2018 Technical Appendix

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2018 Environmental Performance Index

Technical Appendix

This technical appendix is a companion document to the 2018 Environmental Performance Index (EPI) Report. It contains additional details about the methods used in the 2018 EPI. Along with the files available online, the purpose of this technical appendix is to provide all information necessary for fully replicating the analysis.

Table of Contents

1. Data Sources

The 2018 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	The name of the dataset.
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 analysis 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.

HAD	DALY rate for Household Solid Fuels
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2017-11-06
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: *various* Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Household air pollution from solid fuels
Citation	Forouzanfar, M. H., Anderson, H. R., Burnett, R., & Dandona, L. , *et alia* (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053), 1659–1724. https://doi.org/10.1016/S0140-6736(16)31679-8

PMC	Ambient $PM_{2.5}$ concentrations
Source	Atmospheric Composition Analysis Group, Dalhousie University
URL	http://fizz.phys.dal.ca/~atmos/martin/?page_id=140
Citation	van Donkelaar, A., Martin, R. V., Brauer, M., Hsu, N. C., Kahn, R. A., Levy, R. C., … Winker, D. M. (2016). Global Estimates of Fine Particulate Matter using a Combined Geophysical-Statistical Method with Information from Satellites, Models, and Monitors. *Environmental Science & Technology*, *50*(7), 3762–3772. https://doi.org/10.1021/acs.est.5b05833

PDS	Population distribution
Source	Gridded Population of the World, version 4
URL	http://sedac.ciesin.columbia.edu/data/collection
Date received	2017-05-01
Citation	Center for International Earth Science Information Network (CIESIN), Columbia University. 2016. Gridded Population of the World, Version 4 (GPWv4): Population Count. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4X63JVC.

UWD	DALY rate for Unsafe Drinking Water
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2017-11-06
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: *various* Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Unsafe water source
Citation	Forouzanfar, M. H., Anderson, H. R., Burnett, R., & Dandona, L. , *et alia* (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053), 1659–1724. https://doi.org/10.1016/S0140-6736(16)31679-8

USD	DALY rate for Unsafe sanitation
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2017-11-06
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: *various* Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Unsafe sanitation
Citation	Forouzanfar, M. H., Anderson, H. R., Burnett, R., & Dandona, L., *et alia* (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053), 1659–1724. https://doi.org/10.1016/S0140-6736(16)31679-8

PBD	DALY rate for Lead exposure
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2017-11-06
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: *various* Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Lead exposure
Citation	Forouzanfar, M. H., Anderson, H. R., Burnett, R., & Dandona, L. , *et alia* (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053), 1659–1724. https://doi.org/10.1016/S0140-6736(16)31679-8

AMP	Marine Protected Areas
Source	World Database on Protected Areas
URL	http://www.protectedplanet.net
Date received	2017-03-03
Citation	IUCN and UNEP-WCMC (2017), The World Database on Protected Areas (WDPA) [On-line], March Release, Cambridge, UK: UNEP-WCMC.

EEZ	Economic Exclusion Zones
Source	Flanders Marine Institute Maritime Boundaries Geodatabase, World EEZ, version 9
URL	http://www.marineregions.org/
Date received	2017-05-02
Citation	Flanders Marine Institute (2016). Maritime Boundaries Geodatabase: Maritime Boundaries and Exclusive Economic Zones (200NM), version 9. http://dx.doi.org/10.14284/242
Documentation	http://www.marineregions.org/eezmethodology.php

TEW	Terrestrial Ecoregions of the World
Source	World Wide Fund for Nature
URL	https://www.worldwildlife.org/publications/terrestrial-ecoregions-of-the-world
Date received	2017-03-31
Citation	Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., … 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
URL	http://www.protectedplanet.net
Date received	2017-03-03
Citation	IUCN and UNEP-WCMC (2017), The World Database on Protected Areas (WDPA) [On-line], March Release, Cambridge, UK: UNEP-WCMC.

SPI	Species Protection Index
Source	Map of Life
URL	https://mol.org/indicators/
Date received	2017-10-13
via	Personal communication
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
Documentation	https://research.googleblog.com/2015/01/map-of-life-preview-of-how-to-evaluate.html

PAR	Protected Area Representativeness Index
Source	Commonwealth Scientific and Industrial Research Organisation
URL	https://data.csiro.au/
Date received	2017-10-04
via	Personal communication
Citations	Ferrier, S., Manion, G., Elith, J. and Richardson, K. (2007) Using generalised dissimilarity modelling to analyse and predict patterns of beta-diversity 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

SHI	Species Habitat Index
Source	Map of Life
URL	https://mol.org/indicators/
Date received	2017-11-06
via	Personal communication
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
Documentation	https://research.googleblog.com/2015/01/map-of-life-preview-of-how-to-evaluate.html

FOR	Forested land area
Source	Global Forest Watch
URL	http://www.globalforestwatch.org/ https://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.4.html
Date received	2017-10-27
via	Personal communication
Citation	Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., … Townshend, J. R. G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, *342*(6160), 850–853. https://doi.org/10.1126/science.1244693

ATL	Annual loss of forested land
Source	Global Forest Watch
URL	http://www.globalforestwatch.org/ https://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.4.html
Date received	2017-10-27
via	Personal communication
Citation	Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., … Townshend, J. R. G. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, *342*(6160), 850–853. https://doi.org/10.1126/science.1244693

FSC	Fish stock class
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2017-10-13
Instructions	Sea Around Us API Wrapper: data available through R package "library(seaaroundus)"
Citations	http://www.seaaroundus.org/articles/
Documentation	https://github.com/SeaAroundUs/sau-web-mt/blob/master/sunfish/models/rmti.R

CTH	Fish catch
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2017-10-13
Instructions	Sea Around Us API Wrapper: data available through R package "library(seaaroundus)"
Citations	http://www.seaaroundus.org/articles/
Documentation	https://github.com/SeaAroundUs/sau-web-mt/blob/master/sunfish/models/rmti.R

RMT	Regional Marine Trophic Index
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2017-09-08
via	Personal communication
Citations	Kleisner, K., Mansour, H., & Pauly, D. (2015). *The MTI and RMTI as tools for unmasking the fishing down phenomenon*. Sea Around Us, University of British Columbia.

