SWARCO

IMPROVING AIR QUALITY

ISSUES IN URBAN AREAS

MICRO
WHITEPAPER

MyCity Solutions

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1 Abstract

This paper presents the impact of air quality in urban environments with a specific focus on the aspect of mobility. It outlines the detrimental impact of rapidly worsening levels of air quality on health and economy that can, to a large extend, be attributed to congestion from the road transportation sector. Building on this, the paper describes a variety of critical actions that can be implemented via a smart transportation system and roadside infrastructure. Readers of this paper will gain a better understanding of the main root causes that lead to such a high impact from the transportation sector, formulate highly efficient countermeasures, to ultimately influence the policymaking and investment prioritization.

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Version

#	Date	Editors	Changes
1.0	July 17th , 2020	Nikolaus Stieldorf, Tom Buck, Eftychios Papapanagiotou, Laura Coconea	Original version released

Improving air quality issues in urban areas

2 Introduction

Outdoor air pollution could cause 6 to 9 million premature deaths yearly by 2060 and cost between 1% - 5% of global GDP, according to OECD reports. The same report states evidence that suggests that the road transport sector is the leading cause with a share of approximately 50% of air pollution-related deaths in the European Union and the United States. Hence it is clear that policymakers must initiate immediate action in terms of policymaking and prioritization of investments to improve air quality. It is also evident that such actions promise an extraordinarily high benefit-cost ratio from measures implemented to mitigate air pollution with investments in the transportation sector, offering the most significant impact.

3 Problem statement

Pollution, be it noise, light, or air, is a recognized challenge to health and well-being in the urban and rural landscape. The problems have been most acutely experienced in urban areas where the migration of large numbers of the population to cities created crowded living conditions. As more data has become available, however, the problem also affects anyone living and working near significant transport infrastructure. Some of the highest levels of pollutants are now being recorded in areas considered to be unaffected in the past. Ambient air pollution, and precisely a combination of small and fine particulate matter with traffic as the leading cause, is stated as the greatest risk to health – causing more than three million premature deaths yearly worldwide. The expected increase in urban dwellings will exponentially drive and raise pollution levels from human waste, cooking, heating, and transport sources to unprecedented levels. The industrial transition of national economies in previous centuries created a world where it was accepted that people weighted higher levels of economic opportunity against poorer living conditions and high pollution levels. Today, however, this is not the case, and politicians are being forced to take action and reduce the levels of urban pollution populations live with across the world.

Urban pollution

- 3.4 Million deaths linked to outdoor air pollution globally
- 97% of cities in low and middle-income countries do not meet WHO air quality guidelines
- 49% of cities in high-income countries do not meet WHO air quality guidelines
- 500,000 premature deaths in the UK with air pollution accounting or 40,000 of these.
- Costs 1 Trillion Euros per year
- Only active smoking kills more people

Vice versa, improvements in air quality have been directly linked to declines in the risk of stroke, heart disease, lung cancer, and chronic and acute respiratory diseases, including asthma.

4 MyCity as the Solution

"Air pollution is a major cause of disease and death. It is good news that more cities are stepping up to monitor air quality, so when they take actions to improve it they have a benchmark." – Flavio Bustreo, WHO Assistant-Director.

SWARCO's new MyCity solution gives the City the ability, not only to identify where air quality is below or within their planned thresholds, but it also allows to create dynamic strategies that can use the data collected and apply targeted actions before the level becomes a critical problem.

Source Data

Having the right source data available is always key to making the best decisions. The MyCity platform has been built to use a wide range of data sources either supplied directly by SWARCO, already installed by the City as part of legacy projects or collected by other service providers, e.g., regional or national weather services.

