Environmental Performance Index 2022

Technical Appendix

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2022 Environmental Performance Index

Technical Appendix

This technical appendix is a companion document to the 2022 Environmental Performance Index (EPI) report. It contains additional details about the methods used in the 2022 EPI. Along with the files available online, the purpose of this technical appendix is to provide all information necessary for fully replicating the analysis or re-running the analysis using different choices and assumptions.

Note: Throughout this appendix, **TLA** is used to refer to the **t**hree **l**etter **a**bbreviations of the input data sources and resulting indicators, issue categories, and policy objectives.

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1. Indicator and Data Overview

Table TA-1. Organization of the 2020 EPI, with three-letter abbreviations (TLAs) and weights (Wt.) within each level of aggregation.

Policy Objective	Issue Category	TLA	Wt.	Indicator	TLA	Wt.
Climate Change **PCC** (38%)	Climate Change Mitigation	CCH	100%	Projected GHG Emissions in 2050	GHN	36.3%
				CO_2 Growth Rate	CDA	36.3%
				CH_4 Growth Rate	CHA	8.7%
				CO_2 from Land Cover	LCB	3.9%
				GHG Intensity Trend	GIB	3.9%
				F-Gas Growth Rate	FGA	3.7%
				Black Carbon Growth Rate	BCA	2.6%
				GHG Emissions per Capita	GHP	2.6%
				N_2O Growth Rate	NDA	1.8%
Environmental Health **HLT** (20%)	Air Quality	AIR	55%	$PM_{2.5}$ Exposure	PMD	47%
				Household Solid Fuels	HAD	38%
				Ozone Exposure	OZD	5%
				NOx Exposure	NOE	5%
				SO2 Exposure	SOE	2%
				CO Exposure	COE	2%
				VOC Exposure	VOE	2%
	Sanitation & Drinking Water	H2O	25%	Unsafe Drinking Water	UWD	60%
				Unsafe Sanitation	USD	40%
	Heavy Metals	HMT	10%	Lead Exposure	PBD	100%
	Waste Management	WMG	10%	Mismanaged Solid Waste	MSW	50%
				Recycling Rates	REC	25%
				Ocean Plastic Pollution	OCP	25%
Ecosystem Vitality **ECO** (42%)	Biodiversity & Habitat	BDH	43%	Terrestrial Biome Protection (national)	TBN	22.2%
				Terrestrial Biome Protection (global)	TBG	22.2%
				Marine Protected Areas	MPA	22.2%
				Protected Areas Rep. Index	PAR	14%
				Species Habitat Index	SHI	8.3%
				Species Protection Index	SPI	8.3%
				Biodiversity Habitat Index	BHV	3%
	Ecosystem Services	ECS	19%	Tree Cover Loss	TCL	75%
				Grassland Loss	GRL	12.5%
				Wetland Loss	WTL	12.5%
	Fisheries	FSH	11.9%	Fish Stock Status	FSS	36%
				Marine Trophic Index	RMS	36%
				Fish Caught by Trawling	FTD	28%
	Acid Rain	ACD	9.5%	SO_2 Growth Rate	SDA	50%
				NO_X Growth Rate	NXA	50%
	Agriculture	AGR	9.5%	Sustainable Nitrogen Mgmt. Index	SNM	50%
				Sustainable Pesticide Use	SPU	50%
	Water Resources	WRS	7.1%	Wastewater Treatment	WWT	100%

2. Data Sources

The 2022 EPI draws on data from a wide variety of sources. This section of the Technical Appendix describes the sources of data used in the EPI, using the following template.

TLA	Three letter abbreviation for the variable.
Source	The organization that produces the dataset.
URL	Where the dataset may be found on the Internet. If the dataset is not publicly available online, the URL points to the source institution.
Date received	The date on which the dataset used in the 2022 EPI came into the possession of the EPI team.
Instructions	Any special instructions for navigating the data source website or other means of retrieving the dataset.
Citation	Formal citation for the dataset, source organization, or other relevant published materials that are helpful in understanding the dataset.
Documentation	Additional documents that describe the dataset.
Note	Additional details for understanding how to retrieve or use the dataset.

Due to the variety of data sources, not every field is applicable to every dataset. Each entry below provides the fullest account possible.

AMP	Total area of all Marine Protected Areas in a country
Source	World Database on Protected Areas, Flanders Marine Institute Maritime Boundaries Geodatabase, World EEZ, version 9
URL	http://www.protectedplanet.net
Date received	2022-02-01

APR	Pesticide application rate
Source	Maggi et al.
URL	https://doi.org/10.1038/s41597-019-0169-4
Date received	2021-01-14
Reference	Maggi, F., Tang, F.H., la Cecilia, D. and McBratney, A., (2019). PEST-CHEMGRIDS, global gridded maps of the top 20 crop-specific pesticide application rates from 2015 to 2025. *Scientific data*, *6*(1), 1-20.
Note	Application rate data are globally gridded. Post-processing determines country values.

BHV	Biodiversity Habitat Index - Vascular Plants
Source	Commonwealth Scientific and Industrial Research Organization
URL	https://data.csiro.au/
Date received	2022-03-08
Note	Received via personal communication

BLC	Black Carbon Emissions [Gg]
Source	Community Emissions Data Systems
URL	https://zenodo.org/record/4741285#.YrMk-5DMKdY
Date received	2022-01-13
Instructions	Under the Files pane, click to download CEDS_v2021-04-21_emissions.zip (53.7 MB).
Citation	O'Rourke, Patrick R, Smith, Steven J, Mott, Andrea, Ahsan, Hamza, McDuffie, Erin E, Crippa, Monica, Klimont, Zbigniew, McDonald, Brian, Wang, Shuxiao, Nicholson, Matthew B, Feng, Leyang, & Hoesly, Rachel M. (2021). CEDS v_2021_04_21 Release Emission Data (v_2021_02_05) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.4741285
Note	ZIP file contains: BC_CEDS_emissions_by_country_2021_04_21.csv, README.txt, Supplemental Data and Assumptions.pdf, Supplemental Figures and Tables.pdf

CDL	CO_2 emissions from land cover change
Source	Mullion Group
URL	https://flintpro.com
Date received	2022-03-16
Note	Received via personal communication

CDO	CO_2 emissions [Gg], excluding land use and forestry
Source	Potsdam Institute for Climate Impact Research
URL	https://zenodo.org/record/5494497#.YrNVZ5DMKdY
Date received	2022-01-24
Instructions	Under Files, click to download Guetschow-et-al-2021-PRIMAP-hist_v2.3.1_20-Sep_2021.csv (44.6 MB) • Scenario: HISTTP • Category: IPCM0EL • Entity: CO2
Citation	Gütschow, Johannes, Günther, Annika, & Pflüger, Mika. (2021). The PRIMAP-hist national historical emissions time series (1750-2019) v2.3.1 (2.3.1) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5494497

CH4	Methane emissions [Gg]
Source	Potsdam Institute for Climate Impact Research
URL	https://zenodo.org/record/5494497#.YrNVZ5DMKdY
Date received	2022-01-24
Instructions	Under Files, click to download Guetschow-et-al-2021-PRIMAP-hist_v2.3.1_20-Sep_2021.csv (44.6 MB) • Scenario: HISTTP • Category: IPCM0EL • Entity: CH4
Citation	Gütschow, Johannes, Günther, Annika, & Pflüger, Mika. (2021). The PRIMAP-hist national historical emissions time series (1750-2019) v2.3.1 (2.3.1) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5494497

COE	CO exposure
Source	Copernicus Atmosphere Monitoring Service
URL	https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-reanalysis-eac4-monthly
Date received	2021-09-14
Instructions	Variable: Multi Level; Carbon monoxide Model level: 60 Year: Select all Month: Select all Product type: Monthly mean Time: Select all Area: Full model area
References	Wolf, M.J., Esty, D.C., Kim, H., Bell, M.L., Brigham, S., Nortonsmith, Q., Zaharieva, S., Wendling, Z.A., de Sherbinin, A. and Emerson, J.W., (2022). New Insights for Tracking Global and Local Trends in Exposure to Air Pollutants. *Environmental science & technology*, *56*(7), 3984-3996, https://doi.org/10.1021/acs.est.1c08080..
Note	Ground-level concentration data are weighted by population density to derive country-average exposure values. See Wolf et al. 2022 for details.

CTH	Fish catch [tonnes]
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2021-09-07
Note	Received via personal communication.

CXN	Proportion of population connected to wastewater system
Source	UNSD
URL	https://unstats.un.org/unsd/envstats/qindicators.cshtml
Date received	2022-02-24
Instructions	Click on "Inland Water Resources" • Population connected to wastewater treatment o Number of persons of the resident population whose wastewater is treated at wastewater treatment plants.
Documentation	https://unstats.un.org/unsd/envstats/fdes/manual_bses.cshtml https://unstats.un.org/unsd/environment/FDES/MS%205.1%20 Human%20settlements.pdf
Note	EPI CXN is a combination of several distinct data sources. Each source is documented in the file WWT_sources_reduced.csv.

CXN	Proportion of population connected to wastewater system
Source	OECD
URL	https://data.oecd.org/water/waste-water-treatment.htm
Date received	2022-02-24
Instructions	Go to: https://data.oecd.org/water/waste-water-treatment.htm • Click "Download" • Click "Full indicator data" • File name: DP_LIVE_22062022204044791 Go to: https://stats.oecd.org/Index.aspx?DataSetCode=WATER_TREAT • Click "Export" → "Text File (CSV)"
Documentation	https://stats.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=WATER_TREAT&Lang=en
Note	EPI CXN is a combination of several distinct data sources. Each source is documented in the file WWT_sources_reduced.csv.

CXN	Proportion of population connected to wastewater system
Source	Eurostat
URL	https://ec.europa.eu/eurostat/web/products-datasets/-/med_en47
Date received	2022-02-24
Instructions	For "Population connected to Wastewater Treatment" https://ec.europa.eu/eurostat/web/products-datasets/-/med_en47 • Click on "View Table"/"Download" in the upper right • In the CSV section, select "Multiple files" • Unclick "Flags and footnotes" • Click "Download in CSV Format"
Documentation	https://ec.europa.eu/eurostat/cache/metadata/en/env_nwat_esms.htm https://circabc.europa.eu/sd/a/32b27ab0-611c-42e4-add5-2942f2237394/Guidelines%20-%20Definitions_Notes_Schemes.pdf

CXN	Proportion of population connected to wastewater system
Source	Malik *et al*. 2015
URL	https://www.sciencedirect.com/science/article/abs/pii/S1462901115000076?via%3Dihub
Instructions	See data in Appendix A. Supplementary data
Citation	Malik, O. A., Hsu, A., Johnson, L. A., & de Sherbinin, A. (2015). A global indicator of wastewater treatment to inform the Sustainable Development Goals (SDGs). *Environmental Science & Policy, 48*, 172–185. https://doi.org/10.1016/j.envsci.2015.01.005
Note	The supplementary information for this paper contains details of historic sources of information on this variable. For certain countries, no new updates were available from UNSD/UNEP, OECD, or Eurostat. In these cases, data were taken from the previous EPI research, if available. EPI CXN is a combination of several distinct data sources.

EEZ	Total area of all Economic Exclusion Zones in a country
Source	World Database on Protected Areas
URL	http://www.marineregions.org/
Date received	2022-02-01

EXG	Exports of goods and services (% of GDP)
Source	WorldBank
URL	https://data.worldbank.org/indicator/NE.EXP.GNFS.ZS
Date received	2022-02-25
Instructions	Under Download on right side of web page, click "csv"
Documentation	ID: NE.EXP.GNFS.ZS
Note	License URL: https://datacatalog.worldbank.org/public-licenses#cc-by

FTD	Fish catch by trawling and dredging [tonnes], by EEZ and gear type
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2021-09-07
Note	Received via personal communication.

FOG	F-gasses emissions [Gg CO_2-eq.]
Source	Potsdam Institute for Climate Impact Research
URL	https://zenodo.org/record/5494497#.YrNVZ5DMKdY
Date received	2022-01-24
Instructions	Under Files, click to download Guetschow-et-al-2021-PRIMAP-hist_v2.3.1_20-Sep_2021.csv (44.6 MB) • Scenario: HISTTP • Category: IPCM0EL Entity: FGASESAR4
Citation	Gütschow, Johannes, Günther, Annika, & Pflüger, Mika. (2021). The PRIMAP-hist national historical emissions time series (1750-2019) v2.3.1 (2.3.1) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5494497

FSS	Fish stock status [%]
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2021-09-07
Instructions	Data_set: "css" Sum "Collapsed" and "Over-exploited"
Note	Received via personal communication.

