BUILDING A MULTIDIMENSIONAL BIODIVERSITY INDEX

A SCORECARD FOR BIODIVERSITY HEALTH

UN environment programme WCMC

Luc Hoffmann Institute

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Authors' Note: This report represents work in progress and should not be interpreted as definitive of the authors' view, but as a rigorous basis for discussion of a policy-focused biodiversity index in the light of the results of participatory consultations on the topic and the research and work to date. Additional work is required to strengthen the linkages between the proposed concept, index structure and methodology with recent work of the Sustainable Development Goals indicator framework, the post-2020 global biodiversity framework and related initiatives, and to permit the work to be taken forward to practical implementation.

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EXECUTIVE SUMMARY

This report supports the launch of a UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) project, in partnership with the Luc Hoffmann Institute (LHI) and other stakeholders and supported by the Swiss Federal Office for the Environment (FOEN), on developing and testing a Multidimensional Biodiversity Index (MBI) to measure *biodiversity health*. We define biodiversity health as a new concept that combines stocks of nature and flows of biodiversity to people and that considers biodiversity as a multidimensional socio-ecological concept.

The MBI project aims to develop a policy-focused index for biodiversity health as a tool for decision makers to monitor if we are living within the regenerative capacity of nature, or whether we are piling up ecological debt for future generations, and therefore eroding our own opportunities to achieve sustainable development.

The potential for scepticism is clear, biodiversity appears too complex to be captured by a single number. But we start from the premise that measures of economies, poverty and development, as examples, have evolved from income or a dollar-a-day figure to richer and more balanced measures that address social and ecological aspects to facilitate better decision-making, such as the Multidimensional Poverty Index or the Human Development Index. Biodiversity metrics must evolve too. We discuss how this is essential if we want to foster the transformative changes required to effectively tackle one of the defining environmental crises of our time – the biodiversity loss crisis.

Here, we argue the need for a paradigm shift in how we measure biodiversity and link it to action through an improving biodiversity science-policy interface. This paradigm shift requires 1) accounting for the multidimensional nature of biodiversity and the context-dependency of its contributions to people and 2) establishing a science-based healthy and lasting relationship between biodiversity conservation and sustainable development.

The gathering momentum in biodiversity policy on the world stage provides a window of opportunity for a shift from the perception of biodiversity conservation as a ***barrier to growth*** towards its recognition as an ***essential foundation*** for sustainable development. A ***biodiversity health*** *scorecard* for nations, such as we propose, could play a pivotal role in enabling that shift by transforming biodiversity from an abstract notion into a tangible entity that national governments can understand and act on.

This report includes the conceptualisation and framework of a policy focused biodiversity index for use by national governments (Chapters 1 and 2); an overview of biodiversity and socio-economic indices to inform the development of the MBI and a thought piece about the future of environmental and sustainability indices (Chapter 3); a roadmap towards the implementation of an MBI (Chapter 4); and some final recommendations (Chapter 5) to set us on a path to develop an operational index that measures progress towards the societal visions of *living in harmony with nature* and *ecological civilization*.

AT A GLANCE: The MBI in a nutshell

Luc Hoffmann Institute

UN environment programme WCMC

MULTIDIMENSIONAL BIODIVERSITY INDEX (MBI)

BUILDING A SCORECARD FOR BIODIVERSITY HEALTH

Are we living within the regenerative capacity of ecosystems, or piling up ecological debt for future generations?

The answer is difficult. Biodiversity measures remain siloed, fragmented and biased, which makes it difficult for decision makers to make effective political use of the tremendous feat of data collection and analysis achieved by the scientific community. The lack of a headline index for biodiversity might be hindering the interface between biodiversity science and policy making.

An overall measure for biodiversity health, rooted in a socio-ecological perspective, where biodiversity and human well-being are seen as interdependent can contribute to translate biodiversity science into policy's messages for transformational change.

The policy opportunity

The CBD post-2020 global biodiversity framework and its alignment to the 2030 Agenda on Sustainable Development provide a momentum to (i) account for the multidimensional nature of biodiversity and the context-dependency of its values to people, and (ii) to establish a science-based healthy and lasting relationship between biodiversity conservation and sustainable development.

A roadmap for an MBI

Inmediate actions

(i) Ensure relevance to policy needs and socio-ecological contexts

(ii) Robust and evidence-based*

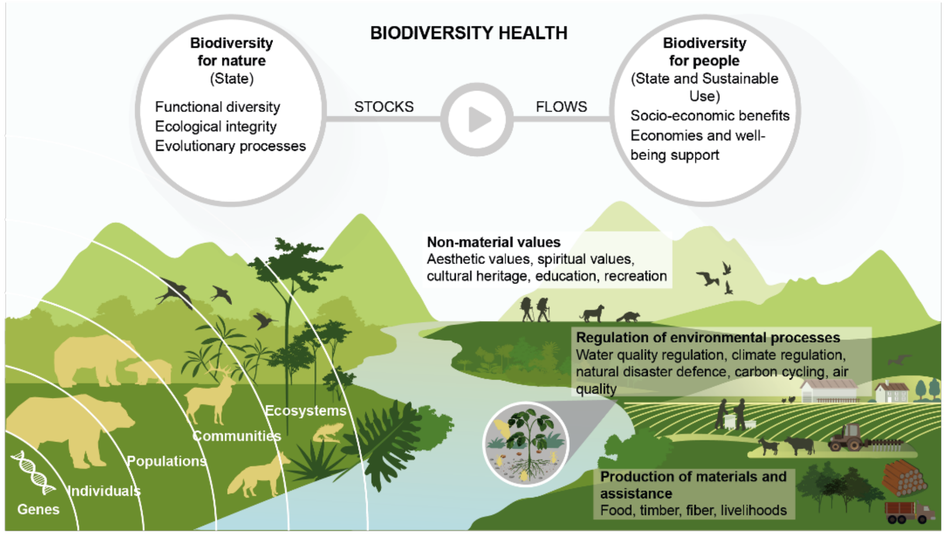
Mid-term actions

(iii) Responsive to positive changes

Long-term actions

(iv) Build partnerships

Measuring progress towards 'living in harmony with nature' or 'ecological civilization'



1 INTRODUCTION

1.1 Setting the scene

In our current world, damaged ecosystems threaten the well-being of 3.2 billion people[1], one million animal and plant species are threatened with extinction[2], and the global population is already exposed to global disease outbreaks[3]. To use, manage and restore biodiversity sustainably, we need to incorporate measures of how our socio-economic systems depend, impact on, derive benefits and interact with biodiversity. These relationships determine biodiversity health, which is more than the number of species in an ecosystem or the remaining primary forest coverage. If we are to effectively tackle the biodiversity loss crisis as a fundamental pillar to achieve sustainable development, we need to redefine biodiversity using a multidimensional approach that considers nature and people as equal parts of a healthy system.

The relentless pressures we are putting on biodiversity, undermining its stability, resilience and ability to support human development and wellbeing, can have catastrophic effects in our society equal to any economic crash. Nevertheless, there is no equivalent index for biodiversity that could influence national level policies and responses in the way that the Gross Domestic Product (GDP) already influences economic decision-making. Current biodiversity policies and decision-making processes rely on multiple unidimensional indicators covering different facets of biodiversity[4,5]. Indicators that describe the state of biodiversity do not translate their results into impacts on well-being; and/or many struggle to be applicable at the scales where policy and management decisions need to be made – typically from national to local scales. This makes it difficult for decision makers to make effective political use of the tremendous efforts in data collection and analysis by the scientific community.

