Monitoring the potential effect of particulate matter on cultural heritage. Contribution of an environmental monitoring system

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ABSTRACT

The air pollution has a contribution to the degradation of surfaces of historical buildings and monuments [1]. The impact of pollutants emitted into the atmosphere on materials is enormous and often irreversible. Corrosion caused by chemicals and soiling caused by particles can lead to economic losses but, more importantly, to the destruction of our cultural heritage, degradation of the public spaces, infrastructures and facilities [2]. Moreover, the effects of the air pollution in façades and on the structural systems lead to unexpected costs for the buildings maintenance. So, these effects must be monitored and assessed for making possible to act in time for minimizing or eliminating the adverse effects and the unexpected costs over the cultural heritage to preserve the identity and memorial value.

Domestic and industrial sources but mainly road traffic sources are the principal sources of emissions of air pollution in cities, which affect directly the quality of life, infrastructures and spaces in urban areas. Several studies of materials have indicated that atmospheric corrosion influenced by acidifying pollutants is costly. Extensive damage has also been observed on historical and cultural structures and monuments calcareous stones, medieval glass and metals. Therefore, evaluating and monitoring the urban environment quality inside the urban areas becomes very important to the urban heritage conservation through the creation of the new environmental policies to minimize and control the air pollution consequences over the urban spaces [1,2,3].

This work presents a methodology to evaluate, on a regular basis, the potential impact of atmospheric pollution on monuments. It uses a monitoring system to collect samples of particulate matter and then analyzes its composition and assesses the degree of risk of degradation. This study is being applied in the Portuguese midsized city of Vila Real where the urban pollution assessment and their effects in urban infrastructures was considered the main goal.

For the development of the project, two systems have been created: A website for the acquisition and the storing of the data; and a technological solution for the data acquisition constituted by one mobile unit of measurement. The mobile unit of measurement is equipped with an air particulate matter monitor/collector (PM10 and PM2.5), a meteorological station, and communication and positioning devices. The devices are connected with the router installed inside the mobile unit that is connected with a database.

This mobile environmental monitoring station carries out measurements in different points of the city that are part of the urban monitoring network. In the urban monitoring network, a set of data is collected and transmitted to the analysis center (air pollutants concentrations and meteorological data). The particulate matter samples are also collected for posterior physical and chemical analysis in laboratory, for identifying the potential corrosion effect influenced by acidifying pollutants substances that constitute the particulate matter. The website to data acquisition is illustrated in Figure 1.

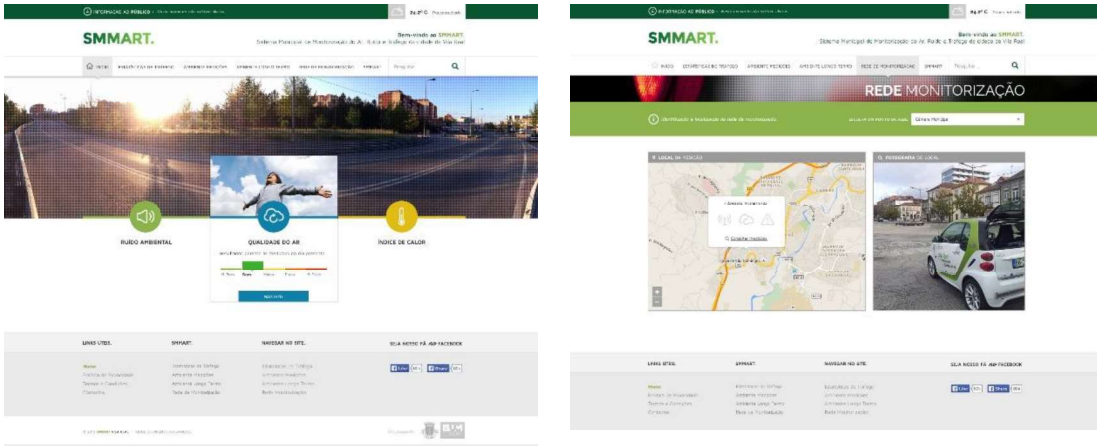

Fig. 1. Website to data acquisition [4].

The data collected include: Time - date and hour of the measurements; particulate matter concentration; particulate matter collection on polytetrafluoroethylene (PTFE) membrane filters with polymethylpentene support ring (2 µm porosity, Ø47 mm), meteorological data (relative humidity, air temperature and wind speed and predominant wind direction).

The samples were evaluated in order to determine the type, chemical composition, morphology and size of the collected particles. In order to obtain chemical and morphological characterization, the following techniques were used: Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy X-rays (EDS), X-Ray Diffraction (XRD).

Historical monuments in urban areas act as passive repositories for air pollutants present in the surrounding atmosphere [5], and the analytical results could confirm that.

In conclusion, this system can provide a large database and important information to use in the decision-making process of urban planners. With this type of data, it is possible to act in time with the goal to protect the urban spaces and avoid the degradation or the irreversible damages in the urban heritage.

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