2020 Technical Appendix

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2020 Environmental Performance Index

Technical Appendix

This technical appendix is a companion document to the 2020 Environmental Performance Index (EPI) Report. It contains additional details about the methods used in the 2020 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.

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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.
Environmental Health **HLT** (40%)	Air Quality	AIR	50%	$PM_{2.5}$ Exposure	PMD	55%
				Household Solid Fuels	HAD	40%
				Ozone Exposure	OZD	5%
	Sanitation & Drinking Water	H2O	40%	Unsafe Sanitation	USD	40%
				Unsafe Drinking Water	UWD	60%
	Heavy Metals	HMT	5%	Lead Exposure	PBD	100%
	Waste Management	WMG	5%	Controlled Solid Waste	MSW	100%
Ecosystem Vitality **ECO** (60%)	Biodiversity & Habitat	BDH	25%	Terrestrial Biome Protection (national)	TBN	20%
				Terrestrial Biome Protection (global)	TBG	20%
				Marine Protected Areas	MPA	20%
				Protected Areas Representativeness Index	PAR	10%
				Species Habitat Index	SHI	10%
				Species Protection Index	SPI	10%
				Biodiversity Habitat Index	BHV	10%
	Ecosystem Services	ECS	10%	Tree Cover Loss	TCL	90%
				Grassland Loss	GRL	5%
				Wetland Loss	WTL	5%
	Fisheries	FSH	10%	Fish Stock Status	FSS	35%
				Marine Trophic Index	RMS	35%
				Fish Caught by Trawling	FGT	30%
	Climate Change	CCH	40%	CO_2 Growth Rate	CDA	55%
				CH_4 Growth Rate	CHA	15%
				F-gas Growth Rate	FGA	10%
				N_2O Growth Rate	NDA	5%
				Black Carbon Growth Rate	BCA	5%
				CO_2 from Land Cover	LCB	2.5%
				GHG Intensity Trend	GIB	5%
				GHG per Capita	GHP	2.5%
	Pollution Emissions	APE	5%	SO_2 Growth Rate	SDA	50%
				NO_X Growth Rate	NXA	50%
	Agriculture	AGR	5%	Sustainable Nitrogen Management Index	SNM	100%
	Water Resources	WRS	5%	Wastewater Treatment	WWT	100%

2. Data Sources

The 2020 EPI draws on data from a wide variety of sources. In the interest of transparency, 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 2020 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	2020-04-03

BHV	Biodiversity Habitat Index - Vascular Plants
Source	Commonwealth Scientific and Industrial Research Organization
URL	https://data.csiro.au/
Date received	2019-12-17
Note	Received via personal communication

BLC	Black Carbon Emissions [Gg]
Source	Community Emissions Data Systems
URL	https://www.geosci-model-dev.net/11/369/2018/gmd-11-369-2018.html
Date received	2020-02-01
Instructions	In the left panel of the page, in the "Download" box, click on "Supplement" (41400 KB).
Citation	Hoesly, Rachel M., O'Rourke, Patrick R, Smith, Steven J., Feng, Leyang, Klimont, Zbigniew, Janssens-Maenhout, Greet, ... Muwan, Presley. (2020). CEDS v_2019_12_23 Emission Data (Version v_2019_12_23) [Data set]. Zenodo. http://doi.org/10.5281/zenodo.3606753
Note	ZIP file contains: BC_CEDS_emissions_by_country_v2016_07_26.csv, README.txt, Supplemental Data and Assumptions.pdf, Supplemental Figures and Tables.pdf

CCO	Control of Corruption
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2020-04-18
Instructions	Country: *various* Series: Control of Corruption 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
Note	Produces both metadata and data file

CDL	CO2 emissions from land cover change
Source	Mullion Group
URL	https://flintpro.com/Global-Run
Date received	2020-03-25
Note	Received via personal communication

CDO	CO2 emissions [Gg], excluding land use and forestry
Source	Potsdam Institute for Climate Impact Research
URL	http://dataservices.gfz-potsdam.de/pik/showshort.php?id=escidoc:4736895
Date received	2020-01-31
Instructions	Go to "Download Data" Click link PRIMAP-hist_v2.1.zip to download files Scenario: HISTTP Category: IPCM0EL Entity: CO2
Citation	Gütschow, J., Jeffery, M. L., Gieseke, R., Gebel, R., Stevens, D., Krapp, M., & Rocha, M. (2016). The PRIMAP-hist national historical emissions time series. Earth System Science Data, 8(2), 571–603. doi:10.5194/essd-8-571-2016

CH4	Methane emissions [Gg]
Source	Potsdam Institute for Climate Impact Research
URL	http://dataservices.gfz-potsdam.de/pik/showshort.php?id=escidoc:4736895
Date received	2020-01-31
Instructions	Go to "Download Data" Click link PRIMAP-hist_v2.1.zip to download files Scenario: HISTTP Category: IPCM0EL Entity: CH4
Citation	Gütschow, J., Jeffery, M. L., Gieseke, R., Gebel, R., Stevens, D., Krapp, M., & Rocha, M. (2016). The PRIMAP-hist national historical emissions time series. Earth System Science Data, 8(2), 571–603. doi:10.5194/essd-8-571-2016

CTH	Fish catch [tonnes]
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2019-05-30
Instructions	Access SAU data through R package "seaaroundus" version 1.2.0 (link below)
Citation	Scott Chamberlain and Robert Scott Reis (2017). seaaroundus: Sea Around Us API Wrapper. R package version 1.2.0. https://CRAN.R-project.org/package=seaaroundus
Note	If downloading data from scratch, to aggregate from EEZs to countries, use the file `Admin_Country_EEZ.csv` for a crosswalk.

