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NEWS

PROJECT

DIAMS - Digital Alliance for Marseille Sustainability

Aix-Marseille Provence metropole, France

TOPIC

Air quality

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ZOOM – IN #2 - ENGAGEMENT OF CITIZENS AND STAKEHOLDERS IN THE FIGHT OF POOR AIR QUALITY: THE UIA-DIAMS APPROACH

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The UIA DIAMS project, led by the Aix-Marseille Métropole, aims to engage the different parts of the society to improve the policies related to air quality to eventually improve the air pollution levels by means of an open-source data-exchange platform focused on service delivery. Around the online platform, air quality data and services, a large engagement plan is designed to reach the different parts of the society to create a consciousness of the problem, favour changes in attitudes and look for democratic solutions. The second zoom-in report focus on the engagement plan that UIA DIAMS has built around the topic of poor urban air quality in the Aix-Marseille Métropole. The engagement plan of the UIA DIAMS project revolves around the idea of the citizen as agent of change. Air quality in many urban centres is poor and citizens are exposed to high-level of pollutants having an impact on their health. However, citizens have little information about the levels they are breathing, how this has an impact on their health, and have very little mechanisms to change this. The UIA DIAMS project aims to provide the right information to the citizens and local and regional stakeholders in the Aix-Marseille Métropole in a way they feel empowered to find the mechanisms to improve the air quality in the cities.

1. Background

Poor air quality is one of the most harmful environmental public health hazards and it is estimated to cause 400,000 premature deaths in Europe every year. Particle air pollution was ranked as the fifth leading risk factor for death in the world in 2015 (Cohen et al., 2017). The negative health impacts of particle exposure include respiratory and cardiovascular mortality and morbidity (e.g., aggravation of asthma, respiratory symptoms), type 2 diabetes, dementia and loss of cognitive function. A significant proportion of Europe's population lives in areas where air pollution exceeds both the legal limits and the ones recommended by the World Health Organization. This is especially true for cities, where population is exposed to elevated levels of particulate matter (PM) and nitrogen dioxide (NO2). And this is the case in cities in the Aix Marseille Metropole.

Although emissions of air pollutants have decreased substantially in Europe over recent decades, (e.g. Guerreiro et al. (2014)) poor air quality continues to harm human health and the environment. Policies to reduce ambient levels of pollutants exist at different levels, from the very local to the European and international wide. Most initiatives, policies and laws are designed by policy makers and governmental entities without involving implicitly the different parts of the society.

Empowering citizens and different stakeholders in the fight of poor air quality has been proved to be a valuable approach. These initiatives have been increasing in Europe in recent years and the UIA – DIAMS (DIgital Alliance for Aix-Marseille Sustainability) project, led by the Aix-Marseille Metropole (AMP), is one of the urban areas that have implemented a vast engagement program around the problem of air quality. This Zoom-In document aims to describe and analyze the public engagement approach followed by UIA-DIAMS, to get a suite of recommendations that other cities and entities can take in empowering citizens, students and stakeholders in the fight of poor air pollution.

2. The UIA – DIAMS engagement plan

One of the main axes of the UIA DIAMS project is the creation of the digital platform were data and services of air quality are centralized. The project oversees data and services as a tool; students, citizens and different

stakeholders as elements of action and change.

The engagement program of the UIA DIAMS is very vast and comprises different elements and stakeholders. In a graphical way this is captured in the map where activities / agents of action are represented in Figure 1. The engagement program aims to mobilise all agents in the society - including politicians, civil servants, companies and industries and citizens – to develop coordinated action plans in the territory (at the individual level, local, urban, regional) to produce data and find solutions to combat poor air pollution.

Figure 1. Map summarizing the engagement actors in the Aix Marseille Metropole

The engagement plan of DIAMS aims to provide information for a better understanding of the air pollution and its dynamics to all actors in the society, providing the tools and the platform to find solutions in a collaborative and democratic way.