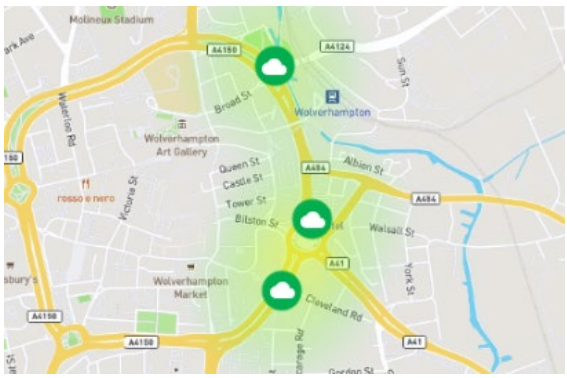
Today, MyCity has already integrated a number of common environmental sensors as well as traffic sensor types. Environmental sensors provide data such as air quality, temperature, humidity, pressure, or vibration, while traditional traffic sensors provide useful baseline data sets that allow us to evaluate the current traffic throughput, average waiting time at red lights, and speed. As more camera-based technologies are deployed, it is now possible to gain a deeper insight into how our road transport networks operate. SWARCO is able to add information on near-crash and crash-data, the ability to classify a wide range of traffic participants form pedestrians to large goods vehicles as well as major KPIs such as route journey time or average speeds for road vehicles.

Managing pollution levels is never just about monitoring levels of its constituent components. The impact pollution levels have in any given location is also highly dependent on other factors that are quite often overlooked. To make sure the basis of the data used is as wide as possible, SWARCO has also established global data-sharing agreements with a range of third parties who can provide data that is complementary to the information already collected. Through these unique agreements, SWARCO's MyCity solution can now add data derived from monitoring the real-time position of individual vehicles over space and time (Probe Data). This is the data almost every modern vehicle passively and anonymously shares anytime it is being used.

The channel to communicate this information is currently based on a cellular connection. However, with the growing number of vehicles that are C-ITS/CAV enabled (connected vehicles, the predecessor of autonomous vehicles), the information will be shared with the roadside equipment via enablers such as SWARCO's C-ITS hub.

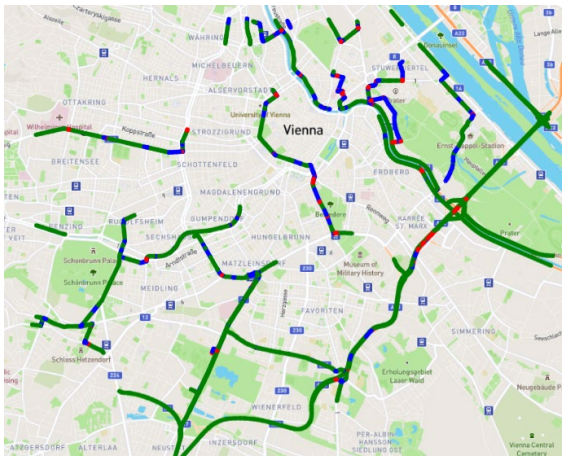
Monitoring Air Quality

Once data has been collected and processed, visualizing the impact of pollution on the environment in a way that helps the user to understand where and how their City is being affected and deriving necessary actions can be challenging. SWARCO's MyCity Environment Monitoring service is designed to make this task an intuitive one for the user. Operators set their own threshold levels, and the data, status, and impact of changing conditions can be viewed in real-time on any web-enabled device.



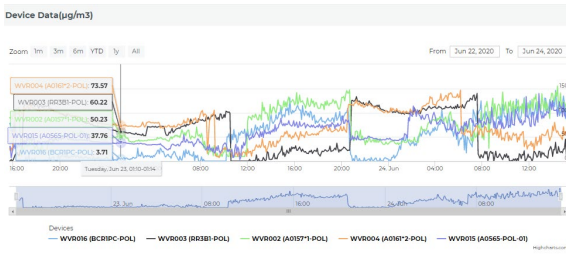
Picture 1 - Heatmap displaying air quality at sensor location

The large variety of data sets is visualized in real-time via different layers on top of the City's map utilizing heat maps and performance-dependent coloring of the road network.



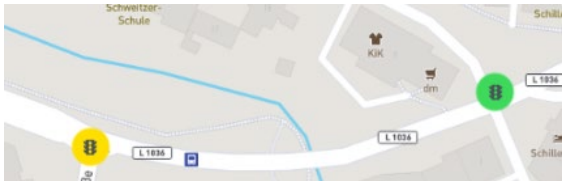
Picture 2 - Visualization of in-vehicle probe data

Users who want to take a more detailed look into the solution can also access a suite of pre-configured reports on the status of the data sources as well as the raw data. From these pages, it is also possible to easily export the data for further separate analysis.