CXN	Proportion of population connected to wastewater system
Source	UNSD
URL	https://unstats.un.org/unsd/envstats/qindicators.cshtml
Date received	2019-08-22
Instructions	Click on "Inland Water Resources" + Population connected to wastewater treatment Number of persons of the resident population whose wastewater is treated at wastewater treatment plants. (p.13)
Documentation	https://unstats.un.org/unsd/envstats/fdes/manual_bses.cshtml https://unstats.un.org/unsd/environment/FDES/MS%205.1%20Human%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	2019-08-22
Instructions	Go to: https://data.oecd.org/water/waste-water-treatment.htm - Click "Download" - Click "Full indicator data" + DP_LIVE_31072019161144468 - 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	2019-08-22
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
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	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. EPI CXN is a combination of several distinct data sources. Each source is documented in the file WWT_sources_reduced.csv.

EBI	Ease of Doing Business Index
Source	WorldBank
URL	https://www.doingbusiness.org/en/custom-query
Date received	2020-04-20
Instructions	Choose Economies: All Choose Topics: All Years to display: 2016–2020
Documentation	https://www.doingbusiness.org/en/methodology

EEZ	Total area of all Economic Exclusion Zones in a country
Source	World Database on Protected Areas
URL	http://www.marineregions.org/
Date received	2020-04-03

EXG	Exports of goods and services (pct of GDP)
Source	WorldBank
URL	https://databank.worldbank.org/source/world-development-indicators
Date received	2019-07-31
Instructions	Country: *various* Series: Exports, value added (% of GDP) Time: *various*
Documentation	ID: NE.EXP.GNFS.ZS
Note	License URL: https://datacatalog.worldbank.org/public-licenses#cc-by

FOG	F-gasses emissions [Gg CO2-eq.]
Source	Potsdam Institute for Climate Impact Research
URL	http://dataservices.gfz-potsdam.de/pik/showshort.php?id=escidoc:4736895
Date received	2020-01-31
Instructions	Go to "Download Data" Click link PRIMAP-hist_v2.1.zip to download files Scenario: HISTTP Category: IPCM0EL Entity: FGASESAR4
Citation	Gütschow, J., Jeffery, M. L., Gieseke, R., Gebel, R., Stevens, D., Krapp, M., & Rocha, M. (2016). The PRIMAP-hist national historical emissions time series. Earth System Science Data, 8(2), 571–603. doi:10.5194/essd-8-571-2016

FSS	Fish stock status [%]
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2019-05-30
Instructions	Access SAU data through R package "seaaroundus" version 1.2.0 (link below)
Citation	Scott Chamberlain and Robert Scott Reis (2017). seaaroundus: Sea Around Us API Wrapper. R package version 1.2.0. https://CRAN.R-project.org/package=seaaroundus
Note	If downloading data from scratch, to aggregate from EEZs to countries, use the file `Admin_Country_EEZ.csv` for a crosswalk.

GDP	GDP [PPP, USD2011]
Source	World Bank
URL	https://databank.worldbank.org/data/source/world-development-indicators#
Date received	2020-03-31
Instructions	Topic: World Development Indicators Country: boxed check mark to highlight all entries Series: x-mark for none Then select GDP, PPP (constant 2011 international) Time: 20 years For Metadata: Select Metadata in the top right, then go to Download Options and select Metadata
Documentation	ID: NY.GDP.MKTP.PP.KD
Note	License URL: https://datacatalog.worldbank.org/public-licenses#cc-by

GDP	GDP [PPP, USD2011]
Source	IMF
URL	https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/index.aspx
Date received	2020-05-13
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 will produce a report to help fill the gaps on the data from other sources that evaluate GDP.

GL5	Gross loss in Grassland area over five-year interval
Source	European Space Agency
URL	https://maps.elie.ucl.ac.be/CCI/viewer/
Date received	2019-05-30
Citation	Nowosad et al, 2019, "Global assessment and mapping of changes in mesoscale landscapes: 1992–2015." https://www.sciencedirect.com/science/article/pii/S0303243418305841
Documentation	Prepared by Jakub Nowosad, received via personal communication

GOE	Government Effectiveness
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2020-04-18
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	European Space Agency
URL	https://maps.elie.ucl.ac.be/CCI/viewer/
Date received	2019-05-30
Citation	Nowosad et al, 2019, "Global assessment and mapping of changes in mesoscale landscapes: 1992–2015." https://www.sciencedirect.com/science/article/pii/S0303243418305841
Note	Prepared by Jakub Nowosad, received via personal communication

FGT	Fish catch by trawling [tonnes], by EEZ and gear type
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2019-05-30
Instructions	Access SAU data through R package "seaaroundus" version 1.2.0 (link below)
Citation	Scott Chamberlain and Robert Scott Reis (2017). seaaroundus: Sea Around Us API Wrapper. R package version 1.2.0. https://CRAN.R-project.org/package=seaaroundus
Note	This variable is available for download in the file `GearType_EEZ.csv`. It does not follow standard EPI file structure because the units of observation are EEZ-gear type-years. To aggregate from EEZs to countries, use the file `Admin_Country_EEZ.csv` for a crosswalk.

