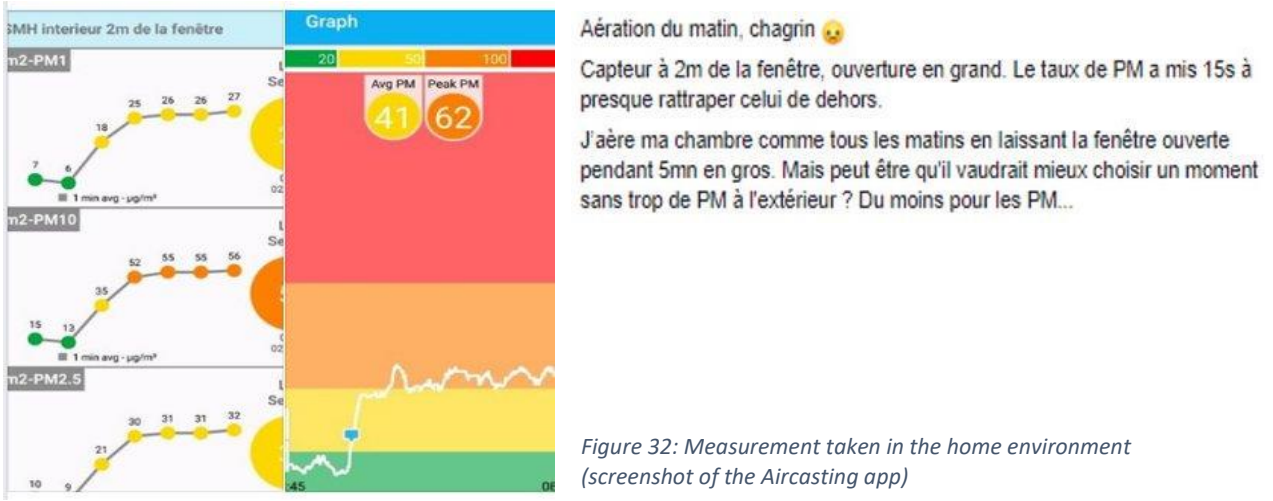

Figure 32: Measurement taken in the home environment (screenshot of the Aircasting app)

The female participant behind the measurement session represented in Figure 32 chose to share the session with other participants via the Facebook group. The commentary she associates demonstrates the strong

impact of the results on her perception of the air quality within her home, as well as the various questions they generate on the behaviour to adopt to improve it.

Like this participant, other people spontaneously evoke how surprised they were to realise that the ambient air within the home is different from the outside air and more often "better", the common and accepted idea being that indoor and outdoor air are one and the same. They also noticed that during a pollution episode, opening the windows resulted in an increase in the levels of particulate matter within the home. This led them to question the benefits of aeration, often leading to changes in behaviour.

Exchanges on their results and conclusions demonstrated the importance of accompaniment to put measurements back into context, in particular by recalling that whilst the Airbeam sensors measure particles only, the indoor air contains multiple other pollutants, present in confined spaces.

The importance of aeration was also recalled, an opportunity to address the subject of temporal variation in pollution, encouraging, where possible, a healthier aeration at the most favourable times (when the levels of fine particles in the ambient air are at their lowest).

Measurements taken during the preparation of a meal or when actually cooking were numerous, and experimented by all participants. It is these measurements and their sometimes very high levels, that profoundly marked participants in their monitoring of indoor air. Volunteers were surprised that an ever-existing vital daily action could generate pollution, especially since good smells are very difficult to associate with the problem. They were also surprised to see that they too can generate pollution in their daily lives.

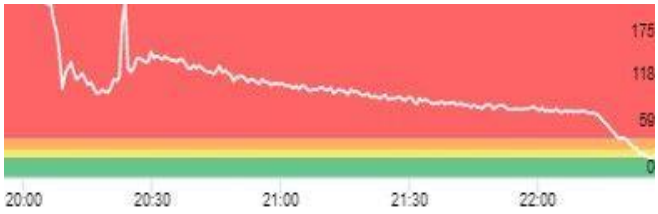

Figure 33: Example of a "Cooking" measurement session (screenshot of the Captotheque platform"

Faced with these measures, participants expressed astonishment, amazement and sometimes anxiety, especially during the "Dialogue" workshops dedicated to exchanges/debates or via the Facebook group. For certain participants, it was only after seeing or hearing the others that they imagined testing the cooking context, for whom this banal and positive action was initially far removed from any form of pollution.

In addition to measuring air during everyday actions, the participants also used the sensor to check whether the equipment in their homes was effective, verifying the Controlled Mechanical Ventilation of the extractor hood, the air purifier, the old or new wood-burner, the air-recycling in the car or the oven. Others took measurements when smoking tobacco, using candles or incense. While the high levels measured during cigarette ignition were not particularly surprising, those from the burning of incense or Armenian paper surprised those participants who use them regularly to "purify the air".

3.2.2.3. Road traffic

Road traffic and its impact on air quality were also the subject of numerous measurements. In particular, there were a large number of readings taken inside a vehicle and often referred to as being taken "outdoors". Indeed, these measurements were mostly aimed at measuring the direct impact of vehicles on the participant

himself and his passengers. However, measurements taken in these conditions are not representative of the concentrations present outside the vehicle (due to the presence of filtering and ventilation systems and other pollutants inside the car).

This observation once again illustrates the importance of accompanying participants throughout the experiment. For the vast majority of participants, these measurements caused great astonishment, due to the relatively low levels recorded. At the same time, measurements taken outdoors, near a busy or major road, also indicated generally low levels, marked nevertheless by "peaks" when certain vehicles passed by.

While some concluded that traffic is not such a significant source of pollution, others further questioned the effectiveness and reliability of the sensor. Exchanges/debates during the restitution workshop were able to place these measurements in context and clarify such interpretations by recalling, in particular, that the sensor records fine particles (but not ultrafine particles), while the main marker of traffic-related pollution is nitrogen dioxide (NO2).

Concerning traffic, some participants particularly enjoyed trying to measure the direct exhaust emissions produced by different types of vehicles, whether to demonstrate the impact of the type of fuel used, the actual influence of the Crit'Air sticker, the age or year of the vehicle's construction or the effectiveness or not of a particle filter. These particular participants then tried to establish a protocol to allow them to compare these different criteria in similar measurement environments.

Although very interesting and a demonstration of the potential of microsensors in such assessments, the exhaust measurements carried out by the participants do not allow to quantify vehicle emissions, due to the lack of strict protocol and adequate testing conditions. We did however note the strong interest of many participants in this type of experiment and in quantified data.

3.2.2.4. Wood-fired heating

An equally significant amount of measurements was carried out in the context of wood-fired heating, mainly by participants with high [knowledge/commitment] profiles. One can remark different types of measurements related to this theme: indoor air measurements when using a wood-burning appliance, outdoor measurements to assess the impact of their system on ambient air and more or less targeted measurements to evaluate the general impact of wood-fired heating on a neighbourhood or hamlet.

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Figure 34: Example of measurements around wood-fired heating, indoors

As described previously, the participants initially chose to record measurements in their immediate environment, especially on indoor air. The first tests concerning wood-fired heating began as such: "I wanted to see the impact my wood-burning appliance has on the air within my home."

These measurements, by far the more numerous on this theme, aimed primarily to verify whether or not one's own device actually emits particles. For those already aware of the emissions from this mode of heating, it was more a question of assessing the quality of the system as a whole, its installation and its use. In the understanding of the problem, some participants took the subject very seriously, trying different methods of fire-lighting, different types of appliances (recent wood-burning stoves and older systems with poor air circulation), open fireplaces, pellet stoves and even sessions dedicated to the maintenance and cleaning of the appliance.

These participants sometimes questioned some of their own personal habits, on discovering the impact of failed ignition or bad air circulation. Many made the comparison between ignition from below, traditionally practiced in France, and Nordic ignition from above. After more or less significant pitfalls, all of the participants seem convinced of the benefits of practicing the later, in terms of the emission of fine particles.