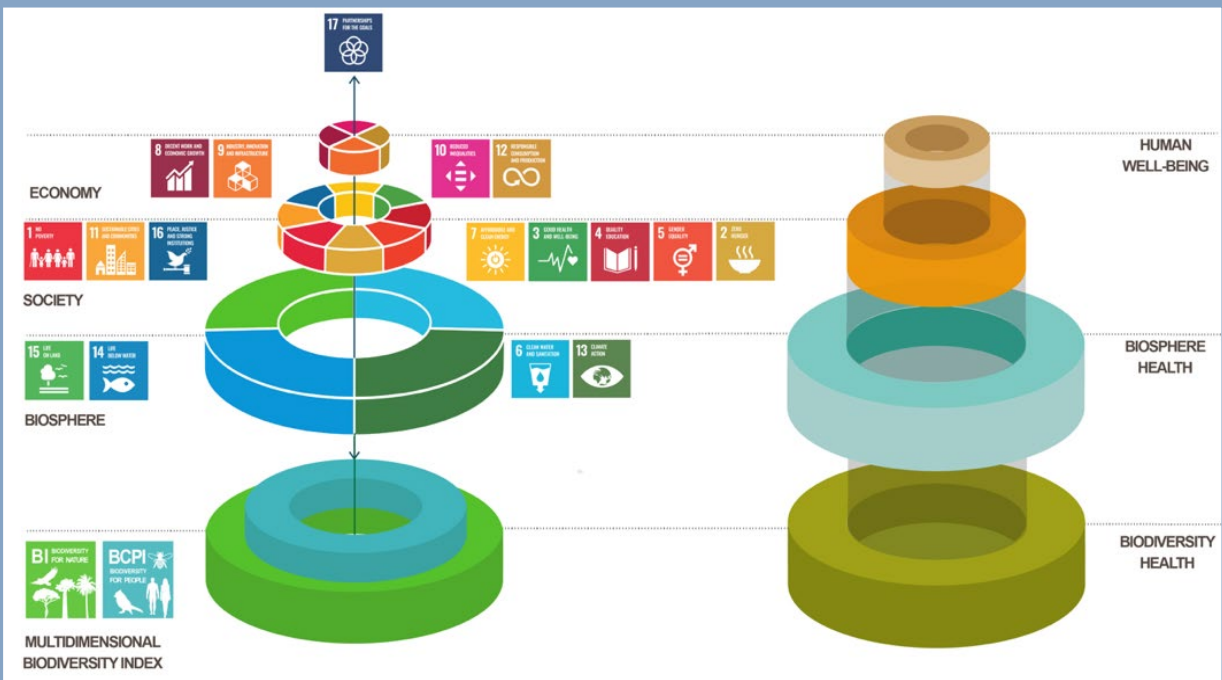
The lack of an over-arching index that offers a complete picture across many facets of biodiversity, and that provides decision makers with a measure of progress towards broad societal visions of 'living in harmony with nature'[6] or 'ecological civilization'[7,8], is one barrier that needs to be overcome if biodiversity is to gain policy traction and be given due attention in decision making. We propose the MBI as a measure of the state of biodiversity and its flows of contributions to people to inform decisions about current and future uses of nature. Nevertheless, there are two major challenges in developing an Index that measures biodiversity health.

Firstly, the nature of biodiversity makes an integrated measure challenging. Biodiversity is inherently multidimensional and dynamic, has emergent properties, different functions, various scales to consider and its parts are interdependent. Hence, any attempt to develop an overall metric for biodiversity is a highly controversial endeavour subjected to substantial critique, with the scientific community arguing that biodiversity is too complex a concept to be captured by a single score.

Secondly, it is difficult to account for the conflicted goals of biodiversity conservation and social development in the same metric, even though we know that long-term human development and well-being relies on biodiversity (Box 1)[9–11]. In our current economic model, the goal of preserving biodiversity collides with the goal of human development under a mindset of continued economic growth. This is because a fundamental problem in our economic system, which is that our activities and total demand on the goods and services that ecosystems provide, outstrip the ecological capacities of the biosphere to regenerate[12].

Box 1. The interconnected nature of the SDGs and the role of biodiversity health in underpinning human well-being (Modified from[13]).

Biodiversity contributes to the fulfilment of the SDGs and many associated targets through a wide range of direct contributions to human well-being, which are embedded in the definition of Nature's Contributions to People (NCP)[9,14]. Far beyond SDG 14 and 15, biodiversity loss can undermine the achievement of all SDGs[15]. The figure shows how economies and societies are inherently embedded in the biosphere, and how economic and ecological systems, often perceived as separated from each other, together underpin human well-being. Healthy economies are dependent on a healthy biosphere, which in turn relies on a healthy and resilient biodiversity system. Hence, future opportunities for human prosperity depend on the future and health of biodiversity. We argue that a coupled MBI framework that explicitly considers biodiversity and people as part of a healthy system (and which is underpinned by two sub-indices; a Biodiversity Index (BI) and a Biodiversity Contributions to people index (BCPI)) can contribute to integrate biodiversity in all assessments, policy decisions and actions affecting human development and well-being.



1.2 The policy opportunity

On current trajectories, the environmental dimension of the Sustainable Development Goals (SDGs) will not be achieved by 2030[16], with further impacts across all other SDGs[9,17,18]. Also, the failure to meet the targets of the Strategic Plan for Biodiversity 2011-2020[9], as agreed by the 195 Parties to the Convention on Biological Diversity (CBD), has created an urgent need for national governments and civil society to raise ambition and forge a new transformative global plan for biodiversity[19].

The current policy momentum in the lead up to key international meetings on nature (such as 15th meeting of the Conference of the Parties (COP 15) to the Convention on Biological Diversity (CBD)) and the climate (the 26th United Nations Climate Change conference) in 2021, represents an important opportunity to rethink and challenge how we measure and monitor biodiversity health, which could increase the utility and uptake of such an index.

Other indices, such as the HDI or GDP, are used for decision making across different government sectors and beyond. This is the ultimate policy goal for an index for biodiversity health and its relationship to human well-being.

Building from lessons in different sectors (see Chapter 7), we argue that an Index for biodiversity health will 1) provide a coherent framework for nations to monitor and track state and progress on safeguarding biodiversity as it will be important under the post-2020 global biodiversity framework, 2) link biodiversity to human well-being and sustainable development as outlined in the 2030 Agenda for Sustainable Development, and 3) provide countries with a national condition indicator for the state of biodiversity which is important to both current and future uses of nature. We expect that, given its connections to human development and well-being, changes in the Index will incentivise and enable policymakers and advocates to guide choices on priority setting and policy formulation on biodiversity conservation. This, together with a system analyses on the associations between changes in indices such as GDP or HDI could be used to derive more accurate and meaningful conclusions in terms of achieving both highest environmental and socio-economic performance.

2 THE MULTIDIMENSIONAL BIODIVERSITY INDEX An integrated framework for Biodiversity and People

1.3 Defining Biodiversity health

We define *biodiversity health* using a dual approach: an ecological and a social perspective (Figure 1). From an ecological perspective biodiversity health is an essential characteristic of a stable and resilient Earth system (biodiversity for nature). The variability of species in the system, their interconnections and the genetic variation within those species enable ecosystems to respond to change, provide ecosystems with sources of complementary functions thereby increasing their stability, and have positive effects on their productivity[15]. This makes biodiversity a form of insurance against environmental collapse. Hence, biodiversity must be preserved for its insurance value, as well as for its intrinsic value. Under this perspective, enhancing biodiversity health means preserving functional diversity, ecological integrity (i.e. connectivity, intactness and resilience) and the evolutionary processes of biodiversity, and it is assessed by looking at fundamental attributes (such as richness, abundance and phylogenetic distance) of its main components (genes, species and ecosystems) (Figure 1).

From a social perspective, biodiversity health is understood as a requirement to maintain the provision of contributions or benefits on which economies and livelihoods rely. These positive contributions are the conduit between biodiversity and a good quality of life as they translate into well-being and sustainable development influencing effects (biodiversity for people). Assessments of biodiversity health under this perspective require examining biodiversity from a human angle to define the socio-economic benefits that people obtain from biodiversity, how we transform what we take from biodiversity and how biodiversity supports our economies and wellbeing.

We argue that, in order to measure progress towards meeting the dual goal of preserving ecological integrity and ensuring that the many ways biodiversity contributes to people's well-being are long lasting, policymakers need an index on biodiversity health that tackles - by design - both aspects together.