AEZ	Areas of EEZs
Source	Sea Around Us
URL	http://www.seaaroundus.org/
Date received	2017-06-14
via	Personal communication

GDP	Gross Domestic Product (PPP)
Source	World Bank
URL	http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&Type=TABLE&preview=on
Date received	2017-06-29
Instructions	Database: World Development Indicators Country: *various* Series: GDP, PPP (constant 2011 international $) Time: *various*
Documentation	Code: NY.GDP.MKTP.PP.KD

GDP	Gross Domestic Product (PPP)
Source	International Monetary Fund
URL	https://www.imf.org/external/pubs/ft/weo/2015/02/weodata/index.aspx
Date received	2017-12-05
Instructions	All countries Select Countries: Eritrea, Libya, Maldives, Qatar, Sao Tome and Principe, Taiwan Select Subjects: Gross domestic product based on purchasing-power-parity (PPP) valuation of country GDP Current international dollar Select Date Range: Start Year = 1997, End Year = 2015 Report for Selected Countries and Subjects

Documentation	Eritrea: IMF used for entire time series Libya: IMF used for entire time series Maldives: IMF data used for 1997–2000 Qatar: IMF data used for 1997–1999 Sao Tome and Principe: Imputed from WB data 1997–1999 based on trajectory of IMF data Taiwan: IMF data used for entire time series
Note	Current international dollars converted into Constant 2011 international dollars

POP	Population
Source	World Bank
URL	http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&Type=TABLE&preview=on
Date received	2017-06-29
Instructions	Database: World Development Indicators Country: *various* Series: Population, total Time: *various*
Documentation	Code: SP.POP.TOTL

POP	Population
Source	International Monetary Fund
URL	https://www.imf.org/external/pubs/ft/weo/2015/02/weodata/index.aspx
Date received	2017-12-05
Instructions	All countries Select Countries: Eritrea Select Subjects: Population Person Select Date Range: Start Year = 1997, End Year = 2015
Documentation	Eritrea: IMF used for entire time series

CDT	CO_2 emissions – Total
Source	World Resources Institute – Climate Analysis Indicators Tool
URL	http://www.wri.org/resources/data-sets/cait-historical-emissions-data-countries-us-states-unfccc
Date received	2017-09-28
Instructions	Click "Download Options"
Citation	CAIT Climate Data Explorer. 2017. Washington, DC: World Resources Institute. Available online at: http://cait.wri.org
Documentation	CAIT Country GHG Emissions - Last updated: 2 October 2017 (CSV)

CDT	CO_2 emissions
Source	Taiwan EPA
URL	https://www.epa.gov.tw/ct.asp?xItem=61773&ctNode=35637&mp=epaen http://unfccc.saveoursky.org.tw/2015nir/uploads/00_abstract_en.pdf
Date received	2017-10-19
Instructions	See Table ES2.1, page 6.
Citation	Taiwan Environmental Protection Agency. (2016). *2015 Taiwan Greenhouse Gas Inventory: Executive Summary*.

CDT	CO_2 emissions
Source	World Bank
URL	http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&Type=TABLE&preview=on
Date received	2017-10-23
Instructions	Database: World Development Indicators Country: Timor-Leste Series: CO2 emissions (kt) Time: *various*
Documentation	Code: EN.ATM.CO2E.KT

CH4	CH_4 emissions
Source	World Resources Institute – Climate Analysis Indicators Tool
URL	http://www.wri.org/resources/data-sets/cait-historical-emissions-data-countries-us-states-unfccc
Date received	2017-09-28
Instructions	Click “Download Options”
Citation	CAIT Climate Data Explorer. 2017. Washington, DC: World Resources Institute. Available online at: http://cait.wri.org
Documentation	CAIT Country GHG Emissions - Last updated: 2 October 2017 (CSV)

CH4	CH_4 emissions
Source	Taiwan EPA
URL	https://www.epa.gov.tw/ct.asp?xItem=61773&ctNode=35637&mp=epaen http://unfccc.saveoursky.org.tw/2015nir/uploads/00_abstract_en.pdf
Date received	2017-10-19
Instructions	See Table ES2.1, page 6.
Citation	Taiwan Environmental Protection Agency. (2016). *2015 Taiwan Greenhouse Gas Inventory: Executive Summary*.

CH4	CH_4 emissions
Source	World Bank
URL	http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&Type=TABLE&preview=on
Date received	2017-10-23
Instructions	Database: World Development Indicators Country: Timor-Leste Series: Methane emissions (kt of CO2 equivalent) Time: *various*
Documentation	Code: EN.ATM.METH.KT.CE

NOT	N_2O emissions
Source	World Resources Institute – Climate Analysis Indicators Tool
URL	http://www.wri.org/resources/data-sets/cait-historical-emissions-data-countries-us-states-unfccc
Date received	2017-09-28
Instructions	Click “Download Options”
Citation	CAIT Climate Data Explorer. 2017. Washington, DC: World Resources Institute. Available online at: http://cait.wri.org
Documentation	CAIT Country GHG Emissions - Last updated: 2 October 2017 (CSV)

NOT	N_2O emissions
Source	Taiwan EPA
URL	https://www.epa.gov.tw/ct.asp?xItem=61773&ctNode=35637&mp=epaen http://unfccc.saveoursky.org.tw/2015nir/uploads/00_abstract_en.pdf
Date received	2017-10-19
Instructions	See Table ES2.1, page 6.
Citation	Taiwan Environmental Protection Agency. (2016). *2015 Taiwan Greenhouse Gas Inventory: Executive Summary*.

