12.3 Modelled O_3, SO_2, NO_2 and CO capture/removal by vegetation

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Modelled air pollutant capture/removal by vegetation	Air Quality
Description and justification	Vegetation can remove air pollutants (particles and gases) by the process of dry deposition. Deposition is the transport from a point in the air to a plant surface, which is mainly related to near-surface pollutant concentration, weather conditions and vegetation properties. Most plants have a large surface area per unit volume, increasing the probability of deposition compared with the smooth, manufactured surfaces present in urban areas. For example, 10-30 times faster deposition has been reported for sub-micrometre (<µm) particles on synthetic grass compared with glass and cement surfaces (Air Quality Expert Group [AQEG], 2013; Roupsard, Amielh, Maro, Coppalle, & Branger, 2013). To estimate the magnitude of this contribution models are commonly used.
Definition	Annual capture of O_3, SO_2, NO_2, CO and $PM_{2.5}$ by trees and shrubs and grass (all expressed in units of mass, report as kg/ha/y)
Strengths and weaknesses	+ Effective method for extensive analyses - Needs expert users and a lot of input data
Measurement procedure and tool	The chemical transport model WRF-Chem (National Oceanic and Atmospheric Administration [NOAA], n.d.) has a dry deposition model that can estimate the amount of pollutants removed by vegetation (O_3, NOX, VOC, PM_{10} and $PM_{2.5}$) with an hourly resolution per grid cell. As input data WRF-Chem requires: i) high resolution inventory of anthropogenic emissions; ii) biogenic emissions (MEGAN model; Guenther et al., 2006); iii) initial and boundary conditions (MOZART model; Emmons et al., 2010); and,

	iv) topography and land use (United States Geological Survey [USGS] 33 classes database; Pineda et al., 2004). These results can be used to calculate the annual amount of pollutants removed by vegetation at the grid, neighbourhood or city scale. The i-Tree Eco model (USDA Forest Service, 2019) can also be applied to estimate the air pollutants removed by vegetation. Although it does not provide spatial variability, it can calculate hourly amounts of pollutants removed by urban forests, as well as the associated percentage of air quality improvement throughout a year. Pollution removal is calculated for ozone (O_3), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particulate matter ($PM_{2.5}$). To apply the i-Tree Eco model, the following data is required: i) extent of vegetation cover and characteristics (e.g., type, age and height); ii) land use; iii) air quality; and, iv) meteorology. Results can be used to calculate the annual amount of pollutants removed by vegetation at the local scale.
Scale of measurement	Street to metropolitan scale
Data source	
Required data	Various requirements based on the model type; see *Measurement procedure and tool*
Data input type	Qualitative and quantitative
Data collection frequency	Before and after the NBS implementation
Level of expertise required	Moderate to High – to apply models and evaluate the outcomes
Synergies with other indicators	Other indicators of the *Air Quality* 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	Air Quality Expert Group [AQEG]. (2018). Impacts of Vegetation on Urban Air Pollution. Prepared for Department for Environment, Food and Rural Affairs, Scottish Government, Welsh Government, and Department of the Environment in Northern Ireland. Carlisle, UK: Department for Environment, Food and Rural Affairs. Retrieved from https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1807251306_180509_Effects_of_vegetation_on_urban_air_pollution_v12_final.pdf. Emmons, L.K., Walters, S., Hess, P.G., Lamarque, J.-F-, Pfister, G.G., Fillmore, D. … Kloster, S. (2010). Description and evaluation of the Model for Ozone and Related chemical Tracers, version 4 (MOZART-4). Geoscientific Model Development, 3, 43-67. Guenther, A., Karl, T., Harley, P., Wiedinmyer, C., Palmer, P.I., & Geron, C. (2006). Estimates of global terrestrial isoprene emissions using MEGAN (Model of Emissions of Gases and Aerosols from Nature). Atmospheric Chemistry and Physics, 6(11), 3181–3210. United States Department of Agriculture (USDA) Forest Service. (2019). i-Tree Eco Manual. Northern Research Station, USDA Forest Service. Retrieved from https://www.itreetools.org/resources/manuals/Ecov6_ManualsGuides/Ecov6_UsersManual.pdf 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/ Pineda, N., Jorba, O., Jorge, J., & Baldasano, J.M. (2004). Using NOAA AVHRR and SPOT VGT data to estimate surface parameters: application to a mesoscale meteorological model. International Journal of Remote Sensing, 25(1), 129–143. Roupsard, P., Amielh, M., Maro, D., Coppalle, A., & Branger, H. (2013). Measurement in a wind tunnel of dry deposition velocities of submicron aerosol with associated turbulence onto rough and smooth urban surfaces. Journal of Aerosol Science, 55, 12-24.