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Temporal patterns and trends of air pollution over distinct European urban areas

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European cities have made significant progress over the last decades towards a clean air. Despite all this progress, several urban areas are frequently exceeding air quality levels allowed by the European legal standards. The ClairCity project funded by the H2020 program addressed air pollution bringing a key missing factor in the way cities and societies organized themselves and work: citizens at the heart not only of the air pollution issues, but also of the solution, focusing on their behaviour, activities and practices. In this work, the ClairCity European pilot cities and regions (Bristol in the UK, Amsterdam in the Netherlands, Ljubljana in Slovenia, Sosnowiec in Poland, the Aveiro region in Portugal and the Liguria region around Genoa in Italy) are studied in terms of air quality for a 10 year period regarding the main atmospheric pollutants over urban areas, namely particulate matter, nitrogen dioxide and ozone.

Therefore, the main objective of this work is to present a comprehensive diagnosis of the air quality and its main emission sources for each case study. The concentrations trends in the different typology of monitoring stations (background, traffic and industrial) were addressed, together with the knowledge of daily, weekly and seasonal pollution patterns to better understand the city specific profiles and to characterise pollutant dynamics and variations in multiple locations.

Each city/ region faces different issues and causes of air pollution, but all of these case studies have been working on to improve their air quality. In Bristol there have been strong downward trends in many air pollutants, but the levels of NO₂ remain persistently high and of concern, with transport the key contributor. PM on the other hand is not widely monitored in Bristol, but background levels at least are under limit values. Similarly, the

main sources of air pollution in Amsterdam are traffic, in particular for NO₂, and international shipping. Decreasing emissions and concentration levels point to some success of Amsterdam air quality policies in recent years. PM₁₀ exceedances are a seasonal pollution problem in Ljubljana, with the main particulate matter sources attributed to residential heating, which is still significantly outdated in some parts of the city, where households still heat with burning wood and biomass during winter. The most pressing issue for air quality within Sosnowiec is emissions from residential heating. Particulate matter are the main critical pollutants, linked with the use of inefficient heating systems, together with poor quality fuels, in winter. On the other hand, NO₂ limit values are also exceeded in Sosnowiec, but in comparison to the low-stack emissions, the problem is far smaller. On contrary, air quality in the Aveiro region is relatively good, due to an overall relatively low population density in the region, and an open landscape in a maritime climate. PM₁₀ and O₃ exceedances do occur occasionally. While, exceedances of NO₂ and O₃ concentrations are still problematic in Liguria region, with road transport, industrial plants and port activities being the main contributors to these problems.