European Environment Agency

8th Environment Action Programme

Environmental inequalities: income-related environmental inequalities associated with air pollution in Europe

8TH EAP HEADLINE INDICATOR, 2023

European Environment Agency

Income-related environmental inequalities associated with air pollution in Europe

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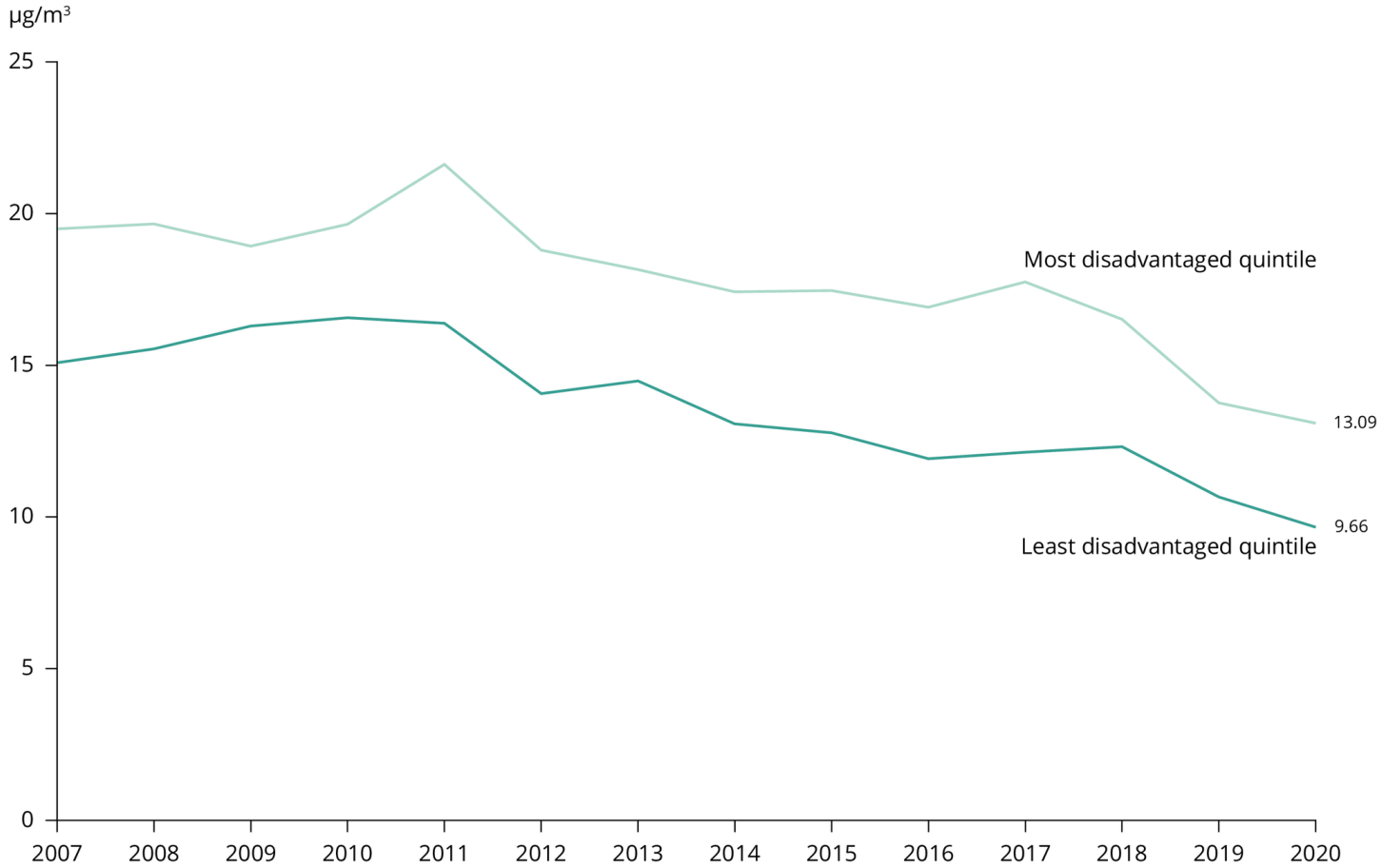
Air pollution poses the greatest environmental risk to health in Europe. Fine particulate matter ($PM_{2.5}$) causes more premature deaths in Europe than any other ambient air pollutant. Despite improving trends in air pollution for both the richest and poorest regions of the EU during 2007-2020, inequalities remained with levels of $PM_{2.5}$ concentrations consistently higher by around one third in the poorest regions. This lack of progress in reducing air pollution exposure disparities seems to indicate that we are not progressing in reducing these important environmental inequalities.

Figure 1. Population-weighted concentrations (micrograms per cubic meter) of fine particulate matter ($PM_{2.5}$) in the richest and poorest NUTS3 regions in the EU-27, 2007-2020



Source: EEA/Eurostat.