For some of them, the experiment then continued with outdoor measurements to assess the impact of their system on ambient air. Surprisingly, awareness of their own impact on the outside air was not immediate or shared by all. For those who did not simply take indoor measurements, the first reflex was to measure the impact of their neighbour's chimney on the ambient air of the neighbourhood. This approach illustrates a certain difficulty for each person to consider his or her own role in air pollution. The few participants who took the approach of individual questioning (going so far as to take measurements directly at their chimney exit), were able to observe a significant impact of their device and sometimes extremely high levels. They placed them in the same context as the high levels from the kitchen and questioned themselves on the health impacts of the different types of aerosol present in this particle mass.

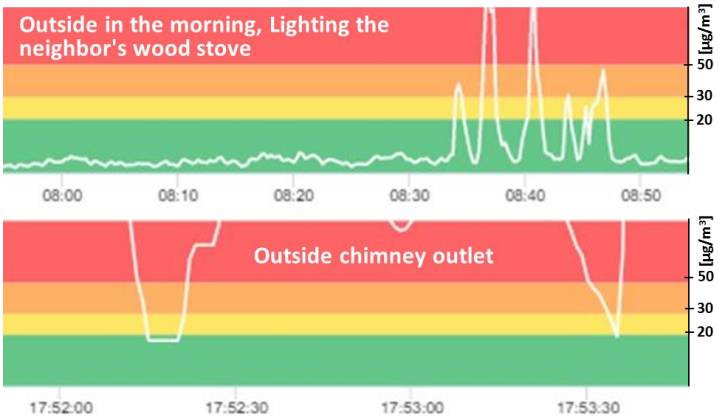

Figure 35: Example of measurements around wood-fired heating, outdoors

The measurements concerning wood-fired heating also enabled a number of people, including the inhabitants of the heights, to identify the presence of sources of pollution at altitude. They were able to identify that, although the base levels are indeed lower than on the valley floor, fine particulate matter could reach high levels, especially near working chimney breasts. By visualising the impact of wood-fired heating these participants were led to question their overall perception of the spatial distribution of particle pollution.

3.2.2.5. Controversial measurements

To the astonishment of the project team, few measurements concerning topics of territorial controversy, such as factories or HGV parking areas, were carried out. While only one of the 15 interviewees effectuated measurements around the incinerator, a total of 8 people among all participants effectuated readings around the incinerator and the industrial estate in Chedde.

However, when such measurements are taken, they must be put into context, as shown in Figure 36. Although they may indeed suggest that the yellow levels witnessed on 25th January 2019 in the vicinity of the Passy incinerator, indicate a direct source of pollution, if we compare them with measurements taken in Chedde at the same time, we realise that these levels are widespread. Measurements made a few days earlier showed levels very much in the green. Recontextualisation prior to interpretation is therefore essential.

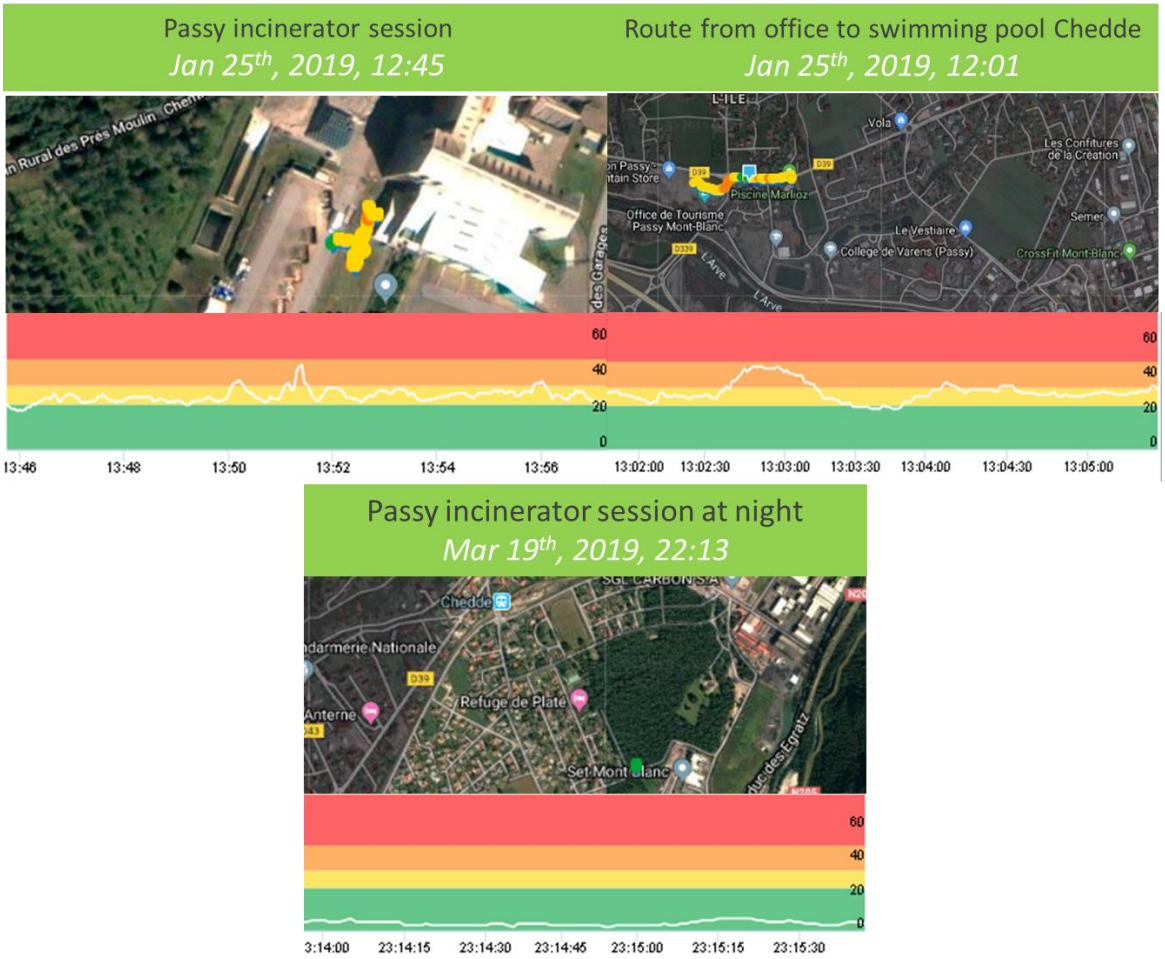

Figure 36: Examples of sessions within proximity of the incinerator

The sociological analysis, fuelled by the rhetoric of the participants themselves, explains several reasons for a lack of investment in such controversial measurements:

- Priority given to the immediate environment.
  Since the 15-day loan of the equipment was considered by the majority of the participants to be too short, priority was given to the measurements of daily life and the immediate environment. As a result, many did not have, or take the time to, investigate measurements in the industrial context.
- Fear of deviating from the rule of confidentiality.
  Since the emphasis was placed during the training session on the non-appointment of an individual or corporate body for reasons of prejudice, certain volunteers carried out such measurements without qualifying them as such.
- Certainties that do not necessitate verification.
  Some participants did not feel the need to take measurements around these two controversial sites because their certainty concerning these sources of pollution was unwavering.
  Opportunistic measurements to “see for yourself”.
  For those who did explore this measurement context, their main objective was to check for themselves the information diffused. One volunteer claims to have taken measurements around the incinerator for the sole purpose of “making up his own mind”, after hearing discordant information concerning this site.

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Of the 8 people who evoked this measurement context during the restitution session, it was mainly the fact that they were in the vicinity that encouraged them to take readings: on a trip to the rubbish tip, on their way to a workshop on CCPMB premises or on the invitation to a friend's house.

- Questions raised concerning the use of the measurement readings.
  Apart from the so-called "controversial" sites, numerous measurements were carried out in the workplace. By not explicitly naming their companies, participants who sometimes encountered surprisingly high levels, questioned the possible use of the data to initiate discussions or even administrative procedures.

3.2.2.6. Spatial and temporal variations

Among the participants, some also sought to improve their knowledge on air quality and its link to environmental conditions (meteorology, altitude variations, temporal variation over the course of a day). These participants, particularly interested and motivated by the measuring procedure, demonstrated a rigorous and scientific approach, carrying out measurement sessions on the same route or at the same fixed point in varying conditions. With higher levels in the morning than in the evening, many were able to identify variations in base levels in the valley during the course of the day (Figure 37).

