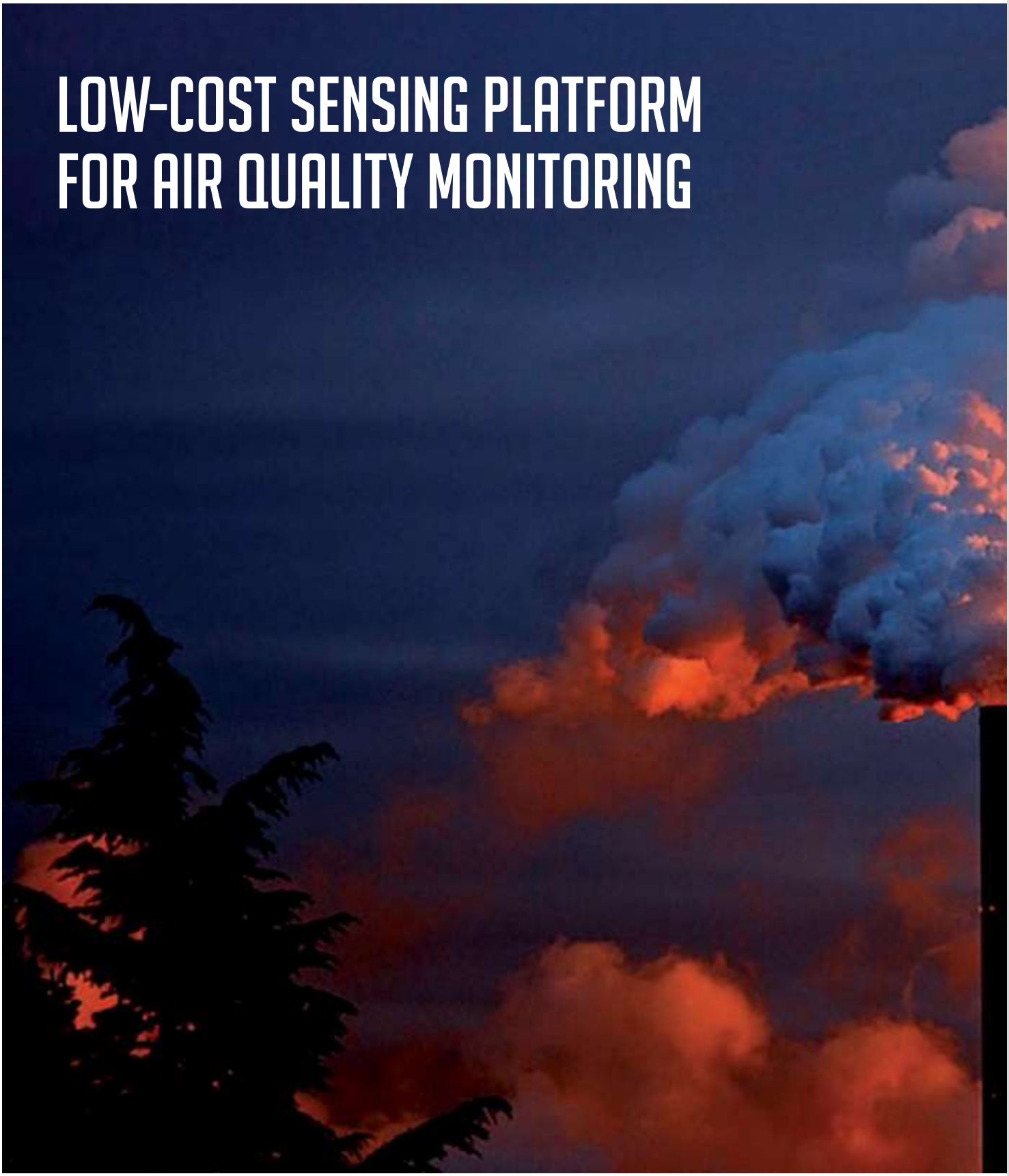
LOW-COST SENSING PLATFORM FOR AIR QUALITY MONITORING



LOW-COST SENSING PLATFORM FOR AIR QUALITY MONITORING

Air pollution is a long-standing problem for public administrators and a constant concern for citizens. It is often considered as an emergency situation, but the issue of air pollution is structural and as such should be addressed. The common approach for monitoring air pollution is by means of monitoring fixed stations, which are expensive, complex and provide low spatial resolution data, since are low density deployed. These stations satisfy legislative requirements but do not provide data about local gradients of pollutant concentrations that can be important for health protection. Furthermore, in smaller towns or in developing regions, air pollution stations may not exist. A possible solution to increment spatial resolution data is by means of lower-cost platforms that provide data in near real time. This is a current trend worldwide and has the potential to integrate regulatory air pollution monitoring stations, and also promoting community engagement. In this work a prototype of a low-cost air quality platform is presented. It allows measuring several metoclimatic parameters and fundamental air quality pollutants (NO2, O3, PM2.5/10). Furthermore, it can be continuously connected to a smartphone allowing geolocalization and providing the user about pollutant levels. It has been compared with reference stations and has been tested in the city of Rome so as to obtain spot data and distributed information on the territory allowing the realization of concentration maps.