GDP	GDP [PPP, constant 2017 international $]
Source	World Bank
URL	https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.KD
Date received	2022-02-31
Instructions	Under Download on right side of web page, click “csv”
Documentation	ID: NY.GDP.MKTP.PP.KD
Note	License URL: https://datacatalog.worldbank.org/public-licenses#cc-by

GDP	GDP [PPP, constant international $]]
Source	IMF
URL	https://www.imf.org/en/Publications/WEO/weo-database/2021/April
Date received	2022-01-18
Instructions	-Click on "By Countries (country-level data) -Click on "All Countries" -Click on "Clear all", and check boxes next to: Djibouti, Eritrea, Libya, Qatar, Sao Tome and Principe, Somalia, South Sudan, Syria, Taiwan, and Venezuela -Select "Gross domestic product, current prices: Purchasing power parity; international dollars" -Select: Start year = 1994, End year = 2018 -Click next to "ISO Alpha-3 Code" -Unclick "Subject descriptor" -Click "Prepare Report" -Click on the icon at the bottom of the page to download the report
Note	This produces a report to help fill data gaps in the World Bank data.

GL5	Gross loss in Grassland area over five-year interval
Source	Copernicus
URL	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover
Date received	2021-07-02
Instructions	• Navigate to the “Download data” tab • Select all years • Select both versions (v2.0.7cds for 1992–2015; v2.1.1 for 2016–2020)
Documentation	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=doc
Note	Copernicus data are globally gridded. Post-processing determines country values.

GOE	Government Effectiveness
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2022-02-25
Instructions	Country: *various* Series: Government Effectiveness Estimate Time: *various*
Citation	Kaufmann, Daniel, Aart Kraay and Massimo Mastruzzi (2010). The Worldwide Governance Indicators: Methodology and Analytical Issues". World Bank Policy Research Working Paper No. 5430 (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130)
Documentation	https://info.worldbank.org/governance/wgi/Home/Documents

GRA	Grassland area [km2]
Source	Copernicus
URL	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover
Date received	2021-07-02
Instructions	• Navigate to the "Download data" tab • Select all years Select both versions (v2.0.7cds for 1992–2015; v2.1.1 for 2016–2020)
Documentation	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=doc

HAD	Household Air Pollution [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2021-02-01
Instructions	Select the following parameters: GDB Estimate: Risk factor Measure: DALYs Metric: Rate Risk: Household air pollution from solid fuels Cause: Total all causes Location: Select all countries and territories Age: Age-standardized Sex: both Year: Select all
Citation	Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3

IEF	Index of Economic Freedom
Source	Heritage Foundation
URL	https://www.heritage.org/index/explore
Date received	2022-02-24
Instructions	Click on "All Index Data" Choose individual countries and/or region: Highlight all countries (Ctrl + A) Select Year(s): Select all years Click "View the Data" Click "Export this dataset to Excel"
Citation	Miller, T., Kim, A. B., & Roberts, J. M., Tyrrell, P., Roberts, K. D. (2022). 2022 Index of Economic Freedom. The Heritage Foundation. https://www.heritage.org/index/
Documentation	https://www.heritage.org/index/pdf/2022/book/02_2022_IndexOfEconomicFreedom_METHODOLOGY.pdf

LDA	Land area (sq. km)
Source	World Database on Protected Areas
Date received	2022-03-02

MAG	Exports of goods and services (% of GDP)
Source	WorldBank
URL	https://data.worldbank.org/indicator/NV.IND.MANF.ZS
Date received	2022-02-25
Instructions	Under Download on right side of web page, click “csv”
Documentation	ID: NV.IND.MANF.ZS
Note	License URL: https://datacatalog.worldbank.org/public-licenses#cc-by

MSW	Mismanaged solid waste
Source	Wiedinmyer et al.
URL	https://pubs.acs.org/doi/10.1021/es502250z
Date received	2021-07-13
Citation	Wiedinmyer, C., Yokelson, R. J., & Gullett, B. K. (2014). Global Emissions of Trace Gases, Particulate Matter, and Hazardous Air Pollutants from Open Burning of Domestic Waste. Environmental Science & Technology, 48(16), 9523–9530. https://doi.org/10.1021/es502250z
Note	Report used for its estimates on waste collection

MSW	Mismanaged solid waste
Source	*What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*
URL	http://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html
Date received	2021-07-21
Citation	Kaza, S., Yao, L., Bhada-Tata, P., & Von Woerden, F. (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050 (Urban Development Series). World Bank. http://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html
Note	Data for this report are drawn from United Nations Statistics Division survey data, OECD data, and regional and national reports.

MSW	Mismanaged solid waste

Source	Lebreton and Andrady
URL	https://doi.org/10.1057/s41599-018-0212-7
Date received	2021-02-23
Citation	Lebreton, L., Andrady, A. (2019). Future scenarios of global plastic waste generation and disposal. *Palgrave Commun* **5,** 6. https://doi.org/10.1057/s41599-018-0212-7
Note	Report used for its estimates on mismanaged waste.

MSW	Mismanaged solid waste
Source	Jambeck et al.
URL	https://doi.org/10.1126/science.1260352
Date received	2021-01-10
Citation	Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R. and Law, K.L., (2015). Plastic waste inputs from land into the ocean. *Science*, *347* (6223), 768-771.
Note	Report used for its estimates on mismanaged waste.

MSW	Mismanaged solid waste
Source	Law et al.
URL	https://doi.org/10.1126/sciadv.abd0288
Date received	2021-02-10
Citation	Law, K.L., Starr, N., Siegler, T.R., Jambeck, J.R., Mallos, N.J. and Leonard, G.H., (2020). The United States' contribution of plastic waste to land and ocean. Science advances, 6(44).
Note	Report used for its estimates on mismanaged waste.

NOE	NO_X exposure
Source	Copernicus Atmosphere Monitoring Service
URL	https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-reanalysis-eac4-monthly
Date received	2021-09-14
Instructions	Variable: Multi Level; Nitrogen monoxide and Nitrogen dioxide Model level: 60 Year: Select all Month: Select all Product type: Monthly mean Time: Select all Area: Full model area
References	Wolf, M.J., Esty, D.C., Kim, H., Bell, M.L., Brigham, S., Nortonsmith, Q., Zaharieva, S., Wendling, Z.A., de Sherbinin, A. and Emerson, J.W., (2022). New Insights for Tracking Global and Local Trends in Exposure to Air Pollutants. *Environmental science & technology*, *56*(7), 3984-3996, https://doi.org/10.1021/acs.est.1c08080..
Note	Ground-level concentration data are weighted by population density to derive country-average exposure values. See Wolf et al. 2022 for details.

NOT	N_2O emissions [Gg]
Source	Potsdam Institute for Climate Impact Research
URL	https://zenodo.org/record/5494497#.YrNVZ5DMKdY
Date received	2022-01-24
Instructions	Under Files, click to download Guetschow-et-al-2021-PRIMAP-hist_v2.3.1_20-Sep_2021.csv (44.6 MB) • Scenario: HISTTP • Category: IPCM0EL Entity: N2O
Citation	Gütschow, Johannes, Günther, Annika, & Pflüger, Mika. (2021). The PRIMAP-hist national historical emissions time series (1750-2019) v2.3.1 (2.3.1) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5494497

NOx	NOx emissions [Gg]
Source	Community Emissions Data Systems
URL	https://zenodo.org/record/4741285#.YrMk-5DMKdY
Date received	2022-01-13
Instructions	Under the Files pane, click to download CEDS_v2021-04-21_emissions.zip (53.7 MB).
Citation	O'Rourke, Patrick R, Smith, Steven J, Mott, Andrea, Ahsan, Hamza, McDuffie, Erin E, Crippa, Monica, Klimont, Zbigniew, McDonald, Brian, Wang, Shuxiao, Nicholson, Matthew B, Feng, Leyang, & Hoesly, Rachel M. (2021). CEDS v_2021_04_21 Release Emission Data (v_2021_02_05) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.4741285
Note	ZIP file contains: NOx_CEDS_emissions_by_country_2021_04_21.csv, README.txt, Supplemental Data and Assumptions.pdf, Supplemental Figures and Tables.pdf

OCP	Marine plastic pollution emissions
Source	Chen et al.
URL	https://doi.org/10.1088/1748-9326/ab8659
Date received	2020-11-13
Citation	Chen, D.M.C., Bodirsky, B.L., Krueger, T., Mishra, A. and Popp, A., (2020). The world's growing municipal solid waste: trends and impacts. Environmental Research Letters, 15(7).
Note	Article used for its estimates on plastic pollution.

OCP	Marine plastic pollution emissions
Source	Borelle et al.
URL	https://doi.org/10.1126/science.aba3656
Date received	2020-10-19
Citation	Borrelle, S.B., Ringma, J., Law, K.L., Monnahan, C.C., Lebreton, L., McGivern, A., Murphy, E., Jambeck, J., Leonard, G.H., Hilleary, M.A. and Eriksen, M., (2020). Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *Science*, *369*(6510), 1515-1518.
Note	Article used for its estimates on plastic pollution.

OCP	Marine plastic pollution emissions
Source	Meijer et al.
URL	https://doi.org/10.1126/sciadv.aaz5803
Date received	2021-05-19
Citation	Meijer, L.J., van Emmerik, T., van der Ent, R., Schmidt, C. and Lebreton, L., 2021. More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. Science Advances, 7(18).
Note	Article used for its estimates on plastic pollution.

OZD	Ozone [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2021-02-01
Instructions	Select the following parameters: GDB Estimate: Risk factor Measure: DALYs Metric: Rate Risk: Ambient ozone pollution Cause: Total all causes Location: Select all countries and territories Age: Age-standardized Sex: Both Year: Select all
Citation	Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3
Note	Users must register for a free account to download data.

PAR	Protected Areas Representativeness Index
Source	Commonwealth Scientific and Industrial Research Organization
URL	https://data.csiro.au/
Date received	2022-03-02
Citations	Ferrier, S., Manion, G., Elith, J. and Richardson, K. (2007) Using generalised dissimilarity modelling to analyse and predict patterns of betadiversity in regional biodiversity assessment. Diversity and Distributions 13: 252-264. Ferrier, S., Powell, G.V.N., Richardson, K.S., Manion, G., Overton, J.M., Allnutt, T.F., Cameron, S.E., Mantle, K., Burgess, N.D., Faith, D.P., Lamoreux, J.F., Kier, G., Hijmans, R.J., Funk, V.A., Cassis, G.A., Fisher, B.L., Flemons, P., Lees, D., Lovett, J.C., and van Rompaey, R.S.A.R (2004) Mapping more of terrestrial biodiversity for global conservation assessment. BioScience 54: 1101-1109. GEO BON (2015) Global Biodiversity Change Indicators. Version 1.2. Group on Earth Observations Biodiversity Observation Network Secretariat. Leipzig. http://www.geobon.org/Downloads/brochures/2015/GBCI_Version1.2_low.pdf Williams, K.J., Harwood, T.D., Ferrier, S. (2016) Assessing the ecological representativeness of Australia's terrestrial National Reserve System: A community-level modelling approach. Publication Number EP163634. CSIRO Land and Water, Canberra, Australia. https://publications.csiro.au/rpr/pub?pid=csiro:EP163634
Note	Prepared by CSIRO, received via personal communication

PBD	Lead Exposure [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2021-02-01
Instructions	Select the following parameters: GDB Estimate: Risk factor Measure: DALYs Metric: Rate Risk: Lead exposure Cause: Total all causes Location: Select all countries and territories Age: Age-standardized Sex: Both Year: Select all
Citation	Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3
Note	Users must register for a free account to download data.

PMD	Ambient PM2.5 [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2021-02-01
Instructions	Select the following parameters: GDB Estimate: Risk factor Measure: DALYs Metric: Rate Risk: Particulate matter pollution Cause: Total all causes Location: Select all countries and territories Age: Age-standardized Sex: Both Year: Select all
Citation	Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3
Note	Users must register for a free account to download data.

PST	Pesticide risk score
Source	Tang et al.
URL	https://doi.org/10.1038/S41561-021-00712-5
Date received	2021-07-25
Reference	Tang, F.H., Lenzen, M., McBratney, A. and Maggi, F., (2021). Risk of pesticide pollution at the global scale. Nature Geoscience, 14(4), 206-210.