During the workshops or restitution sessions, elements were introduced concerning the combined role of the pollution source and the thermal inversion layer, whose elevation in the atmosphere varies during the day. This was hence an opportunity to discuss indoor measurements and to indicate that it is always better to ventilate your dwelling by favouring a time lapse when the thermal inversion layer is higher and/or the dilution of pollutant concentrations is greater.

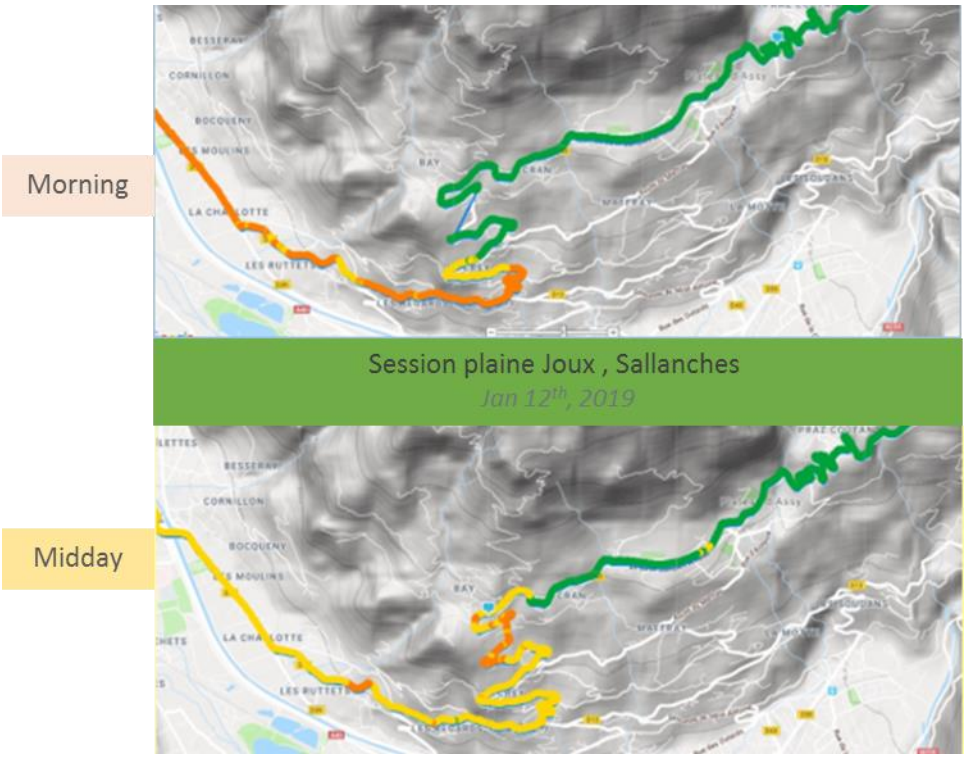

Figure 37: Measurements made by a participant on the same route, at two different times on the same day, illustrate the elevation of the inversion layer and the dilution of pollutant concentrations during the course of the day

Others were also able to identify the major role of weather, in addition to sources, on the concentrations of fine particulate matter. Rainfall leads to very low or zero levels when more stable and sunny conditions favour the development of the thermal inversion phenomenon, resulting in a greater accumulation of pollutants and an increase in levels. The sessions, conducted by the same participant on the same route, 3 days in a row, illustrate the dynamics of pollution and its complexity in space and time (Figure 38).

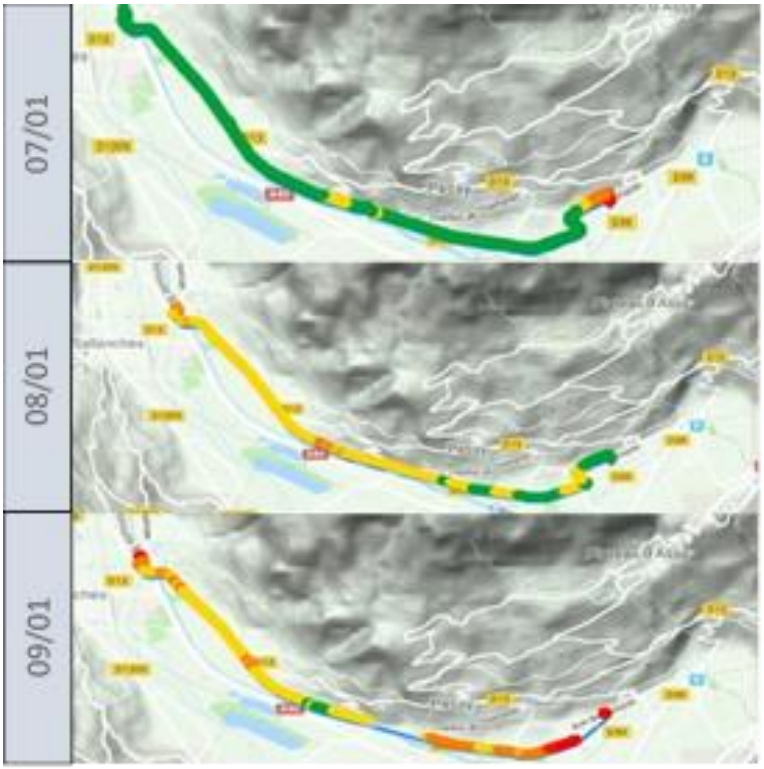

Figure 38: Measurements taken by the same participant, on the same route, 3 days in a row

The presentation of these various measurement sessions and their analysis during the collaborative workshops enabled other participants to understand the complexity of pollution and the spatial-temporal dynamics that depend on numerous environmental factors. This was also an opportunity for some to question their perception of pollution as an inert mass, stable and permanent, clinging to the bottom of the valley.

3.2.2.7. Review of measurement contexts

A wide variety of measurement contexts can be found among all participants and all "profiles". If the higher profiles achieve quantitatively more sessions than the lower profiles, this is not due to a greater diversity of contexts tested but more how to take the measurements and exploit them: the more knowledgeable and scientifically minded seek to put a protocol in place, repeating and comparing the measurements to try to find the variables that influence the levels, whilst the more novice and curious strive to discover the sources, in the multiplication of different contexts.

Finally, relatively few measures were taken "outside everyday life". Participants remained in their close, familiar and usual environment and did not attempt to measure pollution in specific or atypical locations. Consequently, the more original measurements such as ski waxing, the ascent of the Aiguille du Midi or paragliding, were carried out by participants who normally practice these activities.

To conclude this part of the review concerning the analysis of measurements, one notes a feeling of surprise shared by many of the participants, when faced with values generally lower than they had imagined. In individual interviews during equipment restitution, almost half of the volunteers spontaneously express their surprise.

The sociological analysis reconsiders this finding and explains it primarily by the catastrophic vision of the situation that participants had ahead of the experiment and who imagined that the colour red would be largely predominant in their measurement readings. Some of them realise that they have not necessarily experienced episodes of pollution during the period in which they were in possession of the sensor, that values can vary greatly during the same winter season and depend on multiple parameters.

Others, having been in possession of the sensor during episodes of pollution, are surprised that the readings were not higher, in view of the forecasts made by Atmo AuRA. For them, it is important to review the method used by forecasters as well as the differences and links between the colours, values and indicators available on the various tools used to produce and diffuse data. Similarly, it is important to remember that daily variations result in a decrease in pollutant concentrations during the day and a rise in the thermal inversion layer.

Regarding the reaction of participants to their measurement readings, we also noticed a link between the number of measurement sessions carried out and the global pollutant concentration levels across the territory.