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Introduction

Ambient air pollution is a long-standing environmental problem and is a significant health hazard worldwide.

"Globally, 3.7 million deaths were attributable to ambient air pollution (AAP) in 2012. About 88% of these deaths occur in low - and middle –income (LMI) countries, which represent 82% of the world population. " (*WHO, 2014*).

In many urban areas ambient air pollution is the greatest environmental issue threatening human health.

Air quality monitoring

Air quality monitoring is fundamental for:

- understand health effects;
- environmental assessments;
- transportation planning;
- air pollution mitigation strategies;
- provide air quality data to the general public;
- provide data for air quality modelling.

The common approach for air pollution monitoring is by means of fixed stations, which are complex and provide low spatial resolution data, as they are low density deployed.

"Current sophisticated, expensive ambient air pollution monitoring technology is not economically sustainable as the sole approach […]." *US-EPA New Generation Air Monitoring Roadmap 2013*

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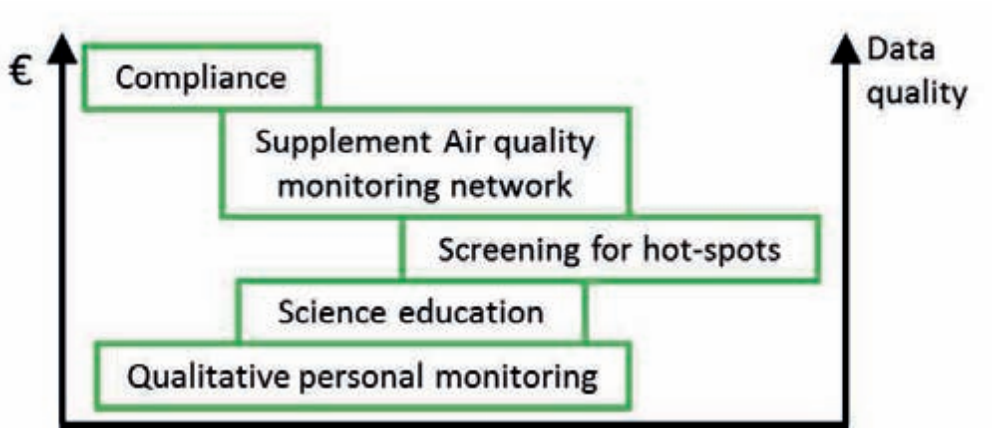
A possible solution to increase spatial resolution data is by means of mobile or multiple low-cost platforms. This can be conducted with monitors that are becoming smaller in size thanks to technological advances.

This is a current trend worldwide and has the potential to supplement regulatory air pollution monitoring networks (*Snyder et al., 2013, C. Borrego et al., 2016, Velasco et al., 2016, Castell et al., 2017*).