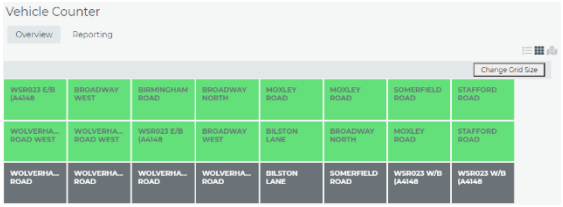


Picture 3 - diagram comparing concentration of air pollutants over a time period

Status regarding the specific type and health of each device is visualized via colored icons on the map view and in a separate device grid dashboard.



Picture 4 - Device type and health status



Picture 5 - Device status grid

'Call for Action' notification

While MyCity Monitor gives users the ability to see what is happening at any moment in time, it is vital to use the information to take targeted, balanced actions if the air quality levels are to be restored to their acceptable levels. MyCity's Strategy Manager service provides users with the ability to configure 'actions' that do just this. 'Actions' can be set-up to be automatically applied, thereby taking away the need for operators to worry about juggling their day-to-day workload. 'Actions' can also be set up to be presented as 'suggestions,' which are then presented through the user interface or can be distributed by email or text, before the user chooses the most suitable for manual deployment while monitoring the different data sets since MyCity will do that job for them. Via user-configurable thresholds, operators will get notified when the air quality exceeds the defined level via email and text message, so further actions such as road closures, rerouting traffic via variable message signs, or limiting access to certain vehicle classes can be implemented immediately, manually or automatically. Thus, the City can ensure that the air we all breathe can remain a strategic focal point in a highly resourceful manner.

Reroute traffic

External pollution has a direct correlation with traffic volume and type of vehicles, so one of the first, and most impacting factors, that can be changed is to reduce the number of cars on the road. The MyCity Strategy Manager service is able to trigger new scenarios where traffic is steered away from highly congested areas by adjusting signal plans, displaying messages, and changing dynamic signs to restrict access to specific areas either generally or for specific vehicle types (environmental badge or electric vehicles only) etc.). Commuters traveling by car which have not yet made their way onto the City's internal

road infrastructure can also be informed of the changes that have been made and be directed to Park & Ride services so that they can switch the last miles using other modes of transport. The dynamic component of the strategy manager then allows the City to apply different sets of actions as the air quality level improves, e.g., re-open areas to all traffic.

Adjust speed of traffic

Traffic speed is another factor recognized as being linked to pollution levels. Moving vehicles create higher levels of pollutants as speed increases, but they also have an impact when stationary as exhaust emissions concentrate around traffic queues. In urban areas moving vehicles help to disperse high levels of pollutants, but when traffic becomes stationary, this effect is lost, and dangerous levels of pollutants quickly build up. Consequently, the main objective would be to move traffic at a constant speed through the urban environment since reducing the average speed in half (20km/h to 10km/h) can lead to a surge of up to 40% in average fuel consumption.

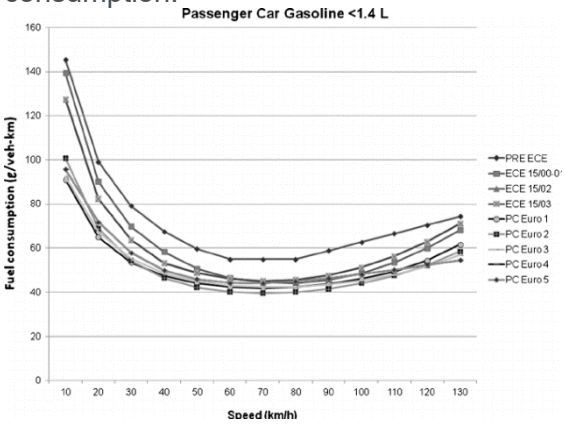


Figure 1 - Average fuel consumption per kilometer in relation to speed (Source: Sobrino N., Andrés S., 2014)

The ability to dynamically manage traffic speed can be a highly effective tool to make streets safer, specifically in times of an increasing share of vulnerable road users. Depending on the modality prioritization, dynamic traffic management can also become one of the primary motivators for drivers to switch to other means of transportation, such as public transport.

