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. Throughout this appendix *TLA* is used to refer to the three letter abbreviations of the input data sources and resulting indicators.

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1. Indicator & Data Overview

Table TA-1. Organization of the 2018 EPI, with three-letter abbreviations (TLAs), weights (Wt.) within each level of aggregation, and page numbers on which indicators are described.

Policy Objective	Issue Category	TLA	Wt.	Indicator	TLA	Wt.	Page
Environmental Health HLT (40%)	Air Quality	AIR	65%	Household Solid Fuels	HAD	40%	5
				$PM_{2.5}$ Exposure	PME	30%	6
				$PM_{2.5}$ Exceedance	PMW	30%	7
	Water & Sanitation	H2O	30%	Drinking Water	UWD	50%	9
				Sanitation	USD	50%	10
	Heavy Metals	HMT	5%	Lead Exposure	PBD	100%	11
Ecosystem Vitality ECO (60%)	Biodiversity & Habitat	BDH	25%	Marine Protected Areas	MPA	20%	12
				Biome Protection (National)	TBN	20%	13
				Biome Protection (Global)	TBG	20%	15
				Species Protection Index	SPI	20%	17
				Representativeness Index	PAR	10%	18
				Species Habitat Index	SHI	10%	19
	Forests	FOR	10%	Tree Cover Loss	TCL	100%	20
	Fisheries	FSH	10%	Fish Stock Status	FSS	50%	21
				Regional Marine Trophic Index	MTR	50%	23
	Climate & Energy	CCE	30%	CO_2 Emissions – Total	DCT	50%	29
				CO_2 Emissions – Power	DPT	20%	30
				Methane Emissions	DMT	20%	31
				N_2O Emissions	DNT	5%	32
				Black Carbon Emissions	DBT	5%	33
	Air Pollution	APE	10%	SO_2 Emissions	DST	50%	34
				NO_X Emissions	DXT	50%	35
	Water Resources	WRS	10%	Wastewater Treatment	WWT	100%	36
	Agriculture	AGR	5%	Sustainable Nitrogen Management	SNM	100%	38

Table TA-2. Abbreviations for data used in the construction of indicators with page numbers for data sources.

Indicator	TLA	Dataset	TLA	Page
Household Solid Fuels	HAD	DALY rate – Household Solid Fuels	HAD	50
$PM_{2.5}$ Exposure	PME	Ambient $PM_{2.5}$ concentrations	PMC	55
$PM_{2.5}$ Exceedance	PMW	Population distribution	PDS	55
Drinking Water	UWD	DALY rate – Unsafe Drinking Water	UWD	61
Sanitation	USD	DALY rate – Unsafe sanitation	USD	60
Lead Exposure	PBD	DALY rate – Lead exposure	PBD	54
Marine Protected Areas	MPA	Marine Protected Areas	AMP	42
		Economic Exclusion Zones	EEZ	47
Biome Protection (Nat'l)	TBN	Terrestrial Ecoregions of the World	TEW	59
Biome Protection (Global)	TBG	Terrestrial Protected Areas	TPA	59
Species Protection Index	SPI	Species Protection Index	SPI	59
Representativeness Index	PAR	Protected Area Rep. Index	PAR	53
Species Habitat Index	SHI	Species Habitat Index	SHI	57
Tree Cover Loss	TCL	Forested land area	FOR	47
		Annual loss of forested land	ATL	42
Fish Stock Status	FSS	Fish stock class	FSC	48
		Fish catch	CTH	47
Regional Marine Trophic Index	MTR	Regional Marine Trophic Index	RMT	57
		Areas of EEZs	AEZ	42
CO_2 Emissions – Total	DCT	CO_2 emissions	CDT	44
CO_2 Emissions – Power	DPT	CO_2 emissions / kWh elect. & heat	CEH	45
Methane Emissions	DMT	CH_4 emissions	CH4	46
N_2O Emissions	DNT	N_2O emissions	NOT	51
Black Carbon Emissions	DBT	Black Carbon emissions	BLC	43
SO_2 Emissions	DST	SO_2 emissions	SO2	58
NO_X Emissions	DXT	NO_x emissions	NOX	52
		Gross Domestic Product	GDP	49
		Population	POP	56
Wastewater Treatment	WWT	Wastewater treated	WST	62
		Connection Rate	CXN	62
Sustainable Nitrogen Management Index	SNM	Agricultural land	LND	50
		Permanent cropland	PRM	56
		Sustainable Nitrogen Mgmt. Index	SNM	58

2. Indicator Construction

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
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.

