URBAN ENVIRONMENTAL MONITORING (UEM):

a demonstration project pooling corporate expertise for smarter cities implemented in Nice Plaine du Var

Philippe Maillard
Project manager, Innovation & Markets, Veolia

Pierre Brunet
Business development director, Innovation & Markets, Veolia

With over 179,000 employees worldwide, Veolia designs and delivers sustainable and competitive water, waste and energy management solutions to its customers. The Innovation & Markets division is tasked to develop marketing at company level and to steer R&D efforts to accelerate changes in Veolia's activities and business models.

KEYWORDS

- URBAN MONITORING
- PUBLIC-PRIVATE PARTNERSHIP
- URBAN SERVICES
- QUALITY OF LIFE
- BEHAVIORAL CHANGE

This article presents the Urban Environmental Monitoring demonstration project, developed jointly by the Nice Côte d'Azur metropolitan authority, Veolia, Orange, m2oCity and IBM since 2012. Exploring new ways of combining new technologies and social sciences, the project seeks to exploit a broad range of data to offer new urban services, designed to make the city of tomorrow more attractive, sustainable and competitive.

INTRODUCTION

The city of Nice is determined to be a laboratory for smart city innovations. Since 2008, the city has accomplished a broad range of experiments and pilot projects: measuring noise levels and the quality of air and light, smart mobility, smart street furniture, smart grids, contactless mobile services, and more. Nice is one of the most innovative smart cities in the world—ranked fourth in Juniper's 2015 Smart City Rankings, behind London and ahead of Singapore.

To take this innovation process a step further, the Smart City Innovation Center – established jointly by the Nice Côte d'Azur metropolitan authority and the Mediterranean Institute for Risk, Environment and Sustainable Development (IMREDD) at the University of Nice Sophia-Antipolis – was opened in March 2015. The center was set up in response to the fact that most smart city projects are compartmentalized and operated in silos. This integrated collaborative platform brings together stakeholders from research and educational backgrounds, leading smart city-focused companies, regional startups and public bodies. Urban Environmental Monitoring is one of the first projects developed by the Smart City Innovation Center, *with a consortium coordinated by Veolia.*

1. THE URBAN ENVIRONMENTAL MONITORING PROJECT: OBJECTIVES AND OPERATING METHODS

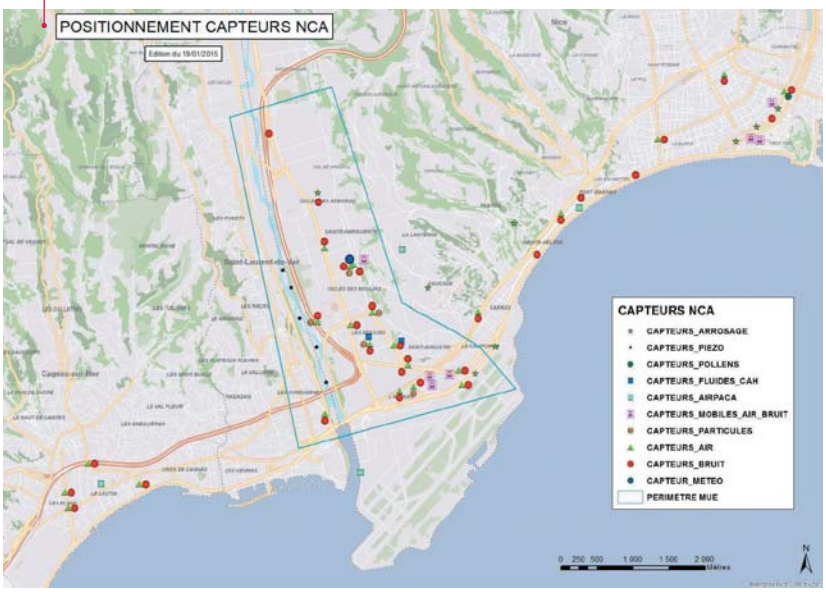
Developed jointly by the metropolitan authority of Nice Côte d'Azur, Veolia, Orange, m2oCity and IBM since 2012, Urban Environmental Monitoring is a unique demonstration project that aims at enabling collaboration between large and small companies, research laboratories, local government authorities and residents to make Nice a smarter city. All these stakeholders share a common concern: how can a broad range of data de developed to advantage to offer new urban services and make the city more attractive, sustainable and competitive?