POP	Population
Source	WorldBank
URL	https://data.worldbank.org/indicator/SP.POP.TOTL
Date received	2022-01-28
Instructions	Under Download on right side of web page, click “csv”
Documentation	SP.POP.TOTL
Note	Eritrea and Taiwan: IMF replaces incomplete World Bank data for entire time series

POP	Population
Source	IMF
URL	https://www.imf.org/en/Publications/WEO/weo-database/2021/April
Date received	2022-01-18
Instructions	-Click on "By Countries (country-level data) -Click on "All Countries" -Click on "Clear all", and check boxes next to Eritrea and Taiwan -Click "Continue" at bottom of page -Select "Population" -Click "Continue" at bottom of page -Select: Start year = 1994, End year = 2018 -Unclick all Notes -Click next to "ISO Alpha-3 Code" -Unclick "Subject descriptor" -Click "Prepare Report"
Note	This produces a report to help fill data gaps in the World Bank data.

REC	Recycling rate
Source	Chen et al.
URL	https://doi.org/10.1088/1748-9326/ab8659
Date received	2020-11-13
Citation	Chen, D.M.C., Bodirsky, B.L., Krueger, T., Mishra, A. and Popp, A., (2020). The world’s growing municipal solid waste: trends and impacts. Environmental Research Letters, 15(7).
Note	Article used for its estimates on rates of recycling by mass.

RMS	Slope of RMTI from peak year to 2018
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2022-01-20
Note	Received via personal communication

ROL	Rule of Law
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2022-02-25
Instructions	Country: *various* Series: Rule of Law Estimate Time: *various*
Citation	Kaufmann, Daniel, Aart Kraay and Massimo Mastruzzi (2010). The Worldwide Governance Indicators: Methodology and Analytical Issues". World Bank Policy Research Working Paper No. 5430 (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130)
Documentation	https://info.worldbank.org/governance/wgi/Home/Documents

RQU	Regulatory Quality
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2022-02-25
Instructions	Country: *various* Series: Regulatory Quality Estimate Time: *various*
Citation	Kaufmann, Daniel, Aart Kraay and Massimo Mastruzzi (2010). The Worldwide Governance Indicators: Methodology and Analytical Issues". World Bank Policy Research Working Paper No. 5430 (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1682130)
Documentation	https://info.worldbank.org/governance/wgi/Home/Documents

SEG	Services, value added (pct of GDP)

Source	WorldBank
URL	https://data.worldbank.org/indicator/NV.SRV.TOTL.ZS
Date received	2022-02-25
Instructions	Under Download on right side of web page, click “csv”
Documentation	ID: NV.SRV.TOTL.ZS
Note	License URL: https://datacatalog.worldbank.org/public-licenses#cc-by

SHI	Species Habitat Index
Source	Map of Life
URL	https://mol.org/indicators/
Date received	2022-01-07
Citations	Jetz, W., D. S. Wilcove, and A. P. Dobson. 2007. Projected Impacts of Climate and Land-Use Change on the Global Diversity of Birds. PLoS Biology 5:1211-1219. Rondinini, C., et al. 2011. Global habitat suitability models of terrestrial mammals. Philosophical Transactions of the Royal Society B: Biological Sciences 366:2633-2641. Jetz, W., J. M. McPherson, and R. P. Guralnick. 2012. Integrating biodiversity distribution knowledge: toward a global map of life. Trends in Ecology and Evolution 27:151-159. GEO BON (2015) Global Biodiversity Change Indicators. Version 1.2. Group on Earth Observations Biodiversity Observation Network Secretariat. Leipzig. http://www.geobon.org/Downloads/brochures/2015/GBCI_Version1.2_low.pdf
Note	Prepared by Map of Life, received via personal communication

SNM	Sustainable Nitrogen Management Index
Source	University of Maryland Center for Environmental Science
URL	http://research.al.umces.edu/xzhang/
Date received	2021-03-29
Citation	Zhang, X., & Davidson, E. (2019). Sustainable Nitrogen Management Index [Preprint]. Soil Science. https://doi.org/10.1002/essoar.10501111.1
Note	Prepared by Xin Zhang *et al*.., received via personal communication

SO2	SO2 emissions [Gg]
Source	Community Emissions Data Systems
URL	https://zenodo.org/record/4741285#.YrMk-5DMKdY
Date received	2022-01-13
Instructions	Under the Files pane, click to download CEDS_v2021-04-21_emissions.zip (53.7 MB).
Citation	O'Rourke, Patrick R, Smith, Steven J, Mott, Andrea, Ahsan, Hamza, McDuffie, Erin E, Crippa, Monica, Klimont, Zbigniew, McDonald, Brian, Wang, Shuxiao, Nicholson, Matthew B, Feng, Leyang, & Hoesly, Rachel M. (2021). CEDS v_2021_04_21 Release Emission Data (v_2021_02_05) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.4741285
Note	ZIP file contains: SO2_CEDS_emissions_by_country_2021_04_21.csv, README.txt, Supplemental Data and Assumptions.pdf, Supplemental Figures and Tables.pdf

SOE	SO_2 exposure
Source	Copernicus Atmosphere Monitoring Service
URL	https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-reanalysis-eac4-monthly
Date received	2021-09-14
Instructions	Variable: Multi Level; Sulfur dioxide Model level: 60 Year: Select all Month: Select all Product type: Monthly mean Time: Select all Area: Full model area
References	Wolf, M.J., Esty, D.C., Kim, H., Bell, M.L., Brigham, S., Nortonsmith, Q., Zaharieva, S., Wendling, Z.A., de Sherbinin, A. and Emerson, J.W., (2022). New Insights for Tracking Global and Local Trends in Exposure to Air Pollutants. *Environmental science & technology*, *56*(7), 3984-3996, https://doi.org/10.1021/acs.est.1c08080..
Note	Ground-level concentration data are weighted by population density to derive country-average exposure values. See Wolf et al. 2022 for details.

SPI	Species Protection Index
Source	Map of Life
URL	https://mol.org/indicators/
Date received	2022-01-07
Citation	Jetz, W., J. M. McPherson, and R. P. Guralnick. 2012. Integrating biodiversity distribution knowledge: toward a global map of life. Trends in Ecology and Evolution 27:151-159. GEO BON (2015) Global Biodiversity Change Indicators. Version 1.2. Group on Earth Observations Biodiversity Observation Network Secretariat. Leipzig. http://www.geobon.org/Downloads/brochures/2015/GBCI_Version1.2_low.pdf
Note	Prepared by Map of Life, received via personal communication

TCA	Tree cover area (30% canopy cover)
Source	Global Forest Watch
URL	https://www.globalforestwatch.org/
Date received	2021-04-19
Citations	Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. “High-Resolution Global Maps of 21st-Century Forest Cover Change.” Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest. Zarin, D., Harris, N.L. et al. 2016. Can carbon emissions drop by 50% in five years? Global Change Biology, 22: 1336-1347. doi:10.1111/gcb.13153 Global Administrative Areas Database, version 3.6. Available at http://gadm.org/
Note	Prepared by GFW, received via personal communication

TCL	Tree cover loss, annual (30% canopy cover)
Source	Global Forest Watch
URL	https://www.globalforestwatch.org/
Date received	2021-04-19
Citations	Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L.

	Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest. Zarin, D., Harris, N.L. et al. 2016. Can carbon emissions drop by 50% in five years? Global Change Biology, 22: 1336-1347. doi:10.1111/gcb.13153 Global Administrative Areas Database, version 3.6. Available at http://gadm.org/
Note	Prepared by GFW, received via personal communication

TEW	Areas of biomes
Source	World Wildlife Fund
URL	https://www.worldwildlife.org/publications/terrestrial-ecoregionsofthe-world
Date received	2022-02-01
Citation	Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., & Kassem, K. R. (2001). Terrestrial Ecoregions of the World: A New Map of Life on Earth. BioScience, 51(11), 933–938. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

TPA	Terrestrial protected areas
Source	World Database on Protected Areas
Date received	2022-02-01
Citation	IUCN and GeUNEP-WCMC (2017), The World Database on Protected Areas (WDPA) [On-line], March Release, Cambridge, UK: UNEP-WCMC.

USD	Unsafe Sanitation [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2021-02-01
Instructions	Select the following parameters: GDB Estimate: Risk factor Measure: DALYs Metric: Rate Risk: Unsafe sanitation Cause: Total all causes Location: Select all countries and territories Age: Age-standardized Sex: Both Year: Select all
Citation	Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3
Note	Users must register for a free account to download data.

UWD	Unsafe Water [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2021-02-01
Instructions	Select the following parameters: GDB Estimate: Risk factor Measure: DALYs Metric: Rate Risk: Unsafe water source Cause: Total all causes Location: Select all countries and territories Age: Age-standardized Sex: Both Year: Select all
Citation	Kyu, H. H., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, M., Abebe, Z., Abil, O. Z., Aboyans, V., Abrham, A. R., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., … Murray, C. J. L. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3
Note	Users must register for a free account to download data.

VOE	Volatile organic compound exposure
Source	Copernicus Atmosphere Monitoring Service
URL	https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-reanalysis-eac4-monthly
Date received	2021-09-14
Instructions	Variable: Multi Level; Ethane, Propane, Formaldehyde, and Isoprene Model level: 60 Year: Select all Month: Select all Product type: Monthly mean Time: Select all Area: Full model area
References	Wolf, M.J., Esty, D.C., Kim, H., Bell, M.L., Brigham, S., Nortonsmith, Q., Zaharieva, S., Wendling, Z.A., de Sherbinin, A. and Emerson, J.W., (2022). New Insights for Tracking Global and Local Trends in Exposure to Air Pollutants. *Environmental science & technology*, *56*(7), 3984-3996, https://doi.org/10.1021/acs.est.1c08080..
Note	Ground-level concentration data are weighted by population density to derive country-average exposure values. See Wolf et al. 2022 for details.

WL5	Gross loss in Wetland area over five-year interval (km^2)
Source	Copernicus
URL	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover
Date received	2021-07-02
Instructions	• Navigate to the “Download data” tab • Select all years Select both versions (v2.0.7cds for 1992–2015; v2.1.1 for 2016–2020)
Documentation	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=doc

WST	Proportion of wastewater collected that is treated
Source	UNSD
URL	https://unstats.un.org/unsd/envstats/qindicators.cshtml
Date received	2021-06-02
Instructions	Go to: https://unstats.un.org/unsd/envstats/qindicators.cshtml - Click on "Inland Water Resources" - Click on the following links to download their corresponding files: + Wastewater generated - receives: Wastewater generated.xlsx + Wastewater treated in independent treatment facilities - receives: Wastewater treated in independent treatment facilities.xlsx + Wastewater treated in other wastewater treatment plants - receives: Wastewater treated in other wastewater treatment plants.xlsx + Wastewater treated in urban wastewater treatment plants - receives: Wastewater treated in urban wastewater treatment plants.xlsx
Documentation	https://unstats.un.org/unsd/envstats/fdes/manual_bses.cshtml https://unstats.un.org/unsd/environment/FDES/MS%205.1%20 Human%20settlements.pdf

WST	Proportion of wastewater collected that is treated
Source	OECD
URL	https://data.oecd.org/water/waste-water-treatment.htm
Date received	2021-06-02
Instructions	- Go to: https://data.oecd.org/water/waste-water-treatment.htm - Click "Download" - Click "Full indicator data" - Go to: https://stats.oecd.org/Index.aspx?DataSetCode=WATER_TREAT - Click "Export" > "Text File (CSV)"
Documentation	https://stats.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=WATER_TREAT&Lang=en

WST	Proportion of wastewater collected that is treated
Source	Eurostat
URL	https://ec.europa.eu/eurostat/web/products-datasets/-/med_en47
Date received	2022-03-03
Instructions	https://ec.europa.eu/eurostat/web/products-datasets/-/env_ww_con - Click on "View Table" - Click the + button next to the dropdown menu that says, "Wastewater treatment plants" with "Total connected to wastewater treatment" as the default selection. - In the pop-up window: - Select "Urban and other wastewater treatment plants - total" (code: URB-OTH) - In the upper right corner, click "Update" - Back in the main window, click on "Download" in the upper right - In the CSV section, select "Multiple files" - Unclick "Flags and footnotes" - Click "Download in CSV Format" - Receive: "env_ww_con.zip" - unzip to get dataset file: + "env_ww_con_1_Data.csv""
Documentation	https://ec.europa.eu/eurostat/cache/metadata/en/env_nwat_esms.htm
Note	EPI WST is a combination of several distinct data sources. Each source is documented in the file WWT_sources_reduced.csv.

WST	Proportion of wastewater collected that is treated
Source	Malik *et al*. 2015
URL	https://www.sciencedirect.com/science/article/abs/pii/S1462901115000076?via%3Dihub
Instructions	On right sidebar of screen, last item, “Extras (1),” click on “Document.”
Citation	Malik, O. A., Hsu, A., Johnson, L. A., & de Sherbinin, A. (2015). A global indicator of wastewater treatment to inform the Sustainable Development Goals (SDGs). *Environmental Science & Policy, 48*, 172–185. https://doi.org/10.1016/j.envsci.2015.01.005
Note	The supplementary information for this paper contains details of historic sources of information on this variable. For certain countries, no new updates were available from UNSD/UNEP, OECD, or Eurostat. In these cases, data were taken from the previous EPI research, if available.