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
Best	5^{th}-percentile	3.43	1.23
Worst	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 $\mu g/m^3$
Countries 228
Years 2008–2015
Transformation $\ln(x)$
Targets World Health Organization guidelines

Performance	Nominal	Raw	Transformed
Best	10 $\mu g/m^3$	10.00	2.30
Worst	99th-percentile	44.44	3.79

Calculations

Component		Units	Source
PMC	Ambient $PM_{2.5}$ concentrations	$\mu g/m^3$	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
Best	0	0.00
Worst	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 : 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
Best	5^{th}-percentile	3.41	1.23
Worst	95^{th}-percentile	4,749.82	8.47

Calculations

none

USD : 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
Best	5^{th}-percentile	1.52	0.42
Worst	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
Best	1^{st}-percentile	21.13	3.05
Worst	99^{th}-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
Best	10 %	10	2.30
Worst	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*. Because each country may have multiple EEZs, the summed area of MPAs is divided by the summed EEZ.

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

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
Best	17 %	17
Worst	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
Best	17 %	17
Worst	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 protected areas in relation to species distributions. The proportion of a species range in a country under protection is calculated for each species as Area of species range in country protected / Area of species range in country and capped at a maximum of 0.17. This value is then averaged for all species occurring in a country, with all species weighted equally.

Units	% of habitat
Countries	185
Years	1990–2014
Source	Map of Life
Transformation	none
Targets	Based on Aichi Target 11

Performance	Nominal	Raw
Best	17 %	17
Worst	0%	0

Calculations

See p. 57 for further information about how this metric is calculated.

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 (CSIRO)

Transformation none

Targets Based on underlying data

Performance	Nominal	Raw
Best	95th-percentile	0.22
Worst	5th-percentile	0.03

Calculations

See pp. 51–52 for further information about how this metric is calculated.

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

Measures changes in the suitable habitats of species to provide aggregate estimates of potential population losses and extinction risk increases. Each species is assessed separately, and the index is calculated as a weighted average of the habitat changes for each species with weights determined by the proportion of global range found in the country,

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
Best	100	100.00
Worst	1st-percentile	93.40

Calculations

See p. 55 for further information about how this metric is calculated.

TCL : Tree Cover Loss / Forests / Ecosystem Vitality

Measures the five-year moving average of percent of forests lost. Forests are defined as land areas having ≥30% canopy cover. Area of forested land (FOR) represents the forested land area at ≥30% canopy cover in the year 2000.

Units % of forested land

Countries 210

Years 2001–2016

Transformation $\ln(x+\alpha)$, $\alpha = 1.94456970161889e\text{-}4$

Targets Based on underlying data

Performance	Nominal	Raw	Transformed
Best	5th-percentile	0.004	-5.47
Worst	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
Best	0	0.00
Worst	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.

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

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 50 countries which do not qualify for the SEA materiality filter, 26 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,

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

Countries in the 2018 EPI for which FSS was imputed

Albania
Bahrain
Belgium
Belize
Benin
Brunei Darussalam
Bulgaria
Cameroon
Côte d'Ivoire
Djibouti
Dominica
Gambia
Georgia
Grenada
Israel
Kuwait
Lebanon
Lithuania
Montenegro
Qatar
Republic of Congo
Romania
Saint Lucia
St Vincent & the Grenadines
Singapore
Togo

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 country's Economic Exclusion Zones (EEZs).

Units	unitless
Countries	133
Years	1950–2014
Transformation	none
Targets	Based on underlying data

Performance	Nominal	Raw
Best	95th-percentile	0.012
Worst	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 Emission Intensity Calculations

The calculation of the indicators of emissions for both Climate & Energy and Air Pollution is especially complex. This more complex approach is borne out of a recognition that countries are at very different levels of economic development, and therefore their performance in terms of current performance and past trends, should be blended in ways that reflect these differences. The logic of this approach is explained in the chapters, "Climate and Energy" and "Air Pollution," under the sections entitled, "Indicator Construction," along with illustrative examples.

