Opportunities for participatory data collection	-
Additional information	
References	Kraus, F.; Scharf, B. (2019): Management of urban climate adaptation with NBS and GREENPASS®. Geophysical Research Abstracts. Vol. 21, EGU2019-16221-1, 2019 EGU General Assembly 2019. Kraus, F.; Scharf, B. (2019): Climate-resilient urban planning and architecture with GREENPASS illustrated by the case study 'FLAIR in the City' in Vienna. OP Conf. Ser.: Earth Environ. Sci. 323 012087. Nature4Cities, D2.1 - System of integrated multi-scale and multi-thematic performance indicators for the assessment of urban challenges and NBS. https://www.nature4cities.eu/post/nature4cities-defined-performance-indicators-to-assess-urban-challenges-and-nature-based-solutions. Nature4Cities, D2.2 - Expert-modelling toolbox Nature4Cities, D2.3 – NBS database completed with urban performance data https://www.nature4cities.eu/post/applicability-urban-challenges-and-indicators-real-case-studies Nature4Cities, D2.4 - Development of a simplified urban performance assessment (SUA) tool

12.4 NO_X and PM in gaseous releases

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

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NO_X and PM in gaseous releases	Air Quality
Description and justification	Other indicators are defined to assess general impacts of implemented NBS on air quality at building, district or city scale. In contrast, this indicator is focused on the impact of specific NBS on a polluted gaseous stream prior to release into the urban atmosphere. This indicator has been mainly defined for the Urban Garden BioFilter but in the future can be used for other NBS to be installed in outdoor pipes to capture pollutants. At laboratory scale, the impact of this NBS has been measured by a setup with air characterisation upstream

	and downstream of the filter. However, real world applications of interventions and measurements of air quality are relatively more complex. Inlet air can be measured by installing a sensor in the area where air is going to be extracted or inside of the inlet pipe. However, outlet air cannot be captured directly as the atmosphere is an open system. Thus, the ideal sensor configuration involves installation of two measuring points, one before and at least one after the BioFilter. One post-filter measuring point should be within the outdoor area in close proximity to the gas release point. A second, more distant post-filter measuring point (within the expected flow path of effluent gas) is recommended. These three measuring points are to be instrumented with $PM_{2.5}$ and NOx sensors.
Definition	Measure air concentrations of NO_2 and $PM_{2.5}$ ($\mu g/m^3$) at sampling points at a range of radii from NBS location both pre- and post-intervention. Compare these data to measurements taken at equivalent locations on equivalent stretches of street without NBS at a similar time of day on the same dates.
Strengths and weaknesses	- Specific Method for polluted air solutions. - PM monitoring device required.
Measurement procedure and tool	**<u>Data processing</u>** Calculation of (weekly, monthly and/or Annually) mean levels of NO_2, PM_{10} and $PM_{2.5}$ at each sampling location as the average value of the all the measurements done before and after of the interventions. Comparison of mean values for NBS intervention and control sample locations in the implementation area. Data comparison before and after of the intervention using the reference to assess possible meteorological or other factors influence. Calculations must be done using comparable periods of time before and after the interventions (i.e., if measurement period before of the intervention goes from nov18-oct19, measurement period must be at minimum from nov19-oct21 and processing can be done for either years or Annually). For this KPI, continuous records of air quality are available and, therefore, a different processing of the information will be applied to evaluate the impact of the NBS. **<u>Results</u>** The calculated values will be compared qualitatively and quantitatively for the periods before and after the interventions in the NBS and reference sections.

Quantitative assessment will be done by 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:

$$\boldsymbol{NBS\ Expected\ average\ after\ intervent.} = \left(\frac{Ref.average\ after\ intervent.}{Ref.average\ before\ intervent.}\right) \times NBS\ Measures\ before\ intervent.$$

Positive or null NO_2, PM_{10} and $PM_{2.5}$ 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 NO_2, PM_{10} and $PM_{2.5}$ concentration.

The additional methodology (using continuous data) aims to find significant differences by comparing the normalized distributions of the difference between the sections with NBS and the reference sections.

First, the normalized distribution of the difference of the hourly values of the NBS location and the reference location is calculated. Then, the distributions of data before and after of the interventions are compared. If significant differences are found between the distributions before and after the implementation, then the impact of the NBS can be assessed.