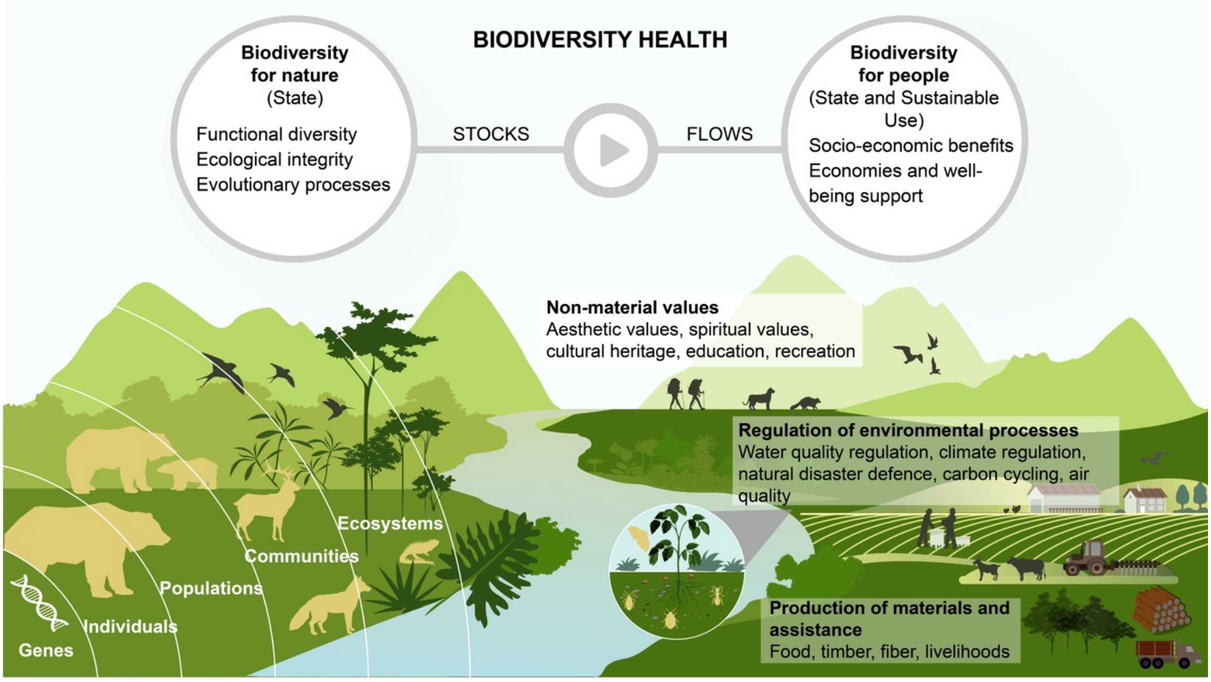


Figure 1. Conceptualisation of biodiversity health. Biodiversity health is defined under a dual approach, 1) an ecological perspective (biodiversity for nature) that considers biodiversity as an insurance value against environmental collapse and 2) a social perspective (biodiversity for people) that considers biodiversity as a requirement to maintain the provision of benefits on which human well-being relies.

1.4 Conceptual framework

We propose the MBI framework as a summary measure of the national achievement of key public *biodiversity health objectives* with both ecological and social data driving the overall score (Figure 2). The framework we outline here considers multiple indicators structured in four analytical and aggregation levels:

1) two sub-indices (Biodiversity State sub-index (BI), and Biodiversity Contributions to People sub-index (BCPI)) representing the two perspectives described above on biodiversity health (Figure 1);

2) a set of relevant dimensions under each of these two components representing fundamental facets of biodiversity and categories of contributions to people,

3) a set of public biodiversity health objectives, and sub objectives where relevant, under each dimension, and

4) policy-relevant metrics, indicators or proxies under each objective measuring performance as distance to a desired state or reference point.

Biodiversity State sub-index (BI). The first component of the MBI framework, BI, measures ecological integrity using three dimensions: diversity, abundance and function. They represent the facets of biodiversity (i.e. genes, species and ecosystems[20]); summarise changes in conservation status[21]; and covers the so-called Essential Biodiversity Variables[22] related to genetic composition, species populations, species traits, community composition, ecosystem structure and functioning. We suggest these dimensions to be underpinned by, but not limited to, six biodiversity health objectives that we define as the conservation and enhancement of 1) genetic diversity, 2) phylogenetic diversity, 3) taxonomic diversity, 4) species populations, 5) community composition and 6) habitats (terrestrial and freshwater) (Figure 2).

Metrics for the BI should represent the structure and function of ecosystems, the composition of biological communities, the diversity and traits of species, and genetic composition.

Biodiversity Contributions to People sub-index (BCPI). The second component of the MBI framework, BCPI, measures the status and sustainable use of the realised benefits that people draw from biodiversity. We use the concept of NCP[14] as a pluralistic approach to recognizing the diversity of positive contributions that people obtain from biodiversity. Hence, we propose BCPI to be composed of three dimensions: regulation of environmental processes; provision of materials and assistance; and provision of non-material contributions. We propose these dimensions to be underpinned by six public biodiversity health objectives and sub objectives corresponding to 1) safe water, 2) climate change mitigation, 3) natural disaster protection, 4) food provision (with three sub objectives on sustainable agriculture, maintenance of agrobiodiversity and traditional knowledge), 5) livelihoods (e.g. forestry and eco-tourism) and 6) health and quality of life (with three sub objectives corresponding to sense of place, proximity to nature and protection of special places).

Given the difficulty of identifying all the critical contributions of biodiversity, BCPI is arranged around broad categories. Nevertheless, this formulation allows for the assessment to be adapted to national contexts using objectives and sub objectives relevant for individual countries. Metrics for the BCPI should represent socio-economic outcomes linked to biodiversity measured as the current state and use or demand of the flows from biodiversity to people.

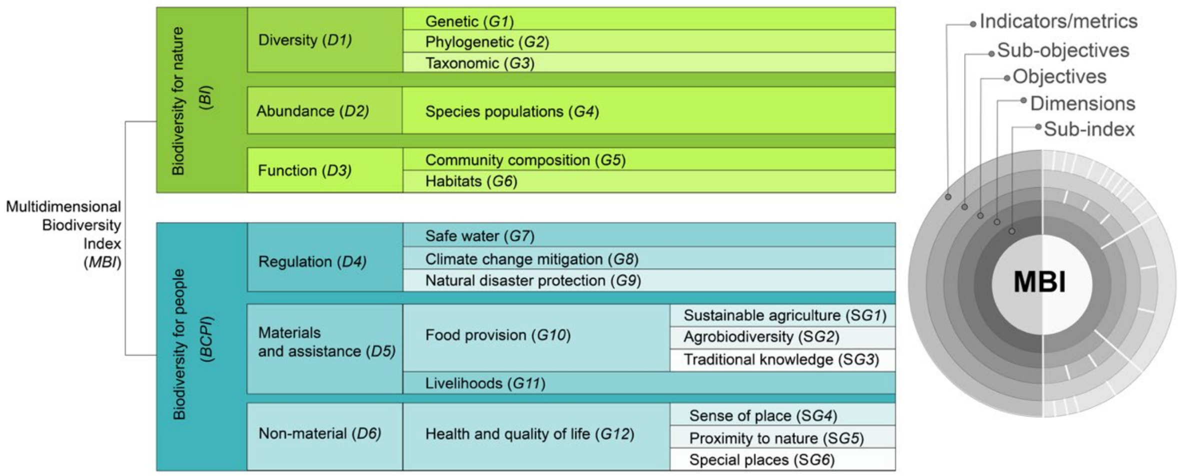


Figure 2. Conceptual framework and core MBI structure. The figure shows the nested structure of the MBI. Each sub-index score (BI and BCP) is derived from a wide range of indicators and metrics. The indicators/metrics in the outer layer are arranged around public biodiversity health objectives (and sub-objectives) and those around biodiversity dimensions. Dimensions combine to indicate the current status for each of the biodiversity objectives.

The MBI framework we outline here provides the ideal to aspire to. We note that some of the objectives described in the framework might not be measurable yet or have existing data for many countries. Hence, it aims to represent a unified framework to assess biodiversity health that countries should aim for and work towards. Nevertheless, for most of the components of the Index existing global data or proxies can be used.

