SPES | Sustainability performances, evidence & scenarios

Annex II: Methodological information on 15 short-listed indicator systems

Supplementary material to deliverable D3.1

Funded by European Union's Horizon Europe Programme under Grant Agreement No. 101094551

Authors

András Gábos– Team leader and researcher, TÁRKI
Orsolya Lelkes– researcher of the SPES Project, TÁRKI
Jacopo Cammeo – researcher of the SPES Project, University of Florence

Contributors and peer reviewers:

Mario Biggeri, University of Florence; Andrea Ferrannini, University of Florence; Adam Francescutto, University of Florence; Luca Lodi, University of Florence Federico Olivieri, ASviS; Emilia Rocco, University of Florence; Marcos Renato Preti, London School of Economics and Political Science.

Acknowledgements:

The authors would like to thank all SPES partners for their inputs provided in several SPES meetings and communications.

Disclaimer

This Report 3.1 for the project SPES has been prepared by the TÁRKI and University of Florence as part of Task 3.1 "Mapping individual indicators and composite indices that might be relevant for measuring transition performances" / Work Package 3. This task has allowed SPES research partners to provide an overview of (i) indicator selection practices of existing measurement frameworks and of (ii) indicators that might be relevant to be included in a new dashboard structured according the four pillars of sustainable human development and are suitable to serve as individual items for a composite index.

The project SPES Funded by European Union's Horizon Europe Programme under Grant Agreement No. 101094551

Introduction

The aim of this Annex is to provide detailed description on the indicator systems selected under Section 3.2 of Deliverable *D3.1 Report on mapping indicators and composite indices relevant to measure transition performances*.

The specific aims of this supplementary material are as follows.

1. **List and describe specific indicators in each of the 15 (short-listed) indicator systems.**

The description includes information for each single/elementary indicator or variable included in the composite indicator:

- the data source and its type (i.e., statistical or administrative + in case of statistical source, whether it concerns the total population or a sample);
- time frequency and how often it is updated;
- level of analysis (national, sub-national, individual etc.).

We aimed to collect information that enables us to find potential shortfalls or gaps in the raw data and to determine how they affect the composite indicator. In addition, the information is expected to help us to assess whether the geographical coverage could be enlarged, in other words, the index could be measured for other countries or regions as well, and whether it was possible to increase the frequency of the observations and the updates of the new release (feasibility of nowcasting).

We also included information on the selection procedure of the indicators in some cases in order to inform us on potential alternative approaches and methods on indicator selection for the upcoming phases of our work.

2. Collect methodological information for each of the 15 short-listed indicator frameworks.

The information includes:

- management of missing data;
- treatment of outliers;
- normalisation (standardization) method;
- weighting of pillars and dimensions;
- aggregation method, as well as the

existence and availability of sensitivity and/or uncertainty analysis, and any other statistical validation.

Table of contents

1. ASviS Composite Index

The objective of the ASviS Composite Index is the evaluation of EU member states' performance to reach the EU SDGs and the objectives of the Europe 2030 agenda, using composite indicators. The Italian Alliance for Sustainable Development (ASviS) is in charge of this initiative.

The ASviS analysis (ASviS 2022) is performed at both the EU level and for Italy. The EU level analysis is based on data published by Eurostat (relating to 81 elementary indicators, aggregated into 16 composite indicators), enables assessment of progress and difficulties relating to the European Union as a whole, and to individual countries. Three different approaches have been adopted to assess the EU as a whole and the individual member states:

- analysis of the composite indicators for the European Union as a whole, with an in-depth look at the elementary indicators which, for each Goal, determine their performance;
- the performances and the differences between the individual states over time, once again with reference to the composite and the elementary indicators that define the trend and the level. The results of the analysis are illustrated by means of bar graphs and maps, which highlight the performances and disparities between countries.

In addition to this analysis, AMPI methodology enables to examine differences among states both spatially and temporally, facilitating the assessment of countries' progress towards achieving the Sustainable Development Goals or diverging from them. However, composite indices alone do not furnish an aggregated measure of how performance varies across different states, nor do they enable us to discern whether the top-performing countries are advancing at a faster rate compared to the least-performing states, or if the latter are catching up with the former. To address this limitation, the "Top5 – Bottom5" indicator is computed as the difference between the average values of the AMPI index recorded by the bottom 20% of states with the poorest performances and the top 20% with the best performances, both in 2010 and 2020. It is calculated for all the SDGs and includes each EU country. A lower Top5 – Bottom5 value indicates reduced disparity in the level of composite indices, while a higher value suggests greater inequality. By measuring the difference in the indicator from 2010 to 2020, we can assess whether EU Member States are progressing uniformly over time or if disparities are diminishing or amplifying. This indicator provides valuable insights into the EU's journey towards sustainable development, aiding in identifying areas that require further attention and improvement.

Also, ASviS periodically develops summary indicators that measure the path Italy (and its local areas) has taken to achieve the SDGs, nevertheless this spatial analysis cannot be conducted at the European level given the lack of regional data for all European countries. The 17 composite indicators presented here are based on elementary indicators produced by Eurostat and developed using the Adjusted Mazziotta-Pareto Index (AMPI) method, which have also been adopted by ISTAT. Furthermore, it was not possible to develop a composite index for Goal 14 due to the lack of data for monitoring the state of marine ecosystems over time.

I. Information on individual indicators

Table 1.1: List of individual indicators in the ASvis Composite Index

Nº	SDG	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
1	No poverty	By 2030, reduce the number of people at risk of poverty or social exclusion by 16% versus 2020 (thousands of people at risk of poverty or social exclusion)	Eurostat	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
2	Good health and wellbeing	By 2025, reduce the probability of death from a non-communicable disease by 25% versus 2013 (probability of death from non-communicable disease)	World Health Organization	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, halve mortalities caused by road traffic accidents versus 2019 (number of deaths due to road traffic accidents)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
3	Quality education	By 2030, reduce the share of students who have not attained basic numeracy skills to below 15% (% of 15 year olds)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, reduce the share of students who are early leavers from education and training to below 9% (% of 18-24 year olds)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2027, provide at least 33% of infants a place in early years education (% of infants 3-36 months)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, increase the proportion of people who are graduates to 50% (% of 30-34 year olds)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
4	Gender equality	By 2030, halve the gender employment gap versus 2020 (% points)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, achieve gender equality in ICT-related jobs (% of women to men in ICT-related jobs)	Eurostat	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national

Nº	SDG	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
5	Reduced inequalities	By 2030, reduce net income inequality (S80/S20) to the levels observed in the best European countries (last quintile/first quintile)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
6	Zero hunger	By 2030, reduce the quantity of fertilisers distributed for non-organic agricultural use by 20% versus 2020 (quintals per farmed hectare)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, allocate 25% of agricultural surface area for organic farming (% of agricultural surface area used for organic farming)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
7	Clean water and sanitation	By 2027, guarantee that all surface water bodies have a high or good level of ecological quality (% of surface water bodies with high or good level of ecological quality)	ISPRA	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, achieve a 90% efficiency rate for drinking water distribution (% water distribution)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
8	Affordable and clean energy	By 2030, achieve a 45% share of energy from renewable sources (% of energy from renewable sources)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, increase the installed capacity of renewable energy to at least 130 GW (gigawatt)	GSE	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, reduce final energy consumption by at least 20% versus 2020 (Mtoe mega tonnes of oil equivalent)	Enerdata	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
9	Sustainable cities and communities	By 2030, increase the rate of seat km/person offered by public transport by 26% versus 2004 (seat km/person)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, reduce exceedances of PM10 limits to below 3 days a year (maximum number of days on which the PM10 limit was exceeded as measured by monitoring stations in provincial capitals)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national

Nº	SDG	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
10	Climate action	By 2030, reduce emissions of CO2 and other greenhouse gases by 55% versus 1990 (tonnes of CO2 equivalent per capita)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
11	Life below water	By 2030, eliminate overfishing (% overfished fish stock)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, ensure that marine protected areas account for a 30% share of territorial waters (% marine protected areas)	ISPRA	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
12	Life on land	By 2050, eliminate the increase in annual land use (annual increase in hectares used per 100,000 inhabitants)	ISPRA	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, ensure that terrestrial protected areas account for a 30% share of national territory (% terrestrial protected areas)	ISPRA	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
13	Decent work and economic growth	By 2030, achieve an employment rate of 78% (% of 20-64 year olds)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, reduce the number of NEETs to below 9% (% of 15-29 year olds)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
14	Industry, innovation and infrastructure	By 2050, double the share of freight transported by rail versus 2015 (thousands of tonnes of freight transported by rail within the country)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, increase the share of GDP spent on R&D to 3% (% of GDP spent on R&D)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2026, guarantee all households have access to the internet at speeds of 1 gigabyte (% of households)	DESI	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
15	Responsible consumption and production	By 2030, increase the share of urban waste recycled to 60% (% urban waste recycled)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national

1. ASviS Composite Index

Nº	SDG	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
16	Peace, justice and strong institution	By 2030, eliminate prison overcrowding (% points)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
		By 2030, reduce the average duration of civil proceedings by 40% versus 2019 (number of days)	ISTAT	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national
17	Partnerships for the Goals	By 2030, increase the share of GNI spent on official development assistance to 0.7% (% GNI spent on official development assistance)	Eurostat	https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf	2010-2020	national

II. Methodological issues related to the index

The composite indices for each SDG goal are built using the adjusted Mazziotta–Pareto index, a non-compensatory composite index used by the Italian National Institute of Statistics for measuring ''Equitable and Sustainable Well-being'' in Italy.

The AMPI is a composite index for summarizing a set of indicators that are assumed to be non-substitutable, i.e., all components must be balanced. It is based on a nonlinear function which, starting from the arithmetic mean, introduces a penalty for the units with unbalanced values of the indicators. Individual indicators are normalized by a re-scaling according to two 'goalposts', i.e., a minimum and a maximum value which represent the possible range of each variable for all time periods and for all units. Such a type of normalization allows us to perform absolute comparisons over time.

1. Management of missing data

The survey in question is not carried out annually or the time series is missing by one or more years for all the EU 27 countries: the missing values of the indicator are estimated through the use of linear interpolation, which, starting from two known values, allows you to calculate one or more values included between them through the use of a function of a linear regression.

The first survey opportunity is subsequent to the time t of the start of the time series (first year taken into account in the calculation of the composite index): the values of the indicator of the first available year (t + n) are replicated for the year or for the previous year's missing in the historical series.

The historical series of the indicator is not yet updated to the last year(s) taken into consideration in the calculation of the composite index. To address missing values in the historical series of the indicator, two methods are employed:

- nowcasting, in cases where a proxy indicator exists that is highly statistically correlated and conceptually linked to the basic indicator, the missing values are estimated using this proxy indicator. The value or values in the base indicator are estimated using a linear regression model, which is constructed based on the observed values from the proxy indicator for the years under estimation. The proxy indicator serves as an explanatory variable in this model.
- extrapolation, if it is not possible to identify a suitable proxy indicator, missing values of the basic indicator are predicted using an autoregressive linear model. The predictive model is considered appropriate if the R2 is greater than 0.7.

If the model does not adapt sufficiently to the observed data, the last observed value is replicated for the year or for the missing years.

The data was not disclosed for a specific country in correspondence of one or more years of the historical series: The missing value corresponding to the individual state is calculated using the observed variation in the estimated values of the indicator obtained through a linear regression

model, where the EU27 territorial aggregate is used as an explanatory variable of the model. Where the values of the indicator are not available in correspondence with the EU27 aggregate, the solutions provided for in points 1 and 2 are applied, according to the specific case;

The indicator for the EU27 aggregate is not available or is not calculated, whereas the value for the individual EU Member States is available: For four of the nearly eighty indicators included in this analysis (People at risk of poverty after social transfers, Civil and commercial litigious cases duration, Prisons overcrowding, Percentage of pre-trial prisoners over total prisoners), the European Union does not publish values for the EU 27 aggregate. However, as these indicators are deemed critical to the analysis, the missing values for the aggregate are reconstructed using a weighted average of the values from the individual territorial units, based on their respective populations;

The values of an indicator for a specific state are missing for the entire historical series, and the EU27 aggregate is not available: the territorial unit is excluded from the calculation of the composite.

2. Treatment of outliers

In the construction of the composite indices are included all European states that meet the requirements for data availability which also includes European countries such as Luxembourg, Malta, Cyprus etc. These countries make up the vast majority of the outliers within the time series of indicators, and direct comparison with countries such as Germany, France, Italy, Spain, etc. results in inevitable distortions in identifying the minimum(Min) and maximum (Max) of the composite indicators. Nevertheless since these countries have equal weight within the decision-making process of the European union they were considered in the analysis. In addition it should be emphasized that all the data used come from official statistics (eurostat, Council of Europe European Commission for the efficiency of justice (CEPEJ)) so the manipulation of outliers that officially describe the reality of the country, is not deemed appropriate.

3. Normalisation (standardization)

Given the matrix $X = \{x_{ij}\}$, we calculate the normalized matrix $R = \{r_{ij}\}$ as follow:

$r_{ij} = (x_{ij} - Min_{xj})/(Max_{xj} - Min_{xj})*60 + 70$

where Min_{xj} and Max_{xj} are the 'goalposts' for the indicator j. If the indicator j has negative 'polarity',the complement of (1) with respect to 200 is calculated.

To facilitate the interpretation of results, the 'goalposts' can be fixed so that 100 represents a reference value (e.g., the average in a given year). A simple procedure for setting the 'goalposts' is the following.

Let Inf_{xj} and Sup_{xj} be the overall minimum and maximum of the indicator j across all units and all time periods considered. Denoting with Ref_{xj} the reference value for the indicator j, the 'goalposts' are defined as:

$Min_{xj} = Ref_{xj} - \Delta$

$Max_{xj} = Ref_{xj} + \Delta$

where $\Delta = (Sup_{xj} - Inf_{xj})/2$. The normalized values will fall approximately in the range (70; 130), where 100 represents the reference value. (Mazziota and Pareto, 2018: pp.969-970)

4. Weighting of pillars and dimensions

The AMPI tends to assign equal weight or importance to each indicator and it is less sensitive to the inclusion or exclusion of individual indicators. (Mazziota and Pareto, 2018: p.974)

5. Aggregation method

Denoting with M_{ri} and S_{ri} , respectively, the mean and standard deviation of the normalized values of the unit i, the generalized form of AMPI is given by:

$AMPI_i^{+/-} = Mri \ +/- \ S_{ri}cv_i$

where cvi = Sri/Mri is the coefficient of variation for the unit i.

If the composite index is 'positive', i.e., increasing values of the index correspond to positive variations of the phenomenon (e.g., socio-economic development), then $AMPI^-$ is used. On the contrary, if the composite index is 'negative', i.e., increasing values of the index correspond to negative variations of the phenomenon (e.g., poverty), then $AMPI^+$ is used. In any case, an imbalance among indicators will have a negative effect on the value of the index.

Therefore, the AMPI decomposes the score of each unit in two parts: mean level (M_{ri}) and penalty ($S_{ri}cv_i$). The penalty is a function of the indicators' variability in relation to the mean value ('horizontal variability') and it is used to penalize the units. The aim is to reward the units that, the mean being equal, have a greater balance among the indicator values.

The AMPI has the same properties as the MPI. Nevertheless, the AMPI allows to compute the score of each unit independently of the others, in contrast to the MPI where the mean and standard deviation of the individual indicators are requested. The 'price' to pay for having scores comparable over time is that indicators with different variability are aggregated. However, normalized indicators in an identical range have much more similar variability than original ones. (Mazziota and Pareto, p.970)

References

ASviS (2022): Italy and the Sustainable Development Goals. ASviS Report. https://asvis.it/public/asvis2/files/Rapporto_ASviS/Rapporto_ASviS_2022/Report_ASviS_ENG_2022.pdf

Mazziotta, M. and A. Pareto (2018): Measuring Well-Being Over Time: The Adjusted Mazziotta–Pareto Index Versus Other Non-compensatory Indices. *Social Indicators Research*, 139: 967-976.

https://asvis.it/public/asvis2/files/Approfondimenti/Mazziotta-Pareto2018_Article_MeasuringWell-BeingOverTimeThe.pdf

2. "Beyond GDP" Sustainable Development Index

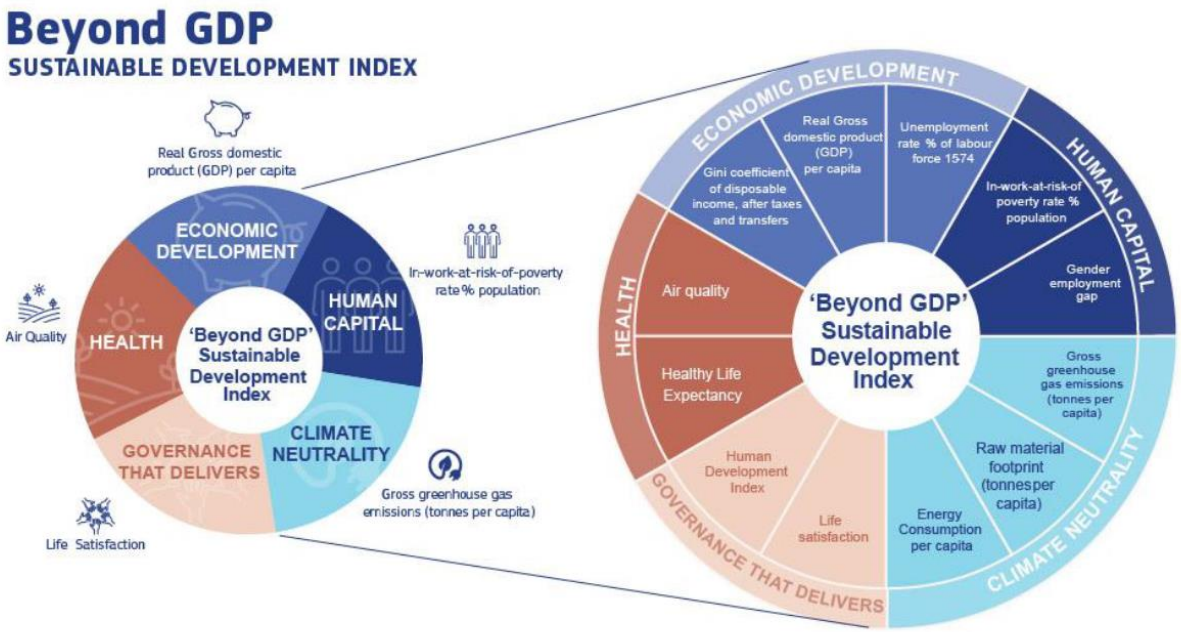
The "Beyond GDP" Sustainable Development Index is still under development, and was created with the ambition to aid to bridge the policy ambition gap between the development and the implementation of EU-wide sustainable transition strategy by the introduction of new evidence-based policy instruments to monitor the countries' progress, options and possible actions.

DG Research and Innovation of the European Commission contracted Vitosha Research EOOD (CSD Group) to study and suggest a draft integrated approach for assessing the well-being of European countries combining the information and data from the multitude of dashboards and indices and the different indicators on socio-economic development, environmental protection, and good governance, which currently exist. The aim was to further try to improve the existing methodologies for tracking the progress to sustainable transition.

The currently available first version of the proposal (EC et al 2022) presents two alternative visions for a 'Beyond GDP' monitoring set of indicators to continuously assess the global progress to achieving the Sustainable Development Goals (SDGs). The Indices are based on the information and data from a multitude of existing dashboards and different indicators on socio-economic development, environmental protection, and good governance. The two proposals for alternative analytical frameworks include an "ambitious scenario" with 5 statistically tested indicators (including GDP), and a "transition scenario" with 12 indicators that is more encompassing of the different existing approaches for the monitoring of sustainable development.

A third, sensitivity version of the "ambitious scenario" was also developed whereas GDP was dropped completely from the five indicators so as to test a pure Beyond GDP scenario. Instead, focus was put on the use of resources, which is a key ingredient to achieving long-term sustainable development. Hence, the Material footprint indicator was included to reflect better sustainability. It should be noted that Material footprint is not necessarily related to economic growth, so in this sensitivity version less focus is put on economic development as a whole.

The results of the alternative scenarios show a moderate improvement of sustainable development indicators across the EU-27 Member States.



Source: EC et al. 2023, p. 7.

I. Information on individual indicators

Table 2.1: List of individual indicators - The ambitious 'Beyond GDP' scenario (BGDP-A)

Dimension	Code	Name	Data source	Timeliness	Type of data
1 Economic development	1	GDP per capita	IMF	timely, 2022 (and even 2023 forecast) available	Admin
2 Climate neutrality	2	Gross greenhouse gas emissions (tonnes per capita),	European Environmental Agency (EEA)	Yearly, latest data from 2020	Admin
3 Health	3	Air quality	EEA	timely, updated monthly. According to Eurostat, data are experimental and provisional and neither seasonally nor calendar adjusted.	Experimental
4 Human capital	4	In-work-at-risk-of-poverty rate (% population),	Eurostat, EU-SILC	yearly, latest data for all countries from 2021	Survey
5 Governance that delivers	5	Life satisfaction	Gallup World Poll	latest Gallup World Poll from 2020, indicates limited timeliness	Survey

Table 2.1: List of individual indicators - The less ambitious transition 'Beyond GDP' scenario (BGDP-12)

Dimension	Code	Name	Data source	Timeliness	Type of data
1 Economic development	1.1	GDP per capita	IMF	timely, 2022 (and even 2023 forecast) available	Admin
	1.2	Gini coefficient of disposable income, after taxes and transfers	Eurostat, EU-SILC	yearly, latest data for all countries from 2021	Survey
	1.3	Unemployment rate (% of labour force 15-74)	Eurostat, EU-LFS	yearly, latest data for all countries from 2022	Survey
2 Climate neutrality	2.1	Gross greenhouse gas emissions (tonnes per capita),	EEA	Yearly, latest data from 2020	Admin
	2.2	Material footprint (tonnes per capita);	UNEP UN-SDGs	Yearly, latest data from 2019	Admin
	2.3	Energy Consumption per Capita	Eurostat?		Admin?
3 Health	3.1	Air quality	EEA	timely, updated monthly. According to Eurostat, data are experimental and provisional and neither seasonally nor calendar adjusted.	Experimental
	3.2	Healthy life expectancy at birth (years)	WHO	Last available year is 2015 in the WHO database (should be checked) Last available year is 2021 in the Eurostat database	Admin
4 Human capital	4.1	In-work-at-risk-of-poverty rate (% population)	Eurostat, EU-SILC	yearly, latest data for all countries from 2021	Survey
	4.2	Gender employment gap	Eurostat, EU-LFS	yearly, latest data for all countries from 2022	Survey
5 Governance that delivers	5.1	Life satisfaction	Gallup World Poll	latest Gallup World Poll from 2020, indicates limited timeliness	Survey
	5.2	Human Development Index	UNDP	Yearly, latest data from 2021	Admin

II. Methodological issues related to the index

The process of indicators assessment began by listing and reviewing all EU dashboards and indicators used for monitoring EU policies as well as other internationally-recognized indices mentioned in the previous section. These composite indexes and dashboards were deconstructed to their building blocks, i.e. their lowest level indicators, which resulted in a database with 624 primary and secondary indicators, as well as a limited number of composite indices. Technical information was collected for all 600+ indicators from the database including:

- indicator description and structure (in the case of composite indicators);
- measurement units and data type: objective data vs expert assessments vs polls vs other;
- data sources: national statistics / Eurostat; other sources; ad hoc surveys, etc.;
- data availability: geographical coverage, time coverage, update regularity, etc., how many composite indexes rely on this raw indicator and others.

All 624 metrics were then rated by at least 2 in-house experts for:

1. comparability over time and space, whether the indicator is interpreted consistently in different composite indexes;
2. how self-explanatory is the raw indicator;
3. conceptual connection to GDP;
4. predicting power of the indicator about different social/economic phenomena;
5. link to the SDGs (and if so, how many SDGs is it related to);
6. uniqueness of the indicators in terms of dimension coverage.

In the case of discrepancies between the experts' assessment scores, more experts provided their assessments in a Delphi-style discussion. A combined qualitative score was computed based, on the one hand, on the expert assessment scores and, on the other, on the update frequency, number of SDGs the indicator is related to and number of composite indexes the indicator is included in.

Following this initial process, 202 primary indicators and composite indexes were selected based on the highest qualitative score as well as on covering all the important thematic dimensions linked to sustainable development. Data was collected for all 202 metrics and for all EU-27 Member States with a 2011-2020 time coverage. This also led to a more precise estimate of the data availability for the indicators – on a scale from 0 to 270, where 270 meant data were available for all 27 Member States and an EU-27 aggregate for all years between 2011 and 2020.

The next step included various statistical tests performed on 143 indicators and indexes for which there had been enough data points. The indicators were tested through a series of statistical analyses including Correlation Analysis, Regression Analysis and Principal Component Analysis. Missing data points for the remaining 143 indicators were replaced through a multiple imputations procedure where all 143 indicators were included as predictors. Imputed data points were less than 10% for each indicator. Principal Component Analysis and Factor Analysis

included principal components method of extraction as well as principal axis factoring extraction, then different types of rotation were attempted: Varimax, Promax and Direct Oblimin. Analyses with extraction based on eigenvalues (with an eigenvalue above 1 criterion) were performed as well as extraction based on a fixed number of factors (either 5 or 12) were both attempted. The performance of difference indicators and indexes in the various analyses was studied carefully and considered when selecting the final short list of 32 indicators.

The tests described above led to a quantitative assessment of each of the 143 indicators. The quantitative score was based on the uniqueness of the indicator (whether it represented a different principal component or belonged in a group with many other indicators), on its strength in terms of good representation of its respective dimension (based on factor loading score), on its usefulness (i.e. whether it represented a strong dimension that could be interpreted qualitatively or not) and on its EU-27 data availability on the scale from 0 to 270.

The statistical assessment yielded 21 possible groups of indicators. Several indicators were selected from each group based on the quantitative scores of the indicators, on the importance of the group (in terms of variance explained) and on qualitative expert assessment of the salience of the indicators and different groups. This eventually led to 32 indicators and composite indexes that were short-listed for further assessment and testing.

The next step in the assessment process included an online survey, where 18 international experts in the field assessed all 32 indicators on 8 dimensions: General Relevance, Effectiveness, Policy relevance, Early warning strength, Short-term changes sensitivity, Foresight assessment sensitivity, Robustness to Data Manipulation, and Robustness to Subjective Bias. An average score was computed for all 32 indicators, ranking them from number 1 with the highest score (“Gross greenhouse gas emissions (tonnes per capita)”) to number 32 (“Freedom House's Freedom in the World Index”). More detailed in-depth interviews were then organized with five of the experts who took part in the survey. The in-depth interviews aimed at tapping into the experts’ knowledge and opinion on various aspects of the current exercise including the challenges in developing a ‘Beyond GDP’ monitoring set, a conceptual framework for sustainable development assessment as well as the difficulties when communicating the results to different stakeholders. More concrete questions were asked regarding the nature of the different indicators from the list and the experts’ rationale behind preferring a certain indicator over the rest. General findings from the in-depth interviews were considered when building the final two ‘Beyond GDP’ indexes.

Finally, additional statistical tests were performed on the short-listed 32 indicators. These led to outlining 9 possible groups of indicators, of which 12 final indicators were selected based on the statistical analyses, on the expert survey ranking of the indicators, and on the in-depth interviews information. These 12 indicators were grouped in 5 different dimensions, finally narrowing down the selection to the best 5 indicators representing these 5 dimensions in an ambitious scenario.

For this methodological description, see EC et al. (2023), pages 29-31.

1. Management of missing data

No information available.

2. Treatment of outliers

No information available.

3. Normalisation (standardization)

All indicators were normalised using min-max normalisation, and where needed, scales were inverted so that for every indicator larger values meant better performance. Normalised scales are from 0 to 100 and the final index computed for the two scenarios shares the same scale - from 0 to 100 where 0 is the lowest performance score and 100 is the highest (EC et al. 2023, pages 30-31).

4. Weighting of pillars and dimensions

The report does not provide explicit information on the weighting procedure. We assume that there is no weighting applied.

5. Aggregation method

The report does not provide explicit information on the aggregation procedure. We assume that arithmetical addition was applied, and that the indices were re-scaled to the 0-100 range.

Reference

European Commission, Directorate-General for Research and Innovation, Vladimirov, M., Gerganov, A., Petrova, V. et al. (2023),. *Developing alternative visions for assessing progress to sustainable development 'Beyond GDP' – Constructing new measurement indicator sets*, Publications Office of the European Union, 2023, **https://data.europa.eu/doi/10.2777/888071**

3. Competitive Sustainability Index

The Competitive Sustainability Index (CSI) provides a new means of assessing and tracking the competitive performance of EU countries as they progress in their transition to sustainability, with a climate neutral economy at its core. The Competitive Sustainability Index has been developed to complement the European Commission's own strategy for competitive sustainability, first articulated in the 2020 Annual Sustainable Growth Strategy and maintained since. This framework has been built with a deliberate focus on competitiveness and an integrated and comprehensive approach to addressing the four relevant dimensions of sustainable development: Economy, Society, Governance and Environment. Therefore, it not only builds on and refines the Commission's own framework, but also integrates the latest thinking on innovation.

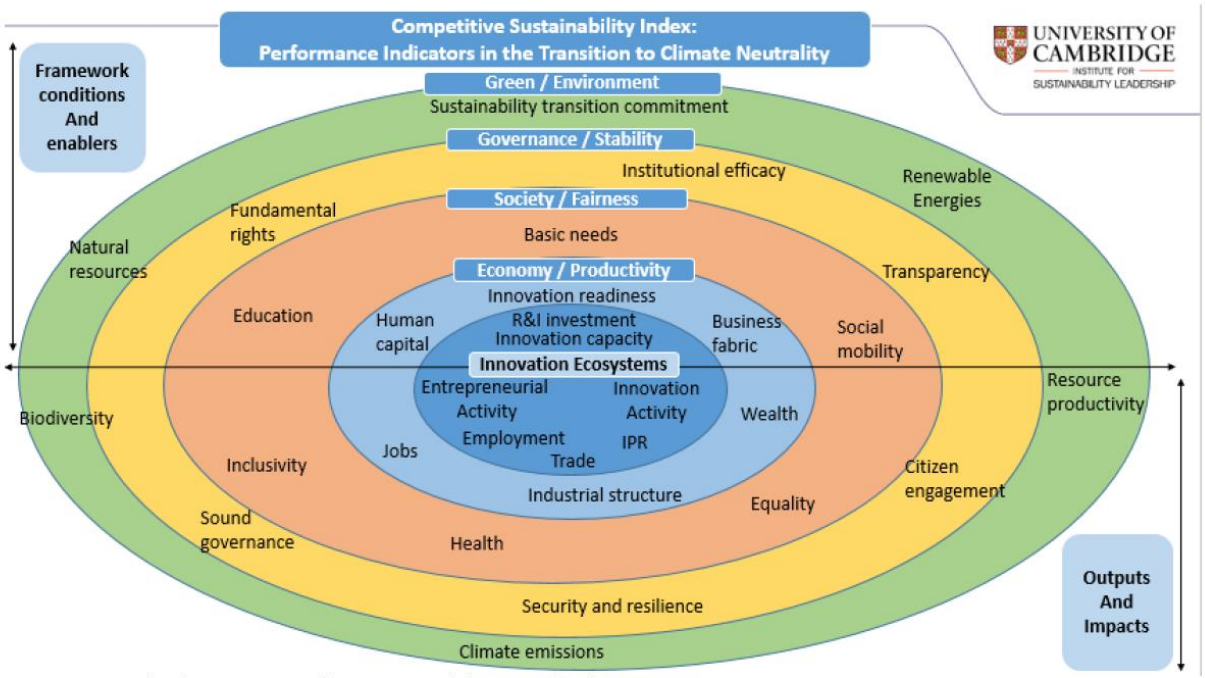
I. Information on individual indicators

Conceptual framework, indicator selection

The conceptual framework is populated with 84 indicators, further aggregated into 31 components, 10 sub-dimensions, 4 dimensions, and finally into an overall index.

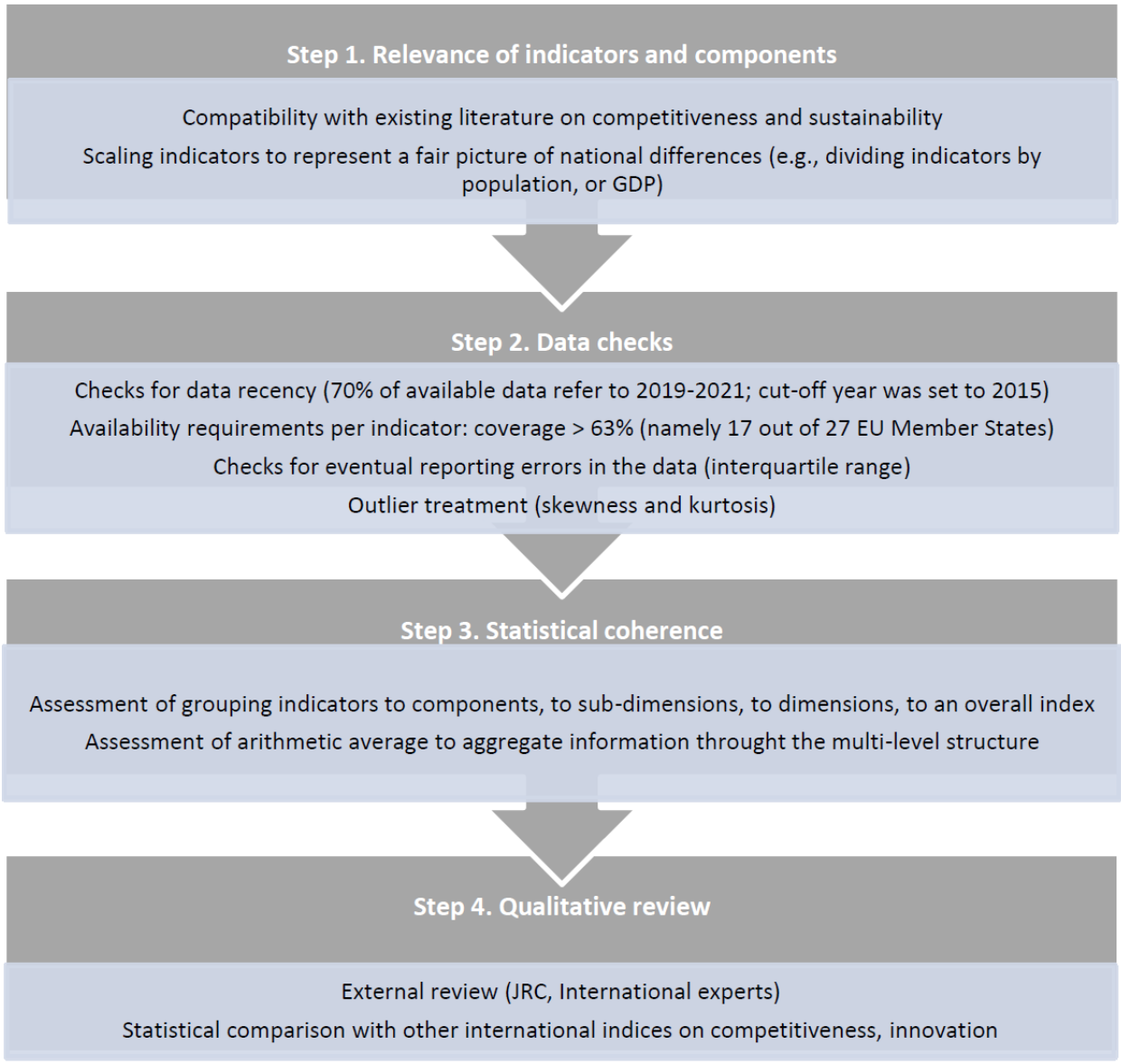
"This first edition of the Competitive Sustainability Index benchmarks EU Member States' performance on four dimensions of competitive sustainability: Economy/Productivity, Society/Fairness, Governance/Stability, and Green/Environment. The conceptual framework is populated with 84 indicators, further aggregated into 31 components, 10 sub-dimensions, 4 dimensions, and finally into an overall index (Figure 3.1).

Figure 3.1: Competitive Sustainability Index framework



Source: Cambridge Institute for Sustainability Leadership

Figure 3.2: Steps of selecting indicators within the Competitive Sustainability Index framework



Step 1: Relevance

Almost 430 indicators were initially screened by the index developers for their relevance to the four dimensions of competitive sustainability on the basis of literature review and expert consultation in 2021-2022. After screening for data coverage and timeliness, and subsequently testing for statistical coherence, 84 indicators were selected. To represent a fair picture of country differences, indicators were scaled either at the source or by the developing team as appropriate and where needed.

Step 2: Data checks

The most recently released data within the period 2015–2021 were used for each EU Member State to reflect the latest updates issued by Eurostat and other leading international statistical bodies from which the database is derived.

Indicators were included if data availability was at least 63% (namely 17 out of the 27 EU Member States). As a result, the Competitive Sustainability dataset data set has 94.7% data coverage across the 27 EU Member States and 84 indicators. The impact of missing values on the competitive sustainability results is further discussed in Section 2.

Potentially problematic indicators that could bias the overall results were identified by the development team, as per the JRC guidelines, on the basis of two measures related to the shape of the indicators' distribution: skewness and kurtosis. Values were treated if the indicators had absolute skewness greater than 2 and absolute value of kurtosis greater than 3.5 (or only kurtosis greater than 10). The indicators affected by outliers were treated through winsorisation, i.e. extreme values were replaced by the closest neighbour. Values were replaced iteratively, until the skewness and kurtosis of the indicator met the above criteria. This data treatment, which is common in a composite indicator context, is undertaken with a view to avoid that few very high or very low values result in polarised indicators and scores, and introduce distortion in the correlation coefficients that are subsequently used for the analysis of the statistical coherence in the competitive sustainability framework.

Step 3: Statistical Coherence

The reliability of the Competitive Sustainability Index depends, inter alia, on the degree of coherence between the conceptual framework – 84 indicators grouped into 31 components, 10 sub-dimensions, 4 dimensions and finally into an index – and the statistical relations of the data. The more the statistical structure of the selected dataset is compatible with the conceptual framework for measuring Competitive Sustainability, the higher will be the reliability of the Index ranks and of the dimensions ranks. The statistical coherence of the indicator framework was assessed by analysing whether the 84 indicators and 31 components explain a sufficient amount of variation in the aggregate scores (either in the dimensions or the overall index) by means of correlation, cross-correlation, and principal component analysis.

Given that the analysis of statistical coherence of the Competitive Sustainability Index is based on correlations, the correspondence of the index to a real-world phenomenon needs to be critically addressed by experts in the field because 'correlations need not necessarily represent the real influence of the individual indicators on the phenomenon being measured'. The point made here is that the validity of the indicator framework underpinning the Competitive Sustainability Index relies on the combination of both statistical soundness and conceptual relevance. In this respect, the Competitive Sustainability framework has been developed following an iterative process that went back and forth between the theoretical understandings of competitive sustainability on the one hand, and data observations on the other.

Principal component analysis was used to assess the extent to which the conceptual framework underpinning the Competitive Sustainability Index is compatible with the data statistical properties. Results suggest that the expectation of a single statistical dimension (i.e., no more than one principal component with eigenvalue greater than 1.0) is confirmed for 24 of the 31 components, for 8 of the 10 sub-dimensions, for all 4 dimensions, and for the overall index. The presence of more than one "statistical dimensions" suggests that some of the information content of some indicators and components in the Competitive Sustainability framework does not arrive at the higher aggregation levels. This finding is discussed in more detail later in this section.

A more detailed analysis of the correlation structure within and across the four dimensions of Competitive Sustainability confirms the expectation that the 31 components are generally more correlated to their own dimension than to any other (see Table 1). This result suggests that the allocation of the 31 components to a specific dimension of a country's competitive sustainability is consistent both from conceptual and statistical perspectives. Furthermore, most associations between components and the respective dimension are statistically significant, and most correlation coefficients within a dimension are close to or greater than 0.70, which suggests that at least half of the variance in the dimension scores can be explained by the underlying components.

The four dimensions of Competitive Sustainability share a single statistical dimension. The Competitive Sustainability Index captures 75% of the total variance in the four dimensions, and the four correlation coefficients (between the index and each dimension) are sufficiently high, 0.90 or greater for the first three dimensions, and 0.68 for the Green/Environment dimension. This result supports the aggregation of the four dimensions into one number and suggests that all four dimensions of a country's competitive sustainability can explain more than half of the variation of the Index scores, and vice versa. The reliability of the Competitive Sustainability Index, measured by the Cronbach-alpha value, is very good at 0.84—well above the 0.7 threshold for a reliable aggregate of the four dimensions.

Thus far, the statistical coherence tests corroborate the multi-level structure in the Competitive Sustainability Index framework. At the same time, a critical review of the results in Table 1 evidences issues that are worthy of further reflection by the index developers, either because they indicate avenues for refining the indicator framework in next releases of the index or because they point to interesting avenues for policy analysis.

First, eight of the 31 components are found to have a transversal impact across three dimensions in the Competitive Sustainability framework. Innovation readiness (1.1.1), which is part of the Framework conditions for Economy/Productivity (with correlation 0.78), is also found to have strong statistical association to Society/Fairness (correlation 0.81) and to Governance/Stability (correlation 0.90). Similarly, Human capital (1.1.2), which is also part of the Framework conditions for Economy/Productivity (correlation 0.61), is also found to have a good correlation to Society/Fairness and to Governance/Stability (correlation about 0.75). The other six components in the framework with such a transversal impact across three dimensions of competitive sustainability are: Education (2.1.1), Social Mobility (2.1.3), Fundamental rights (3.1.1), Transparency (3.1.2), Institutional efficacy (3.1.3), and finally Citizen engagement (3.2.2). The

transversal impact of these eight components of competitive sustainability may be worthy of further reflection and analysis by the index developers, as it may offer additional insights on EU Member States competitive sustainability attributes. In fact, given this transversal impact across three dimensions, these eight components – Innovation readiness, Human capital, Education, Social Mobility, Fundamental rights, Transparency, Institutional efficacy, and Citizen engagement – are also found to be the best predictors for a country's competitive sustainability in the European Union.

Second, there are three components of competitive sustainability that do not significantly correlate either with the respective dimension, or with the overall index. These are Entrepreneurial activity (1.3.2) that is part of the Outputs of Economy/Productivity, and Resource productivity (4.2.1) and Biodiversity (4.2.3) that are both part of the Impacts of Green/Environment. Although conceptually enriching the Competitive Sustainability framework, these three components (and some of their underlying indicators) are found not to co-vary with the overall index. This means that EU Member States may achieve high Competitive Sustainability scores despite poor performance in Entrepreneurial activity, Resource productivity, and Biodiversity. On one hand, the poor correlation between Entrepreneurial activity and the Competitive Sustainability Index may be attributed to the calculation of the indicators underlying Entrepreneurial activity. The JRC recommendation to the developing team is to consider whether a different formulation or different data sources for these indicators may be more appropriate. On the other hand, the poor correlation between Resource productivity and Biodiversity (and also Renewable energies, and Natural resources) with the overall Competitive Sustainability Index is more worrisome, yet not surprising. This finding is in line with relevant scientific literature and a recent article in Nature Communications 5, and it points towards a masking - rather than a synergistic effect - of competitiveness on environmental protection, and the more worrisome finding that up until 2021 there has not been sufficient integration of environmental priorities into EU Member States' growth and competitiveness plans.

