12.8 Concentration of particulate matter at respiration height along roads

Project Names: URBAN GreenUP (Grant Agreement no. 730426) and UNaLab (Grant Agreement no. 730052)

Author/s and affiliations: Raúl Sánchez[1], Jose Fermoso[1], Silvia Gómez, María González[1], Jose María Sanz[1], Esther San José[1], Laura Wendling[2], Ville Rinta-Hiiro[2], Maria Dubovik[2], Arto Laikari[2], Malin zu-Castell Rüdenhausen[2]

[1] *CARTIF Foundation. Parque Tecnológico de Boecillo, 205, 47151, Boecillo, Valladolid, Spain*

[2] *VTT Technical Research Centre Ltd, P.O. Box 1000 FI-02044 VTT, Finland*

Concentration of particulate matter ($PM_{2.5}$ and PM_{10}) at respiration height along roadways and streets	**Air Quality**
Description and justification	Road transport and construction operations are identified as major sources of air pollutants in cities. Airborne particulate matter is associated with harmful effects on human cardiovascular and respiratory health. Particles ≤ 10 µm in diameter (PM10), and particularly the finer particles ≤ 2.5 µm in diameter (PM2.5), are associated with road transport vehicles and are of concern due to their small size. One micron (µm) is one-millionth of a meter, or 0.001 millimetres. Green infrastructure along urban streets may act as barriers to direct dispersal of particulate atmospheric pollutants - such as those from vehicles – away from pedestrian areas. Particulates may be deposited on the leaf surface of vegetation or taken up into the leaf surface wax layer, reducing atmospheric particulate concentrations. Monitoring of air quality parameters is complex; involving many potentially interacting variables. Variation in weather conditions; prevailing wind direction and speed; species, size, density, location and structure of vegetation; and the configuration of built urban infrastructure are among that factors that can affect the trajectory and rate of dispersal of particulate pollutants. To assess the impact of NBS on atmospheric concentration of particulate matter, compare outdoor air concentrations of PM10 and PM2.5 at average respiration height (1.5 m above ground level) at locations with and without street-side green interventions to evaluate whether the NBS are associated with reduced local concentrations of airborne PM2.5 and PM10.
Definition	The concentration of PM2.5 and PM10, respectively, per cubic metre of air (units µg m^{-3}) at a measuring height of 1.5 m above the ground surface to represent the air quality experienced by bicyclists and pedestrians.

Strengths and weaknesses	- This method requires the use of specialised equipment (PM monitoring device). - Monitoring campaigns involve manual measurements, requiring personnel.
Measurement procedure and tool	Measure air concentrations of PM2.5 and PM10 at defined sampling points at a height of 1.5 m above ground level and a range of linear distances from NBS street tree/green wall locations, both pre- and post-intervention. Compare these data to measurements taken at analogous locations on equivalent stretches of road without street-side NBS at similar times of day on the same dates. A portable photometric sampler designed to measure ambient PM2.5 and PM10 concentrations can be used to gather data on a non-continuous basis, i.e., during planned field monitoring campaigns. Data can be collected and stored on the device, then can be downloaded later to a PC. Compare the particulate matter (PM2.5 and PM10) values qualitatively and quantitatively for the periods before and after the interventions in the NBS and reference sections. Quantitatively assess using the following expression: $\boldsymbol{PM\ impact} = \left(\frac{NBS\ Measures\ average\ after\ intervent. - NBS\ Expected\ average\ a}{NBS\ Expected\ average\ after\ intervent.}\right. \times 100$ Where *measures average after intervent.* is the average value of measurements after interventions and *Expected value after intervent.* (but supposing that interventions had not been done) is: $\boldsymbol{NBS\ Expected\ average\ after\ intervent.} = \left(\frac{Ref.average\ after\ intervent.}{Ref.average\ before\ intervent.}\right) \times NBS\ Measures\ before\ intervent.$ PM impact can be calculated both for PM2,5 and PM10. Positive or null PM impact values indicates negative or no impact of the NBS on PM concentration for that implementation. Negative values indicates a positive impact of that NBS on PM concentration.
Scale of measurement	Building - street –neighbourhood scale
Data source	
Required data	Atmospheric PM2.5 and PM10 concentration data (in µg m^{-3}) obtained at a height of 1.5 m above ground level using (a) portable monitoring device(s).