2.1 Sensor data and air quality services

The use of small portable sensors which measure air quality is a promising approach that can have multiple benefits. First, it provides a unique dataset with insights into levels of air pollution in areas without monitoring data, and better quantifies the exposure to harmful pollutants and its consequences on health. This data could help to better inform clean air policies and be used by environmental agencies and research groups to improve air quality models. Second, if portable sensors are distributed among the citizens, it improves public participation in environmental projects, and they are a useful tool to promote change towards a more environmental conscious behaviour. Previous experiences in other cities suggest that the experience with the sensors, in comparison with those participants which were only provided with the traditional air quality information, generates greater motivation among participants (Oltra et al., 2017).

UIA DIAMS is making available 2,000 small sensors to the Métropole. Small sensors which measure particulate matter concentrations, developed by the partner TERA, are available for the local authorities in the Métropole, but also for citizen associations and wider interest groups. Sensors are mobile and they will be deployed to answer specific questions that fixed monitoring cannot do.

2.1.1 Fixed monitoring data

In most developed countries, air pollution is monitored by networks of fixed stations equipped with reference instrumentation, maintained by government agencies and/or universities. The main objective of these networks is to produce high-quality data for regulatory purposes, i.e., evaluate if the annual mean concentrations exceed the legal limits. However, the recent advances in sensor technology and miniaturization, have led to an increase in the number of small sensors available for a more affordable cost. The availability of these small sensors has increased the interest in setting up sensing networks that complement the existing fixed air quality networks in order to increase the spatial and temporal density of measurements (Castell et al., 2013). These networks of small and portable sensors enable cities, community groups, businesses and others to monitor local air quality conditions, raising awareness of air pollution problems and potentially supporting decision making (Schaefer et al., 2020). This is one of the axes of the sensor network deployed in the UIA DIAMS project in the Aix-Marseille Métropole.

Small sensor data combined with air quality modelling can be used to better understand sources of air pollution and the processes that led to high pollution conditions. With this information, better policies and actions can be designed to tackle specific sources. This is one of the approaches that is developed within the UIA DIAMS project. By the time that this zoom-in was written up (August 2021), four (pilot) local authorities within the Metropole deployed five fixed sensor networks (Figure 2). Each local authority chose the focus of their monitoring program: monitoring around schools; monitoring to better understand road traffic sources; monitoring around a wood boiler to monitor green waste incineration, monitoring around industrial sources (cement works); and monitoring around a sports centre. The data from this tailored monitoring program is used as input in a three-dimensional air quality model. The model is used to better understand the processes around sources but also as a tool for urban planning.

Figure 2. Deployment of fixed sensors in local authorities in the Aix-Marseille Métropole: Allauch (left), Cabriès (centre) and Venelles (right).

But this approach is not only useful for local authorities. Other communities can be also benefitted from this tailored monitoring programs enhanced with air quality modelling. For instance, assessing the infiltration rates from outdoor air to indoor premises is a relevant epidemiological question as people remains indoors about 85-90% of their time (Chen & Zhao, 2011) and assessing the infiltration rate in buildings is essential for reducing energy use and improve indoor air quality (Liu et al., 2018). Data from small sensors and three-dimensional air quality modelling is being used by a state agency in Aix to answer this question.

The cases above are just examples of the flexibility and the increased capacity of monitoring around unknown sources. Numerical modelling and observations can be merged to understand better the dispersion of emissions; but also to predict and design actuation plans to improve air quality levels.

2.1.2 Mobile monitoring data

In cities, air quality levels differ significantly from one location to another for multiple reasons. The main reason for that is the spatial heterogeneity in the emissions: cities have hotspots of air pollution due to traffic junctions or heavily trafficked roads where emissions can be trapped in the urban architecture, linger for longer and worsen air quality levels. But residential areas, open and green spaces have lower emission rates of traffic-related pollutants and as consequence they observe lower concentration levels. Because air quality can vary so widely, mapping it across a city requires many measurements in a great number of places.

Conventional approaches to air quality monitoring in cities are based on networks of static measurement stations, which are usually sparse and do not allow capturing tempo-spatial heterogeneity or identify pollution hotspots. Small portable sensors have the advantage that they are easy to deploy on moving platforms and they can be used map the concentrations in a neighbourhood or city.