Overall, the statistical coherence tests corroborate the multi-level structure in the Competitive Sustainability Index framework, whereby the desired unidimensionality is confirmed for 24 of the 31 components, 8 of the 10 sub-dimensions, all four dimensions and for the overall index. Furthermore, most components in the Competitive Sustainability framework are found to be influential, having statistically significant correlations with the dimensions, and their influence arrives up to the overall index. This is a desirable outcome as it suggests that the information content in most of the underlying indicators and components is maintained at all levels of aggregation in the Competitive Sustainability framework.

Step 4: Qualitative Review

The Competitive Sustainability Index results for the EU Member States were also evaluated by an ad-hoc Advisory Panel and by international experts invited by the Cambridge Institute for Sustainability Leadership to verify that they are, to a great extent, consistent with current evidence, existing research and prevailing theory.

To complement this qualitative evaluation, the Competitive Sustainability Index results are compared herein vis-à-vis other similar international indices. The expectation is that the

Competitive Sustainability Index correlates strongly to other international indices on competitiveness and innovation. Table 2 compares the Competitive Sustainability Index for the EU Member States with the most recent versions of four relevant international indices—the World Intellectual Property Organization (WIPO)'s 2022 Global Innovation Index; the European House Ambrosetti's 2022 Global Attractiveness Index; the International Institute for Management Development (IMD)'s 2022 World Competitiveness Index; and INSEAD's Global Talent Competitiveness Index—using the most recent rankings for the EU Member States extracted from these projects' websites. The rank correlation between the Competitive Sustainability Index and all four international indices is substantially high (correlation ranges 0.81-0.94), which suggests that the Competitive Sustainability Index framework is consistent with the frameworks on global innovation, global attractiveness, and global competitiveness. At the same time, looking at the shifts in rankings, 30%, 59%, 19% and 19% of the EU Member States that feature in the other four international indices differ in ranking by 4 or more positions when comparing the Competitive Sustainability Index with the four selected international indices. This indicates that the Competitive Sustainability Index offers additional insights into EU Member States competitive sustainability compared to the 2022 Global Innovation Index, the 2022 Global Attractiveness Index, the 2022 World Competitiveness Index, and the 2022 Global Talent Competitiveness Index.

Notwithstanding these statistical tests and the positive outcomes regarding the statistical soundness and conceptual relevance of the Competitive Sustainability Index, it is important to mention that the index and its indicator framework has to remain open to future improvements as better data, more comprehensive surveys and assessments, and new relevant research studies and data become available." (Saisana et al. 2022, pp. 2-9., own emphasis)

List of individual indicators

Table 3.1: List of indicators - Competitive Sustainability Index

Economy / Productivity	
Framework conditions within Economy/Productivity	
1. Innovation readiness	
	a. Percentage of people with advanced ICT skills
	b. Government, Higher Education and non-profit R&D expenditure (% of GDP)
	c. Broadband at home
2. Human capital	
	a. Population aged 25-34 with tertiary education
	b. Tertiary education graduates in science, math., computing, engineering, manufacturing, construction (per 1000 of population aged 20-29)
	c. Foreign doctorate students (% of all doctorate students)
3. Business fabric	
	a. Turnover share large enterprises (%)
	b. Entrepreneurial culture
Innovation enablers	
1. Business R&I investment	
	a. Expenditure of enterprises on R&D in taxonomy-eligible activities (% GDP)
	b. Enterprises that received public funding for research and development (R&D) or innovation in taxonomy-eligible activities (share in enterprises in taxonomy-eligible activities)
	c. Enterprises that use tax incentives or allowances for research and development (R&D) or innovation in taxonomy-eligible activities (share in enterprises in taxonomy-eligible activities)
	d. Enterprises that obtained debt finance for R&D or innovation in Taxonomy-eligible activities (share in enterprises in Taxonomy-eligible activities)
	e. Enterprises that obtained equity finance for R&D or innovation in Taxonomy-eligible activities (share in enterprises in Taxonomy-eligible activities)
2. Innovation capacity	
	a. Enterprises with research and development (R&D) activities in Taxonomy-eligible activities (share in enterprises in Taxonomy-eligible activities)
	b. Enterprises hampered in their innovation activities in Taxonomy-eligible activities due to lack of

	collaboration partners (share in enterprises in Taxonomy-eligible activities)
Outputs	
1. Intellectual Property Rights	
	a. Enterprises that applied for a patent in Taxonomy-eligible activities (share in enterprises in Taxonomy-eligible activities)
	b. Enterprises that applied for a trademark in Taxonomy-eligible activities (share in enterprises in Taxonomy-eligible activities)
	c. Enterprises that applied for an industrial design in Taxonomy-eligible activities (share in enterprises in Taxonomy-eligible activities)
2. Innovation Activity	
	a. Enterprises in Taxonomy-eligible activities collaborating on business activities with other enterprises or organisations (share in enterprises in Taxonomy-eligible activities)
	b. Turnover of innovative enterprises in Taxonomy-eligible activities (share in turnover of enterprises in Taxonomy-eligible activities)
	c. Companies in Taxonomy-eligible activities with product innovations (% of total enterprises in Taxonomy-eligible activities)
3. Entrepreneurial Activity	
	a. Enterprises created in Taxonomy-eligible activities (share in active enterprises in Taxonomy-eligible activities)
	b. Start-ups in existence 5+ years in Taxonomy-eligible activities (share in enterprises in Taxonomy-eligible activities)
4. Trade	
	a. Turnover of enterprises from new or significantly improved products in Taxonomy-eligible activities (share in turnover of enterprises in Taxonomy-eligible activities)
	b. Trade balance of products from Taxonomy-eligible activities (% GDP)
5. Employment	
	a. Employment in innovative enterprises in Taxonomy-eligible activities (% total employment in the economy)
Impacts within Economy/Productivity	
1. Wealth	

	a. Gross domestic product (GDP) per capita
	b. Taxonomy-eligible economy (% GDP)
	c. Taxonomy-aligned economy (% GDP)
2. Industrial structure	
	a. Early-stage private investment (Venture Capital) in clean technologies
	b. Late-stage private investment (Venture Capital) in clean technologies
	c. Economic Complexity Index
	d. Gross value added of manufacturing (% of GDP)
3. Jobs	
	a. Employment rate of population 20-64 (%)
	b. Average earnings (Household income)
	c. Labour market insecurity
Society / Fairness	
Framework conditions within Society/Fairness	
1. Education	
	a. Government expenditure in education per student (% of GDP per capita)
	b. Tertiary education attainment
	c. Lifelong learning
2. Basic needs	
	a. Unmet medical needs
	b. Insufficient food
3. Social mobility	
	a. Job opportunities
	b. Young people not in education, employment or training (NEET)
Impacts within Society/Fairness	
1. Inclusivity	

	a. Tolerance towards minorities
	b. Quality of support network
2. Equality	
	a. Gini coefficient of disposable income, post taxes and transfers (0-100)
	b. Gender employment gap
	c. Palma ratio
3. Health	
	a. Healthy life expectancy at birth (years)
	b. Self-reported health (Perceived health)
	c. Infant mortality rate
Governance / Stability	
Framework conditions within Governance/Stability	
1. Fundamental rights	
	a. Voice and accountability index
	b. Rule of law
	c. Freedom over life choices
2. Transparency	
	a. Control of Corruption
	b. Open Government and Transparency
	c. Freedom of Press Index
3. Institutional efficacy	
	a. Government Effectiveness
	b. Government Online Service Index
	c. Trust in the legal system
Impacts within Governance/Stability	
1. Sound governance	

	a. General government gross debt (% GDP)
	b. Trust in the national government
2. Citizen engagement	
	a. Active citizenship
	b. Volunteering
	c. Voter turnout
3. Security and Resilience to External Shocks	
	a. Energy imports dependency
	b. Circular material use rate
	c. Global Cybersecurity Index
	d. Security Apparatus
Green/Environment	
Framework conditions within Green/Environment	
1. Renewable Energies	
	a. Availability of wind resources
	b. Availability of solar resources
	c. Share of energy from renewable sources
2. Sustainability transition commitment	
	a. Effective Carbon Rates
	b. Percent of population perceiving climate change as a priority
	c. Fossil Fuel Subsidies
3. Natural resources	
	a. Renewable freshwater availability/capita
	b. Forest area (% of total land)
Impacts within Green/Environment	
1. Resource productivity	

	a. Material footprint (MF tonnes per capita)
	b. Water productivity (GDP/total fresh water abstraction)
	c. Energy productivity (GDP/gross inland energy consumption)
2. Climate Emissions	
	a. Greenhouse gas emission intensities (grams per euro)
3. Biodiversity	
	a. Terrestrial key biodiversity areas protected (%)
	b. Freshwater key biodiversity areas protected (%)
	c. Pesticides use per area of cropland (kg/ha)

II. Methodological issues related to the index

"As suggested in the relevant literature on composite indicators, the robustness assessment of the Competitive Sustainability Index was based on Monte Carlo simulation and multi-modelling approaches, applied to 'error-free' data where eventual errors and typos have already been corrected in a preliminary stage. In particular, the three key modelling issues considered in the assessment of the index were the treatment of missing data, the aggregation formula and weights at the sub-dimension and at dimension level.

Missing data

The Competitive Sustainability Index developers, for transparency and replicability and following common practice on composite indicator development, opted not to estimate missing data. Technically, the 'no imputation' choice is equivalent to replacing an indicator's missing value for a given country with the respective component score. Hence, the available data (indicators) in the incomplete component of competitive sustainability may dominate the results, sometimes biasing the ranks up or down. Furthermore, the 'no imputation' choice might encourage countries not to report low data values. To test the impact of the 'no imputation' choice, the JRC estimated missing values in the Competitive Sustainability dataset using the Expectation Maximization (EM) algorithm that was applied in the entire set of 84 indicators.

Aggregation

Regarding the aggregation formula, decision-theory practitioners challenge the use of simple arithmetic averages because of their fully compensatory nature, in which a comparative high advantage on a few indicators can compensate a comparative disadvantage on many

indicators.8 To assess the impact of this compensability issue, the strong perfect substitutability assumption inherent in the arithmetic average was relaxed in this analysis; instead the geometric average within each of the four dimensions and across them was considered as an alternative. Nevertheless, the arithmetic average has been maintained at the indicator level and component levels, where full compensability may be justifiable. The geometric average is a partially compensatory approach that rewards countries with balanced profiles, and motivates other countries to improve in the Competitive Sustainability sub-dimensions and dimensions in which they perform poorly, and not just in any Competitive Sustainability dimension.

Weights

While the term multi-modelling refers to testing alternative assumptions—that is, an alternative aggregation method, and missing data estimation method—the Monte Carlo simulation explored the issue of weighting and comprised 1,000 runs, each corresponding to a different set of weights for the 10 sub-dimensions and 4 dimensions, randomly sampled from uniform continuous distributions centred in the reference values (equal weighting within and across dimensions). The choice of the range for the weights' variation was driven by two opposite needs: to ensure a wide enough interval to have meaningful robustness checks, and to respect the rationale of the Competitive Sustainability Index that places equal importance on all sub-dimensions and dimensions. Given these considerations, limit values of uncertainty intervals for the sub-dimension and dimension weights are presented in Table 3. In all simulations, sampled weights are then rescaled so that they always sum to 1.

Four models were tested based on the combination of no imputation versus EM imputation at the indicator level, arithmetic versus geometric average at the sub-dimension and dimension levels.

Table 3.2 Uncertainty parameters in the Competitive Sustainability Index: missing values, weights, aggregation

Table 3. Uncertainty parameters in the Competitive Sustainability Index: missing values, weights, aggregation

		Reference	Alternative
I. Uncertainty in the treatment of missing values		No estimation of missing data	Expectation Maximization (EM)
II. Uncertainty in the aggregation formula at pillar level		Arithmetic average	Geometric average
IIIa. Uncertainty in the weights (within a dimension)			
Dimension	*Sub-dimension*	*Reference value for the weight*	*Distribution assigned for robustness analysis*
Economy/Productivity	Framework conditions	0.25	U[0.15, 0.35]
	Innovation enablers	0.25	U[0.15, 0.35]
	Outputs	0.25	U[0.15, 0.35]
	Impacts	0.25	U[0.15, 0.35]
Society/Fairness	Framework conditions	0.50	U[0.40, 0.60]
	Impacts	0.50	U[0.40, 0.60]
Governance/Stability	Framework conditions	0.50	U[0.40, 0.60]
	Impacts	0.50	U[0.40, 0.60]
Green/Environment	Framework conditions	0.50	U[0.40, 0.60]
	Impacts	0.50	U[0.40, 0.60]
IIIb. Uncertainty in the weights (when calculating the index)			
		Reference value for the weight	*Distribution assigned for robustness analysis*
Economy/Productivity		0.25	U[0.15, 0.35]
Society/Fairness		0.25	U[0.15, 0.35]
Governance/Stability		0.25	U[0.15, 0.35]
Green/Environment		0.25	U[0.15, 0.35]

Source: European Commission's Joint Research Centre (2022)

Combined with 1,000 simulations per model (random weights versus fixed weights), a total of 4,000 simulations for the Competitive Sustainability Index were run.

For full transparency and information, the main results of the robustness analysis are shown in Figure 4 with median ranks and the 90% confidence intervals computed across the 4,000 Monte Carlo simulations for the Competitive Sustainability Index and its four dimensions. EU Member States are ordered from higher to lower performance according to their reference rank (black line), the dot being the median rank over the simulations.

All published Competitive Sustainability Index ranks lay within the simulated 90% confidence intervals, and for all EU Member States these ranks can be considered as representative of the plurality of scenarios simulated herein. Taking the median rank as the yardstick for a country's expected rank in the realm of the unavoidable methodological uncertainties, almost all EU Member States are found to shift 1 position or no shift with respect to the median rank in the Competitive Sustainability Index (with the exception of Cyprus that shifts 2 positions compared to the median rank in the simulations). Furthermore, for 25 of the 27 EU Member States the

simulated rank intervals are narrow enough for meaningful inferences to be drawn. For these countries, there are fewer than 4 positions shift. Yet, two countries experience significant changes in rank with variations in weights and aggregation formula and because of the estimation of missing data. These two countries – Cyprus and Malta – have 90 percent confidence interval widths around 7-8 positions. Consequently, their Competitive Sustainability Index ranks – at the 18th position for Cyprus and 21st for Malta – should be interpreted cautiously and certainly not taken at face value. The uncertainty analysis results for the four dimensions of competitive sustainability are also reassuring. For most countries, there are fewer than 4 positions shift across all four dimensions of competitive sustainability, except for Malta (6 positions in the Governance/Stability dimension), and Italy and Croatia (6 and 5 positions, respectively, in the Green/Environment dimension).

Next, the impact of not estimating missing values in the Competitive Sustainability Index is analysed in more detail. The 2015-2021 dataset has very good coverage: 94.7% data available across the 27 EU Member States and 84 indicators. It is reassuring that none of the 5.3% missing values (120 missing data points) are found to have a strong impact either on the Competitive Sustainability Index ranks or any of its dimensions. In all cases, the imputed values by the JRC (using the EM algorithm, as described earlier) result in shifts in country ranks up to 3 positions (for Croatia in the Society/Fairness dimension) and 4 positions (for Slovakia in the Green/Environment dimension).

Concluding, the Competitive Sustainability Index ranks (and those of the four dimensions) are reliable and for all EU Member States the simulated 90% confidence intervals are narrow enough for meaningful inferences to be drawn. Some caution is only needed when interpreting the performance of Cyprus and Malta in the overall Competitive Sustainability Index, of Malta in the Governance/Stability dimension, and of Italy and Croatia in the Green/Environment dimension because of a relatively higher impact of the uncertainty assumptions.

For the readers and policy analysts of the Competitive Sustainability Index report, the recommendation is to consider country ranks for the overall index and its four dimensions within the 90% confidence intervals in order to better appreciate to what degree an EU Member State's rank depends on the three key modelling choices accounted for, namely the estimation of missing data, weights and aggregation formula (at the sub-dimension and dimension level)." (pp. 10-15, JRC Statistical Audit. For more charts and tables, see the JRC report)

Key findings of JRC Statistical Audit

Concluding, the Competitive Sustainability Index ranks (and those of the four dimensions) are reliable and for all EU Member States the simulated 90% confidence intervals are narrow enough for meaningful inferences to be drawn. Some caution is only needed when interpreting the performance of Cyprus and Malta in the overall Competitive Sustainability Index, of Malta in the Governance/Stability dimension, and of Italy and Croatia in the Green/Environment dimension because of a relatively higher impact of the uncertainty assumptions.

For the readers and policy analysts of the Competitive Sustainability Index report, the recommendation is to consider country ranks for the overall index and its four dimensions within the 90% confidence intervals in order to better appreciate to what degree an EU Member State's rank depends on the three key modelling choices accounted for, namely the estimation of missing data, weights and aggregation formula (at the sub-dimension and dimension level)."

The key findings of the JRC's statistical assessment of the Competitive Sustainability Index can be summarised as follows:

1 Competitive Sustainability Index: A statistically coherent monitoring framework

The analysis of the correlation structure finds the conceptual grouping of the 84 indicators into 31 components, 10 sub-dimensions, 4 dimensions and one overall index, largely justifiable from a statistical point. It also shows that the overall Competitive Sustainability Index, which is the average of four key dimensions measuring Economy/Productivity, Society/Fairness, Governance/Stability, and Green/Environment is unidimensional and has high statistical reliability (Cronbach alpha 0.84) well above the recommended threshold (0.7) for a reliable aggregate. The vast majority of the 31 components in the Competitive Sustainability framework are also found to be influential all the way up to the index level.

2 Some competitive sustainability components to be kept under the spotlight

Eight of the 31 components are found to have a transversal impact across three dimensions of Competitive sustainability. Although assigned to one dimension in the conceptual framework, these eight components – Innovation readiness, Human capital, Education, Social Mobility, Fundamental rights, Transparency, Institutional efficacy, and Citizen engagement – are found to correlate strongly to the dimensions capturing Economy/Productivity, Society/Fairness, and Governance/Stability. Consequently, they are also found to be the best predictors for a country's competitive sustainability in the European Union.

Three components of competitive sustainability do not correlate significantly either with the respective dimension, or with the overall index. These are Entrepreneurial activity (within Economy/Productivity), and Resource productivity and Biodiversity (within Green/Environment). This means that EU Member States may achieve high Competitive Sustainability scores despite poor performance in Entrepreneurial activity, Resource productivity, and Biodiversity. On one hand, the poor correlation between Entrepreneurial activity and the Competitive Sustainability Index may be attributed to the calculation of the indicators underlying Entrepreneurial activity. The JRC recommendation to the developing team is to consider whether a different formulation or different data sources for these indicators may be more appropriate. On the other hand, the poor correlation between Resource productivity and Biodiversity (and to some extent also Renewable energies, and Natural resources) with the overall Competitive Sustainability Index is more worrisome, yet not surprising. This finding, which is in line with relevant scientific

literature, evidences that up until 2021 there has not been sufficient integration of environmental priorities into EU Member States' growth and competitiveness plans.

3 Negligible impact of missing data on shifts in the Competitive Sustainability rankings

The Competitive Sustainability dataset has very good data coverage: 94.7% of the data available in 2015-2021 across 84 indicators and 27 EU Member States. Uncertainty and sensitivity analysis have shown that none of the 5.3% missing values (120 missing data points) are found to have a strong impact either on the Competitive Sustainability Index ranks or any of its dimensions. In all cases, the statistical estimates for the missing values result in shifts in country ranks up to 3 positions (for Croatia in the Society/Fairness dimension) and 4 positions (for Slovakia in the Green/Environment dimension).

4 The Competitive Sustainability Index allows to reliably benchmark national competitive sustainability in the vast majority of the EU Member States

Compared to the reference Competitive Sustainability rank, 25 of the 27 EU Member States are found to have simulated rank intervals less than 4 positions wide over 4,000 simulations. Some caution is needed for two countries – Cyprus and Malta – that have confidence interval widths around 7-8 positions, and their index ranks should thereafter not be taken at face value. The uncertainty analysis results for the four dimensions of competitive sustainability are also reassuring. For most countries, there are fewer than 4 positions shift across all four dimensions of competitive sustainability, except for Malta (6 positions in the Governance/Stability dimension), and Italy and Croatia (6 and 5 positions, respectively, in the Green/Environment dimension). Thereafter, the Competitive Sustainability Index and its four dimensions allow to reliably benchmark competitive sustainability at national level in the vast majority of the EU Member States.

5 The Competitive Sustainability Index offers new insights on EU Member States competitive sustainability, while at the same time receives external statistical validity

Last but not least, there is an added value in referring to the Competitive Sustainability Index results in order to identify aspects of EU competitive sustainability that do not directly emerge by looking into the four dimensions separately. In fact, the Competitive Sustainability Index ranking and any of the four dimension rankings differ by 4 positions or more for at least 11% up to 52% of the 27 EU Member States.

Also, the external statistical validity testing of the Competitive Sustainability Index confirms the high degree of association (correlation ≈ 0.8 to 0.9) to the latest releases of four relevant international indices: the IMD World Global Competitiveness Ranking, the Cornell University, INSEAD, and WIPO's Global Innovation Index, the European House Ambrosetti's Global Attractiveness Index, and the INSEAD's Global Talent Competitiveness Index. At the same time, one finds that 30% up to 59% of the EU Member States that feature in these four international indices differ in ranking by more than 4 positions when comparing the Competitive Sustainability Index with the recent releases of these international indices. This latter finding means that the Competitive Sustainability

Index offers additional insights into national competitive sustainability across the EU that complement and go beyond the findings of other international indices.

6 The JRC audit confirms that the Competitive Sustainability Index sufficiently meets international quality standards for statistical soundness

Overall, the JRC audit confirms that the Competitive Sustainability Index sufficiently meets international quality standards for statistical soundness. Consequently, the Competitive Sustainability Index by the Cambridge Institute for Sustainability Leadership offers a sound starting point for more informed discussions on national competitive sustainability in the EU. Academics and policy analysts should also check the Competitive Sustainability Index results beyond the index scores (and ranks) as the 84 indicators, 31 components, 10 sub-dimensions and four dimensions can offer more in-depth insights on the areas to be more carefully addressed for policy action.

The Competitive Sustainability Index represents a well-designed operational indicator framework that can help to stimulate public interest and help focus policy discussions on the multiple aspects that shape a country's competitive sustainability. Still, the Competitive Sustainability Index, as any other indicator framework aimed at capturing a complex, multidimensional and evolving reality, needs to remain open to improvement. The Competitive Sustainability Index developers intend to keep improving the indicator framework in line with the theoretical advancement in the field and the availability of new (and relevant) data. (Saisana et al. 2022, pp. 2-9.)

References

Saisana, M., Caperna, G., Moura, C., Neves, A.R. and Papadimitriou, E. (2022). JRC Statistical Audit of the Competitive Sustainability Index 2022, EUR 31320 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-59141-2, doi:10.2760/426908, JRC131560.

https://publications.jrc.ec.europa.eu/repository/handle/JRC131560

Competitive Sustainability Index Interactive Tool (access after registration on the website, downloading the full dataset is possible)

4. Genuine Progress Indicator

The Genuine Progress Indicator (GPI), as well as its predecessor the Index of Sustainable Welfare (ISEW), were developed as alternative indicators of national progress. The GPI is calculated by adding-up the benefits and deducting the costs of economic, environmental and social externalities. It is usually compared to the GDP to identify whether additional economic growth, as measured by GDP, has actually been beneficial for people's well- being.

The Genuine Progress Indicator (GPI) is a version of the Index of Sustainable Economic Welfare (ISEW) first proposed in 1989. GPI starts with personal consumption expenditures (a major component of GDP), but adjusts it using about 25 different components, including income distribution, environmental costs, loss of leisure time, cost of family breakdown, cost of unemployment, negative activities like crime and pollution, and others. GPI also adds positive components left out of GDP, including the benefits of volunteering and household work. By separating activities that diminish welfare from those that enhance it, GPI better approximates sustainable economic welfare. GPI is not meant to be an indicator of sustainability. It is a measure of economic welfare that needs to be viewed alongside biophysical and other indicators. In the end, since one only knows if a system is sustainable after the fact, there can be no direct indicators of sustainability, only predictors.

GPI starts with Personal Consumption Expenditures (a major component of GDP) but adjusts them using 24 different components, including income distribution, environmental costs, and negative activities like crime and pollution, among others. GPI also adds positive components left out of GDP, including the benefits of volunteering and household work (Talberth et al., 2007). By separating activities that diminish welfare from those that enhance it, GPI better approximates sustainable economic welfare (Posner and Costanza, 2011).

GPI has been calculated for several countries and regions. GPI estimates are often limited by the lack of appropriate social and environmental data compiled by national statistical agencies (Kubiszewski et al 2013).

I. Information on individual indicators

There are methodological differences estimating GPI. "Many GPI studies used the Gini coefficient to estimate the inequality index. The U.K. and Swedish studies used the Atkinson index directly to estimate welfare loss. Some studies count cumulative GHG emission damage; others do not." (p. 59, Kubiszewski et al 2013).

Table 4.1: Indicators and data sources in recent estimates for Australia

GPI Indicators	Method (Calculations / Estimations)	Reference for method	Data source
Personal Consumption Expenditures (PCE) +	ABS: 5206.0 - Australian National Accounts: National Income: TABLE 8 - Household Final Consumption Expenditure (HFCE): A2303280V	(Lawn, 2013; Bagstad et al., 2014)	(ABSa, 2021)
Income Distribution Index (INI) -	INI (2020) = G1/G0 G1: Gini (2020); G0:Base year Gini derived from What-if-Analysis (Goal-Seek) of Gini series.	INI (Lawn, 2003)	Gini series (1967–2013) (Kenny et al., 2019) Gini series (2014–2020) (ABSb, 2022)
Adjusted Personal Consumption (APCE) +	APCE = (PCE Services of Consumer Durables + Cost of Consumer Durables + Cost of Commuting + Cost of Motor Vehicle Crashes) / INI	(Lawn, 2013; Bagstad et al., 2014)	Table 1
Value from Services of Consumer Durables	ABS: 5232.0 - Australian National Accounts: Finance…: TABLE 36 - Analytical Measures of Household Income, Consumption…	(Lawn, 2013)	(ABSc, 2020)
Cost of Consumer Durables -	ABS: 5232.0 - Australian National Accounts: Finance…: TABLE 36 - Analytical Measures of Household Income, Consumption…	(Lawn, 2013)	(ABSc, 2020)
Cost of Unemployment -	ABS: 6202.0 - Labour Force, Australia…: Total Hours worked in Q1,2 of 2020 minus those of 2019 × Average hourly wage ($) (2019: considered base year, with $0 cost)	(Kenny et al., 2019; Lawn, 2013)	(Labour Force, 2020)
Value from Net Capital Investment (NCI) +	ABS: 5232.0 - Australian National Accounts: Finance…: Total Capital Formation in Q1 2019 minus that of 2020;	(Lawn, 2013)	(ABSd, 2020)
Cost of Air Pollution -	PM2.5 (tonnes) × $ cost of PM2.5 per tonne (at an urban density of people/klm2)	(O'Mahony et al., 2018a)	(Kenny et al., 2019; NPI, 2020; EPA, n.d., 2013)
Cost of Climate Change -	[Australia CO2 emissions in Megatonnes in Q1,2 of 2019 minus those in 2020] x $ Cost of C02 per metric tonne	(O'Mahony et al., 2018b)	(Department of Industry, 2020)
Cost of Net Farmland Change -	[National Agricultural Land Area (ha) in 2020 x Average value of 1 ha of agricultural land] minus the value in 2019	(Kenny et al., 2019)	(Agricultural Commodities, 2020; Rabobank. n.d., 2020)
Cost of Nonrenewable Energy Resource Depletion -	Requires estimation of $ cost for preventing the depletion of non-RES via use of RES: N/A for the COVID lockdown period	(Kenny et al., 2019)	(Teske, 2016)
Cost of Ozone Depletion -	Requires Australia CFC emissions impact from COVID: N/A × Average $ cost per tonne of CFC emissions associated to radiation levels of depleted ozone layer	(Kenny et al., 2019)	(Kenny, 2019; Lickley et al., 2020)
Cost of Crime -	$ Cost est. per type of crime in Australia for 2020 vs 2019: N/A	(Kenny et al., 2019)	(Kenny et al., 2019; ACIC, 2020) and sources in Appendix A supp. document.
Value of Leisure Time +	Based on ABS time classification [24 h - (Sleep & Hygiene Hours - Paid Work hours - Unpaid Household work hours - Commuting hours) in Q1,2 of 2020 minus those of 2019] × $ WTA hourly rate (daily est.)	(Kenny et al., 2019)	(ABS, 2006; Labour Force, 2020)
Value of Household work +	Proportionate Estimation: Total ($) value of unpaid housework for 2019 × Total hours of housework per day (in COVID)/ Total hours of housework per day (in 2016)	(PWC, 2017)	(Craig and Churchill, 2021)
Cost of Family Changes -	N/A	N/A	N/A
Value of Volunteer Work +	Volunteer work hours lost during COVID × average hourly wage ($)	(Clarke and Lawn, 2008)	(Volunteering Australia, n.d., 2018; Update on National Volunteer Week, 2020)
Cost of Motor Vehicle Crashes -	# of car crash related fatalities per Q1,2 in 2019 minus those of 2020 × average $ cost of a car crash fatality	(Kenny et al., 2019)	(BITRE, 2020; AAA, 2017)
Cost of Commuting -	Estimation: Cost of (using public transportation + car purchase & maintenance & operation + time lost commuting to work) Statistical error est.: 1% to 10%	(Clarke and Lawn, 2008)	(Australian Institute of Family Studies, 2020)(ABSe, 2017) (FCAI, 2020) (AAA, 2017) (BITRE, 2019)ABSc, 2020 (Morgan, 2020) (Denby, 2019) (ABSc, 2020)
Value of Higher Education +	Value of education in 2019 (annual revenues) minus Value of Education in 2020 (estimated revenues minus losses from drop in international student enrollments)	(Kenny et al., 2019)	(Victoria University Australia, 2020)

Source: Karatopouzis et al. (2022).

In their paper for the EU15, Van der Slycken and Bleys (2021) calculate two EWM – the benefits and costs experienced (BCE) and the benefits and costs of present economic activities (BCPA):

BCE = UW + Ci + S + Gc – DIREp – INQ – NEC (1)

BCPA = UW + Ci + S + Gc – DIREp – INQ – BEC + ΔK (2)

In Eqs. 1 and 2: UW = unpaid work, Ci = individual consumption, S = shadow economy, Gc = non-defensive collective government consumption, DIREp = defensive, intermediate and rehabilitative private expenditures, INQ = welfare losses from income inequality, NEC = narrow ecological costs that are experienced in the present and within domestic borders, BEC = broad ecological costs, including current costs within domestic and the costs shifted in time and space, ΔK = capital

adjustment. UW, Ci, S, Gc are valued positively; INQ, DIREp, NEC and BEC are deducted, whereas ΔK can be either positive or negative.

Both EWM differ because they are based on two distinct welfare interpretations that are inspired by the income concepts of Fisher and Hicks – without being approximations of these income notions (Van der Slycken and Bleys, 2020).

Table 4.2: Indicators in a comparative study across the EU-15 from 1995 to 2018

	Items (category)	**Method of calculation and additional information**
A	Unpaid work (UW)	Total hours of unpaid work x market wages
		Unpaid work covers routine housework, shopping, care for household members, care for non-household members, volunteering, travel related to household activities and other unpaid work and is valued using the replacement cost method to find a market substitute.
B	Actual individual consumption (+) (Ci)	B is the sum of the individual consumption expenditures by households and the individual consumption expenditures made by Non-Profit Institutions Serving Households and government.
C	Defensive, intermediate and rehabilitative private expenditures (-) (DIREp)	C involves subtracting the following from B: 25% of food and alcohol expenditures, 100% of tobacco and narcotics expenditures, 100% of insurance and financial services expenditures and the cost of road accidents. The latter is calculated by using direct and indirect costs estimates for fatalities and injuries in road accidents.
		Defensive expenditures such as insurance expenditures are deducted because they merely serve to defend oneself from the unwanted effects of other economic activities. Intermediate expenditures such as financial services are deducted too, because they are not ultimate consumption. Financial services are at best an intermediate means to final consumption but are by themselves not the ultimate end of economic activity. Rehabilitative expenses after a car accident, for instance, are undertaken to restore to previous, more healthy conditions and are deducted because they are to be seen as costs, not benefits.
D	Cost of consumer durables (-) (Ci)	Current expenditures on durable consumer goods are subtracted.

E	Services of consumer durables (+) (Ci)	Σ previous 8 years' consumer durables expenditures x 0,2
		The services are equal to the depreciation and an imputed interest value of the stock of consumer durables.
F	F Shadow economy (+) (S)	F approximates the value of the shadow economy. Only 50% is included as welfare-enhancing, to exclude illegal activities and avoid double counting with actual individual consumption and unpaid work.
G	Net consumption	Actual individual consumption – defensive, intermediate and rehabilitative private expenditures – cost of consumer durables + services of consumer durables + shadow economy (B-C-D+E+F)
H	Welfare losses from income inequality (-) (INQ)	Inequality adjustment index x net consumption H uses an inequality adjustment index that is based on the diminishing marginal utility of income and normalizes the correction at a sufficiency threshold.
I	Non-defensive government expenditures (+) (Gc)	100% of government expenditures on general public services, housing and community amenities and recreation, culture and religion are included.
J	Cost of air pollution (-) (NEC & BEC)	J is calculated by multiplying annual emissions with cost estimates.
		J compiled from a within border (i.e. production) view captures the costs related to the following pollutants PM 2,5, NOx, NH3, SO2 and NMVOC. It is assumed the direct disamenity cost of air pollution in the narrow ecological costs is equal to 20% of this within border cost. In the broader perspective on air pollution, the costs of air pollution embodied in trade from the pollutants PM 2,5 fossil, PM 2,5 bio, NOx, NH3 and SO2 are added to the within border costs.

K	Ecosystem costs of nitrogen pollution (-) (NEC & BEC)	K is calculated by linking cost estimates to annual emissions of NO2 and NH3 and with the use of inorganic fertilizer. The cost estimates for NO2 and NH3 only cover ecosystem costs in order to avoid double counting of health costs, which are already registered in the costs of air pollution. The ecosystem cost for reactive nitrogen measures the run-off from agricultural sources to rivers and seas. This item is included in both NEC and BEC, as it reflects current ecosystem costs within domestic borders.
L	Cost of climate breakdown (-) (BEC)	L captures the damages related to climate breakdown and is calculated by multiplying a time-varying marginal social cost by the amount of greenhouse gas emissions. The emissions included are domestic emissions, CO2-emissions embodied in trade, emissions from international navigation and aviation, domestic LULUCF-emissions, the emissions related to global land use changes, and biomass emissions. L is forward looking and looking beyond borders. It is only included in the broad ecological costs.
M	Cost of extreme weather events (-) (NEC)	M is equal to the total amount of uninsured losses as insurance (subtracted as defensive expenditures) helps to 'reduce' the costs from extreme weather events. M covers uninsured losses to approximate the damages suffered in the present from extreme weather events for the narrow ecological costs.
N	Depletion of non-renewable energy resources (-) (BEC)	N is calculated by multiplying the primary energy consumption by a transition cost that is needed to replace non-renewable resources and achieve an energy efficiency target of 33% by 2030. N is only included in the broad ecological costs. Using non-renewable energy resources means that resource stocks are being depleted. This item tries to proxy this depletion by using transition costs to replace non-renewable energy resources with a renewable substitute.
O	Costs of use of nuclear power (-) (BEC)	O is calculated by multiplying the amount of nuclear electricity generated by a cost estimate from the German welfare study. O is forward looking and only fits in the broad ecological costs.
P	Net capital growth (+) (ΔK)	P is calculated by taking the difference between this year's and previous year's net capital stock. P only fits in BCPA as net capital growth is seen as a benefit (or cost if negative) of present economic activities.

Source: Van der Slycken and Bleys (2020).

Data source and timeliness

Data years: 1950-2022 (varies depending on country and authors)

Most recent calculation for EU15: 1995-2018 (published in 2021, by Jonas Van der Slycken, Brent Bleys). *The working paper does not include information on data sources, as the Appendix is missing from the published version.*

II. Methodological issues related to the index

Methodological issues vary, as the index was calculated by many different authors and institutes. In the recent paper for Australia, Karatopouzis et al. (2022) note:

> "The (...) mix of GPI indices are in accordance with GPI 1.0 (Posner and Costanza, 2011) to maintain some consistency with one of the last Australian GPI estimates (Kenny et al., 2019). However, 5 of the GPI 1.0 components (including the costs of noise pollution, net wetland change, personal pollution abatement, net forest coverage changes and services of highways and streets) were excluded from the estimation, due to inadequate data (Fig. 2).
>
> Any variations from the valuation methods of previous GPI studies are a result of insufficient data or due to different perspectives in valuation principles. To compensate for this data inadequacy, we made assumptions that allow us to extrapolate or interpolate data, as needed.
>
> For example, we used the results of a survey (Craig and Churchill, 2021) on daily household-work-hours that involve only 3 weeks of the total 54 day national lockdown period that lasted from 23 April (ABSf, 2020) to 15 May (NSW, 2020), but we assume that their findings stay valid for the entire 54 days of Australia's first nationwide lockdown period. Additionally, for the valuation of leisure time we introduce a 'best case' scenario (Scenario 1) with an upper limit to its value equal to $23.83 WTA and a 'worst case' scenario (Scenario 2) with a lower limit to its value equal to ($0) zero." (Karatopouzis et al., 2022, p. 2).

References

Karatopouzis, A., A. A Voinov, I, Kubiszewski, F. Taghikhah, R. Costanza, and D. Kenny (2022). Estimating the Genuine Progress Indicator (GPI) before and during the COVID pandemic in Australia. *Ecological Indicators* 141: 109025

Kubiszewski, I., R. Costanza, C. Franco, P. Lawn, J. Talberth, T. Jackson, and C. Aylmer. (2013). Beyond GDP: Measuring and Achieving Global Genuine Progress. *Ecological Economics* 93:57-68.

Van der Slycken, Jonas, Brent Bleys (2021). TOWARDS ISEW AND GPI 2.0, PART II: IS EUROPE FARING WELL WITH GROWTH? EVIDENCE FROM A WELFARE COMPARISON IN THE EU-15 FROM 1995 TO 2018. Ghent University, Department of Economics. WORKING PAPER 2021/1027. https://wps-feb.ugent.be/Papers/wp_21_1027.pdf

Further literature

A.J. Brennan. (2008) Theoretical foundations of sustainable economic welfare indicators—ISEW and political economy of the disembedded system. Ecological Economics . 67(1): 1-19.

Costanza, R. J. Erickson, K. Fligger, A. Adams, C. Adams, B. Altschuler, S. Balter, B. Fisher, J. Hike, J. Kelly, T. Kerr, M. McCauley, K. Montone, M. Rauch, K. Schmiedeskamp, D. Saxton, L. Sparacino, W. Tusinski, and L. Williams. (2004). Estimates of the Genuine Progress Indicator (GPI) for Vermont, Chittenden County, and Burlington, from 1950 to 2000. *Ecological Economics* 51: 139-155.

Daly, H. & Cobb, J., (1989, 1994). For the Common Good. Beacon Press, Boston.

Kenny, D.C., R. Costanza, T. Dowsley, N. Jackson, J. Josol, I. Kubiszewski, H. Narulla, S. Sese, A. Sutanto, & J. Thompson. (2019). Australia's Genuine Progress Indicator Revisited (1962-2013) *Ecological Economics* 158:1-10

Kubiszewski, I., R. Costanza, N. E. Gorko, M. A. Weisdorf, A. W. Carnes, C. E. Collins, C. Franco, L. R. Gehres, J. M. Knobloch, G. E. Matson, and J. D. Schoepfer. (2015). Estimates of the Genuine Progress Indicator (GPI) for Oregon from 1960-2010 and Recommendations for a Comprehensive Shareholder's Report. *Ecological Economics* 119:1-7.

Kubiszewski, I., R. Costanza, C. Franco, P. Lawn, J. Talberth, T. Jackson, and C. Aylmer. 2013. Beyond GDP: Measuring and Achieving Global Genuine Progress. *Ecological Economics* 93:57-68.

Lawn, Philip A. (2003). "A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes". Ecological Economics. 44 (1): 105–118. doi:10.1016/S0921-8009(02)00258-6

J. Talberth et al. The Genuine Progress Indicator (2006): A Tool for Sustainable Development (2007) https://leeds-faculty.colorado.edu/Rosse/Courses/4003/Readings/GPI_Report.pdf

S.M. Posner et al. A summary of ISEW and GPI studies at multiple scales and new estimates for Baltimore City, Baltimore County, and the State of Maryland Ecological Economics (2011)

5. Green Growth Index

Green Growth Index measures country performance in achieving sustainability targets including Sustainable Development Goals, Paris Climate Agreement, and Aichi Biodiversity Targets for four green growth dimensions – efficient and sustainable resource use, natural capital protection, green economic opportunities and social inclusion. Recent reports are published by the Global Green Growth Institute (Seoul), and authored by Lilibeth A. Acosta (lead author) and a larger group of international scholars.

The four dimensions of green growth are closely interlinked, argues Acosta et al (2019, p. 4). Efficient and sustainable resource use entails more productive use of natural resources and more cumulative economic value with less resources and without endangering needs of future generations. It focuses on physical resources, such as water, energy, land, and materials but also on ecosystem services. These are natural capital, which consists of living and nonliving components of ecosystems that people use to produce goods and services. Natural capital provides basic conditions, such as fertile soil, multifunctional forests, productive land and seas, good quality freshwater and clean air, and pollination. Without natural capital protection, these conditions that support ecosystem services are at risk. Green growth emphasizes the role of natural capital in generating new sources of growth and expanding economic opportunities in the form of green investment and jobs, among other opportunities. This new model of growth focuses on people, where social inclusion becomes a key mechanism to ensuring people's contribution to, sustaining opportunities, and distributing benefits from economic growth.