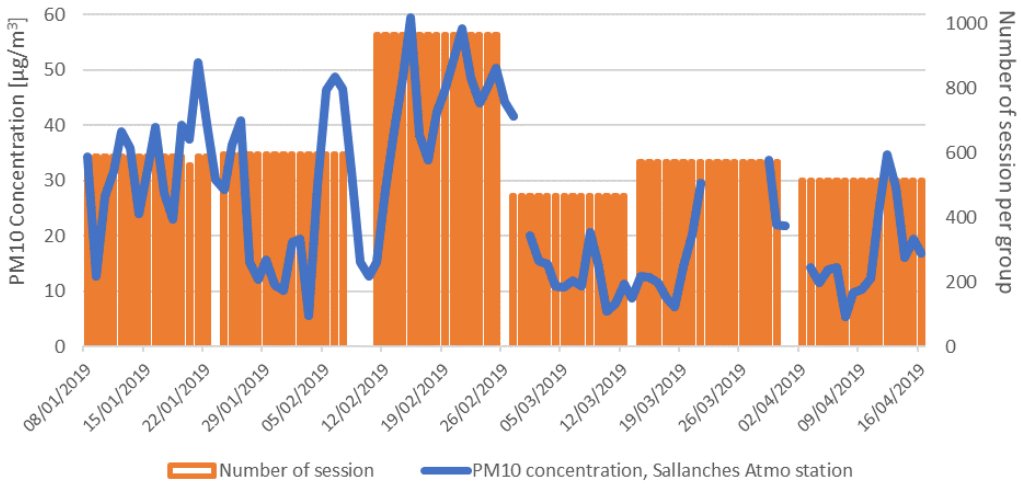

Figure 39: Number of sessions conducted per group of participants (in orange) and daily PM10 pollutant concentrations measured at the observatory station in Sallanches (in blue)

In Figure 39, which demonstrates the number of sessions conducted per group of participants (in orange) and the daily PM10 pollutant concentrations measured at the observatory station in Sallanches (in blue) over the same period, one can remark that group 3 (loan of equipment from 11th to 25th February) performed the highest number of sessions. Yet, it was during this period that the highest levels of fine particulate matter were registered in the Arve Valley, resulting in a pollution alert (yellow to red alert) for several days.

Conversely, during loan session 4 (from 27th February to 18th March), when the lowest readings were registered by official observatory stations across the territory, the participants performed the least measurement sessions.

It can thus be assumed that the announcement of an episode of pollution encourages the measuring process. One must not forget that the motivation specific to each participant can also impact the collective dynamics and influence the number of measurement readings within a group.

Volunteers naturally express some frustration when they failed to measure high levels. One can observe the disappointment of not being able to "prove" or "denounce" the pollution or enjoy the fun aspect of the measurement process that results in a kind of hunt “for fine particles" and the colour “red”!

3.3. PARTICULARLY INTERESTING EXPERIENCES

In this paragraph, we wish to recount the testimonies of some participants whose experience of measurement reading and whose general participation in this project was particularly interesting and enriching. The anecdotes below illustrate the importance of the individual measurement experiment for some citizens, its role in raising awareness and encouraging action in everyday life.

3.3.1. AMBASSADORS OF WOOD-FIRED HEATING

Male, age 34: By carrying out a very large number of tests around wood-fired heating, in indoor and outdoor air (more than half of his sessions), this particular participant was the most interested in this theme. He even climbed onto the roof of his house and that of his neighbour to measure direct emissions from the chimney pots. He also carried out several tests by varying air circulation as well as trying ignition from above. His indoor measurements enabled him to detect a leak in the duct of his wood-burner, which he had repaired in the process.

Male, age 27: A wood-burning stove installation professional, this participant tested different types of appliances (old generation/new generation, various strengths and yields), different species of wood and the impact of ignition from above compared to the more conventional process. He then took the experience even further, testing all the devices he had access to as part of his work. After a discussion with his boss he proposed to participate in the construction of a demonstration wood-burning stove to be used in participatory workshops to demonstrate the impact of good practices on emissions (dirty glass, presence of smoke) and on the levels of fine particles that result.

3.3.2. THE IMPLEMENTATION OF A MEASUREMENT PROTOCOL

Female, age 37: This particular participant was recognised for her rigour and scientific approach, demonstrated throughout her experience. Using a small notebook, she observed and assiduously recorded the weather, a precise description of her environment, the potential sources of pollution she could identify, as well as the average and maximum value for each of the parameters measured by the microsensor. These notes and observations enabled her to understand numerous phenomena and enriched discussions during different workshops and the restitution interview.

Male, age 57: Employed in the “décolletage” industry, this participant initially wanted to take measurements at his clients’ to raise awareness and encourage them to take action to minimise worker exposure. Unfortunately, he experienced problems with the sensor and the smartphone application (sessions that stopped after 10 minutes, sessions that failed to register or disappeared from the app). He therefore chose to base his experiment on this particular problematic, to help us identify the different possible bugs by creating a document listing the problems he encountered and the associated technical details. He did however make some very interesting measurements within “décolletage” companies, with the agreement and interest of the managers concerned.

3.3.3. PARTICIPATIVE ACTIONS/COMMITMENT

Female, age 44 and Female, age 37: Two long-time friends enrolled in the experiment together and performed a very large number of measurements. They worked as a team to carry out as many readings as possible within their municipality, in the attempt to best define particulate pollution. They also involved the Mayor of their commune of residence, the schools and the inhabitants of the different neighbourhoods where they took measurements.

Female, age 42: This participant communicated on a broad scale with her entourage regarding the project. She involved her family, her colleagues and especially her children's school. She even organised a workshop with the junior schoolteacher where she demonstrated the microsensor. Every morning since her demonstration, the children consult the local Atmo index in class.

Through individual experience as well as through meetings with various experts, these participants demonstrated a particular rigour, true scientists looking to deepen their knowledge of a subject. They reveal themselves as good ambassadors of the theme, possessing the capacity to arouse the interest of others and successfully diffuse information. A participatory measurement project carried out in Rennes was able to establish that an ambassador affects an average of 30 people in his/her entourage, illustrating the potential impact in the diffusion of the measurement experience.

3.4. THE LEARNINGS

As mentioned above, this experience is the origin of numerous learnings for both the participants and the project organisers. In the following section, we will endeavour to present some of these learnings, identified in particular by the analysis of the individual interviews that took place during the restitution of equipment.

The feedback questionnaire, distributed to all participants at the end of the project, also nourishes this analysis with the volunteers' feelings and perceptions of the different aspects and elements of the project. As for the partners involved in the organisation of the project, these learnings are more related to the initial objectives established ahead of the experiment and the desire to resume dialogue and trust between citizens and local stakeholders. For Atmo AuRA, these learnings are defined in the development of the future Captotheque facility on a regional scale.

3.4.1. FOR THE PARTICIPANTS

3.4.1.1. From surprise to discovery

Surprise, defined as a reaction to an unexpected situation, corresponds in this experiment to particularly high or low readings in situations where participants expected to obtain the opposite results.

Surprise was the reaction most expressed by volunteers, especially in the case of extreme levels observed in everyday contexts, such as cooking, the use of candles or incense and the waxing of skis - cases that participants sometimes did not even suspect could be the cause of any pollution.

For some of them, the discovery of such levels of fine particles within their daily lives and their most intimate environment was a source of anxiety. Often, the inability to interpret the data leads to a lack of understanding of the phenomenon and therefore a sense of fear.

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Similarly, the presence of pollution at altitude was also the subject of great surprise, mainly for the people living in these areas, who thought they were completely protected from the pollution in the valley floor.

Conversely, the relatively low levels measured near vehicles or inside cars compared to what they had imagined, also largely surprised participants, especially those who were unaware of the variety of pollutants and their sources.

In this context, measurements that reveal lower levels than the initial representation, readings taken around industrial sites and factories have, beyond the surprise, aroused doubts and scepticism among some of our participants.

Different from surprise, discovery is an action of awareness of a reality that was previously unconsidered. Discovery is shown here in a context of curiosity and interest in measurement readings, prompting reflection, ideas of tests and experimentation to confirm or disprove certain beliefs.

For many participants, this experiment was above all a great source of discovery, especially with regard to pollution sources within the territory. For example, during the individual exchanges on equipment restitution, 15 out of 130 people declared to have discovered that wood was a source of pollution, 11.5% of all participants. These people were those who, before the experiment, were sceptical on the subject, not believing in the information published around wood-fired heating or simply without an opinion on the subject, having never considered the question.

Of the 15 people interviewed by the sociologist, 3 were sceptical about the information published on wood-fired heating. If one of them has changed paradigm and today positions wood as the primary source of fine particles during winter, the other two admit the weight of this heating source but remain very sceptical concerning the figures provided.

