	natural area, and *Availability and equitable distribution of blue-green space* indicators
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	Buters, J.T.M., Antunes, C., Galveias, A., Bergmann, K.C., Thibaudon, M., Galán, C. … & Oteros, J. (2018). Pollen and spore monitoring in the world. Clinical and Translational Allergy, 8, 9. Cariñanos, P., & Casares-Porcel, M. (2011). Urban green zones and related pollen allergy: A review. Some guidelines for designing spaces with low allergy impact. Landscape and Urban Planning, 101(3), 205-214. McKinney, M. (2002). Urbanization, Biodiversity, and Conservation: The impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems. BioScience, 52(10), 883-890.

12.6 Trends in NOx and SOx emissions

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

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Trends in Emissions of NOx and SOx	**Air Quality**
Description and justification	It is estimated that in the UK air pollution reduces overall life expectancy by seven to eight months, with estimated annual health costs of up to £20 billion. The impacts are higher on the most vulnerable, including lifelong impact on children. The predominant source of NOx in Europe is road transport and it is thought that half of emissions in Europe originate from this source; certainly the highest concentrations of NO_2 are generally found close to busy roads in urban areas In keeping with other local authorities across England and Wales, Liverpool and the wider city region is close to failing to meet the European Union (EU) air quality standard for Nitrogen Dioxide (NO_2) which is measured as an annual

	mean of 40 µg/m^3. High levels of NO_2 have a health impact on the local population; in particular those suffering from existing heart related conditions, asthma and chronic obstructive pulmonary disease. Whilst air pollution from NO_2 cannot be said to be the single direct causal effect upon hospital emissions, it does contribute. The main source of SO_2 is fossil fuel combustion. SOx emissions in the UK have decreased substantially since 1992, due to reductions in the use of coal, gas and oil, and also to reductions in the sulphur content of fuel oils and diesel fuel used for road vehicles (DERV). The decrease in emissions over time is the continuation of an on-going trend partly due to the decline of the UK's heavy industry.
Definition	Measure air concentrations of NOx and SOx in µg/m^3 at identified sampling points close to planned nature-based interventions and highway improvement schemes both pre- and post-intervention. Compare these data for differences, and also compare these data to historical city wide data to identify trends.
Strengths and weaknesses	It should be noted that diffusion tubes have two limitations. Firstly, they are an indicative monitoring technique. Whilst ideal for screening surveys, or for identifying locations where NO_2 concentrations are highest, they do not provide the same level of accuracy as automatic monitoring techniques. Secondly, as the exposure period is typically several weeks, the results cannot be compared with air quality standards and objectives based on shorter averaging periods such as hourly means. Diffusion tube samplers operate on the principle of molecular diffusion, with molecules of a gas diffusing from a region of high concentration (open end of the sampler) to a region of low concentration (absorbent end of the sampler).
Measurement procedure and tool	Diffusion tubes designed to measure dissolved gaseous emissions of NOx and SOx are a type of passive sampler; that is, they absorb the pollutant to be monitored directly from the surrounding air and need no power supply. Passive samplers are easy to use and relatively inexpensive, so they can be deployed in large numbers over a wide area, giving good spatial coverage. This has made them a popular choice for municipal authorities, who often use diffusive samplers to complement more expensive automatic monitoring techniques, or at locations where it would not be feasible to install an automatic monitor. Cities can compare outdoor air concentrations of NOx and SOx measured by diffusion tube samplers to that

	obtained using established practices to ensure that the data remain comparable to historical citywide baselines. NOx and SOx can be measured by mounting diffusion tubes on street infrastructure owned by the city council, such as lamp posts, a monitoring height of roughly 3 m. The height of the diffusion tube placement is a little higher than adult head height but is necessary in a public place to reduce unauthorised removal of tubes and disruption to monitoring. The diffusion tubes typically remain in situ for a month and are then removed and replaced. Usually two people are required to remove and replace tubes and a litter picker can be used to retrieve and replace tubes. Retrieved diffusion tubes are generally sent to a laboratory for analysis. Concentrations of NOx and SOx ($\mu g/m^3$) will be provided following laboratory analysis.
Scale of measurement	Street-neighbourhood
Data source	
Required data	The location and nature of the various NBS interventions will dictate the final positioning and type of diffusion tube and they will not necessarily be spread equally between NBS demonstration areas or other air quality monitoring stations. An option exists to consider some limited replication at key sites and to utilise any current data from existing diffusion tube sampling at appropriate locations.
Data input type	Numerical data associated at different places at different times.
Data collection frequency	Both the NBS intervention site and the control study site should be sampled on the same occasion. Each fixed sampling location at a study site should be sampled every month for one year pre-intervention, and for a period of at least two years following NBS implementation.
Level of expertise required	High
Synergies with other indicators	
Connection with SDGs	SDG3 / SDG11
Opportunities for participatory data collection	None identified
Additional information	

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