NOT	N_2O emissions
Source	World Bank
URL	http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&Type=TABLE&preview=on
Date received	2017-10-23
Instructions	Database: World Development Indicators Country: Timor-Leste Series: Nitrous oxide emissions (thousand metric tons of CO2 equivalent) Time: *various*
Documentation	Code: EN.ATM.NOXE.KT.CE

CEH	CO_2 emissions per kWh of electricity and heat
Source	International Energy Agency
URL	http://www.oecd-ilibrary.org/energy/data/iea-co2-emissions-from-fuel-combustion-statistics_co2-data-en
Date received	2017-09-28
Instructions	Select "Emissions per kWh of electricity and heat output" Select designated variable: Product = Total Flows = CO2 per kWh of electricity and heat Export as Excel file
Documentation	http://dx.doi.org/10.1787/co2-data-en

BCT	Black Carbon emissions
Source	Emissions Database for Global Atmospheric Research
URL	http://edgar.jrc.ec.europa.eu/overview.php?v=431
Date received	2017-09-29
Instructions	Click on "Timeseries" under **BC**
Citation	Crippa, M., Janssens-Maenhout, G., Dentener, F., Guizzardi, D., Sindelarova, K., Muntean, M., … Granier, C. (2016). Forty years of improvements in European air quality: regional policy-industry interactions with global impacts. *Atmospheric Chemistry and Physics*, *16*(6), 3825–3841. https://doi.org/10.5194/acp-16-3825-2016
Documentation	European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR), release version 4.3.1, 2016.

SO2	SO_2 emissions
Source	Emissions Database for Global Atmospheric Research
URL	http://edgar.jrc.ec.europa.eu/overview.php?v=431
Date received	2017-09-29
Instructions	Click on "Timeseries" under **SO2**
Citation	Crippa, M., Janssens-Maenhout, G., Dentener, F., Guizzardi, D., Sindelarova, K., Muntean, M., … Granier, C. (2016). Forty years of improvements in European air quality: regional policy-industry interactions with global impacts. *Atmospheric Chemistry and Physics*, *16*(6), 3825–3841. https://doi.org/10.5194/acp-16-3825-2016
Documentation	European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR), release version 4.3.1, 2016.

NOX	NO_X emissions
Source	Emissions Database for Global Atmospheric Research
URL	http://edgar.jrc.ec.europa.eu/overview.php?v=431
Date received	2017-09-29
Instructions	Click on "Timeseries" under **NOx**
Citation	Crippa, M., Janssens-Maenhout, G., Dentener, F., Guizzardi, D., Sindelarova, K., Muntean, M., … Granier, C. (2016). Forty years of improvements in European air quality: regional policy-industry interactions with global impacts. *Atmospheric Chemistry and Physics*, *16*(6), 3825–3841. https://doi.org/10.5194/acp-16-3825-2016
Documentation	European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR), release version 4.3.1, 2016.

WST	Wastewater treated
CXN	Connection rate
Source 1	OECD Statistics
URL	http://stats.oecd.org/
Source 2	Eurostat
URL	http://ec.europa.eu/eurostat/data/database
Source 3	United Nations Statistics Division
URL	http://unstats.un.org/unsd/ENVIRONMENT/Time%20series.htm#InlandWaterResources
Source 4	United Nations Statistics Division
URL	http://unstats.un.org/unsd/ENVIRONMENT/Time%20series.htm#InlandWaterResources
Source 5	Global Water Intelligence Water and Wastewater Indicators
URL	https://www.globalwaterintel.com/research/global-picture/global-picture/datasets-2
Source 6	Pinsent Masons Water Yearbooks
URL	http://wateryearbook.pinsentmasons.com/
Source 7	AQUASTAT Main Database
URL	http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
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
Documentation	See Appendix A. Supplementary data

SNM	Sustainable Nitrogen Management Index
Source	Zhang, Xin
Date received	2017-10-06
via	Personal communication
Citation	Zhang, X., & Davidson, E. (2016). Sustainable Nitrogen Management Index (SNMI): methodology. University of Maryland Center for Environmental Science.
Note	This dataset was for 2010 and covered 136 countries.