This scepticism can be explained, in particular, by a lack of understanding of the message that wood is still the main cause of pollution, but which is accompanied by a political subsidy scheme for this mode of heating. This questioning of the Air Bois Fund (a scheme to help renew non-performing wood-fired heating systems) is also present amongst certain participants, those most convinced by the impact of wood-fired heating.

In particular, they do not understand why financial aid is not accorded in the event of a change for another type of energy. They are also very concerned about the lack of legislation and control in this domain, as is the case for gas or fuel boilers, as well the disparities in regulations between neighbouring countries, particularly between France and Switzerland.

3.4.1.2. Complexification of perception (due to a better understanding of phenomena)

While all participants made discoveries or were actually surprised during the course of the experiment, many of them were also able to deepen and refine their knowledge. Evoked by a vast majority, the complexification of the subject and the re-examination of a simplified vision of the theme, is pervasive. This complexification is also visible and quantifiable from the subject knowledge self-assessment exercise, carried out by participants, pre and post experiment. With averages of 4.49/5 and 3.56/5 respectively, we can see that the knowledge score that participants accord themselves post experiment is slightly lower than at the start. This complexification of the subject is even more significant if we analyse individual evolution, according to profile.

The following image demonstrates how the participants adjusted (or not) the score they assigned to their own level of post-experience knowledge: The X-axis describing the points added or not to their score.

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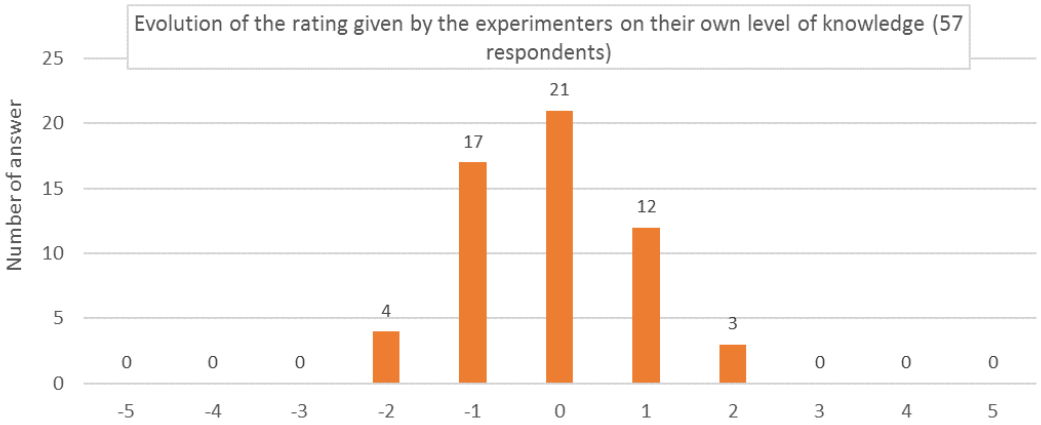

Figure 40: Evolution of the self-assessed knowledge score before and after the experiment

As shown in Figure 40, more people lower their self-assessment score compared to those who increase it (21 versus 15). In fact, it turns out that the participants who dropped their score by 1 or 2 points were those who scored 4 to 5 before participating in the experiment. Participants who increased their score by 1 or 2 points, were those who scored 2 to 3 prior to the experiment.

This interesting development demonstrates that novice participants prior to the project are aware of their gain in competence and that those who considered themselves to be perfectly familiar realise that the subject of air quality is more complex than they had imagined and that they may not master it that well after all.

Hence, participants have improved their knowledge of certain specific topics or complex air quality phenomena. This is particularly the case concerning the spatial-temporal variability of pollution and the multiple parameters that can influence the levels of fine particles in ambient air (altitude, meteorology, presence of nearby sources of pollution etc.).

Prior to the experiment, the participants shared the vision of pollution in the valley floor as homogeneous in its composition and temporality. The presence of sources of pollution at altitude, the role of the thermal inversion phenomenon and its evolution during the day, as well as the wide variety of pollutants, are among the major themes most investigated by volunteers.

They also realised that air pollution presents different forms (indoors, outdoors), that the molecules that compose it are complex, numerous and not yet well known scientifically (notably the question of toxicity and/or a cocktail effect), and that it varies depending on the season and the territory.

The discovery and understanding of the various stakeholders involved in air quality monitoring are also important aspects of the experience for many participants, especially among the most knowledgeable. For some people, even if they were aware of the existence of Atmo AuRA, its internal functioning, its stakeholders and its place within local territory were either unknown or very unclear.

This experiment enabled a number of volunteers to learn more about the structure, meet the professionals involved and further understand the organisation behind air monitoring (current regulations, measurement network structure, methodology of forecasting, the modelling and determination of the air quality index across the territory).

The various workshops, as well as the multiple exchange/debates between Atmo AuRA staff and the participants, played a crucial role in the reconsideration of this structure. For some, it increased their confidence in the association.

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Similarly, the majority of participants did not appear to be aware of the actions taken by the CCPMB to improve air quality in the Arve Valley. Many discovered such actions during the experiment, surveys and/or in their approach of industries (the study on pollutants emitted by “décolletage” industrial plants, filter installation and financial subsidies etc.) and thus reconsidered their view of a negative or passive territorial policy in this matter.

Air quality is henceforth considered more accurately by the majority of participants as a very complex, dynamic and versatile subject of which our knowledge, limited by existing technical and scientific means, is constantly evolving.

3.4.1.3. The figures to prove it

The experience of measurement is also a source of satisfaction for participants, especially when the measurements confirm their ideas, opinions or perceptions. This was mainly the case among those participants who, with the sensor and the figures, were able to see for themselves that wood-fired heating was a source of pollution.

8 out of 15 are satisfied to have been able to prove through this experience that their opinion was consistent with the terrain, despite previous discordant information or a sceptical family entourage.

On the return of equipment, one volunteer confided "*It enabled to raise awareness, particularly as concerns my in-laws who were a little reluctant as to pollution caused by wood-fired heating. We did some tests on the chimney breast inside and out. Not very open-minded, they didn’t believe that their chimney was a source of pollution. Well, they were very surprised!*”

Those citizens who participated in the experiment now possess scientific arguments, evidence obtained through the taking of measurements and scientific resources that enable them to position themselves in different debates, whether they are family-orientated, professional, associative or political. Participants now feel legitimate to give an opinion or criticise the information provided and to position themselves in the political debate, issuing an opinion on the regulations, the actions in place and the local stakeholders.

3.4.1.4. An interpretation of the measurements that sometimes proves difficult

Although the experimentation improved the knowledge of all participants, the measurement experience also raises many unanswered questions. Indeed, certain participants express their desire to be able to obtain explanations for each of their measurements, especially for the more significant, in terms of the levels measured. They admit to having sometimes felt helpless in the face of the measurements taken and the concentrations observed.

Knowing the numbers and the associated colour is no longer sufficient, participants are looking for accurate information concerning the toxicity of the particles they measure at any one time. High measurements in household air are the main cause of a feeling of confusion and incomprehension, sometimes leading to situations of stress or misinterpretation.

To manage this anxiety, some participants reported that they tried to implement instant actions in order to radically change the situation. This is the case of one particular participant who, on observing an increase in particles within the home at the time of aeration, decided to no longer air the house during peak pollution periods.

More than anxiety, for some participants the experience brought pain, guilt and disarray. In these moments, an exchange with experts is essential to put things back in context.

Another participant became interested in pollution when a member of her family developed a serious illness, a few years after their arrival in the valley. Her participation in different workshops and the measurements she carried out in various contexts (during and in the absence of pollution peaks), added to her existing sentiment of anxiety in the face of pollution. Her participation enabled her to materialise pollution (visualisation of graphs, colours, high rates of pollution) and to become aware of the territorial geographical context unfavourable to the dispersion of emissions.

Although numerous discussions on health matters took place between the project team and participants, these specific themes are still at the forefront of scientific research and remain very complex.

The intervention of health professionals, such as toxicologists, epidemiologists or respiratory disease specialists, could further nourish these thoughts and questions. A meeting was in fact previously organised by the CCPMB to enable citizens to exchange with experts in the field, on the occasion of the JNQA conferences in 2018.

One did however note a difference in reaction amidst the different profiles [knowledge/commitment]. If the lowest profiles do not feel able to interpret the measurements and are therefore subject to feelings of anxiety and stress, the most knowledgeable seek to put the measurement levels into context, seeking their origin by comparing them with others.