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	persons	World Bank, IMF
GPC	*per capita* GDP	$/person	
E	Raw emissions	*various*	*various*
X	Logged emission intensity		
Y	Current-year emission intensity score (sub-indicator)		
Z	Ten-year trend in emission intensity score (sub-indicator)		
$\overline{X}$	Best target for current-year emission intensity (95th-percentile)		
$\underline{X}$	Worst target for current-year emission intensity (5th-percentile)		
$\overline{\epsilon}$	Best target for current-year emission intensity (95th-percentile)		
$\underline{\epsilon}$	Worst target for current-year emission intensity (5th-percentile)		
$\overline{\beta}$	Best target for current-year emission intensity (95th-percentile)		
$\underline{\beta}$	Worst target for current-year emission intensity (5th-percentile)		
B	Blended score for emission intensity		
p	Weight on current-year score		
k	A parameter for the calculation of p		
b	A parameter for the calculation of p		
c	An index of countries		

First, we calculate GDP *per capita*.

$$GPC = \frac{GDP}{POP}$$

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

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

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

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

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

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

Fifth, the 180 trends are then regressed over the logged GDP *per capita* in the final trend year.

$$\hat{\beta}_c = \gamma + \delta \ln(GPC_c) + \epsilon_c$$

The δ coefficient represents the effect of wealth on trends in emission intensity, and the residual ϵ measures the deviations of each country from its expected trend, given its level of wealth.

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

For the indicator on CO_2 emissions from electricity and heat (DPT), however, 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 GDP *per capita*, and its current-year score, Y,

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

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

$$k = \begin{cases} -0.25 \; if \; GPC \geq 12{,}000 \\ \tan\left[\frac{GPC}{6500} \times 1.81927 + 1.3223\right] \times - \; 0.0078560837 \; - \; 0.0001202674 \; if \; else \\ 0.25 \; if \; GPC \; \leq 1{,}000 \end{cases}$$

$$b = \begin{cases} 85 \; if \; GPC \geq 12{,}000 \\ \tan\left[\frac{GPC}{6500} \times 1.81927 + 1.3223\right] \times 1.0998517224 + \; 50 \; if \; else \\ 15 \; if \; GPC \; \leq 1{,}000 \end{cases}$$

The cutoff points for GDP *per capita* of $1,000 and $12,000 roughly correspond to the World Bank's classification of "Middle Income" countries.[1]