Small sensors fixed outside the vans from the postal service deliveries is used to map the distribution of concentrations in Marseille as illustrated in Figure 3. The data collected in this platform is used also in mathematical models to understand the spatial and temporal distribution of pollution in the city, to identify hotspots of pollution and the areas of action to improve air quality levels.

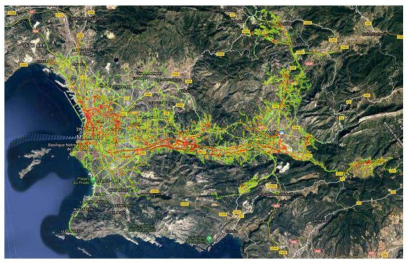

Figure 3. Spatial distribution of pollution in Marseille in 2020.

2.1.3 Quality of data

A main challenge for a large majority of projects based on the use of small sensors is developing accurate measurement devices and assuring data quality (Williams et al., 2018). The data generated by these platforms are often of questionable quality. In a large comparison of a suit of 24 identical commercial low-cost sensors versus CEN (European Standardization Organization) reference analysers, it was observed that their performance varies spatially and temporally as they are dependent on the atmospheric composition and the meteorological conditions. Castell et al. (2017) recommended the examination of each individual unit before its use.

The UIA DIAMS partners have developed an intercomparison plan of the TERA small sensors against the reference instruments on the fixed monitoring stations (Figure 4). The intercomparison exercise and the evaluation of the performance for each sensor is going to be a challenge when all sensors (about 2,000 sensors) will be available all in once, after the delay on the fabrication of the sensors (see Journal num. 2 for explanation).

Data quality is a pertinent concern, especially in citizen applications where citizens are responsible of collecting,

reporting and analysing the data. In general, while low-cost platforms have low accuracy for regulatory or health purposes, they can provide relative and aggregated information about the observed air quality (Castell et al., 2017). Official organizations might guide and help citizens to use and calibrate sensors in order to improve data quality (Jiang et al., 2016).

Figure 4. Intercomparison of a set of TERA small sensors (red circle) against the FIDAS (instrument approved for CEN as reference instrument to measure particulate matter in Europe) in one of the fixed monitoring stations in the Aix Marseille Metropole.

Another aspect that projects should consider when using a network of mobile sensors is the cost of processing the data itself. The post-processing of collected data is labour-intensive and likely to exceed the costs of the sensors themselves (Kumar et al., 2015).

2.2 Stakeholders and citizen groups

2.2.1 Schools and young students

Various education and science initiatives around the world have integrated children and young students as agents of change. Those provide evidence that children have the potential to be catalysts for enhanced sustainability in their local environment (von Braun, 2016).

The partner L'air et moi oversees the educational program within the UIA DIAMS project and aims to engage students at the primary school level with the problem of poor air quality. The program started with schools' workshops with a general introduction to air pollution and its effect on human health, followed by a walk around the school measuring levels of pollutants.

The action around schools will be empowered and pedagogue interventions involving parents are expected for the coming school year (2021/22). This approach sees young children as a factor that can catalyse action within families and therefore have a greater impact on the society.

Matrice had a very ambitious program where young graduates, for a year period, were working on the development of a service around the topic of the air quality. On top of the individual benefit for each student who learnt about the topic of poor air quality and had the opportunity to design a project - from the idea to the final product -, the program was a platform for innovative ideas designing services for the territory.

2.2.2 Citizen projects

One of the biggest challenges in environmental projects is the lack of engagement of citizens. In the air quality topic, most citizens feel that they have no mechanisms to change as policies are designed by local and regional authorities based on criteria far from their needs. UIA DIAMS is trying to overcome this challenge by providing the citizens with the right information regarding the air they are breathing.

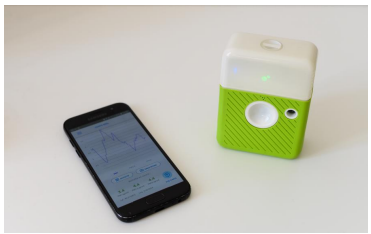

Figure 5. Small sensor designed and built by TERA, partner of the UIA DIAMS project. Mobile app shows the latest particles concentrations as measured by the user. About 2000 sensors will be made available for the DIAMS community.

