11.2 Proportion of population exposed to ambient air pollution

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Proportion of population exposed to ambient air pollution	**Air Quality**
Description and justification	High population densities in urban areas and related economic activities result in increased emissions of air pollutants, which in turn lead to higher ambient concentrations of these pollutants and higher rates of human exposure. Urban areas across the European Union (EU) arehome to more than 70% of the population of the EU-28 (Eurostat, 2014b). The latest World Health Organization (WHO) review of the health effects of air pollution (WHO, 2013) concluded that particulate matter (PM), ozone (O_3) and nitrogen dioxide (NO_2) observed at levels commonly present in Europe have adverse health effects of. A 2013 assessment by the WHO's International Agency for Research on Cancer (IARC) (D. Loomiset al., 2013) concluded that outdoor air pollution is carcinogenic to humans, with the particulate matter component of air pollution most closely associated with an increased incidence of cancer, especially lung cancer. This is in addition to the role air pollution plays in the development of heart and respiratory diseases, including acute respiratory infections and chronic obstructive pulmonary diseases. This indicator focuses on the air pollutants that are more relevant in terms of their health effects and urban concentrations: PM — both PM_{10} (particles with a diameter of 10 micrometres or less) and fine PM, or $PM_{2.5}$ (particles with a diameter of 2.5 micrometres or less); O_3; NO_2; sulphur dioxide (SO_2); and benzo[a]pyrene (BaP). According to several WHO studies (WHO, 2000, 2006, 2013, 2014), exposure to PM can cause or aggravate cardiovascular and lung diseases, heart attacks and arrhythmias. It can also affect the central nervous system, the reproductive system and cause cancer. Exposure to high O_3 concentrations can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases. Exposure to NO_2 increases symptoms of bronchitis in asthmatic children and reduces lung function growth. SO_2 can affect the respiratory system and the

	functioning of the lungs, and causes irritation of the eyes. Finally, BaP is carcinogenic and is used as an indicator of the carcinogenic effect of the total polycyclic aromatic hydrocarbons (PAHs). This indicator can be used to assess the impact of the NBS implantation using data before and after the implementation or to compare data in cities with different level of NBS or GI implantation.
Definition	Urban population exposed to air pollutant concentrations above EU standards and WHO air quality guidelines The following units are used in this indicator: **Concentration**: micrograms (mg) of pollutant per cubic metre for $PM_{2.5}$, PM_{10}, O_3, NO_2 and SO_2. Nanograms (ng) of pollutant per cubic metre for BaP. **Urban population** (POP): number of inhabitants in the 'core city' and, from 2016 on, 'greater city' of the Urban Audit cities represented by the urban stations taken into account in the calculations. **Percentage of the urban population**.
Strengths and weaknesses	+ Accurate results with automated measurements + Based on the reported monitoring data by Member States - Some of the measurement systems can be expensive and require continual management and upkeep - Methodological uncertainty, data uncertainty and rationale uncertainty
Measurement procedure and tool	**Urban population exposure** Information on cities is obtained from the Urban Audit (UA) data (Eurostat, 2014c). The urban population considered is the total number of people represented by any of the urban monitoring stations in the 'core city' and, from 2016, the 'greater city' of the UA cities taking part in the calculations. Initially, stations in the EEA air-quality database are spatially joined with UA core and, from 2016, greater cities in a geographical information system in order to select those stations that fall within the boundaries of the cities included in the UA collection. The selected stations include station types classified as 'urban traffic', 'suburban traffic', 'urban background' and 'suburban background'. According to a study for the European Commission by Entec UK Limited (EC, 2006), in Europe, on average, 5% of the city population lives closer than 100 m from major routes and is therefore potentially exposed to concentrations measured at traffic stations. The remaining 95% of the city population is assumed to be exposed to urban and suburban background concentrations. These percentages vary among jurisdictions.

To calculate the percentages of persons living closer than 100 m to major traffic routes, national data on the population living closer than 100 m from major roads can been taken from Appendix D (EC, 2006).

For PM_{10}, $PM_{2.5}$, O_3, NO_2 and SO_2, only stations with at least 75% of valid data per calendar year are used. For BaP, the minimum data time coverage accepted is 14% (51 days), according to the data quality objectives related to indicative measurements in the Directive 2004/107/EU (EU, 2004).

For each year, each city (i) in country (j), and every pollutant, the total number of urban or suburban traffic stations (nit) and the total number of urban or suburban background stations (nib) are obtained. A percentage (Ptj %) of the total population of the city (Popi) is proportionally assigned to each of the traffic stations and Pbj % of Popi is proportionally assigned to each of the background stations. Thus, every traffic station has an allocated population equal to ((Ptj / 100) * Popi / nit) and every background station has an allocated population equal to ((Pbj /100) *Popi / nib).

EU LIMIT AND TARGET VALUES

Fine particulate matter ($PM_{2.5}$)

The annual mean concentration is calculated for each of the selected stations fulfilling the valid data criteria. Depending on the mean concentration, each station (and its allocated population) is then classified uniquely in one of the two concentration classes (less than or equal to the target value (25 µg/m^3), or greater than the target value).

The percentage of the urban population allocated to these two concentration classes is calculated by dividing the population represented by the stations assigned to each concentration class by the sum of the population assigned to each station.

Coarse particulate matter (PM_{10})

For each selected station that fulfils the valid data criteria, the 90.4 percentile (P90.4) of the daily mean concentration series is calculated. P90.4 represents, in a complete series of 365 elements, the 36th highest value. When P90.4 is less than or equal to 50 µg/m^3, it indicates that the daily limit value (DLV) was not exceeded on more than 35 days.

