12.7 Concentration of particulate matter (PM_{10} and $PM_{2.5}$), NO_2, and O_3 in ambient air

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Concentration of particulate matter (PM_{10} and $PM_{2.5}$), NO_2, and O_3 in ambient air	Air Quality
Description and justification	Air pollution is considered the single largest environmental health risk in the world, causing an estimated 2-6 million or more yearly deaths globally (Health Effects Institute [HEI], 2018; World Health Organisation [WHO], 2016). An important focus of research has been on the role of urban vegetation in the formation and removal of air pollutants in cities (e.g., Miranda et al., 2017) and the associated impacts of air pollution on morbidity, mortality and life-expectancy (e.g., Costa et al., 2014). The most relevant pollutants in air are particulate matter of different sizes (PM2.5, PM10), ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAHs), carbon monoxide (CO), benzene (C_6H_6) and toxic metals (As, Cd, Ni, Pb and Hg) (EEA, 2018b). Whilst different pollutants can have large local effects, the most prevalent pollutants with most serious health effects are particulate matter, ozone and nitrogen dioxide, which are selected for metrics here.
Definition	Concentration of $PM_{2.5}$, PM_{10}, NO_2 and ground-level O_3 ($\mu g/m^3$) in ambient air
Strengths and weaknesses	+ Accurate results with automated measurements - Some of the measurement systems can be expensive and they need constant management and upkeep
Measurement procedure and tool	Air pollution concentrations can be estimated based on measured and/or modelled concentrations in ambient air (O_3, NOx, VOC, PM_{10} and $PM_{2.5}$) near the NBS intervention area. Data can be retrieved from air quality monitoring stations or from measured values during experimental campaigns. Data can also be estimated by applying air quality models, such as the WRF-Chem model (National Oceanic and Atmospheric Administration [NOAA], n.d.), which estimates 3D concentration fields with an hourly resolution at the grid, neighbourhood or city scale.

	Particulate matter (PM_{10} and $PM_{2.5}$) concentration: Particulate matter is measured using an air sampler that draws ambient air at a constant flow rate through a specially shaped inlet onto a filter that is weighed periodically to measure the accumulated particle load. The inlet defines the particle size cut-off (2.5 or 10 µm). A stationary measuring station is placed in a representative traffic, urban, industrial or rural location and continuous measurement of particulate matter using standardized air sampler equipment is undertaken. Daily averages are averaged over a year to reach a yearly average, which acts as the indicator (ISO, 2018). *Nitrogen dioxide (NO2) concentration:* To quantify nitrogen dioxide, a stationary measuring station is placed in a representative traffic, urban, industrial or rural location and continuous measurement of nitrogen dioxide using standardized equipment is undertaken. An average of hourly averages is used to calculate a daily average and daily averages to calculate a yearly average, which acts as the indicator (ISO, 2018). *Ground-level ozone (O_3) concentration:* A stationary measuring station is placed in a representative traffic, urban, industrial or rural location and continuous measurement of ozone using standardized equipment is undertaken. The convention for ozone measurement is to calculate a daily maximum 8-hour mean, which acts as the indicator (ISO, 2018).
Scale of measurement	District to region scale
Data source	
Required data	Pollutant measurement data
Data input type	Quantitative
Data collection frequency	Continuous measurements with hourly, daily, monthly, and yearly averages
Level of expertise required	Low – for continuous measurements Moderate – for evaluating data artefacts
Synergies with other indicators	Other indicators in the *Air quality* indicator group
Connection with SDGs	SDG 3 Good health and well-being, SDG 15 Life on land
Opportunities for participatory data collection	No opportunities identified

Additional information	
References	Costa, S., Ferreira, J., Silveira, C., Costa, C., Lopes, D., Relvas, H., … Teixeira, J.P. (2014). Integrating Health on Air Quality Assessment - Review Report on Health Risks of Two Major European Outdoor Air Pollutants: PM and NO2. Journal of Toxicology and Environmental Health - Part B Critical Reviews, 17(6), 307-340. European Environment Agency. (2018b). Air quality in Europe – 2018 report. EEA Report No. 12/2018. Luxembourg: Publications Office of the European Union. Retrieved from https://www.eea.europa.eu/publications/air-quality-in-europe-2018 Health Effects Institute (HEI). (2018). State of Global Air 2018. Special Report. Boston, MA: Health Effects Institute. International Organization for Standardization (ISO). (2018). Sustainable cities and communities — Indicators for city services and quality of life (ISO 37120:2018). Available from https://www.iso.org/standard/68498.html Miranda, A.I., Martins, H., Valente, J., Amorim, J.H., Borrego, C., Tavares, R., … Alonso, R. (2017). Case Studies: modeling the atmospheric benefits of urban greening, In D. Pearlmutter, C. Calfapietra, R. Samson, L. O'Brien,S. Ostoic, G. Sanesi, R. Alonso (Eds.), The Urban Forest. Cultivating Green Infrastructures for People and the Environment (pp. 89-99). New York: Springer International Publishing. National Oceanic and Atmospheric Administration (NOAA). (n.d.). Weather Research and Forecasting model coupled to Chemistry (WRF-Chem). Retrieved from https://ruc.noaa.gov/wrf/wrf-chem/ World Health Organization (WHO). (2016). Ambient air pollution: A global assessment of exposure and burden of disease. Geneva: World Health Organization. Retrieved from https://www.who.int/phe/publications/air-pollution-global-assessment/en/