NUE	Nitrogen Use Efficiency
Source	Zhang, *et al*. (2016)
URL	https://www.nature.com/articles/nature15743#supplementary-information
Date received	2017-09-01
Instructions	Download “Supplementary information” Excel files Supplementary Data 1
Citation	Zhang, X., Davidson, E. A., Mauzerall, D. L., Searchinger, T. D., Dumas, P., & Shen, Y. (2015). Managing nitrogen for sustainable development. *Nature*. https://doi.org/10.1038/nature15743
Documentation	nature15743-s2.xlsx, tab “NUE”

NSR	Nitrogen Surplus
Source	Zhang, *et al*. (2016)
URL	https://www.nature.com/articles/nature15743#supplementary-information
Date received	2017-09-01
Instructions	Download "Supplementary information" Excel files Supplementary Data 1
Citation	Zhang, X., Davidson, E. A., Mauzerall, D. L., Searchinger, T. D., Dumas, P., & Shen, Y. (2015). Managing nitrogen for sustainable development. *Nature*. https://doi.org/10.1038/nature15743
Documentation	nature15743-s2.xlsx, tab "Nsurplus"

LND	Agricultural land
Source	World Bank
URL	http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&Type=TABLE&preview=on
Date received	2017-10-26
Instructions	Database: World Development Indicators Country: *various* Series: Agricultural land (% of land area) Time: *various*
Documentation	Code: AG.LND.AGRI.ZS

PRM	Permanent cropland
Source	World Bank
URL	http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&Type=TABLE&preview=on
Date received	2017-10-26
Instructions	Database: World Development Indicators Country: *various* Series: Permanent cropland (% of land area) Time: *various*
Documentation	Code: AG.LND.CROP.ZS

2. Metadata

We undertake a number of steps to prepare the data for the EPI. This section describes how the data are used to construct the 24 metrics of the 2018 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
Countries	Number of countries covered by 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
High	Value or percentile	Value	Transformed value
Low	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.

HAD : Household Solid Fuels / Air Quality / Environmental Health

Measures the actual outcomes from exposure to indoor air pollution from household use of solid fuels.

Units Age-standardized Disability-Adjusted Life Years lost per 100,000 persons, or the DALY rate

Countries 195

Years 2000, 2005, 2010, 2016

Source Institute for Health Metrics and Evaluation

Transformation $\ln(x)$

Targets Based on observed data

Performance	Nominal	Raw	Transformed
High	5^{th}-percentile	3.43	1.23
Low	95^{th}-percentile	5,698.97	8.65

Calculations

none

PME : $PM_{2.5}$ Exposure / Air Quality / Environmental Health

Measures the average annual concentration of $PM_{2.5}$ to which the typical citizen of each country is exposed.

Units µg/m^3
Countries 228
Years 2008–2015
Transformation ln(x)
Targets World Health Organization guidelines

Performance	Nominal	Raw	Transformed
High	10 µg/m^3	10.00	2.30
Low	99th-percentile	44.44	3.79

Calculations

Component		Units	Source
PMC	Ambient $PM_{2.5}$ concentrations	µg/m^3	van Donkelaar *et al.*, 2016
PDS	Population distribution	persons	CIESIN, 2016

$$PMC \cap PDS \rightarrow PME$$

PDS (Gridded Population of the World) was resampled at the same 10 x 10 km spatial resolution as the PMC (Annual global surface $PM_{2.5}$ concentrations), and the fraction of country population in each grid cell was calculated. The fraction of country population is multiplied times the $PM_{2.5}$ concentrations in each grid cell, and the result is summed over the entire country to create a population-weighted ambient concentrations of $PM_{2.5}$.

PMW : $PM_{2.5}$ Exceedance / Air Quality / Environmental Health

Measures the weighted percentage of a country's population exposed to annual concentrations of $PM_{2.5}$ that exceed WHO guidelines at four different levels: 10, 15, 25, and 35 µg/m^3. Higher concentration levels are given higher weights in the averaging process.

Units % of population

Countries 228

Years 2008–2015

Transformation none

Targets World Health Organization guidelines

Performance	Nominal	Raw
High	0	0.00
Low	99th-percentile	86.96

Calculations

Component		Units	Source
PMC	Ambient $PM_{2.5}$ concentrations	µg/m^3	van Donkelaar *et al*., 2016
PDS	Population distribution	persons	CIESIN, 2016
PM1	% of population [$PM_{2.5}$]>10 µg/m^3	%	
PM2	% of population [$PM_{2.5}$]>15 µg/m^3	%	
PM3	% of population [$PM_{2.5}$]>25 µg/m^3	%	
PM4	% of population [$PM_{2.5}$]>35 µg/m^3	%	

$$PMC \cap PDS \rightarrow \{PM1, PM2, PM3, PM4\}$$

PDS (Gridded Population of the World) was intersected with spatial masks representing the four different concentration levels of PMC (annual global surface $PM_{2.5}$ concentrations), and the population within the areas above the respective thresholds was summed for each country. The population within the areas of

exceedance was then divided by the country population to arrive at the percentage of population in areas exceeding each threshold.

The calculation of the percent of the population exposed to different levels of $PM_{2.5}$ is given by the following weighted average.

$$PMW = 0.1 \times PM1 + \ 0.2 \times PM2 + 0.3 \times PM3 + 0.4 \times PM4$$

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

Measures the actual outcomes from lack of access or use of improved sources of drinking water.

Units Age-standardized Disability-Adjusted Life Years lost per 100,000 persons, or the DALY rate

Countries 195

Years 2000, 2005, 2010, 2016

Source Institute for Health Metrics and Evaluation

Transformation $\ln(x)$

Targets Based on observed data

Performance	Nominal	Raw	Transformed
High	5th-percentile	3.41	1.23
Low	95th-percentile	4,749.82	8.47

Calculations

none

USD : Unsafe Sanitation / Water & Sanitation / Environmental Health

Measures the actual outcomes from lack of access or use of improved sanitation facilities.

Units Age-standardized Disability-Adjusted Life Years lost per 100,000 persons, or the DALY rate

Countries 195

Years 2000, 2005, 2010, 2016

Source Institute for Health Metrics and Evaluation

Transformation $\ln(x)$

Targets Based on observed data

Performance	Nominal	Raw	Transformed
High	5^{th}-percentile	1.52	0.42
Low	95^{th}-percentile	4,163.21	8.33

Calculations

none

PBD : Lead exposure / Heavy Metals / Environmental Health

Measures the actual outcomes from lead exposure.