WTA	Wetland area [km^2]
Source	Copernicus

URL	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover
Date received	2021-07-02
Instructions	• Navigate to the “Download data” tab • Select all years Select both versions (v2.0.7cds for 1992–2015; v2.1.1 for 2016–2020)
Documentation	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=doc

3. Indicator Construction

Chapter 15 of the 2022 EPI report describes in greater detail the steps undertaken to construct indicators. Data as received by the EPI team undergo several steps before they can be used as indicators, including additional calculations, standardizations, transformations, and scoring. This section describes how the data are used to construct the 40 indicators of the 2022 EPI. On the following pages, you will see each metric described according to the following template.

TLA : Indicator / Issue Category / Policy Objective

Short description of the indicator.

Units	Units of the raw data
Years	Years for which raw data are available
Source	Organization
Transformation	Whether the normalized data had to be transformed
Targets	Basis for selection of targets

Performance	Nominal	Raw	Transformed
Best	Value or percentile	Value	Transformed value
Worst	Value or percentile	Value	Transformed value

Calculations
If any calculations were required, they are described here.

Imputations
If any imputation was required, it is described here.

Note
Any additional information that would be helpful for understanding indicator construction.

Due to the variety of data sources, not every field is applicable to every indicator. Each entry below provides the fullest account possible.

PMD: Ambient particulate matter pollution / Air Quality / Environmental Health

We measure *$PM_{2.5}$ exposure* using the number of age-standardized disability-adjusted life-years lost per 100,000 persons (DALY rate) due to exposure to fine air particulate matter smaller than 2.5 micrometers ($PM_{2.5}$).

Units Age-standardized DALYs/100k people

Years 1990–2019

Source Institute for Health Metrics and Evaluation

Transformation ln(x)

Performance	Nominal	Raw	Transformed
Best	1st percentile	110.918	4.708791
Worst	95th percentile	2709.473	7.904509

HAD: Household air pollution from solid fuels / Air Quality / Environmental Health

We measure *household solid fuels* using the number of age-standardized disability-adjusted life-years lost per 100,000 persons (DALY rate) due to exposure to household air pollution (HAP) from the use of household solid fuels.

Units Age-standardized DALYs/100k people

Years 1990–2019

Source Institute for Health Metrics and Evaluation

Transformation ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	0.785056	-0.2420003
Worst	99th percentile	10838.937508	9.2909003

OZD: Ozone / Air Quality / Environmental Health

We measure *ozone exposure* using the number of age-standardized disability-adjusted life-years lost per 100,000 persons (DALY rate) due to exposure to ground-level ozone pollution.

Units	Age-standardized DALYs/100k people
Years	1990–2019
Source	Institute for Health Metrics and Evaluation
Transformation	ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	1.114494	0.1084001
Worst	99th percentile	255.881032	5.5447126

NOE: NO_x Exposure / Air Quality / Environmental Health

We measure *NO_x exposure* using the population-weighted annual average concentration of the air pollutant at ground level.

Units Concentration (ppm)

Years 2003–2019

Source Copernicus; Wolf et al. 2021

Transformation ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	0.0001038231	-9.172822
Worst	95th percentile	0.0410941280	-3.191890

SOE: SO_2 Exposure / Air Quality / Environmental Health

We measure *sulfur dioxide exposure* using the population-weighted annual average concentration of the air pollutant at ground level.

Units	Concentration (ppm)
Years	2003–2019
Source	Copernicus; Wolf et al. 2021
Transformation	ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	0.0002787108	-8.185336
Worst	95th percentile	0.0626445373	-2.770279

COE: CO Exposure / Air Quality / Environmental Health

We measure *carbon monoxide exposure* using the population-weighted annual average concentration of the air pollutant at ground level.

Units	Concentration (ppm)
Years	2003–2019
Source	Copernicus; Wolf et al. 2021
Transformation	ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	0.06247684	-2.7729593
Worst	95th percentile	0.46986060	-0.7553192

VOE: VOCs Exposure / Air Quality / Environmental Health

We measure *volatile organic compound exposure* using the population-weighted annual average concentration of the air pollutant at ground level.

Units Concentration (ppm)

Years 2003–2019

Source Copernicus; Wolf et al. 2021

Transformation ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	0.000769655	-7.169568
Worst	95th percentile	0.095845771	-2.345015

USD: Unsafe sanitation / Sanitation & Drinking Water / Environmental Health

We measure *unsafe sanitation* using the number of age-standardized disability-adjusted life-years lost per 100,000 persons (DALY rate) due to their exposure to inadequate sanitation facilities.

Units Age-standardized DALYs/100k people

Years 1990–2019

Source Institute for Health Metrics and Evaluation

Transformation ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	1.606842	0.4742707
Worst	95th percentile	4442.251076	8.3989165

UWD: Unsafe Drinking Water / Sanitation & Drinking Water / Environmental Health

We measure *unsafe drinking water* using the number of age-standardized disability-adjusted life-years lost per 100,000 persons (DALY rate) due to exposure to unsafe drinking water.

Units	Age-standardized DALYs/100k people
Years	1990–2019
Source	Institute for Health Metrics and Evaluation
Transformation	ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	2.392264	0.8722401
Worst	95th percentile	5940.937259	8.6896222

PBD: Lead Exposure / Heavy Metals / Environmental Health

We measure *lead exposure* using the number of age-standardized disability-adjusted life-years lost per 100,000 persons (DALY rate) due to lead contamination in the environment.

Units	Age-standardized DALYs/100k people
Years	1990–2019
Source	Institute for Health Metrics and Evaluation
Transformation	ln(x)

Performance	Nominal	Raw	Transformed
Best	1st percentile	22.3544	3.107023
Worst	99th percentile	1372.9363	7.224707

MSW: Mismanaged Solid Waste / Waste Management / Environmental Health

Mismanaged solid waste refers to the proportion of household and commercial waste generated in a country that is not collected and treated in a manner that controls environmental risks. Examples of controlled disposal methods include sanitary landfills, incineration, recycling, composting, and anaerobic digestion.

Units proportion

Years 2019–2019

Sources Kaza et al. 2018, Lebreton and Andrady 2019, Jambeck et al. 2015, Law et al. 2020

Transformation none

Performance	Nominal	Raw
Best	0.0	0.0
Worst	1.0	1.0

Calculations

Country values are determined by the arithmetic mean value of data reported in the above studies.

OCP: Ocean Plastic Pollution / Waste Management / Environmental Health

We measure *ocean plastic pollution* using the total mass of post-consumer plastics entering the ocean each year.

Units million tons

Years 1990–2020

Source Chen et al 2020.; Borelle et al. 2020; Meijer et al. 2021

Transformation $\ln (x + \alpha)$
$\alpha = 4.50 \times 10^{-6}$

Performance	Nominal	Raw	Transformed
Best	0	0	-12.31143
Worst	99th percentile	0.5937248	-0.5213318

Calculations

Country values are determined by the arithmetic mean value of data reported in the above studies.

REC: Mismanaged recyclables / Waste Management / Environmental Health

We measure *mismanaged recyclables* as the proportion of post-consumer recyclable materials (glass, plastic, paper, and metal) that is not recycled.

Units proportion

Years 1990–2020

Source Chen et al 2020.

Transformation none

Performance	Nominal	Raw
Best	0.0	0.0
Worst	1.0	1.0

CDA: CO_2 intensity trend / Climate Change Mitigation / Climate Change

The *CO_2 growth rate* is calculated as the average annual rate of increase or decrease in raw carbon dioxide emissions over the years 2010–2019. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units proportion

Years 1850-2019

Source Potsdam Institute for Climate Impact Research

Transformation none

Performance	Nominal	Raw
Best	-0.0759	-0.0759
Worst	0.0759	0.0759

Calculations

Component		Units	Source
CDO	Emissions of CO_2	Gg	PIK
GDP	Gross Domestic Product	2017 $	World Bank & IMF
CDR	Correlation coefficient	—	
CDB	Emission growth rate	proportion	
t	Years		

First, we calculate Spearman's correlation coefficient between CO_2 emissions and GDP over a ten-year period,

$$CDR = corr(CDO, GDP)$$

Second, we regress logged CO_2 emissions over ten years to find a slope,

$$\ln(CDO) = \alpha + \beta t$$

Third, we calculate an unadjusted average annual growth rate in CO_2 emissions,

$$CDB = \exp(\beta) - 1$$

Fourth, we adjust the negative growth rates by a factor of 1 – the correlation coefficient,

$$\text{CDA} = \begin{cases} \text{CDB if CDB} \geq 0 \\ \text{CDB} \times (1 - \text{CDR}) \text{ if CDB} < 0 \end{cases}$$

CHA: Methane intensity trend / Climate Change Mitigation / Climate Change

The *CH_4 growth rate* is calculated as the average annual rate of increase or decrease in raw methane emissions over the years 2010–2019. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units	proportion
Years	1850-2019
Source	Potsdam Institute for Climate Impact Research
Transformation	none

Performance	**Nominal**	**Raw**
Best	-0.05	-0.05
Worst	0.05	0.05

Calculations

Component		Units	Source
CH4	Emissions of CH_4	Gg	PIK
GDP	Gross Domestic Product	2017$	World Bank & IMF
CHR	Correlation coefficient	—	
CHB	Emission growth rate	proportion	
t	Years		

First, we calculate Spearman's correlation coefficient between CH_4 emissions and GDP over a ten-year period,

$$\text{CHR} = \text{corr}(\text{CH4}, \text{GDP})$$

Second, we regress logged CH_4 emissions over ten years to find a slope,

$$\ln(\text{CH4}) = \alpha + \beta t$$

Third, we calculate an unadjusted average annual growth rate in CH_4 emissions,

$$\text{CHB} = \exp(\beta) - 1$$

Fourth, we adjust the negative growth rates by a factor of 1 – the correlation coefficient,

$$\text{CHA} = \begin{cases} \text{CHB if CHB} \geq 0 \\ \text{CHB} \times (1 - \text{CHR}) \text{ if CHB} < 0 \end{cases}$$

FGA: F-gasses intensity trend / Climate Change Mitigation / Climate Change

The *F-gas growth rate* is calculated as the average annual rate of increase or decrease in raw fluorinated gas emissions over the years 2010–2019.

Units proportion

Years 1850–2019

Source Potsdam Institute for Climate Impact Research

Transformation none

Performance	Nominal	Raw
Best	-0.03943723	-0.03943723
Worst	0.2	0.2

Calculations

Component		Units	Source
FOG	Emissions of F-gases	Gg CO_2-eq.	PIK
FGB	Emission growth rate	proportion	
t	Years		

First, we regress logged F-gas emissions over ten years to find a slope,

$$\ln(FOG) = \alpha + \beta t$$

Second, we calculate an unadjusted average annual growth rate in F-gas emissions,

$$FGB = \exp(\beta) - 1$$

Third, because F-gas emissions are largely uncorrelated with GDP, we simply use the unadjusted average annual emission growth rate,

$$FGA = FGB$$

NDA: N_2O intensity trend / Climate Change Mitigation / Climate Change

The *N_2O growth rate* is calculated as the average annual rate of increase or decrease in raw nitrous oxide emissions over the years 2010–2019. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units	proportion
Years	1850–2019
Source	Potsdam Institute for Climate Impact Research
Transformation	none

Performance	Nominal	Raw
Best	-0.01946605	-0.01946605
Worst	95th percentile	0.05505094

Calculations

Component		Units	Source
NOT	Emissions of N_2O	Gg	PIK
GDP	Gross Domestic Product	2017$	World Bank & IMF
NDR	Correlation coefficient	—	
NDB	Emission growth rate	proportion	
t	Years		

First, we calculate Spearman's correlation coefficient between N_2O emissions and GDP over a ten-year period,

$$\text{NDR} = \text{corr}(\text{NOT}, \text{GDP})$$

Second, we regress logged N_2O emissions over ten years to find a slope,

$$\ln(\text{NOT}) = \alpha + \beta t$$

Third, we calculate an unadjusted average annual growth rate in N_2O emissions,

$$\text{NDB} = \exp(\beta) - 1$$

Fourth, we adjust the negative growth rates by a factor of 1 – the correlation coefficient,

$$\text{NDA} = \begin{cases} \text{NDB if NDB} \geq 0 \\ \text{NDB} \times (1 - \text{NDR}) \text{ if NDB} < 0 \end{cases}$$

BCA: Black Carbon intensity trend / Climate Change Mitigation / Climate Change

The *black carbon growth rate* is calculated as the average annual rate of increase or decrease in black carbon over the years 2010–2019. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units	proportion
Years	1750-2019
Source	Community Emissions Data Systems
Transformation	none

Performance	Nominal	Raw
Best	-0.018698537	-0.018698537
Worst	95th percentile	0.05159549

Calculations

Component		Units	Source
BLC	Emissions black carbon	Gg	CEDS
GDP	Gross Domestic Product	2017$	World Bank & IMF
BCR	Correlation coefficient	—	
BCB	Emission growth rate	proportion	
t	Years		

First, we calculate Spearman's correlation coefficient between black carbon emissions and GDP over a ten-year period,

$$BCR = \text{corr}(BLC, GDP)$$

Second, we regress logged black carbon emissions over ten years to find a slope,

$$\ln(BLC) = \alpha + \beta t$$

Third, we calculate an unadjusted average annual growth rate in black carbon emissions,

$$BCB = \exp(\beta) - 1$$

Fourth, we adjust the negative growth rates by a factor of 1 – the correlation coefficient,

$$\text{BCA} = \begin{cases} \text{BCB if BCB} \geq 0 \\ \text{BCB} \times (1 - \text{BCR}) \text{ if BCB} < 0 \end{cases}$$

GHN: Projected 2050 GHG Emissions / Climate Change Mitigation / Climate Change

The *projected GHG emissions in 2050* metric is calculated by extrapolating each country's emissions trajectory over the most recent 10 years of data to 2050. Countries projected to reach low emissions by or before 2050 receive top scores.