We suggest building on indicators proposed for use under the post-2020 global biodiversity framework, and those already in use or being developed for the SDGs (see Annex 1.9). This will also ensure global policy alignment of the Index to the post-2020 global biodiversity framework and the environmental dimension of the 2030 Agenda. The use of indicators which align with the SDG indicators has the added benefit of the statistical rigor which is the foundation of the SDGs. This will improve the temporal and spatial comparability of the index and it will ensure that there is a global and national commitment to continue to collect the data which underlies the index.

Nevertheless, global datasets used to assess a particular biodiversity health objective in reality may be a compilation of local or regional datasets so national and regional data that countries collect themselves is rolled up into the global index.

We also suggest a (non-prescriptive) set of methodological steps as a first approach to measure biodiversity health (see Annex 1.10). The proposed methodology represents an initial basis for discussion on potential methods to assess biodiversity health. We suggest exploring the feasibility of measuring current state of biodiversity and state and use of its flows to people as a function of present and likely near-term future status, where likely near-term future status is a function of four dimensions: present status, recent trend, current cumulative pressures and current cumulative responses to negative pressures (actions) that increase resilience.

1.5 Designing National MBIs

The core MBI aims to provide a scientific framework of reference for measuring how ‘healthy’ ecosystems are and that allows for inter-country comparisons on fighting biodiversity loss. Hence, for the ‘global’ or core MBI it is important to use global datasets to provide a globally consistent picture so differences in Index scores across reporting units could be attributable to differences in biodiversity health rather than variation in the data.

Nevertheless, global indicators are only the tip of the iceberg as action on biodiversity is not only needed at global levels but at the local, subnational, national and regional levels, and this action has to be supported by data that are fit for purpose. Given the context-dependency of many facets of biodiversity, the MBI framework should be flexible enough to meet two main goals: (i) to be augmented with national data as discussed above so data that countries collect individually is rolled up into the global index through the development of new indicators or datasets for a particular biodiversity health objective and (ii) to be built up entirely using national data and to accommodate different country-dependent objectives and sub-objectives, which will be crucial to allow for countries to calculate independently-led ‘national scorecards’ on biodiversity health (Box 2) that are relevant to their socio-economic contexts.

National MBIs can be a powerful tool for addressing multiple goals, from monitoring biodiversity loss reduction in all its forms to assist in coordinating environmental policies, target the areas in most need of conservation and/or protection, allocate social budgets, and complement sustainability measures.

Here we provide some recommendations, both on the policy and technical processes of developing national MBIs, as a step ahead once the MBI framework has been tested and piloted using case studies (see Chapter 8).

On **the policy-oriented process of developing a national MBI,** and following the experience on developing national Multidimensional Poverty Indexes[23], four pivotal requirements can help guarantee that the measure is sustainable and actively used for policy.

(i) Policy buy-in. National MBIs must be approved and implemented with the support of the country's top leadership. It is crucial to have a clear consensus on the main purpose of the measure at the beginning of the process of developing a new national MBI, as this will guide normative decisions on the structure of the measure and provide information about its possible uses. Hence, each stakeholder must learn about the Index and bring their own views into it, which takes time, discussions and leadership until diverse stakeholders agree on the basic purpose and structure of the measure.

This include 'redefining' the framework with biodiversity health objectives that reflect the priorities of the country as expressed, for example, in its National Biodiversity strategy (if existent) to meet the environmental SDGs. This could be developed though, for example, a Stakeholders Need Analyses (SNA).

Countries that have been through this process for the development of national Multidimensional Poverty Indexes emphasized the relevance of these dialogues in building legitimacy and support for the measure. Having support from the country's top leadership (e.g. the president, vice president or a senior minister in the case of the national MPIs) is crucial to guarantee the sustainability of the process. However, it is necessary to have a champion who drives the process, convening one or several committees, going between technical and political actors, and planning the whole design process from initial proposals to launch events. Also, there must be a technical champion, usually in the office of statistics in charge of the technical aspects of computing a national MBI, with a good understanding of the MPI and the policy implications of technical decisions.

(ii) Technical rigor. National MBIs must generate solid information, for which technical implementation must be rigorous and based on indicators that can be affected by direct action, and it must be updated regularly.

(iii) A strong communications strategy. National MBIs must be proactively communicated to different potential actors. An adequate communications strategy creates a better and easier engagement with stakeholders and facilitates the understanding and use of the results.

(iv) Credibility. Biodiversity health figures must be credible to guarantee the sustainability of the measure over time.

On **the technical process of developing a national MBI,** it is important to keep in mind that national MBIs should developed and calculated locally by each country so they can be tailored to that particular country and its needs, and so that national governments have complete ownership over these measures. The technical and policy processes of development of the measure are interlinked, which means that a continuous dialogue is necessary between stakeholders, and which is of the outmost importance during decisions on what the purposes of the measure are, as that will also guide the technical process.

Following also the experience of developing national MPIs[23], the next twelve steps can guide the development of the measure from a technical perspective.

(i) Decide the purpose of the measure.

(ii) Decide the ideal biodiversity health objectives.

(iii) Choose the unit of identification or reporting unit.

(iv) Select the indicators and data sources (see Table 1 for examples on national-level indicators).

(v) Choose the final structure of the measure based on what is possible with the selected data.

(vi) Select the numerical target or baseline for each indicator.

(vii) Compute the indicators using the selected data.

(viii) Conduct redundancy tests.

(ix) Compute trial measures.

(x) Conduct robustness tests between trial measures and using different specifications.

(xi) Analyse the results: dimension breakdown and decomposition by different units of analyses.

(xii) Conduct analysis over time (if possible).

The selection of data sources to compute national MBIs should be influenced by normative decisions and considerations on the purpose of the national MBI as it determines how often the national MBI needs to be updated, the level of disaggregation possible, information related to the unit of analyses and even what dimensions of biodiversity health can be considered. For example, if the general purpose is to create a measure that targets multidimensionally 'unhealthy' biodiversity areas in all administrative provinces of a country, the data source should be ideally representative at the province level. In turn, if the purpose is to create a national measure that can monitor the fulfilment of the environmental SDGs, the source of data needs to be representative at the national level and include dimensions that capture SDGs targets.

Table 1. Examples on how to augment the core MBI with nationally produced data to calculate national biodiversity health scorecards. Using as a framing the zero draft of the post-2020 global biodiversity framework (CBD/WG2020/2/3), the table shows an example for Goal 1 with suggested elements to be monitored, global indicators identified and nationally produced indicators in Mexico (indicators identified through the Sistema de *Información Espacial para el Soporte de Decisiones sobre Impactos a la Biodiversidad* (SIESDIB) in the *Comisión Nacional para el Conocimiento y Uso de la Biodiversidad* (CONABIO)).

Draft 2050 Goals	Suggested elements of the goals for monitoring	Suggested indicators[1]	National-level indicators for Mexico
No net loss by 2030 in the area and integrity of freshwater, marine and terrestrial ecosystems, and increases of at least [20%] by 2050, ensuring ecosystem resilience.	Change, and rate of change, in extent of natural ecosystems and biomes (overall, for each biome/ecosystem type, and for intact areas, e.g. primary forests).	Forest area as a proportion of total land area. Trends in forest extent and/or tree cover. Trends in primary forest extent* Continuous Global Mangrove Forest Cover Live coral cover. Species Habitat Index. Wetland Extent Trends Index. Biodiversity Habitat Index. Red List for Ecosystems*	Forest area as a proportion of forest ecosystems area (2000-2015). Forest area of primary forests as a proportion of forest ecosystem area (2000-2015)
	Change in ecosystem connectivity and fragmentation.		Forest connectivity (core window 1km^2, 9m^2, 25km^2) (2000-2015) Forest fragmentation (core window 1km^2, 9km^2, 25km^2) (2000-2015) Habitat connectivity for apex predators (2010)
	Change in ecosystem integrity resilience and degradation and rate of ecosystem restoration.	Proportion of land that is degraded over total land area Global Ecosystem Restoration Index. Cumulative human impacts on marine ecosystems.	Ecological integrity index Ecological degradation index Self-organization in predator-prey interactions index Stability in predator-prey interactions index Naturalness in predator-prey interactions index

[1]Except where identified with an asterisk (*), the indicators used in this table have been identified by the Biodiversity Indicators Partnership and/or are used to monitor progress towards the Sustainable Development Goals.