UEM collects a broad spread of environmental data (air quality, noise levels, water network losses, traffic density, energy consumption, waste management, etc.) thanks to a network of close to 3,000 sensors across a 160 hectare eco district at the southern end of Plaine du Var area. Energy-autonomous wireless sensors are located all over the district: on street furniture (light stands, waste collection points, water distribution networks, etc.), in buildings (public buildings, social housing, apartment blocks, etc.), on a fleet of vehicles owned by the Nice Côte d'Azur metropolitan authority and the City of Nice, and in a special sensor-equipped trailer successively moved throughout the district.

Once processed, the data is used to monitor the district's environmental performance and to trigger short, medium and long term actions.

- **Example 1 -** If a sensor detects high levels of air pollution, UEM triggers actions to improve the situation or limit impacts on residents: traffic flow improvement through traffic lights management, communication with drivers thanks to display panels etc.
- **Example 2 -** Sensors fitted to waste collection points enable waste truck routes management so that only full containers are emptied— providing fuel and time savings for the local authority and improving the quality of life for local residents.

Sensors in the district. Source: Veolia



Nice:
RANKED 4TH
in Juniper's 2015
Smart Cities Rankings

3,000 sensors

160 hectares

10% TO 20%
net savings for street lighting, energy and water use

The UEM project has an ambitious final goal: testing new services (and design the relevant technical, economic and contractual models) that will optimize the ways cities are managed, improve urban environmental health, save energy and offer residents an enhanced quality of life.

2. A UNIQUE CROSS-FUNCTIONAL APPROACH

The UEM project's key strength lies in its fundamentally cross-functional nature. At every stage, the project has been designed in integrated and decompartmentalized ways. There are four facets to this cross-functionality:

- **Stakeholders**: the project involves multiple and diverse stakeholders, working in a win-win relationship of co-construction and shared expertise.
- **Services:** unlike many *Smart Cities* initiatives designed in silos, UEM sets out to provide a bunch of highly diversified services at crossroads of multiple challenges and sectors.
- **Levers for improvement**: UEM is a unique process inter-connecting technological and behavioral challenges. Residents are integrated as stakeholders in the project: thanks to the public availability of data, they are encouraged to make informed decisions and to adopt more virtuous behaviors.
- **Tools**: the project pools the radio data transmission network for a broad range of sensors. At the other end of the line, the city uses the same platform to monitor a range of alerts and indicators, and to combine data. Thus, integrated and shared solutions are deployed where separate services could have been relied on.

2.1. AN ECOSYSTEM OF STAKEHOLDERS: CO-CONSTRUCTION AND SHARING EXPERTISE

The origins of the UEM project can be traced to the acknowledgement that inter-stakeholder collaboration is a vital feature of smart cities. One of the key innovations the project offers is the ability to facilitate collaborations between stakeholders sharing a desire to test new services to improve city-living but that have never, or rarely, previously worked together. UEM is built around a virtuous ecosystem that involves five types of stakeholders:

- **A local government authority: the Nice Côte d'Azur metropolitan authority.** UEM would never have been launched without the metropolitan authority's vision and determination, deeply committed to smart city issues. The authority plays multiple roles within the project:
  - Overall project steering;
  - Definition of the needs, in close collaboration with the authority's various departments and residents;
  - Investment in sensors and networks (the authority provided half of the total budget, with a €2.1 million funding. - The balance is reached with the participation of the consortium of partner companies);
  - Supervision of the city hypervisor platform.
- **A consortium of major companies, leaders in smart cities: Veolia, Orange, m2oCity and IBM.** During earlier research, the Nice Côte d'Azur metropolitan authority did not share its data and worked with a single corporate partner at a time. Today, thanks to the Smart City Innovation Center, all corporate stakeholders can pool their data and knowledge for the first time, in turn multiplying the possibilities for experimentation. Convinced that no single company could come up with the full solution, several industry partners decided to pool their skills in a consortium that the authority then signed an R&D agreement with:
  - **Veolia:** world leader in environmental services, Veolia is responsible for consortium coordination, upstream diagnostic assessments, and design and sale of services;
  - **Orange:**tests a new sensor network, experiments new services and exploits the data in close collaboration with partner companies;
  - **m2oCity:** in charge of the sensors network and operational data gathering, this market-leading French company was set up by Veolia and Orange in 2011 to provide connected objects for the Internet of Things;
  - **IBM:** has deployed a platform (Intelligent Operations Center) that retrieves, processes, exploits and transforms data from the sensors in real time.
- **SMEs and startups.** Besides the large companies forming the consortium, UEM also relies on expertise delivered by SMEs and startups. Some are located in the region, such as RPP and its innovative TV applications, and Adam, a social mediation company. Others include Azimut Monitoring (sensors), EcoLogic Sense (sensors), Equitia (social support), Manodo (applications), Simplon (development), Sepia and OpenHealth (data analysis).
- **Universities and institutional partners.** The metropolitan authority and consortium also work closely with universities and institutional partners, including the Mediterranean Institute for Risk, Environment and Sustainable Development (IMREDD) at the University Nice Sophia-Antipolis, where the Smart City Innovation Center is located; AIRPACA, an approved nonprofit tasked with air quality monitoring; Acoucité, a nonprofit specialized in noise issues; Pasteur University Hospital; the Sophia-Antipolis Scientific and Technical Centre for Buildings; the French Environment and Energy Management Agency (ADEME), etc.
- **Residents** test the services, validate the approaches and approve expected results.