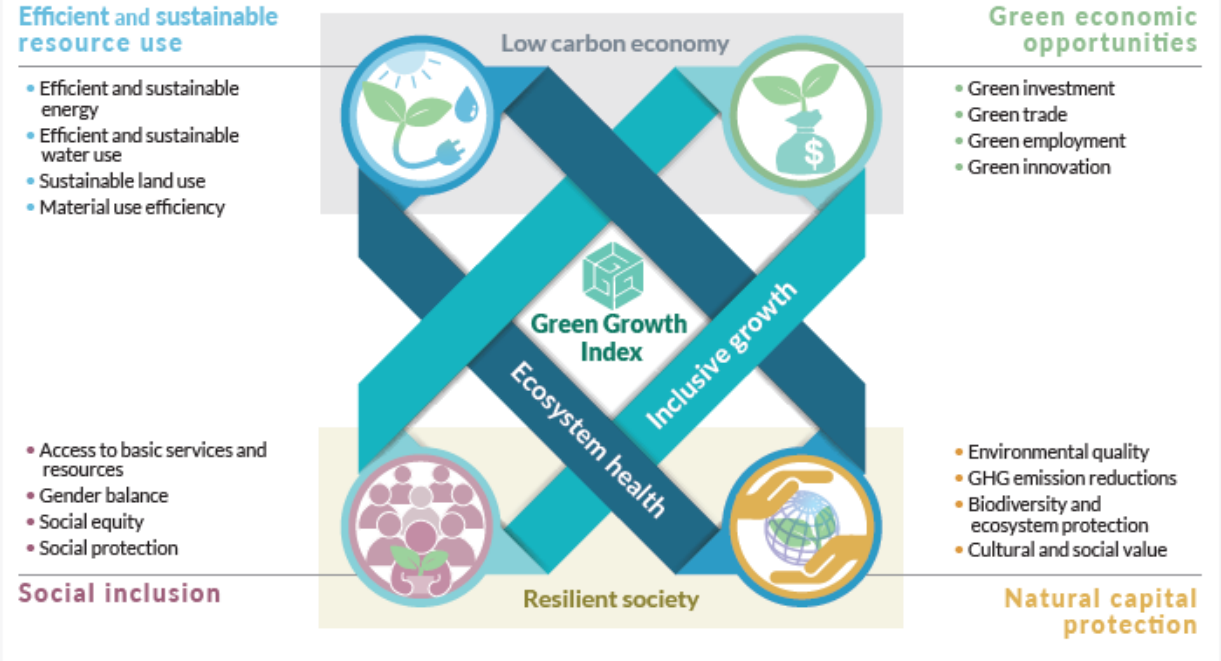
I. Information on individual indicators

Figure 1 Indicator Framework for the Green Growth Index

	Dimensions [Goals]	Indicator categories [Pillars]		Indicators [metrics]
Green Growth Index	Efficient and sustainable resource use	Efficient and sustainable energy	EE1	Ratio of total primary energy supply to GDP (MJ per $2011 PPP GDP)
			EE2	Share of renewables to total final energy consumption (Percent)
		Efficient and sustainable water use	EW1	Water use efficiency (USD per m^3)
			EW2	Share of freshwater withdrawal to available freshwater resources (Percent)
		Sustainable land use	SL1	Average soil organic carbon content (Tons per hectare)
			SL2	Share of organic agriculture to total agricultural land area (Percent)
		Material use efficiency	ME1	Total domestic material consumption (DMC) per unit of GDP (DMC kg per GDP)
			ME2	Total material footprint (MF) per capita (MF tons per capita)
	Natural capital protection	Environmental quality	EQ1	PM2.5 air pollution, mean annual population-weighted exposure (Micrograms per m^3)
			EQ2	DALY rate as affected by unsafe water sources (DALY lost per 100,000 persons)
			EQ3	Municipal solid waste (MSW) generation per capita (Tons per year per capita)
		Greenhouse gas emissions reductions	GE1	Ratio of CO_2 emissions, excluding AFOLU to population (Metric tons per capita)
			GE2	Ratio of non-CO_2 emissions excluding AFOLU to population (Tons per capita)
			GE3	Ratio of non-CO_2 emissions in agriculture to population (Gigagrams per 1,000 persons)
		Biodiversity and ecosystem protection	BE1	Average proportion of Key Biodiversity Areas covered by protected areas (Percent)
			BE2	Share of forest area to total land area (Percent)
			BE3	Soil biodiversity, potential level of diversity living in soils (Index)
		Cultural and social value	CV1	Red list index (Index)
			CV2	Tourism and recreation in coastal and marine areas (Score)
			CV3	Share of terrestrial and marine protected areas to total territorial areas (Percent)
	Green economic opportunities	Green investment	GV1	Adjusted net savings, minus natural resources and pollution damages (Percent GNI)
		Green trade	GT1	Share of export of environmental goods (OECD and APEC class.) to total export (Percent)
		Green employment	GJ1	Share of green employment in total manufacturing employment (Percent)
		Green innovation	GN1	Share of patent publications in environmental technology to total patents (Percent)
	Social inclusion	Access to basic services and resources	AB1	Population with access to safely managed water and sanitation (Percent)
			AB2	Population with access to electricity and clean fuels/technology (Percent)
			AB3	Fixed Internet broadband and mobile cellular subscriptions (Number per 100 people)
		Gender balance	GB1	Proportion of seats held by women in national parliaments (Percent)
			GB2	Ratio of female to male with account in financial institution, age 15+ (Percent)
			GB3	Getting paid, covering laws and regulations for equal gender pay (Score)
		Social equity	SE1	Inequality in income based on Atkinson (Index)
			SE2	Ratio of urban to rural, access to safely managed water/sanitation and electricity (Percent)
			SE3	Share of youth not in education, employment or training, aged 15-24 years (Percent)
		Social protection	SP1	Proportion of population above statutory pensionable age receiving pension (Percent)
			SP2	Healthcare access and quality index (Index)
			SP3	Proportion of urban population living in slums (Percent)

Source: Acosta et al. (2019), p. 4

Figure 8 Conceptual framework for the Green Growth Index



Source: Acosta et al. (2019), p. 22.

Table 5.1: Definitions of the dimensions / indicator categories

1. **Efficient and sustainable energy** refers to delivering more services or products per unit of energy used and meeting present needs by using renewable sources to ensure sustainability of energy for future use. (IRENA and C2E2, 2015; Kutscher, Milford, & Keith, 2018).
2. **Efficient and sustainable water use** refers to delivering more services or products per unit of water used, reducing environmental impact resulting from water scarcity and pollution, and improving water allocation among competing uses. (UNEP, 2014b; Wang, Yang, Deng, & Lan, 2015).
3. **Sustainable land use** refers to delivering more services or products for a fixed amount of land used and without compromising many ecosystem services provided by land. (Auzins, Geipele, & Geipele, 2014; Smith, 2018).
4. **Material use efficiency** refers to delivering more services or products per unit of raw material used and reducing material demand through increased recycling, longer-lasting products, and component re-use, among others. (Allwood, Ashby, Gutowski, & Worrell, 2011; Lifset & Eckelman, 2013).
5. **Environmental quality** refers to properties and characteristics of the environment which may affect the health of human beings and other organisms, including air, water and noise pollution, access to open space, and visual impacts of buildings. (EEA, 2015, 2017).
6.**Greenhouse gas (GHG) emission reduction** refers to the reduction and removal of CO2 and non-CO2 emissions from the atmosphere in order to address climate change. (IPCC, 2013; Symon, 2013).

7. **Biodiversity and ecosystem protection** refers to the protection of species, habitats, and ecosystems as well as the services they provide, with protected areas as an important measure to achieve biodiversity conservation. (UNEP-WCMC and IUCN, 2016; IPBES, 2018)
8.**Cultural and social value** refers to the societal value given to natural capital due to its importance to communities and their local culture which encourages sustainable use and protection of natural resources. (Small, Munday, & Durance, 2017; Rocha, Almassy, & Pinter, 2017).
9. **Green investment** refers to public and private investment that promotes in a direct or indirect manner sustainable resource use, including material, water, energy, and land, and natural capital protection, such as environmental protection and climate action, advancing sustainable development and green growth. (Eyraud, Zhang, Wane, & Clements, 2011; Obradović, 2019).
10. **Green trade** refers to the competitiveness of a country to produce and export environmental goods that can contribute to environmental protection, climate action, green growth, and sustainable development. (PAGE, 2017a; European Parliament, 2019).
11.**Green employment** refers to employment created and sustained by economic activities that are more environmentally sustainable; contribute to protecting the environment and reduce people's environmental footprint; and offer decent working conditions. (UNEP, ILO, IOE, & ITUC, 2008; ILO, 2015).
12. **Green innovation** refers to product, process, and service innovations, such as energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management that yields environmental benefits. (Schiederig, Tietze, & Herstatt, 2011; Gao et al., 2018).
13. **Access to basic services** refers to the general availability of services, such as telecommunications, financial, water and sanitation, and energy services, to people regardless of income and location, and which requires an effective governance at multiple scales due to the local nature of these services. (OECD and WB, 2006; UCLG, 2014).
14. **Gender balance** refers to equality based on gender in terms of rights, resources, opportunities, and protection, and the ability to use them to make strategic choices and decision. Women's social and economic empowerment at work, home, and communities increases inclusive growth and reduces poverty. (UNICEF, 2011; UN Women, 2018).
15. **Social equity** refers to a fair and equitable public and social policy, giving equal opportunities to all by a fair allocation of and access to resources that take into account social inequalities. Addressing and embedding equity issues in the design of a policy will lead to sustainable economic growth over the long term. (Clench-Aas & Holte, 2018; OECD, 2018).
16. **Social protection** refers to programs designed to provide benefits to ensure income security and access to social services, contributing to social equity and inclusive society and reducing poverty and exposure to risks. (UNRISD, 2010; ESCWA, 2015).

Source: Acosta et al. (2019), Box 1, p. 5.

Table 5.2: Individual indicators: description, relevance, data source, time coverage

Indicator	Description, relevance, limitations	Data source	Time
1. Sustainable and efficient resource use			
1.1 Ratio of total primary energy supply to GDP, or energy intensity level of primary energy	Unit: Megajoules per constant 2011 purchasing power parity GDP Definition: Energy intensity is the energy provided to the economy to create a unit of economic output. A low level of energy intensity means less energy is used for a unit of economic output (UNSTATS metadata). Relevance: Energy is one of the most significant inputs for economic growth. Economic growth depends on the available costeffective energy sources. Energy intensity and other energy consumption characteristics are relevant because the energy sector affects economic development. It is a very relevant indicator for green growth because it shows how energy is efficiently used in the economy (Reddy and Mehra, 2017). Limitation(s): The structure of the economy, geography and other structural factors influence the share of total primary energy supply to the GDP in the country. As such, the indicator is not suited for measuring energy efficiency (UNSTATS metadata).	World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, the International Energy Agency, and the Energy Sector Management Assistance Program. Online source: https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?view=chart	1990–2015

Indicator	Description, relevance, limitations	Data source	Time
1.2 Share of renewable to total final energy consumption	Unit: Percentage Definition: Renewable energy is the energy from the natural processes that can be replenished in a fast rate. Renewable energy includes heat and electricity from wind, hydropower, solar, ocean, geothermal, biofuels, and biomass. Renewable energy supports the shift from a less carbon-intensive to a more sustainable energy system (IEA, n.d.). Relevance: Increasing the share of renewable energy can help improve economic growth by helping address energy shortage in developing countries (Marinas et al., 2018). It is also identified as an important tool to address climate change (Nia and Niavand, 2017). It enables countries to protect the environment as renewable energy generates nearly zero emission of greenhouse gases and air pollutants (Uğurlu and Gokcol, 2017). Limitation(s): The measurement of renewable energy takes into account energy generated from biomass and charcoal, which are not necessarily produced in a sustainable way. It also does not take into account off-grid renewables. Moreover, the indicator tends to underestimate the transport costs of renewable energy because heat and electricity are not differentiated in its calculations (UNSTATS metadata; IEA and WB, 2013).	World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, International Energy Agency, and the Energy Sector Management Assistance Program. Online source: https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?view=chart	Time series, 1990–2015

Indicator	Description, relevance, limitations	Data source	Time
1.3 Water use efficiency	Unit: U.S. dollars per cubic meter Definition: Water use efficiency is the total efficiency in the main sectors of the economy weighted according to the proportion of water withdrawn in every sector over the total amount of withdrawals. The indicator provides an indication on the extent that water resources could support the world's ecosystems of the current and future generations (FAO, 2018). Relevance: There are different levels of water use and scarcity between countries because water resources and human population are unevenly distributed around the world (Mekonnen and Hoekstra, 2014). Water scarcity is getting worse, causing intense drought due to increasing intensity of climate change impacts. As such, water competition is increasing in different sectors of the economy, affecting economic growth. Consequently, the demand to increase water use efficiency is growing because the availability of water supply in many countries is limited and increasing the supply is costly (Mancosu et al., 2015). Limitation(s): The indicator considers water for agriculture, mining and quarrying, manufacturing, electricity, gas, steam and air conditioning supply, construction, and all the service sectors. It does not consider, however, water use for energy or the quality of water distribution networks (UNSTATS metadata).	FAO (2018). Online source: http://www.fao.org/3/CA1588EN/ca1588en.pdf	2015
1.4 Share of freshwater withdrawal to available freshwater resources (Level of water stress)	Unit: Percentage Definition: It is the ratio between the total amount of freshwater withdrawn by the main sectors and the total resources of renewable freshwater. The indicator measures how sustainable withdrawal and supply of freshwater can reduce water scarcity and its impacts on society (FAO, n.d.).	FAO Online source: http://www.fao.org/nr/water/aquastat/data/query/results.html (average 1998–2002 and 2003–2007); https://data.worldbank.org/indicator/ER.H2O.FWST.ZS (2014).	1998–2007, 2014

Indicator	Description, relevance, limitations	Data source	Time
1.5 Average soil organic carbon content	Unit: Tons per hectare Definition: Soil organic carbon composes most of soil organic matter. It affects processes related to food production and soil function. High soil organic carbon content improves food productivity by giving plants more nutrients and water. It also significantly contributes to climate change adaptation and mitigation (FAO and ITPS, 2018). Relevance: Farming practices such as organic agriculture contribute to the conservation of organic carbon in the soil. It is also more energy-efficient than traditional farming. Low energy consumption in organic production results from low concentrate feeding, minimal amount of synthetic pesticides, and the absence of synthetic fertilizers. Thus, organic production has the potential to contribute to the sustainable development and growth of society (Cristache et al., 2018). Limitation(s): Various methods exist to calculate soil carbon content. FAO uses quality control and uniformization methods.	FAO. Online source: http://54.229.242.119/GSOCmap/	2018
1.6 Share of organic agriculture to total agricultural land area	Unit: Percentage Definition: Organic agriculture is a production system that improves biodiversity, biological activity in soil, and biological cycles. Agricultural area includes permanent pastures, permanent crops, and arable land (FAO, 2003). Relevance: Agricultural land is crucial, and there is also a limited resource for agricultural goods production. Thus, there is a need to use agricultural land efficiently to provide food security to a growing population (Pilvere et al., 2014). A shift from conventional to organic farming was one of the ways to address the issue. Organic farming integrates and effectively uses the landscape and ecosystem services. It contributes to long-term food security by conserving natural resources and promoting overall sustainability (Kukreja and Meredith, 2011). Limitation(s): This indicator does not consider the debate around organic farming and transgenic crops, in particular with respect to consistency in defining and measuring sustainability (UNSTATS metadata).	Data source: FAO. Online source: https://landportal.org/voc/landvoc/theme/land-food-security	Time series, 2004—2016

Indicator	Description, relevance, limitations	Data source	Time
1.7 Total domestic material consumption (DMC) per unit of GDP	Unit: DMC kg per constant 2005 GDP Definition: Domestic material consumption is the total amount of materials used in the economy at the national level. It is also the total amount of domestic materials handled within the economy, either added to the transport infrastructure or building materials. Moreover, it covers the physical aspect of the economic process. The indicator can be used to measure long-term waste equivalent (UNEP, 2016). Relevance: At the national level, material efficiency is one of the crucial indicators for the success of sustainable resource management. As an economy grows, economic material efficiency increases (Fishman et al., 2014). The increase in material efficiency is crucial to separating resource depletion and its accompanied environmental stresses from the development of the economy (Zhang et al., 2018). Limitation(s): Domestic material consumption is based on material flows from Japan and the European Union but is estimated for the rest of the world using various nonstandardized datasets comprising agriculture, forestry, fisheries, mining, and energy statistics. It does not consider the whole of material consumption (UNSTATS metadata).	U.N. Environment: Secretariat of the International Resource Panel (resourcepanel@unep.org). Online source: https://www.resourcepanel.org/global-material-flows-database	Time series, 1970–2015
1.8 Total material footprint (MF) per capita	Unit: MF tons per capita Definition: Material footprint attributes the universal material extraction to the final domestic demand. The total material footprint is the total amount of footprint for metal ores, nonmetal ores, fossil fuels, and biomass. It shows the needed amount of main materials for the final domestic demand. DMC and MF measure production and consumption, respectively, hence they can be combined to cover both aspects of material flows in the economy. MF includes traded goods (UNSTATS metadata). Relevance: The demand for urban material resources are expected to increase due to future growth in urban population. As a country economically grows, it tends to reduce domestic materials through international trade. With that, the general mass of material consumption increases (Wiedmann et al., 2013). Limitation(s): Similar to DMC, MF is based on material flows from Japan and the European Union, with estimates extrapolated for the rest of the countries in the world. MF is not based on apparent physical consumption and actual physical movement of materials within and among countries. It is based on the estimates from where raw materials are extracted and where a product or service is consumed (UNSTATS metadata, Wiedmann et al., 2013).	Data source: U.N. Environment: Secretariat of the International Resource Panel (resourcepanel@unep.org). Online source: https://www.resourcepanel.org/global-material-flows-database	Time series, 1990–2015

Indicator	Description, relevance, limitations	Data source	Time
2. Natural capital protection			
2.1 PM2.5 air pollution, mean annual population-weighted exposure	Unit: Micrograms per cubic meter Definition: The mean annual population-weighted exposure to PM2.5 measures the average exposure level of a population to the concentration of PM2.5, which penetrates deep into the human respiratory system and therefore severely damages human health. The exposure level is computed by weighting the mean annual PM2.5 concentration by urban and rural population (WB, 2019). Relevance: According to the World Health Organization, PM has harmful effects on human health. PM2.5 is the most commonly used indicator for estimating the effects on mortality. In fact, it ranked as the fifth mortality risk factor in 2015 (Van der Gon et al., n.d.). Moreover, exposure to chronic PM2.5 over a period of one year or more causes around 95 percent of the 3 million deaths globally per year. Thus, prediction of exposure to it is a good indicator for the overall impacts of air pollution on health (Tessum et al., 2017). Limitation(s): The indicator calculates air pollution using satellite data but using urban populations as denominator factor, which can be defined differently according to the country. Furthermore, consultations with countries can lead to adjustments and bias on the data. Data quality varies between high-, low-, and middle-income countries (UNSTATS metadata).	Data source: Brauer, M. et al. 2016, for the Global Burden of Disease Study 2016, World Health Organization. Online source: https://data.worldbank.org/indicator/EN.ATM.PM25.MC.M3	Time series, 1990–2016
2.2 Age-standardized disability-adjusted life years (DALY) rate as affected by unsafe water sources	Unit: DALY lost per 100,000 persons Definition: The disability-adjusted life years (DALY) is the only indicator in health that measures diseases consisting of the total number of years of life lost and the number of years lived with disability (Kim et al., 2018). Relevance: Clean water access is important for the environment, human development, and economic growth. More than 2 billion people across the globe, however, do not have access to safe water resources (EPI, 2018). Urban construction and economic development increase sewage discharges and harshly damages the reservoir environment. The need for safe water has increased because living standards have also improved (Qing et al., 2014). In developing countries, diarrheal disease caused by poor drinking water quality is one of the most common contributors to the disease burden as measured by disability-adjusted life years. Thus, safe water resources play an important role in maintaining human welfare and health (Hunter et al., 2010). Limitation(s): The data on deaths are not up-to-date in all countries as there are not always reliable registration systems, leading to discrepancies between countries and the need to complete the data using other sources (UNSTATS metadata).	Institute for Health Metrics and Evaluation. Online source: http://ghdx.healthdata.org/gbd-results-tool	Time series, 2000–2017

Indicator	Description, relevance, limitations	Data source	Time
2.3 Municipal solid waste (MSW) generation per capita	Unit: Tons per year per capita Definition: Municipal solid waste is defined as the household waste and other waste generated in the same nature by industrial and agricultural areas, business or commercial establishments, and public spaces (UNSTATS metadata). The per capita municipal solid waste is an environmental indicator that measures the intensity of generating waste over time (Kawai & Tasaki, 2016). Relevance: The overload amount of solid wastes from domestic activities of humans disposed in the municipality has caused numerous negative impacts to humans and ecosystem (Azodo and Ismaila, 2016). Also, economic growth, consumption patterns, and the degree of industrialization are related to the amount of solid wastes generated. Solid wastes are a byproduct of urban growth. The growth of population in urban areas results in more municipal solid wastes. Additionally, if there is a lack of technology and efficient methods to dispose of wastes, air quality will deteriorate, thus adversely affecting human health (Tahir et al., 2015). Limitation(s): In many developing countries, municipal solid waste collection and treatment is done through the informal sector. Data on adequate treatment of municipal waste is limited. Furthermore, even if data collection is done correctly, interpretation of what makes municipal waste treatment, for instance, recycling, composting, adequacy of collected data varies greatly from country to country. This leads to limitations in data unification (UNSTATS metadata).	World Bank What a Waste database. Online source: https://datacatalog.worldbank.org/dataset/what-waste-global-database	2018

Indicator	Description, relevance, limitations	Data source	Time
2.4 Ratio of carbon dioxide (CO_2) emissions to population, excluding AFOLU	Unit: Metric tons per capita Definition: CO_2 is a greenhouse gas that is odorless, colorless, and nonpoisonous. It is formed through carbon combustion and respiration of living things (UNFCCC, n.d.). The indicator is based on emissions ensuing from burning fossil fuels and manufacturing cement, including those produced during the consumption of solid, liquid, and gas fuels and gas flaring (WB, 2019a). Relevance: In 2012, carbon dioxide accounts for around three-quarters of total greenhouse gas emissions (Ritchie and Roser, 2018). In China, the total carbon emissions in the cities relate closely to the country's GDP. But per unit area carbon emissions are strongly related with population density in cities (Wang et al., 2012). It is suggested that a more useful indicator for measuring impacts on climate is carbon emissions per capita (The Guardian, 2016). Limitation(s): Different calculation methods and energy sector disaggregation methodologies have caused some discrepancies on estimates of CO_2 emissions among countries due to. (UNSTATS metadata)	Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States. Online source: https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?view=chart	Time series, 1960–2014
2.5 Ratio of non-CO_2 emissions (CH_4, N_2O) to population, excluding AFOLU	Unit: Tons per capita Definition: Methane and nitrous oxide are also sources of greenhouse gas emissions, accounting for around 17 percent and 7 percent of emissions, respectively. In terms of sectors, agriculture and energy contribute about 90 percent of global methane emissions, while agriculture accounts for more than 60 percent of nitrous oxide emissions. Due to the importance of the latter type of emissions, nitrous oxide emissions were included as separate indicator (see GE3 below) (Ritchie and Roser, 2018). Relevance: Non-CO_2 greenhouse gases also contribute to climate change. It is, however, not related to cumulative emissions but determined through annual emissions. Thus, it is important to account independently the additional warming from the non-CO_2 agents when CO_2 emissions compatible with temperature limit is estimated (Friedlingstein et al., 2014). Limitation(s): The EDGAR database uses a bottom-up approach to determine GHG emissions from country statistics. This method is robust for countries with strong statistical data infrastructure but less so for countries with a weak data measurement and reporting body (Janssens-Maenhout, et al. 2017).	FAOSTAT data for both GHG emissions and population. Online source: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions	1990–2010

Indicator	Description, relevance, limitations	Data source	Time
2.6 Ratio of non-CO_2 emissions (CH_4, N_2O) agriculture to population	Unit: Gigagrams per 1,000 persons Definition: Greenhouse gas emitted from the agricultural sector include non-CO_2 gases, such as methane (CH_4) and nitrous oxide (N_2O). Livestock and crop production and management generate these gases (FAO, 2018a). Relevance: Activities related to agriculture, forestry, and other land uses (AFOLU) generate greenhouse gases through removals by sinks. They comprise CO_2 and non-CO_2 emissions from forestry and other land uses and non-CO_2 from agriculture. AFOLU represents almost 25 percent of greenhouse gas emissions globally. Next to the energy sector, AFOLU is the second largest emitting sector. Action in AFOLU is important to many countries where the sector represents a huge part of their economy, is at risk of climate change, and can greatly benefit from climate funding for GHG reduction, food security, and rural development (Tubiello et al., 2014). Limitation(s): The indicator for emissions from agriculture is constructed using the Tier 1 IPCC methodology. Using higher tier data modelling would reduce the uncertainty by 10 percent to 20 percent (Tubiello et al., 2013).	FAO for emissions, WB for population. Online source: http://www.fao.org/faostat/en/#data/GL; https://data.worldbank.org/indicator/SP.POP.TOTL	1961–2016
2.7 Average proportion of terrestrial, freshwater, marine, and mountain key biodiversity areas (KBAs) covered by protected areas	Unit: Percentage Definition: The indicator is the proportion of main biodiversity areas, whether terrestrial, freshwater, marine, and mountain, covered by protected areas. These areas significantly affect biodiversity preservation globally. Protecting these key ecosystems improves biodiversity and sustains the use of natural resources (UNSTATS metadata). Relevance: As humans encroach on the natural systems, adverse impacts on the terrestrial, freshwater, and marine ecosystems also increase. Establishing protected areas has become a major strategy to conserve biodiversity. Well-managed protected areas provide healthy ecosystems and benefits even to humans. These benefits include ecosystem services, such as food security, disaster risk reduction, and clean water (Bertzky et al., 2012). Moreover, integrating establishment of protected areas in land use plans can address issues relating to species loss and climate change adaptation (Lopoukhine et al., 2012). Limitation(s): This indicator does not include how the effectiveness of establishing protected areas in protecting biodiversity and ecosystems, which depends on enforcement and appropriate management. Regarding key biodiversity areas, the list is not complete in all regions, and there are some omissions (UNSTATS metadata).	BirdLife International, IUCN and UNEP-WCMC (2018). Online source: https://unstats.un.org/sdgs/indicators/database/	2000–2018

Indicator	Description, relevance, limitations	Data source	Time
2.8 Share of forest area to total land area	Unit: Percentage Indicator Definition: Forest area is a land with trees with a minimum of five meters in situ. It does not include trees in agricultural areas,such as fruit plantations and agroforestry, and in gardens and parks (WB, 2019a). Forest area is important for human as it provides goods, such as nonwood and wood forest products, and services, such as carbon sequestration, coastal protection, soil preservation, water conservation, and biodiversity habitat (UNSTATS metadata). Relevance: Forestry can help conserve natural resources and contribute to their sustainable growth through protecting water resources and enhancing biodiversity. The forestry sector can contribute to green growth through instituting policies on climate change. IT can help expand renewable energy and reduce greenhouse gas emissions. Generally, forests contribute to green building and infrastructure and acts as carbon sinks (United Nations, 2009). Limitation(s): Forest surveys are conducted at irregular intervals from country to country. Remote sensing can be used but cannot detect long-term tree growth or low canopy cover density forests. The indicator is used to measure the extent of forest preserved and restored but only partially measures the extent of forests that are managed sustainably (UNSTATS metadata).	FAO, electronic files and web site http://www.fao.org /faostat/en/#data/ EL. Online source: https://data.worldb ank.org/indicator/A G.LND.FRST.ZS;	1990–2016
2.9 Soil biodiversity, or the potential level of diversity living in soils	Unit: Index Definition: This indicator is based on the soil biodiversity map with an index showing the level of diversity living in soils. Data include the distribution of soil microbial diversity and soil fauna diversity (Serna-Chavez et al., 2013). Relevance: Soil biodiversity reflects the diversity of living organisms in soils. These organisms interact with different animals and plants in the ecosystem. Moreover, these organisms contribute important services for sustainable ecosystem. They regulate organic matter dynamics, greenhouse gas emissions, and carbon sequestration in soils. Also, they enhance the efficiency of acquiring nutrients and plant health (El-Hage Scialabba, n.d.). Limitation(s): This indicator uses measurements that uniformly made one meter underground. This is sometimes underneath the organic ground layer and in the sedimentary layer, meaning it does not account completely for soil biodiversity (Serna-Chavez et al., 2013).	Joint Research Centre, European Soil Data Centre (ESDAC). Online source: https://esdac.jrc.ec .europa.eu/content /global-soil- biodiversity-maps-0	2016

Indicator	Description, relevance, limitations	Data source	Time
2.10 Red List Index	Unit: Index Definition: The Red List Index, which ranges from 0 to 1, measures the variation in the total extinction across species groups. It is based on the variation in the total number of species in every type of extinction risk based on the IUCN Red List of Threatened Species. A value of 1 means the species is of least concern for extinction; a value of 0 means the species is extinct. The index shows how far the species groups have moved toward extinction. Therefore, it can be used to compare species groups in terms of extinction risk level and the rate that such a risk changes (UNSTATS metadata). Relevance: There is still a significant number of species threatened by extinction despite different conservation efforts. Contributing factors include habitat destruction, pollution, overexploitation, and introduction of exotic species. To boost conservation efforts, many countries have been using the IUCN Red List. The list is a commonly used system to assess the risk of and quantify threats to a species to go extinct (Kideghesho, 2009). Species that are highly valued are considered cultural indicators and critical when planning restoration and rehabilitation projects with local communities (Harmsworth et al., 2011). Limitation(s): The Red List Index includes several sources of uncertainty. Species can be inadequately qualified as to their endangered status, and there can be inconsistency in assessing species. Some species are also too poorly known to be Included in the Red List's data (UNSTATS metadata).	BirdLife International and IUCN (2018). Online source: https://www.sdg.org/datasets/indicator-15-5-1-red-list-index/data	1993–2016

Indicator	Description, relevance, limitations	Data source	Time
2.11 Tourism and recreation in coastal and marine areas	Unit: Scores, 1–100 Definition: Tourism in coastal and marine areas contributes to economic growth. The indicator on tourism and recreation represents the cultural experiences of visitors in coastal and marine attractions. This indicator only represents participation in coastal tourism. The Ocean Health Index measures the economic aspects of coastal and marine attractions in Coastal Livelihoods and Economies goal (OHI, 2019). Relevance: Ecotourism promotes responsible tourism in natural areas, improves the well-being of local communities, and contributes to conserving the environment (Zambrano et al., 2010). Determining the symbolic species depends on the existence of that species, and that its value for a particular cultural area increases when it is rare and its habitat is inaccessible (Schirpke et al., 2018). Limitation(s): The model used for this index is the study of participation rates in 19 marine-related activities per capita. Thus, a wide range of marine activities are not included (Halpern et al., 2014).	Ocean Health Index. Online source: http://data.oceanhealthindex.org/home	2014–2017
2.12 Share of terrestrial and marine protected areas to total territorial areas	Unit: Percentage Definition: Terrestrial protected areas are at least 1,000 hectares of completely or partially protected areas designated by the national government as nature reserves, national parks, wildlife sanctuaries, natural monuments, and protected landscapes. Protected areas also include scientific areas that cannot be publicly accessed and areas that are managed sustainably. Marine protected areas are subtidal or intertidal land, overlying water, and associated fauna and flora preserved by law. It also includes the cultural and historical characteristics of the area (WB, 2019a). Relevance: Planning for tourism areas consider the environment and people in protected areas. A tourism planning and development strategy normally takes into account aspects such as adequate zoning, safeguarding guidelines, regulations, and proper management (Yamauchi and Lee, 1999). Limitation(s): The indicator excludes sites protected under local or provincial law (WB, 2019a).	World Database on Protected Areas (WDPA), whose compilation and management is carried out by the United Nations Environment World Conservation Monitoring Centre (UNEP-WCMC) in collaboration with governments, non-governmental organizations, academia, and industry. https://data.worldbank.org/indicator/ER.PTD.TOTL.ZS; https://www.protectedplanet.net/	2016, 2017
3. Green economic opportunities			

Indicator	Description, relevance, limitations	Data source	Time
3.1 Adjusted net savings, taking account of natural resources and pollution damages	Unit: Percentage of gross national income (GNI) Definition: Adjusted net savings are computed by adding net national savings and expenses in education and subtracting mineral depletion, energy depletion, net forest depletion, damages from particulate emissions, and carbon dioxide (WB, 2019c). It measures the sustainability of the economy based on the extended national accounts. Saving creates a surplus for investment, which helps countries escape a state of low-level subsistence (EU 2012). Relevance: Natural capital is the most abundant asset is accessible in all countries. Environmental degradation for increasing economic growth is rational because the growth of economy depends on the natural resources available. In fact, natural capital is the largest part of wealth in low-income countries. In the adjusted net saving (ANS), the gross national saving minus capital depreciation and depletion of natural resources is used as a measure. ANS guides policymakers on the direction of the economy and actions for long-term growth. It indicates if the country is using more wealth than what it is adding (Lange et al., 2018). Limitation(s): The methodology is different from that of national accounts: The unit prices used to calculate the value of natural resource depletion are regional and international, and not local. Concerning energy and mineral depletion, average cost is used instead of marginal cost to calculate unit resource rent. Finally, net forest depletion does not include all forest benefits but only timber benefits (WB, 2018).	World Bank staff estimates based on sources and methods described in "The Changing Wealth of Nations 2018: Building a Sustainable Future" (Lange et al 2018). Online source: https://data.worldbank.org/indicator/NY.ADJ.SVNG.GN.ZS?view=chart	Time series, 1990–2017

Indicator	Description, relevance, limitations	Data source	Time
3.2 Share of export of environmental goods (OECD and APEC classifications) to total export	Unit: Percentage Definition: Green trade is the share of exports of environmental goods in total exports. These goods are environment-friendly in production, usage, and disposal. Thus, they reduce environmental pollution and hazards. This indicator measures how a country competes in creating and selling environmental goods. Also, it measures the result of policies and investments related to green trade (Page 2017). Relevance: In Asia-Pacific, environmental goods present an essential trade opportunity for exports and imports. The region has a large share of exports, and their shares have been increasing. The main contributor to such growth was renewable energy. Environmental good exports from developing countries account for more than 75 percent of the region's total. These countries have also increased their environmental goods export share (Jacob & Moller, 2017). Limitation(s): Environmental goods under harmonized customs codes can comprise products that have both environmental and nonenvironmental end uses (Moll de Alba & Todorov, 2018).	Computed using UNCOMTRADE data and OECD and APEC classifications of environmental goods; based on the methods applied by U.N. Environment (Page 2017). Online source: https://comtrade.un.org/data/	Time series, 2000–2017
3.3 Share of green manufacturing employment in total manufacturing employment	Unit: Percentage Definition: This indicator measures the impact of manufacturing on employment through its capability to absorb excess labor force from the traditional and agricultural sectors (UNSTATS metadata). Relevance: The labor market will be restructured as there is transition toward green growth. It will create new green employment opportunities. There is, however, an issue as employment is relocated between industries due to structural changes caused by greener growth. Research shows that carbon-intensive industries emit almost 90 percent of CO_2 but only generate a little more than 10 percent of employment. Thus, these industries with large environmental footprint should adapt. There should be adjustments in labor market employment for greener growth. Also, good policies on innovation and environment can create new markets (OECD, 2014). Limitation(s): Analysis covered only limited data and a number of countries were excluded (Moll de Alba & Todorov, 2018).	Moll de Alba and Todorov 2018, 2019. Online source: https://www.inderscienceonline.com/doi/pdf/10.1504/WRSTSD.2018.093223	2000–2015

Indicator	Description, relevance, limitations	Data source	Time
3.4 Share of patent publications in environmental technology to total patents	Unit: Percentage Definition: Patents in environmental technology measure the innovative capability to produce goods and services that are environment-friendly. Green innovations ensue from policies on research and development and other private initiatives. Environment- friendly inventions contribute to the production of environmental goods and thus making new markets and employment (PAGE 2017). Relevance: The dynamics in green technologies are increasing since 2007. This resulted in an increased share of patents in environmental technology (Walz et al., 2017). The patent grants are an indicator used to determine the innovative level in the field of environment. Ecoinventions patents are used in measuring invention and research activities and in studying the research direction in a given technological field. Ecoinnovations patents, meanwhile, are used in measuring innovations that reduce environmental risk and negative impacts (OECD, 2014). Limitation(s): The criteria for a patent to be environmental technology are not extensive, and they include climate change mitigation; capture, storage, sequestration or disposal of greenhouse gases; and environmental and water-related adaptation technologies (OECD 2014).	World Intellectual Property Organization (WIPO) statistics database. Last updated: December 2018. Online source: https://www3.wipo.int/ipstats/index.htm?tab=patent	1980–2017
4. Social Inclusion			

Indicator	Description, relevance, limitations	Data source	Time
4.1 Population with access to safely managed water and sanitation	Unit: Percentage Definition: This indicator indicates the population that uses drinking water from safe sources that are accessible and available. Safe water sources include delivered water, protected springs, protected wells, piped water, and tubewells. Also, it indicates the population that has sanitation facilities not shared with others. Sanitation facilities include septic tanks, flush-to-piped sewer systems, and improved toilets with slabs (WB, 2019a). Relevance: Access to safely managed water and sanitation is the foundation of socio-economic development, human dignity, well-being, and health (Anthonj et al., 2018). However, a number of people do not have this. In the past century, the use of water was more than twice the population rate. Even though there is no water shortage yet, 40 percent of the global population living around a river basin are experiencing water scarcity. Environmental degradation and water competition are some of the effects of water scarcity (Ako Ako et al., 2010). Moreover, clean water and sanitation inaccessibility causes children's death. Those who do not have access to clean water and sanitation also experience less opportunities in reaching their potential (Armah et al., 2018). Limitation(s): Data on access to safely managed water and sanitation is not yet uniform, and national discrepancies exist. Faecal and chemical contamination is not considered in all cases (UNSTATS metadata). The indicators that were usually used in monitoring progress in response to water and sanitation issues are at the international level only. There have been many new and useful initiatives at the local level that contribute to the availability of clean water and sanitation (Osumanu et al., 2010), but these are not considered yet in measuring the indicator.	WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene (washdata.org). Online source: https://data.worldbank.org/indicator/SH.H2O.SMDW.ZS; https://data.worldbank.org/indicator/SH.STA.SMSS.ZS	2000–2015

Indicator	Description, relevance, limitations	Data source	Time
4.2 Population with access to electricity and primary reliance on clean fuels and technology	Unit: Percentage Definition: Electricity access is the percentage of the population with access to electricity. The data are from national surveys, industries, and other international organizations. Clean fuel access is the percentage of the population that uses clean fuels for cooking, excluding kerosene (WB, 2019a). The use of solid fuels and kerosene in households contribute to mortality rates from respiratory-related diseases (WHO 2018). Fuels are categorized as clean based on their emission rate and specific recommendations. The population proportion is computed by dividing the number of people who use clean fuels for heating, cooking, and lighting by the total number of people who use any method for heating, cooking, and lighting (UNSTATS metadata). Relevance: Efforts to ensure access to affordable and clean energy have progressed due to recent initiatives in electrification and improvements in energy efficiency. There is, however, still a need to establish national policies on affordable energy. Some of the causes of global energy problems today are high fuel prices, poverty, and lack of access to clean fuels. Countries with severe climate and heating demand are greatly affected by these problems (Kerimray et al., 2017). Limitation(s): Data on household cooking, heating and lighting is not yet unified and universally measured. Concerning electricity, the availability of an electric outlet does not always imply the electric supply is reliable and constant (UNSTATS metadata).	World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework led jointly by the World Bank, International Energy Agency, and the Energy Sector Management Assistance Program; World Bank, Sustainable Energy for All (SE4ALL) database from WHO Global Household Energy database. Online source: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS; https://data.worldbank.org/indicator/EG.CFT.ACCS.ZS	2000–2017

Indicator	Description, relevance, limitations	Data source	Time
4.3 Fixed Internet broadband and mobile cellular subscriptions per 100 people	Unit: Number of subscriptions per 100 people Definition: Fixed internet broadband subscriptions refer to the subscriptions of people to high-speed public internet. It includes DSL, fiber, cable modem, and other wired broadband, wireless broadband, and satellite broadband. It does not include access to mobile networks. Mobile cellular subscriptions refer to the subscriptions to a public mobile service that has access to PSTN through cellular technology. It includes prepaid and postpaid subscriptions. It does not include subscriptions through USB modems, mobile data services, private mobile radio, and telepoint (WB, 2019a). Relevance: There has been a difference among people when it comes to the access of digital information and communications technologies (ICT). This is observed in developed countries with different groups of socioeconomic status. The economic factors play an important role in the access of ICTs (Ronquillo and Currie, 2012). Mobile communications is important for people in rural areas with low income and literacy because of its mobility, flexibility, and low costs. In fact, the billion mobile subscribers are from rural poor (Index Mundi, n.d.). In terms of broadband subscriptions, there is an increasing trend in its use which contributes to economic growth and lives of users (Prieger, 2012). Limitation(s): The indicator is easy to collect and trustworthy, due to the limited number of mobile and broadband operators. The highest source of uncertainty comes from population data (UNSTATS metadata).	International Telecommunication Union, World Telecommunication /ICT Development Report and database. Online source: https://data.worldbank.org/indicator/IT.NET.BBND.P2; https://data.worldbank.org/indicator/IT.CEL.SETS.P2	2000–2017

Indicator	Description, relevance, limitations	Data source	Time
4.4 Proportion of seats held by women in national parliaments	Unit: Percentage Definition: Participation of women in parliament is a major opportunity for them politically. It is linked to their empowerment. This indicator measures the extent of women's equal access to parliament (UNSTATS metadata). Relevance: Involvement of women in politics has good social and economic impacts. It is crucial in advancing gender equality and democracy in a country. Also, involvement of women in decision-making balances the dominance of men in politics. In a political sense, their involvement improves policies and inclusion of minority groups. In the economic sense, it promotes the role of women in development and their inclusion in the labor market (Asiedu et al., 2018). Limitation(s): The indicator does not consider results in by-elections and upper chambers of parliament. It also is not a complete measure of women's political power (UNSTATS metadata).	Inter-Parliamentary Union (IPU) (ipu.org). Online source: https://data.worldbank.org/indicator/SG.GEN.PARL.ZS?view=chart	1990 and 1997–2017
4.5 Ratio of female to male with account in financial institution (ratio female-male, % age 15+)	Unit: Percentage Definition: Account in financial institution refers to the proportion of people age 15 and older who have access to financial or mobile money services, such as payments, insurance, savings, remittances, and credit irrespective of their age, education, address, and income (WB, 2019b). The indicator was computed using the ratio of female and male with accounts in financial organizations. Relevance: Financial inclusion provides people with insurance and access to credit. Poor Low-income individuals rely on their own savings and earnings if they are excluded from financial systems. There is a wide gender gap when it comes to measuring financial inclusion through usage. Aside from income, gender has an impact on financial inclusion (Fanta and Mutsonziwa, 2016). People who have access to financial services can manage their lives and participate in businesses (UNSTATS metadata). Limitation(s): The indicator is built using representative surveys of 140 countries, which are conducted every three years. This method implies uncertainties on the values (UNSTATS metadata; WB, 2019b).	World Bank Global Findex database. Online source: https://globalfindex.worldbank.org/#data_sec_focus	2011, 2014, 2017

Indicator	Description, relevance, limitations	Data source	Time
4.6 Getting paid, laws and regulations for equal gender pay	Unit: Score, 0–100 Definition: This indicator refers to the legal gender discrimination that influences employment and economic choices of women. It also covers the laws that require equal pay for labor of equal value (WB, 2019c). Relevance: Similar to men, women have become better workforce members. There are also many social policies that support the employment of women. Gender pay gap, however, persists, partly due to the lack of political will to redistribute wage share. Gender quality will require more sharing of work and social support. Also, there is a need to change the behavior of employers and perspectives of countries that give opportunities for women (Rubery and Koukiadaki, 2016). Limitation(s): This indicator does not consider the whole of the labor force (WB, 2019c).	World Bank Women, Business and the Law. Online source: http://wbl.worldbank.org/en/reports	2009–2018
4.7 Inequality in income based on Atkinson	Unit: Index Definition: Inequality in income based on Atkinson is one of the most used welfare-based indicators that measure inequality. It measures the percentage of total income to be waived by a society to achieve equal income shares among citizens. A high value means more acceptance for lesser income in order to achieve equal distribution of income (UNDESA 2015). Relevance: The indicator measures income differences but cannot indicate the standard of living (Oregon Community Foundation, 2015). Studies show that measuring income inequality is a factor in determining the poverty level, economic growth rate, human rights, and the level of crime, violent conflict, and social unrest (McKay, 2002). The Atkinson Index is popularly used in measuring inequality. It shows the total income percentage that needs to be foregone to achieve equal income shares. This index also depends on the society's aversion to income inequality (Afonso et al., 2015). Limitation(s): There are different methods for measuring income inequality, so it is important to understand their strengths and weaknesses (Tahsin, 2019). The Palma ratio is a recently recommended indicator for income inequality, but data remain limited.	UNDP Human Development Data (based on Atkinson, 1970). Online source: http://hdr.undp.org/en/data#	2010–2017

Indicator	Description, relevance, limitations	Data source	Time
4.8 Ratio of urban to rural, access to safely managed water and sanitation, and access to electricity	Unit: Percentage Definition: It is calculated based on the portion of population who has access to basic services, such as safe water, sanitation, and electricity. Relevance: There is a big difference between the population in rural and urban areas when it comes to access to basic services. According to research, eight out of 10 people without safe water sources are in rural areas. Services such as sanitation, water, hygiene, and electricity are essential for improved living. However, poor people particularly in rural areas have low access to these basic services (United Nations, 2011). Limitation(s): This indicator has the same issues concerning water and sanitation as AB1. Concerning energy, it has the same issue as AB2.	Computation of the indicator used data on access to safely managed water and sanitation as well as access to electricity. Online source: See above sources for the indicators on access to safely managed water and sanitation as well as access to electricity	2000–2016
4.9 Share of youth not in education, employment or training, aged 15-24 years	Unit: Percentage Definition: The number of youths aged 15-24 who are not in education, employment, or training is an indicator that measures the involvement of youth in the labor market and does not cover youth that are unemployed. It also includes youth workers who are outside the labor market because of their disability or involvement in household chores or other tasks (UNSTATS metadata). Relevance: Increasing human capital through employment, education, and training is one of the contributing factors for economic growth. The level of educational attainment is an important factor for employability. The youths who finished secondary education will less likely experience difficulty in searching for work (OECD, 2014). The youths who did not finish education nor attended training are the vulnerable ones in the labor market (Eurostat, 2019). Limitation(s): The age coverage defining youth is different from country to country — some use 15 to 24; others 15 to 29 — so the data are not uniform (WB, 2019a).	ILOSTAT database. Data retrieved in April 2019. Online source: https://data.worldbank.org/indicator/SL.UEM.NEET.ZS	1990–2018

Indicator	Description, relevance, limitations	Data source	Time
4.10 Proportion of population above statutory pensionable age receiving a pension	Unit: Percentage Definition: The proportion of population above statutory pensionable age receiving a pension is an indicator that measures the number of people who are covered by a social protection system. Access to social protection is a human right. This indicator also reflects the degree of security of the living condition of people. Social protection system benefits people covering disability, unemployed persons, child and maternity benefits, injured workers, and older persons (UNSTATS metadata). Relevance: According to the International Labour Organization, old-age income security pension schemes are still relevant. Many countries are giving pensions in periodic cash forms under one scheme. Usually, it is through a combination of noncontributory and contributory schemes. Globally, those who receive pension comprise the 68 percent of people with above retirement age, either covered by noncontributory or contributory schemes (ILO, 2017). Limitation(s): Countries provide statistics, which do not imply that pension is sufficient for the persons above pensionable age to live well. Furthermore, pensionable age varies from country to country (UNSTATS metadata).	International Labour Organization (ILO). Online source: http://www.social-protection.org/gimi/gess/RessourceDownload.action?ressource.ressourceId=54610	Various years to represent 2015
4.11 Health care Access and Quality Index	Unit: Index Definition: Universal health coverage is facilitated when everyone has access to quality health care. Health systems aims to provide access to quality health care to improve the health conditions of people and prevent early death (GBD 2018). Relevance: Even though there has been debate on the contribution of health care and health initiatives to population health, research shows that access to quality health care improves health outcomes, helping to reduce incidence of infectious diseases, cancers, maternal disorders, and noncommunicable diseases. Thus, assessment of mortality from these health concerns can give an important perspective on the quality of health care. Such an assessment on access to quality healthcare can contribute to population health improvement (Barber et al., 2017). Limitation(s): The indicator will need to incorporate improvements in measuring health care access and quality into more comprehensive assessments of health system performance, such as expanding estimation to subnational locations (GBD 2018).	Institute for Health Metrics and Evaluation, based on Global Burden of Disease Study 2015 (GBD 2015). Online source: http://ghdx.healthdata.org/record/global-burden-disease-study-2015-gbd-2015-healthcare-access-and-qualityindex-based-amenable	1990–2015

Indicator	Description, relevance, limitations	Data source	Time
4.12 Proportion of urban population living in slums	Unit: Percentage Definition: The proportion of urban population living in slums is an indicator that measures the number of people in urban areas who do not have good housing condition. It also measures the capability of people to meet the basic need for a shelter. It reflects people living in homes that lack basic services, such as resilient housing, tenure security, safe water, improved sanitation, and electricity. These are indices for poverty (UN Habitat, 2003). Relevance: As urban population grows so are informal settlers in the urban areas. The urban population living in slums has been increasing since the 20th century. Urban people living without basic services is a serious issue. Countries have been addressing this issue because it can cause further concerns, such as epidemics, political instability, mass migration, and national insecurity (Hermanson, 2016). Limitation(s): Potential limitations include the lack of universally agreed definitions and characteristics for deteriorated housing conditions, underestimation of deteriorated housing units due to a lack of appropriate measurement tools, complex links between security land and property tenure, and the lack of data consistency globally due to limited capacity for collecting, managing, updating, and monitoring data in some countries (UNSTATS metadata).	United Nations Human Settlements Programme (UN-HABITAT). Online source: https://data.worldbank.org/indicator/SL.EMP.WORK.ZS	1991–2018

Source: Reformatted and restructured based on Acosta (2019). Metadata.
Note: see the references in the References section of Acosta (2019).