HAD	Household Air Pollution [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2019-04-18
Instructions	Deselect all fields except for the following: Base: Single Context: Risk Measure: DALYs Location: "select only countries and territories" Age: "Age-standardized" Sex: both Year: 1990, 1995, 2000, 2005, 2010, 2015, 2017 Metric: Rate Cause: "Total all causes" Risk: "Household air pollution from solid fuels"
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	2020-04-18
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. (2020). In 2020 Index of Economic Freedom. The Heritage Foundation. https://www.heritage.org/index/
Documentation	https://www.heritage.org/index/pdf/2020/book/methodology.pdf

LDA	Land area (sq. km)
Source	World Database on Protected Areas
Date received	2020-04-03

MAG	Manufacturing, value added (pct of GDP)
Source	WorldBank
URL	https://databank.worldbank.org/source/world-development-indicators
Date received	2019-07-31
Instructions	Country: *various* Series: Manufacturing, value added (% of GDP) Time: *various*
Documentation	ID: NV.IND.MANF.ZS
Note	License URL: https://datacatalog.worldbank.org/public-licenses#cc-by

MSW	Sustainably controlled solid waste
Source	Wiedinmyer et al.
URL	https://pubs.acs.org/doi/10.1021/es502250z
Date received	2020-06-11
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	Sustainably controlled 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	2020-06-11
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.

NOT	N2O emissions [Gg]
Source	Potsdam Institute for Climate Impact Research
URL	http://dataservices.gfz-potsdam.de/pik/showshort.php?id=escidoc:4736895
Date received	2020-01-31
Instructions	Go to "Download Data" Click link PRIMAP-hist_v2.1.zip to download files Scenario: HISTTP Category: IPCM0EL Entity: N2O
Citation	Gütschow, J., Jeffery, M. L., Gieseke, R., Gebel, R., Stevens, D., Krapp, M., & Rocha, M. (2016). The PRIMAP-hist national historical emissions time series. Earth System Science Data, 8(2), 571–603. doi:10.5194/essd-8-571-2016

NOX	NOx emissions [Gg]
Source	Community Emissions Data Systems
URL	https://zenodo.org/record/3606753
Date received	2020-02-01
Instructions	Scroll down and click "Download" button
Citation	Hoesly, Rachel M., O'Rourke, Patrick R, Smith, Steven J., Feng, Leyang, Klimont, Zbigniew, Janssens-Maenhout, Greet, ... Muwan, Presley. (2020). CEDS v_2019_12_23 Emission Data (Version v_2019_12_23) [Data set]. Zenodo. http://doi.org/10.5281/zenodo.3606753

OZD	Ozone [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2019-04-11
Instructions	Base: Single Context: Risk Measure: DALYs Location: "select only countries and territories" Age: "Age-standardized" Sex: both Year: 1990, 1995, 2000, 2005, 2010, 2015, 2017 Metric: Rate Cause: "Ambient ozone pollution" Risk: "Ambient Ozone Pollution"
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	Click "Both" when given the option between "Names" and "ID Number"

PAR	Protected Areas Representativeness Index
Source	Commonwealth Scientific and Industrial Research Organization
URL	https://data.csiro.au/
Date received	2019-12-17
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	2019-04-12
Instructions	Base: Single Context: Risk Measure: DALYs Location: "select only countries and territories" Age: "Age-standardized" Sex: both Year: 1990, 1995, 2000, 2005, 2010, 2015, 2017 Metric: Rate Cause: "Total all causes" Risk: "Lead Exposure"
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

PMD	Ambient PM2.5 [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2019-04-11
Instructions	Base: Single Context: Risk Measure: DALYs Location: "select only countries and territories" Age: "Age-standardized" Sex: both Year: 1990, 1995, 2000, 2005, 2010, 2015, 2017 Metric: Rate Cause: "Total all causes" Risk: "Ambient Particulate Matter pollution"
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

POP	Population
Source	World Bank
URL	https://databank.worldbank.org/source/world-development-indicators
Date received	2020-02-14
Instructions	Topic: World Development Indicators Country: boxed check mark to highlight all entries Series: x-mark for none Then select Population (total) Time: 20 years For Metadata: Select Metadata in the top right, then go to Download Options and select Metadata
Note	Eritrea: IMF replaces incomplete World Bank data for entire time series

POP	Population
Source	IMF
URL	https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/index.aspx
Date received	2020-05-14
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	Eritrea: IMF replaces incomplete World Bank data for entire time series

RMS	Slope of RMTI from peak year to 2014
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2019-05-30
Note	Received via personal communication

ROL	Rule of Law
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2020-04-18
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	2020-04-18
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

SAV	Political Stability and the Absence of Violence
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2020-04-18
Instructions	Country: *various* Series: Political Stability and the Absence of Violence 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://databank.worldbank.org/source/world-development-indicators
Date received	2019-07-31
Instructions	Country: *various* Series: Services, value added (% of GDP) Time: *various*
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	2020-04-06
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	2019-09-03
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/3606753
Date received	2020-02-01
Instructions	Scroll down and click on "Download" button
Citation	Hoesly, Rachel M., O'Rourke, Patrick R, Smith, Steven J., Feng, Leyang, Klimont, Zbigniew, Janssens-Maenhout, Greet, ... Muwan, Presley. (2020). CEDS v_2019_12_23 Emission Data (Version v_2019_12_23) [Data set]. Zenodo. http://doi.org/10.5281/zenodo.3606753

SPI	Species Protection Index
Source	Map of Life
URL	https://mol.org/indicators/
Date received	2020-04-06
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	2019-06-04
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

TCC	Tree cover loss, annual (30% canopy cover)
Source	Global Forest Watch
URL	https://www.globalforestwatch.org/
Date received	2019-06-04
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	2020-04-03
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
Note	This variable is available for download in the file `TPA_biomes.csv`. It does not follow standard EPI file structure because the units of observation are country-biome-years.