Units	Gg CO_2-eq.
Years	1999–2019
Source	Potsdam Institute for Climate Impact Research
Transformation	$\ln(x + \alpha)$ $\alpha = 1$

Performance	Nominal	Raw	Transformed
Best	5th percentile	234.3796	5.46120
Worst	95th percentile	1109493.1941	13.91941

Calculations

Component		Units	Source
CDO	Emissions of CO_2	Gg	PIK
CH4	Emissions of CH_4	Gg	PIK
FOG	Emissions of F-gases	Gg CO_2-eq.	PIK
NOT	Emissions of N_2O	Gg	PIK
GHR	Correlation coefficient	—	
GHG	Emissions of GHG	Gg CO_2-eq.	
E50	Projected 2050 GHG Emissions	Gg CO_2-eq.	
t	Years		

First, we calculate total greenhouse gas emissions, applying Global Warming Potentials to convert all units to Gg of CO_2-equivalents. N.B. that F-gas emissions are already converted to CO_2-eq. by the Potsdam Institute.

$$GHG = CDO + FOG + 273 \times NOT + 27.2 \times CH4$$

Then, we calculate Spearman's correlation coefficient between total greenhouse gas emissions and GDP over a ten-year period,

$$\text{GHR} = \text{corr}(\text{GHG}, \text{GDP})$$

Next, we regress GHG emissions from over 10 years to find a slope,

$$\text{GHG} = \alpha + \beta t$$

To avoid projecting emissions that have been declining due to economic recessions, we adjust the slopes as follows:

$$\beta' = \begin{cases} \beta \text{ if } \beta \leq 0 \text{ OR GHR} < 0 \\ \beta \times (1 - \text{GHR}) \text{ if } \beta < 0 \text{ OR GHR} \geq 0 \end{cases}$$

Using this adjusted slope, we then extrapolate emissions from the latest year's data out to 2050:

$$\text{E50} = \text{GHG}_t + \beta'(2050 - t)$$

Country scores are based on logged projected emissions in 2050.

GHP: GHG emissions per capita / Climate Change Mitigation / Climate Change

We calculate *greenhouse gas (GHG) emissions per capita* for each country in the year 2019.

Units	Gg CO_2-eq./person
Years	1990–2019
Source	Potsdam Institute for Climate Impact Research
Transformation	ln(x)

Performance	Nominal	Raw	Transformed
Best	5th percentile	0.0009949607	-6.912807
Worst	95th percentile	0.0233008255	-3.759266

Calculations

Component		Units	Source
CDO	Emissions of CO_2	Gg	PIK
CH4	Emissions of CH_4	Gg	PIK
FOG	Emissions of F-gases	Gg CO_2-eq.	PIK
NOT	Emissions of N_2O	Gg	PIK
POP	Population	persons	World Bank & IMF
GHG	Emissions of GHG	Gg CO_2-eq.	

First, we calculate total greenhouse gas emissions, applying Global Warming Potentials to convert all units to Gg of CO_2-equivalents. N.B. that F-gas emissions are already converted to CO_2-eq. by the Potsdam Institute.

$$\text{GHG} = \text{CDO} + \text{FOG} + 273 \times \text{NOT} + 27.2 \times \text{CH4}$$

Second, we calculate GHG emissions per capita (GHP) as the GHG emissions divided by population (POP).

$$\text{GHP} = \text{GHG} \div \text{POP}$$

LCB: CO_2 from Land Cover / Climate Change Mitigation / Climate Change

This new indicator measures trends in *CO_2 emissions from land cover change* and is calculated over the years 2010–2017.

Units	proportion
Years	2010–2017
Source	Mullion Group
Transformation	none

Performance	Nominal	Raw
Best	5th percentile	-0.1295422
Worst	95th percentile	0.2142180

Calculations

Component		Units	Source
CDL	CO_2 emissions from land cover change (LULC)	Gg	Mullion Group
t	Time	Years	

First, we regress logged CO_2 emissions from land cover change (LULC) over 10 years to find a slope,

$$\ln(CDL) = \alpha + \beta t$$

Then, we calculate an unadjusted average annual growth rate in these CO_2 emissions,

$$LCB = \exp(\beta) - 1$$

GIB: GHG emission intensity growth rate / Climate Change Mitigation / Climate Change

Our *greenhouse gas (GHG) intensity growth rate* indicator serves as a signal of countries' progress in decoupling emissions from economic growth. We calculate an annual average growth rate in GHG emissions per unit of GDP over the years 2010–2019. This indicator highlights the need for action on climate change mitigation in countries at all income levels.

Units	proportion
Years	1999–2019
Source	Potsdam Institute for Climate Impact Research
Transformation	none

Performance	**Nominal**	**Raw**
Best	5th percentile	-0.06317897
Worst	95th percentile	0.02831323

Calculations

Component		Units	Source
CDO	Emissions of CO_2	Gg	PIK
CH4	Emissions of CH_4	Gg	PIK
FOG	Emissions of F-gases	Gg CO_2-eq.	PIK
NOT	Emissions of N_2O	Gg	PIK
GDP	GDP	2017$, PPP	World Bank & IMF
GHI	GHG Intensity	Gg CO_2-eq./$	

First, we calculate total greenhouse gas emissions, applying Global Warming Potentials to convert all units to Gg of CO_2-equivalents. N.B. that F-gas emissions are already converted to CO_2-eq. by the Potsdam Institute.

$$\text{GHG} = \text{CDO} + \text{FOG} + 273 \times \text{NOT} + 27.2 \times \text{CH4}$$

Second, we calculate the GHI, which is the quotient of GHG and GDP,

$$\text{GHI} = \frac{\text{GHG}}{\text{GDP}}$$

Third, we regress logged greenhouse gas emission intensity over ten years to find a slope,

$$\ln(\text{GHI}) = \alpha + \beta t$$

Finally, we calculate an unadjusted average annual growth rate,

$$\text{GIB} = \exp(\beta) - 1$$

TBN: Terrestrial Biome Protection (National weights) / Biodiversity / Ecosystem Vitality

We derive the terrestrial biome protection indicators by first calculating the proportions of the area of each of a country's biome types that are covered by protected areas and then constructing a weighted sum of the protection percentages for all biomes within that country. For the "national weights" indicator, protection percentages are weighted according to the prevalence of each biome type within that country. This indicator evaluates a country's efforts to achieve 17% protection for all biomes within its borders, as per Aichi Target 11.

Units	%
Years	1990–2022
Source	World Database on Protected Areas
Transformation	none

Performance	Nominal	Raw
Best	17.0	17.0
Worst	0.0	0.0

Calculations

Component		Units	Source
TEW	Area of biomes	sq. km	World Wide Fund for Nature
TPA	Area of TPAs	sq. km	World Database of Protected Areas
PCT	Raw % of biome within TPA		
ICT	Credited % of biome within TPA		
w	Weight of ICT in indicator construction		
i	An index of all TPAs in a country		
b	An index of biomes		
c	An index of countries		

First, the percent of each biome present in a country that lies within a protected area is given by,

$$PCT_{bc} = \sum_i TPA_{ibc} / TEW_{bc}$$

Second, the credit given to a country for protecting any given biome is capped at 17%,

$$ICT_{bc} = \begin{cases} PCT_{bc} \text{ if} PCT_{bc} \leq 0.17 \\ 0.17 \text{ if } PCT_{bc} > 0.17 \end{cases}$$

Third, the national weight placed on each biome is calculated by the proportion of that biome for the entire country,

$$w_{bc} = TEW_{bc} / \sum_b TEW_{bc}$$

Fourth, the metric is calculated as the weighted sum of percent protection for all biomes in a country.

$$TBN_c = \sum_b [w_{bc} \times ICT_{bc}] \times 100$$

TBG: Terrestrial Biome Protection (Global weights) / Biodiversity / Ecosystem Vitality

We derive the terrestrial biome protection indicators by first calculating the proportions of the area of each of a country's biome types that are covered by protected areas and then constructing a weighted sum of the protection percentages for all biomes within that country. For the "global weights" indicator, protection percentages are weighted according to the global prevalence of each biome type. This indicator evaluates a country's contribution toward the global 17% protection goal.

Units	%
Years	1990–2022
Source	World Database on Protected Areas
Transformation	none

Performance	Nominal	Raw
Best	17.0	17.0
Worst	0.0	0.0

Calculations

Component		Units	Source
TEW	Area of biomes	sq. km	World Wildlife Fund
TPA	Area of TPAs	sq. km	World Database of Protected Areas
PCT	Raw % of biome within TPA		
ICT	Credited % of biome within TPA		
w	Weight of ICT in indicator construction		
i	An index of all TPAs in a country		
b	An index of biomes		
c	An index of countries		

First, the percent of each biome present in a country that lies within a protected area is given by,

$$PCT_{bc} = \sum_i TPA_{ibc} / TEW_{bc}$$

Second, the credit given to a country for protecting any given biome is capped at 17%,

$$ICT_{bc} = \begin{cases} PCT_{bc} \text{ if} PCT_{bc} \leq 0.17 \\ 0.17 \text{ if } PCT_{bc} > 0.17 \end{cases}$$

Third, the global weight placed on each biome is calculated by the global rarity of the biome,

$$w_{bc} = \left[\frac{TEW_{bc}}{\sum_c TEW_{bc}}\right] \Big/ \left[\sum_b \frac{TEW_{bc}}{\sum_c TEW_{bc}}\right]$$

Fourth, the metric is calculated as the weighted sum of percent protection for all biomes in a country.

$$TBG_c = \sum_b [w_{bc} \times ICT_{bc}]$$

MPA: Marine Protected Areas / Biodiversity / Ecosystem Vitality

The *marine protected areas* indicator measures the percentage of a country's total exclusive economic zone (EEZ) designated as marine protected areas (MPAs). MPAs are a critical tool for protecting marine ecosystems from unsustainable fishing practices, pollution, and human disturbance. This indicator evaluates a country's contribution toward the global 10% protection goal, as defined in Aichi Biodiversity Target 11.

Units	%
Years	1990–2022
Source	World Database on Protected Areas
Transformation	none

Performance	**Nominal**	**Raw**
Best	10.0	10.0
Worst	0.0	0.0

Calculations

Component		Units	Source
AMP	Area of MPAs	sq. km	World Database of Protected Areas
EEZ	Area of EEZs	sq. km	Flanders Marine Institute
i	An index of all MPAs in a country		
j	An index of all EEZs in a country		

These components are used to calculate the metric on *Marine Protected Areas*. Because each country may have multiple EEZs, the summed area of MPAs is divided by the summed EEZ.

$$MPA = \sum AMP_i \Big/ \sum EEZ_j \times 100$$

PAR: Protected Areas Representativeness Index / Biodiversity & Habitat / Ecosystem Vitality

The *PARI* indicator measures ecological representativeness as the proportion of biologically scaled environmental diversity included in a country's terrestrial protected areas. The measure relies on remote sensing, biodiversity informatics, and global modeling of fine-scaled variation in biodiversity composition for plant, vertebrate, and invertebrate species.