Air pollution poses the greatest environmental risk to health in Europe [1]. Fine particulate matter with a diameter of 2.5µm or less ($PM_{2.5}$) is the ambient air pollutant associated with the highest number of premature deaths [1], with no thresholds below which exposure is considered safe in terms of the impacts on health [2]. $PM_{2.5}$ exposure also demonstrates to be a reliable indicator of risk associated with air pollution in general and in different environments [3]. Monitoring $PM_{2.5}$ levels is therefore useful for exploring income-related inequalities in the distribution of health impacts of air pollution and more broadly of environmental risks.

This indicator explores these inequalities by comparing the exposure to air pollution by fine particulate matter experienced by the population living in the poorest regions of the EU with that in the richest regions. The analysis uses population-weighted concentrations of $PM_{2.5}$ in the 20% NUTS3 regions (i.e. in small regions like a prefecture) of the EU with the least per capita income (in terms of purchasing power) and in the 20% NUTS3 regions with the highest per capita income. Exposure at NUTS3 is an imperfect proxy for actual inequalities in air pollution exposure. Most likely, within a city the inequalities can be much higher than between NUTS3 regions, depending on the local situation (proximity to main roads, industry, etc.). However, while we have data on exposure to fine particles at a very fine scale (down to a 1 by 1km cell grid), we do not have Europe-wide data on GDP at a level smaller than NUTS3. Therefore, NUTS3 is the smallest scale at which we can calculate the indicator as currently defined.

Between 2007 and 2020, air quality, measured as population-weighted concentrations of $PM_{2.5}$, improved in both the least disadvantaged (i.e. richest) and the most disadvantaged (i.e. poorest) quintiles of the EU-27's NUTS3 regions (figure 1). However, regions in the richest quintile had lower $PM_{2.5}$ levels to begin with (around 15µg/m^3 in 2007) than those in the poorest quintile (19.5µg/m^3 in 2007).

In an environmentally equal Europe, poverty and pollution would not be correlated. $PM_{2.5}$ concentrations have decreased at relatively similar rates in regions in the richest quintile (3.15% average year-to-year decrease between 2007 and 2020) and in the poorest quintile (2.77% average year-to-year decrease in the same period), with no statistically significant difference in the trends. However, despite improving trends in air pollution in both the richest and the poorest regions over the 2007-2020 period, inequalities remained with levels of $PM_{2.5}$ being consistently higher by around one third in the poorest regions (figure 2).

The indicator, defined as the ratio of population weighted concentration of $PM_{2.5}$ in EU NUTS3 regions in the most and in the least deprived quintiles remained relatively stable from 2007 to 2020 (see supporting information) and well above 1.0. This indicates that so far there has been no progress with reducing environmental inequalities in the EU, at least when it comes to air pollution.

Figure 2. Ratio of population-weighted concentrations of $PM_{2.5}$ in EU NUTS3 regions in the most deprived quintile relative to those in the least deprived quintile, 2007-2020

Source: EEA/Eurostat.

Some of the most highly polluted NUTS3 regions spatially coincide with the poorest regions in the eastern part of Europe, although there are pockets of highly polluted NUTS3 regions elsewhere in Europe with both high and low purchasing power per capita. However, almost no NUTS3 regions in the quintile with the highest purchasing power per capita are in the quintile with the most pollution.

In terms of what the future trend could be for this indicator, the absence of disaggregated projections at the NUTS3 level for both $PM_{2.5}$ concentrations and purchasing power makes evidence-based predictions challenging. While there are national level projections in $PM_{2.5}$ emissions and concentrations (i.e. including cross-border transfers) by country stemming from the third clean air outlook, these cannot be readily used to derive NUTS3-level extrapolations, nor would it be reasonable to assume that NUTS3 GDP levels will remain constant. Thus, no reasonable prediction can be given for this indicator based on existing evidence. The past trend indicates, however, that so far there has been no real progress in reducing the environmental inequalities associated with air pollution. On that basis it therefore seems unlikely that the EU will make significant progress in reducing environmental inequalities, at least those related to air pollution.

Supporting information

Definition

This indicator monitors concentrations of $PM_{2.5}$ in the richest and poorest NUTS3 regions of the EU-27. More specifically it measures the ratio ofpopulation-weighted $PM_{2.5}$ concentrations of the most disadvantaged quintile compared to the ones of the least disadvantaged quintile (based on GDP per

capita at purchasing power standard) at NUTS3-region level. Population-weighting is a statistical technique that assigns greater weight to the air pollution experienced where most people live. GDP: Gross Domestic Product, a basic measure of the overall size of a country's or region's economy. Per capita (Latin: "per head") indicates the average per person in a group, in this case the population of a given NUTS3 region. NUTS3 is the smallest subdivision of the NUTS classification (Nomenclature of territorial units for statistics), a hierarchical system for dividing up the economic territory of the EU. PPS: purchasing power standard, an artificial currency unit with which theoretically, one could buy the same amount of goods and services in each country. PPS is a more accurate way to compare wealth per capita than raw GDP because it reduces the effect of price differences. $PM_{2.5}$, particulate matter with a diameter of 2.5µm or less.

The definitions of GDP, per capita and PPS come from the Eurostat glossary (https://ec.europa.eu/eurostat/statistics-explained)

Methodology

The indicator is formally defined as '$PM_{2.5}$ exposure ratio between most disadvantaged and least disadvantaged quintile (GDP per capita at purchasing power standard) at NUTS3 region level'.