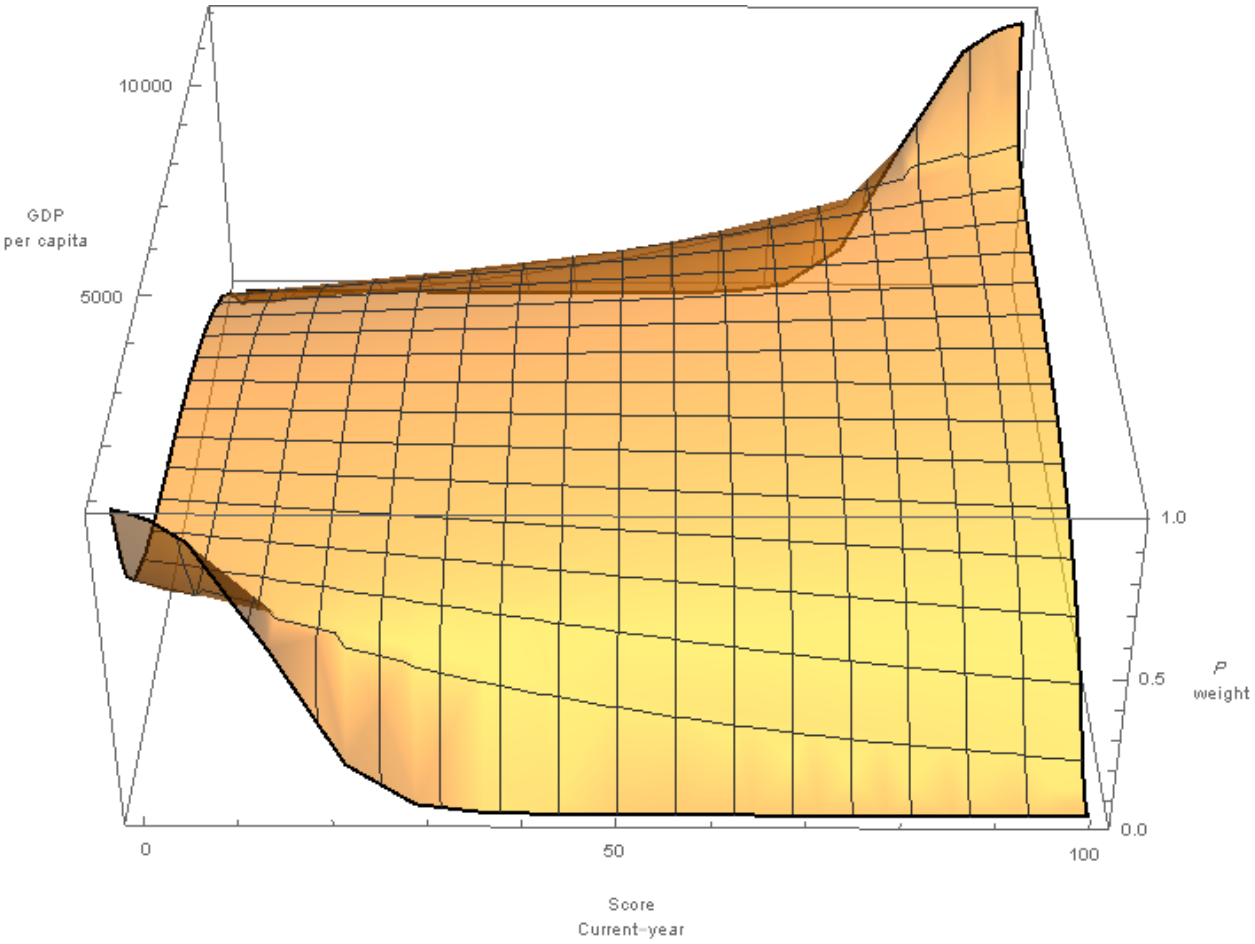


Figure TA-1. The weight, p, given to the current-year score, Y, is a function of both Y and GDP *per capita*. The range shown here is only for Middle Income countries. Low-income countries all use the curve shown at the "front" of the figure, and high-income countries all use the curve shown at the "back" of the figure.

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 emission intensity.

[1] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups Though the World Bank uses Gross National Income (GNI) *per capita*, this measurement is highly correlated with GDP *per capita*.

DCT : CO_2 Emission 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*
X	CDI	CO_2 Intensity		
β	TCI	CO_2 Intensity Trend		
ϵ	DCI	CO_2 Intensity Deviations		
B	DCT	CO_2 Intensity Blended Score		

Targets

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

DPT : CO_2 Emission 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 $\ln(E)$

Targets Based on observed data

Calculations

Component			Units	Source(s)
E	CEH	CO_2 emissions per kWh	g CO_2/kWh	IEA
β	TPI	CO_2 per kWh Trend		
B	DPT	CO_2 per kWh Blended Score		

Targets

Performance		Nominal	Transformed
Best	$\overline{X}$	95th-percentile	6.682
Worst	$\underline{X}$	5th-percentile	850.420
Best	$\overline{\beta}$	95th-percentile	-0.119
Worst	$\underline{\beta}$	5th-percentile	0.061

DMT : CH_4 Emission 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*
X	CHI	CH_4 Intensity		
β	TMI	CH_4 Intensity Trend		
B	DMT	CH_4 Intensity Blended Score		

Targets

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

DNT : N_2O Emission 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*
X	NOI	N_2O Intensity		
β	TNI	N_2O Intensity Trend		
ϵ	DNI	N_2O Carbon Intensity Deviations		
B	DNT	N_2O Intensity Blended Score		