TPA	Terrestrial protected areas
Source	World Database on Protected Areas
Date received	2020-04-03
Citation	IUCN and GeUNEP-WCMC (2017), The World Database on Protected Areas (WDPA) [On-line], March Release, Cambridge, UK: UNEP-WCMC.
Note	This variable is available for download in the file `TPA_biomes.csv`. It does not follow standard EPI file structure because the units of observation are country-biome-years.

URP	Annual Percentage of Population at Mid-Year Residing in Urban Areas
Source	United Nations Population Division
URL	https://population.un.org/wup/Download/
Date received	2019-07-29
Instructions	Click on WUP2018-F02-Proportion_Urban.xls" (File 2) Click UP2018-F06-Urban_Growth_Rate.xls' (File 6)
Citation	United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision, Online Edition.

USD	Unsafe Sanitation [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2019-04-09
Instructions	To retrieve these data, use the following settings: Base: Single Context: Risk Measure: DALYs Location: "select only countries and territories" Age: Age-standardized Sex: both Year: 1990, 1995, 2000, 2005, 2010, 2015, 2017 Metric: Rate Cause: Total All Causes Risk: Unsafe sanitation
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

UWD	Unsafe Water [DALY rate]
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2019-04-04
Instructions	To retrieve these data, use the following settings: Base: Single Context: Risk Measure: DALYs Location: "select only countries and territories" Age: Age-standardized Sex: both Year: 1990, 1995, 2000, 2005, 2010, 2015, 2017 Metric: Rate Cause: Total All Causes Risk: Unsafe sanitation
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

VOA	Voice and Accountability
Source	Worldwide Governance Indicators
URL	https://databank.worldbank.org/source/worldwide-governance-indicators
Date received	2020-04-18
Instructions	Country: *various* Series: Voice and Accountability 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

WL5	Gross loss in Wetland area over five-year interval (km^2)
Source	European Space Agency
URL	https://maps.elie.ucl.ac.be/CCI/viewer/
Date received	2019-05-30
Citation	Nowosad et al, 2019, "Global assessment and mapping of changes in mesoscale landscapes: 1992–2015." https://www.sciencedirect.com/science/article/pii/S0303243418305841
Note	Prepared by Jakub Nowosad, received via personal communication

WST	Proportion of wastewater collected that is treated
Source	UNSD
URL	https://unstats.un.org/unsd/envstats/qindicators.cshtml
Date received	2019-07-30
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%20Human%20settlements.pdf
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	OECD
URL	https://data.oecd.org/water/waste-water-treatment.htm
Date received	2019-08-22
Instructions	- Go to: https://data.oecd.org/water/waste-water-treatment.htm - Click "Download" - Click "Full indicator data" + DP_LIVE_31072019161144468 - 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 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	Eurostat
URL	https://ec.europa.eu/eurostat/web/products-datasets/-/med_en47
Date received	2019-07-31
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 https://circabc.europa.eu/sd/a/32b27ab0-611c-42e4-add5-2942f2237394/Guidelines%20-%20Definitions_Notes_Schemes.pdf
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. EPI WST is a combination of several distinct data sources. Each source is documented in the file `WWT_sources_reduced.csv`.

WTA	Wetland area [km2]
Source	European Space Agency
URL	Link to ESA CCI-LC viewer: https://maps.elie.ucl.ac.be/CCI/viewer/
Date received	2019-05-30
Citation	Nowosad et al, 2019, "Global assessment and mapping of changes in mesoscale landscapes: 1992–2015." https://www.sciencedirect.com/science/article/pii/S0303243418305841
Note	Prepared by Jakub Nowosad, received via personal communication

3. Indicator Construction

As described in Chapter 15: Methodology in the 2020 EPI Report, data as received by the EPI team undergo a number of 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 32 indicators of the 2020 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	118.458	4.7746
Worst	99th percentile	3961.869	8.2845

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	0.8433	-0.1704
Worst	99th percentile	10588.0738	9.2675

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	0.8278	-0.189
Worst	99th percentile	245.4382	5.503

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	1.6145	0.479
Worst	95th percentile	4439.9447	8.3984

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	2.3585	0.858
Worst	95th percentile	5889.3255	8.6809

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	23.323	3.1494
Worst	99th percentile	1389.7858	7.2369

MSW: Solid Waste / Waste Management / Environmental Health

Controlled solid waste refers to the proportion of household and commercial waste generated in a country that is collected and treated in a manner that controls environmental risks. This metric counts waste as "controlled" if it is treated through recycling, composting, anaerobic digestion, incineration, or disposed of in a sanitary landfill.