Another difficulty in the interpretation of the results is the correlation between the values measured using the microsensor and those announced on the Atmo AuRA site (in reality, a multi-pollutant index and not a concentration index like the one measured). About 15 people amongst the participants said they wanted to make this comparison and were puzzled when faced with the incoherence between the two values.

While the explanation given during the dialogue workshop or during the individual restitution sessions helped to explain this difference and make it acceptable to the participant, this lack of correlation often led to the questioning of the sensor reliability at the time of measurement. It is interesting to note that a difficulty to appropriate the Atmo index concerns the 3/3 profiles, the most novice profiles not yet being aware of value comparison logic.

Similarly, the interpretation of the colour code, more frequently viewed and considered than concentration values, was confusing for some participants.

Indeed, if a colour code is a recognised means of enabling participants to become the actor of their measurements by allowing them, in the context of this project, to gain an idea of the danger associated to the measured levels, their personal interpretation is subject to a certain subjectivity, specific to each and every volunteer. People have different levels of tolerance to colours: for some, danger is only present when the colour is red, while for others, overrunning green demonstrates a danger.

Volunteers who relied mainly on the proposed colour codes, interpreted or reacted to the measurements in a variety of ways, sometimes inaccurate. Listening to the restitution sessions, it appears, for example, that 3 participants were reassured concerning their measurements. However, after discussion and analysis, their rates revealed to be relatively high. Relying only on colours, they failed to correctly assess the levels of pollution.

The support of volunteer citizens in their experience of measuring air quality is again essential to assist them in their interpretation of measurements. Although ongoing technical support was in place throughout the

project, it was impossible to respond individually to all participants concerning the measurements they carried out.

The Dialogue workshops and the one-on-one restitution sessions were therefore an opportunity for many participants to ask questions and seek precise and scientific answers. The new version of the Captotheque platform aims to provide collective support, directly via the exchange platform, seeking to optimise the need for exchange and precision concerning the measurements effectuated.

Although some participants appeared troubled in their interpretation of the results, it is important to note that all volunteers found themselves, at least once, searching for the origin of the pollution.

Unlike other experiments, where the sensor does not offer immediate visualisation of the measurement reading, the fact that the volunteers were able to see the levels immediately made them more proactive in their approach. Instant colours or measurement readings allow participants to consider the origin of the source of pollution and look for influential parameters.

In 2012, Airparif demonstrated that during a citizen sensor loan experiment, using a device that does not enable instant visualisation of measurements, that participants failed to appropriate the topic and were not in a process of research. They remained distant from the subject despite being motivated at the start.

3.4.1.5. A social marker

For many of the experimenters, the sensor was not only a measuring tool but also the symbol of belonging to a citizen experiment project. By hanging it from their bag or positioning it in a visible way, they demonstrated that they are acting on the problem by participating in a new experience.

The microsensor thus assumes the role of social marker and becomes a distinctive sign of an active group. Consequently, many participants left the tool prominent in their workplace for the sole purpose of drawing attention, encouraging remarks and/or questions from their colleagues. Some participants even recognised each other at the school gates, sensors attached to their bags.

While the measuring experience was primarily an individual one, it often extended into discussions and debates within the home and social circles. The experience had considerable impact in the entourage of the volunteers: each participant discussed it with at least 1 person within the family, the neighbourhood, professional circles or school environment. Participants thus position themselves as mediators, diffusing the knowledge acquired and communicating around the experience.

Overall, this experience led to a true increase in knowledge on the topic of air quality for all participants involved. This is due to a combination of factors and to a scheme that combines both individual and collective dynamics, that one may resume as follows:

1- An individual approach to taking action
2- A primary individual reflection on the interpretation and understanding of these measurements
3- A collective approach through exchanges and debates, sharing ideas and good practices in workshops and on virtual exchange platforms
4- An individual and collective approach to learning alongside experts. The combination of visual data, interpretations, research and participative workshops form a rigorous support system in the learning process.

It is this combination of “visual data – interpretations – learning – research – workshops” that forms a rigorous framework to assist the gain in knowledge.

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3.4.2. FOR THE PROJECT PARTNERS

For the project partners, Atmo Auvergne-Rhône-Alpes and the CCPMB, the aim of the experience was to recreate a dialogue between local stakeholders and the population on the theme of air quality, by enabling the latter to endorse the topic and improve their knowledge of this complex subject.

In many respects, this project is a success, and has enabled the expected increase in knowledge. However, it has limitations that we will endeavour to describe in the following section. For Atmo Auvergne-Rhône-Alpes, these learnings also concern improvements to the Captotheque facility.

3.4.2.1. Appropriation of air quality issues

It is mainly on this point that the success of the project is illustrated. Through the action of measurement, as well as in the context of reflection and collective exchange, all participants appropriate the problem, ranging from discovery for some to the understanding of complex phenomena for others.

The fun aspect of the experiment made it possible to dramatise the problem (without minimising it), and to approach it from a scientific point of view, with rationality and not emotion. In this case, the individual sensor embodies the supporting object of this understanding and is thus the key element to its adoption.

The successful appropriation of the theme was also favoured by the establishment of a certain trust between the organisers and the participants, made possible by the absence of sanctimonious and denunciatory speeches that target one source of pollution rather than another, by avoiding certain sensitive subjects and by not seeking to impose a particular representation.

The entire technical and human scheme was designed and built with a desire for transparency and openness, leaving considerable room for the participant, his perception, his initial beliefs and his own objectives.

Throughout the project, each participant was the stakeholder in his experience of measurement, enriched by discussions and exchanges with other participants and experts.

Regarding the adoption of the theme by the largest number, especially people initially unaware and uncommitted to the subject, the method used nevertheless demonstrates certain limits.

Indeed, the experience only attracted people whose interest in the theme already existed. Although the volunteers differed in their level of knowledge and commitment, they were all people with an interest in the issue.

Concerning the continuation of the Captotheque facility, it would be useful to set up other means of communication and selection, especially in professional and sports circles, to reach people with different socio-economic profiles. One could also communicate on one of the related topics, such as new technologies, citizen participation or health, in order to reach people who may feel more concerned or interested in these issues. The educational project carried out in collaboration with high schools in Passy and Cluses, on the construction of a citizen microsensor observatory in the valley, is a step in this direction.

3.4.2.2. The improvement of public knowledge on issues concerning the use of wood-fired energy

The aspect of improving public knowledge on wood-energy issues was underlying in this project. Indeed, the aim was to make participants aware of the impact of wood-fired heating on air quality, while leaving them free in their choice of measurements and the contexts investigated.

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During the different moments of exchange as well as across the different digital discussion forums, this theme was not particularly highlighted in relation to the other sources of pollution present across the territory.

Naturally, all participants were able to identify, by themselves, an impact of wood-fired heating on the levels of fine particles present in ambient air, resulting in an increase of awareness or understanding of this problem. This understanding came mainly from discovery, when taking individual measurements, but also from exchange workshops between participants.

Good practices for a cleaner use of wood-fired heating were thus understood, tested by volunteers and adopted permanently by some. The strong interest of some participants on this theme, led them to request more information and advice on such practices. Consequently, in addition to the workshops promoting financial aid, different schemes or effective techniques to reduce particulate emissions, many would have appreciated further demonstrations in-situ and live educative sessions to learn the right gestures.

Figure 41: Publication by a female participant on the Facebook group "Exchange Captotheque"

Nevertheless, as mentioned earlier, this awareness has led to incomprehension among volunteers concerning the way the problem is managed at territorial level, in particular with regard to the non-application of regulations during episodes of pollution (additional wood-fired heating forbidden or the shutdown of factories) and the grants allocated under the Air Bois Fund.

The exchanges that took place during the workshops also served as a reminder of the balance that exists between taking into account sustainable energy management and the evaluation of the impacts on health. The other unexpected effect of the experiment was the reconsideration, by some, of a project to purchase wood-fired heating equipment or even more radically, the abrupt cessation of the use of this mode of energy. However, the potential short-term and long-term impacts of the project will require reassessment at a later date.