Targets

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

DBT : Black Carbon Emission 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	BLC	Black Carbon emissions	Mt	EDGAR
X	BCI	Black Carbon Intensity		
β	TBI	Black Carbon Intensity Trend		
ϵ	DBI	Black Carbon Intensity Deviations		
B	DBT	Black Carbon Intensity Blended Score		

Targets

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

DST : SO_2 Emission 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
X	SDI	SO_2 Intensity		
β	TSI	SO_2 Intensity Trend		
ϵ	DSI	SO_2 Intensity Deviations		
B	DST	SO_2 Intensity Blended Score		

Targets

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

DXT : NO_X Emission 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
X	NXI	NO_X Intensity		
β	TXI	NO_X Intensity Trend		
ϵ	DXI	NO_X Intensity Deviations		
B	DXT	NO_X Intensity Blended Score		

Targets

Performance		Nominal	Transformed
Best	$\overline{X}$	95th-percentile	-21.667
Worst	$\underline{X}$	5th-percentile	-19.469
Best	$\overline{\epsilon}$	95th-percentile	-0.061
Worst	$\underline{\epsilon}$	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
Best	100	100	4.61
Worst	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,

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

Countries in the 2018 EPI for which WWT was imputed

Antigua & Barbuda
Bahamas
Barbados
Brunei Darussalam
Comoros
Gambia
Grenada
Kiribati
Lebanon
Maldives
Micronesia
Saint Lucia
St Vincent & the Grenadines
Samoa
São Tomé and Príncipe
Seychelles
Tonga
Vanuatu

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. See Figure 14-1 in the 2018 EPI Report.

Units unitless
Countries 136
Years 2015
Transformation none
Targets Based on the observed data

Performance	Nominal	Raw
Best	0	0.00
Worst	99th-percentile	1.16

Calculations

Component		Units	Source
NUE	Nitrogen Use Efficiency	kg N / kg N	Zhang *et al.*, unpublished
NSR	Nitrogen Surplus	kg N / sq. km	Zhang *et al.*, unpublished
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, 46 of which were included in the 2018 EPI. In order to impute missing values for these countries, we use regional averages and other variables. 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,

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

Countries in the 2018 EPI for which SNM was imputed

Afghanistan
Antigua & Barbuda
Bahamas
Barbados
Belgium
Belize
Botswana
Brunei Darussalam
Burundi
Cabo Verde
Central African Republic
Chad
Comoros
Cuba
Djibouti
Dominica
Equatorial Guinea
Eritrea
Fiji
Grenada
Guinea-Bissau
Guyana
Haiti
Kiribati
Laos
Lesotho
Liberia
Libya
Maldives
Mauritania
Micronesia
Papua New Guinea
Saint Lucia
St Vincent & the Grenadines
Samoa
São Tomé and Príncipe
Seychelles
Sierra Leone
Solomon Islands
Swaziland
Taiwan
Timor-Leste
Tonga
Turkmenistan
Uzbekistan
Vanuatu

3. 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	Three letter abbreviation for 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.

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

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.

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

BLC	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.

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	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 These estimate supplemented incomplete CAIT data.

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*.
Documentation	These estimate supplemented incomplete CAIT data.

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

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	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 These estimate supplemented incomplete CAIT data.

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*.
Documentation	These estimate supplemented incomplete CAIT data.

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

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

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

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

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, São Tomé & Príncipe, 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	Incomplete World Bank data were supplemented or replaced for the following countries. 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 São Tomé & Príncipe: 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

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

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

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	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 These estimate supplemented incomplete CAIT data.

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.*
Documentation	These estimate supplemented incomplete CAIT data.

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.

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

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

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.

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

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 replaces incomplete World Bank data for entire time series

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

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.

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

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 2015 and covered 136 countries.

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.

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

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.