Units proportion

Years 2017–2017

Sources Wiedinmyer et al. 2014 & Kaza et al. 2018

Transformation none

Performance	Nominal	Raw
Best	1.0	1.0
Worst	0.0	0.0

Calculations

Component		Units	Source
SWG	Solid waste generated	tonnes	various
SW	Solid waste by fate	tonnes	various
i	An index of fates		

Possible fates, *i*, for solid waste

i	Description	*i*	Description
1	Anaerobic digestion	7	Unspecified landfill
2	Compost	8	Open dump
3	Sanitary landfill with gas capture	9	Other
4	Incineration	10	Unaccounted for
5	Recycling	11	Water/marine
6	Controlled landfill	12	Uncollected

$$MSW = \frac{\sum_1^5 SW_i + 0.8 \times SW_{i=6} + 0.8 \times SW_{i=7}}{SWG}$$

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 *terrestrial biome protection (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 1990–2020

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%,

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

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 *terrestrial biome protection (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 1990–2020

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%,

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

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

We calculate the *marine protected areas* indicator as the percentage of a country's total exclusive economic zone (EEZ) designated as marine protected areas (MPAs). MPAs represent a critical tool for protecting marine ecosystems from unsustainable fishing practices, pollution, and human disturbance.

Units %

Years 1990–2020

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 2000–2016

Source Commonwealth Scientific and Industrial Research Organization

Transformation none

Performance	Nominal	Raw
Best	0.31	0.31
Worst	5th percentile	0.0306

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	93.3115

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 1980–2019

Source Map of Life

Transformation none

Performance	Nominal	Raw
Best	100.0	100.0
Worst	0.0	0.0

Countries for which SPI 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

BHV: Variable / Biodiversity & Habitat / Ecosystem Vitality

We introduce the *Biodiversity Habitat Index (BHI)* to the 2020 EPI as a new indicator which estimates the effects of habitat loss, degradation, and fragmentation on the expected retention of terrestrial biodiversity.

Units unitless

Years 2005–2015

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 from the extent of forest cover in the reference year 2000. We define a forest as any land area with over 30% canopy cover.

Units proportion

Years 2005–2018

Source Global Forest Watch

Transformation $ln(x + \alpha)$
α = 9.70E-07

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-10.9436
Worst	99th percentile	0.0478	-3.04

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 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 1992–2015 released by the European Space Agency's (ESA) Climate Change Initiative.

Units proportion

Years 1997–2015

Source European Space Agency

Transformation $ln(x + \alpha)$
α = 4.45E-06

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-10.5632
Worst	99th percentile	0.087	-2.4422

Calculations

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

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

$$GL5 = \sum_{i=0}^{4} Yearly\ Grassland\ loss_{t-i}$$

Next, GRL is calculated by dividing 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 European Space Agency's (ESA) Climate Change Initiative.

Units proportion

Years 1997–2015

Source European Space Agency

Transformation $ln(x + \alpha)$
α = 2.47E-06

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-10.5632
Worst	99th percentile	0.087	-2.4422

Calculations

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

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

$$WL5 = \sum_{i=0}^{4} Yearly\ Wetland\ loss_{t-i}$$

Next, WTL is calculated by dividing 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 1950–2014

Source Sea Around Us

Transformation $\ln(x + \alpha)$
$\alpha = 1.13E\text{-}05$

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-11.3907
Worst	99th percentile	0.8012	-0.2216

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.

$$FSS = \frac{\sum_e \left[FSC_{k=1,e} \times CTH_e\right] + \sum_e \left[FSC_{k=2,e} \times CTH_e\right]}{\sum_e CTH_e}$$

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 2014–2014

Source Sea Around Us

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

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-13.8658
Worst	99th percentile	0.0381	-3.2688

FGT: Fish caught by Trawling / Fisheries / Ecosystem Vitality

Fish caught by trawling measures the percentage of a country's fish caught by bottom or pelagic trawling, where a fishing net is pulled through the water behind a boat. This practice is indiscriminate and wasteful and can severely damage marine ecosystems.

Units proportion

Years 1950–2014

Source Sea Around Us

Transformation $\ln(x + \alpha)$
α = 8.40E-08

Performance	Nominal	Raw	Transformed
Best	0.0	0.0	-16.2924
Worst	99th percentile	0.917	-0.0866

Calculations

Component		Units	Source
FGT	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 = pelagic trawling, 3 = gillnets, 4= longline, 5= other}		

$$FGT = \frac{\sum_{g=1}^{2} \sum_{e} FGT_{eg}}{\sum_{e} CTH_{e}}$$

CDA: CO2 intensity trend / Climate Change / Ecosystem Vitality

The *CO_2 growth rate*, which makes up 55% of the Climate Change issue category, is calculated as the average annual rate of increase or decrease in raw carbon dioxide emissions over the years 2008–2017. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units proportion

Years 1850-2017

Source Potsdam Institute for Climate Impact Research

Transformation none

Performance	Nominal	Raw
Best	-0.0759	-0.0759
Worst	95th percentile	0.1003

Calculations

Component		Units	Source
CDO	Emissions of CO_2	Gg	PIK
GDP	Gross Domestic Product	2011$	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,

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

CHA: Methane intensity trend / Climate Change / Ecosystem Vitality

The *CH_4 growth rate*, which makes up 15% of the Climate Change issue category, is calculated as the average annual rate of increase or decrease in raw methane emissions over the years 2008–2017. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units proportion

