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Indoor and Outdoor Air Pollution Monitoring Developments in the Municipality of Thessaloniki – Preliminary Actions from Three European Funded Projects

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Introduction

In 2014 Thessaloniki was selected to join the 100 Resilient Cities (100RC) network. Since then, the Municipality of Thessaloniki has developed its resilience strategy based on 8 city values (Social Cohesion, Local Identity & Heritage, Environmental Management, Health and Wellbeing, Youth Empowerment, Multi-stakeholder Engagement, Technology Adaptation, Economic Prosperity), which represent the city's identity and guide about future planning. Within the aforementioned strategy, Urban Resilience is described as "the capacity of cities to function, so that people living and working in cities - particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter". However, a number of, more or less, similar definitions, for Urban Resilience, can be found in the literature (i.e., 100 RCs 2018, Meerow et al., 2016, Spaans and Waterhout 2017).

Environmental Management is one of the key values of Thessaloniki's Resilience Strategy and Thessaloniki has engaged into several activities supporting this value. Within this context, air pollution is one of the main environmental concerns of the Municipality of Thessaloniki. Therefore, the Municipality established a Network of 6 Air Pollution and 9 Meteorological Monitoring Stations, in order to monitor air pollutants and meteorological parameters, since 1990 (Kassomenos et al., 2011; Kelessis et al., 2006; Tzoumaka, et al., 2008; Vouitsis et al., 2015). The stations are distributed within the limits of the Municipality and cover a wide range of air pollution station types, according to the EU relevant directives. At these stations some fundamental meteorological parameters are also measured.

The monitoring and recording of the measurements of the Municipal Network is systematic on 24 hour basis. The air pollutants measured are particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), sulphur dioxide (SO_2), ozone (O_3), nitrogen monoxide NO and nitrogen dioxide (NO_2). All the analyzers are compliant with the EU standards for air quality monitoring and are frequently calibrated. Additionally, measurements of BTEX have been performed at two sites and their monitoring has been added to the monitoring schedule. The meteorological parameters measured are ambient temperature, relative humidity, wind velocity, wind direction and atmospheric pressure.

Having all of the above in mind, the aim of the present work is to present the current developments regarding indoor and outdoor air monitoring actions that the Municipality of Thessaloniki has taken in order to increase its resilience towards values described in its strategy such as Environmental Management, Health and Wellbeing and Technology Adaptation.

Study area and Project(s) Description and Goals

The study area is located in northern Greece and includes the Municipality of Thessaloniki, which is the 2nd largest municipality in Greece with 325.000 inhabitants. The past years the Municipality of Thessaloniki has developed short-term (5 year operational program) and long-term (Thessaloniki 2030, Resilience Strategy) strategies, in which has set several environmental issues as top priorities. In the previous years, the Municipality of Thessaloniki was a partner-beneficiary in more than 45 projects that received funding, either from National Regional or Sectoral Programmes or from other funding tools with a total, initial budget that was over 100 mil. Euros. Building on this experience, the Municipality continued becoming a partner in proposals, seeking funding from various sources; thus, seeking to add knowledge to issues that are considered crucial for the Municipality, such as air pollution, digital services, resilience and others. These proposals were built upon the partnerships of previous years and resulted in several of the proposals being accepted for funding, concerning various sections (i.e., mobility, migration etc.). Three of these projects are dealing with issues such as outdoor air pollution, indoor air pollution, IoT, governance, co-creation and resilience, in general. These projects are entitled CUTLER, AIRTHINGS and LIFE SMART IN'AIR and are described below.

The full title of the **CUTLER** project is "*Coastal Urban developmenT through the LEnses of Resiliency*" and is funded under the Horizon 2020 Programme. The project's total budget is 5,080,125.00 €, while the Municipality of Thessaloniki has 241,250.00 € assigned to its budget. The project's duration is 36 months and the consortium consists of 15 partners from Greece, Ireland, Belgium, Turkey, Germany, and Finland. CUTLER project is strongly connected with the concept of Urban Resilience. With this project an effort is being made to shift the existing paradigm of policy making, which is largely based on intuition, towards an evidence-driven approach enabled by big data. The Municipality of Thessaloniki is the lead partner in Work Package 9 and as a pilot action, the Municipality has chosen to use the CUTLER platform to design, implement, monitor, and evaluate a new Controlled Parking System (CPS) in the 1st, 3rd and 5th Municipal Districts of the city. The Dpt. of Environment of the Municipality has a large dataset regarding the air quality of the city (SO_2, PM_{10}, CO, NO, NO_2, O_3), which is available through its open data portal and it will be

used to make a first assessment of the new CPS on the air quality of the city. The platform that will be developed by the technical partners of the project will be used to evaluate the environmental impact of the new CPS on the quality of the ambient area. This will be achieved by examining and comparing air pollutants' trends for selected periods, first with Key Performance Indicators (KPIs) and finally with an Air Quality Index adapted for the urban Thessaloniki area. The final environmental goal will be to provide evidence to decide if there has been an improvement, deterioration or no change of state in the environmental conditions due to the proposed parking policy.

