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Analysis and characterization of the predominant pollutants in the Catania's air quality monitoring stations.

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Abstract

It is useful to know about whether one or more pollutants predominate in different parts of a city and contributes to evaluating the efficacy of a variety of counter-measures for lowering pollutants in urban areas. This paper compares Catania (Italy) air quality measured in 2003 with that in 2012. The investigation was carried out at four monitoring stations of the city's Air Quality Monitoring Network (AQMN). The monitoring station locations had not changed from 2003 to 2012.

The impact of the city's primary and secondary pollutants was estimated from analyses of the daily concentrations of CO, SO₂, PM₁₀, NO₂ and O₃, and then by assembling the data into classes by applying Sturge's rule which provides the optimal number of intervals (or classes). Each class provides frequency density to make comparable intervals with different amplitudes. By analysing the frequency density intervals, the prevalence of a pollutant class could be highlighted and consequently linked to a range of representative concentrations in each urban area for each year analysed. Thus, after a decade, the decrease, stability or increase in a given pollutant could be defined providing a general overview of air quality traits in Catania and giving guidelines for pollution control policies.

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1. Introduction

Continuous atmospheric monitoring for potential human health and ecosystem risks is critically important [1]. Increasing traffic pollutant concentrations are proportional to the increasing number of vehicular traffic. Measures taken in the last ten years especially those norms relating to fuel quality and the emissions of newly registered vehicles have had clearly positive effects regarding CO, C₆H₆ and SO₂. This partial improvement is above all perceived in those cities where the predominant source of pollution is vehicular.

The city of Catania falls into this category having one of the highest motorization indices in Italy at 700 vehicles per 1000 inhabitants. Furthermore, many of these vehicles are old in Euro class 0, registered prior to 1993. Moreover, added to this is the huge number of scooters and motorcycles abetted by the warm climate, the traffic congestion and the shortage of parking [2]. Factors such as domestic heating (abetted by the warm climate) are insignificant as are the emissions from industrial production. Time studies of air pollution concentrations in Catania [3,4] reveal how PM₁₀ concentrations have remained at acceptable levels even in the most congested areas, daily levels of 50 µg/m³ occasionally being verified when air currents bring in dust from the Sahara. In these same areas the most critical air quality criteria is NO₂ above all in urban centres [5,6]. Despite not having reached hourly concentration peaks of 200 µg/m³, during most congestion and least wind concentrations of over 100 µg/m³ have been measured as well as annual means above the baseline of 40 µg/m³ (EU Directive 2008/50). The critically high levels of NO₂ in many cities have not been remedied as they have for other pollutants [7,8].

These analyses identified the pollutants characteristic of the main urban conglomerations of Catania city. The pollutant concentration data were monitored in four monitoring stations in the Air Quality Monitoring Network (AQMN) of the city council. The station locations remained the same between 2003 and 2012 allowing a comparison over ten years of the pollutant concentrations to which the inhabitants had been exposed.

The data population used in this analysis is from the daily average pollutant concentrations in each monitoring station. The pollutants considered were carbon monoxide (CO), nitrogen dioxide (NO₂), nitrogen oxide (NO), sulphur dioxide (SO₂), the particulate (PM₁₀) and ozone (O₃).

To compare the pollutant concentrations measured over the two years were grouped into classes. The subdivisions into classes were carried out as per H.A. Sturges [9,10], which takes into account sample size and provides the optimum interval number (classes). Each class provides a frequency density so intervals with various amplitudes can be compared. The classes with greater frequency densities helped identify the associated concentration interval (CI). By iterating the calculation for each pollutant at the monitoring station, the prevalent pollutant concentration range characteristic for each station could be found and tied to the associated urban conglomeration.

Knowing the various criticalities of city areas in relation to their characteristic pollutants is useful for evaluating pollutant reduction measures and mitigation in urban environments and avoiding less efficient and often useless procedures [11,12].

Nomenclature

N° ₂₀₀₃	Number of Samples for 2003 year [-]
N° ₂₀₁₂	Number of Samples for 2012 year [-]
μ _{max}	Daily maximum mean [µg/m ³] or [mg/m ³]
μ _{min}	Daily minimum mean [µg/m ³] or [mg/m ³]
C	Optimal number of classes [-]
h	Amplitude of the classes [-]
CI	Concentration interval [-]

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