Small sensors are available for citizens in the Métropole willing to know the concentrations they are breathing, to discover the patterns of air pollution and the areas where they walk with the highest levels. Also, citizen associations are organizing events around air quality, data and solutions. So far, 8 civil associations spread across the Métropole are working towards the design and deployment of events around the topic of air quality with slightly different focus: awareness campaigns about poor air quality, about green waste burning; walks in areas of nature highlighting the functionality of lichens; awareness campaigns based on art works representing air pollution; etc.

2.2.3 Industrial partners

The UIA DIAMS approached different industrial partners in the Métropole looking for their engagement with the project. Several meetings with individual industries were held during the first and the second year of implementation but they were not fully satisfactory. A new approach was tested and DIAMS approached industries through the Association of Industrial and Territorial Ecology 'PIICTO'. The AMP; local authorities in the region; and several industries are members of the association and all showed some levels of environmental sustainability and engaged in practices such as the circular economy. The approach of UIA DIAMS to the industrial stakeholders was done highlighting the benefits that industrial patterns could bring to improve the understanding about air quality levels in the region; and reassuring them they would not be punished by their actions. By bringing up the positive aspects of their participation, this led to the participation of some industries to the activity of UIA DIAMS by sharing their emission data – not only the information required by the law but also further activity data (emission patterns, days of no activity, etc.).

1. 1. **2.2.4. Other economic actors**

Reaching and engaging with different economic sectors of the society is a priority for DIAMS, for a complete coverage and representation of the society. For instance, one state agency in the Metropole (CDC Habitat) and La Poste are companies engaged with the project.

3. New era of tools to combat poor air quality

Initiatives such as UIA DIAMS focused on air pollution using data from mobile sensors has a twofold objective:

First, it increases the production of information on local air quality and the exposure of the population to air pollution, complementing measurements taken by official air quality monitoring networks and helping improve air quality models. Air quality models can help estimate the pollution levels and properly quantify the population exposure to harmful pollutants; to identify areas and better suitable actions to improve air quality. UIA DIAMS is offering a new tool for urban planning to evaluate air quality actions to the local authorities within the Metropole based on sensor data and air quality modelling. In the near future, the increasing number of data flow combined with new data digitalisation approaches, may represent a paradigm shift in the way that air quality is monitored. A large network of mobile sensors combined with air quality modelling and novel statistical approaches - including machine learning - could complement the current official data and provide new pathways to obtain information about air quality.

The tools made available by UIA DIAMS is offering a more localized network to better respond to community needs to improve local air quality. It is equipping individuals with better information about local air quality; with the aim to empower communities to modify activities and support air quality concerns in the short- and long-term to reduce exposure to air pollution.

Second, it is a valuable approach to raise awareness of local air quality problem, empowering citizens and local stakeholders as a focus of action and change. Raising public awareness of air quality problems with personal data from mobile sensors can lead to stronger public measures to address the issue or changes in personal behaviour, such as switching from driving to walking or cycling.

Instead of relying on scientific and regulatory experts to assess air quality at given places and times for recommendations communicated to passive citizens, the UIA DIAMS model empowers citizens with access and information to interpret local air quality data and make more informed, local decisions.

Mobile air quality sensors are generally easy to use, require minimum maintenance, and can provide data in near real-time through smartphone applications. However, the accuracy of sensors should be quantified to ensure the accuracy of the data obtained. And this might need the guidelines from experts and scientists.

4. More engagement, better practices

Community and citizen science can be described as the suit of activities and programs in which members of the public collaborate with professional scientists on scientific research and monitoring in either scientist-led or community-led endeavours (Ballard et al., 2017). Social scientists highlight the benefits of engagement projects in environmental projects. Citizen science projects have been shown to enable large-scale data collection, increase scientific literacy, and monitor environmental quality (Johnson et al., 2014). In the literature is discussed the benefits that individual participants gain when participating in environmental monitoring projects; ranging from learning new knowledge and community awareness to changing attitudes and behaviours, building social capital, and ultimately, influencing change in environmental management and policies (Stepenuck & Green, 2015). Additional to increase in knowledge, citizens might diffuse their acquired skills (i.e. monitoring air pollution skills) and knowledge to peers through social networks (Johnson et al., 2014) and feel more confident to express their ideas to policy makers and environmental authorities (Ballard et al. 2017).