II. Methodological issues related to the index

This section was compiled based upon Acosta et al. (2019).

Data Imputation

A direct and most common approach to address missing data is to simply exclude or omit them. The Green Growth Index partly adopts this approach. This is applied to indicators with time series data, where indicators are excluded when they have missing data for two consecutive years prior to the baseline year, which refers to the year that was used in computing the index. Examples of sustainability indices that do not apply data imputation include the Environmental Vulnerability Index of the South Pacific Applied Geoscience Commission, the UNEP Green Economy Progress Index, and ADB's Inclusive Green Growth Index. Kang (2013) emphasized the problems with missing data, including reduction in statistical power, bias in estimation of parameters, reduced representativeness of the samples, and increased complexity of analysis. While these are very relevant for complex modelling analysis, using simple and transparent aggregation methods to

generate the Green Growth Index can reduce these problems (Chapter 5.8). Moreover, He (2010) explained that when data are missing completely at random (MCAR), analysis with missing data is unbiased. In most cases, there is no clear basis on whether data are missing at random, which is a prerequisite in most imputation methods (Nardo et al., 2005). Gelman & Hill (2007) also pointed out that excluding indicators with missing data will reduce the number of samples in the analysis.

Imputation methods, such as mean imputation, linear interpolation, regression analyses, maximum likelihood, multiple imputation, are widely used to fill in missing data (Horton & Kleinman, 2007; OECD & JRC, 2008; Kang, 2013; Wicklin, 2017). Examples of sustainability indices that apply data imputation include the Global Green Economy Index of DC, which uses the mean of the five closest countries; the African Green Growth Index of AfDB, which uses the mean of normalized indicators; the Ecological Footprint of the Global Footprint Network, which uses inter- or extrapolation; the Environmental Performance index of the Yale University and Columbia University, which imputes the closest data points and uses extrapolation; the Sustainable Society Index of the Sustainable Society Foundation, which uses expert judgment; and the Happy Planet Index of the New Economics Foundation, which imputes data from the closest years. He (2010) categorized the methods of mean imputation and of treating missing data as a separate category as ad hoc because imputation is based on implausible assumptions, noting that "these methods impute the missing data only once and then proceed to the completed data analysis" (He, 2010: p.3). Single imputation methods are known to underestimate variance and standard errors because they assume to know the unobserved value with certainty (He, 2010; OECD & JRC, 2008). As far as the computation of composite indices is concerned, there are serious statistical problems associated with these imputation methods, which can affect the reliability of the analysis. For example, mean imputed data will not only reduce the variance but also change the correlation between the indicators (Wicklin, 2017). Both are problematic because a good variance is important to capture differences in scores across countries and, as discussed in Chapter 5.5, correlation is important to identify redundant indicators. In short, there are trade-offs when using data imputation, and decisions often depend on subjective judgement. The motivations for using, and not using, imputation methods should thus be justified because "[n]o imputation model is free of assumptions" (OECD & JRC, 2008: p.25). In order to minimize the statistical implications of various imputation methods, the GGPM team adopted the simplest approach of the Happy Planet Index, which imputed data only from the closest years; for instance, missing data for 2017 was imputed by data from 2016. In very few cases, the mean of the closest years was used when there was a lack of time series data to observe the trend, and only two data points were available.

Table 1 below provides information on data availability for the indicators and which indicators that were subjected to imputation. Out of the 36 indicators, 12 required imputations. However, four out of 10 indicators only needed imputation for one country. The indicators with the largest number of countries subjected to imputation include GJ1 Share of green employment in total manufacturing employment (GT1) and share of youth (aged 15-24 years) not in education, employment or training (SE3). Data for GJ1 were estimated by the United Nations Industrial Development Organization (UNIDO) based on the methods developed by Moll de Alba & Todorov (2018, 2019 in press). SE3 is an SDG indicator. Data for both indicators are expected to improve in the next years.

Table 1 Characteristics of the indicators in terms of data availability and required imputation

Indicator	Available Data	Baseline data	Number countries	Required imputation	Number of countries imputed	Type of imputation
Efficient and sustainable resource use						
EE1	1990–2015	2015	191	Yes	3	Data from 2014
EE2	1990–2015	2015	212	No	-	-
EW1	2015	2015	165	No	-	-
EW2	1998–2007, 2014	2014	184	No	-	-
SL1	2019	2019	243	No	-	-
SL2	2004–2016	2016	162	Yes	1	Data from 2015
ME1	1970–2015	2015	186	No	-	-
ME2	1990–2015	2015	174	No	-	-
Natural Capital Protection						
EQ1	1990–2016	2016	194	No	-	-
EQ2	2000–2017	2017	195	No	-	-
EQ3	2018	2018	216	No	-	-
GE1	1960–2014	2014	201	Yes	1	Data from 2013
GE2	1990–2010	2010	203	No	-	-
GE3	1961–2016	2016	226	No	-	-
BE1	2000–2018	2018	225	No	-	-
BE2	1990–2016	2016	208	Yes	1	Data from 2015
BE3	2016	2016	218	No	-	-
CV1	1993–2016	2016	223	No	-	-
CV2	2014–2017	2017	184	No	-	-
CV3	2016, 2017	2017	210	No	1	Data from 2016
Green Economic Opportunities						
GV1	1990–2017	2016	126	Yes	7	Closest data from 2012 to 2015
GT1	2000–2017	2016	148	Yes	15	Data from 2014 or 2015**
GJ1	2000–2015	2015	119	No	-	-
GN1	1980–2017	2016	93	Yes	10	Data from 2015**
Social Inclusion						
AB1	2000–2015	2015	117	No	-	-
AB2	2000–2017	2015	214	No	-	-
AB3	2000–2017	2017	203	No	-	-
GB1	1990, 1997–2017	2018	193	No	-	-
GB2	2011, 2014, 2017	2017	144	Yes	7	Data from 2014
GB3	2009–2018	2018	187	No	-	-
SE1	2010–2017	2017	156	Yes	5	Data from 2016

Table 1 Characteristics of the indicators in terms of data availability and required imputation *(continued)*

Indicator	Available Data	Baseline data	Number countries	Required imputation	Number of countries imputed	Type of imputation
Social Inclusion						
SE2	2000–2016	2016	203	No	-	-
SE3	1990–2018	2016	88	Yes	23	Data from 2015 or 2017
SP1	2015	2015	175	No	-	-
SP2	1990–2015	2015	194	No	-	-
SP3	2000, 2005, 2010, 2014, 2016	2016	118	Yes	8	Data from 2014

*Refers to Figure 1 for the definition of the indicator codes
**Few datapoints were imputed using mean of data from 2015 and 2017

Source: Acosta et al. (2019), pp. 33-34.

Distribution and outliers

An outlier is an observed value that has an "abnormal distance," whether extremely large or small value, from other values of a dataset (NIST-SEMATECH, 2013). Outliers can "distort mean, standard deviation and the covariance structure of the indicator" and alter correlation between indicators (Mishra, 2008). They also affect the normalized values of the indicators and thus need to be identified and accounted for (Nardo et al., 2005; OECD & JRC, 2008). Boxplots of the indicators were computed to show the distribution of numerical data and identify extreme values or outliers in the indicators. Figure 13 illustrates the boxplot for the ratio of the total primary energy supply to GDP, showing the presence of extreme outliers. It also shows the interpretation of the boxplots of the indicators.

Table 2 summarizes the information from the boxplots, which were used to identify the outliers and the indicators that needed capping, where:

IQR = 75th percentile - 25th percentile

Lower fence = 25th percentile - μ x IQR

Upper fence = 75th percentile + μ x IQR

With μ = 3.0 the multiplier.

Although 2.2 is the recommended multiplier (Hoaglin & Iglewicz, 1987; Iglewicz & Banerjee, 2001), the GGPM team used a relatively higher multiplier to avoid generating too many extreme outliers and capping the data of many countries. Moreover, 3.0 is mostly applied in many standard statistical software to compute for extreme outliers. In some cases, the normalization approach that was used to compute the Green Growth Index allowed capping of the outliers through benchmarking. As explained in detail in Chapter 5.6.2, this will depend on the relationship of the indicator to green growth, whether negative or positive, and value of the indicators relative to the sustainability targets, whether above or below. When extreme outliers cannot be capped through

benchmarking, they were capped prior to normalization. This is the case for the following indicators. Table 2 presents the number of capped values.

- EE1: Ratio of total primary energy supply to GDP (MJ per $2011 PPP GDP)
- EW2: Share of freshwater withdrawal to available freshwater resources (Percent)
- ME2: Total material footprint (MF) per capita (MF tons per capita)
- EQ1: PM2.5 air pollution, mean annual population weighted exposure (Micrograms per m3)
- EQ2: DALY rate as affected by unsafe water sources (DALY lost per 100,000 persons)
- EQ3: Municipal solid waste (MSW) generation per capita (Tons per year per capita)
- GE1: Ratio of CO2 emissions to population, excluding AFOLU (Metric tons per capita)
- GE2: Ratio of non-CO2 emissions to population, excluding AFOLU (Tons per capita)
- GE3: Ratio of non-CO2 emissions in agriculture to population (Gigagrams per 1,000 persons)
- GV1: Adjusted net savings minus natural resources and pollution damages (Percent of GNI)
- SE2: Ratio of urban-rural access to basic services, such as water, sanitation, and electricity (Percent)

Capping outliers implies replacing extreme values with other values that more or less correspond to the structure of the rest of the dataset or the normal distribution. For the Green Growth Index, the GGPM team used the values of the lower and upper fences depending on whether the extreme outliers are beyond lower or upper fences as shown in Appendix 2. Except for the adjusted net savings minus natural resources and pollution damages (GV1), all other indicators with extreme outliers took the upper fence as their capped values.

Table 2 Summary of information for identifying and capping outliers

Indicator codes	25th Percentile	75th Percentile	IQR	Lower Fence	Upper Fence	Sustainability Targets*	Number Outliers**
Efficient and Sustainable Resource Use							
EE1	3.49	6.36	2.88	-5.15	15.00	1.09	6
EE2	5.08	46.91	41.83	-120.40	172.39	51.40	0
EW1	4.00	32.30	28.30	-80.90	117.20	265.76	0
EW2***	1.96	30.10	28.14	-82.46	114.52	25.00	11
SL1	37.75	108.26	70.51	-173.79	319.79	289.34	0
SL2	0.14	3.20	3.06	-9.04	12.38	11.90	0
ME1	1.02	5.08	4.06	-11.15	17.25	0.17	0
ME2	3.55	20.89	17.34	-48.47	72.91	5.00	3
Natural Capital Protection							
EQ1	15.28	46.25	30.97	-77.62	139.14	10.00	4
EQ2	33.52	1085.98	1052.47	-3123.88	4243.38	0.00	7
EQ3	0.17	0.48	0.32	-0.78	1.43	0.00	1
GE1	0.81	6.19	5.38	-15.32	22.32	0.05	6
GE2	0.14	0.56	0.42	-1.13	1.82	0.00	17
GE3	0.22	0.93	0.71	-1.91	3.06	0.00	9
BE1	25.19	65.78	40.59	-96.58	187.55	100.00	0
BE2	10.93	48.06	37.13	-100.46	159.45	17.00	0
BE3	0.48	0.93	0.45	-0.86	2.27	1.16	0
CV1	0.78	0.94	0.16	0.30	1.42	1.00	0
CV2	25.00	80.00	55.00	-140.00	245.00	100.00	0
CV3	1.81	18.45	16.64	-48.11	68.37	13.50	0

Table 2 Summary of information for identifying and capping outliers *(continued)*

Indicator codes	25th Percentile	75th Percentile	IQR	Lower Fence	Upper Fence	Sustainability Targets*	Number Outliers**
Green Economic Opportunities							
GV1	1.02	14.73	13.71	-40.11	55.86	32.44	2
GT1	0.48	3.80	3.32	-9.48	13.76	13.52	0
GJ1	0.01	0.08	0.07	-0.20	0.29	0.14	0
GN1	0	0.02	0.02	-0.06	0.08	0.08	0
Social Inclusion							
AB1	51.93	92.88	40.95	-70.91	215.71	100.00	0
AB2	50.76	100.00	49.25	-96.98	247.74	100.00	0
AB3	43.82	78.44	34.62	-60.03	182.28	100.00	0
GB1	12.60	29.50	16.90	-38.10	80.20	50.00	0
GB2	1.03	1.26	0.23	0.36	1.93	1.00	0
GB3	50.00	100.00	50.00	-100.00	250.00	100.00	0
SE1	17.25	28.23	10.98	-15.68	61.15	7.96	0
SE2	1.00	1.36	0.36	-0.08	2.44	1.00	31
SE3	10.88	27.38	16.50	-38.62	76.88	0.00	0
SP1	16.87	98.55	81.68	-228.17	343.59	100.00	0
SP2	49.70	76.60	26.90	-31.00	157.30	100.00	0
SP3	12.33	53.08	40.75	-109.93	175.33	0.00	0

*Refers to Table 4 for details of the sustainability targets.
**Refers to outliers that were capped prior to normalization.
*** The share of freshwater withdrawal to available freshwater resources has a lower bound (25 percent) and an upper bound (75 percent). The extreme outliers refer to the upper bound, so the capped outliers assumed the values of the upper fence.

Source: ibid, pp. 35-36.

Normalization of indicators

Normalization is a key method when developing a composite index, particularly when the index builds on multidimensional concepts and covers a large number of indicators. It helps to transform indicators with different units into uniform scales and unitless numbers that allow meaningful comparisons (Nardo et al., 2005; Pollesch & Dale, 2016); align indicators with positive and negative relationships to the phenomenon, which, in the case of this report, is green growth (Mazziotta & Pareto, 2013); and reduce uneven influence of indicators with extreme values on the index (Talukder, Hipel, & VanLoon, 2017). The most common methods for normalization include ranking; distance to target, or the best performer; standardization, or z-scores; re-scaling, or min-max transformation; and proportionate normalization (Nardo et al., 2005; Saisana & Saltelli, 2011; Mazziotta & Pareto, 2013; Talukder et al., 2017). There are no general rules for selecting appropriate normalization methods, so they are commonly based on subjective or expert judgement (Böhringer & Jochem, 2006; Hsu, Johnson, & Lloyd, 2013). But the choice of methods should consider properties of the indicators and objectives for constructing the composite index (Nardo et al., 2005; OECD, 2018).

Rescaling method, also known as min-max transformation, was chosen to normalize the indicators in the Green Growth Index for the following reasons:

- It is simple and the most widely used method, which will allow replication of the Green Growth Index by governments at the national and subnational levels.
- It can integrate upper and lower bounds in the method, which will reduce the problems of extreme values and partially correct for outliers.
- It allows application of targets in the method, which will represent benchmarking of sustainability targets.

Rescaling (min-max)

Generally, the method rescales a given indicator xi into different intervals with an identical range between 0 and 1 based on a minimum (X_{min}) and a maximum (X_{max}) *(Equation 1)*.

Equation 1

$$X_{norm} = \frac{x_i - X_{min}}{X_{max} - X_{min}}$$

where: X_i^{norm} = normalised *ith* indicator
$X = (x_1, x_2 \ldots, x_n)$
$n = 1, 2 \ldots$, n number of countries

Many sustainability, environmental, and governance indices are using the rescaling method to normalize indicators. They include the Human Development Index of the United Nations Development Programme (UNDP), the Inclusive Green Growth Index of ADB, the Sustainable Society Index of the Sustainable Society Foundation (SSF), the Worldwide Governance Index of the World Bank (WB), the E-Government Development Index of the UN Public Administration Network, and the Democracy Index of the Economist Intelligence Unit (EIU). The range of the indices, however, is often not [0,1] because the rescaling method offers the advantage of setting boundaries (Talukder et al., 2017). *For further details, see pp 37-39, ibid.*

Weights of indicators and dimensions

Weights determine the relative importance of the indicators to each other. It entails the use of expert or subjective judgement that can become complicated in case of a multidimensional concept (OECD & JRC, 2008; Michaela Saisana & Saltelli, 2011). Gan et al. (2017) broadly categorized methods for weighting indicators into three: statistic-based weighting, public/expert opinion-based weighting, and equal weighting.

Statistic-based weighting uses quantitative methods to identify explicit weights, such as the principal component analysis, the data envelopment analysis, and the conjoint analysis (Nardo et al., 2005; OECD & JRC, 2008; Greco et al., 2018). The principal component analysis (PCA) is widely used to transform data into fewer dimensions and provides summaries of characteristics of high-dimensional data (Lever, Krzywinski, & Altman, 2017; Lever et al. 2017), but it can also be used to generate weights for the indicators based on the factor loadings (Chao & Wu, 2017; Hong-jun & Jin-feng, 2013). The GGPM team used PCA to compute the weights for the indicators

(Appendix 4). The PCA weights, however, were not used in computing the Green Growth Index for two reasons: first, properties of the data influence the weights, which are expected to change when a new dataset with different structures are added to the composite index (Chapter 7.1); second, according to OECD & JRC (2008), this weight construction method is not valid and can be misleading for policy-guiding indicators. The weights from the PCA were used for the robustness check (see chapter 5.10).

The analytic hierarchy process (AHP) and the budget allocation process are examples of public or expert opinion-based weighting (Hudrliková, 2013). AHP is a participatory and multicriteria decision-making approach that informs about the relative importance of indicators based on their pairwise comparisons (Dedeke, 2013; Pakkar, 2014). In AHP, the subjective judgment of the experts influences the weights. To facilitate the participation of the experts in identifying weights for the indicators, a survey questionnaire on AHP was developed for the Green Growth Index and distributed during the regional consultation workshops. The results of AHP revealed that there is a large divergence in consensus not only across regions but also across dimensions of green growth (Appendix 4). For this reason, it makes it difficult to use the AHP results to assign weights to the indicators. A higher level of consensus would be needed to identify the appropriate weights for the indicators.

The GGPM team used equal weighting for the Green Growth Index. Equal weighting is the most commonly used method in composite indices (Gan et al., 2017; Greco et al., 2018). Equal weights, which are often based on normative assumptions or based on understanding of the underlying concepts, are applied in composite indices, such as the Human Development Index, the Ecological Footprint, the Genuine Saving Index, the Environmental Vulnerability Index, the Sustainable Society Index, and the Corruption Perception Index. By not using weights from either AHP or PCA, the GGPM team assumed implicitly that the indicators have equal weights. Explicitly, however, the indicators do not have equal weights because the dimensions have a different number of indicators. This is clearly revealed by the PCA results in Figure A4.1 (see Appendix 4), where more weights are estimated for dimensions with the least number of indicators.

Aggregation of indicators and dimensions

Aggregation reduces dimensionality and provides a single holistic value (Pollesch & Dale, 2016) to measure performance. The two most common and simple methods include linear aggregation using arithmetic mean and geometric aggregation using geometric mean (Santeramo, 2016), with the former being more widely applied than the latter (Greco et al., 2018). For example, the Environmental Vulnerability Index and the Corruption Perception Index use linear aggregation, while the Human Development Index and the Sustainable Society Index use the geometric aggregation. The choice of aggregation methods should consider the properties of data, level of compensability, and implications on policy (Table 5). Both methods were used at the different levels of aggregation of the Green Growth Index (Figure 15).

At level 1, the indicators were linearly aggregated into indicator categories using the arithmetic mean. An important consideration here is the compensability of the individual indicators in each indicator category. This allows countries with poor performance in one indicator, for instance, due to lack of resources, to be compensated by another indicator in the same indicator category.

In most cases, the level of correlation between indicators in the same category is not negligible (Chapter 5.5), which can be assumed that they have some degree of substitution. Moreover, at level 1 of aggregation, a rule on missing value for a category with more than four indicators was applied: Countries with more than 25 percent of missing values were dropped. This method was adopted from Jha et al. (2018) in developing ADB's Inclusive Green Growth Index, which allowed indicators with missing values to be "substituted" by other indicators. This rule was not applied for the indicators in resource efficiency and green economic opportunities, which have less than three indicators in each category.

At level 2, geometric aggregation was applied to the indicator categories to allow only partial compensability between indicators in each dimension. Similar to level 1, the 25 percent rule on missing values was applied to dimensions with more than four indicator categories, such as in the case of resource efficiency and green economic opportunities. This rule was not applied for the indicator categories under natural capital protection and social inclusion, which have only three categories each.

At level 3, geometric aggregation was applied to the dimensions, and the 25 percent rule on missing values was not applied. At this level of aggregation, no dimension was allowed to easily substitute for the other dimensions to improve the Green Growth Index. Thus, as the level of aggregation increases, the level of substitutability decreases.

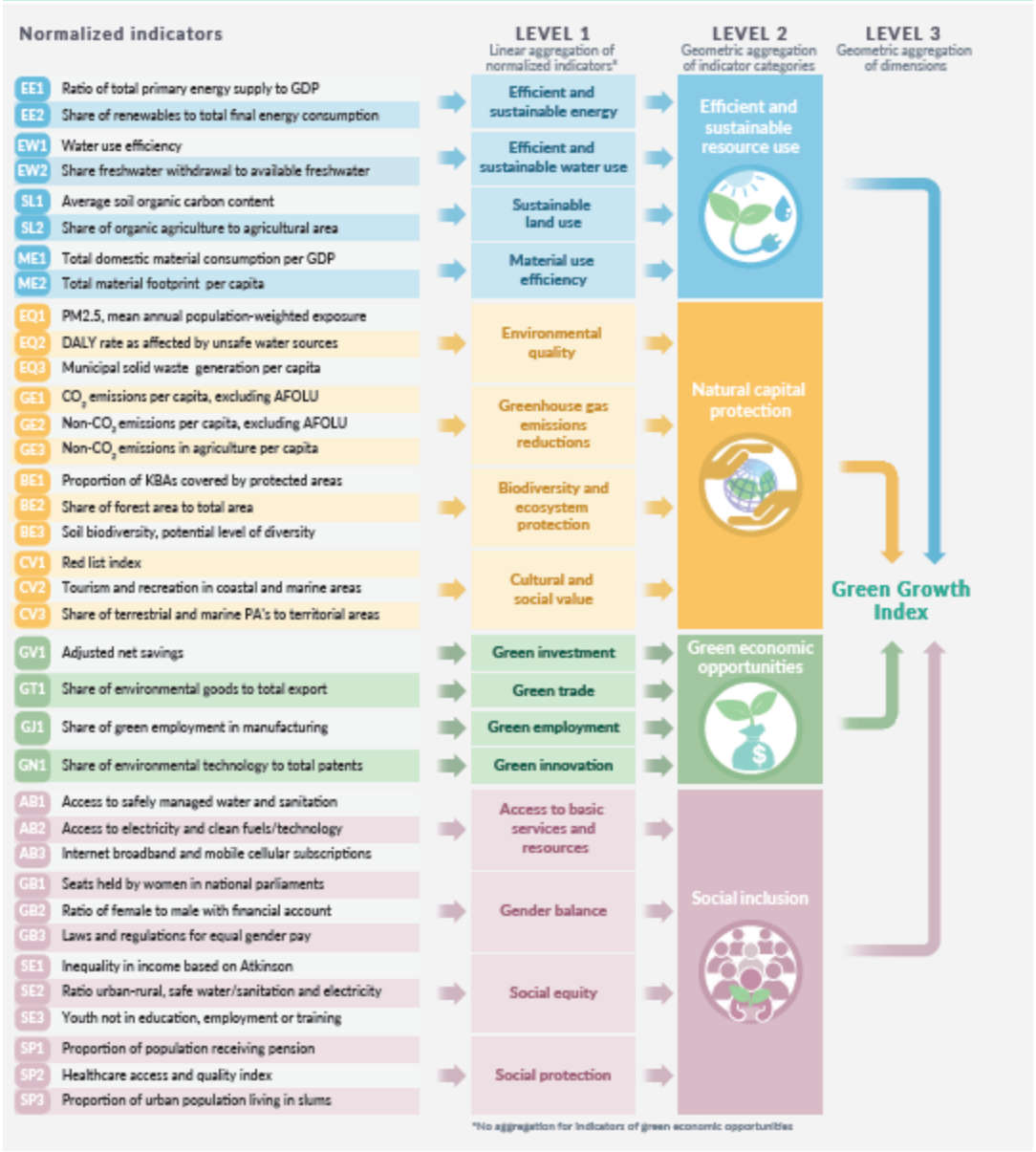
Table 5 Comparison of linear and geometric aggregations

Characteristics	Types of aggregation methods	
	Linear/Additive	Geometric/Multiplicative
Data properties	A useful method when all individual indicators have the same measurement units, and further ambiguities due to the scale effects have been neutralized.	An appropriate method when noncomparable and strictly positive individual indicators are expressed in different ratio scales.
	It is useful when the underlying indicators are correlated.	It is useful in the presence of minor outliers.
Compensability	Full and constant compensability is allowed, such that deficits in one dimension can be traded off or substituted with surplus in another. Weights are substitution rates and depend on the trade-off value.	Partial compensability, limiting the ability of indicators with very low scores to be fully compensated for by indicators with high scores. No indicator's range dominates the mean values.
Policy implications	Priority will be to continue specializing in sectors where country has a comparative advantage.	Priority will be to increase in performance in sectors with the lowest score to improve overall ranking.

Sources: (OECD & JRC, 2008; Nardo & Saisana, 2008; Munda & Nardo, 2005; Saisana & Saltelli, 2011; Hudrliková, 2013; Gan et al., 2017; Greco et al., 2018).

Source: ibid., p. 46.

Figure 15 Methods of aggregation at the indicator, indicator category, and dimension levels



Source: ibid., p. 47.

Further methodological issues discussed in Acosta et al. (2019):

- Robustness check, sensitivity analysis, uncertainty analysis
- Dimensions by regions

Data availability

Availability of data is another important challenge that affects the relevance of the indicators. The GGPM team considered indicators to be of high relevance for the framework if they are not only conceptually relevant but also publicly available. The completeness or lack of the data influences scores of the Green Growth Index. For example, a country with complete data for all indicators for green economic opportunities will have lower scores if one of the four indicators have a value of zero, thus pulling values of other indicators down. In contrast, another country with incomplete data will have a higher score because the fourth indicator, which may also have a value of zero but missing and unknown, will be excluded by default. The lack of data thus causes some level of uncertainty in the results of the Green Growth Index. Allowing missing values is, however, necessary for two reasons: first, to allow substitutability of indicators that represent the same concept as represented by the indicator category; second, to maintain a larger number of countries until the last level of aggregation. Not allowing for substitutability at the first and second levels of aggregation will exclude countries with missing values. Table 10 provides information on data gaps for indicators in the Green Growth Index by region and their implications on the number of countries.

If there were no missing values, the index could be computed for about 207 countries globally. Due to data gaps, however, the current index has been computed only for 115 countries (Figure 3). The data gap is the largest for the indicators for green economic opportunities, with Oceania and Africa having as high as 83 percent and 61 percent missing values, respectively. There are no data gaps for the indicators for natural capital protection in any of the regions. Data gaps for each country are presented in Table A1.14 (Appendix 1).

References

Acosta, L.A., P. Maharjan, H. Peyriere, L. Galotto, R.J. Mamiit, C. Ho, B.H. Flores, and O. Anastasia. (2019). Green Growth Index: Concepts, Methods and Applications, GGGI Technical report No. 5, Green Growth Performance Measurement (GGPM) Program, Global Green Growth Institute, Seoul.

https://greengrowthindex.gggi.org/wp-content/uploads/2019/12/Green-Growth-Index-Technical-Report_20191213.pdf

Acosta, L.A (2019). Metadata. Green Growth Index. Concepts, Methods and Applications. Global Green Growth Institute: Seoul, Republic of Korea https://greengrowthindex.gggi.org/wp-content/uploads/2019/10/Appendix_Metadata.pdf

Additional references (cited in the text above) can be found in the list of References in the above-mentioned two reports.

6. Just Transition Score

The Just Transition Score by the Social Progress Imperative (a global nonprofit based in Washington, DC) shows where the Paris Agreement Goals are met - reducing our carbon emissions while adapting to climate change and improving the quality of life of people. The Just Transition Score combines the comprehensive, human-centered measurement of the Social Progress Index with data on countries' consumption-based per capita CO_2 emissions.

The purpose of the Just Transition Score (JTS) is to measure the carbon efficiency of social progress of each country. Based on the ratio of consumption-based CO_2 emissions per capita to the Social Progress Index (SPI), it measures the per capita carbon content in each unit of SPI. The higher the ratio, the less carbon efficient a country is in generating social progress. This approach allows to account for the performance in social progress (as measured by the SPI) as well as for the extent of environmental damage (as measured by the CO_2 emissions), thereby summarizing countries' environmental sustainability of social progress, and providing trends over time.

Covering 158 countries, the Just Transition Score tracks progress over time from 2011-2022.

I. Information on individual indicators

Table 6.1: List of individual indicators

Dimension	Code	Name	Data source	Timeliness
Basic human needs	1.1	Child stunting	Institute for Health Metrics and Evaluation	2011-
	1.2	Infectious diseases	Institute for Health Metrics and Evaluation	2011-
	1.3	Maternal mortality rate	Institute for Health Metrics and Evaluation	2011-
	1.4	Child mortality rate	UN Inter-agency Group for Child Mortality Estimation	2011-
	1.5	Undernourishment	Food and Agriculture Organization of the United Nations	2011-
	1.6	Diet low in fruits and vegetables	Institute for Health Metrics and Evaluation	2011-
	1.7	Unsafe water, sanitation and hygiene	Institute for Health Metrics and Evaluation	2011-
	1.8	Access to improved sanitation	Institute for Health Metrics and Evaluation	2011-
	1.9	Access to improved water source	Institute for Health Metrics and Evaluation	2011-
	1.10	Satisfaction with water quality	Gallup World Poll	2011-
	1.11	Household air pollution	Institute for Health Metrics and Evaluation	2011-
	1.12	Access to electricity	SE4ALL Global Tracking Framework (World Bank, International Energy Agency, and the Energy Sector Management Assistance Program)	2011-
	1.13	Usage of clean fuels and technology for cooking	WHO	2011-
	1.14	Dissatisfaction with housing affordability	Gallup World Poll	2011-
	1.15	Transportation related injuries	Institute for Health Metrics and Evaluation	2011-
	1.16	Interpersonal violence	Institute for Health Metrics and Evaluation	2011-
	1.17	Political killings and torture	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	1.18	Intimate partner violence	Institute for Health Metrics and Evaluation	2011-
	1.19	Money stolen	Gallup World Poll	2011-
Foundations of well-being	2.1	Equal access to quality education	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	2.2	Population with no schooling	Institute for Health Metrics and Evaluation	2011-
	2.3	Secondary school attainment	UNDP Human Development Data	2011-
	2.4	Primary school enrollment	UNESCO Institute for Statistics	2011-
	2.5	Gender parity in secondary attainment	UNDP Human Development Data	2011-
	2.6	Alternative sources of information index	Varieties of Democracy (V-Dem), Dataset Version 12	2011-

	2.7	Mobile telephone subscriptions	International Telecommunications Union	2011-
	2.8	Internet users	International Telecommunications Union	2011-
	2.9	Access to online governance	UN Department of Economic and Social Affairs E-Government Survey	2011-
	2.10	Equal access to quality healthcare	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	2.11	Life expectancy at 60	Institute for Health Metrics and Evaluation	2011-
	2.12	Premature deaths from non-communicable diseases	Institute for Health Metrics and Evaluation	2011-
	2.13	Access to essential health services	Institute for Health Metrics and Evaluation	2011-
	2.14	Satisfaction with availability of quality healthcare	Gallup World Poll	2011-
	2.15	Lead exposure	Institute for Health Metrics and Evaluation	2011-
	2.16	Particulate matter pollution	Institute for Health Metrics and Evaluation	2011-
	2.17	Outdoor air pollution	Institute for Health Metrics and Evaluation	2011-
	2.18	Species protection	Environmental Performance Index Map of Life	2011-
Opportunity	3.1	Freedom of religion	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.2	Property rights of women	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.3	Freedom of peaceful assembly	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.4	Access to justice	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.5	Freedom of discussion	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.6	Political rights	Freedom House	2011-
	3.7	Early marriage	UN Population Division	2011-
	3.8	Satisfied demand for contraception	UN Population Division	2011-
	3.9	Young people not in education, employment or training	ILO	2011-
	3.10	Vulnerable employment	ILO	2011-
	3.11	Perception of corruption	Transparency International	2011-
	3.12	Freedom of domestic movement	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.13	Equal protection index	Varieties of Democracy (V-Dem), Dataset Version 12	2011-

	3.14	Equal access index	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.15	Power distributed by sexual orientation	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.16	Access to public services distributed by social group	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.17	Acceptance of gays and lesbians	Gallup World Poll	2011-
	3.18	Discrimination and violence against minorities	Fund for Peace Fragile States Index	2011-
	3.19	Academic freedom	Varieties of Democracy (V-Dem), Dataset Version 12	2011-
	3.20	Women with advanced education	Institute for Health Metrics and Evaluation	2011-
	3.21	Expected years of tertiary schooling	UNESCO Institute for Statistics	2011-
	3.22	Citable documents	Scimago Journal & Country Rank	2011-
	3.23	Quality weighted universities	Times Higher Education World University Rankings, QS World University Rankings, and Academic Ranking of World Universities; Varieties of Democracy (V-Dem), Dataset Version 12; SPI calculations	2011-

Data

Table 6.2: Data source of specific indicators - Just Transition Score

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
1	Child stunting	Risk-weighted prevalence of stunting in children under 5 (0=low risk; 100=high risk)	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
2	Infectous diseases	DALYs caused by infectious diseases/100,000 people	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
3	Maternal mortality rate	deaths/100,000 livebirths in women aged 10-54 years	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/ihme-data/gbd-2017-health-related-sdgs-1990-2030	2011-2022	national
4	Child mortality rate	Probability of dying between birth and exactly 5 years of age/1,000 livebirths	UN Inter-agency Group for Child Mortality Estimation	http://www.childmortality.org/	2011-2022	national
5	Undernourishment	Comparing a probability distribution of habitual daily dietary energy consumption with a threshold level called the minimum dietary energy requirement (% of population)	Food and Agriculture Organization of the United Nations	http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/	2011-2022	national
6	Diet low in fruits and vegetables	Risk-weighted, age-standardized prevalence of nutrition low in fruits and vegetables (0=low risk; 100=high risk)	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
7	Unsafe water, sanitation and hygiene	DALYs attributable to unsafe water, sanitation and hygiene/100,000 people	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
8	Access to improved sanitation	Proportion of population with access to specific improved toilet types	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/global-burden-disease-study-2019-gbd-2019-covariates-1980-2019	2011-2022	national

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
9	Access to improved water source	Proportion of population with access to specific improved water sources	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/global-burden-disease-study-2019-gbd-2019-covariates-1980-2019	2011-2022	national
10	Satisfaction with water quality	The proportion of respondents answering 'satisfied' to the question, "In the city or area where you live, are you satisfied or dissatisfied with the quality of water?"	Gallup World Poll	https://ga.gallup.com/	2011-2022	national
11	Household air pollution	DALYs caused by household air pollution from solid fuels/100,000 people	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
12	Access to electricity	Percentage of the population with access to electricity	SE4ALL Global Tracking Framework (World Bank, International Energy Agency, and the Energy Sector Management Assistance Program)	https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS	2011-2022	national
13	Usage of clean fuels and technology for cooking	Proportion of population primarily using clean cooking fuels and technologies for cooking	World Health Organization	https://apps.who.int/gho/data/node.main.SDGFUELS712?lang=en	2011-2022	national
14	Dissatisfaction with housing affordability	The proportion of respondents answering 'dissatisfied' to the question, "In the city or area where you live, are you satisfied or dissatisfied with the availability of good, affordable housing?"	Gallup World Poll	https://ga.gallup.com/	2011-2022	national
15	Transportation related injuries	DALYs due to injuries related to transportation/100,000 people	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
16	Interpersonal violence	DALYs from interpersonal violence/100,000 people	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
17	Political killings and torture	Based on indicators that reflect violence committed by government agents and that are not directly referring to elections (0=low freedom; 100=high freedom)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
18	Intimate partner violence	Percentage of women aged 15+ who experienced physical or sexual violence by a current or former intimate partner in the last 12 months	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/ihme-data/gbd-2017-health-related-sdgs-1990-2030	2011-2022	national
19	Money stolen	Proportion of respondents answering 'yes' to the question, "Within the last 12 months, have you had money or property stolen from you or another household member?"	Gallup World Poll	https://ga.gallup.com/	2011-2022	national
20	Equal access to quality education	Aggregated evaluation of the question, "To what extent is high quality basic education guaranteed to all, sufficient to enable them to exercise their basic rights as adult citizens?" (0=unequal; 4=equal)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
21	Population with no schooling	Proportion of population with no schooling	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/global-burden-disease-study-2019-gbd-2019-covariates-1980-2019	2011-2022	national
22	Secondary school attainment	Proportion of population aged 25+ with some secondary education	United Nations Development Programme (UNDP) Human Development Data	http://hdr.undp.org/en/data	2011-2022	national
23	Primary school enrollment	Percentage of the total population of official primary school age	UN Educational, Scientific, and Cultural Organization	http://data.uis.unesco.org/	2011-2022	national

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
			Institute for Statistics			
24	Gender parity in secondary attainment	Absolute deviation from parity (=1) in secondary education attainment of women and men	United Nations Development Programme (UNDP) Human Development Data	http://hdr.undp.org/en/data	2011-2022	national
25	Alternative sources of information index	Aggregated evaluation of the questions: To what extent is the media (a) un-biased in their coverage or lack of coverage of the opposition, (b) allowed to be critical of the regime, and (c) representative of a wide array of political perspectives? (0=low risk; 1=high risk)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
26	Mobile telephone subscriptions	Number of mobile telephone subscriptions per 100 inhabitants.	International Telecommunications Union	http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx	2011-2022	national
27	Internet users	Estimated number of Internet users out of the total population	International Telecommunications Union	http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx	2011-2022	national
28	Access to online governance	The availability of e-participation tools on national government portal for e-information, e-consultation, e-decision-making (0=low risk; 1=high risk)	UN Department of Economic and Social Affairs E-Government Survey	https://publicadministration.un.org/egovkb/en-us/Data-Center	2011-2022	national
29	Equal access to quality healthcare	Aggregated evaluation of the question, "To what extent is high quality basic healthcare guaranteed to all, sufficient to enable them to exercise their basic political rights as adult citizens?" (0=unequal; 4=equal)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
30	Life expectancy at 60	The average number of years that a person of 60 to 64 years of age could expect to live	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
31	Premature deaths from non-communicable diseases	Mortality rate due to non-communicable diseases among populaions aged 30-70	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/ihme-data/gbd-2017-health-related-sdgs-1990-2030	2011-2022	national
32	Access to essential health services	Measures the coverage of 9 tracer interventions and risk-standardized death rates from 32 causes amenable to personal healthcare (0=none; 100=full coverage)	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/global-burden-disease-study-2019-gbd-2019-covariates-1980-2019	2011-2022	national
33	Satisfaction with availability of quality healthcare	The proportion of respondents answering 'satisfied' to the question, In the city or area where you live, are you satisfied or dissatisfied with the availability of quality healthcare?	Gallup World Poll	https://ga.gallup.com/	2011-2022	national
34	Lead exposure	DALYs attributable to lead exposure/100,000 people	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
35	Particulate matter pollution	Population-weighted mean annual exposure µg/m3	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/global-burden-disease-study-2019-gbd-2019-covariates-1980-2019	2011-2022	national
36	Outdoor air pollution	DALYs resulting from ambient particulate matter pollution/100,000 people	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/gbd-results-tool	2011-2022	national
37	Species protection	Calculated using remote sensing data, global biodiversity informatics, and integrative models to map suitable habitat for over 30,000 terrestrial species at high resolutions (0=low; 100=high)	Environmental Performance Index Map of Life	https://mol.org/indicators/	2011-2022	national

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
38	Freedom of religion	Aggregated evaluation of the question, "Is there freedom of religion?" (0=no freedom; 4=full freedom)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
39	Property rights of women	Aggregated evaluation of the question, "Do women enjoy the right to private property?" (0=no rights; 5=full rights)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
40	Freedom of peaceful assembly	Aggregated evaluation of the question, "To what extent do state authorities respect and protect the right of peaceful assembly?" (0=no freedom; 4=full freedom)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
41	Access to justice	Aggregated evaluation of the question, "Do citizens enjoy secure and effective access to justice?" (0=nonexistent; 1=full observed)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
42	Freedom of discussion	Aggregated evaluation of the question, "Are citizens able to openly discuss political issues in private homes and in public spaces?" (0=low; 1=high)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
43	Politcal rights	Evaluation of three subcategories of political rights: electoral process, political pluralism and participation, and functioning of government (0 and lower=no rights; 40=full rights)	Freedom House	https://freedomhouse.org/report-types/freedom-world	2011-2022	national
44	Early marriage	Percentage of women married or in-union aged 15-19	United Nations Population Division	https://www.un.org/en/development/desa/population/theme/marriage-unions/marriage_estimates.asp	2011-2022	national
45	Satisfied demand for contraceptio n	Percentage of total demand for family planning among married or in-union women aged 15 to 49 satisfied with modern methods	United Nations Population Division	http://www.un.org/en/development/desa/population/theme/family-planning/cp_model.shtml	2011-2022	national
46	Young people not in education,	The proportion of youth (15-24 year olds) who are not in employment and not in education or training	International Labor Organization	https://ilostat.ilo.org/data/	2011-2022	national

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
	employment or training					
47	Vulnerable employment	Contributing family workers and own-account workers as a percentage of total employment	International Labor Organization/World Bank	https://data.worldbank.org/indicator/SL.EMP.VULN.ZS	2011-2022	national
48	Perception of corruption	Perceived level of public sector corruption (0=high corruption; 100=low corruption)	Transparency International	http://www.transparency.org/cpi	2011-2022	national
49	Freedom of domestic movement	Aggregated evaluation of the question, "Do citizens enjoy freedom of movement and residence?" (0=low; 1=high)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
50	Equal protection index	Aggregated evaluation of the question, "How equal is the protection of rights and freedoms across social groups by the state?" (0=low; 1=high)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
51	Equal access index	Aggregated evaluation of the question, "How equal is access to power?" (0=low; 1=high)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
52	Power distributed by sexual orientation	Aggregated evaluation of the question, "To what extent is political power distributed according to sexual orientation?" (0=extremely unequal; 3=equal)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
53	Access to public services distributed by social group	Aggregated evaluation of the question, "Are basic public services, such as order and security, primary education, clean water, and healthcare, distributed equally across social groups?" (0=extremely unequal; 4=equal)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
54	Acceptance of gays and lesbians	Proportion of respondents answering yes to the question, “Is the city or area where you live a good place or not a good place to live for gay or lesbian people?”	Gallup World Poll	https://ga.gallup.com/	2011-2022	national

6. Just Transition Score

Nº	Specific variables list	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
55	Discrimination and violence against minorities	Group Grievance indicator (0=low; 10=high)	Fund for Peace Fragile States Index	https://fragilestatesindex.org/	2011-2022	national
56	Academic freedom	Aggregated evaluation of the question, "To what extent is academic freedom respected?" (0=low; 1=high)	Varieties of Democracy (V-Dem), Dataset Version 12	https://v-dem.net/vdemds.html	2011-2022	national
57	Women with advanced education	Proportion of females with 12–18 years of education	Institute for Health Metrics and Evaluation	http://ghdx.healthdata.org/record/global-burden-disease-study-2019-gbd-2019-covariates-1980-2019	2011-2022	national
58	Expected years of tertiary schooling	Number of years a person of tertiary school entrance age can expect to spend within tertiary education	UN Educational, Scientific, and Cultural Organization Institute for Statistics	http://data.uis.unesco.org/	2011-2022	national
59	Citable documents	Citable documents/1,000 people	Scimago Journal & Country Rank	https://www.scimagojr.com/countryrank.php	2011-2022	national
60	Quality weighted universities	Number of universities in a country weighted by the quality of universities, measured by university rankings on any of the three most widely used international assessments	Times Higher Education World University Rankings, QS World University Rankings, and Academic Ranking of World Universities; Varieties of Democracy (V-Dem), Dataset Version 12; SPI calculations	https://www.timeshighereducation.com/world-university-rankings/2022 ; https://www.shanghairanking.com/rankings/arwu/2020 ; https://v-dem.net/vdemds.html	2011-2022	national

“To provide more reliable information on the environmental sustainability of countries, the Just Transition Score is using consumption-based CO_2 emissions, thus adding the emissions caused by the production of imported goods to domestic ones, and removing the emissions caused by exported goods, thereby correcting for spillovers from international trade.