Units unitless

Years 2000–2020

Source Commonwealth Scientific and Industrial Research Organization

Transformation none

Performance	Nominal	Raw
Best	0.31	0.31
Worst	5th percentile	0.03079113

SHI: Species Habitat Index / Biodiversity & Habitat / Ecosystem Vitality

Species Habitat Index (SHI) estimates potential population losses, as well as regional and global extinction risks of individual species, using habitat loss as a proxy. The *SHI* indicator measures the proportion of suitable habitat within a country that remains intact for each species in that country relative to a baseline set in the year 2001.

Units	%
Years	2001–2014
Source	Map of Life
Transformation	none

Performance	Nominal	Raw
Best	100.0	100.0
Worst	1st percentile	93.27

Countries for which SHI values were censored. Map of Life warns that estimates for countries with land areas less than 100,00 sq. km may be unreliable.

Antigua and Barbuda
Bahrain
Barbados
Brunei Darussalam
Cabo Verde
Comoros
Cyprus
Dominica
Grenada
Kiribati
Luxembourg
Maldives
Malta
Marshall Islands
Mauritius
Micronesia
Saint Lucia
Saint Vincent and the Grenadines
Samoa
Sao Tome and Principe
Seychelles
Singapore
Tonga
Trinidad and Tobago

SPI: Species Protection Index / Biodiversity & Habitat / Ecosystem Vitality

Species Protection Index (SPI) evaluates the species-level ecological representativeness of each country's protected area network. The *SPI* metric uses remote sensing data, global biodiversity informatics, and integrative models to map suitable habitat for over 30,000 terrestrial vertebrate, invertebrate, and plant species at high resolutions. Data for this indicator come from the Map of Life.

Units	%
Years	1980–2021
Source	Map of Life
Transformation	none

Performance	Nominal	Raw
Best	100.0	100.0
Worst	0.0	0.0

BHV: Variable / Biodiversity & Habitat / Ecosystem Vitality

The *Biodiversity Habitat Index (BHI)* estimates the effects of habitat loss, degradation, and fragmentation on the expected retention of terrestrial biodiversity. Due to updated methodology used to derive the BHI, only one year of data (2020) is available.

Units unitless

Years 2020–2020

Source Commonwealth Scientific and Industrial Research Organization

Transformation none

Performance	Nominal	Raw
Best	1.0	1.0
Worst	0.0	0.0

TCL: Tree cover loss, % / Ecosystem Services / Ecosystem Vitality

We quantify tree cover loss by constructing a five-year moving average of the percentage of forest lost since the reference year 2000. We define a forest as any land area with over 30% canopy cover.

Units	proportion
Years	2006–2020
Source	Global Forest Watch
Transformation	ln (x + α) α = 9.70E-07

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-13.84597
Worst	99th percentile	0.01985199	-3.919402

Calculations

Component		Units	Source
TCA	Tree cover area (30% canopy cover)	ha	Global Forest Watch
TCC	Tree cover loss	ha	Global Forest Watch
TC5	Sum of last 5 years of loss	ha	Global Forest Watch
t	An index of years		

First, TC5 is calculated by adding the last 5 years of tree cover loss for a country,

$$TC5 = \sum_{i=0}^{4} TCC_{t-i}$$

Next, TCL is calculated by dividing TC5 by five times the tree cover area (TCA) from the reference year of 2000,

$$TCL = \frac{TC5}{5 \times TCA_{2000}}$$

GRL: Grassland Loss / Ecosystem Services / Ecosystem Vitality

Grassland loss is measured using a five-year moving average of percentage of gross losses in grassland areas compared to the 1992 reference year. Data are derived from a time series of annual global land cover maps for the years 1992–2020 released by the Copernicus Climate Change Service.

Units	proportion
Years	1997–2020
Source	Copernicus
Transformation	$\ln(x + \alpha)$ α = 4.45E-06

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-12.32261
Worst	99th percentile	0.06958161	-2.665191

Calculations

Component		Units	Source
GL5	Gross loss in Grassland area over five-year interval	km^2	Copernicus
GRA	Grassland Area	km^2	Copernicus
t	An index of time		

First, GL5 is calculated by adding the last 5 years of grassland loss for a country,

$$GL5 = \sum_{i=0}^{4} \text{Yearly Grassland Loss}_{t-i}$$

Next, GRL is calculated by dividing GL5 by five times the total grassland area (GRA) from the reference year of 1992,

$$GRL = \frac{GL5}{5 \times GRA_{1992}}$$

WTL: Wetland Loss / Ecosystem Services / Ecosystem Vitality

Wetland loss is quantified using a five-year moving average of percentage of gross losses in wetland areas compared to the 1992 reference year. Data are derived from a time series of annual global land cover maps for the years 1992–2015 released by the Copernicus Climate Change Service.

Units proportion

Years 1997–2020

Source Copernicus

Transformation $\ln(x + \alpha)$
$\alpha = 2.47E\text{-}06$

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-12.91129
Worst	99th percentile	0.06668734	-2.707703

Calculations

Component		Units	Source
WL5	Gross loss in Wetland area over five-year interval	km^2	Copernicus
WTA	Wetland Area	km^2	ESA Copernicus
t	An index of time		

First, WL5 is calculated by adding the last 5 years of wetland loss for a country,

$$WL5 = \sum_{i=0}^{4} \text{Yearly Wetland Loss}_{t-i}$$

Next, WTL is calculated by dividing WL5 by five times the total wetland area (WTA) from the reference year of 1992,

$$WTL = \frac{WL5}{5 \times WTA_{1992}}$$

FSS: Fish Stock Status / Fisheries / Ecosystem Vitality

Fish stock status evaluates the percentage of a country's total catch that comes from overexploited or collapsed stocks, considering all fish stocks within a country's EEZs. Because continued and increased stock exploitation leads to smaller catches, this indicator sheds light on the impact of a country's fishing practices.

Units	proportion
Years	1950–2018
Source	Sea Around Us
Transformation	$\ln(x + \alpha)$ α = 1.13E-05

Performance	**Nominal**	**Raw**	**Transformed**
Best	0.01	0.01	-4.604041
Worst	99th percentile	0.7775384	-0.2516077

Calculations

Component		Units	Source
FSC	Fish stock class	%	*Sea Around Us*
CTH	Catch	tonnes	*Sea Around Us*
e	An index of EEZs in a country		
k	An index of classes: {1 = collapsed, 2 = over-exploited, 3 = exploited, 4= developing, 5= rebuilding}		

The metric is calculated as an average percentage weighted by catch and summed across classes of concern.

$$\text{FSS} = \frac{\sum_e \left[\text{FSC}_{k=1,e} \times \text{CTH}_e\right] + \sum_e \left[\text{FSC}_{k=2,e} \times \text{CTH}_e\right]}{\sum_e \text{CTH}_e}$$

RMS: Regional Marine Trophic Index / Fisheries / Ecosystem Vitality

Marine Trophic Index (MTI) describes the health of a country's fishing stock based on expected catch and changes over time. The MTI describes the degree to which a country is depleting species at higher trophic levels and "fishing down the food web."

Units unitless

Years 2018–2018

Source Sea Around Us

Transformation $\ln(x + \alpha)$
$\alpha = 9.51E\text{-}07$

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-13.86575
Worst	99th percentile	0.03546256	-3.339251

Calculations

Marine Trophic Index is defined as the slope of the trophic index (TI) from the year of peak trophic index to the trophic index in the latest year of data, 2018.

$$MTI = \frac{TI_{max} - TI_{2018}}{Year_{max} - 2018}$$

FTD: Fish caught by Trawling and Dredging / Fisheries / Ecosystem Vitality

Fish caught by trawling measures the percentage of a country's fish caught by bottom trawling, where a fishing net is pulled along the seafloor behind a boat, or dredging, where the seafloor is scraped in search bottom-dwelling species. These practices are indiscriminate and wasteful and can severely damage marine ecosystems.

Units	proportion
Years	1950–2018
Source	Sea Around Us
Transformation	$\ln(x + \alpha)$ $\alpha = 8.40E\text{-}08$

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-16.29245
Worst	99th percentile	0.9644296	-0.03621834

Calculations

Component		Units	Source
FTD	Catch by gear type and EEZ	tonnes	Sea Around Us
CTH	Catch by EEZ	tonnes	Sea Around Us
e	An index of EEZs in a country		
g	An index of gear types: {1 = bottom trawling, 2 = dredging, 3 = pelagic trawling, 4 = gillnets, 5 = longline, 6 = other}		

$$FTD = \frac{\sum_{g=1}^{2} \sum_e FTD_{eg}}{\sum_e CTH_e}$$

SDA: SO2 intensity trend / Pollution Emissions / Ecosystem Vitality

The *SO_2 growth rate* is calculated as the average annual rate of increase or decrease in SO_2 over the years 2010–2019. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units	unitless
Years	1750–2019
Source	Community Emissions Data Systems
Transformation	none

Performance	Nominal	Raw
Best	-0.03943723	-0.03943723
Worst	95th percentile	0.1021492

Calculations

Component		Units	Source
SO2	Emissions of SO_2	Gg	CEDS
GDP	Gross Domestic Product	2017$	World Bank & IMF
SDR	Correlation coefficient	—	
SDB	Emission growth rate	proportion	
t	Years		

First, we calculate Spearman's correlation coefficient between SO_2 emissions and GDP over a ten-year period,

$$SDR = corr(SO2, GDP)$$

Second, we regress logged SO_2 emissions over ten years to find a slope,

$$\ln(SO2) = \alpha + \beta t$$

Third, we calculate an unadjusted average annual growth rate in SO_2 emissions,

$$SDB = \exp(\beta) - 1$$

Fourth, we adjust the negative growth rates by a factor of 1 – the correlation coefficient,

$$\text{SDA} = \begin{cases} \text{SDB if SDB} \geq 0 \\ \text{SDB} \times (1 - \text{SDR}) \text{ if SDB} < 0 \end{cases}$$

NXA: NOx intensity trend / Pollution Emissions / Ecosystem Vitality

The *NO_X growth rate* is calculated as the average annual rate of increase or decrease in NO_X over the years 2010–2019. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units	unitless
Years	1750–2019
Source	Community Emissions Data Systems
Transformation	none

Performance	Nominal	Raw
Best	-0.03943723	-0.03943723
Worst	95th percentile	0.09454618

Calculations

Component		Units	Source
NOX	Emissions of NO_X	Gg	CEDS
GDP	Gross Domestic Product	2017$	World Bank & IMF
NXR	Correlation coefficient	—	
NXB	Emission growth rate	proportion	
t	Years		

First, we calculate Spearman's correlation coefficient between NO_X emissions and GDP over a ten-year period,

$$NXR = corr(NOX, GDP)$$

Second, we regress logged NO_X emissions over ten years to find a slope,

$$\ln(NOX) = \alpha + \beta t$$

Third, we calculate an unadjusted average annual growth rate in NO_X emissions,

$$NXB = \exp(\beta) - 1$$

Fourth, we adjust the negative growth rates by a factor of 1 – the correlation coefficient,

$$\text{NXA} = \begin{cases} \text{NXB if NXB} \geq 0 \\ \text{NXB} \times (1 - \text{NXR}) \text{ if NXB} < 0 \end{cases}$$

SNM: Sustainable Nitrogen Management Index / Agriculture / Ecosystem Vitality

The *Sustainable Nitrogen Management Index (SNMI)* seeks to balance efficient application of nitrogen fertilizer with maximum crop yields as a measure of the environmental performance of agricultural production. The 2022 EPI uses the *SNMI* as a proxy for agricultural drivers of environmental damage.

Units	unitless
Years	1961–2015
Source	UMCES
Transformation	none

Performance	**Nominal**	**Raw**
Best	0.0	0.0
Worst	99th percentile	1.364048

Imputation

Since Taiwan was missing, its value was imputed as an average of five neighbors: Japan, Philippines, South Korea, Malaysia, and Indonesia.

SPU: Sustainable Pesticide Use / Agriculture / Ecosystem Vitality

We calculate the *sustainable pesticide use* indicator by adjusting a country's pesticide risk score (Tang et al. 2021) using pesticide application rates (Maggi et al. 2019) to balance food security with ecosystem health.