LILI-1: Low-cost air quality platform

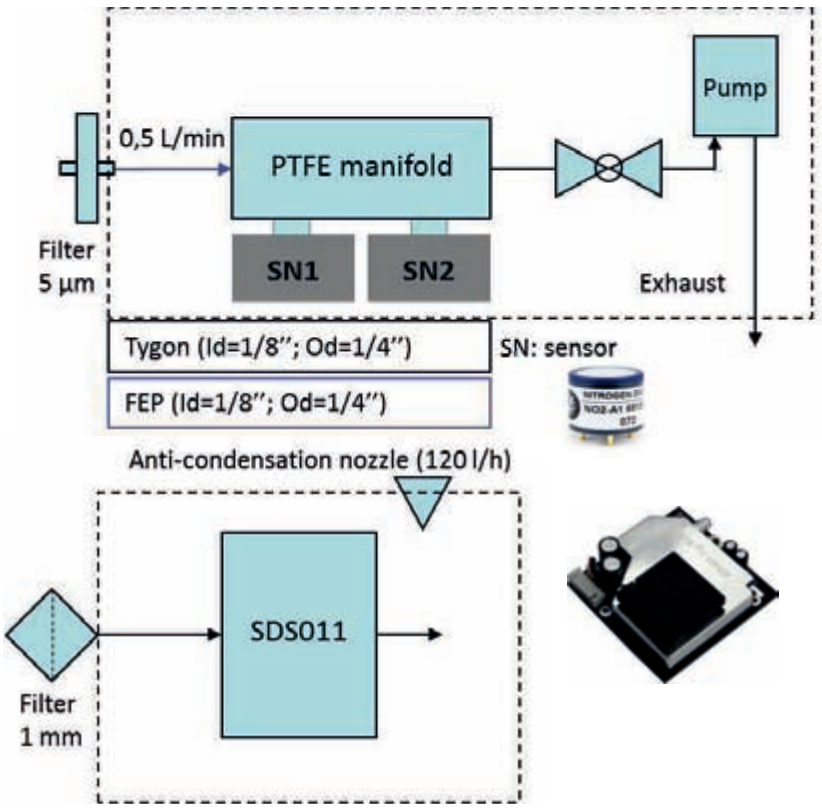
Compact, light weight air quality station, which can be easily moved and installed in different places.

It can also be installed, for example, on a bicycle and georeferencing acquired data

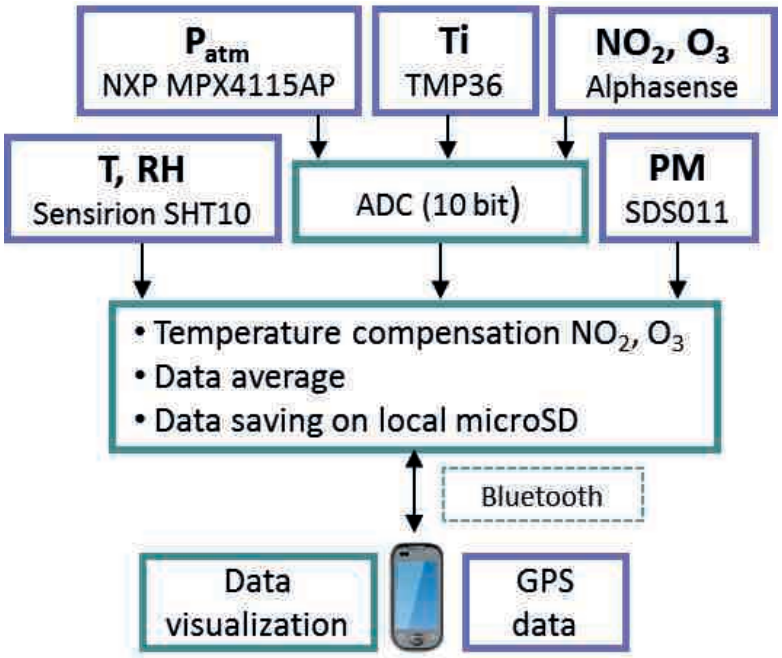
Characteristics

- Max dimensions: 170x270x210 mm
- Weight: 1.5 kg
- Parameters: NO_2, O_3, PM10, PM2.5, temperature, relative humidity, pressure;
- Power: < 2A@5V