Data for consumption-based CO_2 emissions were obtained from Our World in Data, where it is originally sourced from the Climate Watch. In addition, missing data points were imputed with linear regression predictions using modelled consumption-based CO_2 emissions as a predictor. The latter is provided by Eora Global Supply Chain Database. The last available year for CO_2 emissions data (2019) was shifted forward to 2022 to match the SPI’s year alignment.” (Green et al., 2022, p. 14)

II. Methodological issues related to the index

The approach allows to account for the performance in social progress (as measured by the SPI) as well as for the extent of environmental damage (as measured by the CO_2 emissions), thereby summarizing countries' environmental sustainability of social progress, and providing trends over time.This approach, however, requires a prior treatment to prevent the results being disproportionately influenced by the variable with higher dispersion. For instance, CO_2 emissions represent a variable with a significant skew (75% of countries emit less than 8t per capita annually, while the other 25% emit up to 50t) which makes the ratio heavily driven by CO_2 emissions in the numerator. This would yield results showing countries with extremely low CO_2 emissions per capita as the most carbon-efficient regardless of their performance in SPI, or in other words, reward poor countries and penalize the developed ones.

Dietz et al. (2012) and Jorgenson et al. (2014), addressed this complication by simply forcing the coefficient of variation of the numerator and denominator to be equal by adding a constant to one term (the numerator, in our case). This allows a simple linear transformation that shifts the mean without changing the variance, thus equalizing the coefficients of variation:

$$JTS = \frac{CO2\ p.c. + const}{SPI}$$

Where the equalizing constant const was obtained by the following formula:

$$const = \left(\frac{\sigma_{CO2} \cdot \mu_{SPI}}{\sigma_{SPI}}\right) - \mu_{co2}$$

Where σ and are the standard deviation and the mean of CO_2 emission and σ and μ are the standard deviation and mean of SPI. The values of the ratio are then inverted and scaled from 0 to 100 so that higher scores show better performance in the Just Transition Score:

$$JTS_{score} = \frac{max(JTS) - JTS_{it}}{max(JTS) - min(JTS)}$$

To calibrate the Just Transition Score the dystopian value max(JTS) was set to 1, assuming that in the worst case a country would have one unit of per capita CO_2 emissions per each unit of SPI. Similarly, the utopian value min(JTS) was set to (const/100) so that in the best case scenario, there are no CO_2 emissions per capita (except for the equalizing constant) in the numerator while there is the best possible SPI score (100) in the denominator.

To provide more reliable information on the environmental sustainability of countries, the Just Transition Score is using consumption-based CO_2 emissions, thus adding the emissions caused by the production of imported goods to domestic ones, and removing the emissions caused by exported goods, thereby correcting for spillovers from international trade.

Data for consumption-based CO_2 emissions were obtained from Our World in Data, where it is originally sourced from the Climate Watch. In addition, missing data points were imputed with linear regression predictions using modeled consumption-based CO_2 emissions as a predictor. The latter is provided by Eora Global Supply Chain Database. The last available year for CO_2 emissions data (2019) was shifted forward to 2022 to match the SPI's year alignment.

1. Management of missing data

For information on the methodology of the SPI, see the relevant chapter of this report. No information on the consumption based CO_2 emission is available in the documentation.

2. Treatment of outliers

For information on the methodology of the SPI, see the relevant chapter of this report. No information on the consumption based CO_2 emission is available in the documentation.

3. Normalisation (standardization)

For information on the methodology of the SPI, see the relevant chapter of this report. No information on the consumption based CO_2 emission is available in the documentation.

4. Weighting of pillars and dimensions

For information on the methodology of the SPI, see the relevant chapter of this report. No information on the consumption based CO_2 emission is available in the documentation.

5. Aggregation method

For information on the methodology of the SPI, see the relevant chapter of this report. No information on the consumption based CO_2 emission is available in the documentation.

References

Green, Michael, Jaromir Harmacek, Valeria Horton, Mohamed Htitich, Balaaj Ahmad Mustafa and Sophie Sutherland (2022). Just Transition Score. Social Progress Imperative, https://www.socialprogress.org/static/e1977d5b833d24ddcfd4a0ad381262f9/Just%20Transition%20Score%20-%20Social%20Progress%20Imperative-%202022.pdf

Stern, Scott, Jaromir Harmacek, Petra Krylova and Mohamed Htitich (2022). Social Progress Index. Methodological Report. Social Progress Imperative. https://www.socialprogress.org/static/96abc80d11ac298c6ef2e6ce4a149ff0/2022%20Social%20Progress%20Index%20Methodology__final__infosheets.docx.pdf

7. Legatum Prosperity Index

The Legatum Prosperity Index is a framework that assesses countries on the promotion of their residents' flourishing, reflecting both economic and social wellbeing. It captures the richness of a truly prosperous life, moving beyond traditional macroeconomic measurements of a nation's prosperity, which rely solely on indicators of wealth such as average income per person (GDP per capita).

I. Information on individual indicators

The index is built on 12 pillars of prosperity split into 67 discrete policy-focussed elements, and grouped into three domains essential to prosperity: Inclusive Societies, Open Economies, and Empowered People. 299 different indicators from over 70 different data sources are used to construct the Index.

The optimum structure for the Prosperity Index, was created with the involvement of expert advisers. Hundreds of variables were identified to underpin each element of prosperity. As a next step, the most relevant indicators within each element were identified, driven by a set of selection criteria as well as advice from external experts on data and research around each pillar. An extensive variety of publicly available data sources were used that gave comprehensive international coverage. This list was refined based on input from the experts in each pillar area, who advised on the reliability of data sources, alternative measures, and the credibility of indicators' measurement. Each of the 12 pillars captures a fundamental theme of prosperity, and each element captures a discrete policy area, which is measured by the indicators. Each pillar has between five and eight elements, and each element has between one and eight indicators.

The 299 indicators, as well as their data sources are described in a methodological paper by Legatum Institute titled Sources and Indicators.

Table 7.1: Individual indicators and data sources - Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
1	Two-sided conflict deaths	War and civil conflict	Safety and Security	deaths /1,000,000 population	(UCDP)	https://ucdp.uu.se/	2007-2022	national
2	Civil and ethnic war			coding, 0-9	(CSP)	https://www.systemicpeace.org/	2007-2022	national
3	Conflict-driven internal displacement			people /1,000,000 population	(IDMC)	http://www.internal-displacement.org/	2007-2022	national
4	Refugees (origin country)			people /1,000,000 population	(UNHCR)	https://www.unhcr.org/en-us/	2007-2022	national
5	Terrorism deaths	Terrorism		deaths /1,000,000 population	(GTD)	https://www.start.umd.edu/gtd/	2007-2022	national
6	Terrorism injuries			injuries /1,000,000 population	(GTD)	https://www.start.umd.edu/gtd/	2007-2022	national
7	Terrorism incidents			incidents /1,000,000 population	(GTD)	https://www.start.umd.edu/gtd/	2007-2022	national
8	Property cost of terrorism			US $ /billion US 2010 $	(GTD)	https://www.start.umd.edu/gtd/	2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
9	Political terror	Politically related terror and violence		index, 1-5	(PTS)	http://www.politicalterrorscale.org/	2007-2022	national
10	Extrajudicial killings			coding, 0-2	(CIRIGHTS)	https://www.binghamton.edu/institutes/hri/researcher-resources.html	2007-2022	national
11	Use of torture			coding, 0-2	(CIRIGHTS)	https://www.binghamton.edu/institutes/hri/researcher-resources.html	2007-2022	national
12	Disappearance cases			coding, 0-2	(CIRIGHTS)	https://www.binghamton.edu/institutes/hri/researcher-resources.html	2007-2022	national
13	Political imprisonment			coding, 0-2	(CIRIGHTS)	https://www.binghamton.edu/institutes/hri/researcher-resources.html	2007-2022	national
14	One-sided conflict deaths			deaths /1,000,000 population	(UCDP)	https://ucdp.uu.se/	2007-2022	national
15	Intentional homicides	Violent crime		homicides /100,000 population	(WB-DI)	https://datacatalog.worldbank.org/dataset/world-development-indicators	2007-2022	national
16	Dispute settlement through violence			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
17	Safety walking alone at night			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
18	Physical security of women			index, 0-4	(WomStat)	http://www.womanstats.org/	2007-2022	national
19	Property stolen	Property crime		percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
20	Business costs of crime and violence			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
21	Business costs of organised crime			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
22	Personal autonomy and individual rights	Agency	Personal Freedom	coding, 0-16	(FH)	https://freedomhouse.org/	2007-2022	national
23	Due process and rights			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
24	Freedom of movement			coding, 0-4	(CIRIGHTS)	https://www.binghamton.edu/institutes/hri/researcher-resources.html	2007-2022	national
25	Women's agency			coding, 0-16	(WomStat)	http://www.womanstats.org/	2007-2022	national
26	Freedom from arbitrary interference with privacy			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
27	Freedom from forced labour			index, 0-1	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
28	Government response to slavery			index, -10-100	(GSI)	https://www.globalslaveryindex.org/	2007-2022	national
29	Satisfaction with freedom			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
30	Right to associate and organise	Freedom of assembly and association		coding, 0-12	(FH)	https://freedomhouse.org/	2007-2022	national
31	Guarantee of assembly and association			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
32	Autonomy from the state			index, 0-1	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
33	Press freedom from government censorship	Freedom of speech and access to information		index, 0-100	(FH)	https://freedomhouse.org/	2007-2022	national
34	Press freedom from physical repression			index, 0-100	(RsF)	https://rsf.org/en	2007-2022	national
35	Freedom of opinion and expression			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
36	Government media censorship			coding, 0-4	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
37	Alternative sources of information			index, 0-1	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
38	Political diversity of media perspectives			coding, 0-3	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
39	Equal treatment and absence of discrimination	Absence of legal discrimination		expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
40	Non-discriminatory civil justice			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
41	Freedom from hiring and workplace discrimination			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
42	LGBT Rights			coding, 0-3	(ILGA)	https://ilga.org/	2007-2022	national
43	Protection of women's workplace, education and family rights			coding, 0-8	(WomStat)	http://www.womanstats.org/	2007-2022	national
44	Freedom of belief and religion			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
45	Government religious intimidation and hostility			index, 0-1	(Pew)	https://www.pewresearch.org/	2007-2022	national
46	Executive powers are effectively limited by the judiciary and legislature	Executive constraints	Governance	expert survey, 0-3	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
47	Government powers are subject to independent and non-governmental checks			expert survey, 0-3	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
48	Transition of power is subject to the law			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
49	Military involvement in rule of law and politics			index, 0-10	(FI)	https://www.fraserinstitute.org/	2007-2022	national
50	Government officials are sanctioned for misconduct			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
51	Consensus on democracy and a market economy as a goal	Political accountability		expert judgement, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
52	Political participation and rights			coding, 1-7	(FH)	https://freedomhouse.org/	2007-2022	national
53	Democracy level			expert judgement, -10-10	(CSP)	https://www.systemicpeace.org/	2007-2022	national
54	Complaint mechanisms			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
55	Judicial independence	Rule of law		expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
56	Civil justice			expert survey, 0-6	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
57	Integrity of the legal system			index, 0-10	(FI)	https://www.fraserinstitute.org/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
58	Efficiency of dispute settlement			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
59	Use of public office for private gain	Government integrity		expert survey, 0-4	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
60	Diversion of public funds			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
61	Anti-corruption policy			(...)	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
62	Clientelism			(...)	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
63	Legislative corruption			(...)	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
64	Judicial corruption			(...)	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
65	Executive corruption			(...)	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
66	Public sector corruption			(...)	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
67	Government quality and credibility	Government effectiveness		index, -2.5 - +2.5	(WGI)	https://info.worldbank.org/governance/wgi/	2007-2022	national
68	Prioritisation			expert judgement, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
69	Efficiency of government spending			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
70	Efficient use of assets			expert judgement, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
71	Implementation			expert judgement, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
72	Policy learning			expert judgement, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
73	Policy coordination			expert judgement, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
74	Right to information	Regulatory quality		expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
75	Publicised laws and government data			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
76	Transparency of government policy			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
77	Budget transparency			index, 0-100	(IBP)	https://www.internationalbudget.org/	2007-2022	national
78	Regulatory quality			index, -2.5 - +2.5	(WGI)	https://info.worldbank.org/governance/wgi/	2007-2022	national
79	Enforcement of regulations			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
80	Efficiency of legal framework in challenging regulations			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
81	Delay in administrative proceedings			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
82	Confidence in local police	Institutional trust		percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
83	Public trust in politicians			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
84	Confidence in financial institutions and banks			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
85	Confidence in judicial systems and courts			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
86	Confidence in national government			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
87	Confidence in military			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
88	Help from family and friends when in trouble	Personal and family relationships	Social Capital	percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
89	Family give positive energy			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
90	Respect	Social networks		percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
91	Opportunity to make friends			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
92	Helped another household			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
93	Generalised interpersonal trust	Interpersonal trust		percentage	(WVS)	https://www.worldvaluessurvey.org/wvs.jsp; https://europe-anvaluesstudy.eu/; https://www.globalbarometer.net; https://www.arabbarometer.org/; https://www.latinobarometro.org/latContents.jsp	2007-2022	national
94	Helped a stranger			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
95	Perceived tolerance of ethnic minorities	Social tolerance		percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
96	Perceived tolerance of LGBT individuals			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
97	Perceived tolerance of immigrants			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
98	Donated money to charity			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
99	Voter turnout	Civic and social participation		percentage (adjusted)	(IDEA)	https://www.idea.int/	2007-2022	national
100	Volunteering			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
101	Voiced opinion to a public official			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
102	Regulation of property possession and exchange	Property rights	Investment Environment	expert survey, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
103	Lawful process for expropriation			expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
104	Protection of property rights			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
105	Intellectual property protection			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
106	Quality of land administration			index, 0-8	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
107	Auditing and reporting standards	Investor protection		expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
108	Insolvency regulatory framework			index, 0-16	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
109	Recovery rate of insolvency			percentage	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
110	Shareholder governance			index, 0-10	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
111	Regulation of conflict of interest			index, 0-10	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
112	Alternative dispute resolution mechanisms	Contract enforcement		expert survey, 0-1	(WJP)	https://worldjusticeproject.org/our-work/wjp-rule-law-index	2007-2022	national
113	Contract intensity			(…)	(Harvard)	https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/8RPC9E	2007-2022	national
114	CPIA property rights and rule-based governance rating			(…)	(WB-CPIA)	https://datacatalog.worldbank.org/search/ dataset/0038988	2007-2022	national
115	Quality of banking system and capital markets	Financing ecosystem		expert survey, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
116	Venture capital availability			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
117	Soundness of banks			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
118	Financing of SMEs			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
119	Access to finance			percentage	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
120	Commercial bank branches			branches /100,000 adult population	(IMF-FAS)	https://data.imf.org/	2007-2022	national
121	National credit registry coverage (borrowers per 1,000 adults)			(…)	(WB)	https://data.worldbank.org/indicator/IC.CRD.PUBL.ZS	2007-2022	national
122	Business impact of rules on FDI	Restrictions on international investment		expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
123	Capital controls			percentage	(FI)	https://www.fraserinstitute.org/	2007-2022	national
124	Freedom to own foreign currency bank accounts			index, 0-10	(FI)	https://www.fraserinstitute.org/	2007-2022	national
125	Restrictions on financial transactions			index, 0-1	(Chinn-Ito)	http://web.pdx.edu/~ito/Chinn-Ito_website.htm	2007-2022	national
126	Prevalence of foreign ownership of companies			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
127	Freedom of foreigners to visit			index, 0-10	(FI)	https://www.fraserinstitute.org/	2007-2022	national
128	Market-based competition		Enterprise Conditions	expert survey, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
129	Anti-monopoly policy	Domestic market contestability		expert survey, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
130	Extent of market dominance			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
131	State ownership of the economy			(…)	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
132	Distortive effect of taxes and subsidies	Price distortion		expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
133	Energy subsidies			percentage of GDP	(IMF)	https://www.imf.org/external/index.htm	2007-2022	national
134	Private companies are protected and permitted	Environment for business creation		expert survey, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national
135	State of cluster development			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
136	Labour skill a business constraint			percentage	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
137	Availability of skilled workers			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
138	Taxes and bureaucracy	Burden of regulation		(…)	(WB-ALT)	https://www.worldbank.org/en/programs/business-enabling-environment/alternative-existing-indicators	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
139	Ease of paying taxes			(…)	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
140	Time spent complying with regulations			percentage	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
141	Burden of government regulation			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
142	Days to obtain a construction related permit			(…)	(WB-ALT)	https://www.worldbank.org/en/programs/business-enabling-environment/alternative-existing-indicators	2007-2022	national
143	Cooperation in labour-employer relations	Labour market flexibility		expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
144	Flexibility of hiring practices			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
145	Redundancy costs			weeks	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
146	Flexibility of employment contracts			index, 0-1	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
147	Flexibility of wage determination			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
148	International internet bandwidth	Communications	Infrastructure and	kilobits per capita	(ITU)	https://www.itu.int/en/Pages/default.aspx	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
149	2G, 3G and 4G network coverage		Market Access	index, 0-100	(GSMA)	https://www.gsma.com/	2007-2022	national
150	Fixed broadband subscriptions			number /100 population	(ITU)	https://www.itu.int/en/Pages/default.aspx	2007-2022	national
151	Internet usage			percentage	(ITU)	https://www.itu.int/en/Pages/default.aspx	2007-2022	national
152	Installed electric capacity	Energy		kilowatts per capita	(UNESD)	https://unstats.un.org/unsd/energy/edbase.htm	2007-2022	national
153	Number of electrical outages in a typical month			(...)	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
154	Average duration of a typical electrical outage			(...)	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
155	Time to obtain an electrical connection upon application			(...)	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
156	Gross fixed water assets	Water		USD per population served	(IBNET)	https://www.ib-net.org/	2007-2022	national
157	Water production			litres per capita per day	(IBNET)	https://www.ib-net.org/	2007-2022	national
158	Reliability of water supply			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
159	Logistics performance	Transport		index, 1-5	(WB-LPI)	https://lpi.worldbank.org/	2007-2022	national
160	Airport connectivity			index, 0-500	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
161	Efficiency of seaport services			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
162	Liner shipping connectivity			index, rebased to 100 in 2004	(UNCTAD)	https://unstats.un.org/unsd/trade/default.asp	2007-2022	national
163	Quality of roads			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
164	Road density			km /100 sq km of land area	(FAO)	http://www.fao.org/home/en/	2007-2022	national
165	Rail density			km per sq km of land area	(UIC)	https://ucdp.uu.se/	2007-2022	national
166	Efficiency of customs clearance process	Border administration		survey, 1-5	(WB-LPI)	https://lpi.worldbank.org/	2007-2022	national
167	Number of documents required to be filled out for exports			(...)	(WB-LPI)	https://lpi.worldbank.org/	2007-2022	national
168	Number of documents required to be filled out for imports			(...)	(WB-LPI)	https://lpi.worldbank.org/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
169	Clearance time with physical inspection			hours	(WB-LPI)	https://lpi.worldbank.org/	2007-2022	national
170	Average time to clear exports through customs (days)			(…)	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
171	Domestic and international market access for goods	Open market scale		percentage of global GDP	(WTO)	https://www.wto.org/	2007-2022	national
172	Domestic and international market access for services			percentage of global GDP	(WTO)	https://www.wto.org/	2007-2022	national
173	Trade-weighted average tariff faced in destination markets			percentage	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
174	Margin of preference in destination markets			index, 1-100	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
175	Share of imports free from tariff duties	Import tariff barriers		percentage	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
176	Average applied tariff rate			percentage	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
177	Complexity of tariffs			index, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
178	Extent of liberalisation of foreign trade	Market distortions		expert survey, 1-10	(BTI)	https://www.bti-project.org/en/home/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
179	Prevalence of non-tariff barriers			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
180	Non-tariff measures			number	(UNCTAD)	https://unstats.un.org/unsd/trade/default.asp	2007-2022	national
181	Government budget balance	Fiscal sustainability	Economic Quality	percentage	(IMF-WEO)	https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/index.aspx	2007-2022	national
182	Government debt			percentage	(IMF-WEO)	https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/index.aspx	2007-2022	national
183	Country credit rating			score, 0-100	(TE)	https://tradingeconomics.com/	2007-2022	national
184	Country risk premium			percentage	(AD)	http://pages.stern.nyu.edu/~adamodar/New_Home_ Page/data.html	2007-2022	national
185	Gross savings			percentage	(WB-DI & OECD)	https://datacatalog.worldbank.org/dataset/world-development-indicators; https://www.oecd.org/	2007-2022	national
186	GDP per capita growth	Macroeconomic stability		percentage	(WB-DI & OECD)	https://datacatalog.worldbank.org/dataset/world-development-indicators; https://www.oecd.org/	2007-2022	national
187	Inflation volatility			percentage	(IMF)	https://www.imf.org/external/index.htm	2007-2022	national
188	Labour productivity	Productivity and		2011 US $ PPP	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
189	Economic complexity	competitiveness		index, -3-3	(ECI)	https://oec.world/en/rankings/country/eci/	2007-2022	national
190	Export quality			index, 0-1.2	(IMF)	https://www.imf.org/external/index.htm	2007-2022	national
191	High-tech manufactured exports			percentage	(UNCOM)	https://comtrade.un.org/	2007-2022	national
192	New business density	Dynamism		number /100 working age population	(WB-ES)	https://www.enterprisesurveys.org/	2007-2022	national
193	Patent applications			applications /1,000,000 population	(WIPO)	https://www.wipo.int/portal/en/index.html	2007-2022	national
194	Capacity to attract talented people			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
195	Labour force participation	Labour force engagement		percentage	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national
196	Female labour force participation			percentage	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national
197	Waged and salaried workers			percentage	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national
198	Unemployment			percentage	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
199	Youth unemployment			percentage	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national
200	Poverty rate at national poverty lines	Material resources	Living Conditions	percentage	(WB-DI)	https://datacatalog.worldbank.org/dataset/world-development-indicators	2007-2022	national
201	Poverty rate at $1.90 a day			percentage	(WB-DI)	https://datacatalog.worldbank.org/dataset/world-development-indicators	2007-2022	national
202	Poverty rate at $3.20 a day			percentage	(WB-DI)	https://datacatalog.worldbank.org/dataset/world-development-indicators	2007-2022	national
203	Poverty rate at $5.50 a day			percentage	(WB-DI)	https://datacatalog.worldbank.org/dataset/world-development-indicators	2007-2022	national
204	Households with a refrigerator			percentage	(GDL)	https://globaldatalab.org/	2007-2022	national
205	Ability to source emergency funds			percentage	(WB-GFI)	https://globalfindex.worldbank.org/	2007-2022	national
206	Ability to live on household income			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
207	Availability of adequate food	Nutrition		percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
208	Prevalence of undernourishment			percentage	(FAO)	http://www.fao.org/home/en/	2007-2022	national
209	Prevalence of wasting in children under-5			percentage	(UNICEF, WHO, WB-DI)	https://www.unicef.org/; https://www.who.int/; https://datacatalog.worldbank.org/dataset/world-development-indicators	2007-2022	national
210	Prevalence of stunting in children under-5			percentage	(UNICEF, WHO, WB-DI)	https://www.unicef.org/; https://www.who.int/; https://datacatalog.worldbank.org/dataset/world-development-indicators	2007-2022	national
211	Access to electricity	Basic services		percentage	(IEA, IRENA, UNSD, WHO)	https://www.iea.org/; https://www.irena.org/; https://unstats.un.org/UNSDWebsite/; https://www.who.int/	2007-2022	national
212	Access to basic water services			percentage	(JMP)	https://www.unwater.org/publication_categories/ whounicef-joint-monitoring-programme-for-watersupply-sanitation-hygiene-jmp/	2007-2022	national
213	Access to piped water			percentage	(JMP)	https://www.unwater.org/publication_categories/ whounicef-joint-monitoring-programme-for-watersupply-sanitation-hygiene-jmp/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
214	Access to basic sanitation services			percentage	(JMP)	https://www.unwater.org/publication_categories/ whounicef-joint-monitoring-programme-for-watersupply-sanitation-hygiene-jmp/	2007-2022	national
215	Unsafe water, sanitation or hygiene			DALYs /100,000 population	(IHME)	http://www.healthdata.org/	2007-2022	national
216	Availability of adequate shelter	Shelter		percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
217	Housing deprivation			percentage	(OPHI)	https://ophi.org.uk/	2007-2022	national
218	Access to clean fuels and technologies for cooking			percentage	(WHO)	https://www.who.int/	2007-2022	national
219	Indoor air quality			DALYs /100,000 population	(IHME)	http://www.healthdata.org/	2007-2022	national
220	Access to a bank account	Connectedness		percentage	(WB-GFI)	https://globalfindex.worldbank.org/	2007-2022	national
221	Use of digital payments			percentage	(WB-GFI)	https://globalfindex.worldbank.org/	2007-2022	national
222	Access to a cellphone			percentage	(GDL)	https://globaldatalab.org/	2007-2022	national
223	Rural access to roads			percentage	(RAI)	https://datacatalog.worldbank.org/dataset/rural-access-in-dex-rai	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
224	Satisfaction with public transportation			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
225	Satisfaction with roads and highways			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
226	Death and injury from road traffic accidents	Protection from harm		DALYs /100,000 population	(IHME)	http://www.healthdata.org/	2007-2022	national
227	Death and injury from forces of nature			DALYs /100,000 population	(IHME)	http://www.healthdata.org/	2007-2022	national
228	Unintentional death and injury			DALYs /100,000 population	(GBD)	http://www.healthdata.org/gbd	2007-2022	national
229	Occupational mortality			deaths /100,000 labour force population	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national
230	Obesity	Behavioural risk factors	Health	percentage	(WHO-GDO)	https://www.who.int/mental_health/neurology/dementia/Global_Observatory/en/	2007-2022	national
231	Smoking			percentage	(WHO)	https://www.who.int/	2007-2022	national
232	Substance use disorders			number /100,000 population	(GBD)	http://www.healthdata.org/gbd	2007-2022	national
233	Diphtheria immunisation	Preventative interventions		percentage	(WHO & UNICEF)	https://www.who.int/; https://www.unicef.org/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
234	Measles immunisation			percentage	(WHO & UNICEF)	https://www.who.int/; https://www.unicef.org/	2007-2022	national
235	Hepatitis immunisation			percentage	(WHO & UNICEF)	https://www.who.int/; https://www.unicef.org/	2007-2022	national
236	Contraceptive prevalence			percentage	(UNPD)	https://www.un.org/development/desa/pd/	2007-2022	national
237	Antenatal care coverage			percentage	(UNICEF)	https://www.unicef.org/	2007-2022	national
238	Existence of national screening programs			percentage	(WHO)	https://www.who.int/	2007-2022	national
239	Healthcare coverage	Care systems		percentage	(ILO)	https://www.ilo.org/global/lang--en/index.htm	2007-2022	national
240	Health facilities			index, 0-0.3	(WHO)	https://www.who.int/	2007-2022	national
241	Health practitioners and staff			index, 0-1	(WHO)	https://www.who.int/	2007-2022	national
242	Births attended by skilled health staff			percentage	(UNICEF)	https://www.unicef.org/	2007-2022	national
243	Tuberculosis treatment coverage			percentage	(WHO)	https://www.who.int/	2007-2022	national
244	Antiretroviral HIV therapy			percentage	(UNAIDS)	https://www.unaids.org/en	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
245	Satisfaction with healthcare			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
246	Emotional wellbeing	Mental health		index, 0-1	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
247	Depressive disorders			years /100,000 population	(GBD)	http://www.healthdata.org/gbd	2007-2022	national
248	Suicide			deaths /100,000 population	(WHO)	https://www.who.int/	2007-2022	national
249	Physical pain	Physical health		percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
250	Health problems			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
251	Communicable diseases			years /100,000 population	(GBD)	http://www.healthdata.org/gbd	2007-2022	national
252	Non-communicable diseases			years /100,000 population	(GBD)	http://www.healthdata.org/gbd	2007-2022	national
253	Raised blood pressure			percentage	(WHO)	https://www.who.int/	2007-2022	national
254	Maternal mortality	Longevity		deaths /100,000 live births	(WHO, UNICEF, UNFPA, WB-DI, UNPD)		2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
255	Under 5 mortality			number /1,000 newborns	(UNIGME)	https://childmortality.org/	2007-2022	national
256	5–14 mortality			number /1,000 5 year-olds	(UNIGME)	https://childmortality.org/	2007-2022	national
257	15–60 mortality			number /1,000 15- year olds	(WHO)	https://www.who.int/	2007-2022	national
258	Life expectancy at 60			years	(WHO)	https://www.who.int/	2007-2022	national
259	Pre-primary enrolment (net)	Pre-primary education	Education	percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national
260	Primary enrolment	Primary education		percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national
261	Primary completion			percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national
262	Primary education quality			score, 0-625	(AltAng& Pat)	https://datacatalog.worldbank.org/ search?q=harmonized%20learning %20outcomes%20 hlo%20database	2007-2022	national
263	Secondary school enrolment	Secondary education		percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national
264	Lower-secondary completion			percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
265	Access to quality education			index, 0-4	(V-DEM)	https://www.v-dem.net/en/	2007-2022	national
266	Secondary education quality			score, 0-625	(AltAng& Pat)	https://datacatalog.worldbank.org/ search?q=harmonized%20learning %20outcomes%20 hlo%20database	2007-2022	national
267	Tertiary enrolment	Tertiary education		percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national
268	Tertiary completion			percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national
269	Average quality of higher education institutions			index, 0-1	(QS, TES)	https://www.topuniversities.com/ qs-world-university-rankings; https://www.timeshighereducation.com/content/ world-university-rankings	2007-2022	national
270	Skillset of university graduates			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
271	Quality of vocational training			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
272	Adult literacy	Adult skills		percentage	(UNESCO)	http://uis.unesco.org/	2007-2022	national
273	Education level of adult population			index, 0-1	(BL)	http://www.barrolee.com/	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
274	Women's average years in school			years	(IHME)	http://www.healthdata.org/	2007-2022	national
275	Education inequality			index, 0-1	(Cas&Dom)	https://ideas.repec.org/p/iei/wpaper/1201.html	2007-2022	national
276	Digital skills among population			expert survey, 1-7	(WEF)	http://reports.weforum.org/global-competitiveness-report-2018/	2007-2022	national
277	CO2 emissions	Emissions	Natural Environment	index, 0-1	(GCB & CW)	https://www.icos-cp.eu/science-and-impact/global-carbon-budget; https://www.climatewatchdata.org/ghg-emissions?end_year=2019&start_year=1990	2007-2022	national
278	SO2 emissions			index, 0-1	(EDGAR)	https://www.eea.europa.eu/themes/air/links/data-sources/emission-database-for-global-atmospheric	2007-2022	national
279	NOx emissions			index, 0-1	(EDGAR)	https://www.eea.europa.eu/themes/air/links/data-sources/emission-database-for-global-atmospheric	2007-2022	national
280	Black carbon emissions			index, 0-1	(EDGAR)	https://www.eea.europa.eu/themes/air/links/data-sources/emission-database-for-global-atmospheric	2007-2022	national
281	Methane emissions			index, 0-1	(EDGAR)	https://www.eea.europa.eu/themes/air/links/data-	2007-2022	national

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
						sources/emission-database-for-global-atmospheric		
282	Exposure to fine particulate matter	Exposure to air pollution		percentage	(EPI)	https://epi.envirocenter.yale.edu/	2007-2022	national
283	Health impact of air pollution			DALYs /100,000 population	(IHME)	http://www.healthdata.org/	2007-2022	national
284	Satisfaction with air quality			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
285	Forest area	Forest, land and soil		percentage	(FAO)	http://www.fao.org/home/en/	2007-2022	national
286	Flood occurrence			index, 0-5	(WRI)	https://www.wri.org/	2007-2022	national
287	Sustainable nitrogen management			index, 0-√2	(EPI)	https://epi.envirocenter.yale.edu/	2007-2022	national
288	Renewable water resources	Freshwater		m^3 per capita	(FAO)	http://www.fao.org/home/en/	2007-2022	national
289	Wastewater treatment			percentage	(EPI)	https://epi.envirocenter.yale.edu/	2007-2022	national
290	Freshwater withdrawal			percentage	(FAO)	http://www.fao.org/home/en/	2007-2022	national
291	Satisfaction with water quality			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national
292	Overexploitation of fish stocks	Oceans		percentage	(EPI)	https://epi.envirocenter.yale.edu/	2007-2022	national

7. Legatum Prosperity Index

Nº	Indicators	Elements	Pillar	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
293	Stability of marine biodiversity			index, 0-100	(EPI)	https://epi.envirocenter.yale.edu/	2007-2022	national
294	Clean ocean water			index, 0-100	(OHI)	http://www.oceanhealthindex.org/	2007-2022	national
295	Terrestrial protected areas	Preservation efforts		percentage	(WDPA)	https://www.protectedplanet.net/	2007-2022	national
296	Marine protected areas			percentage	(WDPA)	https://www.protectedplanet.net/	2007-2022	national
297	Long term management of forest areas			percentage	(FAO)	http://www.fao.org/home/en/	2007-2022	national
298	Protection for biodiverse areas			index, 0-1	(UNSDG)	https://sdgs.un.org/goals	2007-2022	national
299	Pesticide regulation			index, 0-25	(EPI)	https://epi.envirocenter.yale.edu/	2007-2022	national
300	Satisfaction with preservation efforts			percentage	(Gallup)	https://www.gallup.com/home.aspx	2007-2022	national

II. Methodological issues related to the index

1. Management of missing data

No information is available.

2. Treatment of outliers

No information is available.

3. Normalisation (standardization)

The indicators in the Index are based on many different units of measurement, including numbers of events, years, percentages, and ordinal scales. The indicators need to be normalised for comparison between indicators and countries to be meaningful. A distance to frontier approach was employed for this task. The distance to frontier approach compares a country's performance in an indicator with the value of the logical best case, as well as that of the logical worst case. As a result, the distance to frontier score captures a country's relative position. This approach also makes it possible to compare Index scores over time.

4. Weighting of pillars and dimensions

Each indicator is assigned a weight, indicating the level of importance within the element it has in affecting prosperity. Four weights are typically used: 0.5, 1, 1.5, or 2. Each indicator is weighted as 1 by default, but based on its significance to prosperity, this may be adjusted downwards or upwards accordingly. For example, an indicator with a weight of 2 means that it is twice as important in affecting the element as another indicator in that element with a weight of 1. Weights were determined by two factors, ordered by priority: (1) the relevance and significance of the indicator to prosperity, as informed by the academic literature and our experts' opinions, and, to a lesser degree, (2) the statistical significance of the indicator to the economic and social well-being of a country, as measured by productive capacity and Cantril's Ladder, respectively. Analogously, elements are assigned weights based on their relative importance within each pillar, led by the same two factors above. At the element level, percentages rather than factors are used as weights, giving a greater range of possible weights than at the indicator level.

When calculating scores for regions and the world as a whole, a population-weighted average score is taken. This is because the effect on individuals rather than countries is aimed to be captured. For example, if the scores of two countries change, then the more populous country has a greater effect on the global and regional scores than the less populous country. For the analysis on the bottom 40, middle 87 and top 40 countries, non-population weighted averages were used.

5. Aggregation method

Element scores are created using a weighted sum of indicator scores using the indicator weights assigned at the previous step. The same process is repeated to determine pillar scores with elements within the pillar, using the percentages discussed at the previous step. Countries are then ranked according to their scores in each pillar. Domain scores are determined by assigning the same weight to each pillar, and the overall The Prosperity Index score is determined by assigning equal weight to each domain, as each pillar and domain is as important to prosperity as each other. The mean of the three domain scores yields an overall prosperity score for each country. The overall prosperity rankings are based on this score. While the Index score provides an overall assessment of a country's prosperity, each pillar (and element) score serves as a reliable guide to how that country is performing with respect to a particular foundation of prosperity.

References

Legatum Institute (2023). 2023 Legatum Prosperity Index™ report. London: Legatum Institute https://www.prosperity.com/download_file/view_inline/4789

Legatum Institute (2023). Prosperity Index - Sources and Indicators. Sixteenth Edition. London: Legatum Institute. February 2023

https://docs.prosperity.com/5816/7756/6585/Sources_and_Indicators.pdf

8. OECD Better Life Index

The OECD has developed a well-being framework covering 11 dimensions of well-being: income and wealth; work and job quality; housing; health; knowledge and skills; environment quality; subjective well-being; safety; work-life balance; social connections; and civic engagement. The framework also considers inequalities across all dimensions of well-being, as well as the resources and risk factors that shape future well-being.

The Better Life Index aims to involve citizens in the debate on measuring the well-being of societies, and to empower them to become more informed and engaged in the policy-making process that shapes all our lives. Each of the 11 topics of the Index is currently based on one to three indicators. Within each topic, the indicators are averaged with equal weights. The indicators have been chosen on the basis of a number of statistical criteria such as relevance (face-validity, depth, policy relevance) and data quality (predictive validity, coverage, timeliness, cross-country comparability etc.) and in consultation with OECD member countries. These indicators are good measures of the concepts of well-being, in particular in the context of a country comparative exercise. Other indicators will gradually be added to each topic.