Depending on the value of P90.4, each station (and its allocated population) is then classified uniquely in one of the two concentration classes (P90.4 > 50 µg/m^3, i.e., greater than the DLV and P90.4 ≤ 50 µg/m^3, i.e., less than the DLV).

The percentage of the urban population allocated to these two concentration classes is calculated by dividing the population represented by the stations assigned to each individual

concentration class by the sum of the population assigned to each station.

Ozone (O_3)

For each selected station fulfilling the valid data criteria, the 93.2 percentile (P93.2) of the daily maximum 8-hourly mean concentration series is calculated. P93.2 represents, in a complete series of 365 elements, the 26th highest value. When P93.2 is less than or equal to 120 µg/m^3, it indicates that the long term objective was not exceeded on more than 25 days.

Depending on the value of P93.2, each station (and its allocated population) is then classified uniquely in one of the two concentration classes (P93.2 >120 µg/m^3, i.e., exceedance of the long term objective on more than 25 days, and P93.2 ≤120 µg/m^3, i.e., exceedance of the long term objective on fewer than or equal to 25 days).

The percentage of the urban population allocated to these two concentration classes is calculated by dividing the population represented by the stations assigned to each individual concentration class by the sum of the population assigned to each station.

Nitrogen dioxide (NO_2)

The annual mean concentration is calculated for each of the selected stations that fulfills the valid data criteria.

Depending on the annual mean concentration, each station (and its allocated population) is then classified uniquely in one of the two concentration classes (less than or equal to the limit value (40 µg/m^3), or greater than the limit value).

The percentage of the urban population allocated to these two concentration classes is calculated by dividing the population represented by the stations assigned to each concentration class by the sum of the population assigned to each station.

Benzo[a]pyrene (BaP)

The annual mean concentration is calculated for each of the selected stations fulfilling the valid data criteria.

Depending on the mean concentration, each station (and its allocated population) is then classified uniquely in one of the two concentration classes (less than or equal to the target value (1.0 ng/m^3), or greater than the target value).

The percentage of the urban population allocated to these two concentration classes is calculated by dividing the population represented by the stations assigned to each concentration class by the sum of the population assigned to each station.

	Sulfur dioxide (SO_2) For each selected station that fulfills the valid data criteria, the 99.2 percentile (P99.2) of the daily mean concentration series is calculated. P99.2 represents, in a complete series of 365 elements, the 4th highest value. When P99.2 is less than or equal to 125 µg/m^3, it indicates that the daily limit value would was not exceeded on more than three days. Depending on the value of P99.2, each station (and its allocated population) is then classified uniquely in one of these two concentration classes (P99.2 >125 µg/m^3, i.e., greater than the daily limit value and P99.2 ≤125 µg/m^3, i.e., less than the daily limit value). The percentage of the urban population allocated to these two concentration classes is calculated by dividing the population represented by the stations assigned to each individual concentration class by the sum of the population assigned to each station. *For a more detailed description of the indicator, please follow the link in the first reference listed below.*
Scale of measurement	At sampling points as indicated by the data resolution needed to quantify NBS impacts. EEA data are provided at district to region scale. Data regarding microclimatic impacts of NBS can be obtained by installation of specific sensors in close proximity to implemented NBS.
Data source	
Required data	• Air Quality e-Reporting (AQ e-Reporting) provided by European Commission (https://www.eea.europa.eu/ds_resolveuid/DAT-3-en) • AirBase - The European air quality database provided by European Environment Agency (EEA) (https://www.eea.europa.eu/ds_resolveuid/DAT-3-en) • Gisco - Urban Audit 2012 provided by Statistical Office of the European Union (Eurostat) (https://www.eea.europa.eu/data-and-maps/data/external/gisco-urban-audit) • City population provided by City Population (https://www.eea.europa.eu/data-and-maps/data/external/city-population)
Data input type	Quantitative
Data collection frequency	Annually

Level of expertise required	Moderate to High (Air quality expert and IT expert)
Synergies with other indicators	*Number of days during which air quality parameters exceed threshold v*alues, *European Air Quality Index* and the other indicators of the Air Quality group.
Connection with SDGs	SDG 3 Good health and well-being; SDG 11 Sustainable cities and communities; SDG 15 Life on land
Opportunities for participatory data collection	None identified
Additional information	
References	**Exceedance of air quality standards in urban areas EEA (2019).** https://www.eea.europa.eu/data-and-maps/indicators/exceedance-of-air-quality-limit-3/assessment-5 Permalink: https://www.eea.europa.eu/ds_resolveuid/13c96efc7a1f44ee9337b2e2cdf077a9 EC, 2006 - Development of a methodology to assess the population exposed to high levels of noise and air pollution close to major transport infrastructure, prepared by Entec UK Limited (Appendix D). ETC/ACC, 2009 - Indicators on urban air quality. A review of current methodologies. ETC/ACC Technical paper 2009/8 (http://acm.eionet.europa.eu/reports/ETCACC_TP_2009_8_UrbanAQindicators) EU, 2004 - Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004L0107 Eurostat, 2014c - Urban Audit. (http://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/urban-audit).https://www.eea.europa.eu/data-and-maps/indicators/exceedance-of-air-quality-limit-3/assessment-5 https://www.eea.europa.eu/data-and-maps/indicators/exceedance-of-air-quality-limit-3/assessment-5