Pneumatic system



Data transmission



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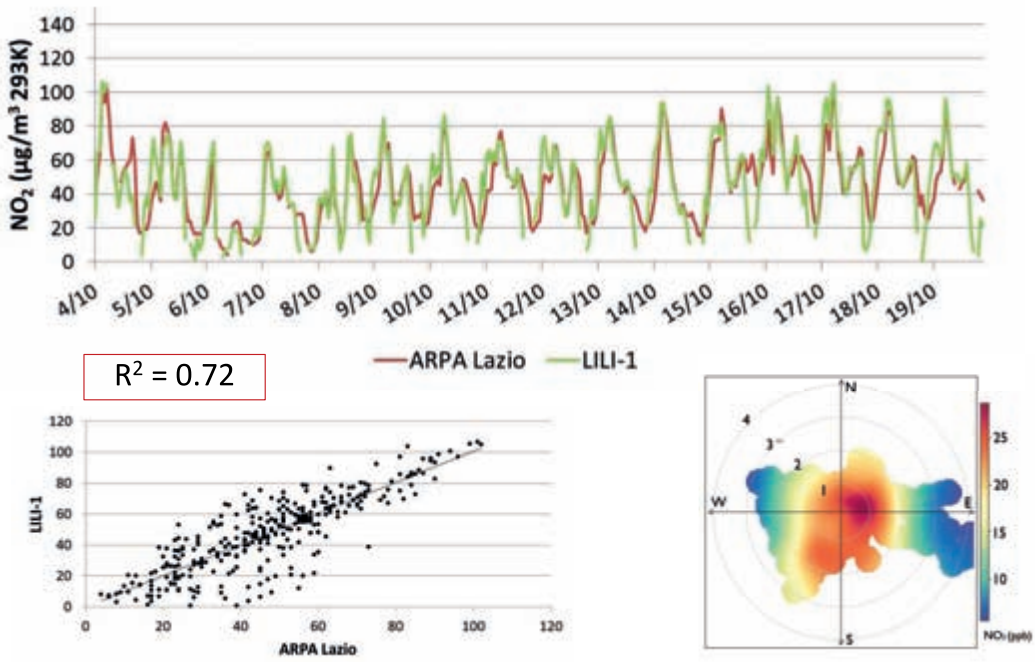
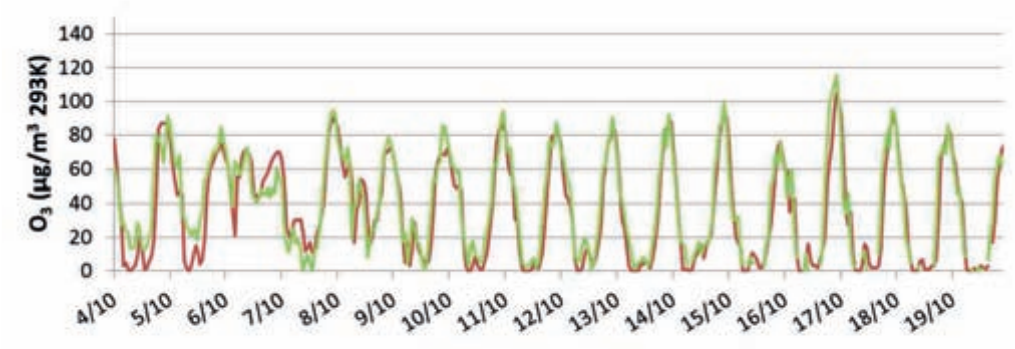
Validation test

LILI-1 located on the roof of ARPA Lazio building in the center of Rome for 16 days, comparing it with certified NO_x (*Teledyne-API 200E*) , O_3 (*Teledyne-API 400E*), PM10 (*ENVIRONMENT MP101M*) and PM2.5 (*SWAM5a FAI*) analyzers.

