22.8 Exposure to noise pollution

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Exposure to noise pollution	Health and well-being
Description and justification	Prolonged exposure to noise, such as the environmental noise pollution caused by road, rail and airport traffic, industry, construction, and other outdoor activities, can lead to significant physical and mental health effects (ISO, 2018). Environmental noise pollution is any disturbing noise that interferes with or harms humans or wildlife. The L_{DEN} indicator has been defined several years ago by a European expert group, in order to compare different noise situations all over European cities (noise maps of people exposed to sound pollution) through the use of a single, common and harmonized indicator. Despite the assumptions and limitations of such energetic descriptors, the L_{DEN} indicator is now stabilized and generalized. The L_{DEN} is a daily equivalent sound pressure level (T=00h-24h), with a 0dB(A) penalty increase for the Day period (T=6h-18h), a 5dB(A) penalty increase for the Evening period (T=18h-22h) and a 10dB(A) penalty increase for the Night period (T=22h-6h).
Definition	The L_{DEN} is an acoustic indicator for sound environment. L_{DEN} is expressed in dB(A) because it is based on a combination of equivalent sound pressure levels Leq,T (energetic summation through logarithmic law), calculated with the A ponderation on 3 periods (day, evening, night), depending on the sound source emission (i.e., road traffic conditions).

	The indicator is the proportion (%) of population exposed to noise levels of L_{den} > 55 dB(A), before and after NBS implementation.
Strengths and weaknesses	+ Relatively easy to measure - Accurate data require extensive and precise measurements
Measurement procedure and tool	<u>L_{DEN} - Day-evening-night noise level (Nature4Cities):</u> Measured L_{DEN} (in situ measurements) $L_{den} = 10\log_{10}\frac{1}{24}\left(12\times10^{\frac{L_{day}}{10}} + 4\times10^{\frac{L_{evening}+5}{10}} + 8\times10^{\frac{L_{night}+10}{10}}\right)$ In which L_{day}, L_{night} and $L_{evening}$ are the A-weighted long-term averages Simulated L_{DEN} (numerical predictions): NMPB2008 or CNOSSOS-EU (see reference pdf document from UN/Ifsttar/LAE/BG) Measurement unit: Decibels with A ponderation: “dB(A)” Tools: - Measured L_{DEN} (in situ measurements): integrating sonometer, either professional, low-cost or even smartphone http://noise-planet.org/noisecapture.html - Simulated L_{DEN} (numerical predictions): noise prediction software, e.g., open-source tool “NoiseModelling” http://noise-planet.org/noisemodelling.html <u>Exposure to noise pollution (UNaLab):</u> Environmental noise pollution is commonly measured in level of A-weighted decibels (dB(A)), which accounts for the hearing threshold of a human ear being less sensitive to very high and very low frequencies, which means that noise reduction can be calculated as: $\left(\frac{dB(A)\ level\ after\ NBS\ implementation}{dB(A)\ level\ before\ NBS\ implementation}\right)\times 100 = \%\ change\ in\ noise\ level$ An alternative calculation involves an estimation of the share of the population of a defined urban area that is affected by noise >55 dB during the night: $\left(\frac{No.\ inhabitatants\ exposed\ to\ noise > 55\ dB(A)}{Total\ number\ of\ inhabitants}\right)\times 100 = \%\ population\ affected\ by\ noise$ Regardless of the calculation used, the noise level should be measured (or modelled) at the object receiving the noise. In urban areas, “night” hours are defined differently depending on jurisdiction but typically involve a specific