Data input type	
Data collection frequency	Both intervention and analogous control study sites should be sampled on the same occasion during each round of sampling (i.e., an NBS intervention site and matched control should be sampled on the same date and as close to the same time of day as possible). Ideally, each pre-determined sampling location at a study site should be repeat sampled every 4 weeks for one year pre-intervention, and for at least two years following intervention.
Level of expertise required	Medium
Synergies with other indicators	
Connection with SDGs	SDG3 / SDG11
Opportunities for participatory data collection	Potential to collaborate with local universities or secondary schools (e.g., science and/or health classes) to collect data, depending on availability of sampling equipment.
Additional information	
References	URBAN GreenUP Deliverable D2.4 - Monitoring program to Valladolid. https://www.urbangreenup.eu/insights/deliverables/d2-4---monitoring-program-to-valladolid.kl URBAN GreenUP Deliverable D3.4 - Monitoring program to Liverpool https://www.urbangreenup.eu/insights/deliverables/d3-4---monitoring-program-to-liverpool.kl URBAN GreenUP Deliverable D4.4 – Monitoring program to Izmir https://www.urbangreenup.eu/insights/deliverables/d4-4--monitoring-program-to-izmir.kl URBAN GreenUP Deliverable D5.3: City Diagnosis and Monitoring Procedures https://www.urbangreenup.eu/insights/deliverables/d5-3-city-diagnosis-and-monitoring-procedures.kl Air Pollution in the UK 2015. https://uk-air.defra.gov.uk/library/annualreport/index Bottalico, F., Chirici, G., Giannetti, F., De Marco, A., Nocentini, S., Paoletti, E., Salbitano, F., Sanesi, G., Serenelli, C., Travaglini, D., 2016. Air pollution removal by green infrastructures and urban forests in the city of Florence. Agric. Agric. Sci. Procedia 8, 243–251. doi:10.1016/j.aaspro.2016.02.099. Mullaney, J., Lucke, T., Trueman, S.J., 2015. A review of benefits and challenges in growing street trees in paved urban

	environments. Landscape Urban Plan. 134, 157–166. doi:10.1016/j.landurbplan.2014.10.013. Baró, F., Haase, D., Gómez-Baggethun, E., Frantzeskaki, N., 2015. Mismatches between ecosystem services supply and demand in urban areas: A quantitative assessment in five European cities. Ecol. Indic. 55, 146–158. doi:10.1016/j.ecolind.2015.03.013.

12.9 Mean level of exposure to ambient air pollution

Project Name: URBAN GreenUP (Grant Agreement no. 730426)

Author/s and affiliations: Raúl Sánchez[1], Jose Fermoso[1], Silvia Gómez, María González[1], Jose María Sanz[1], Esther San José[1]

[1] *CARTIF Foundation. Parque Tecnológico de Boecillo, 205, 47151, Boecillo, Valladolid, Spain*

Mean level of exposure to ambient air pollution	Air Quality
Description and justification	Air pollution consists of many pollutants, among other particulate matter. These particles are able to penetrate deeply into the respiratory tract and therefore constitute a risk for health by increasing mortality from respiratory infections and diseases, lung cancer, and selected cardiovascular diseases. The mean annual concentration of fine suspended particles of less than 2.5 microns in diameters ($PM_{2.5}$) is a common measure of air pollution. The mean is a population-weighted average for urban population in a country, and is expressed in micrograms per cubic meter [µg/m3]. Other important pollutants are ozone and NO_X. This indicator can be calculated using the different pollutants depending on the data availability and problems caused by each pollutant (according maximum levels reached in extreme events). This indicator has been defined using the SDG indicators numbers 3.9.1 and 11.6.2 as references but adapting it for use at urban scale.
Definition	This KPI is useful to assess the level of population exposed to low air quality levels in the city and the importance of this challenge for the city. Further analysis could be developed using public health or hospital admission data to correlate the importance or green infrastructure on air quality levels. This KPIs is calculated from ground measurements by the official Air Quality monitoring networks in cities applying a methodology defined by URBAN GreenUP Project adapted from different sources. Additionally, information on the