Years 1970-2014

Source Potsdam Institute for Climate Impact Research

Transformation none

Performance	Nominal	Raw
Best	-0.0107	-0.0107
Worst	95th percentile	0.0512

Calculations

Component		Units	Source
CH4	Emissions of CH_4	Gg	PIK
GDP	Gross Domestic Product	2011$	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,

$$CHR = corr(CH4, GDP)$$

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

$$ln(CH4) = \alpha + \beta t$$

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

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

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

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

FGA: F-gasses intensity trend / Climate Change / Ecosystem Vitality

The *F-gas growth rate*, which makes up 10% of the Climate Change issue category, is calculated as the average annual rate of increase or decrease in raw fluorinated gas emissions over the years 2008–2017. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units proportion
Years 1850–2017
Source Potsdam Institute for Climate Impact Research
Transformation none

Performance	Nominal	Raw
Best	-0.0394	-0.0394
Worst	95th percentile	0.9366

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: N2O intensity trend / Climate Change / Ecosystem Vitality

The *N_2O growth rate*, which makes up 5% of the Climate Change issue category, is calculated as the average annual rate of increase or decrease in raw nitrous oxide emissions over the years 2008–2017. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units proportion

Years 1850–2017

Source Potsdam Institute for Climate Impact Research

Transformation none

Performance	Nominal	Raw
Best	-0.0195	-0.0195
Worst	95th percentile	0.0525

Calculations

Component		Units	Source
NOT	Emissions of N_2O	Gg	PIK
GDP	Gross Domestic Product	2011$	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,

$$NDR = corr(NOT, GDP)$$

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

$$ln(NOT) = \alpha + \beta t$$

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

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

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

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

BCA: Black Carbon intensity trend / Climate Change / Ecosystem Vitality

The *black carbon growth rate*, which makes up 5% of the Climate Change issue category, is calculated as the average annual rate of increase or decrease in black carbon over the years 2005–2014. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units proportion

Years 1750-2014

Source Community Emissions Data Systems

Transformation none

Performance	Nominal	Raw
Best	-0.0187	-0.0187
Worst	95th percentile	0.0526

Calculations

Component		Units	Source
BLC	Emissions black carbon	Gg	CEDS
GDP	Gross Domestic Product	2011$	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,

$$BCR = corr(BLC, GDP)$$

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,

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

GHP: GHG emissions per capita / Climate Change / Ecosystem

We calculate *greenhouse gas (GHG) emissions per capita* for each country in the year 2017.

Units Gg CO2-eq./person

Years 1990–2017

Source Potsdam Institute for Climate Impact Research

Transformation $ln(x)$

Performance	Nominal	Raw	Transformed
Best	5th percentile	0.001	-6.9467
Worst	95th percentile	0.0225	-3.7924

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 CO2-eq.	

First, we calculate total greenhouse gas emissions, applying Global Warming Potentials to convert all units to Gg of CO_2-equivalents,

$$GHG = CDO + FOG + 298 \times NOT + 25 \times CH4$$

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

$$GHP = GHG \div POP$$

LCB: CO2 from Land Cover / Climate Change / Ecosystem Vitality

This new indicator estimates *CO_2 emissions from land cover change* and is calculated over the years 2001–2015.

Units proportion

Years 2001–2015

Source Mullion Group

Transformation none

Performance	Nominal	Raw
Best	5th percentile	-0.0786
Worst	95th percentile	0.1685

Calculations

Component		Units	Source
CDL	CO2 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 15 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 / Ecosystem Vitality

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 2008–2017. This indicator highlights the need for action on climate change mitigation in countries at all income levels.

Units proportion

Years 1999–2017

Source Potsdam Institute for Climate Impact Research

Transformation none

Performance	Nominal	Raw
Best	5th percentile	-0.0673
Worst	95th percentile	0.0297

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	2011$, PPP	World Bank & IMF
GHI	GHG Intensity	Gg CO2-eq./$	

First, we calculate total greenhouse gas emissions, applying Global Warming Potentials to convert all units to Gg of CO_2-equivalents,

$$GHG = CDO + FOG + 298 \times NOT + 25 \times CH4$$

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

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

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

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

Finally, we calculate an unadjusted average annual growth rate,

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

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 2005–2014. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units unitless

Years 1750–2014

Source Community Emissions Data Systems

Transformation none

Performance	Nominal	Raw
Best	-0.0394	-0.0394
Worst	95th percentile	0.111

Calculations

Component		Units	Source
SO2	Emissions of SO_2	Gg	CEDS
GDP	Gross Domestic Product	2011$	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,

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

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 2005–2014. It is then adjusted for economic trends to isolate change due to policy rather than economic fluctuation.

Units unitless

Years 1750–2014

Source Community Emissions Data Systems

Transformation none

Performance	Nominal	Raw
Best	-0.0394	-0.0394
Worst	95th percentile	0.0892

Calculations

Component		Units	Source
NOX	Emissions of NO_X	Gg	CEDS
GDP	Gross Domestic Product	2011$	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,

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

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 2020 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	1.3641

Imputation

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

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 2018–2018

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	2011$/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 straightforward product,

$$WWT = WST \times CXN$$

Imputation — CXN

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

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

where $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ 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."

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

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.

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

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,

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

where $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ 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."

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

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.