I. Information on individual indicators

The data mostly come from official sources such as the OECD or National Accounts, United Nations Statistics, National Statistics Offices. A couple of indicators are based on data from the Gallup World Poll a division of the Gallup Organization that regularly conducts public opinion polls in more than 140 countries around the world. More than 80% of the indicators in *Your Better Life Index* have been already published by the OECD.

Read about this in greater detail in the OECD companion publication, How's Life? – Measuring Well-Being.

Table 8.1: Individual indicators within the Better Life Index and their data source

Dimension	Indicator, description and unit of measurement	Data source
Income and Wealth	***Household net adjusted disposable income*** It's the maximum amount that a household can afford to consume without having to reduce its assets or to increase its liabilities. It's obtained, as defined by the System of National Accounts – SNA, adding to people's gross income (earnings, self-employment and capital income, as well as current monetary transfers received from other sectors) the social transfers in-kind that households receive from governments (such as education and health care services), and then subtracting the taxes on income and wealth, the social security contributions paid by households as well as the depreciation of capital goods consumed by households. Available data refer to the sum of households and non-profit institutions serving households (S14_S15). Unit of measurement: US dollars at 2018 PPP per capita* * PPPs used are those for actual individual consumption	OECD calculations based on *OECD National Accounts Statistics* (database), http://dx.doi.org/10.1787/na-data-en
	Household net wealth It considers the total wealth: financial and non-financial assets, net of liabilities, held by private households resident in the country. Non-financial assets include the principal residence, other real estate properties, vehicles, valuables and other non-financial assets (e.g. other consumer durables). It is compiled following the *OECD Guidelines for Micro Statistics on Household Wealth* (OECD, 2013). The indicator excludes pension schemes related to employment, as available only for a limited number of countries Unit of measurement: US dollars at 2019 PPP per household** Note: ** PPPs used are those for private consumption	OECD calculations based on *OECD Wealth Distribution* (database), https://stats.oecd.org/Index.aspx?DataSetCode=WEALTH 2

Jobs and earnings	***Employment rate*** It is the number of employed persons aged 15 to 64 over the population of the same age. Employed people are those aged 15 or more who report that they have worked in gainful employment for at least one hour in the previous week, as defined by the International Labour Organization – ILO. Unit of measurement: Percentage of the working-age population (aged 15-64). Additional information: Gender inequality (men versus women).	*OECD Labour Force Statistics by Sex and Age – Indicators* (database), https://stats.oecd.org/Index.aspx?DataSetCode=LFS_SEXAGE_I_R.
	Long term unemployment rate This indicator refers to the number of persons who have been unemployed for one year or more as a percentage of the labour force (the sum of employed and unemployed persons). Unemployed persons are defined as those who are currently not working but are willing to do so and actively searching for work. Unit of measurement: Percentage of the labour force Additional information: Gender inequality (men versus women).	OECD calculations based on *OECD Labour Force Statistics by Sex and Age – Indicators* (database), https://stats.oecd.org/Index.aspx?DataSetCode=LFS_SEXAGE_I_R and *OECD Unemployment by duration* (database), https://stats.oecd.org/Index.aspx?DataSetCode=DUR_I.
	Average gross annual earnings of full-time employees/ Personal earnings This indicator refers to the average annual wages per full-time equivalent dependent employee, which are obtained by dividing the national-accounts-based total wage bill (Wages and salaries – SNA D11) by the average number of employees in the total economy, which is then multiplied by the ratio of average usual weekly hours per full-time employee to average usually weekly hours for all employees (sourced from the Labour Force Surveys). It considers the employees' gross remuneration, that is, the total before any deductions are made by the employer in respect of taxes, contributions of employees to social security and pension schemes, life insurance premiums, union dues and other obligations of employees. Unit of measurement: US dollars at 2020 PPP* per full-time and full-year equivalent employee in the total economy. Note: * PPPs used are those for private consumption	*OECD Average annual wages* (database), http://stats.oecd.org/Index.aspx?DataSetCode=AV_AN_WAGE.

	Labour market insecurity This indicator is defined in terms of the expected earnings loss associated with unemployment. This loss depends on the risk of becoming unemployed, the expected duration of unemployment and the degree of mitigation against these losses provided by government transfers to the unemployed (effective insurance). Unit of measurement: Percentage of previous earnings	*OECD Job quality* (database), https://stats.oecd.org/Index.aspx?DataSetCode=JOBQ.
Housing	***Number of rooms per person/ Rooms per person*** This indicator refers to the number of rooms (excluding kitchenette, scullery/utility room, bathroom, toilet, garage, consulting rooms, office, shop) in a dwelling divided by the number of persons living in the dwelling. Unit of measurement: Rate (number of rooms divided by the number of people living in the dwelling)	European Union Statistics on Income and Living Conditions (EU-SILC), National Statistical Offices and OECD's calculations.
	Dwellings without basic facilities This indicator refers to the percentage of the population living in a dwelling without indoor flushing toilet for the sole use of the household. Flushing toilets outside the dwelling are not to be considered in this item. Flushing toilets in a room where there is also a shower unit or a bath are also counted. Unit of measurement: Percentage of the population	European Union Statistics on Income and Living Conditions (EU-SILC), National Statistical Offices.
	Housing expenditure This indicator considers the expenditure of households in housing and maintenance of the house, as defined in the SNA (P31CP040: Housing, water, electricity, gas and other fuels; P31CP050: Furnishings, households' equipment and routine maintenance of the house). It includes actual and imputed rentals for housing, expenditure in maintenance and repair of the dwelling (including miscellaneous services), in water supply, electricity, gas and other fuels, as well as the expenditure in furniture and furnishings and households equipment, and goods and services for routine maintenance of the house as a percentage of the household gross adjusted disposable income. Data refer to the sum of households and non-profit institutions serving households (S14_S15).	: OECD calculations based on OECD National Accounts Database, https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE5 and https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE14A .

	Unit of measurement: Percentage of the household gross adjusted disposable income	
Health Status	***Life expectancy at birth*** Life expectancy measures how long on average people could expect to live based on the age-specific death rates currently prevailing. This measure refers to people born today and is computed as a weighted average of life expectancy for men and women. Unit of measurement: Number of years Additional information: Gender inequality (men versus women)	*OECD Health status* (database), http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT .
	Self-reported health status This indicator refers to the percentage of the population aged 15 years old and over who report "good" or better health. The WHO* recommends using a standard health interview survey to measure it, phrasing the question as "How is your health in general?" with response scale "It is very good/ good/ fair/ bad/ very bad"**. Unit of measurement: Percentage of the population Additional information: Gender inequality (men versus women); Socio-economic inequality ("High"/"low" refer to values for people with net disposable income*** in the highest/lowest quintile) Notes: * WHO (1996), "Health Interview Surveys: Towards International Harmonization of Methods and Instruments", *Who Regional Publications*, European Series, No. 58 ** Please note that not all OECD countries have adopted this standardised instrument. Differences in the question and response scale used need to be reported. *** If net disposable income (after taxes and transfers) is not available, gross income is considered. Data coming from health surveys relate to individual income, while data coming from household surveys relate to household (equivalised) income. For more details, please refer to the metadata in the "Health status", OECD Health Statistics (database), http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT.	*OECD Health status* (database), http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT .

Work and Life	***Employees working very long hours*** This indicator measures the proportion of dependent employed whose usual hours of work per week are 50 hours or more. Unit of measurement: Percentage of dependent employed Additional information: Gender inequality (men versus women)	*OECD Labour Force Statistics by Sex and Age – Indicators* (database), https://stats.oecd.org/Index.aspx?DataSetCode=LFS_SEXAGE_I_R (unpublished data).
	Time devoted to leisure and personal care This indicator measures the amount of hours (minutes) per day that, on average, full-time employed people spend on leisure and on personal care activities. Leisure includes a wide range of indoor and outdoor activities such as walking and hiking, sports, entertainment and cultural activities, socializing with friends and family, volunteering, taking a nap, playing games, watching television, using computers, recreational gardening, etc. Personal care activities include sleeping (but not taking a nap), eating and drinking, and other household or medical or personal services (hygiene, visits to the doctor, hairdresser, etc.) consumed by the respondent. Travel time related to personal care is also included. The information is generally collected through national Time Use Surveys, which involve respondents keeping a diary of their activities over one or several representative days for a given period. Unit of measurement: Number of hours per day spent on leisure and personal care. Additional information: Gender inequality (men versus women)	OECD calculations based on public-use time use survey microdata when available; *Eurostat's Harmonised European Time Use Surveys* (database), https://ec.europa.eu/eurostat/web/time-use-surveys and tabulations from National Statistical Offices.
Education and skills	***Educational attainment*** Educational attainment considers the number of adults aged 25 to 64 holding at least an upper secondary degree over the population of the same age, as defined by the ISCED classification. Unit of measurement: Percentage of the adult population (aged 25 to 64) Additional information: Gender inequality (men versus women)	"Educational attainment and labour force status", OECD Education at a glance (database), http://stats.oecd.org/Index.aspx?DataSetCode=EAG_NEAC.

	Students' cognitive skills Students' average score in reading, mathematics and science as assessed by the OECD's Programme for International Student Assessment (PISA). PISA assessments are conducted once every three years, with the focal subject cycling between mathematics, reading and science. PISA results are normalised such that the OECD average is 500 points, with a standard deviation of 100 points. Because PISA assessments are conducted within schools, they capture the cognitive ability only of 15-year-olds who are currently enrolled in school. These tests thus do not include drop-outs, or home-schooled students. Unit of measurement: Average PISA scores Additional information: Gender inequality (boys versus girls); Socio-economic inequality (PISA index of economic, social and cultural status (ESCS) top quartile versus bottom quartile)	OECD calculations based on *PISA 2018 Results (Volume I): What Students Know and Can Do*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/5f07c754-en
	Expected years in education This indicator is the average duration of education in which a 5 year old child can expect to enrol during his/her lifetime until the age of 39. It is calculated under the current enrolment conditions by adding the net enrolment rates for each single year of age from the age of five onwards. Unit of measurement: Number of years Additional information: Gender inequality (boys versus girls) Note: For the OECD countries enrolment data by single year of age is only available for the ages of 5 to 29 years. For the ages of 30 to 39, enrolment rates are estimated on the basis of 5 years age bands.	OECD Education at a glance (unpublished data).

Civic engagement and governance	***Stakeholder engagement for developing regulations*** This indicator describes the extent to which formal stakeholder engagement is built in the development of primary laws and subordinate regulations. The indicator is calculated as the simple average of two composite indicators (covering respectively primary laws and subordinate regulations) that measure four aspects of stakeholder engagement, namely i) systematic adoption (of formal stakeholder engagement requirements); ii) methodology of consultation and stakeholder engagements; iii), transparency of public consultation processes and open government practices; and iv) oversight and quality control that refers to existence of oversight bodies and publicly available information on the results of stakeholder engagement. The maximum score for each of the four dimensions/categories is one and the maximum aggregate score for the composite indicator is then four. The stakeholder engagement indicator has been computed based on responses to the 2017 OECD's regulatory indicators survey for OECD countries as well as Colombia and Costa Rica, and to the OECD-IDB Survey on Regulatory Policy and Governance 2015 for Brazil. Data for the Russian Federation and South Africa are based on the 2009 Regulatory Management Systems survey. Respondents to all surveys were government officials. The scores for primary laws refer exclusively to processes for developing primary laws *initiated by the executive*. There is no score for primary laws for the United States, where all primary laws are initiated by Congress, and Brazil. In the majority of countries, most primary laws are initiated by the executive, except for Mexico and Korea, where a higher share of primary laws are initiated by parliament/congress (respectively 66% and 87%).	*OECD Indicators of Regulatory Policy and Governance (iREG),* http://www.oecd.org/gov/regulatory-policy/indicators-regulatory-policy-and-governance.htm for *OECD* countries, Brazil, Colombia, Costa Rica; and *OECD Indicators of Regulatory Management Systems country notes 2011,* http://www.oecd.org/gov/regulatory-policy/rmscountrynotes.htm for the Russian Federation and South Africa
	Voter turnout Voter turnout is here defined as the ratio between the number of individuals that cast a ballot during an election (whether this vote is valid or not) to the population registered to vote. As institutional features of voting systems vary a lot across countries and across types of elections, the indicator refers to the elections (parliamentary or presidential) that have attracted the largest number of voters in each country. Unit of measurement: Percentage of the population	*International Institute for Democracy and Electoral Assistance (IDEA)* (database) (2021), https://www.idea.int/

Environmental quality	***Air pollution*** The indicator is the population weighted average of annual concentrations of particulate matters less than 2.5 microns in diameter (PM2.5) in the air. Data are averaged over a three-year period. Unit of measurement: Micrograms per cubic meter.	*OECD Exposure to PM2.5 in countries and regions* (database), http://stats.oecd.org/Index.aspx?DataSetCode=EXP_PM2_5
	Satisfaction with water quality The indicator captures people's subjective appreciation of the environment where they live, in particular the quality of the water. It is based on the question: "In the city or area where you live, are you satisfied or dissatisfied with the quality of water?" and it considers people who responded they are satisfied Unit of measurement: Percentage of people aged 15 and over Additional information: Gender inequality (men versus women)	OECD calculations based on Gallup World Poll, https://gallup.com/analytics/232838/world-poll.aspx
Personal security/Safety	***Homicides rates*** Deaths due to assault. Unit of measurement: Age-standardised rate per 100,000 population Additional information: Gender inequality (men versus women)	*OECD Health Status: Causes of Mortality* (database), http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT .
	Feeling safe walking alone at night The indicator is based on the question: "Do you feel safe walking alone at night in the city or area where you live?" and it shows people declaring they feel safe. Unit of measurement: Percentage of people aged 15 and over Additional information: Gender inequality (men versus women)	OECD calculations based on *Gallup World Poll* (database), https://gallup.com/analytics/232838/world-poll.aspx.

Social connections /Community	***Social network support*** It's a measure of perceived social network support. The indicator is based on the question: "If you were in trouble, do you have relatives or friends you can count on to help you whenever you need them, or not?" and it considers the respondents who respond positively (the other response categories being "no", and "don't know"). Unit of measurement: Percentage of people aged 15 and over Additional information: Gender inequality (men versus women); Socio-economic inequality ("High"/ "Low" refer to the percentage of people with tertiary/ below upper secondary education)	OECD calculations based on *Gallup World Poll* (database), https://gallup.com/analytics/232838/world-poll.aspx
Life satisfaction (Subjective well-being)	***Life satisfaction*** The indicator considers people's evaluation of their life as a whole. It is a weighted-sum of different response categories based on people's rates of their current life relative to the best and worst possible lives for them on a scale from 0 to 10, using the Cantril Ladder (known also as the "Self-Anchoring Striving Scale") Unit of measurement: Mean value (Cantril Ladder) Additional information: Gender inequality (men versus women); Socio-economic inequality ("High"/ "Low" refer to values for people with tertiary/ below upper secondary education)	OECD calculations based on *Gallup World Poll* (database), https://gallup.com/analytics/232838/world-poll.aspx

Source: Reformatted based on "OECD: BETTER LIFE INDEX: DEFINITIONS AND METADATA February 2022." https://www.oecd.org/wise/OECD-Better-Life-Index-definitions-2021.pdf

Analysis on the quality of the indicators

Table 2.1. **The quality of income and wealth indicators**

		Target concept	INDICATORS							
			Relevance to measure and monitor well-being				Statistical quality			
			Face validity	Unambiguous interpretation (good/bad)	Policy amenable outcomes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Income and wealth										
IW I	Household Net Adjusted Disposable Income	Current and future consumption possibilities	√	√	~	fl	√	√	√	√
IW II	Household Net Financial Wealth		~	√	~	fl	√	√	√	√
iw 1	Household Final consumption	Realised material well-being	√	√	~	fl	√	√	√	√
iw 2	Household Total consumption		~	~	~	fl	~	~	~	~
iw 3	Subjective evaluation of material well-being	Satisfaction with material conditions	~	√	~	√	~	~	√	√

Note: The symbol √ shows that the indicator selected largely meets the criterion shown in the table; the symbol ~ that the indicator meets the criterion to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p. 41.

Table 3.1 **The quality of job and earnings indicators**

		Target concept	INDICATORS							
			Relevance to measure and monitor well-being				Statistical quality			
			Face validity	Unambiguous interpretation (good/bad)	Amenable to policy changes	Can be disaggregated	Collected through a well-established instrument	Comparable definition	Country coverage	Recurrent data collection
Jobs and Earnings										
JE I	Employment rate	Quantity of jobs	√	√	√	√	√	√	√	√
JE II	Long-term unemployment		√	√	√	√	√	√	√	√
je 1	Involuntary part-time employment		√	√	√	√	√	~	√	√
JE III	Average annual earnings per employee	Quality of jobs	~	√	√	fl	~	~	√	√
je 2	Employees working on temporary contracts		√	√	√	√	√	~	√	√
je 3	Work accidents: fatal and non fatal injuries		√	√	√	~	~	~	~	√

Note: The symbol √ shows that the indicator selected largely meets the criteria shown in the table; the symbol ~ that the indicator meets the criteria to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p. 62.

Table 4.1. **The quality of housing indicators**

	Target concept	INDICATORS							
		Relevance to measure and monitor well-being				Statistical quality			
		Face validity	Unambiguous interpretation (good/bad)	Amenable to policy changes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Housing									
HO I Number of rooms per person in a dwellin	Quality of housing	~	√	√	fl	√	~	~	~
ho 1 Housing cost overburden rate	Housing affordability	√	√	√	√	fl	√	√	fl
HO II Lack of access to basic sanitary facilities: abscence of indoor ushing toilets and/or a bathroom (bath or shower)	Quality of housing	~	√	~	fl	√	~	~	~
ho 2 Satisfaction with housing	Satisfaction with housing	√	~	~	√	fl	√	√	fl

Note: The symbol √ shows that the indicator selected largely meets the criteria shown in the table; the symbol ~ that the indicator meets the criteria to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p. 86.

Table 5.1. **The quality of health status indicators**

	Target concept	INDICATORS							
		Relevance to measure and monitor well-being				Statistical quality			
		Face validity	Unambiguous interpretation (good/bad)	Amenable to policy changes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Health status									
HS I Life eflpectancy at birth	Length of life	√	√	√	~	√	√	√	√
hs 1 Infant mortality		√	√	√	~	√	√	√	√
HS II Self-reported health status	Morbidity in its different dimensions	√	√	√	√	√	~	~	√
hs 2 Self-reported longstanding illness		√	√	√	√	√	~	~	~
hs 3 Self-reported limitations in daily activities		√	√	√	√	√	~	~	~
hs 4 Overweight and obesity		~	√	√	√	√	~	√	√

Note: The symbol √ shows that the indicator selected largely meets the criteria shown in the table; the symbol ~ that the indicator meets the criteria to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent

Source: OECD (2020), p. 109.

Table 6.1. **The quality of work-life balance indicators**

		Target concept	INDICATORS							
			Relevance to measure and monitor well-being				Statistical quality			
			Face validity	Unambiguous interpretation (good/bad)	Policies amenable outcome	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Work-Life Balance										
WL I	Employees working more than 50 hours per week	Work-life time balance	√	√	√	√	√	√	√	√
WL II	Time in leisure and personal care		√	√	~	~	√	~	~	~
wl 1	Commuting time		√	√	~	~	√	~	~	~
wl 2	Satisfaction with work-life time allocation	Satisfaction with work-life time balance	√	√	~	√	~	√	~	~
WL III	Employment rate of mothers with school-age children	Ability to reconcile family and work	~	√	√	~	√	√	√	√

Note. The symbol √ shows that the indicator selected largely meets the criterion shown in the table; the symbol ~ that the indicator meets the criterion to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p. 130.

Table 7.1. **The quality of environmental indicators**

		Target concept	INDICATORS							
			Relevance to measure and monitor well-being				Statistical quality			
			Face validity	Unambiguous interpretation (good/bad)	Amenable to policy changes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Education and skills										
ES I	Educational attainment	Quantity of education	√	√	√	√	√	√	√	√
es 1	Education eflpectancy		~	√	√	~	√	√	√	√
es 2	Lifelong learning		√	√	√	~	~	√	~	~
ES II	Students' cognitive skills	Quality of education	√	√	√	√	√	√	√	~
es3	Civic skills		√	√	√	√	√	√	~	~

Note: The symbol √ shows that the indicator selected largely meets the considered criterion; the symbol ~ that the indicator meets the criterion to a large extent; the symbol x that the indicator does not meet the criterion or meets it only to a limited extent.

Source: OECD (2020), p. 149.

Table 8.1. **The quality of indicators of social connections**

		Target concept	INDICATORS							
			Relevance to measure and monitor well-being				Statistical quality			
			Face validity	Unambiguous interpretation	Amenable to policy changes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Social Connections										
SC I	Social network support	Personal relationships	√	√	~	√	fl	√	√	√
sc 1	Frequency of social contact	Community relationships	~	√	~	√	~	√	~	~
sc 2	Time spent volunteering		√	√	~	~	~	~	~	fl
sc 3	Trust in others	Norms and values	√	√	~	√	fl	√	√	√

Note: The symbol √ shows that the indicator selected largely meets the criteria shown in the table; the symbol ~ that the indicator meets the criteria to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent

Source: OECD (2020), p. 175.

Table 9.1. **The quality of civic engagement and governance indicators**

		Target concept	INDICATORS							
			Relevance to measure and monitor well-being				Statistical quality			
			Face validity	Unambiguous interpretation (good/bad)	Amenable to policy changes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Civic engagement and governance										
CEG I	Voter turnout	Civic engagement	~	√	√	fl	~	√	√	~
ceg 1	Participation in political activities		√	~	√	√	~	√	√	~
CEG II	Consultation on rule-making	Quality of governance	~	√	√	fl	√	√	√	~
ceg 2	Confidence in national government, judicial system and courts and media	People's confidence in their public institutions	√	√	√	√	fl	√	√	~

Note: The symbol √ shows that the indicator selected largely meets the criteria shown in the table; the symbol ~ that the indicator meets the criteria to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p. 196.

Table 9.A.1 **The construction of the composite indicator on rule-making**
2008

Questions	Weights	Scores
a) Is public consultation with parties affected by regulations a part of developing new draft primary laws?	1/12.25	No=0, In some cases=0.5, Yes=1
b) Is public consultation with parties affected by regulations a part of developing new draft subordinate regulations?	1/12.25	No=0, In some cases=0.5, Yes=1
b(iv) Primary laws: Is consultation mandatory?	0.5/12.25	No=0, Yes=1
b(iv) Subordinate regulations: Is consultation mandatory?	0.5/12.25	No=0, Yes=1
b(vii-1) Primary laws: What forms of public consultation are routinely used (tick all that apply):		
- Broad circulation of proposals for comment?	0.25/12.25	No=0, Yes=1
- Public notice and calling for comment?	0.5/12.25	No=0, Yes=1
- Public meeting?	0.25/12.25	No=0, Yes=1
- Simply posting proposals on the internet?	0.25/12.25	No=0, Yes=1
- Advisory group?	0.25/12.25	No=0, Yes=1
- Preparatory public commission/committee?	0.25/12.25	No=0, Yes=1
b(vii-2) Subordinate regulations: What forms of public consultation are routinely used (tick all that apply):		
- Broad circulation of proposals for comment?	0.25/12.25	No=0, Yes=1
- Public notice and calling for comment?	0.5/12.25	No=0, Yes=1
- Public notice and calling for comment?	0.5/12.25	No=0, Yes=1
- Public meeting?	0.25/12.25	No=0, Yes=1
- Simply posting proposals on the internet?	0.25/12.25	No=0, Yes=1
- Advisory group?	0.25/12.25	No=0, Yes=1
- Preparatory public commission/committee?	0.25/12.25	No=0, Yes=1
b(viii) Primary laws: Can any member of the public choose to participate in the consultation?	0.5/12.25	No=0, Yes=1
b(viii) Subordinate regulations: Can any member of the public choose to participate in the consultation?	0.5/12.25	No=0, Yes=1
c) Where there is a formal requirement for public consultation with parties affected by regulations, what is the minimum period for consultation that is specified? In number of weeks from 1 to 25 weeks.		
c(i-1) What is the minimum period for allowing consultation comments inside government?	0.5/12.25	0, 0.125, 0.25, 0.375, 0.5 (0, 1, 2, 3, 4 or more weeks)
"c(ii-1) What is the minimum period for allowing consultation comments by the public, including citizens, business and civil society organisations?"	0.75/12.25	0, 0.125, 0.25, 0.375, 0.5, 0.75 (0, 2, 4, 6, 8, 12 or more weeks)
d(i-1) Primary laws: Are the views of participants in the consultation process made public?	0.5/12.25	No=0, Yes=1
d(i-2) Subordinate regulations: Are the views of participants in the consultation process made public?	0.5/12.25	No=0, Yes=1
d(ii-1) Primary laws: Are regulators required to respond in writing to the authors of consultation comments?	0.25/12.25	No=0, Yes=1
d(ii-2) Primary laws: Are regulators required to respond in writing to the authors of consultation comments?	0.25/12.25	No=0, Yes=1
d(iii-1) Primary laws: Are the views eflpressed in the consultation process included in the regulatory impact analysis?	0.5/12.25	No=0, Yes=1
d(iii-2) Subordinate regulations: Are the views eflpressed in the consultation process included in the regulatory impact analysis?	0.5/12.25	No=0, Yes=1
d(iv-1) Primary laws: Is there a process to monitor the quality of the consultation process (*e.g.* surveys or other methods)?	0.5/12.25	No=0, Yes=1
d(iv-2) Subordinate regulations: Is there a process to monitor the quality of the consultation process (*e.g.* surveys or other methods)?	0.5/12.25	No=0, Yes=1

Source: OECD (2008), OECD Regulatory Management Systems' Indicators Survey 2008, Question 9, www.oecd.org/regreform/indicators

Source: OECD (2020), p.212.

Table 10.1. **The quality of environmental indicators**

	Target concept	INDICATORS							
		Relevance to measure and monitor well-being				Statistical quality			
		Face validity	Unambiguous interpretation (good/bad)	Policy amenable outcomes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Environmental quality									
EN I Air quality	Quality of environment	~	√	√	fl	√	√	√	~
en 1 Environmental burden of disease	Impact of environmental hazards on human health	√	√	√	fl	√	√	√	~
en 2 Satisfaction with local environment	Subjective perceptions of environment	√	~	~	√	fl	√	√	√
en 3 Access to green spaces		√	√	√	√	fl	√	~	~

Note: The symbol √ shows that the indicator selected largely meets the criterion shown in the table; the symbol ~ that the indicator meets the criterion to a large extent; the symbol X that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p.217.

Table 11.1. **The quality of personal security indicators**

	Target concept	INDICATORS							
		Relevance to measure and monitor well-being				Statistical quality			
		Face validity	Unambiguous interpretation (good/bad)	Amenable to policy changes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Personal security									
PS I Intentional homicides	Opportunities to live in a safe environment	~	√	√	fl	√	√	√	~
PS II Self-reported victimization		√	√	√	√	fl	√	√	√
ps 1 Domestic violence on children		~	√	√	fl	√	√	√	~
ps 2 Feeling of security	Fear of crime	~	~	√	√	fl	√	√	√

Note: The symbol √ shows that the indicator selected largely meets the criteria shown in the table; the symbol ~ that the indicator meets the criteria to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p.244.

Table 12.1. **The quality of subjective well-being indicators**

		Target concept	INDICATORS							
			Relevance to measure and monitor well-being				Statistical quality			
			Face validity	Unambiguous interpretation (good/bad)	Policy amenable outcomes	Can be disaggregated	Well-established instrument collected	Comparable definition	Country coverage	Recurrent data collection
Subjective well-being										
SW I	Life Satisfaction	Evaluation of life	√	√	~	√	fl	√	√	√
SW II	Affect Balance	Positive and negative feelings	√	√	~	√	fl	√	√	√

Note. The symbol √ shows that the indicator selected largely meets the criteria shown in the table; the symbol ~ that the indicator meets the criteria to a large extent; the symbol x that the indicator does not meet the criterion or it meets it only to a limited extent.

Source: OECD (2020), p.171.

II. Methodological issues related to the index

Geographical coverage:

Countries and territories: 40.

The 38 countries are the members of the Organisation for Economic Cooperation and Development, or OECD, which brings together most of the world's developed economies and a number of emerging economies, plus Brazil, Russia and South Africa.

Indicators: 24

Latest release: 2020

Time frame: 2020

Normalization procedure

The Index gathers many indicators, expressed on very different units (dollars, years, etc). To compare and aggregate values expressed in different unities, the values have to be normalised.

This normalisation is done according to a standard formula which converts the original values of the indicators into numbers varying in a range between 0 (for the worst possible outcome) and 1 (for the best possible outcome). The formula is:

(value to convert –minimum value) / (maximum value – minimum value)

When an indicator measures a negative component of well-being (e.g. unemployment) the formula used is:

1 - (value to convert – minimum value) / (maximum value – minimum value)

Weighting of pillars and dimensions

Each of the 11 topics of the Index is currently based on one to four indicators. Within each topic, the indicators are averaged with equal weights.

The web application that builds the Index requires some default weights at the start. For simplicity, these weights have been set equal to the grade of 1 for all topics. These default weights do not represent the OECD's view on the relative importance of each topic.

Weights are assigned by the users, who build and customise their own Index. To do so, users have to rate each topic from 0 ("not important") to 5 ("very important"). The score given to each topic is converted into a weight, by dividing the grade given to each topic by the sum of the grades given to all topics. For example, if a user assigns of a score of 5 to Health and Education and 3 to all the other topics, their Index will weigh health and education by a factor of 5/37 (i.e. around 13.5%) and all the other topics by a factor of 3/37 (i.e. around 8.1%). The sum of all weights is 100%.

Aggregation method

Each topic of well-being is measured by one to four indicators. After normalisation, indicators are averaged with equal weights. For instance education is measured through educational attainment, students' skills and years in education. The education score will thus be given by:

educational attainment score + students' skills score + years in education / 3

Missing values/ imputed values

For a very small number of observations (less than 5% of the data), the values used to compute *Your Better Life* Index rely on imputed values. Imputed values refer to estimates of missing data points that are carried out through specific statistical techniques. Although these imputations do not significantly affect the results of the Index, estimated values have to be taken with caution.

Comparability over time

Data cannot be compared between editions of the Better Life Index. For time series, please refer to the How's Life – Well-being database.

At the moment the Index cannot be compared over time, as its methodology is still being fine-tuned. In addition, many of the BLI indicators do not move quickly over time and thus before assessing genuine progress/regression over time it will be necessary to wait a few more years.

Regional comparison or comparison across social groups

At the moment, most of the indicators entering the *Better Life Index* are not available at a more disaggregated level; in other words, they don't allow comparisons of disparities within a country or between various social groups (e.g. men vs. women, youth vs. elderly, etc.) Depending on data availability, future editions of the Index may have this feature.

Information on social inequalities is shown for selected indicators of the BLI in the topics and countries pages. This information is shown by comparing the achievements of people with high socio-economic status with the achievements of people with low socio-economic status, through the social inequalities ratio. Socio-economic status refers to either income or educational level, depending on data availability on the type of socio-economic breakdown for the various BLI indicators. In the case of income, high socio-economic status is defined as the group of the population belonging to the top income quintile while low socio-economic status is defined as the group of the population belonging to the bottom income quintile. In the case of education, high socio-economic status is defined as the group of the population with a tertiary education degree while low socio-economic status is defined as the group of the population with a primary education degree.

For more details on the type of socio-economic breakdown available by indicator, please refer to the following table: Social inequalities in the BLI .

References

OECD (2020), *How's Life? 2020: Measuring Well-being*, OECD Publishing, Paris, https://doi.org/10.1787/9870c393-en.

Index website: https://www.oecdbetterlifeindex.org/#/11111111111

OECD (2022): Better Life Index: Definitions and Metadata. February 2022.

https://www.oecd.org/wise/OECD-Better-Life-Index-definitions-2021.pdf

Further information

Handbook on Constructing Composite Indicators: Methodology and User Guide

https://doi.org/10.1787/9789264043466-en

https://read.oecd-ilibrary.org/economics/handbook-on-constructing-composite-indicators-methodology-and-user-guide_9789264043466-en#page9

- Guidelines on Measuring the Quality of the Working Environment
- Guidelines on Measuring Trust
- Guidelines on Measuring Subjective Well-being
- Guidelines for Micro Statistics on Household Wealth

- Framework for Statistics on the Distribution of Household Income, Consumption and Wealth
- Measuring and managing business impacts on people's well-being and sustainability
- Quality of jobs
- Gender Equality
- Framework for measuring well-being in Latin America and the Caribbean

9. Planetary Pressure-adjusted Human Development Index

PHDI is an experimental index that adjusts the Human Development Index (HDI) for planetary pressures in the Anthropocene.

I. Information on individual indicators

In addition to the data used to calculate the HDI, the PHDI uses data on carbon dioxide emissions per capita (production) and material footprint per capita.

Table 9.1: Individual indicators in PHDI

Indicator	Description	Data source
Carbon dioxide emissions per capita (production)	carbon dioxide emissions produced as a consequence of human activities (use of coal, oil and gas for combustion and industrial processes, gas flaring and cement manufacture), divided by midyear population. Values are territorial emissions, meaning that emissions are attributed to the country in which they physically occur.	Global Carbon Project. 2022. Global Carbon Atlas. https://www.globalcarbonproject.org/
Material footprint per capita	material footprint is the attribution of global material extraction to domestic final demand of a country. Material foot-print is calculated as raw material equivalent of imports plus domestic extraction minus raw material equivalents of exports. The total material footprint is the sum of the material footprint for biomass, fossil fuels, metal ores and nonmetal ores. Material footprint per capita describes the average material use for final demand.	UNEP (2022). World Environment Situation Room, Data down-loader. https://wesr.unep.org/downloader.

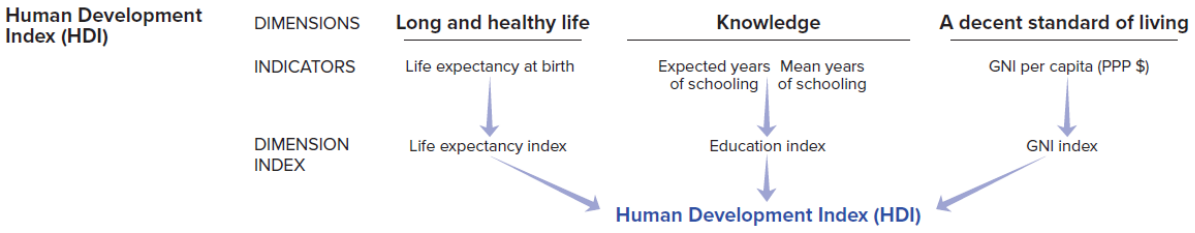
Due to data limitations, PHDI values are calculated for a smaller set of countries (than HDI values).

Table 9.2: Time series of individual indicators in PHDI

Full name	Short name	Time series
HDI		
HDI Rank	hdi_rank	2021
Human Development Index (value)	hdi	1990-2021
Life Expectancy at Birth (years)	le	1990-2021
Expected Years of Schooling (years)	eys	1990-2021
Mean Years of Schooling (years)	mys	1990-2021
Gross National Income Per Capita (2017 PPP$)	gnipc	1990-2021
PHDI		
Difference from HDI rank	rankdiff_hdi_phdi	2021
Planetary pressures–adjusted Human Development Index (value)	phdi	1990-2021
Difference from HDI value (%)	diff_hdi_phdi	1990-2021
Carbon dioxide emissions per capita (production) (tonnes)	co2_prod	1990-2021
Material footprint per capita (tonnes)	mf	1990-2021

Source: Metadata

II. Methodological issues related to the index



PHDI discounts the HDI for pressures on the planet to reflect a concern for intergenerational inequality, similar to the Inequality-adjusted HDI adjustment which is motivated by a concern for intragenerational inequality. It is computed as the product of the HDI and (1 – index of planetary pressures) where (1 – index of planetary pressures) can be seen as an adjustment factor.

Steps to calculate Planetary pressures-adjusted Human Development Index values

Step 1. Calculating the carbon dioxide emissions index and the material footprint index

Carbon dioxide emissions per capita and material footprint per capita are normalized in the same way as the components of the HDI. Through a min-max transformation each becomes an index with values between 0 and 1 calculated as:

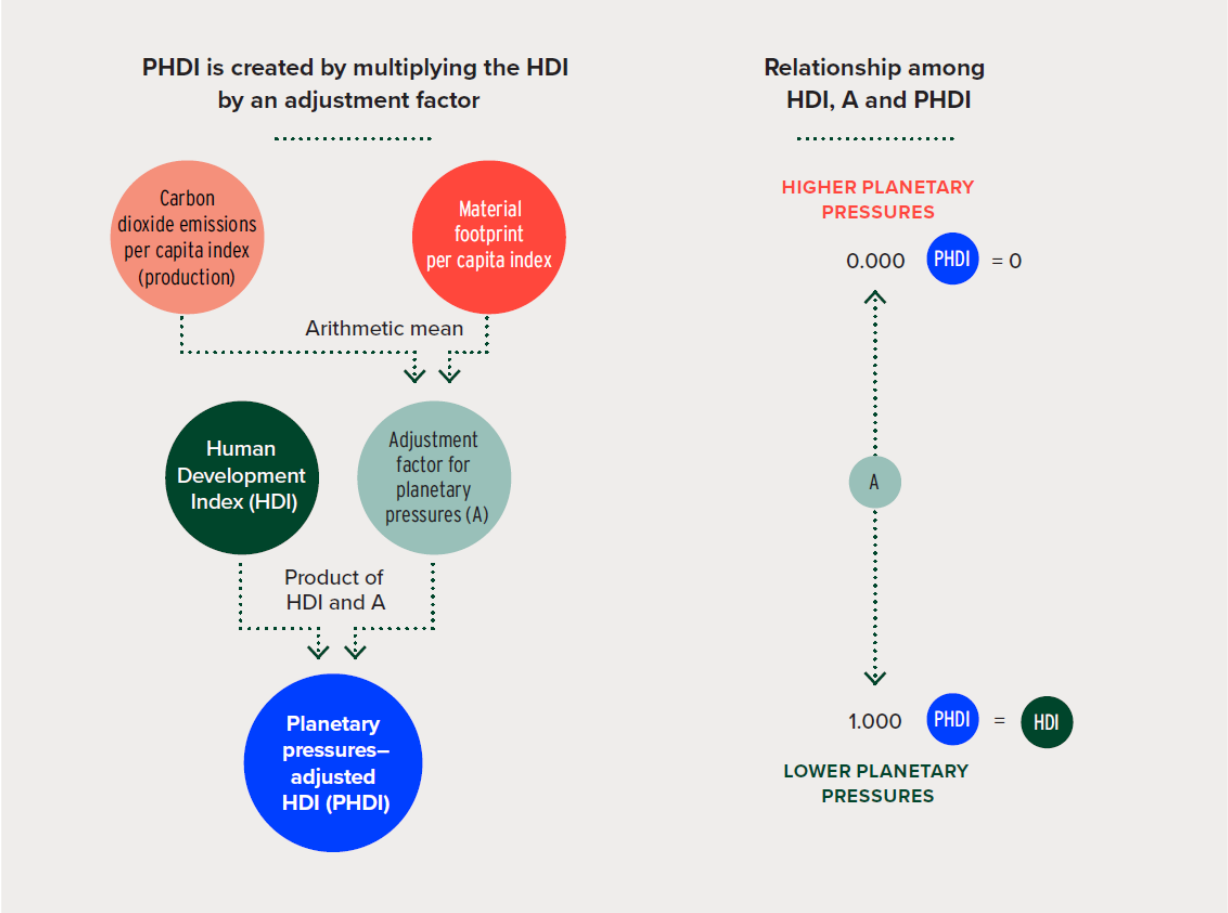
$$A_j \text{ index} = (\text{maximum}_j - \text{observed value}_j) / (\text{maximum}_j - \text{minimum}_j)$$

where j = 1,2 refers to the two included planetary pressure indicators.

Zero was set as minimum. The maximum corresponds to the maximum value observed historically for all countries since 1990, in line with the similar approaches in the literature, such as Biggeri and Mauro (2018). For carbon dioxide emissions per capita the maximum value is 68.72 tonnes, observed for Qatar in 1997. For material footprint per capita the maximum value is 107.42, observed for Kuwait in 1996. The ranking of countries is sensitive to the selection of the maximum.

For both carbon dioxide emissions per capita and material footprint per capita, the higher the observed value and the closer to the maximum, the higher the pressures on the planet, implying a smaller value of the index and a larger adjustment to the HDI.

Figure 1 Relationship of the components of the Human Development Index and the Planetary pressures–adjusted Human Development Index



Source: Human Development Report Office.

Step 2. Constructing the adjustment for planetary pressures

The adjustment factor for planetary pressures (A) is the arithmetic average of the indices measuring carbon dioxide emissions per capita and material footprint per capita, which assumes perfect substitution of these two indicators. Lower pressures on the planet result in a larger A and smaller adjustment to the HDI (see figure 1).

A = (Carbon dioxide emissions index + material footprint index) / 2

In addition, the index of planetary pressures, P, is defined as the complement of A: P = (1 – A).

Step 3. Adjusting the Human Development Index to account for planetary pressures

The PHDI is the product of the HDI and the adjustment factor, A:

PHDI = HDI . A,

or, equivalently, PHDI = HDI . (1 – P).

The difference between the HDI and the PHDI values due to planetary pressures, expressed as a percentage, is:

$$\text{Difference in HDI value} = \left(\frac{HDI - PHDI}{HDI}\right) \cdot 100$$

$$= P \cdot 100$$

References

UNDP (2022). Human Development Report 2021/2022: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World. New York: United Nations Development Programme.

UN Website: https://hdr.undp.org/planetary-pressures-adjusted-human-development-index#/indicies/PHDI

2021/22 HDR Technical Note: https://hdr.undp.org/sites/default/files/2021-22_HDR/hdr2021-22_technical_notes.pdf

Statistical references: https://hdr.undp.org/sites/default/files/2021-22_HDR/2021-22_statistical_references.pdf

Data links:

- 2021/22 PHDI dataset (XLS)
- All composite indices and components time series (1990-2021)
- Metadata

10. Social Progress Index

The Social Progress Index, developed and sustained by the Social Progress Imperative (a global nonprofit based in Washington, DC) aims

- to measure social progress directly, rather than utilize economic proxies;
- to measure the outcomes that matter to the lives of real people, not the inputs;
- to create a holistic measure of social progress that encompasses the many aspects of the health of societies and is relevant to all countries.

SPI offers a practical way for policymakers to track and report on progress towards the SDGs in a consistent manner, particularly for governments conducting their Voluntary National Reviews (VNRs). And the SPI framework has been successfully adapted in countries, cities and communities of every size thanks to its ability to incorporate locally-relevant data into each index. This flexibility means the index can be used to localize implementation of the SDGs at a more granular level, where change can happen quickest but formal SDG indicators are often unavailable or unreliable.

The 2022 Social Progress Index uses 12 components and 60 indicators to measure the social performance of 169 countries fully and an additional 27 countries partially.