Units Age-standardized Disability-Adjusted Life Years lost per 100,000 persons, or the DALY rate

Countries 195

Years 2000, 2005, 2010, 2016

Source Institute for Health Metrics and Evaluation

Transformation $\ln(x)$

Targets Based on observed data

Performance	Nominal	Raw	Transformed
High	1st-percentile	21.13	3.05
Low	99th-percentile	848.06	6.74

Calculations

none

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

Measures the percent of a country's Economic Exclusion Zone (EEZ) set aside as a marine protected area (MPA).

Units % of EEZ

Countries 179

Years 2000–2017

Transformation ln(x+ α), α = 1.22e-5

Targets Based on Aichi Target 11

Performance	Nominal	Raw	Transformed
High	10 %	10	2.30
Low	0 %	0	-11.31

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.

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

TBN : Terrestrial Protected Areas (National weights) / Biodiversity & Habitat / Ecosystem Vitality

Measures the percent of a country's biomes in terrestrial protected areas (TPAs), weighted by the prevalence of different biome types within that country.

Units % of EEZ

Countries 233

Years 1990–2017

Transformation none

Targets Based on Aichi Target 11

Performance	Nominal	Raw
High	17 %	17
Low	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 Protected Areas (Global weights) / Biodiversity & Habitat / Ecosystem Vitality

Measures the percent of a country's biomes in terrestrial protected areas (TPAs) weighted by the prevalence of different biome types around the world.

Units % of EEZ

Countries 233

Years 1990–2017

Transformation none

Targets Based on Aichi Target 11

Performance	Nominal	Raw
High	17 %	17
Low	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 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.

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

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

Measures the average area of species distributions in a country under protection, weighted by a country's stewardship for each species

Units % of habitat

Countries 185

Years 1990–2014

Source Map of Life

Transformation none

Targets Based on Aichi Target 11

Performance	Nominal	Raw
High	17 %	17
Low	0%	0

Calculations

none

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

Measures the extent to which a country's protected areas are ecologically representative.

Units unitless

Countries 230

Years 1970, 1980, 1990, 2000, 2010, 2012, 2014, 2016

Source Commonwealth Scientific and Industrial Research Organisation

Transformation none

Targets Based on underlying data

Performance	Nominal	Raw
High	95th-percentile	0.22
Low	5th-percentile	0.03

Calculations

none

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

Measures the average loss in suitable habitat for species in a country, weighted by the country's stewardship for that species.

Units % of habitat

Countries 185

Years 2001–2014

Source Map of Life

Transformation none

Targets Based on underlying data and Aichi Targets 5 and 12

Performance	Nominal	Raw
High	100	100.00
Low	1st-percentile	93.40

Calculations

none

TCL : Tree Cover Loss / Forests / Ecosystem Vitality

Measures the five-year moving average of percent of forested land lost. Forested land is defined as having ≥30% canopy cover. Area of forested land uses year 2000 as baseline.

Units % of forested land

Countries 210

Years 2001–2016

Transformation ln(x+ α), α = 1.94456970161889e-4

Targets Based on underlying data

Performance	Nominal	Raw	Transformed
High	5th-percentile	0.004	-5.47
Low	95th-percentile	1.177	0.16

Calculations

Component		Units	Source
FOR	Forested land	ha	Global Forest Watch
ATL	Annual area lost	ha	Global Forest Watch
t	An index of years		

The metric is calculated as a five-year moving average of tree cover loss.

$$TCL = \frac{1}{5}\sum_{i=0}^{4}\frac{ATL_{t-i}}{FOR}$$

FSS : Fish Stock Status / Fisheries / Ecosystem Vitality

Measures the percentage of a country's total catch that come from taxa that are classified as either over-exploited or collapsed.

Units % of catch

Countries 133

Years 1950–2014

Transformation none

Targets Based on underlying data

Performance	Nominal	Raw
High	0	0.00
Low	99th-percentile	90.82

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.

$$FSS = \sum_{k=1}^{2} \frac{\sum_e [FSC_{ke} \times CTH_e]}{\sum_e \sum_k [FSC_{ke} \times CTH_e]}$$

Note: EEZs where the catch was less than 1.5% of a country's total catch were excluded from the calculation.

Imputation

FSS is missing for 52 countries which do not qualify for the SEA materiality filter, 40 of which were included in the 2018 EPI. In order to impute missing values for these countries, we use regional averages. First, we run the regression,

$$FSS = \alpha + \boldsymbol{\delta R} + \varepsilon,$$

on countries with non-missing values, where $\boldsymbol{R}$ is a vector of region dummies. This then allows us to calculate missing values for the remaining countries,

$$\widehat{FSS} = \hat{\alpha} + \hat{\boldsymbol{\delta}}\boldsymbol{R}.$$

MTR : Regional Marine Trophic Index / Fisheries / Ecosystem Vitality

Measures the trends in the Regional Marine Trophic Indices of a country, or mean trophic level of the fish catch in each region of the Economic Exclusion Zones.

