EGU24-18978, updated on 12 Jul 2024
https://doi.org/10.5194/egusphere-egu24-18978
EGU General Assembly 2024

Vegetation role in urban atmospheric dynamics and chemistry: comprehensive assessment in two Italian cities

Mihaela Mircea[1], Gino Briganti[1], Felicita Russo[1], Sandro Finardi[2], Camillo Silibello[2], Massimo D'Isidoro[1], Maria Gabriella Villani[1], Andrea Cappelletti[1], Mario Adani[1], Ilaria D'Elia[1], Antonio Piersanti[1], Lina Vitali[1], Andrea Bolignano[1], Nicola Pepe[2], Rossella Prandi[3], and Giuseppe Carlino[3]

[1]Laboratory of Atmospheric Pollution, Italian National Agency for New Technologies, Energy and Sustainable Economic Development – ENEA, Bologna, 40129 Italy (mihaela.mircea@enea.it)

[2]ARIANET Srl, Milano, 20128 Italy

[3]SIMULARIA Srl, Via Sant'Antonio da Padova 12, Torino, 10121 Italy

Cities and towns have become the primary human living space as they offer many opportunities for people, such as employment, educational opportunities, medical assistance, cultural and recreational activities. According to the United Nations studies, the level of urbanization is expected to increase all over the world. Planning a sustainable rapid urbanisation becomes therefore crucial, and it requires scientific based evidence also regarding the effects of vegetation on urban atmosphere considering the urban built structure and all emission sources. This information is also important for urban regeneration making use of nature-based solutions (NBS) and aiming at improving air quality and reducing the impact of climate changes.

It is largely recognised that vegetation contributes to reduce the air temperature and to remove air pollutants in cities, but the impact of its emissions on air quality, together with its effects on the dispersion capacity of the atmosphere, are less known. Biogenic volatile organic compounds (BVOC) that vary with specie and with meteorological conditions, are continuously emitted by vegetation in the atmosphere contributing to the generation, destruction, and transformation of atmospheric pollutants such as gases (O_3 and its precursors) and aerosol particles (PM10).

Here, a comprehensive assessment of vegetation effects on urban atmosphere will be shown for two Italian cities, Bologna and Milan, using the approach proposed in the European project Life VEG-GAP (https://www.lifeveggap.eu/). Specifically, the role of vegetation on urban meteorology is investigated, followed by an evaluation of its impact on air quality. Thus, the direct effects of vegetation on pollution through removal and emission processes are distinctly evaluated from its "indirect" effect acting through meteorology.

The assessments are based on numerical simulations carried out with a state-of-the-art air quality modelling system that uses the chemical transport model FARM and the meteorological model WRF. The BVOC emissions were produced with the species-specific model PSEM and the urban trees inventories provided by the Municipalities.

The outcomes show: 1) the contribution of vegetation ecosystems both as a source and a sink of air pollution in urban areas; 2) the urban vegetation ecosystems' effects on air temperature (urban heating and cooling patterns) and 3) its impact on air quality for the most relevant pollutants (O_3, NO_2, PM10). They also show the relationship between the presence of vegetation and temperature, pollutants' concentrations, and depositions, according to land-use classes and vegetation fraction.

The intercomparison of vegetation effects on urban atmosphere for Bologna and Milan shows that their magnitude, pattern, and space/time variability are city dependent for both meteorological and chemical quantities. In addition, the continuous changes of large-scale meteorological conditions lead to a high variability in the ecosystem services of vegetation that can be realistically assessed only using a VEG-GAP-like approach and cannot be resumed in a simple quantification at city-scale.