The indicator is calculated via the formula:

Exposure ratio = Pop. weighted PM2.5 exposure (µg/m^3) MDQ/Pop.weighted PM2.5 exposure (µg/m^3) LDQ

Where:

'Pop. weighted $PM_{2.5}$ exposure (µg/m^3) MDQ' is the annual average population-weighted concentration of $PM_{2.5}$ in ambient air measured in micrograms per cubic meter of the most deprived (i.e. poorest) quintile of NUTS3 regions, measured based on GDP per inhabitant at purchasing power standard in euros.

'Pop. weighted $PM_{2.5}$ exposure (µg/m^3) LDQ' is the annual average population-weighted concentration of $PM_{2.5}$ in ambient air measured in micrograms per cubic meter of the least deprived (i.e. richest) quintile of NUTS3 regions, measured based on GDP per inhabitant at purchasing power standard in euros.

Because the numberator and denominator of this indicator are in the same units, the resulting ratio has no units. Both parts of this ratio are easily measurable and based on readily available data. In an environmentally equal Europe, in terms of $PM_{2.5}$, this ratio would be close to 1. If the poorer regions were more polluted than the richer regions, the ratio would be greater than 1; a ratio of lower than 1 would indicate the opposite.

Policy/environmental relevance

This indicator will provide an objective and comparable estimate over time of the inequalities in $PM_{2.5}$ exposure (and thus of associated health risks) between the poorest and the richest regions in Europe.

This indicator is a proxy headline indicator on environmental inequalities for monitoring progress towards the 8^{th} Environment Action Programme (8^{th} EAP), (EU, 2022). It contributes mainly to monitoring aspects of the 8^{th} EAP Article 2.1 that requires 'by 2050 at the latest, people live well, within

the planetary boundaries in a well-being economy where nothing is wasted, growth is regenerative, climate neutrality in the Union has been achieved and inequalities have been significantly reduced… .'. It further contributes to monitoring aspects of the Article 3.f which requires 'ensuring that social inequalities resulting from climate- and environmental-related impacts and policies are minimised and that measures taken to protect the environment and climate are carried out in a socially fair and inclusive way'. The European Commission Communication on the 8th EAP monitoring framework specifies that this indicator should monitor whether the EU 'reduces environmental inequalities and ensures a fair transition', (EC, 2022).

EU, 2022, Decision (EU) 2022/591 of the European Parliament and of the Council of 6 April 2022 on a General Union Environment Action Programme to 2030, OJL 114, 12.4.2022, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022D0591 accessed October 24, 2022

EC, 2022, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the monitoring framework for the 8th Environment Action Programme: Measuring progress towards the attainment of the Programme's 2030 and 2050 priority objectives, COM/2022/357 final, EUR-Lex - 52022DC0357 - EN - EUR-Lex (europa.eu), accessed October 24, 2022

Accuracy and uncertainties

GDP per capita at NUTS3 level is an imperfect measure of economic deprivation, but it is a fair proxy that is published regularly and is easy to understand for most audiences. The assessment of population weighted concentrations also has uncertainties inherent to the estimation, though those are known and limited. The trend analyses for this indicator is performed via linear regression and a T test for the significance of slope value. The indicator showed from 2007 to 2020 a small but statistically significant ($p<0.05$) upward linear slope of 0.02. However, with such a small value and a standard error of around 0.01, this trend cannot be assessed as significantly different from stable.

Data sources and providers

- Gross domestic product (GDP) at current market prices by NUTS 3 regions (nama_10r_3gdp), Statistical Office of the European Union (Eurostat)
- Air Quality Health Risk Assessments, European Environment Agency (EEA)

Metadata

DPSIR

State

Topics

 # Air pollution **# Environmental inequalities** **# Environmental health impacts**

Tags

8th EAP # income # AIR009 # inequalities # air pollution

Temporal coverage

2007-2020

Geographic coverage

Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden

Typology

Descriptive indicator (Type A - What is happening to the environment and to humans?)

UN SDGs

Good health and well-being

Unit of measure

The population-weighted concentrations of $PM_{2.5}$

is measured in micrograms per cubic meter and the ratio of population-weighted concentrations of $PM_{2.5}$ has no units, it is expressed as ratio.

Frequency of dissemination

Once a year

Contact

info@eea.europa.eu

References and footnotes

1. Air quality in Europe 2022 — European Environment Agency, 2022, (https://www.eea.europa.eu/publications/air-quality-in-europe-2022) accessed April 17, 2023. a b

2. WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide, 2021, (https://www.who.int/publications-detail-redirect/9789240034228) accessed March 5, 2023. ↵

3. Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., Amann, M., Anderson, H. R., Andrews, K. G., Aryee, M., Atkinson, C., Bacchus, L. J., Bahalim, A. N., Balakrishnan, K., Balmes, J., Barker-Collo, S., Baxter, A., Bell, M. L., Blore, J. D. et al., 2013, 'A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010', *Lancet* 380(9859), pp. 2224–2260. ↵