The UEM project offers unique working methods governance, based primarily on collaboration and co-design.

2.2. A CONCEPT DESIGNED TO OFFER A BUNCH OF SERVICES, AT CROSSROADS BETWEEN DIFFERENT SECTORS

Whereas most connected or smart city initiatives are run on a sector-by-sector basis and thus remain relatively compartmentalized, UEM offers a fundamentally new approach: starting with a cross-functional analysis at crossroads between a number of different sectors, it then offers a bunch of services answering the issues cities face.

Services tested by the UEM project have to meet three criteria:
- Be aligned with the challenges the metropolitan authority faces;
- Making it possible to reuse and exploit the data and test innovative solutions;
- Be based on an economic model capable of generating benefits and cost-savings for the authority, local residents and partner companies.

In all, the UEM project will test around 20 different services, divided into three broad groups:

- **Group 1:** services improving health, air quality and living conditions in the city (monitoring air quality, noise levels, pollen count, temperature hotspots, biodiversity indicators, etc.);
- **Group 2:** services that make it possible to manage existing public services' improvement (mainly management of water, energy and waste: watering green spaces, monitoring drinking water quality, smart management of heat networks, local waste drop-off points, etc.);
- **Group 3:** new services created by exploiting and reusing urban data (tracking water and energy use in buildings, air quality monitoring and information, city noise levels and pollen counts, dashboard of city indicators, etc.).

For a stakeholder like Veolia, UEM represents an unparalleled innovation source: although the services in the second group are just enhanced existing solutions that the company already delivers, services in groups 1 and 3 represent profoundly innovative solutions in fields where the consortium's industrial partners are

not traditionally involved. In offering a chance to explore this new field, the UEM project acts as an innovation catalyst for all involved stakeholders.

2.3. A CROSS-FUNCTIONAL APPROACH THAT EMBRACES TECHNOLOGY AND SOCIAL SCIENCES

There is more to smart cities than simply a technology issue. For smart cities to be effective, they have to be embedded within a participatory framework that will ensure residents' long-term engagement and backing. This is the mindset that underpins the UEM project.

Residents are involved in the new services' validation process as active participants in the experiments. Their views are sought and listened to (a e-questionnaire will be sent to eco-district residents, designed to assess their opinions about the progress enabled by the experimental program). By associating residents with the improvement of their living conditions process and inviting them to join in, the UEM project aims to maximize the long-term impacts of the new offered services.

For example, as part of the project to help manage household water and energy consumption (see below), some 50 households were invited to join the experiment and track their water and electricity use. These households were supported by local nonprofit bodies responsible for raising awareness and helping households to adopt new and more eco-friendly behavior patterns (managing energy use, cutting bills, etc.).

By linking technology (sensors, monitoring tools, applications, etc.) with social sciences (behavioral change and resident participation), UEM is configured to provide a cross-functional response to the challenges smart cities face.

"THE UEM PROJECT'S KEY STRENGTH LIES IN ITS FUNDAMENTALLY CROSS-FUNCTIONAL NATURE. AT EVERY STAGE, THE PROJECT HAS BEEN DESIGNED IN AN INTEGRATED AND DECOMPARTMENTALIZED WAY. [...] ONE OF THE KEY INNOVATIONS OF THE PROJECT IS TO FACILITATE COLLABORATIONS BETWEEN STAKEHOLDERS [...] THAT HAVE NEVER, OR RARELY, PREVIOUSLY WORKED TOGETHER."

3. FOCUS ON TWO APPLICATIONS OF THE URBAN ENVIRONMENTAL MONITORING PROJECT: MANAGING CONSUMPTION AND POLLEN COUNTS

To give a better insight into the realities of the services tested as part of the UEM project, we will now look at two experiments in greater detail:

- support for household water and energy consumption management;
- pollen counts.