3.4.2.3. *The re-creation of dialogue and trust*

The main objective of this project was to recreate a dialogue of trust between the different stakeholders across the territory. For the CCPMB, the project aimed at promoting the recognition of political actions to improve air quality across the territory. For Atmo Auvergne-Rhône-Alpes it aimed at restoring public confidence in the association and its work to monitor air quality. Both were able to learn from the experience and benefit in different ways.

For Atmo Auvergne-Rhône-Alpes, the objective to create places and times of dialogue was particularly successful. The experience enabled a "demystification" of this institution through meetings with experts, the possibility to discover its function, its organisation, the forecasting system and measurement devices. The majority of volunteers became aware of the work done within the association, in terms of its regulatory and complementary objectives but also in terms of its limits.

Project participants were themselves able to verify the integrity of professionals and banish the image of a corrupt structure at the service of politicians and industrialists. It is however necessary to further redefine the association's role in specific issues related to the impact on general health, on which the participants would have liked to obtain more information.

For the CCPMB, the success of the experiment lies in the aspect of public and citizen mobilisation. The running of collective workshops and debates in a political venue such as the CCPMB favours a climate of trust, a positive note in the light of the prevailing territorial context (news and demonstrations). Many participants also discovered the territorial actions currently in place to combat pollution in the valley and were able to deepen their knowledge on the subject.

As desired by numerous participants, more direct exchanges with elected representatives would have allowed one to go even further in this process of resuming dialogue and creating a common citizen dynamic. Such exchanges could also have further contributed to changing the belief of a lack of involvement and commitment on their part concerning the issue of air pollution.

The presence and intervention of elected officials at the final event was greatly appreciated by the participants who were able to exchange directly with them. This demonstrates the importance of greater participation of elected officials in this type of project.

It would be interesting to continue a collective experience across the territory in order to maintain the engagement and success of the BB-Clean project. Beyond the measurement experience, it is the involvement of citizens and their capacity as ambassadors that must be perpetuated, by directly involving volunteer citizens in future discussions. With this in mind, the CCPMB has established links with certain participants (via a citizen's list) to encourage debates, reflections and proposals for action to improve air quality across the territory.

3.4.3. CONCERNING THE CAPTOTHEQUE BY ATMO AURA

BB-Clean is one of the first projects led by Atmo Auvergne-Rhône-Alpes to involve citizen measurement participation. It is therefore the source of numerous learnings, to be taken into account for the future, particularly for the development of the Captotheque system at a regional level.

3.4.3.1. Adapting tools to broaden the audience

Although profiling and selection have allowed for diversity among experimenters, over-representation of certain socio-economic profiles occurs within the experiment.

It is therefore necessary to identify the limits of communication, of the chosen application and selection methods with regard to the objective of the programme to reach a wide variety of citizen profiles in order to enable global and collective awareness and increase in knowledge.

The microanalysis of socio-economic data shows that the chosen means of communication (social networks, communal communication, word of mouth) favoured those already accustomed to this type of collective or participatory project. Work remains to be done to reach all age groups and socio-professional categories. The sociological analysis proposes, primarily, to extend communication to other fields, such as the professional environment or leisure activities.

Similarly, the only source of registration being via the Captotheque IT platform, the experience is in fact more difficult to access by people less accustomed to computer systems, unequipped or unable to master these tools.

More oriented studies with prior non-digital registration (direct contact at the town hall, telephone survey, communication and collection of information from stands in public places such as markets or fairs...) and a more individual or question-oriented accompaniment should be considered.

However, one should be reminded that in this type of participatory project, non-digital alternatives are not always possible (measurement technology, data display etc.).

Work must therefore be carried out to adapt the tools, deployment and communication around the service and find new frameworks to broaden the audience.

3.4.3.2. Handling the tools

While the majority of BB-Clean participants are comfortable with new technologies, individual and collective support for the handling of the various tools proved necessary.

Group training sessions proved relevant and more effective for project managers than the method used in Mobicit'Air, individual face-to-face.

Although some people needed more help and support during their loan session, all participants left knowing how to take measurements using the sensor and how to record them using the Smartphone app. The collective and collaborative aspect of these sessions was also appreciated by the participants themselves, finding it enjoyable and a good opportunity to "meet new people".

Mutual aid between the participants was rapidly established during these sessions, the most technology-orientated willingly helping those less comfortable with this type of tool.

However, one should note that in terms of session organisation and management, certain limits were reached: the loan session could not be shortened or made available to more people at the same time.

Also, within the confines of this format, it is important to note that the Captotheque platform was presented very briefly during the loan session, mainly due to lack of time, which may explain its mixed use throughout the experiment.

A more in-depth presentation of the collaborative aspect and the knowledge sharing possibilities would surely allow those who simply viewed the data on their phone, to further participate in group dynamics proposed on the various online exchange forums (Captotheque platform and Facebook group).

To increase this particular aspect of citizen measurement programmes, Atmo Auvergne-Rhône-Alpes used this experience to improve the functionality of the new platform, in particular to facilitate virtual exchanges and discussions.

Finally, technical support during the fortnight sensor loan period was moderately used. On average, about one-third of participants requested additional technical assistance, with the number decreasing as loan sessions progressed (due to an overall improvement in the training session by the organisers). Additional support took the form of telephone back up, e-mail exchanges, individual appointments, exchanges on Facebook and even the organisation of "technical reminder" sessions for those who missed part of the training session or who wanted additional information (although necessary for the first loan sessions, “technical reminder” sessions were not systematically organised thereafter).

3.4.3.3. Recurrent technical problems and disadvantages

Various tool defects as well as technical problems, most of which were already known to the organisers, were raised by the participants and may have hindered certain volunteers in their measurements. Sensor operational problems, such as the bluetooth connection or GPS, occurred frequently. This is also the case concerning the lack of indication that the measurement session has indeed been transferred to the server. The absence of a microsensor battery charge indicator left some volunteers frustrated when the sensor cut out in the middle of a measurement session as did the lack of information on the toxicity of the levels measured at the moment T. The Tag system, which aimed to provide a primary method of measurement classification on the platform, proved imperfect and, as a result, was not used much by the participants. Some found the system complicated to use (manual entry of the tag at the time of recording) and too imprecise for effective analysis in the future. One again notes the desire for access to a more advanced protocol and measurement methodology to make measurements more comparable to each other and therefore more useful. These comments have been taken into account and are integrated in the new features of the Captotheque.

3.4.3.4. Individual support

The individual accompaniment of participants throughout the experiment proved essential to the success of the project but also very time-consuming. Accompaniment took the form of technical support by telephone, exchanges by email with the project team and above all 30 minute-long individual interviews on restitution of the equipment.

The sensor restitution session was an important event for participants, considered an opportunity to ask questions, confide their doubts and voice their opinions. Overall, the volunteers found the allocated time too short to allow for a constructive exchange. Aware of being the first to participate in this particular experience, they clearly wished to make suggestions for improvement to the programme, the sensor and the application.

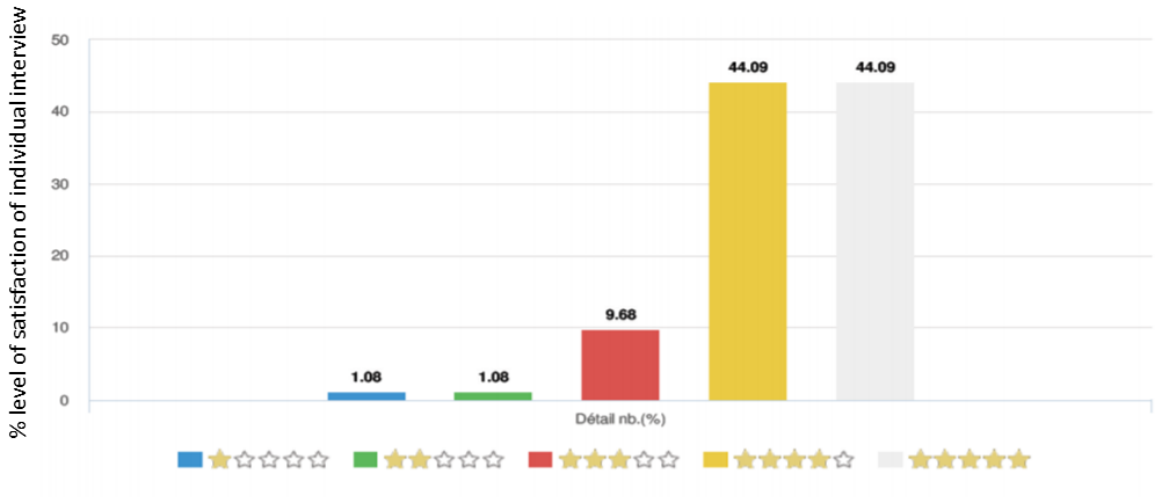

Figure 42: Level of satisfaction of participants concerning the individual restitution interview

While these individual interviews were perceived in a positive manner by the participants (Figure 42), they also contributed to the development of a climate of trust between organisers and volunteers, far greater and more personal than during collective sessions.