Units	unitless
Years	2020
Source	Tang et al. 2021; Maggi et al. 2019.
Transformation	none

Performance	**Nominal**	**Raw**
Best	0.0	0.0
Worst	4.5	4.5

Calculations

Component		Units	Source
PRS	Pesticide risk score	—	Tang et al. 2021
APR	Pesticide application rate	$kg\ ha^{-1}\ yr^{-1}$	Maggi et al. 2019
c	Country index		

We first identify the 25^{th} percentile of pesticide application rate to use as a baseline for sustainable pesticide application rates:

$$APR_{25th} = \text{percentile}(APR, 25\%)$$

We then correct each country's pesticide risk score based on how far its pesticide application rate falls below the baseline application rate:

$$SPU = \begin{cases} PRS_c \text{ if } APR_c \geq APR_{25th} \\ (APR_{25th} - APR_c) \times APR_{25th} + PRS_c \text{ if } APR_c < APR_{25th} \end{cases}$$

WWT: Wastewater treatment level / Water Resources / Ecosystem Vitality

We measure *wastewater treatment* as the percentage of wastewater that undergoes at least primary treatment in each country, normalized by the proportion of the population connected to a municipal wastewater collection system.

Units	proportion
Years	2020–2020
Source	UNSD, OECD, Eurostat, etc.
Transformation	none

Performance	**Nominal**	**Raw**
Best	1.0	1.0
Worst	0.0	0.0

Calculations

Component		Units	Source
WST	Wastewater treatment level	proportion	*various*
CXN	Sewerage connection rate	proportion	various
GPC	GDP per capita	2017$/person	World Bank & IMF
PDN	Population density	Persons/km^2	PIK
R	A vector of region dummies		
S	A vector of source dummies	{UNSD, OECD, Eurostat, PMY, GWI, EPI]	

The WWT metric was calculated through the product of treatment level and connection rate:

$$WWT = WST \times CXN$$

Imputation — CXN

First, we run a predictive model on countries for which we have data,

$$CXN = \alpha + \beta GPC + \gamma R + \delta S + \varepsilon$$

where γ and δ are coefficients for categorical dummies in the vectors of R and S.

Second, we predict values for countries where CXN is missing but GPC and R are not. We force the source, S, to take the value of "UNSD."

$$\widehat{CXN} = \hat{\alpha} + \hat{\beta} GPC + \hat{\gamma} R + \hat{\delta} S$$

Third, we limit the range of CXN to fall within the range of 0–1 and apply a 25% penalty for failing to report data to the applicable organization requesting information on wastewater treatment.

$$CXN = 0.25 \times \begin{cases} 0 \text{ if } \widehat{CXN} < 0 \\ \widehat{CXN} \text{ if } 0 \leq \widehat{CXN} \leq 1 \\ 1 \text{ if } \widehat{CXN} > 1 \end{cases}$$

Countries for which CXN was imputed

Antigua & Barbuda	Grenada	Samoa
Bahamas	Kiribati	São Tomé and Príncipe
Barbados	Kyrgyzstan	Seychelles
Comoros	Micronesia	St Vincent & Grenadines
Côte d'Ivoire	Republic of Congo	Tonga
Eswatini	Saint Lucia	Vanuatu
Gambia		

Imputation — WST

First, we run a predictive model on countries for which we have data,

$$WST = \alpha + \beta GPC + \theta PDN + \gamma R + \delta S + \varepsilon$$

where γ and δ are coefficients for categorical dummies in the vectors of R and S.

Second, we predict values for countries where WST is missing but GPC, PDN, and R are not. We force the source, S, to take the value of "UNSD."

$$\widehat{WST} = \hat{\alpha} + \hat{\beta} GPC + \hat{\theta} PDN + \hat{\gamma} R + \hat{\delta} S$$

Third, we limit the range of WST to fall within the range of 0–1 and apply a 25% penalty for failing to report data to the applicable organization requesting information on wastewater treatment.

$$WST = 0.25 \times \begin{cases} 0 \text{ if } \widehat{WST} < 0 \\ \widehat{WST} \text{ if } 0 \leq \widehat{WST} \leq 1 \\ 1 \text{ if } \widehat{WST} > 1 \end{cases}$$

Countries for which WST was imputed

Antigua & Barbuda	Dominica	Maldives	São Tomé and Príncipe
Bahamas	Gambia	Micronesia	Seychelles
Barbados	Grenada	North Macedonia	St Vincent & Grenadines
Belize	Iceland	Republic of Congo	Tonga
Brunei Darussalam	Kiribati	Saint Lucia	Trinidad and Tobago
Comoros	Kyrgyzstan	Samoa	Vanuatu
Côte d'Ivoire			

4. Country Coverage

The EPI seeks to cover as many countries as possible. When selecting datasets for our calculations, the EPI team gathers information on all territories that data providers have to offer. After the team has finalized the list of indicators used in the EPI, a survey of country data coverage determines which countries have sufficient information to be included in rankings. Unfortunately, some countries do not have sufficient data to support the calculation of an overall EPI score. Whether or not a country is included is not a reflection of the environmental performance of those countries; rather, data sparseness makes it impossible to say something meaningful. Another set of countries is excluded because government instability skews available information. As we discuss in Chapter 15 the 2022 EPI Report, we also identify certain territories for which data may be reported separately but should be considered as under the control or protection of a sovereign government. In these cases, we aggregate data on the territories with the sovereign country.

4.1 Countries in the 2022 EPI

Afghanistan
Albania
Algeria
Angola
Antigua & Barbuda
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia & Herzegovina
Botswana
Brazil
Brunei Darussalam
Gambia
Georgia
Germany
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
Iceland
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Jamaica
Japan
Jordan
North Macedonia
Norway
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Republic of Congo
Romania
Russia
Rwanda
Saint Lucia
St Vincent & Grenadines
Samoa
São Tomé and Príncipe
Saudi Arabia
Senegal
Serbia
Seychelles

Bulgaria
Burkina Faso
Burundi
Cabo Verde
Cambodia
Cameroon
Canada
Central African Rep.
Chad
Chile
China
Colombia
Comoros
Costa Rica
Côte d'Ivoire
Croatia
Cuba
Cyprus
Czech Republic
Dem. Rep. Congo
Denmark
Djibouti
Dominica
Dominican Republic
Ecuador
Egypt
El Salvador
Equatorial Guinea
Eritrea
Estonia
Eswatini
Ethiopia
Fiji
Finland
France
Gabon
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Laos
Latvia
Lebanon
Lesotho
Liberia
Lithuania
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Micronesia
Moldova
Mongolia
Montenegro
Morocco
Mozambique
Myanmar
Namibia
Nepal
Netherlands
New Zealand
Nicaragua
Niger
Nigeria
Sierra Leone
Singapore
Slovakia
Slovenia
Solomon Islands
South Africa
South Korea
Spain
Sri Lanka
Sudan
Suriname
Sweden
Switzerland
Taiwan
Tajikistan
Tanzania
Thailand
Timor-Leste
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States of America
Uruguay
Uzbekistan
Vanuatu
Venezuela
Viet Nam
Zambia
Zimbabwe

4.2 Countries excluded from the 2022 EPI

- Andorra
- Anguilla
- Aruba
- Bermuda
- British Virgin Isls.
- Cayman Islands
- Cook Islands
- Curacao
- Faeroe Islands
- Falkland Islands
- French Polynesia
- Greenland
- Guernsey
- Holy See
- Hong Kong
- Isle of Man
- Jersey
- Kosovo
- Libya
- Liechtenstein
- Macao
- Monaco
- Nauru
- New Caledonia
- Niue
- North Korea
- Palau
- Saint Barthelemy
- St Kitts & Nevis
- San Marino
- Sint Maarten
- Somalia
- South Sudan
- State of Palestine
- Syria
- Turks & Caicos Isls.
- Tuvalu
- Wallis & Futuna Isls.
- Western Sahara
- Yemen

4.3 Territories within sovereign countries

Table TA-2. Territories found in gathered data sets and their sovereign countries.

Territory	Sovereign
Åland Islands	Finland
American Samoa	United States of America
Bonaire, Sint Eustatius, and Saba	Netherlands
Bouvet Island	Norway
British Indian Ocean Territory	United Kingdom
Christmas Island	Australia
Cocos Islands	Australia
French Guiana	France
French Southern Territories	France
Gibraltar	United Kingdom
Guadeloupe	France
Guam	United States of America
Heard Island and McDonald Islands	Australia
Martinique	France
Mayotte	France
Montserrat	United Kingdom
Norfolk Island	Australia
Northern Mariana Islands	United States of America
Pitcairn	United Kingdom
Puerto Rico	United States of America
Reunion	France
Saint Helena	United Kingdom
Saint Martin	France
Saint Pierre and Miquelon	France
South Georgia and the South Sandwich Islands	United Kingdom
Svalbard and Jan Mayen Islands	Norway
Tokelau	New Zealand
United States Minor Outlying Islands	United States of America
United States Virgin Islands	United States of America

5. Temporal Coverage

Table TA-3. Temporal coverage for indicators used in the 2022 EPI.

TLA	95					00					05					10					15					20		
GHN					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
CDA					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
CHA					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
LCB																■	■	■	■	■	■	■	■					
GIB					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
FGA					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
BCA					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
GHP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
NDA					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
PMD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
HAD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
OZD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
NOE								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
SOE								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
COE								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
VOE								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
UWD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
USD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
PBD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
MSW																									■			
REC	■					■					■					■					■					■		
OCP	■					■					■					■					■					■		
TBN	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TBG	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
MPA	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PAR						■					■					■	■	■	■	■	■	■				■		
SHI							■	■	■	■	■	■	■	■	■	■	■	■	■	■								
SPI	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
BHV																										■		
TCL												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
GRL			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
WTL			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
FSS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
RMS																								■				
FTD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
SDA					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
NXA					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
SNM	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
SPU																										■		
WWT																										■		
GDP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
POP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		

Table TA-4. Designations of years supporting the current and baseline scores for each indicator.

Indicators	**Current**	**Baseline**
Climate Change Mitigation		
Projected GHG Emissions in 2050	2019	2009
CO_2 Growth Rate	2019	2009
CH_4 Growth Rate	2019	2009
CO_2 from Land Cover	2017	2010
F-gas Growth Rate	2019	2009
Black Carbon Growth Rate	2019	2009
GHG Emissions per Capita	2019	2009
N_2O Growth Rate	2019	2009
Air Quality		
$PM_{2.5}$ Exposure	2019	2009
Household Solid Fuels	2019	2009
Ozone Exposure	2019	2009
NOx Exposure	2019	2009
SO2 Exposure	2019	2009
CO Exposure	2019	2009
VOC Exposure	2019	2009
Sanitation & Drinking Water		
Unsafe Sanitation	2019	2009
Unsafe Drinking Water	2019	2009
Heavy Metals / Lead Exposure	2019	2009
Waste Management		
Controlled Solid Waste	2019	2019
Recycling Rates	2020	2010
Ocean Plastic Pollution	2020	2010
Biodiversity & Habitat		
Terrestrial Biome Protection (national)	2022	2012
Terrestrial Biome Protection (global)	2022	2012
Marine Protected Areas	2022	2012
Protected Areas Representativeness Index	2020	2010
Species Habitat Index	2014	2004
Species Protection Index	2021	2011
Biodiversity Habitat Index	2020	2020

Indicators	Current	Baseline
Ecosystem Services		
Tree Cover Loss	2020	2010
Grassland Loss	2020	2010
Wetland Loss	2020	2010
Fisheries		
Fish Stock Status	2018	2008
Marine Trophic Index	2018	2018
Fish Caught by Trawling	2018	2008
Acid Rain		
SO2 Growth Rate	2019	2009
NOx Growth Rate	2019	2009
Agriculture		
Sustainable Nitrogen Management Index	2015	2005
Sustainable Pesticide Use	2020	2020
Water Resources / Wastewater Treatment	2020	2020

6. Transformations & Targets

Table TA-5. Transformations and targets used in indicator construction.