3.1. SUPPORT FOR HOUSEHOLD WATER AND ENERGY CONSUMPTION MANAGEMENT

Household Energy Management Support (AMCI) is an experimental service offered by Veolia to two apartment blocks managed by social housing provider Côte d'Azur Habitat in the Moulins district of Nice. The aim of this experiment is to encourage tenants to monitor and manage their water and energy use to reduce their bills. AMCI should enable tenants to make an overall 10% saving on their water and electricity bills (saving €150 to €200 excluding taxes per home per year). The landlord should see a return on investment within three years.

There are two pillars to the service, simultaneously tested in a dozen pilot areas across France:

- **the technology pillar: smart monitoring and digital apps.** Apartments are fitted with room temperature sensors, calorimetric sensors, and sensors measuring volumes of water and hot water used. Apps have also been designed to enable tenants and landlords to track changes in consumption over time;
- **the behavioral pillar:** it is important that tenants take ownership of the service if the targetted 10% savings is to be met. Veolia has tasked Equitia, a company specialized in behavioral change support, and Adam, a nonprofit specialized in social mediation, to ensure that the tested solution is both welcomed and fully understood. Both contractors are in charge of raising residents' awareness so that they adopt energy-saving habits. Personalized coaching programs based on individual analyses of consumption and behavior patterns are offered for a six-month period.

The question of behavior is key. Initial experimental feedback shows that although 90% of contacted residents agreed to have sensors fitted in their apartments (around 50 households in total), they met trouble taking ownership of the consumption monitoring tools and applications. This underlines that extended prevention and awareness-raising actions targeting users are needed to support changes in behavior, technology cannot come alone.

Thanks to this careful combination of the technology and behavioral pillars,the AMCI service provides a twofold advantage:

- **for tenants:** higher disposable income thanks to reduced water and energy bills; better control over bills for water, electricity and heating; greater awareness of the impact of personal behavior on household bills; a shared bond with their neighbors;
- **for social landlords:** direct savings on internal costs; higher household disposable incomes leads to fewer rent defaults; better management of the tenant relationship; establishment of relationships more closely aligned with tenants' real concerns.

"THERE IS MORE TO SMART CITIES THAN SIMPLY A TECHNOLOGY ISSUE. FOR SMART CITIES TO BE EFFECTIVE, THEY HAVE TO BE EMBEDDED WITHIN A PARTICIPATORY FRAMEWORK THAT WILL ENSURE RESIDENTS' LONG-TERM ENGAGEMENT AND BACKING."

3.2. REAL-TIME POLLEN COUNTS AND MONITORING

An experiment is currently running as part of the UEM project – in collaboration with the National Aerobiological Surveillance Network (RNSA) – offering an innovative service that provides real-time counting and monitoring of airborne pollen concentrations, which in turn increases the effectiveness of allergy prevention strategies.

Traditionally, pollen counts are obtained from air samples analyzed in a laboratory, a task that can be both lengthy and painstaking. The UEM project offers real-time information thanks to an innovative

TAKEAWAYS FROM THE RÉFLEXE EXPERIMENT: THE DIFFICULTY OF CHANGING USERS' BEHAVIOR

To add further food for thought about the behavioral dimensions inherent in any smart city project, we want to take a brief look at the takeaways from another research project run by Veolia Research & Innovation teams in the south of France in 2012 and 2013. Known as RéFLexE (Response Flexibility in Electricity), the project set out to assess the social acceptability of flexible electricity consumption within the context of a smart grid. It should be remembered that the value of smart grids is the ability to adjust to needs in real time, using ITC to connect electrical demand and supply infrastructures. For instance, when demand exceeds supply, smart grids can briefly reduce electrical consumption in a group of buildings. On the other hand, when supply exceeds demand, the purpose of smart grids is to call on energy storage solutions. This is what we term flexible electricity consumption.

In this respect, an experiment was run at a group of office buildings in the PACA region of southern France, seeking to assess the social acceptability of this type of intelligent grid mechanism. In office buildings, flexible electricity consumption can be responsible for the alteration of occupants' thermal comfort through the production of heat and/or cooling. This experiment was also used to assess the extent to which users are occasionally prepared to compromise their comfort as part of electric consumption adjustment processes.