If the centers of the histograms of both distributions (before and after the implementation) are separated by more than the sum of the standard deviations, σ (i.e., 2σ), then they will be considered as significantly different (with a 95% probability). If the center of the histogram of the situation after the implementation is lower than that of the previous situation (and the differences are significant) then it will be concluded that the impact of the NBS is appreciable. As an equation, this statement could be presented as follows:

$$Absolut\ value\left(Aver._{before} - Aver._{after}\right) > \sigma_{before} + \sigma_{after}\ Positive\ impact$$

$$Absolut\ value\ \left(Prom._{before} - Prom._{after}\right) < \sigma_{before} + \sigma_{after}\ Neglective\ impact$$

	This procedure is suitable for both $PM_{2.5}$ and NO_2.
Scale of measurement	street/Building
Data source	
Required data	Concentrations of NO_2 and airborne particulate matter are measured by recording PM mass per cubic metre of air ($PM_{2.5}$ and PM_{10}). PM - Micrograms (mcg) per cubic metre, µg/m^3. (Microgram (µg) One-millionth of a gram; a milligram (mg) = 1000 micrograms). NO_2 – ppb (parts per billion). Parts per billion (ppb) is the number of units of mass of a contaminant per 1000 million units of total mass.
Data input type	Continuous monitoring of NO2 and particulate matter.
Data collection frequency	Continuous monitoring in the selected points hourly.
Level of expertise required	High
Synergies with other indicators	
Connection with SDGs	SDG3 / SDG11
Opportunities for participatory data collection	--
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

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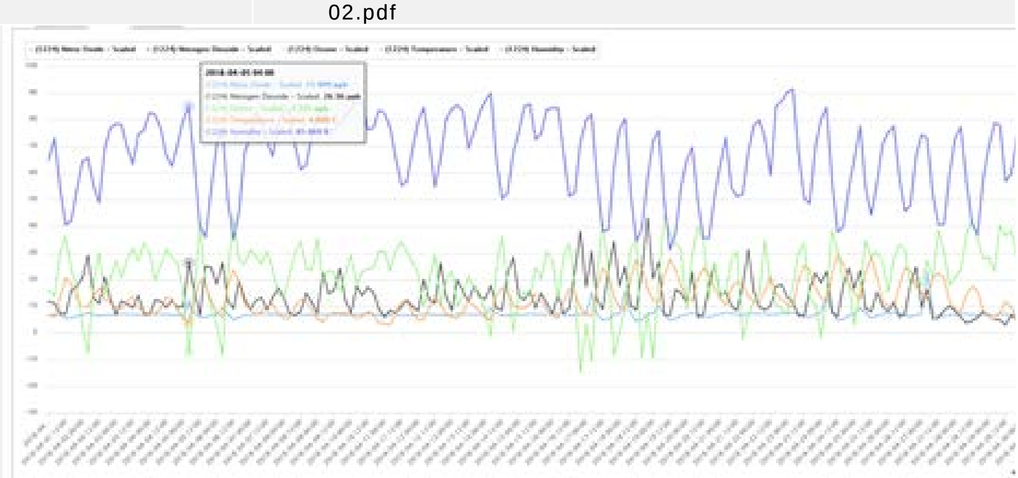
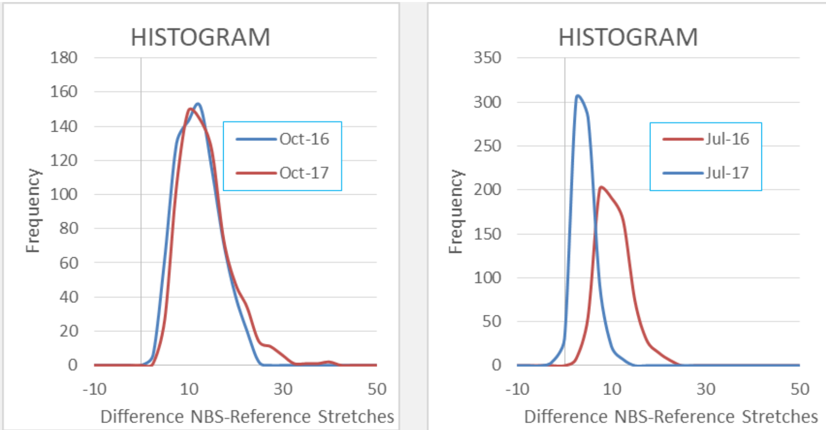
SDG indicator 3.9.1 https://unstats.un.org/sdgs/metadata/files/Metadata-03-09-01.pdf

SDG indicator 11.6.2. https://unstats.un.org/sdgs/metadata/files/Metadata-11-06-02.pdf



Data collection example.



No significant differences — Significant differences

	Oct-16	Oct-17
Average	10,8	12,4
Stand. Desv.	4,5	5,4

	Oct-16	Oct-17
Average	9,3	3,1
Stand. Desv.	3,6	2,3

Example of data processing.

12.5 Ambient pollen concentration

Project Name: UNaLab (Grant Agreement no. 730052)

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Ambient pollen concentration	**Green Space Management Air Quality**
Description and justification	Urban green spaces frequently have a limited number of plant species, including a higher proportion of non-native species in comparison with rural areas (McKinney, 2002). The low species diversity in many urban areas is directly linked to the formation of concentrated pollen emission sources. In particular, large-scale use of a small number of roadside tree species results in production of large quantities of a single species of pollen. Areas of concentrated pollen may not be readily dispersed by air currents. Some studies indicate that urban citizens are 20% more likely to suffer airborne pollen allergies than people living in rural areas, largely due to the uniformity of green spaces, where a small number of species that