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

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 be a comprehensive index, covering as many countries as possible. When collecting datasets for our calculations, we gather information on all territories that our data providers have to offer. After we have finalized the list of indicators we will use in the EPI, we then look at the country coverage to see for which countries we have sufficient data to support the construction of all material indicators. Unfortunately, there is always some set of countries for which we have some data – but not enough to include in the EPI. This decision 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, Section 2 of the 2020 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 2020 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
Gambia
Georgia
Germany
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
Iceland
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Jamaica
Japan
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

Brunei Darussalam
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
Jordan
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
Seychelles
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 2020 EPI

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

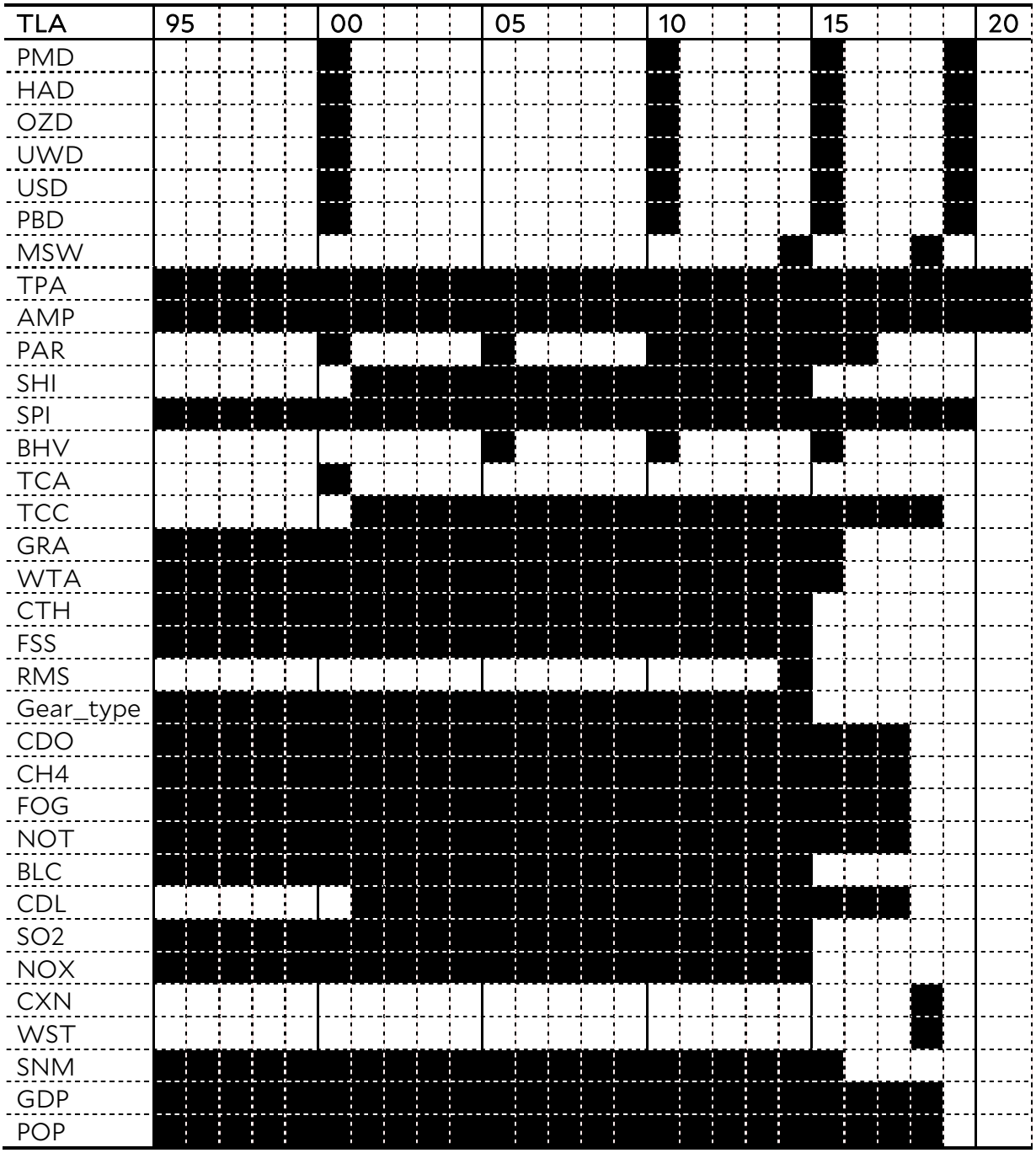
4.3 Territories within sovereign countries

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 2020 EPI.



Note: Some datasets extend before 1995, but these data were not relevant to the calculations for the 2020 EPI.

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

Indicators	Current	Baseline
Air Quality		
$PM_{2.5}$ Exposure	2019	2010
Household Solid Fuels	2019	2010
Ozone Exposure	2019	2010
Sanitation & Drinking Water		
Unsafe Sanitation	2019	2010
Unsafe Drinking Water	2019	2010
Heavy Metals / Lead Exposure	2019	2010
Waste Management / Controlled Solid Waste	2017	2017
Biodiversity & Habitat		
Terrestrial Biome Protection (national)	2020	2010
Terrestrial Biome Protection (global)	2020	2010
Marine Protected Areas	2020	2010
Protected Areas Representativeness Index	2016	2005
Species Habitat Index	2014	2004
Species Protection Index	2019	2009
Biodiversity Habitat Index	2015	2005
Ecosystem Services		
Tree Cover Loss	2018	2008
Grassland Loss	2015	2005
Wetland Loss	2015	2005
Fisheries		
Fish Stock Status	2014	2004
Marine Trophic Index	2014	2014
Fish Caught by Trawling	2014	2004
Climate Change		
CO_2 Growth Rate	2017	2007
CH_4 Growth Rate	2017	2007
F-gas Growth Rate	2017	2007
N_2O Growth Rate	2017	2007
Black Carbon Growth Rate	2014	2004
CO_2 from Land Cover	2015	2015

