Assessment of Alternative Fuels in Sustainable Mobility: A Case Study on the Modelling of the Atmospheric Emissions Dispersion in the Urban Area of Naples

N. Molaro*, F. Sasso*, E.A. Scelzo*, A. D'Anna*
nunzia.molaro@unina.it
* DICMaPI, Università di Napoli Federico II, P.le Tecchio 80, 80125, Napoli, Italy.

Abstract
Over the twentieth century, the rise in motorized mobility had significant negative social and environmental impacts. This has led to the emergence of the concept of sustainable mobility, which includes low- and zero-emission transport. The aim of this work is to examine the impact of alternative fuels on vehicular traffic emissions and air quality in a small urban area and assess their contribution to a more sustainable mobility. A bottom-up approach to the dispersion analysis was adopted to evaluate three scenarios: the current (baseline) scenario considering all vehicle types currently circulating on the roads within the study area, and two future scenarios involving alternative fuels, one assuming the exclusive use of last generation petrol-powered vehicles, and the other assuming only diesel-powered vehicles. Emission factors for latest-generation alternative fuels were obtained following an experimental campaign, while those for the evaluation of the current scenario were sourced from the literature. Starting from individual vehicle emission factors, an emissions inventory for road traffic was developed and used as input for the CALPUFF dispersion model. The emission factors inventory accounted for hourly traffic volumes, Euro standard classification, fuel type (diesel, petrol, and alternative fuels), and single emission factors for NO_x, $PM_{2.5}$, and CO. The modelling domain was defined as the urban area of San Vitaliano, located in the Naples metropolitan area, covering approximately 6 km², for the period February 2nd–8th, 2023. This small town features a major regional road (Via Nazionale delle Puglie) and a nearby school, both contributing to high traffic volumes and elevated emissions. Seven urban roads and one regional roadway segment were selected as emission sources within the model. Contour maps representing the weakly averaged concentrations of NO_x, CO, and primary $PM_{2.5}$ have been generated for three emission scenarios each. Secondary aerosol formation is also investigated by accounting for the atmospheric chemical processes that transform primary pollutants, as these reactions play a critical role in shaping local air quality dynamics. The results show that areas of maximum impact for all pollutants are concentrated along the regional roadway and near the adjacent school. In future scenarios involving exclusively sustainable petrol and diesel-powered vehicles, emissions are projected to decrease significantly, leading to reduced impacts on local air quality.