Draft 2050 Goals	Suggested elements of the goals for monitoring	Suggested indicators[1]	National-level indicators for Mexico
		Ocean Health Index. Vegetation health index* Human footprint*	Mobile links apex predators index Mobile links avian functional groups index Functional diversity in predator prey habitat index Spatial habitat integrity for apex predators Functional bird (habitat) diversity indicator Functional mammal (habitat) diversity index Forest biocomplexity index (biodiversity, stand condition and development) Stand complexity index Stand development index Ecosystem tree diversity index (Shannon equivalent numbers) Forest (ecosystems) tree biodiversity index (Shannon, Shannon equivalent numbers, Smax, alpha, beta) Stand density index (forest ecosystems) Maximum tree height condition index Natural regeneration in forest ecosystems Human impacts in apex predators Human impacts in forest ecosystems

Box 2. A national scorecard for biodiversity health.

The figure shows different opportunities to summarise and visualise biodiversity information (Note: Results are not based on real data but hypothesised for the purpose of visualisation. Maps in Figure B represent tree diversity for all communities and ecological integrity for predator-prey interactions from data derived from the Sistema de *Información Espacial para el Soporte de Decisiones sobre Impactos a la Biodiversidad* (SIESDIB) in the *Comisión Nacional para el Conocimiento y Uso de la Biodiversidad* (CONABIO)). The MBI framework enables the production of an overall Index score and individual biodiversity health objective scores aggregated at the national level (Figure A). The Index provides an easy-to-understand message on progress and a headline indicator for nations to inform about the official level of biodiversity health in a country (i.e. how biodiversity and its derived contributions to human development are enhanced or eroded in that country); show the extent to which biodiversity health objectives are met as well as trends over time on progress and distance to targets; and allow for comparison across subnational regions and benchmarking. These scores can indeed reveal patterns which do not directly emerge by looking at the objectives separately. Nevertheless, greater value to inform policy decisions derives from delving into the individual objectives scores to analyse whether policy attention is needed in specific areas. Such an analysis can assist in refining policy choices, understanding the determinants of progress in biodiversity conservation and sustainable use of its contributions, and maximizing the return on governmental investments in the form of biodiversity outcomes. Furthermore, as the Index is intended to be disaggregated by, for example, subnational regions (Figure B), this allows the identification of ecologically degraded areas and/or also areas where benefits derived from biodiversity are in higher demand so targeted action can be informed based on risk assessments. The Index can be complemented with dashboards or 'heatmaps' (Figure C) and risk assessments (Figure D) to show the performance at individual objective level, to identify strengths and weaknesses through the scores and trends of indicators, and to identify opportunities that may contribute to building resilience. In summary, national MBIs can inform coordinated actions by different ministries, provide targets for each indicator, and act as a monitoring and accountability tool within governments.

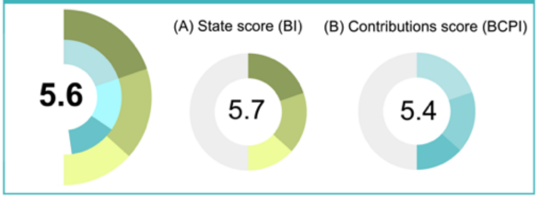
Mexico

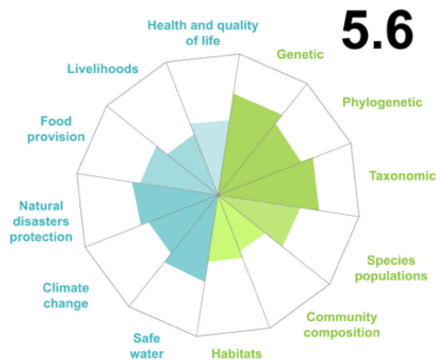
A - Performance overview

Index component	Score	Trend	Average distance to goals
Multidimensional Biodiversity Index (MBI)	5.6		
Component A - Biodiversity State Sub-index	5.7		
1st dimension: Diversity	6.9		
2nd dimension: Abundance	5.8		
3rd dimension: Function	4.6		
Component B - Biodiversity Contributions to People Sub-index (BCPI)	5.4		
4th dimension: Regulations	5.8		
5th dimension: Materials and assistance	5.1		
6th dimension: Non-materials	5.3		

Edition	2020-202	2022-202	2024-2026	2026-2028
Score	4.8	4.9	5.2	5.6

MBI and sub-indices scores

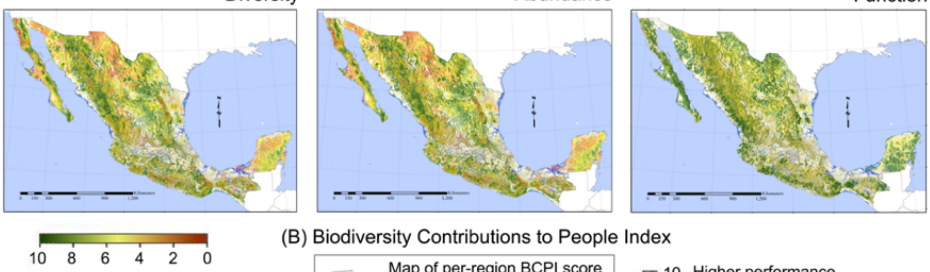




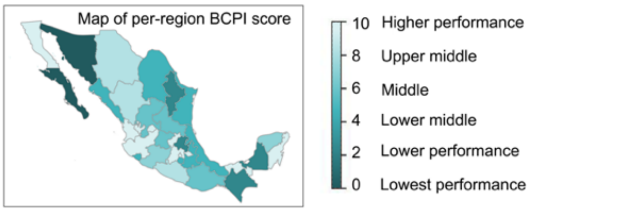
B - Mutidimensional Biodiversity Index scores

Spatial assessments

(A) Biodiversity State Index

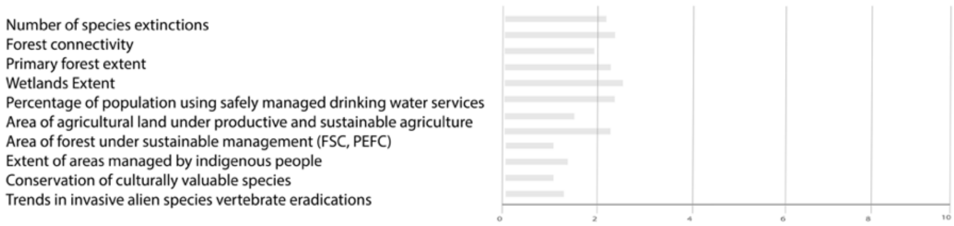


(B) Biodiversity Contributions to People Index



C - Heatmap indicators

D - Risks assessment



3 MEASURING COMPLEXITY THROUGH INDICES

1.6 The world in numbers - Learning from socio-economic indices

Numerical indices make decision makers face trade-offs explicitly[24] and their use to guide decision making has a long and diverse history. From social aspects to governance and the environment, the number of their applications is constantly growing at a rapid pace[25–27]. For example, a report in 2011 by the UN Development Programme[27] identified over 400 composite indices that assess a country according to economic, political, social, or environmental measures, and another report by the UN Development Programme in 2014[28] documented over 100 composite measures of human progress.

These inventories, whilst far from exhaustive, give us a good understanding of the popularity of composite indicators. The increase over the past 20 years is exponential[29], and the number of yearly publications shows no sign of a decline. Moreover, their widespread adoption by global institutions (e.g. OECD, World Bank or EU) has gradually raised media and policy makers attention[30], while their simplicity has fostered their adoption.

In this work we were particularly interested on multidimensional indices; those that measure a suite of indicators from significantly different dimensions, such as, for example, the Multidimensional Livelihood Vulnerability Index[31], which was designed to measure multidimensional livelihood vulnerability to climatic, environmental, and socio-economic change. Common characteristics of a multidimensional index include, a) they are comprised of several dimensions, each with multiple indicators, b) they are targeted at policy makers and c) they are scalable and replicable across countries, with scope to produce a global score.