Units unitless

Countries 133

Years 1950–2014

Transformation none

Targets Based on underlying data

Performance	Nominal	Raw
High	95th-percentile	0.012
Low	5th-percentile	-0.009

Calculations

Component		Units	Source
RMT	Regional MTI	unitless	*Sea Around Us*
AEZ	Area of EEZ	sq. km	*Sea Around Us*
r	An index of regions in an EEZ, {1 … R}		
e	An index of EEZs in a country		
t	An index of years		

The calculation of the metric relies on the ratio of the annual change in the five-year moving average to the ten-year moving average.

$$MTR_{ret} = \frac{\frac{1}{5}\sum_{i=0}^{4} RMT_{re,t-i} - \frac{1}{5}\sum_{i=1}^{5} RMT_{re,t-i}}{\frac{1}{10}\sum_{i=0}^{9} RMT_{re,t-i}}$$

The RMTI trend in each region of an EEZ is then averaged in each year.

$$MTR_{et} = \frac{1}{R}\sum_{r} MTR_{ret}$$

The average EEZ metrics are then averaged to the country-level, weighted by the surface area of the country's EEZs.

$$MTR_{t} = \sum_{e}\left[MTR_{et} \times \frac{AEZ_{e}}{\sum_{e} AEZ_{e}}\right]$$

Note: EEZs where the catch was less than 1.5% of a country's total catch were excluded from the calculation.

Generalized Emissions Intensity Calculations

The calculation of the indicators of emissions for both Climate & Energy and Air Pollution is especially complex. This sub-section gives an initial, generic account of how this indicator is constructed from the following components. Specific details are then provided for each of these metrics in the subsequent entries.

Component		Units	Source(s)
GDP	Gross Domestic Product (PPP)	2011US$	World Bank, IMF
POP	Population	person	World Bank, IMF
GPC	Logged *per capita* GDP	ln($/person)	
E	Raw emissions	*various*	*various*
X	Logged emissions intensity		
Y	Current-year emissions intensity score (sub-indicator)		
Z	Ten-year trend in emissions intensity score (sub-indicator)		
$\overline{X}$	High target for current-year emissions intensity (95th-percentile)		
$\underline{X}$	Low target for current-year emissions intensity (5th-percentile)		
$\overline{\epsilon}$	High target for current-year emissions intensity (95th-percentile)		
$\underline{\epsilon}$	Low target for current-year emissions intensity (5th-percentile)		
$\overline{\beta}$	High target for current-year emissions intensity (95th-percentile)		
$\underline{\beta}$	Low target for current-year emissions intensity (5th-percentile)		
B	Blended score for emissions intensity		
p	Weight on current-year score		
k	A parameter for the calculation of p		
b	A parameter for the calculation of p		

First, we calculate logged GDP *per capita*.

$$GPC = ln\left(\frac{GDP}{POP}\right)$$

Second, we calculate logged emissions intensity for every country with the following formula.

$$X = \ln\left(\frac{E}{GDP}\right)$$

Third, this current-year emissions intensity is scored using the distance-to-target procedure, treating current-year emissions intensity as if it were an indicator.

$$Y = \frac{X - \underline{X}}{\overline{X} - \underline{X}} \times 100$$

Fourth, we regress the current-year emissions intensity over time to create a 10-year trend, represented by the parameter β.

$$X = \alpha + \beta t + \varepsilon$$

Fifth, these trends are then regressed over the logged GDP *per capita*.

$$\hat{\beta} = \gamma + \delta GPC + \epsilon$$

The δ coefficient represents the effect of wealth on trends in emissions intensity, and the residual ϵ measures the deviations of each country from its expected trend, given its level of wealth. This deviation is then scored using the distance-to-target procedure, treating deviation as if it were an indicator.

$$Z = \frac{\epsilon - \underline{\epsilon}}{\overline{\epsilon} - \underline{\epsilon}} \times 100$$

If, however, the δ coefficient is not negative, *i.e.*, trends do not decline with wealth, we instead construct the deviation indicator from the β coefficients.

$$Z = \frac{\beta - \underline{\beta}}{\overline{\beta} - \underline{\beta}} \times 100$$

The ultimate indicator of performance for each gas is a blend of the two sub-indicators. We take a weighted average of the current-year sub-indicator and the trend sub-indicator.

$$B = p \times Y + (1 - p) \times Z$$

The weighting factor p is itself a function of a country's wealth, measured by logged GDP *per capita*,

$$p = 1/(1 + exp[k \times (GPC - b)])$$

where the parameters k and b are determined by the formula,

$$k = \begin{cases} -0.25 \; if \; GPC \geq 9.3927 \\ \tan\left[\frac{exp(GPC)}{6500} \times 1.81927 + 1.3223\right] \times -0.0078560837 \; - \; 0.0001202674 \; if \; else \\ 0.25 \; if \; GPC \; \leq 6.9078 \end{cases}$$

$$b = \begin{cases} 85 \; if \; GPC \geq 9.3927 \\ \tan\left[\frac{exp(GPC)}{6500} \times 1.81927 + 1.3223\right] \times 1.0998517224 + \; 50 \; \; if \; else \\ 15 \; if \; GPC \; \leq 6.9078 \end{cases}$$

The goal of the weighting scheme is to place a higher weight on the current-year sub-indicator for wealthy countries that have a history of controlling emissions. These countries typically have low trend sub-indicator scores, as they have limited options for further reducing emissions intensity.

DCT : CO_2 Emissions Intensity – Total / Climate & Energy / Ecosystem Vitality

Measures the intensity of CO_2 emissions from the entire economy, as a blend of current-year intensity and a 10-year trend.