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

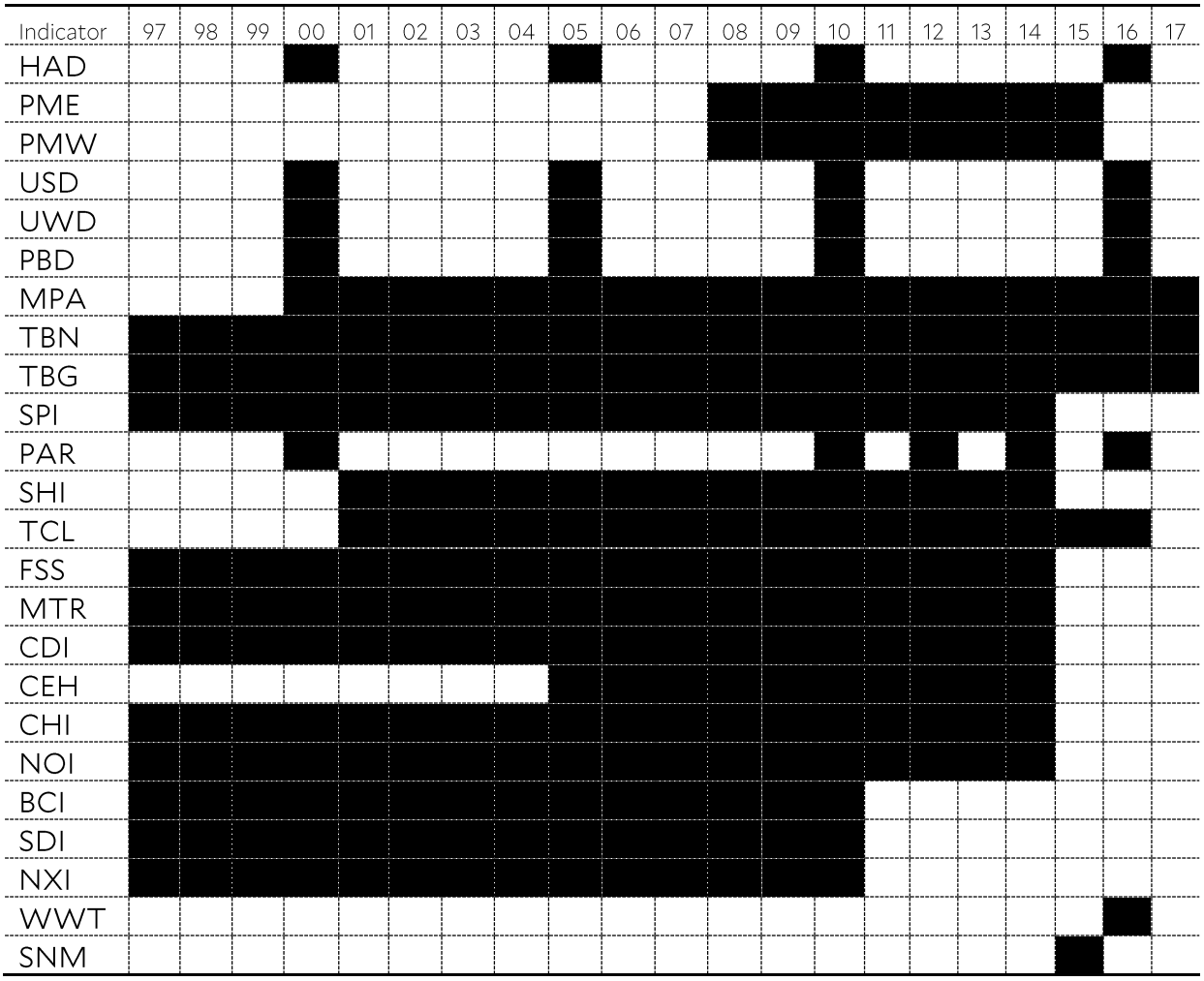
UWD	DALY rate for Unsafe Drinking Water
Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Date received	2017-11-06
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: *various* Age: Age-standardized 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

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

4. 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-3. Temporal coverage for indicators used in the 2018 EPI.



Note: Some datasets extend before 1997, but these data were not relevant to the calculations for the 2018 EPI.

Table TA-4. 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 Emission intensity – Total	2014	2006
CO_2 Emission intensity – Power	2014	2004*
Methane Emission intensity	2014	2006
N_2O Emission intensity	2014	2006
Black Carbon Emission intensity	2010	2006
Air Pollution		
SO_2 Emission intensity	2010	2006
NO_X Emission intensity	2010	2006
Water Resources / Wastewater Treatment	2016	—
Agriculture / Sustainable Nitrogen Management	2015	2001*

* Global aggregates only.