Using SWARCO's MyCity Strategy Manager enables the City to smooth traffic flows which not only enhances the driver experience but also helps to minimize travel times and reduces emissions while prioritizing the health of a City's residents, As air quality changes traffic signal plans can be dynamically changed and with the introduction of variable speed limit signs on key routes drivers can be quickly advised of the most optimum speed to use to get to their destination balancing emissions with time. One of the most powerful tools is the implementation of Variable Message Signs such as SWARCO's Variable Speed Limit Signs (VMS), which provide the City with full flexibility of the type of message to be displayed on their full-color, full-matrix displays. In this specific use case, the VMS will display a new speed limitation with an optional warning message of increased fines until the air quality has dropped below the threshold.

Adjust traffic signal plan

In congested urban areas, traffic signal coordination is vital for a reduced number of stops and emissions. MyCity's adaptive traffic control solution handles coordination at a regional level and adapts local control to prevailing traffic conditions. The objective function of network-wide optimization aims for an optimal flow ratio based on a utilized function for every scenario. In addition, rule-based decision making can be placed on a higher level to support signal plan selection based on emission levels.

Real-time data sharing

The combined MyCity' Pollution Monitoring and Strategy Manager services are not just limited to managing systems that are directly supplied by SWARCO. There are a number of open API's available that provide the City with all the tools they need to also share the data collected with other relevant systems e.g., tolling systems can be informed about the excessive air congestion leading to a dynamic price adjustment along the applicable routes or MaaS (Mobility-as-a-Service) providers such as electric scooter companies could notify or even reroute their users to suggest not only the quickest but also healthiest route.

Lastly, Cities increasingly identified Open Innovation as one of the core sources to find new creative ways of solving their specific challenges while empowering the local economy. MyCity's open API's allow Cities to make all these valuable data sets available to the public in a highly standardized and lean manner. The operators or the IT department, as well as the local entrepreneurs, won't have to deal with a large variety of data sources, formats, or vendors but benefit from MyCity serving as the future-ready single data aggregator and provider for such smart city applications. This way, MyCity not only presents the ideal tool to monitor, maintain, and improve a Cities air quality but empowers the local entrepreneurship community to participate and benefit from these solutions as well.