Indicators	Current	Baseline
GHG Intensity Trend	2017	2010
GHG per Capita	2017	2007
Pollution Emissions		
SO_2 Growth Rate	2014	2004
NO_X Growth Rate	2014	2004
Agriculture / Sustainable Nitrogen Mgmt. Index	2015	2005
Water Resources / Wastewater Treatment	2018	2018

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
BCA			-0.0187	95%	-0.0187	0.0554
BHV			1	0	1	0
CDA			-0.0759	95%	-0.0759	0.0992
CHA			-0.0107	95%	-0.0107	0.0525
FGA			-0.0394	95%	-0.0394	0.6773
FGT	log	8.399E-08	0	99%	0	0.9528
FSS	log	1.129E-05	0	99%	0	0.7028
GHP	log		5%	95%	0.00091	0.02267
GIB			5%	95%	-0.06691	0.02432
GRL	log	4.447E-06	2.14E-05	99%	2.14E-05	0.09569
HAD	log		5%	99%	0.7559	11409.99
LCB			5%	95%	-0.07563	0.16548
MPA			10	0	10	0
MSW			1	0	1	0
NDA			-0.0195	95%	-0.0195	0.05251
NXA			-0.0394	95%	-0.03943	0.08343
OZD	log		5%	99%	0.963	245.529
PAR			0.31	5%	0.31	0.03414
PBD	log		1%	99%	23.07565	1369.7176
PMD	log		1%	99%	112.4182	3965.3181
RMS	log	9.508E-07	0	99%	0	0.03395
SDA			-0.0394	95%	-0.03944	0.10957
SHI			100	1%	100	94.9438
SNM			0	99%	0	1.3451
SPI			100	0	100	0
TBG			17	0	17	0
TBN			17	0	17	0
TCL	log	9.695E-07	1.67E-05	99%	1.67E-05	0.0223
USD	log		5%	95%	1.65134	4916.9621
UWD	log		5%	95%	2.6663	6535.38075
WTL	log	2.467E-06	2.14E-05	99%	2.14E-05	0.06754
WWT			1	0	1	0

Note: % indicates percentile, not the units of the indicator.

7. Materiality

Table TA-6. Materiality Filter applied to the 2020 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
			Marine Protected Areas	

Countries in the 2020 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

8. Global Scorecard

The country-level indicators can also be aggregated to produce global measures. Sometimes, global aggregates are available from the sources of raw data that went into the construction of indicators, and other times, the indicators had to be combined by various means. This section describes how the construction of the global scorecard values for the 2020 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	NOx	CEDS
SO2	SO2	CEDS
BLC	Black Carbon	CEDS
PAR	Protected Areas Rep. Index	CSIRO
BHV	Biodiversity Habitat Index	CSIRO
PMD	PM2.5 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
CDO	CO2	PIK
CH4	Methane	PIK
FOG	F-gasses	PIK
NOT	N2O	PIK
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.

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

The global aggregate of *Marine Protected Areas* is calculated as a simple 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%,

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

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.

$$WTL = \frac{1}{5}\sum_{i=0}^{4} \frac{\sum_c WTC_{c,t-i}}{\sum_c WTA_c}$$

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.

$$FSS^g = \sum_{k=1}^{2} \frac{\sum_c \sum_e [FSC_{kec} \times CTH_{ec}]}{\sum_c \sum_e \sum_k [FSC_{kec} \times CTH_{ec}]}$$

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.

$$FGT^g = \frac{\sum_{m=1}^{3} \sum_c \sum_e Gear\_type_{ecm}}{\sum_c \sum_e CTH_{ec}}$$

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.

$$WWT^g = \sum_c \left[WWT_c \times \frac{POP_c}{\sum_c POP_c} \right]$$

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

SHI Species Habitat Index

9. Data File Guide

An important distinction to using the 2020 EPI data available for download is the difference between raw data and indicators. *Raw data* refer to the constituent data in their original units. The sources for these data are described on Section 2. *Indicators* are the final list of 32 metrics that have been put onto a 0–100 scale. Section 3 describes how we turned the raw data into indicators. If one were to replicate the 2020 EPI, it would be necessary to first obtain the raw data from the data sources (§2) and then perform any necessary calculations, transformations, and rescalings (§3) to obtain the indicator scores.

In the data available for download, the raw data are distinguished in the variable names, which take the form *TLA*`.raw.`*YYYY*, where *TLA* is the three-letter abbreviation and *YYYY* is the year. Note that not every indicator TLA is in the raw data – these indicators must be calculated from other raw data, as described in Section 3. Note also that 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.

Variables for indicators are distinguished as having the following form, *TLA*`.ind.`*YYYY*. Note that the years covered in each `ind` file are not the same as the underlying data files, for two reasons. First, we resize every file to begin in 1990 and end in 2020. Second, as part of our data pipeline, we use linear interpolation to fill in missing data years between observations and hold values constant to extend beginning and ending years. That is, if a data series ends in, for example, 2017, we hold that data value constant over the years 2018–2020, or if a data series begins in, for example, 1995, we hold that data value constant over the years 1990–1994. To understand the actual temporal coverage of an underlying data value, consult the relevant raw data file or Table TA-3.