Thus, several in-situ temperature adjustment tests were carried out, and a questionnaire issued to participants to assess their reactions to their thermal comfort's alteration and the extent to which they accepted this kind of changes. The experiment demonstrated that, on the whole, occupants' satisfaction in regard to thermal comfort was very noticeably impacted by the flexibility actions tried out. As an example, after lowering air-conditioning in buildings in July between 1 and 3 p.m. (raising indoor temperatures from 23 to 25°C), 65% of respondents stated that the apparent temperature was "**far hotter**" than normal, with 32% even stating that the temperature was "**far too hot.**"

Working from these results, researchers running the project attempted to identify factors that could be obstacles to behavior changes (in this case, altering temperatures at a set time of day), as well as possible levers to circumvent these obstacles. Among other findings, they demonstrated that:

- **Acceptance of flexible electricity consumption varies according to the context.** Users appear willing to make efforts in emergency or exceptional circumstances (for instance, during extreme consumption peaks in winter, or in the event of an incident such as a fire or grid fault). They are driven by the feeling that they have no choice in the face of a potential power cut and/or because of a sense of responsibility toward other specific users on the same grid: they declare that child daycare centers, rest homes and hospitals take precedence over their personal comfort. There are, however, far more divergences of opinion regarding less sensitive situations, for example the intermittent production offered by renewable energy sources. Aside from emergencies or situations engaging their sense of social responsibility, users frequently find it less acceptable to compromise their comfort. During the experiment, users expressed their reluctance with varying degrees of directness. For example, they expressed views about what their colleagues would think — "***people are going to complain***" — rather than their own opinions, and/or formulating avoidance strategies designed to minimize or totally negate any personal discomfort (e.g., adjusting the air conditioning in June, or during the morning, to avoid the sensation of a rise in temperature);
- **irrespective of whether they are generally positive or negative about adjusting consumption, users all seem to be sensitive to three arguments: efficiency** (flexible electricity consumption is seen as a way to save energy, a core consideration for some of the people surveyed); justice (efforts must be made by all in society); responsibility (equally, the division of constraints must align with the respective responsibilities of the various stakeholders involved in regard with the problems to be solved). The researchers concluded that these three levers should, in varying proportions relative to the targetted public, be at the heart of all communication strategies deployed to convince users to alter their behavior.

For any project aiming at making our cities smarter, this example serves as a reminder of how critical it is to accompany users as they try to change their behavior. They have to be educated, informed and offered lasting encouragements in accurately designed ways to answer their specific preoccupations (their perception of the environment in which they live, sensations of discomfort, motivations, relationship to others, etc.).

sensor, the FIDAS-200. For the first time in Europe, an optical analyzer provides instant data on the granulometric distribution of pollen particles, making it possible to predict periods of high pollen incidence.

An initial test phase, run in central Nice from March to July 2015, with sensors positioned on the roof of the Museum of Modern and Contemporary Art, demonstrated the efficiency of the analyzer, particularly in comparison to traditional traps.

After these promising initial results, the decision was taken to pursue the experiment, issuing an alert bulletin based on readings from the FIDAS-200. The *Metropollen* bulletin, which has been tested by various volunteers from the Nice Côte d'Azur metropolitan authority since January 2016, provides a 24-hour real-time description of pollen concentrations. Users have the choice of consulting different sections: history, neighborhood pharmacies and allergy specialists, advice, impact studies, etc.

The project has a twofold ambition for the years ahead:
- improve quality of life for the thousands of people with pollen-related allergies who live in the city (preventing and reducing allergic attacks);
- reduce expenditure on healthcare relating to consumption of anti-allergens.

A study will run during the second half of 2016 to assess the impact of the new alert bulletin in regard to the above factors.

Metropollen bulletin screenshot. Source: Veolia

CONCLUSION

The UEM project's cross-disciplinary nature (involvement of a large number of stakeholders, the broad range of services tested and the combination of technology and social sciences) makes it a unique innovation laboratory for tomorrow's smart city's imagination and design. Focusing on collaboration and co-design within a genuinely experiment-driven mindset, it facilitates integrated testing at the district level of a multitude of new services for cities.

The project's implementation is scheduled in two steps: experimental phase from 2014 to 2017, and deployment and economic development from 2017. This approach should soon yield the first results. the set out targets are already encouraging:

- ***financial and economic impacts:*** *net cost savings of 10–20% for energy and water use in public buildings and for street-lighting, 10% increase in efficiency across the public water network (rate achieved in Beaune, where a similar service was tested), etc.;*
- ***environmental impacts:*** *15% cut in greenhouse gas emissions and local air pollution thanks to better managed collections from local waste drop-off points, etc.;*
- ***social and societal impacts:*** *improved quality of life for residents (public health, well-being, time savings, etc.).*