5. Transformations & Targets

Table TA-5. Summary of which indicators were logarithmically transformed and the targets used in indicator construction.

			Nominal Targets		Value Targets	
Indicator	Trans.	Shift (α)	Best	Worst	Best	Worst
BCI			5%	95%	-25.86	-21.10
CDI			5%	95%	-23.36	-21.18
CEH			5%	95%	6.68	850.42
CHI			5%	95%	-24.80	-20.72
DBI			5%	95%	-0.07	0.07
DCI			5%	95%	-0.06	0.05
DMI			5%	95%	-0.06	0.03
DNI			5%	95%	-0.07	0.04
DSI			5%	95%	-0.08	0.09
DXI			5%	95%	-0.06	0.05
FSS			0	99%	0.00	90.82
HAD	log		5%	95%	1.23	8.65
MPA	log	1.22E-05	10	0	2.30	-11.31
MTR			95%	5%	0.01	-0.01
NOI			5%	95%	-26.23	-21.49
NXI			5%	95%	-21.67	-19.47
PAR			95%	5%	0.22	0.03
PME	log		10	99%	2.30	3.79
PMW			0	99%	0.00	86.96
SDI			5%	95%	-22.83	-19.25
SHI			100	1%	100.00	93.40
SNM			0	99%	0.00	1.16
SPI			17	0	17.00	0.00
TBG			17	0	17.00	0.00
TBN			17	0	17.00	0.00
TCL	log	0.000194	0.004	95%	-5.47	0.16
TPI			5%	95%	-0.12	0.06
USD	log		5%	95%	0.42	8.33
UWD	log		5%	95%	1.23	8.47
WWT	log	0.01	100	0	4.61	-4.61

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

For the indicators MPA, TCL, and WWT, there were values of zero in the dataset. Before these indicators could be logarithmically transformed, a small shift (α) was added to each value.

6. Materiality Filters

Table TA-6. Materiality Filters applied to the 2018 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
Forest	Total forested (≥ 30% canopy cover) area < 200 km^2	Forests	*Tree Cover Loss*	30
Sea	Landlocked *or* Coastline : Land area ratio < 0.01	Fisheries	*Fish Stock Status*	44
			Regional MTI	
			Marine Protected Areas	

Countries in the 2018 EPI affected by the Forest Materiality Filter

Antigua and Barbuda
Bahrain
Barbados
Burkina Faso
Cabo Verde
Djibouti
Eritrea
Gambia
Iceland
Iraq
Jordan
Kiribati
Kuwait
Lesotho
Libya
Maldives
Malta
Mauritania
Namibia
Nigeria
Oman
Qatar
Samoa
São Tomé and Príncipe
Saudi Arabia
Seychelles
Singapore
Tonga
Turkmenistan
United Arab Emirates

Countries in the 2018 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
Ethiopia
Hungary
Iraq
Jordan
Kazakhstan
Kyrgyzstan
Laos
Lesotho
Luxembourg
Macedonia
Malawi
Mali
Moldova
Mongolia
Nepal
Niger
Paraguay
Rwanda
Serbia
Slovakia
Slovenia
Swaziland
Switzerland
Tajikistan
Turkmenistan
Uganda
Uzbekistan
Zambia
Zimbabwe

7. 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 2018 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 global metric was then turned into a 0–100 score using the same targets and transformations summarized in Section 5.

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.

HAD : Household Solid Fuels / Air Quality / Environmental Health

This indicator is available as a global aggregate from the data source.

Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: Global Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Household air pollution from solid fuels

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

The global aggregate of *$PM_{2.5}$ Exposure* is calculated as a population-weighted average of all country-level values.

$$PME^g = \sum_c \left[PME_c \times \frac{POP_c}{\sum_c POP_c} \right]$$

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

The global aggregate of *$PM_{2.5}$ Exceedance* is based on the population-weighted average of all country-level values for percentage of the population exceeding WHO thresholds.

