22.20 Morbidity, Mortality and Years of Life Lost due to poor air quality

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Morbidity, Mortality and Years of Life Lost due to poor air quality	Air Quality Health and Wellbeing
Description and justification	Air pollution has been related to numerous adverse health effects, typically expressed in several morbidity and mortality endpoints (see Costa et al., 2014). In particular, an increasing amount of epidemiological and clinical studies observes that exposure to air pollution is associated with increased risk of heart disease, myocardial infarction and stroke as well as lung cancer (e.g., Costa et al., 2014). While the impact of these health effects may appear low at the individual level, the overall public-health burden is sizable as the entire population is exposed (Pascal et al., 2011).
Definition	Reduction in years of life (y) due to premature mortality in comparison with standard life expectancy (Morbidity): Long-term (annual) incidence of chronic bronchitis due to poor air quality calculated using atmospheric NO_2 and PM_{10} data (Mortality): Long-term (annual) incidence of mortality due to poor air quality calculated using atmospheric $PM_{2.5}$, PM_{10}, O_3 and NO_2 data
Strengths and weaknesses	+ The indicator is easy to define - The method needs a lot of input data
Measurement procedure and tool	The general approach in health impact assessment is to use exposure-response functions, linking the concentration of pollutants to which the population is exposed to the number of health events occurring in that population (Costa et al., 2014; Silveira et al., 2016). Therefore, the following aspects are usually considered: i) involved pollutants and their air concentration levels, ii) health indicators analysed in terms of morbidity and mortality, iii) affected age groups, and iv) exposure time. The health response is usually calculated by:

$\Delta R = IR \times CRF \times \Delta C \times Pop$

Where,

- ΔR is the response as a result of the number of the unfavourable implications (cases, days or episodes) over all health indicators;
- IR is the baseline morbidity/mortality annual rate (%); this information is available in the national statistical institute of each country;
- CRF is the correlation coefficient between the pollutant concentration variation and the probability of experiencing a specific health indicator (%; i.e., Relative Risk (RR) associated with a concentration change of 1 μg m^{-3});
- ΔC indicates the change in the pollutant concentration (μg m^{-3}) after adoption of the adaptation/mitigation measure;
- Pop is the population units per age group exposed to pollution.

Morbidity (chronic bronchitis) due to poor air quality is calculated using NO_2 and PM_{10} to determine CRF and ΔC in the preceding equation.

Mortality, assessed as total mortality, is calculated using PM_{10}, $PM_{2.5}$, O_3 and NO_2 to determine CRF and ΔC in the preceding equation.

Both morbidity and mortality are based on long-term (annual) effects (Table). Where air quality data are derived from WRF-Chem results can be calculated on a daily/weekly/monthly/annual basis at the grid, neighbourhood or city scale.

Table. Air pollutant health indicators (WHO, 2013)

Pollutant	Health outcome	Age group
PM_{10}	Chronic bronchitis (incidence)	>18 y
	Chronic bronchitis (prevalence)	6-18 y
	Total mortality	<1 y
		>30 y

$PM_{2.5}$	Total mortality	>30 y
NO_2	Total mortality	>30 y
	Prevalence of bronchitic symptoms in asthmatic children	5–14 y
O_3 (April-September)	Total mortality (respiratory diseases)	>30 y

Years of life lost (YLL) is an often-used health indicator, and refers to the total number of years of reduced life due to premature mortality. Using the mortality indicator, the YLL can be calculated as the number of deaths multiplied by a standard life expectancy at the age at which death occurs (see Gardner & Sanborn, 1990).

Scale of measurement	Street to metropolitan scale
Data source	
Required data	i) involved pollutants and their air concentration levels, ii) health indicators analysed in terms of morbidity and mortality, iii) affected age groups, and iv) exposure time
Data input type	Quantitative
Data collection frequency	Daily, weekly, monthly or annually
Level of expertise required	Moderate
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

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22.21 Prevalence and incidence of autoimmune diseases

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Prevalence and incidence of autoimmune diseases	**Health and Wellbeing**
Description and justification	Numerous authors stress the relevance of immune-regulatory mechanisms in the manifestation of the generally expected beneficial effects of exposure to nature (Hanski et al, 2012; Kuo, 2015; Rook, 2013; von Hertzen et al., 2015). Rook (2013) argue that multiple physiological consequences of exposure to the natural environment (e.g., sunlight, physical exercise) supplement the immune-regulatory effects of microbial biodiversity (i.e., low CRP levels, low inflammation, low cytokine response to stress) and the psychological rewards of interaction with nature (e.g., relaxation, restoration, exercise, social capital). These notions have been brought forth by *the hygiene hypothesis (i.e., Old Friends mechanism, biodiversity hypothesis)* that explains the increasing prevalence of chronic inflammatory diseases (autoimmunity, allergy and inflammatory bowel diseases) in urban communities in high-income countries by a predisposition to poor regulation of inflammation gradually developed through