

Summary

Air pollution, mobility and urban space are three critical issues for many European cities, including Torino, a city located in northern Italy and chosen as the case study for this research project. In Torino city, traffic and heating represent the primary source of air pollution and the monitoring network constantly records values that exceed the legal limits for various air pollutants. European air quality standards for particulate matter (PM) currently use PM mass concentration [PM with aerodynamic diameters $\leq 10 \mu\text{m}$ (PM10) or $\leq 2.5 \mu\text{m}$ (PM2.5)] as a metric. It would be desirable to determine whether participatory approaches based on citizen science can be used as a tool to investigate and integrate new air quality indicators such as Black Carbon (a component of fine particulate matter not yet regulated at European level). Furthermore, it would be useful to understand if and how the outputs obtained through participatory science experiments can support policy makers in traffic planning and management and air quality monitoring on an urban scale. The project '*Participatory Approach for the Monitoring of Air Pollution in urban environments (PA-MAP)*' was conducted with the cooperation of the University College of Dublin (Ireland), the University of Castilla La Mancha (Toledo, Spain) and University of Milano (Italy). Furthermore, PA-MAP was supported by various Italian and Irish cultural associations and involved students and citizens of Torino and Dublin, with the aim of creating a team of volunteers for monitoring air quality (AQTEAM) in two European cities. As part of PA-MAP, three pilot studies (PS) were carried out which made it possible to evaluate the effectiveness of emission source regulation policies also in terms of local and specific health risk of the exposed population. Novel participatory approaches for urban-scale air quality monitoring were evaluated and modeled through PA-MAP. The three pilot studies conducted in Torino made it possible to collect social, environmental and clinical data in real-life conditions. Each pilot study was designed to form a series of overlapping and sequential case studies of continuous learning and knowledge extension, promoting and emphasizing participatory governance, solidarity and cross-sectoral collaboration. The first pilot study (PS#1) involved 15 volunteers residing in Turin, the volunteers monitored their direct exposure to Black Carbon for one week (from 7 to 12 November 2021), AE51 portable aethalometers were used during this study. The objective of PS#1 was to collect real-time personal BC exposure information, understand how behavior, lifestyle, job, residence and different microenvironments, are related to daily exposure to BC. Through this pilot study, citizens have been made aware of the promotion of '*actions for change*' to protect their health and the environment in which they live. During the second pilot study (PS#2), the respiratory parameters of 50 male volunteers suffering from chronic obstructive pulmonary disease (COPD) were monitored for one year (2020). All the volunteers were resident in Turin for at least 5 years and lived in areas with different traffic densities. This study allowed to investigate the associations between PM concentrations, BC, respiratory function and residence. During this pilot study, BC and PM data collected by the urban control unit (managed by regional environmental protection agency-ARPA) and spirometric data (collected by a portable clinical sensor) were used. PS#2 showed that people with COPD who reside in busier areas appear more vulnerable to air pollution and have more airway obstruction. Finally, a social survey was organized through the dissemination of a semi-structured questionnaire (PS#3) in Torino and Dublin (Ireland). Dublin was selected as a comparison city because it represents one of the European cities in which citizens' satisfaction regarding air quality is very high. The questionnaire was disseminated electronically with the support of the cultural associations and university institutes involved (Politecnico of Torino and University College of Dublin). In each city, 384 responses were collected (for a total of 768 responses) obtaining information on citizens' perception of air quality, sources of pollution, pollution control and their behavior in support of environmental policies. Each pilot study, seemingly different, is interconnected by a common denominator: data collected by users, such as active human sensors, provide information to be integrated into the management of air quality regulatory policies at the local level. Through a participatory approach involving the population, it is possible to investigate urban hotspots, the hours of the day when people are most exposed and during which activities, the behaviors that

make citizens more vulnerable, their perception of air quality, how traffic emissions are related to respiratory parameters and cause relapses in the most vulnerable people. Furthermore, it was also possible to collect suggestions from citizens to deal with the impacts of air pollution in their own city and to promote actions for change. PA-MAP also highlighted how standard monitoring reflects regional sources of pollution and may not be able to discern spatial variations of local emissions within the city, which could also challenge the criteria for protocol management anti-smog adopted by local politics. Furthermore, the SP#1 pilot study demonstrated that Black Carbon may be a more suitable marker for detecting differences in pollution in different areas of the city and consequently quantifying the benefit of air quality in terms of risk to citizens' health. PA-MAP has implemented the "Healthy Cities" approach, supported by the World Health Organization (WHO) in the Health21 strategy and aligned with the European Health 2020 policy framework and the 2030 Agenda for Sustainable Development. The 'Healthy Cities' approach recognizes the determinants of health and the growing need to overlay multi-sectoral data to ensure a better quality of life for European citizens. Through an interdisciplinary approach, PA-MAP involved the local population in the experimental activities and highlighted the need to use alternative data in decision-making processes and in organizational collective development to obtain global results that bring benefits to the entire community. In April 2023, PA-MAP received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No. 945380. The project will be implemented in two European cities: Ljubljana and Barcelona for a period of two years (2023-2025).