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

Where, for example,

$$PM1^g = \sum_c \left[PM1_c \times \frac{POP_c}{\sum_c POP_c} \right]$$

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

This indicator is available as a global aggregate from the data source.

Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: Global Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Unsafe water source

USD : Unsafe Sanitation / Water & Sanitation / Environmental Health

This indicator is available as a global aggregate from the data source.

Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: Global Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Unsafe sanitation

PBD : Lead exposure / Heavy Metals / Environmental Health

This indicator is available as a global aggregate from the data source.

Source	Institute for Health Metrics and Evaluation
URL	http://ghdx.healthdata.org/gbd-results-tool
Instructions	To retrieve these data, use the following settings. Base: Single Context: Risk Measure: DALYs Location: Global Age: Age-standardized Sex: both Year: various Metric: Rate Cause: Total All Causes Risk: Lead exposure

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, global weights / 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.

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

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

The global aggregate of *Species Protection Index* is calculated as a land area-weighted average of all country-level values.

$$SPI^g = \sum_c \left[SPI_c \times \frac{LAN_c}{\sum_c LAN_c} \right]$$

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

This indicator is available as a global aggregate from the data source.

Source	Commonwealth Scientific and Industrial Research Organisation
URL	https://data.csiro.au/
Date received	2017-11-21
via	Personal communication

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

The global aggregate of *Species Habitat Index* is calculated as a land area-weighted average of all country-level values.

$$SHI^g = \sum_c \left[SHI_c \times \frac{LAN_c}{\sum_c LAN_c} \right]$$

TCL : Tree Cover Loss / Forests / Ecosystem Vitality

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

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

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.

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

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

MTR : Regional Marine Trophic Index / Fisheries / Ecosystem Vitality

The global aggregate of *Fish Stock Status* is calculated as a EEZ area-weighted average of all country-level values.

$$MTR^{g} = \sum_{c}[MTR_{c} \times AEZ_{c}] \Big/ \sum_{c} AEZ_{c}$$

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

Generalized Emission intensity Calculations

While country-level scores for the Emission Intensity are a blend of current-year and trend-based scores, the global aggregates are only based on current-year data on emissions. This is because there is no income-based standard against which a trend could be referenced at the global level. Therefore, the global scorecard for emission intensity scores should not be interpreted as an assessment of global trends.

For most global aggregates of emission intensity, the values are calculated from simple aggregations of country-level data.

DCT : CO_2 Emission intensity – Total / Climate & Energy / Ecosystem Vitality

$$DCT^g = \ln\left[\frac{\sum_c CDT_c}{\sum_c GDP_c}\right]$$

DPT : CO_2 Emission intensity – Power / Climate & Energy / Ecosystem Vitality

This indicator is available as a global aggregate from the data source.

Source	International Energy Agency
URL	http://www.oecd-ilibrary.org/energy/data/iea-co2-emissions-from-fuel-combustion-statistics_co2-data-en
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

DMT : CH_4 Emission intensity / Climate & Energy / Ecosystem Vitality

$$DMT^g = \ln\left[\frac{\sum_c CH4_c}{\sum_c GDP_c}\right]$$

DNT : N_2O Emission intensity / Climate & Energy / Ecosystem Vitality

$$DNT^g = \ln\left[\frac{\sum_c NOT_c}{\sum_c GDP_c}\right]$$

DBT : Black Carbon Emission intensity / Climate & Energy / Ecosystem Vitality

$$DBT^g = \ln\left[\frac{\sum_c BCT_c}{\sum_c GDP_c}\right]$$

DST : SO_2 Emission intensity / Air Pollution / Ecosystem Vitality

$$DST^g = \ln\left[\frac{\sum_c SO2_c}{\sum_c GDP_c}\right]$$

DXT : NO_X Emission intensity / Air Pollution / Ecosystem Vitality

$$DXT^g = \ln\left[\frac{\sum_c NOX_c}{\sum_c GDP_c}\right]$$

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.

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

SNM : Sustainable Nitrogen Management Index / Agriculture / Ecosystem Vitality

This indicator is available as a global aggregate from the data source.

Source	Zhang, Xin
Date received	2017-12-14
via	Personal communication