5 Functional architecture

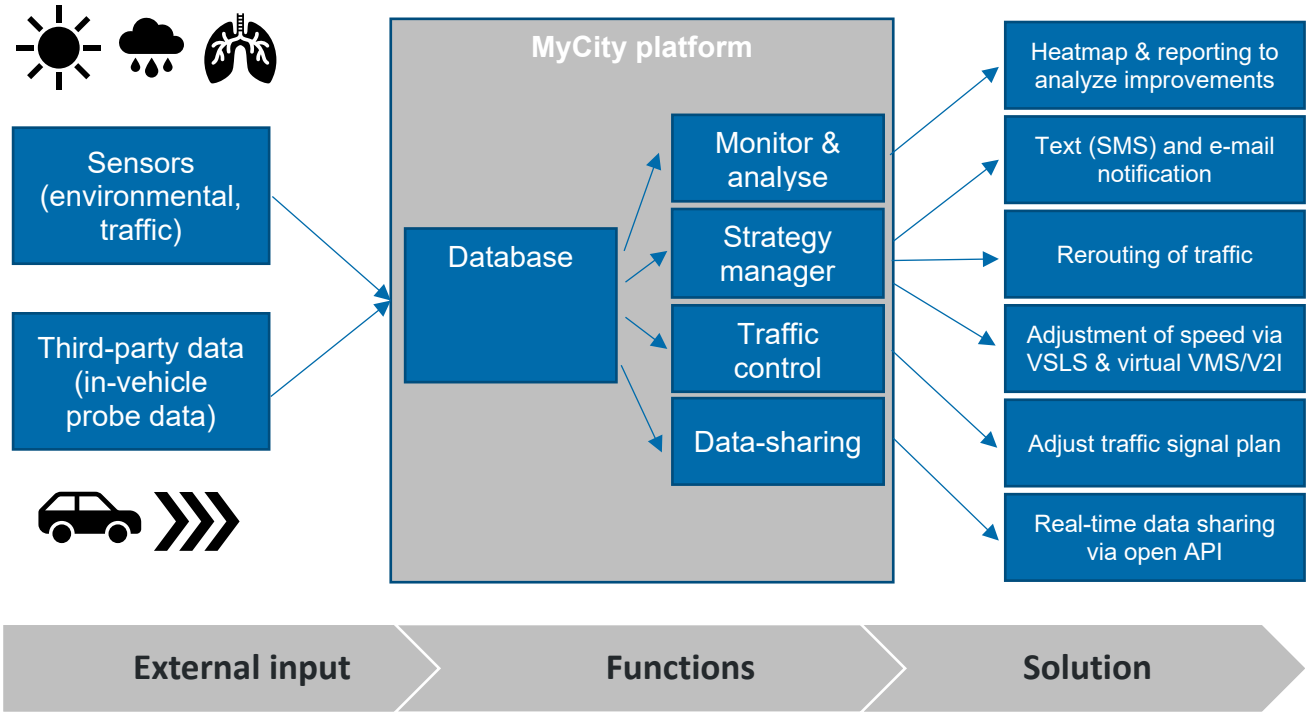


Figure 2 - Functional architecture

6 Related topics

6.1 Vehicle-to-infrastructure (V2I) technology

V2I is a subdomain of the larger technology trend of connected vehicles, often also referred to as C-ITS (Europe) or CAV (North America). It builds the core of autonomous driving, where sensors detect what's going on around them to then also communicate this information to other road users such as vehicles, bicycles, and the roadside infrastructure. For the specific use case of improving air quality in urban areas, V2I is described as one of the most promising solutions, for both monitoring – since the richness of data will lead to better decision making and scenario planning – and control – since through V2I a direct channel opens with the vehicle for real-time communications (e.g. speed limits, in vehicle information).

6.2 Adaptive Traffic Control

MyCity's Adaptive Traffic Control is the ideal complementary solution to ease the City's congestion further and therefore improve the air quality. It enhances the performance of local adaptive controls by identifying and reallocating unused green times. This ensures that just as much green time is provided, as it is needed for the expected vehicle count. Furthermore, MyCity's Adaptive Traffic Control optimizes the offset of coordinated controls to increase the quality of green waves. Its adaptive network control is agnostic to most common traffic protocols and manufacturers, which allows cities to continuously shop for the best in class products and integrate these into their MyCity platform. The comprehensible, modular structure of this control algorithm can be adapted to a broad range of needs specific to the customer's project. Parking Guidance & Wayfinding

6.3 Variable Message Signs (VMS)

SWARCO's VMS constitute the cutting-edge of optical quality in signalization and are used worldwide for dynamic traffic management on highways and traffic guidance in urban areas. Known for their brilliant legibility, energy efficiency, and an excellent luminance ratio, these signs are the ideal tool to communicate to individual road users. The freely programmable VMS can display speed limitations, routing and rerouting information, warnings (accidents, congestion), closures of specific roads or areas due to air congestion, or simply provide information around the current air quality levels. Also, along with the evolution towards automation, the diffusion of In Vehicle Information systems will allow the use of Virtual Variable Message Signs – providing wider options for configurations and scenarios setting and fully exploiting the traditional features while reducing operations and maintenance costs for physical devices.

6.4 Multifunctional Traffic Lights

SWARCO‘s traffic light family COMBIA can do much more than just red-amber-green. In a rapidly changing world with new technologies, this signal head has much more functionalities. It is an essential contribution to the evolution of intersection management. A multifunctional traffic signal is the evolution of the traffic light towards Smart Mobility, by integrating additional sensing equipment: sensors for detecting people and objects as well as an environmental station for measuring air quality. The data provided by AirDec can be visualised in MyCity and can act as a trigger for traffic management strategies aimed at improving the air quality in the controlled area.

6.5 Open Architecture for continuous Innovation

MyCity's flexibility to integrate with other third-party systems and Open APIs enables municipalities to enable their residents to participate in making their City better, safer, more convenient, and environmentally sound. Provide data access for your local entrepreneurship scene, let them create new innovative solutions, and therefore create new opportunities for your local economy. And SWARCO's Innovation Team is happy to work and support these entrepreneurs with domain expertise and potentially partner for joint commercialization of their solution.