Nevertheless, more than 75 hours were spent on these interviews. In the eventuality of a Captotheque facility at regional level, it appears necessary to reconsider the format of these restitution sessions.

The analysis carried out from listening to the recordings also indicates that the interviews are all relatively similar. One can quite easily make a list of the main questions and topics of discussion that arise regularly during these moments of exchange. This observation leads us to envisage collective restitution sessions covering the identified themes, based on the same format as the DIALOGUE workshops, enabling all volunteers to participate.

3.4.3.5. Group workshops

As mentioned, numerous times, a support scheme is necessary to allow each participant to interpret his/her own measurements in an optimal context. If the restitution session partly meets this requirement, complementary workshops also fulfilled this need, while making it possible to provide further knowledge and to create collective group dynamics.

DIALOGUE workshops particularly appealed to the participants, with the number of people present at each session, ranging from 12 to 22. Exchanges with other participants and experts gave volunteers different measurement ideas and contexts to test, tips and practical advice with regards to wood-fired heating. Above all, it is during these moments of discussion that participants learnt the most about the actions in place to reduce pollution across the territory.

Among the various COMPREHENSION workshops, the first workshop, "Understanding Measurement", was particularly appreciated. The second workshop, on emissions and modelling, proved a little too complex for some participants whilst the 3rd workshop, on managing an episode of pollution, also pleased participants by its "role-play" aspect.

Concerning ACTION workshops, the workshop "How to talk to children about air quality" was the most successful. Indeed, the fun family approach allowed for children to be present and actively participate in their parent's experience.

Conversely, the COMPARISON workshop, designed as a collective measurement course, did not attract the participants and had to be cancelled twice due to a lack of participation, the bad weather having surely contributed. Certain participants expressed very little interest in this workshop (it proposed to carry out a measurement protocol that everyone could already carry out alone).

A session dedicated to children, in the form of an orienteering course or a "fine particle hunt", could be considered to attract more people. Finally, the workshop on "good practices" for better wood-fired heating also had good returns, although the lack of live demonstrations was regrettable.

Unsurprisingly, one remarks that the workshops involving practical participation appeal most to participants. Similarly, the presence of local experts and representatives is essential to an increase in public knowledge and the establishment of a local collective dynamic, one of trust and action.

One should note that participation in these workshops never exceeded 20 people. Analysis of the post-project final evaluation questionnaire allows us to identify the main reasons for such an average participation.

- Lack of time: the measurement experiments, the equipment loan session and the restitution session, already required a lot of time. Many of the participants did not have the time to participate further. The development of virtual content, accessible online (recordings of workshops, written reports ...) or even live filmed lectures have been proposed and will be considered in the context of future developments.
- The issue of child care. The question of the possibility to assist sessions with children came up very frequently during the project. It would therefore be interesting to reflect on proposals for collective child care during these workshops. One could imagine the children attending a parallel awareness workshop conducted by the CCPMB, similar to those that they organise in schools.

It is important to note, with regard to these collective workshops, that the most novice and least committed participants were difficult to mobilise. "Low" profiles attended far less than "high" profiles. The sociological analysis offers several explanations for the low participation of these volunteers:

- the discovery of a subject involving self-censorship or their illegitimacy to debate on the issue
- a different time scale, in order to appreciate the subject: to discover for oneself in the first instance, followed by the opportunity to participate in exchanges and debates (which is not the case in this experience).

In order to further involve this particular profile of participant, several options could be considered: to solicit them individually (by SMS, telephone etc.); to adapt the content of the workshops according to their levels of knowledge (conduct 2 workshops on the same subject with different content).

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4. CONCLUSION AND FUTURE PERSPECTIVES

Conceived as a means, a tool and place of dialogue, the BB-Clean programme, a French citizen experimentation, aimed to re-establish a situation of trust between citizens, experts, local stakeholders and political figures by encouraging regular citizens to adopt the theme of air quality and increase their knowledge on the use of wood-fired energy.

Consequently, the primary expectation was to determine whether citizens, equipped with the necessary tools, could adopt the problems of local atmospheric pollution by further understanding territorial phenomena, thus encouraging them to broadly reflect on individual and collective behaviour that could contribute to improving the situation.

To this end, a scheme for the loan of citizen fine particle microsensors, as well as technical and sociological support, was put in place across CCPMB territory throughout the winter of 2019, based on the Atmo Auvergne-Rhône-Alpes Captotheque facility.

More than 150 citizens took part in the project, freely experimenting with air quality measurements and participating in various workshops and discussions. This experience allowed them to improve their understanding of the phenomena observed and strengthen their general knowledge on the topic.

While the 153 participants experienced the measuring process in their own individual way, all volunteers were able to grasp the theme by experimenting with particle measurement in multiple contexts and situations. From cooking to the waxing of the skis, they were able to identify the impact of everyday actions, thought to be harmless.

Outdoors, they endeavoured to test various traffic or industrial related contexts. Some enhanced their experience by measuring variations in fine particulate matter levels at different altitudes, in different weather contexts and at different times of the day, in order to identify the main factors that influence the concentration of fine particles in ambient air.

Wood-fired heating was also extensively tested by the participants, whether it be the indoor air around their own appliances or outdoors in their neighbourhood, within the proximity of working chimneys. All were able to identify the impact of wood-fired heating, and the role of associated good practices, on the quality of the air.

Beyond the measurement process, the different exchange times proposed throughout the experiment (training sessions, group workshops, individual interviews) enabled participants to fully grasp the theme and to develop their understanding of complex subjects. The different discussions, amongst participants, or between experts and volunteers, have all been rich in learning and sharing.

The experience increases the volunteers' desire to develop and improve their knowledge on the topic. They become aware of their immediate environment, looking for sources of pollution when faced with an unusual smell. They observe the colour of smoke and attempt to analyse the weather conditions. They are thus more involved in a process of observation, research and interpretation.

After participating in this experiment, many volunteers desire to take further individual action. They are in demand of support in the implementation of behavioural changes or of more global reflection on improving air quality.

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Beyond the BB-Clean experience, many of them wish for further discussions and workshops to present and demonstrate good practices for the use of wood-fired heating. They question themselves on transport issues and alternative modes of soft mobility, in both practical and financial terms (grants for a change of vehicle, the development of cycle paths, improvements in infrastructure and assistance in car “detachment”.

They also feel better equipped to take a stand in discussions on air quality issues and are therefore more motivated in their desire to take action, individually or with their fellow citizens.

The end of this citizen experiment consequently raises the question of its continuation across CCPMB territory. More than 57% of participants desire to get more involved, by investing themselves further in pollution issues, a logical follow-up to the experience.

Many hope that experimentation will continue in the area in the aim to reach other members of the public or to enable them to undertake a similar pollution measurement experience in the future using a device to capture other pollutants. More than 75% desire the creation of a citizens’ observatory on air quality, a place where fine particulate measurements taken by individuals could be stored and made accessible to population.

Finally, more than 95% are awaiting for actions to be taken as a result of this experiment. They hope that this particular project will serve the territory in concrete terms and will lead to wider citizen mobilisation and increased political and institutional efforts.

For Atmo Auvergne-Rhône-Alpes, the end of the BB-Clean experiment announces further fields of research and development for its regional Captotheque facility. It confirms enthusiasm and interest in such a device, to raise awareness and renew dialogue. Consequently, the feedback from these first experimental phases will continue to enrich the Captotheque facility before it is progressively proposed, in service mode, to all citizens of the Auvergne-Rhône-Alpes region.

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