			Nominal Targets		Value Targets		
TLA	**Trans.**	**Shift (α)**	**Best**	**Worst**	**Best**	**Worst**	**Polarity**
BCA			-0.0187	$95^{\%}$	-0.0187	0.0516	-
BHV			1	0	1	0	+
CDA			-0.0759	0.0759	-0.0759	0.0759	-
CHA			-0.05	0.05	-0.05	0.05	-
COE	log		$5^{\%}$	$95^{\%}$	-2.773	-0.7553	-
FGA			-0.0394	0.2	-0.0394	0.2	-
FSS	log	1.13E-05	0.01	$99^{\%}$	-4.604	-0.2516	-
FTD	log	8.40E-08	0	$99^{\%}$	-16.2924	-0.03622	-
GHN	log	1	$5^{\%}$	$95^{\%}$	5.4511	13.9194	-
GHP	log		$5^{\%}$	$95^{\%}$	-6.9128	-3.7593	-
GIB			$5^{\%}$	$95^{\%}$	-0.06318	0.02831	-
GRL	log	4.45E-06	0	$99^{\%}$	-12.3226	-2.6652	-
HAD	log		$5^{\%}$	$99^{\%}$	-0.242	9.2909	-
LCB			$5^{\%}$	$95^{\%}$	-0.1295	0.2132	-
MPA			10	0	10	0	+
MSW			0	1	0	1	-
NDA			-0.0195	$95^{\%}$	-0.0195	0.05505	-
NOE	log		$5^{\%}$	$95^{\%}$	-9.17282	-3.19189	-
NXA			-0.0394	$95^{\%}$	-0.03943	0.09455	-
OCP	log	4.50E-06	0	$99^{\%}$	-12.31143	-0.52133	-
OZD	log		$5^{\%}$	$99^{\%}$	0.1084	5.54471	-
PAR			0.31	$5^{\%}$	0.31	0.030791	+
PBD	log		$1^{\%}$	$99^{\%}$	3.10702	7.22471	-
PMD	log		$1^{\%}$	$95^{\%}$	4.70879	7.90451	-
REC			0	1	0	1	-
RMS	log	9.51E-07	0	$99^{\%}$	-13.86575	-3.33925	-
SDA			-0.03944	$95^{\%}$	-0.03944	0.10215	-
SHI			100	$1^{\%}$	100	93.27	+
SNM			0	$99^{\%}$	0	1.36405	-
SOE	log		$5^{\%}$	$95^{\%}$	-8.18534	-2.77028	-
SPI			100	0	100	0	+
SPU			0	4.5	0	4.5	-
TBG			17	0	17	0	+
TBN			17	0	17	0	+
TCL	log	9.70E-07	0	$99^{\%}$	-13.84597	-3.9194	-
USD	log		$5^{\%}$	$95^{\%}$	0.47427	8.39892	-
UWD	log		$5^{\%}$	$95^{\%}$	0.87224	8.68962	-

VOE	log		5$^{\%}$	95$^{\%}$	-7.16957	-2.34501	**-**
WTL	log	2.47E-06	0	99$^{\%}$	-12.91129	-2.7077	**-**
WWT			1	0	1	0	**+**

Notes:

1. $^{\%}$ indicates percentile, not the units of the indicator.
2. Negative (-) polarity indicates lower raw values are better.

7. Materiality

Table TA-6. Materiality Filters applied to the 2022 EPI. Countries meeting the listed criteria are not scored on the associated indicators and issue categories.

Materiality Filter	Criteria	Issue Category	Indicator	No. of Countries
SEA	Landlocked *or* Coastline : Land area ratio < 0.01	Fisheries	*Fish Stock Status, MTI, Fish caught by trawling*	44
		Biodiversity & Habitat	*Marine Protected Areas*	
TCF	No tree cover in 2000	Ecosystem services	*Tree cover loss*	12
GRF	Missing grassland area	Ecosystem services	*Grassland loss*	14
WLF	Missing wetland area	Ecosystem services	*Wetland loss*	23

Countries in the 2022 EPI affected by the SEA Materiality Filter

Afghanistan
Armenia
Austria
Azerbaijan
Belarus
Bhutan
Bolivia
Bosnia & Herzegovina
Botswana
Burkina Faso
Burundi
Central African Rep.
Chad
Czech Republic
Dem. Rep. Congo
Eswatini
Ethiopia
Hungary
Iraq
Jordan
Kazakhstan
Kyrgyzstan
Laos
Lesotho
Luxembourg
Malawi
Mali
Moldova
Mongolia
Nepal
Niger
North Macedonia
Paraguay
Rwanda
Serbia
Slovakia
Slovenia
Switzerland
Tajikistan
Turkmenistan
Uganda
Uzbekistan
Zambia
Zimbabwe

Countries in the 2022 EPI affected by the TCF Materiality Filter

Bahrain
Cabo Verde
Djibouti
Iceland
Kiribati
Kuwait
Marshall Islands
Oman
Qatar
Samoa
Tonga
UAE

Countries in the 2022 EPI affected by the GRF Materiality Filter

Bahrain
Brunei Darussalam
Fiji
Kiribati
Kuwait
Marshall Islands
Micronesia
Qatar
Saint Lucia
Samoa
Sao Tome and Principe
Singapore
Solomon Island
Tonga

Countries in the 2022 EPI affected by the WLF Materiality Filter

Brunei Darussalam
Comoros
Dominica
Fiji
Indonesia
Kiribati
Kyrgyzstan
Lebanon
Luxembourg
Malaysia
Maldives
Malta
Marshall Islands
Micronesia
Papua New Guinea
Philippines
Samoa
Seychelles
Singapore
Solomon Islands
Timor-Leste
Tonga
Vanuatu

8. Global Scorecard

Many of the EPI's 40 indicators can be aggregated to produce global metrics of performance. Some global aggregates are available from the original data sources, detailed in Sections 2 and 3 above. Other times, the data can be combined to permit global-scale analyses. This section describes how the construction of the global scorecard values for the 2022 EPI. First, a global aggregate for each metric was either downloaded from a data partner or calculated from the raw, country-level data. Second, these data were constructed into indicators, as described in Section 3. Third, these global indicators were then turned into a 0–100 score using the same targets and transformations summarized in Section 5.

8.1 Data available from data partners already aggregated to the global level.

Table TA-7. Variables available from data sources already aggregated to the global level.

TLA	Variable	Source
NOX	NO_X growth rate	CEDS
SO2	SO_2 growth rate	CEDS
BLC	Black carbon growth rate	CEDS
SOE	SO_2 exposure	Copernicus
NOE	NO_X exposure	Copernicus
COE	CO exposure	Copernicus
VOE	VOE exposure	Copernicus
PAR	Protected Areas Rep. Index	CSIRO
BHV	Biodiversity Habitat Index	CSIRO
PMD	$PM_{2.5}$ exposure	IHME
HAD	Household solid fuels	IHME
OZD	Ozone exposure	IHME
UWD	Unsafe drinking water	IHME
USD	Unsafe sanitation	IHME
PBD	Lead exposure	IHME
SPI	Species Protection Index	MOL
LCB	CO_2 from land cover	Mullion
CDO	CO_2 growth rate	PIK
CH4	CH_4 growth rate	PIK
GHN	Projected emissions in 2050	PIK
FOG	F-gas growth rate	PIK
NOT	N_2O growth rate	PIK
GHP	GHG emissions per capita	PIK/World Bank
GIB	GHG intensity trend	PIK/World Bank
SNM	Sustainable Nitrogen Mgmt. Index	UMCES

8.2 Data requiring aggregation to the global level

In the descriptions to follow, the superscript g indicates a global aggregate metric, and the subscript c is an index of countries in the raw data.

MSW: Mismanaged Solid Waste / Waste Management / Environmental Health

The global aggregate of *mismanaged solid waste* is calculated by diving the sum of all countries' mismanaged solid waste by the total waste generated:

$$MSW^g = \sum_c \frac{\text{Mismanaged Waste}_c}{\text{Total Waste}_c}$$

OPC: Ocean Plastic Pollution / Waste Management / Environmental Health

The global aggregate of *ocean plastic pollution* is calculated by aggregating country-level pollution data:

$$OCP^g = \sum_c OCP_c$$

Poor performance is benchmarked relative to the 99th percentile of global pollution levels through all years of data.

REC: Mismanaged recyclables / Waste Management / Environmental Health

The global aggregate of *mismanaged recyclables* is defined as the proportion of all countries' recyclable materials that are recycled.

MPA: Marine Protected Areas / Biodiversity & Habitat / Ecosystem Vitality

The global aggregate of *Marine Protected Areas* is calculated by the aggregation of country-level data.

$$MPA^g = {\sum_c \sum_i AMP_{ic}} \Big/ {\sum_c \sum_j EEZ_{jc}} \times 100$$

TBG: Terrestrial Protected Areas / Biodiversity & Habitat / Ecosystem Vitality

Because national weights do not apply to global aggregates, there is no comparable metric for TBN. Instead, TBG serves as the global indicator of *Terrestrial Protected Areas* and is calculated as a simple aggregation of country-level data.

First, the percent of each biome in the world that lies within a protected area is given by,

$$PCT_b = {\sum_c TPA_{bc}} \Big/ {\sum_c TEW_{bc}}$$

Second, the credit given to a country for protecting any given biome is capped at 17%,

$$ICT_b=\begin{cases}PCT_b & \text{if} PCT_b \leq 0.17\\ 0.17 & \text{if } PCT_b > 0.17\end{cases}$$

Third, the global weight placed on each biome is calculated by the global rarity of the biome,

$$w_b=\sum_c TEW_{bc} \Big/ \sum_b \sum_c TEW_{bc}$$

Fourth, the metric is calculated as the weighted sum of percent protection for all biomes in a country.

$$TBG^g=\sum_b [w_b \times ICT_b]$$

TCL: Tree Cover Loss / Ecosystem Services / Ecosystem Vitality

The global aggregate of *tree cover loss* is calculated as a simple aggregation of country-level data.

$$TCL=\frac{1}{5}\sum_{i=0}^{4}\frac{\sum_c TCC_{c,t-i}}{\sum_c TCA_c}$$

GRL: Grassland Loss / Ecosystem Services / Ecosystem Vitality

The global aggregate of *grassland loss* is calculated as a simple aggregation of country-level data.

$$GRL=\frac{1}{5}\sum_{i=0}^{4}\frac{\sum_c GRC_{c,t-i}}{\sum_c GRA_c}$$

WTL: Wetland Loss / Ecosystem Services / Ecosystem Vitality

The global aggregate of *wetland loss* is calculated as a simple aggregation of country-level data.

$$\text{WTL}=\frac{1}{5}\sum_{i=0}^{4}\frac{\sum_c \text{WTC}_{c,t\text{-}i}}{\sum_c \text{WTA}_c}$$

FSS: Fish Stock Status / Fisheries / Ecosystem Vitality

The global aggregate of *fish stock status* is calculated as a catch-weighted average of all country-level values.

$$\text{FSS}^g=\sum_{k=1}^{2}\frac{\sum_c\sum_e[\text{FSC}_{kec}\times\text{CTH}_{ec}]}{\sum_c\sum_e\sum_k[\text{FSC}_{kec}\times\text{CTH}_{ec}]}$$

FGT: Fish Caught by Trawling / Fisheries / Ecosystem Vitality

The global aggregate of *fish caught by trawling* is calculated as a catch-weighted average of all country-level values.

$$\text{FGT}^g=\frac{\sum_{m=1}^{3}\sum_c\sum_e \text{Gear\_type}_{ecm}}{\sum_c\sum_e \text{CTH}_{ec}}$$

WWT: Wastewater Treatment / Water Resources / Ecosystem Vitality

The global aggregate of *Wastewater Treatment* is calculated as a population-weighted average of all country-level values.

$$\text{WWT}^g=\sum_c\left[\text{WWT}_c\times\frac{\text{POP}_c}{\sum_c \text{POP}_c}\right]$$

8.3 Indicators for which it was not possible to construct a global aggregate.

SHI Species Habitat Index

RMS Marine Trophic Index

SPU Sustainable Pesticide Use

9. Data File Guide

The data underlying the 2022 EPI report's analyses is available for download from https://epi.yale.edu/downloads. These include both raw data and indicator data. Raw data files contain the data in their original units. Section 2 of this appendix describes the sources for these data. Indicator data contain the scores for the 40 metrics on a 0 to 100 scale. Section 3 of this appendix describes how the raw data are converted into indicator data.

Raw data files are named according to three-letter abbreviations (TLAs) unique to each variable. Within these files, columns are labeled *TLA.raw.YYYY*, where *YYYY* is the year. Not every indicator TLA is in the raw data – some indicators must be calculated from other raw data, as described in Section 3. Higher level aggregations, i.e., issue categories and policy objectives, will not have raw data files.

We provide two versions of each raw data file, with and without missing data codes. For all raw data files that are named *TLA_raw.csv*, missing values are noted with the following codes,

-9999	the as-received dataset has cells with missing values
-8888	the country is not reported by the data source
-7777	the missing values are missing because they are not material
-4444	censored data (values not reliable due to small country size)

For all raw data files that are named *TLA_raw_na.csv*, missing values are noted simply as NA.

Indicator file columns are formatted as *TLA.ind.YYYY*. The years covered in each indicator file are not necessarily the same as the underlying raw data files for two reasons. First, the EPI team resizes every file to begin in 1990 and end in 2022. Second, the EPI data processing pipeline uses linear interpolation to fill in missing data years between observations and hold values constant to extend to beginning and ending years. For example, if a data series ends in the year 2019, we hold that value constant over the years 2020 to 2022. Table TA-3 illustrates the actual temporal coverage of raw data.