Our (non-exhaustive) analyses of indices developed to measure complex societal issues such as human development[32], poverty[33], modern slavery[34], global rights[35] or corruption[36] among others (see Table 2 and Annex 1.11), suggests that the widespread adoption of indices seems to be linked to their potential as effective tools for policy analyses, advocacy and social awareness.

In Table 2 and Annex 1.11 we offer a description of 43 indices developed in the areas of economy, human development, well-being, happiness, sustainability, poverty, inequality, vulnerability, rights, gender inequality, corruption, governance, technology, innovation, and competitiveness with comprehensive information on their definition and justification, dimensions, advantages and limitations as well as their impact and policy use.

Two outstanding examples for their impact and uptake are GDP and HDI. Whether or not GDP and HDI are flawed metrics of what they are intended to measure, they leverage strong political action and allocation of resources. More importantly, their limitations have reshaped our understanding of sustainable development and economic prosperity, which brings important lessons to learn for the biodiversity community.

The United Nations has used the HDI since 1990 as a powerful flagship metric for understanding a more nuanced picture of development, wellbeing and progress. It was developed to represent the basic capabilities enabling people to be and do what they aspired to in life and to capture the *human development journey* of countries (i.e. how much of the road to human development has been covered by a given country). Nevertheless, in the 21st century governments are recognising that the various transitions and transformations to achieve development (e.g. poverty eradication, improving governance, climate action or gender equality) are all connected[37].

Similarly, many economists are calling for a profound paradigm shift in the way that economic progress is measured, arguing that economies must be designed to thrive and balance not to grow[12,18,38–41]. GDP is very short-termist, as it measures the wealth of nations as a function of short-term income[42], and misusing GDP growth as a policy goal is distorting decisions about real progress[39]. Although it is likely it will continue to be used as reference for a nation's economic performance, economists increasingly emphasise the need to reshape our perception of economic prosperity as the long-term capacity of the economy to deliver sustain development and improving living standards[12,42]. In other words, a transition towards a socio-ecologically centred mindset that considers both the social and ecological conditions underpinning collective human well-being and economic prosperity.

We argue that biodiversity governance must also adopt a socio-ecologically centred perspective if we are to effectively inform the necessary policy decisions to tackle the biodiversity loss crisis. The MBI aims to be a tool for policy makers to identify if we are living within the regenerative capacity of nature or whether we are piling up ecological debt for future generations, and therefore eroding our own opportunities to achieve sustainable well-being.

A few other examples of established or recently developed environmental sustainability indices to learn from and build up upon include the Sustainable Development Goals Index and dashboard[43], the Environmental Sustainability Gap (ESGAP) framework[44] and the Global Green Growth Index[45].

The Sustainable Development Goal Index and dashboard (SDGI) is particularly interesting. The SDGs have an associated set of indicators, more than 300 in number, and the many countries that have signed up to the SDGs have to report progress on these until 2030. Thus, at a global scale, it is likely the SDGI will grow in importance, at least in the next decade.

Table 2. Socio-economic indices developed in different areas of societal endeavour. Examples shown are based on criteria of impact or use by international institutions and governments to leverage advocacy, to perform inter-country comparisons, to monitor compliance of international agreements and/or for resource allocation.

Area	Index (abbreviation)	Institution	Description	Scale	Impact or Use
Economy	Gross Domestic Product (GDP)[46]	National governments and statistical agencies	GDP measures the market value of goods and services produced within a nation's border in a year. The spending approach measures household spending, investment, government spending, and net exports; whilst the income approach measures compensation of employees, gross operating surplus, gross mixed income and taxes, subsidies on production and imports.	Global and national	Leading indicator of overall health and growth of an economy. It is central in economic planning and it informs monetary and fiscal in-country policies. It allows policymakers, economists and business to analyse whether the economy is growing, stagnant, or experiencing recession; to make investment and production decisions; to plan employment or to evaluate risks of inflation. GDP (and especially forecasting of GDP) is also useful to guide socio-economic policy decisions; to forecast economic performance; and to evaluate the impact of tax, spending, and monetary policies.
Poverty	Multidimensional Poverty Index (MPI)[47,48]	United Nations Development Programme (UNDP), Oxford Poverty and Human Development Initiative (OPHI)	MPI identifies overlapping deprivations that people experience across the same three dimensions as the Human Development Index (health, education and standard of living). It shows the proportion of people that are poor and the average number of deprivations that each poor person experiences at the same time.	Global, regional, national, and local	It enables more effective and efficient poverty reduction policymaking. National or local MPIs have been adopted as official poverty measures in many countries. They are used for monitoring poverty trends, evaluating poverty reduction policies, national planning, SDG prioritization, intra-government coordination across ministries, budget allocation and policy formulation. National MPIs are developed and calculated locally by each country, so they are

					tailored to a particular country and its needs. National governments have complete ownership over these measures, which are embedded into governance systems, ensuring sustainability over time.
Sustainability	Sustainable Development Goals Index and Dashboards (SDG Index and Dashboards)[43]	Bertelsmann Stiftung Foundation, Sustainable Development Solutions Network (SDSN)	The SDG Index and Dashboards measures countries' current performance and trends on the 17 SDGs.	Global and national	It is used to monitor progress towards SDGs, to ensure compliance, and to identify sectors in need of action. See further information in Annex 1.11
	Environmental Performance Index (EPI)[49,50]	Yale University (Centre for Environmental Law & Policy), Columbia University (Centre for International Earth Science Information Network, Earth Institute), World Economic Forum	EPI measures two fundamental dimensions of sustainable development: (1) environmental health, which rises with economic growth and prosperity, and (2) ecosystem vitality, which comes under strain from industrialization and urbanization.	Global and national	It evaluates environmental performance by providing a gauge at a national scale of how close countries are to established environmental policy goals. It highlights leaders and laggards in environmental performance; it gives insight on best practices and it provides guidance on areas for government to invest and design policies on sustainability. See further information in Annex 1.11

	Inclusive Wealth Index (IWI)[51]	United Nations University (UNU), International Human Dimensions Programme on Global Environmental Change, and UN Environment Programme (UNEP)	IWI measures country's inclusive wealth as the social value (not dollar price) of all its capital assets, including natural capital, human capital and manufactured capital.	Global	It guides nations to follow a sustainable path within planetary boundaries. It is applicable to macroeconomic policy design, investment decisions and identification of trade-offs involved in sustainable development. See further information in Annex 1.11
	Ocean Health Index (OHI)[52]	National Centre for Ecological Analysis and Synthesis, Sea Around Us, Conservation International, National Geographic, and the New England Aquarium.	OHI assesses progress on 10 human goals: food provision, artisanal fishing opportunities, natural products, carbon storage, coastal protection, livelihoods and economies, tourism and recreation, sense of place, clean waters and biodiversity.	Global, regional, national, and local	Proposed as overall indicator for SDG 14. 20+ local to national-scale groups have done OHI+ assessments in their own waters (Israel was the first example in 2014-2015) and assessments are adopted by nations as part of their strategies to manage and monitor ocean health and to perform ocean planning and place-based management.
	Ecological Footprint (EF)[53,54]	Global Footprint Network	EF measures the biological productive land and water that a given population demands to produce what it consumes and to absorb its waste. Its main dimensions are cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land	Global and national	The Global Footprint Network has engaged with more than 70 countries and more than 15 national governments to apply the metric. The Ecological Footprint Explorer open data platform, launched in 2017, makes the most recent Footprint and biocapacity data for more than 200 countries. The individual Ecological Footprint Calculator draws almost 3 million users per year. See further information in Annex 1.11