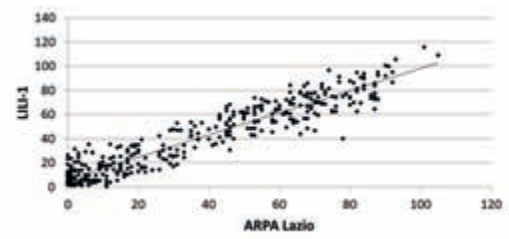
Validation test: NO_2

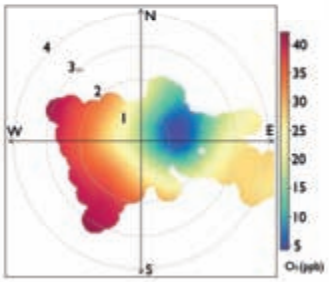


Validation test: O_3

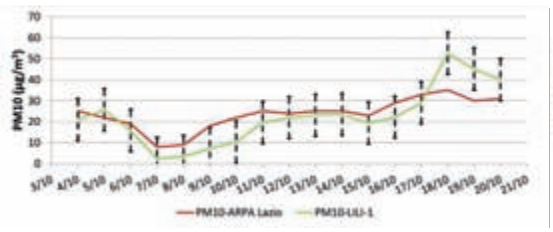


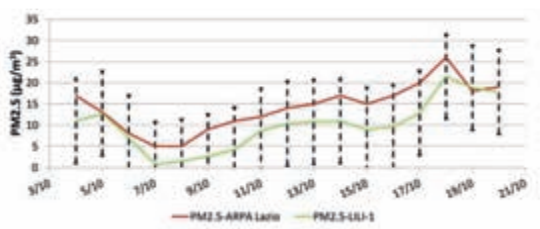
$R^2 = 0.89$





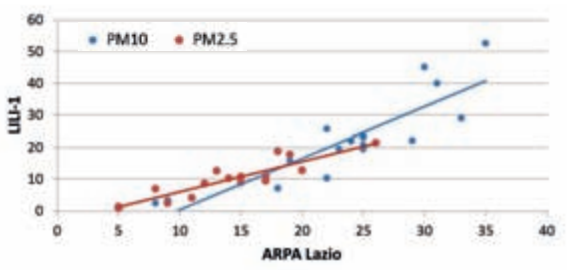
Validation test: PM

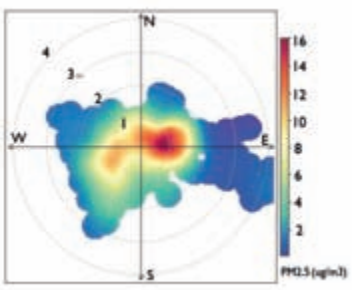




$R^2 = 0.75$ (PM10)

$R^2 = 0.81$ (PM2.5)





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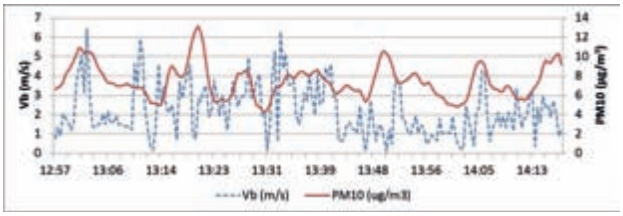
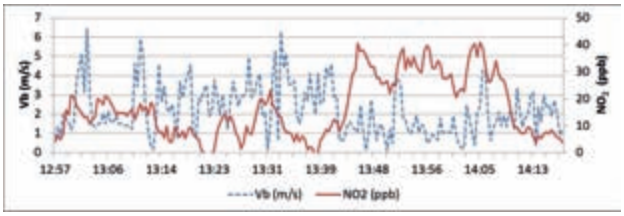
Field test

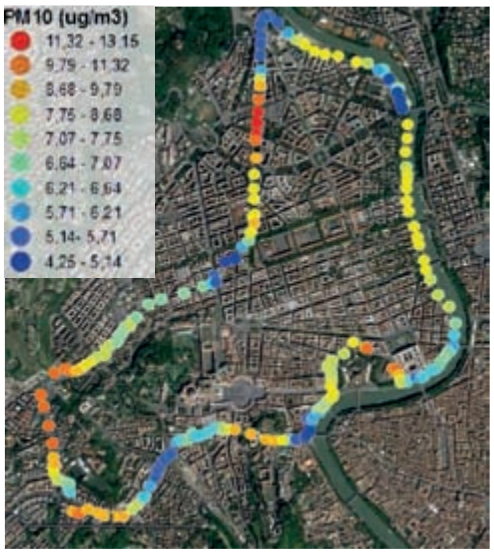
The Air quality sensing device was transported by bicycle in the center of Rome by alternating static and moving periods in order to verify if movement affects precision



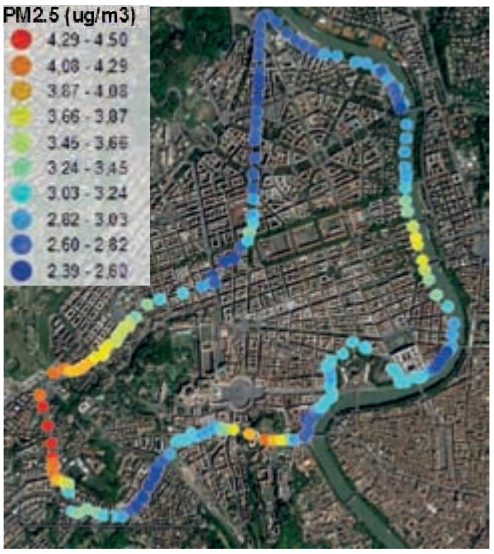


NO_2

O_3



PM10



PM2.5

Conclusion

- A mobile and low-cost system to monitor air quality is proposed to complement the existing compliance one in urban areas.
- The proposed system is capable of increase spatial resolution down to street level.
- The measurements although less accurate, have demonstrated a strong correlation with compliance analysers.
- Monitoring can be conducted in multiple locations and using a geolocalization system.
- Future works will include further validation and field measurements, and testing other case design.

The future of Air Quality monitoring could be a combination of high cost compliance monitoring stations and a high number of low-cost monitoring platforms.

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