I. Information on individual indicators

Table 10.1: List of individual indicators

Pillar	Subpillar	Code	Name	Definition	Data source	Type of data
1 Basic human needs	1.1 Nutrition and basic medical care	1.1.1	Undernourishment	The prevalence of undernourishment expresses the probability that a randomly selected individual from the population consumes an amount of calories that is insufficient to cover her/his energy requirement for an active and healthy life. The indicator is computed by comparing a probability distribution of habitual daily dietary energy consumption with a threshold level called the minimum dietary energy requirement. Both are based on the notion of an average individual in the reference population.	Food and Agriculture Organization of the United Nations	Admin
		1.1.2	Maternal mortality rate	Maternal deaths per 100,000 livebirths in women aged 10-54 years	Institute for Health Metrics and Evaluation	Admin

		1.1.3	Child mortality rate	Probability of dying between birth and exactly 5 years of age, expressed per 1,000 live births.	UN Inter-agency Group for Child Mortality Estimation	Admin
		1.1.4	Child stunting	Risk-weighted prevalence of stunting in children under 5 as measured by the summary exposure value (SEV) for child stunting.	Institute for Health Metrics and Evaluation	
		1.1.5	Deaths from infectious disease	Age-standardized Disability-Adjusted Life Years (DALYs) rate caused by infectious diseases per 100,000 people.	Institute for Health Metrics and Evaluation	Admin
		1.1.6	Diet low in fruits and vegetables	Risk-weighted, age-standardized prevalence of nutrition low in fruits and vegetables as measured by the summary exposure value (SEV).	Institute for Health Metrics and Evaluation	
	1.2 Water and sanitation	1.2.1	Access to improved sanitation	Proportion of population with access to improved toilet types as defined by the Joint Monitoring Program (JMP).	Institute for Health Metrics and Evaluation	
		1.2.2	Access to improved water source	Proportion of population with access to improved water sources as defined by the Joint Monitoring Program (JMP)	Institute for Health Metrics and Evaluation	
		1.2.3	Unsafe water, sanitation and hygiene	Age-standardized Disability-Adjusted Life Years (DALYs) rate attributable to unsafe water, sanitation and hygiene per 100,000 people.	Institute for Health Metrics and Evaluation	
		1.2.4	Satisfaction with water quality	The proportion of respondents answering 'satisfied' to the question, "In the city or area where you live, are you satisfied or dissatisfied with the quality of water?"	Gallup World Poll	Survey
	1.3 Shelter	1.3.1	Access to electricity	The percentage of the population with access to electricity.	SE4ALL Global Tracking Framework (World Bank, International Energy Agency, and the Energy Sector Management Assistance Program)	
		1.3.2	Household air pollution	Age-standardized Disability-Adjusted Life Years (DALYs) rate caused by household air pollution from solid fuels per 100,000 people. Household air pollution includes exposure to particulate matter less than 2.5 microns in diameter (PM2.5) due to the use of solid fuels for cooking, including	Institute for Health Metrics and Evaluation	

				coal, charcoal, wood, agricultural residue, and animal dung		
		1.3.3	Dissatisfaction with housing affordability	The proportion of respondents answering 'dissatisfied' to the question, "In the city or area where you live, are you satisfied or dissatisfied with the availability of good, affordable housing?"	Gallup World Poll	Survey
		1.3.4	Usage of clean fuels and technology for cooking	The proportion of population primarily using clean cooking fuels and technologies for cooking.	World Health Organization	
	1.4 Personal safety	1.4.1	Interpersonal violence	Age-standardized Disability-Adjusted Life Years (DALYs) per 100,000 people from interpersonal violence. Interpersonal violence is defined as death or disability from intentional use of physical force or power, threatened or actual, from another person or group not including military or police forces.	Institute for Health Metrics and Evaluation	
		1.4.2	Transportation related injuries	Age-standardized Disability-Adjusted Life Years (DALYs) per 100,000 people due to injuries related to transportation. These injuries include road injuries (death or disability due to unintentional interaction with an automobile, motorcycle, pedal cycle, or other vehicles) as well as other transport injuries.	Institute for Health Metrics and Evaluation	
		1.4.3	Political killings and torture	Physical violence index is based on indicators that reflect violence committed by government agents and that are not directly referring to elections.	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		1.4.4	Intimate partner violence	Age-standardized prevalence of ever-partnered women aged 15 years and older who experienced physical or sexual violence by a current or former intimate partner in the last 12 months (%)	Institute for Health Metrics and Evaluation	
		1.4.5	Money stolen	The proportion of respondents answering 'yes' to the question, "Within the last 12 months, have you had money or property stolen from you or another household member?"	Gallup World Poll	Survey
2 Foundations of well-being	2.1 Access to basic knowledge	2.1.1	No schooling	Proportion of population (age-standardized) with no schooling.	Institute for Health Metrics and Evaluation	

		2.1.2	Primary school enrollment	Total number of students of official primary school age who are enrolled in any level of education, expressed as a percentage of the total population of official primary school age. Statistic is termed 'total net primary enrollment rate.'	UN Educational, Scientific, and Cultural Organization Institute for Statistics	
		2.1.3	Secondary school attainment	Population with at least some secondary education (% ages 25 and older)	UN Educational, Scientific, and Cultural Organization Institute for Statistics	
		2.1.4	Gender parity in secondary attainment	The absolute deviation from parity (=1) in secondary education attainment of women and men.	United Nations Development Programme (UNDP) Human Development Data	
		2.1.5	Equal access to quality education	Country experts' aggregated evaluation of the question, "To what extent is high quality basic education guaranteed to all, sufficient to enable them to exercise their basic rights as adult citizens?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
	Access to information and communication	2.2.1	Mobile telephone subscription	Subscriptions to a public mobile telephone service using cellular technology, including the number of pre-paid SIM cards active during the past three months, expressed as the number of mobile telephone subscriptions per 100 inhabitants	International Telecommunications Union	Admin
		2.2.2	Internet users	The estimated number of Internet users out of the total population, using the Internet from any device (including mobile phones) in the last 12 months.	International Telecommunications Union	Admin
		2.2.3	Access to online governance	The availability of e-participation tools on national government portal for of the following uses: e-information – provision of information on the Internet; e-consultation – organizing public consultations online; and e-decision-making – involving citizens directly in decision processes. E-participation is defined as the process of engaging citizens through ICTs in policy, decision-making, and service design and delivery in order to make it participatory, inclusive, and deliberative.	UN Department of Economic and Social Affairs E-Government Survey	Expert
		2.2.4	Alternative source of information index	Country experts' aggregated evaluation of the questions: To what extent is the media (a) un-biased in their coverage or lack of	Varieties of Democracy (V-Dem), Dataset Version 12	Expert

				coverage of the opposition, (b) allowed to be critical of the regime, and (c) representative of a wide array of political perspectives?		
	Health and wellness	2.3.1	Life expectancy at 60	The average number of years that a person of 60 to 64 years of age could expect to live, if he or she were to pass through life exposed to the sex- and age-specific death rates prevailing at the time of his or her 60 years, for a specific year, in a given country, territory, or geographic area.	Institute for Health Metrics and Evaluation	Admin
		2.3.2	Premature deaths from non-communicable diseases	Mortality rate due to cardiovascular diseases, cancers, diabetes, and chronic respiratory diseases among populations aged 30–70 years.	Institute for Health Metrics and Evaluation	Admin
		2.3.3	Access to essential services	Country experts' aggregated evaluation of the question, "To what extent is high quality basic healthcare guaranteed to all, sufficient to enable them to exercise their basic political rights as adult citizens?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		2.3.4	Access to quality healthcare	The universal health coverage (UHC) measures the coverage of 9 tracer interventions and risk-standardized death rates from 32 causes amenable to personal healthcare, including vaccine-preventable diseases (e.g., diphtheria, tetanus, measles), respiratory infections, cancer (breast, cervical, uterine, testicular), heart diseases, diabetes, kidney disease), and the adverse effects of medical treatment.	Institute for Health Metrics and Evaluation	Admin
		2.3.5	Satisfaction with the availability of available healthcare	The proportion of respondents answering 'satisfied' to the question, In the city or area where you live, are you satisfied or dissatisfied with the availability of quality healthcare?	Gallup World Poll	Survey
	Environmental quality	2.4.1	Outdoor air pollution	Age-standardized Disability-Adjusted Life Years (DALYs) per 100,000 people resulting from ambient particulate matter pollution, including emissions from industrial activity, households, cars and trucks.	Institute for Health Metrics and Evaluation	
		2.4.2	Lead exposure	Age-standardized Disability-Adjusted Life Years (DALYs) per 100,000 people attributable to lead exposure. Lead exposure is defined	Institute for Health Metrics and Evaluation	

				as acute exposure, measured by micrograms of lead per decilitre of blood, and chronic exposure, measured by micrograms of lead per gram of bone.		
		2.4.3	Particulate matter pollution	Population-weighted mean levels of annual exposure to suspended particles smaller than 2.5 microns in aerodynamic diameter (PM2.5), which are capable of penetrating deep into the respiratory tract and causing severe health damage.	Institute for Health Metrics and Evaluation	
		2.4.4	Species protection	An index of how well a country's terrestrial protected areas overlap with the ranges of its vertebrate, invertebrate, and plant species. The Species Protection Index is calculated using remote sensing data, global biodiversity informatics, and integrative models to map suitable habitat for over 30,000 terrestrial species at high resolutions. A score of 100 indicates full coverage of all species' ranges by a country's protected areas, and a score of 0 indicates no overlap.	Environmental Performance Index Map of Life	Modelling
3 Opportunity	3.1 Personal rights	3.1.1	Political rights	An evaluation of three subcategories of political rights: electoral process, political pluralism and participation, and functioning of government on a scale from 0 (no political rights) to 40 (full political rights). Some countries and territories score below zero on the questions used to compose the indicator	Freedom House	Expert
		3.1.2	Freedom of peaceful assembly	Country experts' aggregated evaluation of the question, "To what extent do state authorities respect and protect the right of peaceful assembly?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		3.1.3	Freedom of religion	Country experts' aggregated evaluation of the question, "Is there freedom of religion?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		3.1.4	Access to justice	Country experts' aggregated evaluation of the question, "Do citizens enjoy secure and effective access to justice?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		3.1.5	Property rights for women	Country experts' aggregated evaluation of the question, "Do women enjoy the right to private property?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert

		3.1.6	Freedom of discussion	Country experts' aggregated evaluation of the question, "Are citizens able to openly discuss political issues in private homes and in public spaces?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
	3.2 Personal freedom and choice	3.2.1	Vulnerable employment	Contributing family workers and own-account workers as a percentage of total employment.	International Labor Organization/World Bank	
		3.2.2	Early marriage	The percentage of women aged 15-19 years who are married or in-union.	United Nations Population Division	
		3.2.3	Satisfied demand for contraception	The percentage of total demand for family planning among married or in-union women aged 15 to 49 that is satisfied with modern methods	United Nations Population Division	
		3.2.4	Corruption	The perceived level of public sector corruption based on expert opinion, measured on a scale from 0 (highly corrupt) to 100 (very clean).	Transparency International	Expert
		3.2.5	Freedom of domestic movement	Country experts' aggregated evaluation of the question, "Do citizens enjoy freedom of movement and residence?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		3.2.6	Young people not in education, employment or training	The proportion of youth who are not in employment and not in education or training. Youth are defined as persons between the ages of 15 and 24 years. The series is part of the ILO modelled estimates	International Labor Organization	Survey
	3.3 Inclusivenes s	3.3.1	Acceptance of gays and lesbians	The proportion of respondents answering yes to the question, “Is the city or area where you live a good place or not a good place to live for gay or lesbian people?”	Gallup World Poll	Survey
		3.3.2	Discrimination and violence against minorities	Group Grievance indicator: discrimination, powerlessness, ethnic violence, communal violence, sectarian violence, and religious violence.	Fund for Peace Fragile States Index	Expert
		3.3.3	Equal protection index	Country experts' aggregated evaluation of the question, "How equal is the protection of rights and freedoms across social groups by the state?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		3.3.4	Equal access index	Country experts' aggregated evaluation of the question, "How equal is access to power?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
		3.3.5	Power distributed by sex orientation	Country experts' aggregated evaluation of the question, "To what extent is political power distributed according to sexual orientation?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert

		3.3.6	Access to public services distributed by social groups	Country experts' aggregated evaluation of the question, "Are basic public services, such as order and security, primary education, clean water, and healthcare, distributed equally across social groups?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert
	3.4 Access to advanced education	3.4.1	Expected years of tertiary education	Number of years a person of tertiary school entrance age can expect to spend within tertiary education. For a child of a certain age a, the school life expectancy is calculated as the sum of the age specific enrollment rates for the levels of education specified. The part of the enrolment that is not distributed by age is divided by the school-age population for the level of education they are enrolled in, and multiplied by the duration of that level of education. The result is then added to the sum of the age-specific enrolment rates. The indicator seeks to show the overall level of development of an educational system in terms of the average number of years of schooling that the education system offers to the eligible population, including those who never enter school.	UN Educational, Scientific, and Cultural Organization Institute for Statistics	
		3.4.2	Women in advanced education	Proportion of females (age-standardized) with 12–18 years of education.		
		3.4.3	Quality weighted universities	The number of universities in a country weighted by the quality of universities, measured by university rankings on any of the three most widely used international assessments. Universities in the top 400 on any list are given double weight. Not ranked universities are given 5% weight of the top ranked universities.	Times Higher Education World University Rankings, QS World University Rankings, and Academic Ranking of World Universities; Varieties of Democracy (V-Dem), Dataset Version 12; SPI calculations	
		3.4.4	Citable documents	Citable documents - articles, reviews and conference papers - per 1,000 population.	Scimago Journal & Country Rank	Admin
		3.4.5	Academic freedom	Country experts' aggregated evaluation of the question, "To what extent is academic freedom respected?"	Varieties of Democracy (V-Dem), Dataset Version 12	Expert

			GDP per capita, PPP (constant 2017 international $)	GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2017 international dollars.	World Bank	Admin

Note: source for the description of the methodology: Stern et al. (2022).

Timeliness, other issues related to individual indicators

The set of indicators is subject to year-by-year comprehensive review, in terms of both data update and whether new indicators have been published that are well-suited to describing social progress concepts. While the underlying structure of the SPI remained unchanged since 2011, several new indicators were added and a few removed due to their discontinuation or the lack of updated data. The sources and the measurement of a handful of indicators were also changed during the period.

"(...) while we establish a twelve-year time-series of social progress from 2011 to 2022, not all indicator data are updated on an annual basis. Therefore, change over time is best interpreted over the entire span of these eleven years rather than focusing on annual change." (Stern et al., 2022, p.18.)

II. Methodological issues related to the index

1. Management of missing data

We ensure that all indicators included in the Social Progress Index are missing as few observations as possible to avoid jeopardizing the statistical quality of the index. Missing values can stem from lack of coverage by the data source, incomplete reporting by the country to international organizations, or outdated data whose publication date is older than 2008. In cases where an indicator is missing a country data point, we assess our imputation methodology both before and during index calculation. Imputations used prior to calculation are included and marked in the published dataset on our website; imputations generated during calculation are not. There is an imputation process both prior and during calculation (page 11-13).

2. Treatment of outliers

In 2022, a top and bottom boundary was applied on 12 indicators (page 9-10). Further, four additional indicators contain extreme values in relation to the rest of the indicator data distribution. Based on external research, it was determined that these extreme values are not erroneous and should be preserved as a distinguishing characteristic of the countries they describe. As such, these indicators were transformed using natural log (page 10). Several indicators based on surveys were transformed to limit the annual volatilities of the measures. This method was applied on all indicators from the Gallup World Poll. Indicator values are calculated as floating 3-year average (Stern et al., 2022, p.10).

3. Normalisation (standardization)

We convert indicators to the same scale in a three-step process. First, we set best- and worst case scenarii to provide concrete boundaries on both ends of the scale that are based on theoretical or historical values. We then invert indicators when increasing values reflect lower social progress. Finally, we standardize the indicators into z-scores prior to applying PCA. While the best- and worst-case scenarii are defined at the indicator level, we strive to follow the same method for similar metrics. For indicators with pre-defined boundaries (all indicators from Varieties of Democracy, summary exposure values etc.) we use these to establish the upper and lower scenarii. We use natural boundaries for indicators that have a natural best-case scenario – such as maternal mortality, mobile phone subscriptions, primary school enrollment etc. For indicators that do not have a clear worst case or where the probability of reaching an upper boundary is extremely unlikely (e.g., child mortality, for which the theoretical worst case would be that every child dies before the age of five), we use a boundary based on the worst recorded performance five years prior to the first year of measurement (i.e., five years prior to the 2011 Social Progress Index). Best- and worst-case data values are included with the country dataset when PCA is applied. See Appendix B for the specific values used for each indicator's bounds. Once we establish a full dataset with indicator values for 2011 through 2022 and the best- and worst-case scenarii, we invert indicators for which a higher value denotes lower social progress. There are 23 inverted indicators in the 2022 Social Progress Index. These include: Undernourishment, Maternal mortality rate, Child mortality rate, Child stunting, Diet low in fruits and vegetables, Infectious diseases, Unsafe water, sanitation and hygiene, Household air pollution, Dissatisfaction with housing affordability, Interpersonal violence, Money stolen, Transportation related injuries, Intimate partner violence, Population with no schooling, Gender parity in secondary attainment, Premature deaths from non-communicable diseases, Outdoor air pollution, Lead exposure, PM 2.5, Vulnerable employment, Early marriage, Young people not in education, employment or training, and Discrimination and violence against minorities. As a final step prior to applying PCA, we standardize the indicators into z-scores. Doing so produces scores with a mean of 0 and standard deviation of 1, ensuring the comparability of the indicators across the dataset in measurement (Stern et al., 2022, p.13).

4. Weighting of pillars and dimensions

There is a 3-step procedure to prepare the index. In this section we consider the calculation of component and dimension scores (Stern et al., 2022, p.13-14.). The method of calculation of the index score is presented in Stern et al. (2022), section 5.

4.1. Calculation of component scores

To calculate component scores, we aggregate the set of indicators within each component into a factor using PCA and all twelve years of data.6 PCA combines indicators in a way that captures the maximum amount of variance in the data while reducing redundancy between indicators. It essentially assigns each indicator a weight, a method we select over equal weighting to ensure that indicators are meaningfully contributing to a component score, while accounting for similarities between them.

Within many of the twelve components, PCA generates similar weights for the indicators we include because we ensure a fair level of correlation between them (e.g., not too high or low a correlation) prior to finalizing our framework. However, for those cases in which indicators are less correlated with other indicators within their component, we consider PCA a good statistical approach for determining these indicators' contribution to the component scores while remaining objective.

The formula below reflects indicator aggregation into a principal component, where c=Social Progress Index component and i=indicator.

Formula 1

Our choice of PCA as the basis for aggregation at the component level was also influenced by the quality and quantity of data available on social progress. For PCA to be valid, each indicator must be relatively free of measurement error (Dunteman, 1989). Thus, it should precisely measure what it was intended to measure and do so consistently across countries. Our design principles and the data we use fulfill this requirement.

To convert each principal component into a component score on a scale of 0 to 100, we use a simple min-max formula, where X=component value and j=country.

Formula 2

As noted in the prior section, only countries that are ranked or qualify as 'partial' are included in the country sample that determines PCA-generated weights. For countries that do not have enough data to calculate at least nine components, we use the weights generated by the original country sample to calculate component scores when possible. If a country outside the ranked and partial country sample has enough data to calculate all four components within a dimension, we proceed to calculate dimension scores as well.

4.2 Dimension Scores

Each dimension is the arithmetic average of the four components that make up that dimension. Countries that do not have scores in all four components of a given dimension do not have a

dimension score. The formula for calculating a dimension score is below, where d=dimension and c=component.

5. Aggregation method

The overall Social Progress Index score is calculated as the arithmetic average of the three dimensions. Countries that do not have scores in all three dimensions do not have a Social Progress Index score. The formula for calculating a Social Progress Index score is below, where d=dimension. In establishing country rankings for overall performance, we divide country scores into six tiers based on hierarchical clustering. (Stern et al., 2022, p.15.)

References

Harmacek, J., Krylova, P., Htitich, M. (2022). Social Progress Index Data. Social Progress Imperative. Washington, DC.

Norlen, H. and Caperna, G. (2018). The JRC Statistical Audit of the Social Progress Index (SPI), EUR 29576 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-98411-2, doi:10.2760/343522, JRC113130. https://op.europa.eu/en/publication-detail/-/publication/ce3b82ae-072d-11e9-81b4-01aa75ed71a1/language-en

Stern, S., Harmacek, J., Krylova, P. & Htitich, M. (2022). Social Progress Index Methodology Summary. Social Progress Imperative. Washington, DC. https://www.socialprogress.org/static/96abc80d11ac298c6ef2e6ce4a149ff0/2022%20Social%20Progress%20Index%20Methodology__final__infosheets.docx.pdf

Social Progress Imperative (2022). Social Progress Index®. Social Progress Imperative. Washington, DC. https://www.socialprogress.org/global-index-2022-results/

11. Sustainable Development Goals Index and Dashboards

The SDG Index and Dashboards track the annual progress of all 193 UN Member States towards the SDGs, and is an initiative of the United Nations.

The dashboard and trend arrows help identify priorities for further actions and indicate whether countries are on track or off track to achieve the goals and targets by 2030, based on latest trend data. The 2023 SDG Index edition includes 97 global indicators.

The Sustainable Development Report 2023 (Sachs et al 2023) provides an assessment of progress made towards the SDGs by all UN Member States. The Report includes the SDG Index, in which scores are presented on a scale of 0 to 100 and can be interpreted as a percentage towards optimal SDG performance. Therefore, the difference between 100 and a country's SDG Index score is the distance, in percentage points, that must be overcome to reach optimum SDG performance.

The SDG Dashboards provide visual representations of countries' performance on the 17 SDGs. The "traffic light" color scheme (green, yellow, orange, and red) illustrates how far a country is from achieving a particular goal. The SDG Dashboards are presented for all countries where data permits, including those that are not included in the SDG Index. As in previous years, the SDG Dashboards and country profiles for OECD countries incorporate additional metrics that are not available for non-OECD members. The SDG Trend Dashboards indicate whether a country is on track to achieve the goals by 2030, based on past performance. Trends are calculated for each indicator, building on annual growth rates since 2015 which are extrapolated to 2030. The country's resultant indicator trends are then aggregated at the goal level, to give an indication of how it is progressing towards each SDG.

I. Information on individual indicators

Table 11.1 Individual indicators and data sources in the Sustainable Development Goals Index

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
1	1.1.1	Poverty headcount ratio at $2.15/day (2017 PPP, %)	2015 - 2023	2023	World Data Lab	http://worldpoverty.io/
1	1.1.1	Poverty headcount ratio at $3.65/day (2017 PPP, %)	2015 - 2023	2023	World Data Lab	http://worldpoverty.io/
1	1.2.1	Poverty rate after taxes and transfers (%)	2015 - 2020	2020	OECD	http://stats.oecd.org/Index.aspx?DataSetCode=IDD
2	2.1.1	Prevalence of undernourishment (%)	2015 - 2020	2020	FAO	https://www.fao.org/faostat/en/#data/SDGB
2	2.2.1	Prevalence of stunting in children under 5 years of age (%)	2015 - 2022	2022	UNICEF et al.	http://data.worldbank.org/indicator/SH.STA.STNT.ZS
2	2.2.2	Prevalence of wasting in children under 5 years of age (%)	2015 - 2020	2021	UNICEF et al.	http://data.worldbank.org/indicator/SH.STA.WAST.ZS
2	2,2	Prevalence of obesity, BMI ≥ 30 (% of adult population)	2013 - 2016	2016	WHO	http://apps.who.int/gho/data/view.main.CTRY2450A?lang=en
2	-	Human Trophic Level (best 2-3 worst)	2014 - 2017	2017	Bonhommeau et al. (2013) data updated to 2017	https://doi.org/10.1073/pnas.1305827110
2	2.3 & 2.4	Cereal yield (tonnes per hectare of harvested land)	2015 - 2021	2021	FAO	http://data.worldbank.org/indicator/AG.YLD.CREL.KG
2	2.4	Sustainable Nitrogen Management Index (best 0-1.41 worst)	2015 - 2018	2018	Zhang and Davidson (2019)	https://doi.org/10.1002/essoar.10501111.1
2	2.3 & 2.4	Yield gap closure (% of potential yield)	na	2021	Global Yield Gap Atlas	http://www.yieldgap.org/web/guest/glossary
2	3,9	Exports of hazardous pesticides (tonnes per million population)	na	2020	FAO	http://www.fao.org/faostat/en/#data/RT/metadata
3	3.1.1	Maternal mortality rate (per 100,000 live births)	2015 - 2020	2020	WHO et al.	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/maternal-mortality-ratio-(per-100-000-live-births)
3	3.2.2	Neonatal mortality rate (per 1,000 live births)	2015 - 2021	2021	UNICEF et al.	https://childmortality.org/
3	3.2.1	Mortality rate, under-5 (per 1,000 live births)	2015 - 2021	2021	UNICEF et al.	https://childmortality.org/

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
3	3.3.2	Incidence of tuberculosis (per 100,000 population)	2015 - 2021	2021	WHO	http://data.worldbank.org/indicator/SH.TBS.INCD
3	3.3.1	New HIV infections (per 1,000 uninfected population)	2015 - 2021	2021	UNAIDS	https://aidsinfo.unaids.org/?chp=false
3	3.4.1	Age-standardized death rate due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease in adults aged 30–70 years (%)	2015 - 2019	2019	WHO	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/probability-(-)-of-dying-between-age-30-and-exact-age-70-from-any-of-cardiovascular-disease-cancer-diabetes-or-chronic-respiratory-disease
3	3.9.1	Age-standardized death rate attributable to household air pollution and ambient air pollution (per 100,000 population)	na	2019	WHO	https://unstats.un.org/sdgs/indicators/database/?indicator=3.9.1
3	3.6.1	Traffic deaths (per 100,000 population)	2015 - 2019	2019	WHO	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/estimated-road-traffic-death-rate-(per-100-000-population)
3	3.1 : 3.9	Life expectancy at birth (years)	2015 - 2019	2019	WHO	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/life-expectancy-at-birth-(years)
3	3.7.2	Adolescent fertility rate (births per 1,000 females aged 15 to 19)	2015 - 2020	2020	WHO	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/adolescent-birth-rate-(per-1000-women-aged-15-19-years)
3	3.1.2	Births attended by skilled health personnel (%)	2015 - 2020	2020	UNICEF	http://data.worldbank.org/indicator/SH.STA.BRTC.ZS
3	3.b.1	Surviving infants who received 2 WHO-recommended vaccines (%)	2015 - 2021	2021	WHO and UNICEF	https://data.unicef.org/topic/child-health/immunization/#data
3	3.8.1	Universal health coverage (UHC) index of service coverage (worst 0-100 best)	2015 - 2019	2019	WHO	https://unstats.un.org/sdgs/indicators/database/?indicator=3.8.1
3	3.4	Subjective well-being (average ladder score, worst 0-10 best)	2015 - 2022	2022	Gallup	https://ga.gallup.com/
3	3.8	Gap in life expectancy at birth among regions (years)	2015 - 2020	2021	OECD	https://www.oecd-ilibrary.org/governance/oecd-regions-and-cities-at-a-glance-2018/health-status_reg_cit_glance-2018-20-en
3	3.8	Gap in self-reported health status by income (percentage points)	2015 - 2019	2020	OECD	https://stats.oecd.org/index.aspx?queryid=48833
3	3.a.1	Daily smokers (% of population aged 15 and over)	2015 - 2020	2021	OECD	https://data.oecd.org/healthrisk/daily-smokers.htm
4	4.2.2	Participation rate in pre-primary organized learning (% of children aged 4 to 6)	2015 - 2021	2021	UNESCO	http://sdg4-data.uis.unesco.org/
4	4.1.2	Net primary enrollment rate (%)	2015 - 2021	2021	UNESCO	http://data.uis.unesco.org/
4	4.1.2	Lower secondary completion rate (%)	2015 - 2020	2021	UNESCO	https://data.worldbank.org/indicator/SE.SEC.CMPT.LO.ZS
4	4.6.1	Literacy rate (% of population aged 15 to 24)	2015 - 2020	2021	UNESCO	https://data.worldbank.org/indicator/SE.ADT.1524.LT.ZS

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
4	4,3	Tertiary educational attainment (% of population aged 25 to 34)	2015 - 2021	2021	OECD	https://data.oecd.org/eduatt/population-with-tertiary-education.htm
4	4.6.1	PISA score (worst 0-600 best)	2015 - 2018	2018	OECD	http://pisadataexplorer.oecd.org/ide/idepisa/dataset.aspx
4	4.5.1	Variation in science performance explained by socio-economic status (%)	2015 - 2018	2018	OECD	http://pisadataexplorer.oecd.org/ide/idepisa/dataset.aspx
4	4.6.1	Underachievers in science (% of 15-year-olds)	2015 - 2018	2018	OECD	http://pisadataexplorer.oecd.org/ide/idepisa/dataset.aspx
5	3.7.1	Demand for family planning satisfied by modern methods (% of females aged 15 to 49)	na	2023	UNDESA	https://unstats.un.org/sdgs/indicators/database/
5	3.7.1	Modeled estimate: Demand for family planning satisfied by any modern method (% of females aged 15 to 49)	2015 - 2022		UNDESA	https://www.un.org/development/desa/pd/data/family-planning-indicators
5	4.5.1	Ratio of female-to-male mean years of education received (%)	2015 - 2021	2021	UNDP	http://hdr.undp.org/en/data (education > mean years of schooling)
5	5,5	Ratio of female-to-male labor force participation rate (%)	2015 - 2022	2022	ILO	https://databank.worldbank.org/source/gender-statistics/Series/SL.TLF.CACT.FM.ZS
5	5.5.1	Seats held by women in national parliament (%)	2015 - 2021	2021	IPU	http://data.worldbank.org/indicator/SG.GEN.PARL.ZS
5	8,5	Gender wage gap (% of male median wage)	2015 - 2020	2021	OECD	https://data.oecd.org/earnwage/gender-wage-gap.htm
6	6.1.1	Population using at least basic drinking water services (%)	2015 - 2020	2020	JMP	https://data.worldbank.org/indicator/SH.H2O.BASW.ZS
6	6.2.1	Population using at least basic sanitation services (%)	2015 - 2020	2020	JMP	https://data.worldbank.org/indicator/SH.STA.BASS.ZS
6	6.4.2	Freshwater withdrawal (% of available freshwater resources)	na	2019	FAO	https://unstats.un.org/sdgs/indicators/database/?indicator=6.4.2
6	6.3.1	Anthropogenic wastewater that receives treatment (%)	na	2020	EPI	http://epi.yale.edu/
6	6,4	Scarce water consumption embodied in imports (m3 H2O eq/capita)	na	2018	UNEP	http://scp-hat.lifecycleinitiative.org/module-2-scp-hotspots/
6	6.1.1	Population using safely managed water services (%)	2015 - 2020	2020	JMP	https://data.worldbank.org/indicator/SH.H2O.SMDW.ZS
6	6.1.1	Population using safely managed sanitation services (%)	2015 - 2020	2020	JMP	https://data.worldbank.org/indicator/SH.STA.SMSS.ZS
7	7.1.1	Population with access to electricity (%)	2015 - 2020	2020	IEA, IRENA, UNSD, WB, WHO	http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS
7	7.1.2	Population with access to clean fuels and technology for cooking (%)	2015 - 2020	2020	WHO	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-phe-primary-reliance-on-clean-fuels-and-technologies-proportion

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
7	7,2	CO_2 emissions from fuel combustion per total electricity output ($MtCO_2$/TWh)	2015 - 2019	2019	IEA	https://www.pik-potsdam.de/paris-reality-check/primap-hist/ https://www.eia.gov/international/data/world/electricity/electricity-generation
7	7.2.1	Renewable energy share in total final energy consumption (%)	2015 - 2019	2019	IEA, IRENA, UNSD, WB, WHO	https://trackingsdg7.esmap.org/time
8	8.1.1	Adjusted GDP growth (%)	na	2021	World Bank	https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD
8	8,7	Victims of modern slavery (per 1,000 population)	na	2018	Walk Free Foundation (2018)	https://www.globalslaveryindex.org/
8	8.10.2	Adults with an account at a bank or other financial institution or with a mobile-money-service provider (% of population aged 15 or over)	2014 - 2021	2021	Global Findex Database	https://data.worldbank.org/indicator/FX.OWN.TOTL.ZS
8	8.5.2	Unemployment rate (% of total labor force, ages 15+)	2015 - 2023	2023	ILO	https://www.ilo.org/shinyapps/bulkexplorer14/?lang=en&segment=indicator&id=UNE_2EAP_SEX_AGE_RT_A
8	8.8.2	Fundamental labor rights are effectively guaranteed (worst 0–1 best)	2015 - 2021	2021	World Justice Project	https://worldjusticeproject.org/our-work/wjp-rule-law-index
8	8.8.1	Fatal work-related accidents embodied in imports (per 100,000 population)	2015 - 2018	2018	Alsamawi et al. (2017) data updated to 2018	https://doi.org/10.1016/j.jclepro.2016.12.110
8	8,7	Victims of modern slavery embodied in imports (per 100,000 population)	na	2018	Malik et al (2022)	Data provided by Malik A. https://onlinelibrary.wiley.com/doi/abs/10.1111/jiec.13169
8	8,5	Employment-to-population ratio (%)	2015 - 2021	2022	OECD	https://data.oecd.org/emp/employment-rate.htm
8	8.6.1	Youth not in employment, education or training (NEET) (% of population aged 15 to 29)	2015 - 2021	2021	OECD	https://data.oecd.org/youthinac/youth-not-in-employment-education-or-training-neet.htm
9	9.1.1	Rural population with access to all-season roads (%)	na	2022	SDSN (2023), based on Workman, R. & McPherson, K., TRL (2019)	https://sdsn.maps.arcgis.com/home/item.html?id=d386abdab7d946aa8b1a0cd11496d91f
9	17.8.1	Population using the internet (%)	2015 - 2021	2021	ITU	https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
9	9.c.1 & 17.6.1	Mobile broadband subscriptions (per 100 population)	2015 - 2021	2021	ITU	https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
9	9,1	Logistics Performance Index: Quality of trade and transport-related infrastructure (worst 1-5 best)	2014 - 2018	2018	World Bank	https://lpi.worldbank.org/international/global

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
9	-	The Times Higher Education Universities Ranking: Average score of top 3 universities (worst 0-100 best)	na	2022	Times Higher Education	https://www.timeshighereducation.com/world-university-rankings
9	9,5	Articles published in academic journals (per 1,000 population)	2015 - 2021	2021	Scimago Jounal Rank	https://www.scimagojr.com/countryrank.php?year=2020
9	9.5.1	Expenditure on research and development (% of GDP)	2015 - 2020	2020	UNESCO	http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS
9	9.5.2	Researchers (per 1,000 employed population)	2015 - 2020	2020	OECD	https://data.oecd.org/rd/researchers.htm
9	9,5	Triadic patent families filed (per million population)	2015 - 2020	2020	OECD	https://data.oecd.org/rd/triadic-patent-families.htm#indicator-chart
9	9.c	Gap in internet access by income (percentage points)	2015 - 2020	2020	OECD	https://stats.oecd.org/
9	4,3	Female share of graduates from STEM fields at the tertiary level (%)	2014 - 2017	2018	World Bank	https://databank.worldbank.org/source/gender-statistics/Series/SE.TER.GRAD.FE.SI.ZS
10	10,1	Gini coefficient	2015 - 2019	2020	World Bank	https://data.worldbank.org/indicator/SI.POV.GINI
10	10,1	Palma ratio	2015 - 2020	2020	OECD & UNDP	http://stats.oecd.org/Index.aspx?DataSetCode=IDD https://data.worldbank.org/indicator/SI.DST.10TH.10
10	10.2.1	Elderly poverty rate (% of population aged 66 or over)	2015 - 2020	2020	OECD	https://data.oecd.org/inequality/poverty-rate.htm
11	11.1.1	Proportion of urban population living in slums (%)	2016 - 2020	2020	UN Habitat	https://data.unhabitat.org/pages/housing-slums-and-informal-settlements
11	11.6.2	Annual mean concentration of particulate matter of less than 2.5 microns in diameter (PM2.5) (µg/m³)	2015 - 2019	2019	IHME	http://www.healthdata.org/gbd/2019
11	11,1	Access to improved water source, piped (% of urban population)	2015 - 2020	2020	WHO and UNICEF	https://washdata.org/data/household#!/table?geo0=region&geo1=sdg
11	11.2.1	Satisfaction with public transport (%)	2015 - 2022	2022	Gallup	https://ga.gallup.com/
11	11,1	Population with rent overburden (%)	2015 - 2019	2019	OECD	http://www.oecd.org/housing/data/affordable-housing-database/
11	-	Proportion of population with access to points of interest within a 15min walk (%)	na	2022	SDSN (2023), based on Nicoletti, L., Sirenko, M., & Verma, T. (2023)	https://sdg-transformation-center-sdsn.hub.arcgis.com/datasets/sdsn::pedestrian-accessibility-indicators-by-country-oecd-members-only/about
12	12,5	Municipal solid waste (kg/capita/day)	na	2019	World Bank	https://openknowledge.worldbank.org/handle/10986/30317 https://datacatalog.worldbank.org/search/dataset/0039597

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
12	12.4.2	Electronic waste (kg/capita)	na	2019	UNU-IAS	https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf
12	9,4	Production-based SO_2 emissions (kg/capita)	na	2018	Lenzen et al. (2022)	Data provided by Malik, A.
12	9,4	SO_2 emissions embodied in imports (kg/capita)	na	2018	Lenzen et al. (2022)	Data provided by Malik, A.
12	9,4	Production-based nitrogen emissions (kg/capita)	2015 - 2018	2018	UNEP	http://scp-hat.lifecycleinitiative.org/module-2-scp-hotspots/
12	9,4	Nitrogen emissions embodied in imports (kg/capita)	2015 - 2018	2018	UNEP	http://scp-hat.lifecycleinitiative.org/module-2-scp-hotspots/
12	12,4	Exports of plastic waste (kg/capita)	2016 - 2020	2021	UN Comtrade	https://comtrade.un.org/data/
12	11.6.1	Non-recycled municipal solid waste (kg/capita/day)	2015 - 2021	2021	OECD	https://stats.oecd.org/Index.aspx?DataSetCode=MUNW
13	13.2.2	CO_2 emissions from fossil fuel combustion and cement production (tCO2/capita)	2015 - 2021	2021	Global Carbon Project	https://www.icos-cp.eu/science-and-impact/global-carbon-budget/2022
13	13,2	CO_2 emissions embodied in imports (tCO_2/capita)	2015 - 2018	2018	Lenzen et al. (2022)	Data provided by Malik, A.
13	13,2	CO_2 emissions embodied in fossil fuel exports (kg/capita)	na	2021	UN Comtrade	https://comtrade.un.org/data/
13	13,2	Carbon Pricing Score at EUR60/tCO_2 (%, worst 0-100 best)	2015 - 2018	2018	OECD	https://stats.oecd.org/Index.aspx?DataSetCode=ECR&_ga=2.210449308.885305165.1646569249-1295670724.1646080129# http://www.oecd-ilibrary.org/taxation/effective-carbon-rates_9789264260115-en
14	14.5.1	Mean area that is protected in marine sites important to biodiversity (%)	2015 - 2022	2022	Birdlife International et al.	https://unstats.un.org/sdgs/indicators/database/?indicator=14.5.1
14	14.1.1	Ocean Health Index: Clean Waters score (worst 0-100 best)	2015 - 2022	2022	Ocean Health Index	https://oceanhealthindex.org/global-scores/data-download/
14	14.4.1	Fish caught from overexploited or collapsed stocks (% of total catch)	2015 - 2018	2018	Sea around Us	http://epi.yale.edu/
14	14,4	Fish caught by trawling or dredging (%)	2015 - 2019	2019	Sea Around Us	http://www.seaaroundus.org/data/#/search
14	14,4	Fish caught that are then discarded (%)	2015 - 2019	2019	Sea around Us	http://www.seaaroundus.org/data/#/search
14	14,4	Marine biodiversity threats embodied in imports (per million population)	na	2018	Lenzen et al. (2012) data updated to 2018	https://www.nature.com/articles/nature11145

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
15	15.1.2	Mean area that is protected in terrestrial sites important to biodiversity (%)	2015 - 2022	2022	Birdlife International et al.	https://unstats.un.org/sdgs/indicators/database/?indicator=15.1.2
15	15.1.2	Mean area that is protected in freshwater sites important to biodiversity (%)	2015 - 2022	2022	Birdlife International et al.	https://unstats.un.org/sdgs/indicators/database/?indicator=15.1.2
15	15.5.1	Red List Index of species survival (worst 0-1 best)	2015 - 2023	2023	IUCN and Birdlife International	http://unstats.un.org/sdgs/indicators/database/?indicator=15.5.1
15	15,2	Permanent deforestation (% of forest area, 3-year average)	2015 - 2021	2021	Curtis et al. (2018) data updated to 2021	http://science.sciencemag.org/content/361/6407/1108
15	15,5	Terrestrial and freshwater biodiversity threats embodied in imports (per million population)	na	2018	Lenzen et al. (2012) data updated to 2018	https://www.nature.com/articles/nature11145
16	16.1.1	Homicides (per 100,000 population)	2015 - 2020	2021	UNODC	https://dataunodc.un.org/dp-intentional-homicide-victims
16	16.3.2	Unsentenced detainees (% of prison population)	2015 - 2020	2020	UNODC	https://dataunodc.un.org/dp-prisons-persons-held
16	16.1.4	Population who feel safe walking alone at night in the city or area where they live (%)	2015 - 2022	2022	Gallup	https://ga.gallup.com/
16	16.9.1	Birth registrations with civil authority (% of children under age 5)	na	2022	UNICEF	http://data.unicef.org/child-protection/birth-registration.html
16	16.5.1 & 16.5.2	Corruption Perceptions Index (worst 0-100 best)	2015 - 2022	2022	Transparency International	https://www.transparency.org/
16	8.7.1	Children involved in child labor (% of population aged 5 to 14)	na	2021	UNICEF	https://data.unicef.org/topic/child-protection/child-labour/
16	16,1	Exports of major conventional weapons (TIV constant million USD per 100,000 population)	na	2021	Stockholm Peace Research Institute	https://sipri.org/databases/armstransfers
16	16,1	Press Freedom Index (worst 0-100 best)	2015 - 2023	2023	Reporters sans frontières	https://rsf.org/en/ranking
16	16.3.1 & 16.3.3	Access to and affordability of justice (worst 0–1 best)	2015 - 2021	2021	World Justice Project	https://worldjusticeproject.org/rule-of-law-index/

SDG	Target	Indicator	Period for trend calculation	Reference year	Source	Link
16	16,6	Timeliness of administrative proceedings (worst 0 - 1 best)	2015 - 2021	2021	World Justice Project	https://worldjusticeproject.org/rule-of-law-index/
16	16,6	Expropriations are lawful and adequately compensated (worst 0 - 1 best)	2015 - 2021	2021	World Justice Project	https://worldjusticeproject.org/rule-of-law-index/
16	-	Persons held in prison (per 100,000 population)	2015 - 2019	2020	UNODC	https://dataunodc.un.org/data/Prison/Persons%20held%20in%20prison
17	1.a.1	Government spending on health and education (% of GDP)	2015 - 2020	2021	UNESCO	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/domestic-general-government-health-expenditure-(gghe-d)-as-percentage-of-gross-domestic-product-(gdp)-(-) https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS
17	17.2.1	For high-income and all OECD DAC countries: International concessional public finance, including official development assistance (% of GNI)	2019 - 2022	2022	OECD	https://data.oecd.org/oda/net-oda.htm
17	17.1.1	Other countries: Government revenue excluding grants (% of GDP)	2015 - 2020	2020	IMF	https://data.worldbank.org/indicator/GC.REV.XGRT.GD.ZS?view=chart
17	-	Corporate Tax Haven Score (best 0-100 worst)	na	2021	Tax Justice Network	https://corporatetaxhavenindex.org/
17	-	Financial Secrecy Score (best 0-100 worst)	2018 - 2022	2022	Tax Justice Network	https://fsi.taxjustice.net/en/introduction/fsi-results
17	-	Shifted profits of multinationals (US$ billion)	2015 - 2019	2019	Zucman et al. (2019)	https://missingprofits.world/
17	17.18.1 : 17.19.2	Statistical Performance Index (worst 0-100 best)	2016 - 2022	2022	World Bank	https://databank.worldbank.org/Statistical-Performance-Indicators-(SPI)/id/c6cc9909

II. Methodological issues related to the index

The SDG Index is an assessment of each country's overall performance on the 17 SDGs, giving equal weight to each Goal. The score signifies a country's position between the worst possible outcome (score of 0) and the target (score of 100).