In the area of nature conservationism, Burgos-Ayala et al. (2020) studied 182 projects and concluded that to succeed in the implementation of environmental projects, environmental managers should implement five actions:

- Promote more clearly the benefits societies and citizens get from nature (and clean air) in policies, plans and programmes
- Increase and boost education and training programmes
- Make communication, education and participation actions the core of all projects, from design to implementation
- Consider and engage a diversity of stakeholders
- Develop and implement social indicators to evaluate environmental management practices (for example, the quality of participation of stakeholders involved) to complement the more commonly used environmental measures of success

Therefore, citizen science in environmental monitoring can increase the potential for acquiring new knowledge while creating information that goes into policy formulation, planning, and management activities at various levels of government.

5. The DIAMS Community & the engagement program

Previous experiences highlight that there is a higher degree of engagement and contribution to those campaigns and programs that outcomes are shared on open data portals (Jiang et al., 2016). Citizens engage at both individual and collective level. The UIA DIAMS platform is built to be an open platform were data coming from different projects or individuals is going to be made available for the community. It is also going to integrate the data collected by regional and reference monitoring stations. And it would be a platform were services around the air quality domain were going to be built. Each part of the engagement project of UIA DIAMS is feeding one or more dimensions of the DIAMS platform (Figure 6) which ensures that data is disseminated, of good quality and assimilable for all.

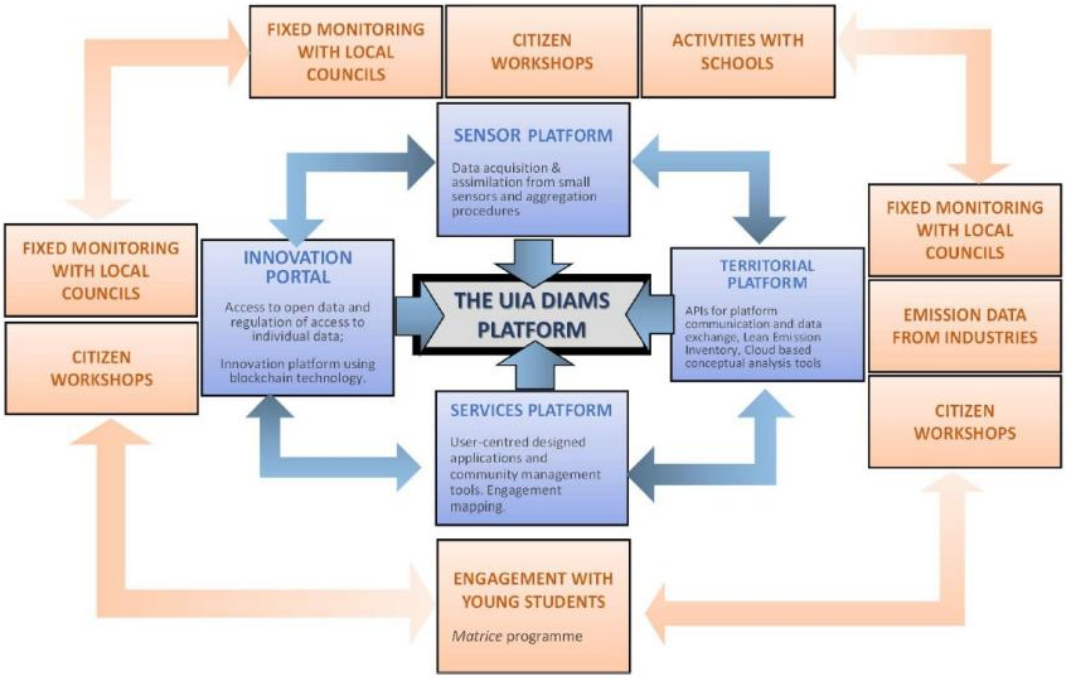

Figure 6. The UIA DIAMS platform and its connection to the engagement program.

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