The full title of the project **AIRTHINGS** is "*Fostering resource efficiency and climate change resilience through community based Air Quality Internet of Things*". The project is funded under the Balkan – Mediterranean 2014-2020 – Interreg V-B" (BalkanMed) Programme. The total budget of the project is 1,417,322.66 €, out of which 227,390.00 € are assigned to the budget of the Municipality of Thessaloniki. The project has a duration of 24 months and its consortium consists of 5 partners from Greece, Cyprus, Albania, and FYROM. Under the AIRTHINGS project, three important technologies will be disseminated among the Balkan countries: (i) IoT Sensors Grid: A grid of 91 IoT Sensors will be distributed and will start measuring air quality in the cities of Sofia (22), Thessaloniki (22), Cyprus (19), Tirana (17) Skopje (11), (ii) Open Data Platform for sharing online information obtained from the sensors, and (iii) 61 chimney filters (chimney filter reduces PM emissions with 60% on average). All the above actions will help the project partners to combine state of the art technologies and know-how into synergic unity that will result in sustainable development and urban resilience. Relying on the community-based approach the partners will pilot demonstrate the capabilities of new real-time monitoring node network, thus providing local communities with information which is not being available previously.

The full title of the project **LIFE SMART IN'AIR** is "*Smart indoor air monitoring network to reduce the impacts of pollutants on environment and health*". The project is funded under the LIFE 2014 - 2020 Programme. Its total budget is 3,919,777.00 €, while the Municipality's budget is 63,001.00 €. The duration of the project is 50 months and the consortium consists of 10 partners from Greece, France, Spain, Portugal, Belgium, and Bulgaria. The project's main objective is to provide a complete and smart solution to monitor and improve In Air Quality (IAQ). This will be done through innovative micro-analysers for BTEX and formaldehyde connected to a user-friendly web and smartphone interface to easily treat the data, link them with risks on human and environment health and implement actions to reduce this pollution. The project will demonstrate a method that hasn't been applied and tested before: sensitive, fast and easy-to use micro-analysers for real-time detection of 2 types of hazardous Volatile Organic Compounds (VOCs): formaldehyde and BTEX (Benzene, Toluene, Ethylbenzene and Xylenes). These microanalysers will be connected to a user interface for data interpretation (e.g. link between pollutants concentrations and alert and health) and implementation of practical measures for improving IAQ. The Municipality of Thessaloniki will use its expertise to implement the demonstration of the LIFE SMART IN'AIR project in one school. It will be responsible to use chemical data monitored by the micro-analyzers to improve the indoor air quality of the school and to implement good practices. The Municipality will also be involved in the communication and dissemination activities.

Concluding remarks

With air pollution being one of the first environmental problems to be addressed by the EU, clean air is considered essential to good health. Hence, all available information and understanding of the air quality issue is essential part of tackling it with efficiency. The 3 funded projects that the Municipality of Thessaloniki is a partner of, are trying to provide complete knowledge regarding a sensitive matter, and all future accomplishments that will come through their successful implementation will be a step forward towards a better understanding of the problem, an increase in the city's resilience and in the well being of the city's population.

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References

100 RCs (Resilient Cities). 2018. The EU Resilience Prospectus. Available on line at www.100resilientcities.org, last access November 2018.

Kassomenos, P.A., Kelessis, A., Paschalidou, A.K., Petrakakis, M. 2011. Identification of sources and processes affecting particulate pollution in Thessaloniki, Greece. Atmospheric Environement 45, 7293-7300.

Kelessis, A.G., Petrakakis, M.J., Zoumakis, N.M. 2006. Determination of benzene, toluene, ethylbenzene and xylenes in urban air of Thessaloniki, Greece. Environmental Toxicology 21(4), 440-443.

Meerow, S., Newell, J.P. and Stults, M. 2016. Defining urban resilience: A review. Landscape and Urban Planning 147, 38-49.

Spaans, M. and Waterhout, B. 2017. Building up resilience in cities worldwide – Rotterdam as participant in the 100 Resilient Cities Programme. Cities 61, 109–116.

Tzoumaka, P.N., Kelessis, A.G., Petrakakis, M.J., Samara, C., Papagiannopoulos, N.M., Zoumakis, N.M., Tzourelis, G. 2008. Experimental measurements of C2-C5 and C6-C10 in urban area of Thessaloniki, Greece, Fresenius Environmental Bulletin, 17,10a, 1594-1600.

Vouitsis, I., Amanatidis, S., Ntziachristos, L., Kelessis, A., Petrakakis , M., Stamos, I., Mitsakis E., Samaras, Z., 2015. Daily and seasonal variation of traffic related aerosol pollution in Thessaloniki, Greece, Atmospheric Environment 122, 577-587.