The same basket of indicators and similar performance thresholds are used for all countries, to generate comparable scores and rankings. Substantial differences in rankings may result from small differences in aggregate SDG Index scores. This calls for caution when comparing country rankings. Differences of two or three positions between countries should not be interpreted as "significant", whereas a differences of 10 places may be ascribed to meaningful differences in performance.

Two-thirds of the data come from official statistics (typically United Nations custodian agencies) with one third from non-traditional statistics, including research centers, universities, and non-governmental organizations. Published since 2015, the SDG Index and Dashboards has been peer-reviewed and the global edition has been statistically audited by the European Commission in 2019 (Schmidt-Traub et al. 2017; Papadimitriou, Neves, and Becker 2019). More detailed information is available in the Methods Annex, in the detailed methodology paper (Lafortune et al. 2018), and on the Index website (www.sdgindex.org).

1. Management of missing data

To minimize biases from missing data, the SDG Index only includes countries that have data for at least 80% of the indicators or that have been in previous editions of the SDG Index and have data for at least 75% of the indicators. We do, however, include all UN Member States in the SDG Dashboards and we feature country profiles for each one. These profiles also indicate any gaps in a country's available SDG data. Due to the lack of widely accepted statistical models for imputing country-level data for many SDG priorities, we do not generally impute or model missing data apart from a few exceptional circumstances. The list of indicators where imputations have been performed is available online in the Codebook.

2. Treatment of outliers

3. Normalisation

To make the data comparable across indicators, each variable was rescaled from 0 to 100 – with 0 denoting the worst performance and 100 describing the optimum. Rescaling is sensitive to the choice of limits, as extreme values (outliers) risk becoming unintended thresholds that can introduce spurious variability in the data. Consequently, the choice of upper and lower bounds can affect the relative ranking of countries in the index.

The upper bound for each indicator was determined using the following decision tree:

1. Use the absolute quantitative thresholds of the SDGs and targets: e.g., zero poverty, universal school completion, universal access to water and sanitation, full gender equality.

2. Where no explicit SDG target is available, apply the principle of "leave no one behind" to set the upper bound to universal access, or zero deprivation.
3. Where science-based targets exist that must be achieved by 2030 or later, use these to set the 100% upper bound (e.g., zero greenhouse gas emissions from CO_2 as required by no later than 2050 to limit global warming to 1.5°C, 100% sustainable management of fisheries).
4. For all other indicators, use the average of the top five performers.

These principles interpret the SDGs as "stretch targets" and focus attention on those indicators where a country is lagging behind. The lower bound was defined at the 2.5th percentile of the distribution. Each indicator distribution was censored, so that all values exceeding the upper bound scored 100, and values below the lower bound scored 0.

After establishing the upper and lower bounds, variables were transformed linearly to a scale between 0 and 100 using the following rescaling formula for the range [0; 100]:

Image A.1 | Rescaling equation

$$x' = \frac{x - min(x)}{max(x) - min(x)} \times 100$$

where x is the raw data value; max/min denote the upper and lower bounds, respectively; and x' is the normalized value after rescaling.

The rescaling equation ensured that all rescaled variables were expressed as ascending variables (i.e., higher values denoted better performance). In this way, the rescaled data became easy to interpret and compare across all indicators: a country that scores 50 on a variable is halfway towards achieving the optimum value, whereas a country with a score of 75 has covered three quarters of the distance from worst to best.

4. Weighting

Several rounds of expert consultations on earlier drafts of the SDG Index made it clear that there is little consensus across different epistemic communities on assigning higher weights to some SDGs over others. As a normative assumption, we therefore opted to assign a fixed, equal weight to every SDG, to reflect policymakers' commitment to treat all SDGs equally and as an integrated and indivisible set of goals. This implies that countries need to pay attention to all goals to improve their SDG Index score, but focus particularly on those where they are furthest from achieving the SDGs and where incremental progress might therefore be expected to be fastest.

5. Aggregation

To compute SDG Index scores, we first estimate scores on each goal using the arithmetic mean of indicators for that goal. These goal scores are then averaged across all 17 SDGs to obtain the

final Index score. Various sensitivity tests were carried out, with the results available online, including comparisons of arithmetic mean versus geometric mean and Monte-Carlo simulations at the Index and Goal level. Monte-Carlo simulations call for prudence in interpreting small differences between countries' Index scores and rankings, however, as these may be sensitive to the weighting scheme.

6. JRC audit

The report by Papadimitriou et al (2019) touches upon data quality issues, the conceptual and statistical coherence of the framework and the impact of modelling assumptions on the results. The fact that the SDGs are universal and highly diverse in nature makes the work of aggregating into a single number quite challenging from a statistical point of view. Nevertheless, the SDG Index is a remarkable effort of synthetizing the 17 SDGs into a single measure. The index ranks are robust enough, allowing meaningful conclusions to be drawn from the index.

The main challenge on the construction of the SDG Index lays on the inverted relationship between socio-economic goals and environmental ones, in particular SDG12 (responsible consumption and production) and SDG13 (climate action). Also, SDG 14 (life below water) and SDG 15 (life on land) show no significant association with the SDG Index. The negative relationship between goals is a sign of trade-off, whereby some countries that have poor performance on SDG12 and SDG13 have good performance on all the other goals and viceversa. Upon these considerations, the JRC recommendation would be to focus on a complementary analysis on the relationships between goals and to consider the option of using the geometric average instead of the arithmetic average. The geometric average could serve as an alternative aggregation method that is non-compensatory and fits with the view that scores in different dimensions of sustainable development should not compensate one another. The uncertainty and sensitivity analyses carried out confirm that the uncertainty is manageable and allows meaningful conclusions to be drawn from the SDG Index. Nevertheless, both the aggregation method and the set of indicators do cause a modest contribution to the uncertainty. A suggestion would be to guide the conclusions that can be drawn from the SDG Index using the following information: differences of two or three places between countries cannot be taken as "significant", whereas differences of 10 places can show a meaningful difference. All things considered, the SDG Index is a noteworthy effort of synthetizing the 17 adopted SDGs into a single figure. Overall, the ranks of the SDG Index are fairly robust. The index is anchored on the 2030 Agenda for Sustainable Development adopted by all UN member states and rigorously follows the same structure of 17 goals. The fact that the goals are universal and highly diverse in nature makes the work of aggregating into a single number quite challenging from a statistical point of view. The index is also complemented by dashboards, which are a very communicative and neat way to show the performance of countries at individual goal level. The SDG Index proposes a first-of-its-kind composite measure to track progress on SDGs at national and global level, but it is fundamental that communication of its results is accompanied by a deep understanding of its underlying components and the relationships between them.

References

Lafortune, Guillaume, Grayson Fuller, Jorge Moreno, Guido Schmidt-Traub, and Christian Kroll (2018). SDG Index and Dashboards. Detailed Methodological paper. Paris: Bertelsmann Stiftung and Sustainable Development Solutions Network. http://sdgindex.org/assets/files/2018/Methodological%20Paper_v1_gst_jmm_Aug2018_FINAL.pdf

Papadimitriou, E.; Neves, A. R.; Becker, W. (2019). JRC Statistical Audit of the Sustainable Development Goals Index and Dashboards, EUR 29776 EN, 2019, ISBN 978-92-76-08995-7, doi:10.2760/723763, JRC116857.

Sachs, J.D., Lafortune, G., Fuller, G., Drumm, E. (2023). Implementing the SDG Stimulus. Sustainable Development Report 2023. Paris: SDSN, Dublin: Dublin University Press, 2023. 10.25546/102924

Schmidt-Traub, Guido, Christian Kroll, Katerina Teksoz, David Durand-Delacre, and Jeffrey D. Sachs (2017). National baselines for the Sustainable Development Goals assessed in the SDG Index and Dashboards. Nature Geoscience 10 (8): 547-55. https://doi.org/10.1038/ngeo2985

12. Sustainable Development Index

The Sustainable Development Index was proposed and calculated by Jason Hickel (2020) with the aim to update the Human Development Index (HDI) for the ecological realities of the Anthropocene.

The SDI retains the base formula of the HDI but places a sufficiency threshold on per capita income, and divides by two key indicators of ecological impact: CO2 emissions and material footprint, both calculated in per capita consumption-based terms and rendered vis-à-vis planetary boundaries. The SDI is an indicator of strong sustainability that measures nations' ecological efficiency in delivering human development.

The calculations cover 165 countries for the period 1990-2019.

I. Information on individual indicators

The Sustainable Development Index includes five indicators: education, life expectancy, income, CO2 emissions and material footprint.

Table 12.1: List of individual indicators

Pillar	Name	Definition/Method	Data source	Type of data
1. Development index	Education index	Average of - mean years of schooling for adults aged 25 and above (years), and - expected years of schooling for children at school entering age indexed within a range of 0 and 15	UNDP global databases	Admin
	Life expectancy index	Life expectancy at birth Indexed within a range of 20 and 85	UNDP global databases	Admin
	Modified income index	GNI per capita Indexed within a range of $100-20,000	UNDP global databases	Admin
2. Ecological index	Material footprint		Eora MRIO database	Admin
	CO2 emissions		UN International Resource Panel Global Material Flows database (https://www.materialflows.net/)	Admin

The SDI is calculated as a ratio of the 'development index' and the 'ecological impact index'. The 'development index' is a geometric average of the education index, the life expectancy index, and the modified income index. The 'ecological impact index' is calculated as the average overshoot of CO2 emission and material footprint vis-a-vis their per capita planetary boundaries, indexed on a natural exponential scale.

Data and timeliness

Data for life expectancy, education and income runs through 2019. Income is represented in 2017 PPP. Data for material footprint runs through 2017. Data for emissions runs through 2018, using Eora's 2021 data release. MF and emissions figures are projected horizontally to 2019 for the final years of missing data.

II. Methodological issues related to the index

1. Management of missing data

There is no information on handling missing data.

2. Treatment of outliers

There is no information on outlier treatment in the SDI. However, while the index follows the base formula of the HDI), there is a sufficiency threshold on income, $20,000 instead of $75,000.

3. Normalisation

Each of the development indicators is indexed within a range defined by maximum and minimum values.

- Life expectancy: minimum value 20 years, maximum value 85 years
- Education: minimum value 0 years, maximum value 15 years
- GNi: minimum value $100, maximum value $20,000

4. Weighting of pillars and dimensions

The 'development index' is the geometric mean of its components. The index is defined as follows:

$$\text{Development Index} = \sqrt[3]{\text{Life Expectancy Index} * \text{Education Index} * \text{Income Index}}$$

$$\text{Life Expectancy Index} = \frac{\text{LE} - 20}{85 - 20}$$

$$\text{Education Index} = \frac{\text{MYSI} + \text{EYSI}}{2}$$

$$\text{Income Index} = \frac{\ln(\text{GNIpc}) - \ln(100)}{\ln(20{,}000) - \ln(100)}$$

The ecological index is the average overshoot of CO_2 emissions and material footprint vis-à-vis their per capita planetary boundaries, indexed on a natural exponential scale. The index is defined as follows:

$$\text{Ecological Impact Index} = 1 + \frac{e^{\text{AO}} - e^{1}}{e^{4} - e^{1}}$$

$$\text{if AO} > 4, \text{then EII} = \text{AO} - 2$$

$$\text{AO} = \sqrt[2]{\left(\frac{\text{MF}}{\text{boundary}} \geq 1\right) * \left(\frac{\text{Co2}}{\text{boundary}} \geq 1\right)}$$

5. Aggregation method

The SDI is calculated as the quotient of the ‘development index’ and the ‘ecological impact index’.

References

Hickel, Jason (2020). The Sustainable Development Index: Measuring the Ecological Efficiency of Human Development in the Anthropocene, Ecological Economics vol 167. https://doi.org/10.1016/j.ecolecon.2019.05.011

13. Sustainable Human Development Index

The Sustainable Human Development Index (SHDI) is an extension of the HDI, methodologically based on Multidimensional Synthesis of Indicators (MSI) – a new class of indexes that can be used for monitoring Sustainable Human Development. It was developed by Mario Biggeri and Vincenzo Mauro (2018).

The SHDI goes beyond HDI by integrating two important sustainability-related dimensions that are missing in the HDI: namely, the environment and freedom (defined as political rights and civil liberties).

I. Information on individual indicators

Table 12.1: List of individual indicators

Name	Definition/Method	Data source	Type of data
Education index	Average of - mean years of schooling for adults aged 25 and above (years), and - expected years of schooling for children at school entering age indexed within a range of 0 and 15	UNDP global databases	Admin
Life expectancy index	Life expectancy at birth Indexed within a range of 20 and 85	UNDP global databases	Admin
Modified income index	GNI per capita Indexed within a range of $100-20,000	UNDP global databases	Admin
Freedom	The opportunity to act spontaneously in a variety of fields outside the control of the government and other centers of potential domination.	Freedom House	Expert survey
CO2 emissions		World Bank WDI	Admin

Timeliness, other issues related to individual indicators

For statistical tests and data simulations, years up to 2017 have been used. Otherwise data to produce the indicators in case are collected yearly or more frequently and are more or less timely, with a few years delay (see Sustainable Development index).

II. Methodological issues related to the index

1. Management of missing data

There is no missing data (sample of 50 countries).

2. Treatment of outliers

No information on the treatment of outliers.

3. Normalisation

Normalisation using min and max values.

4. Weighting of pillars and dimensions

See aggregation method.

5. Aggregation method

SHDI uses an alternative method of aggregation, which expands on the three standard HDI dimensions, while avoiding problems associated with the geometric mean that tends to collapse to zero. To address the problems of the HDI method (geometrical mean), the SHDI returns to the arithmetical mean and introduces the MSI method to cope with the increase in dimensions and also to penalize heterogeneity between achievements. Key properties: any change must be captured, the function must be continuous, heterogeneity between accomplishments, elasticity of substitution. A function g(.) is introduced to allow for the high degree of flexibility in the index and it can take account of theoretical considerations regarding the structure of substitutability rates between achievements.

In addition, relying on the flexibility of the MSI approach, another related index has been developed: the Environmentally centered Sustainable Human Development Index (ESHDI), which puts the environmental dimension at the core of the analysis. For ESHDI, the overall mean in the substitutability parameter is replaced with the score found in the environmental dimension.

Reference

Mario Biggeri, Vincenzo Mauro, "Towards a more 'Sustainable' Human Development Index: Integrating the environment and freedom". Ecological Indicators, Volume 91, August 2018, pp.220-231.

https://www.sciencedirect.com/science/article/abs/pii/S1470160X18302012

14. Sustainable Society Index

The Sustainable Society Index (SSI), developed by the Sustainable Society Foundation in the Netherlands in 2006 aims to be a comprehensive and quantitative method to measure and monitor the health of coupled human-environmental systems. In recent years, the Technische Hochschule Köln created updates of the index. The SSI comprises eight policy categories and three well-being dimensions (Human, Environmental, Economic) and is calculated for 151 countries around the world accounting for 99% of the world population.

Globally, the 2012 index score for Human Well-being is 6.2 out of 10, for Environmental Well-being is 4.5, and for Economic Well-being is 3.8, with developed countries generally performing better than developing countries on Human and Economic Well-being, but worse on Environmental Well-being, yet with notable exceptions. On Human Well-being, only 42% of countries score higher than 7, whereas 23% score lower than 5. On Environmental Well-being, only 14% of the countries score higher than 7, whereas 61% score lower than 5. Finally, on Economic Well-being, only 7% of countries score higher than 7, whereas 78% score lower than 5.

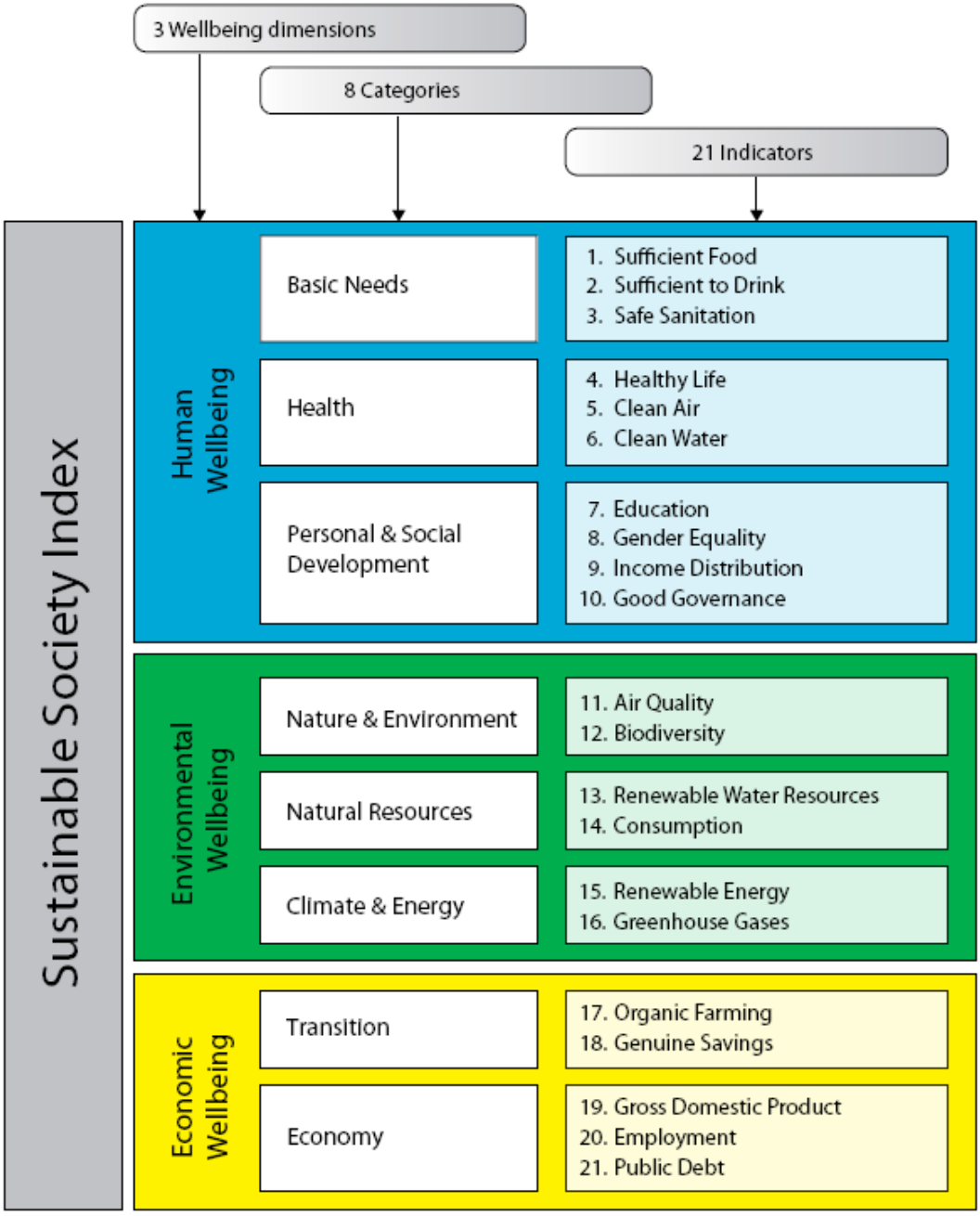
The index is built on 3 dimensions (see above), 8 policy categories and 21 indicators.

(i) Human well-being dimension: basic needs category (sufficient food, sufficient to drink, safe sanitation), personal development category (healthy life, education opportunities, gender equality), well-balanced society category (good governance, income distribution, population growth).

(ii) Environmental Well-being: healthy environment category (air quality - humans, air quality - nature, surface water quality), climate and energy category (renewable energy, emission greenhouse gases, energy consumption), natural resources category (renewable water resources, forest area, biodiversity).

(iii) Economic Well-being: preparation for the future category (material consumption, organic farming, genuine savings), economy category (GDP, employment, public debt).

Figure 14.1: Revised 2012 Framework for the SSI



Source: Sustainable Society Index SSI-2012.

The main objective for Edition 2023 was to deliver data for more countries/territories on a yearly baseline in order to better support cross-sectional and longitudinal analyses. In doing this, TH

Köln kept the statistical quality of version 1 and 2 without concentrating on improving it. Some high correlations between a few indicators remained, because their technical meaningfulness is still given. Although the perception of sustainability changed since the start of the development of the SSI at the early 2000s, they haven't changed the indicators conceptually yet.

I. Information on individual indicators

Table 14.1: List of individual indicators

Dimension	Code	Name
Human well-being	1.1	Sufficient food
	1.2	Sufficient drinking water
	1.3	Safe sanitation
	1.4	Education
	1.5	Healthy life
	1.6	Gender equality
	1.7	Income distribution
	1.8	Population growth
	1.9	Good governance
Environmental well-being	2.1	Biodiversity
	2.2	Renewable water sources
	2.3	Consumption
	2.4	Energy use
	2.5	Energy savings
	2.6	Greenhouse gases
	2.7	Renewable energy
	2.8	Organic farming
Economic well-being	3.1	Genuine savings
	3.2	GDP
	3.3	Employment
	3.4	Public debt

Data

Table 14.2: Data sources of specific indicators - Sustainable Society Index

Nº	Specific variables	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
1	Sufficient food	Prevalence of undernourishment (% of population)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
2	Sufficient drinking water	People using at least basic drinking water services (% of population)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
3	Safe sanitation	People using at least basic sanitation services (% of population)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
4	Education	Gross enrolment ratio, primary and secondary, both sexes (%)	Unesco	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
5	Healthy life	Life expectancy at birth, total (years)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
6	Gender equality	Gender Gap Index	World Economic Forum	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
7	Income distribution	gini_disp	Standardized World Income Inequality Database (SWIID)	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
8	Population growth	Population growth (annual %)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2015-2019	national
9	Good governance	Sum of the values of the six Worldwide Governance Indicators	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
10	Biodiversity	Biodiversity & Habitat (BDH)	Environmental Performance Index (EPI)	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
11	Renewable water sources	Total freshwater withdrawn as percent of Total renewable water resources		https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
12	Consumption	Ecological Footprint (global hectares (gha) per person)	Global Footprint Network	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
13	Energy use	Consumption (Total) in milion Tones of oil-equivalent (MTOE)	EIA	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
14	Energy savings	Change in energy usage within five years in %	EIA	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2015-2019	national

N°	Specific variables	Variable type	Data sources	Link of data sources	Time frequency	Level of analysis
15	Greenhouse gases	CO2 per capita	IEA	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
16	Renewable energy	Renewable energy consumption (% of total final energy consumption)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
17	Organic farming	Organic area share of total farmland [%]	FiBL	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
18	Genuine savings	Adjusted net savings, including particulate emission damage (% of GNI)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
19	GDP	GDP per capita, PPP (current international $)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
20	Employment	Unemployment, total (% of total labor force) (modeled ILO estimate)	Worldbank	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national
21	Public debt	Gross Debt	International Monetary Fond (IMF)	https://ssi.wi.th-koeln.de/documents/edition-2023/2019-indicator-descriptions.pdf	2019	national

II. Methodological issues related to the index

1. Management of missing data

The dataset used for the development of the SSI has an excellent data coverage: over 90% data availability per year. Few data gaps were filled in by expert judgment of the SSI team in consultation with relevant experts.

2. Treatment of outliers

No information on the treatment of outliers.

3. Normalisation

The indicators are expressed in different units (percentages, tonnes, and other), have different ranges and variances, and thus a normalization to a common scale is required. The methods that are most frequently used are standardization (or z-scores) and rescaling.

Standardization: $(x_i\text{-mean}(x))/\text{std}(x)$

This method converts the indicators to a common scale of mean zero and standard deviation of one. Therefore it rewards exceptional behavior, i.e. above-average performance of a given indicator yields higher scores than consistent average scores across all indicators.

Re-scaling: $(x_i\text{-min}(x))/(\max(x)\text{-min}(x))$

This approach is easier to communicate to a wider public, given that it normalizes indicators to an identical range [0, 1], where higher scores represent better achievement. A key advantage of this method over standardization, at least in the context of the SSI framework, is that re-scaling widens the range of an indicator, which is an advantage for those indicators with a small range of values, as it allows differentiation between countries with similar levels of performance.

However, this method is not appropriate in the presence of extreme values or outliers, which can distort the normalized indicator. To control for this, in step 1 above the necessary treatment was made to avoid that extreme values could bias the results. The minimum and maximum values needed for the re-scaling were determined in most cases based on “natural” minimum and maximum values instead of observed minimum and maximum over 2006-2012. For example, the Gender Gap Index, which is the proxy for Gender Equality under the Human Wellbeing dimension, is by construction expressed in a 0-1 scale. Thus, the 0 and 1 values were respectively the minimum and maximum values during the normalization here, although the observed minimum and maximum values over 2006-2012 across the 151 countries were 0.46 and 0.85 respectively.

The direction of the indicators’ effect was taken into account at this stage. For indicators where higher raw values are desirable, the formula was $(x_i–\min(x))/(\max(x)\text{-min}(x)) \times 9+1$. For indicators where lower raw values are desirable, the formula was: $(\max(x)\text{-}x_i)/(\max(x)\text{-min}(x)) \times 9+1$.

At this stage all normalised indicators are expressed in a 1-10 scale. We avoided values lower than 1 for reasons that will be explained in the aggregation step (see Step 5 below).

4. Weighting of pillars and dimensions

The SSI categories and Wellbeing dimensions are calculated using equal weights for the underlying components. There are no highly correlated indicators (all Pearson correlations coefficients are lower than 0.82). We anticipate here that assigning equal weights to the indicators does not necessarily guarantee an equal contribution of the indicators to an index. We will discuss this point thoroughly in Section 4.

5. Aggregation method

The most popular aggregation methods in the relevant literature are the arithmetic and geometric means. The arithmetic mean has been traditionally used to compute most of the well-known indices in the international scene and all previous versions of the SSI. Some counter arguments for the use of the arithmetic mean are: (a) perfect substitutability, i.e. poor performance in one indicator can be fully compensated by good performance in another, (b) no penalty for an unbalanced performance: the arithmetic mean does not penalize the differences in values between indicators, i.e. it does not reward balanced achievement in all indicators, (c) no impact of poor performance: the arithmetic mean does not consider that the lower the performance in a particular indicator, the more urgent it becomes to improve achievements in that indicator.

In the case of the SSI, the Basic Needs category is composed of Sufficient Food, Sufficient to Drink and Safe Sanitation. To make the case we consider two countries, Ghana with (normalized) values 10.0, 8.6, and 1.4 and Senegal with values 8.1, 7.2, and 5.2 respectively. These two countries have very similar scores (roughly 6.7 points) in the Basic Needs category if the arithmetic average is used (assuming equal weights for the three indicators). However, the arithmetic mean does not penalize the more uneven performance of Ghana with respect to Senegal (see differences in standard deviations). Instead, the geometric mean penalizes Ghana for the uneven performance, whereby its aggregate score is reduced from 6.7 (arithmetic mean) to 4.9 points (geometric mean), whilst the score of Senegal remains practically unaffected. Furthermore, if Ghana improves in Sufficient to Drink by 1 point, then the geometric mean increases from 4.9 to 5.1. Instead, if Ghana improves by 1 point on the aspects that is most weak, namely on Safe Sanitation, then the geometric mean increases from 4.9 to 5.9. If the arithmetic mean is used, improvement on either indicator (be it Sufficient to Drink or Safe Sanitation) gives the same mean score (7 points).

Upon these conceptual considerations, the aggregation formula for the SSI components was changed from arithmetic to geometric mean. The geometric mean of the SSI indicators (or categories), as opposed to the arithmetic mean, produces lower scores, with the largest changes occurring in countries with uneven performance across indicators. Given that the geometric mean requires strictly positive values, and because indicator values close to 0 would bring the aggregate score close to zero, we have preferred to normalize the indicators in the 1-10 scale (Step 3 above).

6. JRC audit

The JRC analysis (Saisana and Filippas 2012) concluded that “the Sustainable Society Index appears to be a comprehensive and quantitative method to measure and monitor the health of coupled human-environmental systems at national level worldwide.

The overall conclusions of this audit are:

1. The revised SSI framework is conceptually coherent:

- the indicators are more correlated to their own category than to any other category;
- all correlations within a category are significant and positive;
- the same conclusions are drawn at the dimension level.

2. The revised SSI framework meets the statistical requirements set by JRC:

- in most SSI categories the underlying indicators have similar implicit weights in classifying countries within each category;
- few imbalances were found within the Transition and the Economy category;
- the marginal weights of the indicators on the SSI categories scores do not differ too much;
- the robustness analysis of country ranks for each SSI Wellbeing dimension showed that the SSI provides a reliable picture of the countries’ performance, that is not driven by methodological assumptions.

References

Sustainable Society Index, 2023 Edition, https://ssi.wi.th-koeln.de

Saisana, M and D. Filippas (2012). Sustainable Society Index (SSI): Taking societies` pulse along social, environmental and economic issues. The Joint Research Centre audit on the SSI. EUR 25578 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2012. JRC76108

15. Transitions Performance Index

The TPI is a scoreboard of the European Commission that monitors and ranks countries based on their 4 transitions to fair and prosperous sustainability.

The transition is measured on 4 dimensions

- economic (education, wealth, labour productivity and research and development intensity, industrial base)
- social (health life, work and inclusion, free or non-remunerated time, equality)
- environmental (greenhouse gas emissions reduction, biodiversity, material use, energy productivity)
- governance (fundamental rights, security, transparency, sound public finances)

These measurements are the basis for a new model of prosperity for Europe and the world. A model which focuses on resilience, inclusiveness and sustainability and which supports the EU's 2022 Annual Sustainable Growth Strategy.

Most of the TPI indicators are outcome-oriented in order to present to the public and policymakers the combined impact of the policy mix implemented in each country. Using a 'beyond GDP' approach, it enables a comparison of country performances in progressing towards fair, equitable and sustainable prosperity.

All EU countries and 45 other countries are included in the TPI. Using comparable international data, the TPI covers countries representing 76% of the total population.

I. Information on individual indicators

Table 15.1: List of individual indicators

Pillar	Subpillar	Code	Name	Data source	Level of analysis
Economic transition	Education, internet use and ICT skills	1.1.1.	Government expenditure in education per student (% of GDP per capita)	Eurostat, UNESCO, OECD, UNPD	N
		1.1.2.	Internet users (%)		I
		1.1.3.	Proportion of people with ICT skills (composite)		I
	Wealth	1.2.	Gross domestic product (GDP) per capita, current dollars (PPP$)	IMF WEO	N
	Labour productivity and R&D intensity	1.3.1.	Output per worker (2011 constant GDP PPP$)	ILO	N
		1.3.2.	Gross expenditure on R&D (% of GDP)	UNESCO, OECD	N
	Industrial base	1.4.1.	Gross value added of manufacturing (% of GDP)	Eurostat, WB WDI	N
		1.4.2.	Patent families filed in two offices (per billion PPP$ GDP)	WIPO	N
Social transition	Health	2.1.	Healthy life expectancy at birth (years)	WHO	N

	Work and inclusion	2.2.1	Employment rate of population 20-64 (%)	Eurostat, ILO, UNPD	I
		2.2.2.	Employment-to-population ratio gender gap 25+ (%)	ILOSTAT	I
		2.2.3.	Gross enrolment ratio, preprimary, both sexes (%)	OECD, UNESCO	I
	Free or non-remunerated time	2.3.	Free time of the active population (AR * (1 - T/H))	Eurostat, OECD, TCB, ILO	
	Equality	2.4.1.	Gini coefficient of disposable income, after taxes and transfers	WB, OECD	I
		2.4.2.	Income share held by the poorest quintile (%)	WB WDI	I/H
Environmental transition	Emissions reduction	3.1.	Gross greenhouse gas emissions (tonnes per capita)	Eurostat, OECD, UNFCCC, WB (JRC)	N
	Biodiversity	3.2.1.	Terrestrial key biodiversity areas (KBAs) protected (%),	UN SDGs	N
		3.2.2.	Freshwater KBAs protected (%),	UN SDGs	N
		3.2.3.	Pesticides use per area of cropland (kg/ha)	FAO, Eurostat	N
	Material use	3.3.1.	Resource productivity (PPP$ per kg)	Eurostat, UN SDGs	N
		3.3.2.	Material footprint (tonnes per capita)		N
	Energy productivity	3.4.	Energy productivity (PPP$ per koe)	IEA	N
Governance transition	Fundamental rights	4.1.1.	Voice and accountability index	WB WGI	
		4.1.2.	Rule of law index	WB WGI	
	Security	4.2.	Homicide rate (per 100000 inhabitants)	UNODC	N
	Transparency	4.3.1.	Corruption Perceptions Index	Transparency International	
		4.3.2.	Basel Anti-Money Laundering Index	Basel Institute of Governance-AML	
	Sound public finances	4.4.	General government gross debt (% of GDP)	IMF	N

Source: TPI Database.
Note: information related to the data source is incomplete in the TPI Database, some indicators are not included.

Timeliness, other issues related to individual indicators

In their JRC Report, Caperna and Panella (2021) find that the data coverage of the framework is “very good”. Most indicators contain no missing values for 2020 because the developers imputed the data from previous years. At the time of their assessment (2021), they found that the use of 2019 data is a “perfectly acceptable lag for the TPI considering the international coverage of the index”.

Table 15.3: Summary statistics of indicators included in the TPI

	Ind. number	Indicator	N. missing	Missing (%)	Mean	Min	Max	Range	Skew	Kurtosis
ECONOMIC TRANSITION	ind.01	1.1.1	3	4.05	58.97	20.47	96.51	76.04	0.05	-1.06
	ind.02	1.1.2	0	0	80.1	22.57	100	77.43	-1.54	3.28
	ind.03	1.1.3	17	22.97	45.17	5.77	78.59	72.82	-0.04	-0.41
	ind.04	1.2	0	0	44.24	6.57	100	93.43	0.44	-0.72
	ind.05	1.3.1	0	0	47.28	6.57	100	93.43	0.3	-0.84
	ind.06	1.3.2	1	1.35	27.76	3.14	98.82	95.68	1.22	1.33
	ind.07	1.4.1	0	0	46.14	12.33	100	87.67	0.65	0.5
	ind.08	1.4.2	0	0	50.1	0	97.83	97.83	-0.06	-1.11
SOCIAL TRANSITION	ind.09	2.1	0	0	76.47	31.3	96.97	65.67	-1.13	1.76
	ind.10	2.2.1	1	1.35	53.25	0	100	100	-0.61	-0.72
	ind.11	2.2.2	0	0	70.79	7.19	100	92.81	-1.74	2.51
	ind.12	2.2.3	2	2.7	70.92	0	100	100	-1.17	0.43
	ind.13	2.3	0	0	68.01	30.55	94.28	63.73	-0.78	0.12
	ind.14	2.4.1	0	0	66.72	4.44	89.78	85.34	-1.27	2.89
	ind.15	2.4.2	0	0	63.96	0	100	100	-0.64	0.62
ENVIRONMENTAL TRANSITION	ind.16	3.1	0	0	64.35	0	93.61	93.61	-1.29	1.57
	ind.17	3.2.1	0	0	52.77	0	97.24	97.24	0.04	-1.25
	ind.18	3.2.2	3	4.05	56.49	0	99.96	99.96	0.02	-1.24
	ind.19	3.2.3	5	6.76	75.27	6.64	99.93	93.29	-1.35	1.4
	ind.20	3.3.1	0	0	38.62	9.38	100	90.62	1.21	0.86
	ind.21	3.3.2	0	0	49.42	0	93.24	93.24	-0.14	-0.89
	ind.22	3.4	0	0	57.36	15.74	100	84.26	0.16	-0.32
GOVERNANCE TRANSITION	ind.23	4.1.1	0	0	63.71	4.96	95.77	90.81	-0.73	-0.67
	ind.24	4.1.2	0	0	66.06	19.29	98.12	78.83	-0.28	-1.4
	ind.25	4.2	0	0	69.16	0	95.98	95.98	-1.75	2.98
	ind.26	4.3.1	0	0	54.92	25	88	63	0.29	-1.18
	ind.27	4.3.2	0	0	52.54	12.4	76.6	64.2	-0.91	2.17
	ind.28	4.4	0	0	70.3	0	100	100	-1.18	1.14

Note: The cell with the percentage of missing values exceeding 10% are shaded in light red. The values of skewness and kurtosis if any exceeding the thresholds are written in red.
Source: European Commission's Joint Research Centre, 2021.

Source: Caperna and Panella 2021, *Table V.2.*

II. Methodological issues related to the index

1. Management of missing data

"The data used to construct the TPI are based on a time series from 2011 to 2020. Whenever data were missing, the developer followed these three rules (the order reflects the priority among the rules): 1. interpolation between time points – whenever data are available for a few years only, the intermediate years are linearly interpolated; 2. last observation carried forward (LOCF) and first observation carried backwards (FOCB); 3. data points obtained preferably from national institutions or international organisations (details in the TPI report).

The data used in this audit are the result of this first step of data imputation performed by the developers. They are based on time series and refer only to the most recent year (2020). Many values used for 2020 are based on LOCF of 2019 or older data. In this situation, it is common practice to use the last available year accepting the unavoidable delay in the preparation of international data. For remaining missing values, the developers opted for an implicit imputation at the aggregate level. In practice, the choice was to not impute the values. Because of this, the score of the aggregate containing the missing value is based on the other elements which are observed. This approach is usually selected to improve transparency and avoid any methodological black box. In the audit of the previous edition, the JRC-COIN checked the effect of this choice on the results.

In the final data set, only the countries with a maximum of three missing values (out of 28) are included. All the 72 countries included in this analysis fulfilled this criterion. There are five indicators that contain between one and three missing values, and only two indicators show five or more missing data points: indicators 1.1.3 (Proportion of people with ICT skills), and 3.2.3 (Pesticide use per area of cropland, TABLE V.2). The Governance pillar has the best coverage among the pillars with no missing values.“

2 Treatment of outliers

“A few indicators present outliers that are implicitly treated with goalpost normalisation by the developers.” (p. V20)

“The audit also investigated the presence of outliers that could potentially bias the effect of the indicators on the aggregates. The JRC recommends an approach for outlier identification based on skewness and kurtosis values1 , i.e. when the variables simultaneously have absolute skewness higher than 2.0 and kurtosis higher than 3.5. The developers followed the same approach in the construction of the TPI, identifying indicators 1.3.2 (Gross expenditure on R&D), 3.3.2 (Material footprint) and 4.2 (Homicide rate). Indicators 1.4.2 and 4.2 are log-transformed, while indicator 3.3.2 is winsorised as an effect of the normalisation based on goalposts. In fact, the normalisation method based on goalposts can be effective in reducing outliers.”

3 Normalisation

“The indicators are rescaled to a 0-100 scale, with 0 as the lowest score achieved by countries, and 100 as the highest. This is a common – and usually desired – practice in the construction of composite indicators. The developers set minimum and maximum values for each indicator, called goalposts. In this approach, if a value is lower than the lower goalpost it has the value 0 assigned, while if the value is higher than the higher goalpost the assigned value is 100. Moreover, all the intermediate values are computed with the following two formulas:

For a positive indicator:

$$score = \frac{value - lower\ bound}{upper\ bound - lower\ bound} * 100$$

For a negative indicator:

$$score = \frac{upper\ bound - value}{upper\ bound - lower\ bound} * 100$$

An indicator is intended to be positive when higher values indicate better performance (it is negative if higher values indicate worse performance). The direction of all the indicators is represented in TABLE V.1. Indicators 4.1.1 and 4.1.2 are World Bank worldwide governance indicators (Voice and accountability index, and Rule of law index), and are normalised following a slightly different procedure described in the technical report of the TPI."

4. Weighting of pillars and dimensions

Economic	0.20
Social	0.20
Environmental	0.35
Governance	0.25

5. Aggregation method

"The TPI team opted for the arithmetic averaging of the four pillars, which implies a strong compensability, allowing for an outstanding performance in some aspects to balance weaknesses in others and vice-versa. This approach puts countries that have both high and low results at the same level, with more 'balanced' countries showing average results."

6. Additional analysis in the JRC Report

- Correlation analysis (section 4.1.)
    - Correlation analysis between indicators and aggregates
    - Correlation analysis between sub-pillars
    - Correlation analysis between aggregates and the index
- Principal components analysis of the TPI (section 4.2.)

- Added value of the TPI (section 4.3)
- Impact of the components of the TPI (4.4)
- Impact of modelling assumptions on the TPI results (5.)

TABLE V.9: Alternative assumptions considered in the robustness analysis

	Reference	Alternative
I. Aggregation formula	Arithmetic average	Geometric average
II. Imputation of missing data	No imputation	Expectation-Maximisation
III. Weighting system of pillars	Fixed weights	Varying up to 20 %
Economic	0.20	U[0.16;0.24]
Social	0.20	U[0.16;0.24]
Environmental	0.35	U[0.28;0.42]
Governance	0.25	U[0.20;0.30]

Source: European Commission's Joint Research Centre, 2021.

Special focus: larger sample of countries

"The JRC statistical audit also includes a specific focus covering the potential extension of the TPI to a larger sample of countries (by adding 39 new countries). This focus has been requested by the developers to explore the impact of this potential extension on some of the characteristics of the index and its structure.

Following the same approach of the original data set, only the countries with a maximum of three missing values (out of 28) are included. All the 113 entities included in this analysis fulfilled this criterion.

Only two indicators contain more than five missing values (at least 96 % of coverage): indicators 1.1.3 (Proportion of people with ICT skills), and 3.2.3 (Pesticide use per area of cropland. Despite the indicators with missing values being the same as in the main database, the proportion of missing values in indicator 1.1.3 increases to 37 % (22 % in the original data set). With respect to the detection of outliers, no further comments are needed for the extended data set.

Most of the characteristics of the TPI's structure are not particularly affected by the addition of almost forty countries."

Recommendation: strict monitoring of the Environmental pillar

"The JRC-COIN team suggests keeping the Environmental pillar under strict monitoring since it is clearly describing something that is related to the overall concept from a different perspective in respect to the other pillars. It is a common result for environmental aspects included in social and economic composite indicators. The JRC-COIN team suggests to highlight the specificity of the Environmental pillar when describing the TPI.

Considering the specificity of the Environmental pillar, this audit confirms that the TPI is reliable, and that the framework has a good statistical coherence. The audit also acknowledges the significant efforts by the developers to obtain a balanced and transparent result." (p. V20)

References

Caperna, G., F. Panella (2021). JRC Statistical Audit of the Transitions Performance Index, European Commission, Joint Research Centre

https://commission.europa.eu/system/files/2022-03/ec_rtd_tpi-2021-statistical-audit.pdf

European Commission, Directorate-General for Research and Innovation, Prevost, S., Benavente, D., Stevenson, A. et al. (2022). Transitions performance index 2021 – Towards fair and prosperous sustainability, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2777/09602

TPI Database: https://commission.europa.eu/document/download/0f53edd8-5a8b-4f77-baaa-8bb0ad82894e_en?filename=ec_rtd_tpi-database.xlsx

SPES | **Sustainability** performances, evidence & scenarios

www.sustainabilityperformances.eu