Wellbeing	Human Development Index (HDI)[55]	United Nations Development Programme (UNDP)	HDI measures the average achievement in three key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living.	Global and national	It is used to inform and coordinate multisectoral efforts on designing and implementing development strategies, and as a platform for public debates on national policy priorities. See further information in Annex 1.11
	Social Progress Index (SPI)[56]	Social Progress Imperative (SPI)	SPI measures social progress, independent of economic indicators, as a function of three main elements: basic human needs, foundations of well-being and opportunity.	Global and national	It is used to track and report on progress towards the SDGs particularly for governments conducting their Voluntary National Reviews (VNRs). It has been successfully adapted in countries, cities and communities due to its ability to incorporate locally relevant data into the Index, so it can be used to localize implementation of the SDGs at a more granular level. See further information in Annex 1.11
	Better Life Index (BLI)[57]	Organization for Economic Co-operation and Development (OECD)	BLI measures 11 dimensions that shape people's well-being in OECD and partner countries covering income and wealth, jobs and earnings, housing, health, education, work-life balance, environment, social connections, civic engagement, safety and subjective well-being, and four different resources for future well-being (natural, human, economic and social capital).	Global, national, regional, and local	It is used to monitor how well-being outcomes are changing over time and how they are distributed among different population groups; to engage OECD citizens in policy-making debates; and to inform on the environment, inequalities, and difficulties faced by individuals. See further information in Annex 1.11
Inequality	Inequality Index[58]	Development Finance and Oxfam International	It measures the commitment of governments to reduce the gap between poor and rich in three policy areas: social spending,	Global	It allows to measure progress towards Goal 10 of the SDGs and monitor government performance in reducing inequality.

			progressivity of tax policy, and labour rights and minimum wages.		
Gender Inequality	Gender Inequality Index (GII)[59]	UN Development Programme (UNDP)	GII measures the human development costs of gender inequality based on reproductive health, empowerment and economic status	Global	Intercountry gender disparities comparisons allow to identify areas in need of policy intervention and to stimulate public debate to overcome systematic disadvantages of women. See further information in Annex 1.11
	Global Gender Gap Index (GGGI)[60]	World Economic Forum (WEF)	GGGI measures gender-based gaps in access to resources and opportunities. Its main dimensions are economic participation and opportunity, educational attainment, political empowerment, health and survival.	Global	It is used to monitor progress towards closing gender gaps over time; to design effective policies to reduce the gender gap; and to create global awareness of the challenges posed by gender disparity. See further information in Annex 1.11
Rights	Global Rights Index (GRI)[61]	International Trade Union Confederation (ITUC)	GRI depicts the world's worst countries for workers based on the degree of respect for workers' rights. It measures standards of fundamental rights at work, in particular the right to freedom of association, the right to collective bargaining and the right to strike.	Global	It documents violations of internationally recognised workers' labour rights by governments and employers. It increases visibility and transparency of country's record on workers' right to foster governments' accountability. It also enables to classify recurring types of violations and to map patterns of abuses over time and geography. It informs best practices and it formulates and intensifies advocacy campaigns where rights are seriously threatened. See further information in Annex 1.11

	Global Slavery Index (GSI)[62]	Minderoo Foundation's Walk Free initiative	GSI measures modern slavery across three dimensions: size of the problem (estimated prevalence in terms of percentage of population and absolute numbers (by country)); government response and vulnerability (i.e. factors that explain or predict prevalence).	Global	It provides a country ranking of the number of people suffering modern slavery. It also serves to analyse the actions governments are taking to respond, and the factors that make people vulnerable to modern slavery. It can be used to monitor achievement of the SDG 8.7 on eradication of modern slavery by building a knowledge base to inform action and driving legislative change in key countries in partnership with faiths, businesses, academics, NGOs, and governments.
Innovation	Global Innovation Index[63]	Cornell University, INSEAD, and World Intellectual Property Organization-WIPO	It measures an economy's innovation performance focusing on innovation inputs and outputs.	Global	It is used to as a tool to foster dialogue between policymakers, businesses and other stakeholders to emphasize the relevance of innovation policy for development, and to track annual progress of innovation. See further information in Annex 1.11
Competitiveness	Global Competitiveness Index (GCI)[64]	World Economic Forum (WEF)	GCI measures the drivers of total factor productivity defined as enabling environment (institutions, infrastructure, ICT adoption, Macroeconomic stability), human capital (health, skills), markets (product market, labour market, financial system, market size) and innovation ecosystem (business dynamism, and innovation capability).	Global	It is used to monitor progress of countries in productivity, economic growth, and human development and to inform long-term economic growth policies.

Governance	Rule of Law Index[65]	World Justice Project (WJP)	It assesses the extent to which countries adhere to eight dimensions of the rule of law in practice: limited government powers; absence of corruption; order and security; fundamental rights; open government; regulatory enforcement; civil justice; and criminal justice.	Global	It is intended for a broad audience that includes policy makers, civil society organizations, academics, citizens, and legal professionals, among others, to help identifying countries' strengths and weaknesses and to encourage policy choices that strengthen the rule of law within and across countries.
Corruption	Corruption Perceptions Index (CPI)[66]	Transparency International	CPI ranks countries by their perceived levels of public sector corruption, where corruption is defined as the misuse of public power for private benefit.	Global and regional	It informs about countries' performance in tackling corruption; it advocates for political integrity; and it enables the design of measures to curb corruption.

1.7 Biodiversity indices

Making best use of biodiversity data depends on sharing and synthesizing cutting-edge knowledge on biodiversity, so this information can be used to analyse the impact, effectiveness and efficiency of existing actions to limit and reverse biodiversity loss. Indices are an effective tool to package information into biodiversity knowledge products for science-policy interfacing and data-driven biodiversity policymaking. Nevertheless, as discussed in the previous section, whilst areas such as economics, poverty or development have benefited from a long history on the development, use and uptake of indices by policy makers, the biodiversity sector is steps behind on this matter.

Who already use biodiversity indices? Governments and the secretariats of Multilateral Environmental Agreements (MEAs) use several biodiversity indices to monitor global goals and many indices specifically target policy makers[67–71]. Also, conservation NGOs use biodiversity indices either for monitoring their own performance or monitoring the state of nature and to raise awareness. For example, WWF and the Zoological Society of London (ZSL) produce a Living Planet Report every two years using the Living Planet Index and the Ecological Footprint index to assess global trends in biodiversity state and biodiversity pressures (see e.g.[72]). In addition, the Durrell Wildlife Conservation Trust is one of the first conservation organisations to have a 'key performance indicator', the Durrell Red List Index of Species Survival, which uses the IUCN Red List of Threatened Species to measure progress towards achieving its mission, saving species from extinction.

(https://www.durrell.org/wildlife/wildlife/durrell-index/).

We conducted an assessment of biodiversity indices through a web search and literature review to identify global biodiversity indices in use. We reviewed the list of indicators relevant to the themes of the Aichi Biodiversity Targets in the Strategic Plan for Biodiversity 2011-2020 and the available indicators to measure progress towards the Goals and Targets of the post-2020 global biodiversity framework draft, the Biodiversity Indicators Partnership (BIP) https://www.bipindicators.net/, the core indicators of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and the list of indicators for the SDGs from the updated Tier Classification as per April 2020 by IAEG-SDG Members.

We identified 45 biodiversity-related indices which are presented in Annex 1.12. Of these, 28 of those indices are relevant for assessing progress in the attainment of the Aichi Biodiversity targets in the Strategic Plan for Biodiversity 2011 2020, and seven to measuring progress towards SDG targets (see Annex 1.12).

The Biodiversity Indicators Partnership has identified several indices for Aichi Targets that relate to the monitoring of:

- **i)** species populations (e.g. Living Planet Index; Red List Index; Wild Bird Index; Wildlife Picture Index)
- **ii)** habitats and protected areas (e.g. Biodiversity Habitat Index; Biodiversity Intactness Index; Protected Area Connectedness Index; Protected Area Representativeness Index; Water Quality Index for Biodiversity; Wetland Extent Trends Index)
- **iii)** threats to biodiversity (e.g. Marine Trophic Index)
- **iv)** multidimensional aspects of marine system services (Ocean Health Index).