Units unitless

Countries 191

Years 1997–2014

Transformation $\ln(x)$

Targets Based on observed data

Calculations

Component			Units	Source(s)
E	CDT	CO_2 emissions	Mt	WRI-CAIT, *et alia*
Y	CDI	CO_2 Intensity Current-year Score		
Z	DCI	CO_2 Intensity Trend Score		
B	DCT	CO_2 Intensity Blended Score		

Calculations

Component			Units	Source(s)
Y	CEH	CO_2 emissions per kWh	g CO_2/kWh	IEA
Z	TPI	CO_2 Power Intensity Trend Score		
B	DPT	CO_2 Power Intensity Blended Score		

Targets

Performance		Nominal	Transformed
High	$\overline{X}$	95th-percentile	-23.355
Low	$\underline{X}$	5th-percentile	-21.180
High	$\overline{\epsilon}$	95th-percentile	-0.056
Low	$\underline{\epsilon}$	5th-percentile	0.050

DPT : CO_2 Emissions Intensity – Power / Climate & Energy / Ecosystem Vitality

Measures the intensity of CO_2 emissions per kilowatt-hour of electricity and heat, as a blend of current-year intensity and a 10-year trend.

Units unitless

Countries 191

Years 2005–2014

Transformation $\ln(Y)$

Targets Based on observed data

Targets

Performance		Nominal	Transformed
High	$\overline{X}$	95th-percentile	6.682
Low	$\underline{X}$	5th-percentile	850.420
High	$\overline{\epsilon}$	95th-percentile	-0.119
Low	$\underline{\epsilon}$	5th-percentile	0.061

DMT : CH_4 Emissions Intensity / Climate & Energy / Ecosystem Vitality

Measures the intensity of methane emissions from the entire economy, as a blend of current-year intensity and a 10-year trend.

Units unitless

Countries 191

Years 1997–2014

Transformation none

Targets Based on observed data

Calculations

Component			Units	Source(s)
E	CH4	CH_4 emissions	Mt	WRI-CAIT, *et alia*
Y	CHI	CH_4 Intensity Current-year Score		
Z	DMI	CH_4 Intensity Trend Score		
B	DMT	CH_4 Intensity Blended Score		

Targets

Performance		Nominal	Transformed
High	$\overline{X}$	95th-percentile	-24.802
Low	$\underline{X}$	5th-percentile	-20.717
High	$\overline{\beta}$	95th-percentile	-0.060
Low	$\underline{\beta}$	5th-percentile	0.030

DNT : N_2O Emissions Intensity / Climate & Energy / Ecosystem Vitality

Measures the intensity of N_2O emissions from the entire economy, as a blend of current-year intensity and a 10-year trend.

Units unitless

Countries 191

Years 1997–2014

Transformation none

Targets Based on observed data

Calculations

Component			Units	Source(s)
E	NOT	N_2O emissions	Mt	WRI-CAIT, *et alia*
Y	NOI	N_2O Intensity Current-year Score		
Z	DNI	N_2O Intensity Trend Score		
B	DNT	N_2O Intensity Blended Score		

Targets

Performance		Nominal	Transformed
High	$\overline{X}$	95th-percentile	-26.229
Low	$\underline{X}$	5th-percentile	-21.493
High	$\overline{\beta}$	95th-percentile	-0.068
Low	$\underline{\beta}$	5th-percentile	0.039

DBT : Black Carbon Emissions Intensity / Climate & Energy / Ecosystem Vitality

Measures the intensity of Black Carbon emissions from the entire economy, as a blend of current-year intensity and a 10-year trend.

Units unitless

Countries 215

Years 1997–2010

Transformation none

Targets Based on observed data

Calculations

Component			Units	Source(s)
E	BCT	Black Carbon emissions	Mt	EDGAR
Y	BCI	Black Carbon Current-year Score		
Z	DBI	Black Carbon Intensity Trend Score		
B	DBT	Black Carbon Intensity Blended Score		

Targets

Performance		Nominal	Transformed
High	$\overline{X}$	95th-percentile	-25.861
Low	$\underline{X}$	5th-percentile	-21.103
High	$\overline{\epsilon}$	95th-percentile	-0.070
Low	$\underline{\epsilon}$	5th-percentile	0.068

DST : SO_2 Emissions Intensity / Air Pollution / Ecosystem Vitality

Measures the intensity of SO_2 emissions from the entire economy, as a blend of current-year intensity and a 10-year trend.

Units unitless

Countries 215

Years 1997–2010

Transformation none

Targets Based on observed data

Calculations

Component			Units	Source(s)
E	SO2	SO_2 emissions	Mt	EDGAR
Y	SDI	SO_2 Current-year Score		
Z	DSI	SO_2 Intensity Trend Score		
B	DST	SO_2 Intensity Blended Score		

Targets

Performance		Nominal	Transformed
High	$\overline{X}$	95th-percentile	-22.835
Low	$\underline{X}$	5th-percentile	-19.255
High	$\overline{\epsilon}$	95th-percentile	-0.085
Low	$\underline{\epsilon}$	5th-percentile	0.087

DXT : NO_X Emissions Intensity / Air Pollution / Ecosystem Vitality

Measures the intensity of NO_X emissions from the entire economy, as a blend of current-year intensity and a 10-year trend.

Units unitless

Countries 215

Years 1997–2010

Transformation none

Targets Based on observed data

Calculations

Component			Units	Source(s)
E	NOX	NO_X emissions	Mt	EDGAR
Y	NXI	NO_X Current-year Score		
Z	DXI	NO_X Intensity Trend Score		
B	DXT	NO_X Intensity Blended Score		

Targets

Performance		Nominal	Transformed
High	$\overline{X}$	95th-percentile	-21.667
Low	$\underline{X}$	5th-percentile	-19.469
High	$\overline{\epsilon}$	95th-percentile	-0.061
Low	$\underline{\epsilon}$	5th-percentile	0.053

WWT : Wastewater Treatment / Water Resources / Ecosystem Vitality

Measures the percentage of wastewater treated, weighted by the connection rate of the population to the wastewater treatment system.