	time range, e.g., 22:00-07:00, rather than the meteorological definition of night as the period between dusk and dawn. Noise reduction rates applied to UGI within a defined road (URBAN GreenUP): It is accounted for two factors that influence noise reduction services: vegetation (NBS) characteristics and distance to the noise source. The analysis is focused on road traffic noise, as this is a constant source and most disturbing to people. The measurements before and after the intervention have to be made on similar dates, same day of the week and hour. Simulations with and without NBS will be assessed to define the impact of the NBS. A strategic noise map is the presentation of data on one of the following aspects: - A noise situation in terms of the noise indicators L_{DEN} and L_{NIGHT}; - The exceeding of a limit value; - The estimated number of dwellings that are exposed to specific values of a noise indicator; - The estimated number of people exposed to noise. Values of L_{DEN} and L_{NIGHT} can be determined either by computation or by measurement (at the assessment positions) and that for prediction, only computation is applicable.
Scale of measurement	Object, neighbourhood and city scale
Data source	
Required data	- Measured L_{DEN} (in situ measurements): acoustic acquisition (in dB(A)) on hourly periods (with typically 1 sec sampling rate), gathered on 3 periods (Day, Evening, Night) and next aggregated on 24h (see definition above). - Simulated L_{DEN} (numerical predictions): acoustic simulation (in dB(A)) on hourly periods (depending on input data, e.g., road traffic characterization, built-up implementation through GIS, etc.), gathered on 3 periods (Day, Evening, Night) and next aggregated on 24h (see definition above). - Georeferenced data for built-up area: data from OPEN STREET MAP (OSM) - Road traffic counts: data from district, city or regional agencies - Number of inhabitants exposed to noise, and total number of inhabitants
Data input type	- Measured L_{DEN} (in situ measurements): quantitative (L_{DEN} acquisition in dB(A) using sonometer)

	- Simulated L_{DEN} (numerical predictions): quantitative (georeferenced data, traffic counts, etc.) + qualitative (e.g., typology of NBS in urban medium)
Data collection frequency	At least before and after the project's implementation, to characterize the vegetation or occasional measurement (and long-period monitoring) of biomass size or continuous measurement of climatic data
Level of expertise required	Relatively easy to understand. Low to moderate
Synergies with other indicators	Related to *Area devoted to roads* indicator
Connection with SDGs	SDG 3 Good health and Well-being, SDG 9 Industry, innovation and Infrastructure, SDG 11 Sustainable cities and communities, SDG 15 Life on land
Opportunities for participatory data collection	No opportunities identified
Additional information	
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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

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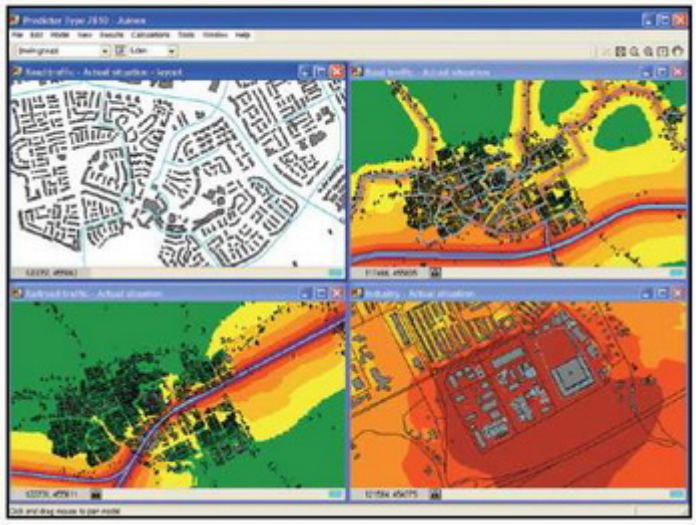

Figure: Example of data visualization.

22.9 Perceived chronic loneliness

Project Name: CONNECTING Nature (Grant Agreement no. 730222)

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Chronic loneliness	Health and Wellbeing
Description and justification	Loneliness is a growing problem in industrialized countries, where around one in three people is affected, and one in 12 severely (Cacioppo & Cacioppo, 2018). It has become a public health problem, since in addition to the serious consequences for the psychological well-being of individuals who suffer it, longitudinal studies show that loneliness implies an increased risk of morbidity and premature mortality, when compared with individuals who are more socially integrated or do not feel isolated (Cacioppo & Cacioppo, 2018; Shankar et al., 2017). Specifically, loneliness increases the risk of premature death by 26% (Cacioppo & Cacioppo, 2018), and the strength of social