Units Weighted %
Countries 176
Years 2016
Transformation ln(x+ α), α = 0.01
Targets Absolute limits

Performance	Nominal	Raw	Transformed
High	100	100	4.61
Low	0	0	-4.61

Calculations

Component		Units	Source
WST	Wastewater treated	%	*various*
CXN	Connection rate	%	*various*

The WWT metric was calculated through the straightforward product,

$$WWT = WST \times CXN$$

Imputation

WWT is missing for 60 countries, 18 of which are in the 2018 EPI. In order to impute missing values for these countries, we use regional averages. First, we run the regression,

$WWT = \alpha + \boldsymbol{\delta R} + \varepsilon,$

on countries with non-missing values, where $\boldsymbol{R}$ is a vector of region dummies. This then allows us to calculate missing values for the remaining countries,

$\widehat{WWT} = \hat{\alpha} + \hat{\boldsymbol{\delta}}\boldsymbol{R}.$

SNM : Sustainable Nitrogen Management Index / Agriculture / Ecosystem Vitality

Measures the Euclidean distance from an ideal point with optimal nitrogen use efficiency (NUE) and crop yield.

Units unitless

Countries 136

Years 2010

Transformation none

Targets Based on the observed data

Performance	Nominal	Raw
High	0	0.00
Low	99th-percentile	1.16

Calculations

Component		Units	Source
NUE	Nitrogen Use Efficiency	kg N / kg N	Zhang *et al.*, 2015
NSR	Nitrogen Surplus	kg N / sq. km	Zhang *et al.*, 2015
LND	Agricultural land	% of land area	World Bank
PRM	Permanent cropland	% of land area	World Bank
NRY	Raw Nitrogen Yield	kg N / ha	
NNY	Normalized Nitrogen Yield	kg N / ha	

First, a raw measure of Nitrogen yield can be calculated from the Nitrogen Surplus and Nitrogen Use Efficiency.

$$NRY = \frac{NSR/100}{\frac{1}{NUE} - 1}$$

Second, the raw Nitrogen yield is normalized by the reference yield of 90 kg N/ha/

$$NNY = \begin{cases} \frac{NRY}{90} if \frac{NRY}{90} < 1 \\ 1 \; if \; \frac{NRY}{90} \geq 1 \end{cases}$$

Finally, the SNMI is the Euclidean distance of a point defined by a country's NNY and NUE from the ideal point defined as (NUE = 1, NNY = 1).

$$SNM = \sqrt{(1 - NNY)^2 + (1 - NUE)^2}$$

Imputation

SNM is missing for 100 countries, 71 of which were included in the 2018 EPI. In order to impute missing values for these countries, we use regional averages and other . First, we run the regression,

$SNM = \alpha + \beta \times LND + \gamma \times PRM + \boldsymbol{\delta R} + \varepsilon,$

on countries with non-missing values, where $\boldsymbol{R}$ is a vector of region dummies. This then allows us to calculate missing values for the remaining countries,

$\widehat{SNM} = \hat{\alpha} + \hat{\beta} \times LND + \hat{\gamma} \times PRM + \hat{\boldsymbol{\delta}} \boldsymbol{R}.$

3. Temporal Coverage

The data used in the 2018 EPI cover a variety of time periods. This section summarizes the temporal coverage of the different indicators and clarifies which years support the current and baseline scores.

Table TA–1. Temporal coverage for indicators used in the 2018 EPI.

Indicator	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
HAD				■					■					■						■	
PME												■	■	■	■	■	■	■			
PMW												■	■	■	■	■	■	■			
USD				■					■					■						■	
UWD				■					■					■						■	
PBD				■					■					■						■	
MPA				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TBN	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TBG	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SPI	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
PAR				■										■		■		■		■	
SHI					■	■	■	■	■	■	■	■	■	■	■	■	■	■			
TCL					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
FSS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
MTR	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
CDI	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
CEH									■	■	■	■	■	■	■	■	■	■			
CHI	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
NOI	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
BCI	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
SDI	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
NXI	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
WWT																				■	
SNM														■							

Note: Some datasets extend before 1997, but these data were rarely relevant to the calculations for the 2018 EPI.

Table TA—2. Designations of years supporting the current and baseline scores for each indicator.

Indicators	Current	Baseline
Air Quality		
Household Solid Fuels	2016	2005
$PM_{2.5}$ Exposure	2015	2008
$PM_{2.5}$ Exceedance	2015	2008
Water & Sanitation		
Drinking Water	2016	2005
Sanitation	2016	2005
Heavy Metals / Lead Exposure	2016	2005
Biodiversity & Habitat		
Marine Protected Areas	2017	2007
Terrestrial Biome Protection	2017	2007
Species Protection Index	2014	2004
Protected Area Representativeness Index	2016	2000
Species Habitat Index	2014	2004
Forests / Tree Cover Loss	2016	2006
Fisheries		
Fish Stock Status	2014	2004
Regional Marine Trophic Index	2014	2004
Climate & Energy		
CO_2 Emissions Intensity – Total	2014	2006
CO_2 Emissions Intensity – Power	2014	2004*
Methane Emissions Intensity	2014	2006
N_2O Emissions Intensity	2014	2006
Black Carbon Emissions Intensity	2010	2006
Air Pollution		
SO_2 Emissions Intensity	2010	2006
NO_X Emissions Intensity	2010	2006
Water Resources / Wastewater Treatment	2016	—
Agriculture / Sustainable Nitrogen Management	2010	2001*

* Global aggregates only.