The biodiversity-related indices included in the UN Statistics Division indicator set for monitoring SDG targets relate to the monitoring of:

v) Species populations (Red List Index)
vi) Habitats Mountain (Green Cover Index)
vii) Coastal pollution (Index of coastal eutrophication and floating plastic debris density).
viii) Additional measures related to food and agriculture (Agriculture orientation index for government expenditures; Food Loss Index; Food Waste Index)

Other additional biodiversity-related indices not currently listed as official Aichi Target or SDG indicators include, for example, species diversity indices such as the Shannon Index or Simpson Index, taxa-specific indices such as the Dragonfly Biotic Index[73] or the Macroinvertebrate Community Index[74], Environmental Democracy Index[75], Environmental Performance Index[49,50], Global Footprint Network's National Footprint Accounts[76], Global Human Influence Index[77], Mangrove Quality Index[78], Spatial Human Footprint Index[79], STAR Vegetation Health Index[80], Vulnerability to Climate Change Index, Environmental Performance Index[49], Ecological Footprint[76], Agrobiodiversity Index[81], or the Species Threat Abatement and Restoration (STAR) metric (In press).

The Ocean Health Index (OHI)[52] and the Environmental Performance Index (EPI)[49] are two particularly interesting initiatives to learn from.

The OHI was developed as a standardized, quantitative, transparent and scalable measure that can be used by scientists, managers, policy makers and the public to better understand, track and communicate ecosystem status and design strategic actions to improve overall ocean health. It comprises ten diverse public goals for a healthy coupled human–ocean system. The ten goals (dimensions) relate to: food provision; artisanal fishing opportunity, natural products, carbon storage, coastal protection, tourism and recreation, coastal livelihoods and economies, sense of place, clean waters and biodiversity. Each of the ten goals comprising the index can be considered separately or aggregated into an overall score for a region, country, or the entire ocean, and compared across these scales, provided that data sources are consistent. Tracking individual components of ocean health and benefits is useful but combining them into a synthetic measure using a concise set of indicators facilitates communication and allows direct comparison among management objectives.

The EPI ranks countries on 24 performance indicators across ten dimensions (air quality, water quality, heavy metals, biodiversity, forests, fisheries, climate & energy, air pollution, water resources, agriculture). These metrics provide a gauge at a national scale of how close countries are to established environmental policy goals around environmental health and ecosystem vitality.

1.8 **In my view:** *Fighting biodiversity loss with a data revolution, by Carolina Soto-Navarro*

There will always be a need to condense complexity to help inform decisions, we do it on a daily basis without even realising. Hence, despite their criticisms, weaknesses and major drawbacks, it is highly likely that as tools, and whether we like it or not, indices will always be present in our societies.

But what are the frontiers in the indices' world? The future world of indices may be something of a fight on a number of fronts, spanning from the classic running battles of aggregation or the selection of indicators, to less explored battlefields such as the space between production and use or how technology can influence the future of indices[82,83]. Here, we provide some food-for-thought on the last two points.

One field where much work still needs to be done is the space between production and use. Answering questions like who uses indices, for what purposes and how and to what extent they have succeeded in achieving change remain largely an uphill struggle. To date, indices development has been largely creator-led with little, if any, input from users of those indices. Nevertheless, even the best indices are of little influence and importance if they are not used in any way by their intended users. Hence, there is a need to move towards a model focused on co-creation with the voices, priorities and necessities of users being part of the process. We need to be more reflective in our assumptions, and be better informed on who the users are, what they are looking for and how we can best help. This requires a greater emphasis in research on the uses to which indices (referring here particularly to sustainability and environmental indices) are put and how that information can feed back into the development and presentation of these indices to decision makers.

An interesting potential solution on this 'use' frontier could be **a case-study based body of knowledge regarding sustainability and environmental indices**. The rise and rise of indices and indicators make it crucial to devote more research efforts to identify generic patterns as to what works, or not, so better insights can be drawn. This can allow for new patterns to emerge and old ones to be questioned.

For example, if we 'look' at the planet in the form of indicators and indices, what we see across the globe is a consistent message[84]. Generally speaking, national wealth, expressed as GDP, tends to bring better human development (HDI), less poverty (MPI), greater equality (Gini Index), less corruption (CPI), less vulnerability to climate change, better environmental sustainability (ESI) and performance (EPI), more happiness (Happiness Index and Happy Planet Index) and more sustainable development (SDGI). Exploring relationships between those indices[84], one may reach to the conclusion that national wealth is at the heart of the index relationships. So, does it all really come down to focus on improving national wealth and everything else will follow?

Clearly not. As a generalization, of course, this is not true for all countries and the details really do matter. This is where a case-study body of knowledge can make a big difference. As scientists, we normally focus on the general trends as they provide the big picture for academic publications and provide a neat and simple, whilst dangerous and potentially perverse, message for policymakers. Nevertheless, we need a more nuanced and context-specific approach to better inform decisions.

This is a very challenging work, and a dilemma as to how to get such case study-based material published when these studies are normally dismissed in scientific journals as being too "context-specific" and linked to a specific place and time, and then not readily generalisable. Perhaps, as many of us strive for evidence-based decision making, there is a need and space for a *sustainability evidence initiative* to emerge in the public domain, similar to the *conservation evidence initiative* (https://www.conservationevidence.com/) but on the science-policy interface. This body of knowledge focused on case-studies on the use of sustainability and environmental indices for policy and decision making would allow, for example, scientists and developers to do research and meta-analyses on what work and what does not, and to index users to derive lessons learned from the application of indices to similar contexts.

The second interesting frontier in the indices' world is the potential **contribution of technology to the development and use of indices.** One of the challenges with indicators and indices is the need for both quantity and quality of data to populate them. Resources need to be committed to data collection and verification, and this is normally expensive and time-consuming. Nevertheless, without good quality data there is a likelihood that indices may be deeply flawed and hence readily dismissed, which may hinder their uptake and use. But technology may help here.

Collecting data in a timely manner and of the required quality is likely to be resource-demanding and/or imagination challenging but big data collected from unconventional sources to supplement official statistics and science data could be used to populate indices. For example, Statistics South Africa is assessing the use of scanner data from retail chains as inputs to the consumer price index[85]. Also, we can think of the wealth of data collected 'incidentally' on a daily basis on mobile phones by millions of people. Perhaps, at one level, there could be a possibility of levering this amount of data for environmental and sustainability indices purposes.

As technology evolves, machine learning is expanding, and researchers become more aware of this potential for big data collection. The rise of citizen science and its applications on environmental studies is one example of this new age of automation, where machine and human can combine to revolutionize data collection. But how can the *power of the commons* through citizen-collected data be leveraged to play a pivotal role in the world of environmental and sustainability indices? Well, we just may need to think of the millions of pictures taken via mobile phones every second around the world, even in the most remote and poorest corners of our planet.

Pictures are visual clues[84]. We can look at them as *indicators* of the state of the world around us. In Figure 3A we can recognise poverty, and perhaps even say something about its intensity. Probably we do not need the Multidimensional Poverty Index score for that area to tell us the well-being predicament of the people who live there. Could we use technology and train algorithms to identify in Figure 3B *indicators* that would inform an assessment of the levels of *biodiversity health* for that region as a function of predetermined parameters and features?

We know that poverty estimations, for example, influence how governments allocate limited resources to create policies and conduct research. So, would we be willing to share our data if we knew that our pictures could inform poverty, climate change or biodiversity policies in the countries we live in, or visit in our travels? There could be a multi-million-dollar investment behind strategic alliances and research collaborations among some of the world's largest tech companies and governments to build image-based digital biodiversity tracking tools for policy and accounting purposes.

Figure 3. From pictures to indices? Phone pictures taken in A) a floating fishing village in Cambodia and B) Paro, Bhutan.

But this is not new. There already exist methods for analysing visual material, under the broad heading of content analysis that can analyse the presence of indicators in pictures (e.g.[86]). We are witnessing the rise of a version of this concept of translating images into indices in the form of Earth observations via satellites.

Jean et al. 2016[87] provide an intriguing example on how to use machine learning to predict poverty using satellite imagery. Night-time luminosity intensity can be used as a proxy to measure levels of economic activity in vast geographical areas. There is a correlation between satellite nightlights intensity of an area an its levels of economic activities. Nevertheless, the nightlights method *per se* is unable to detect economic activity in regions that are below the international poverty line. Hence, they combined survey and satellite data and trained a convolutional neural network (CNN) to discern features on daylight satellite images in five African developing countries (Figure 4). The CNN can be trained to identify image features that can explain up to 75% of the variation in local-level economic outcomes with a granularity of the household level.

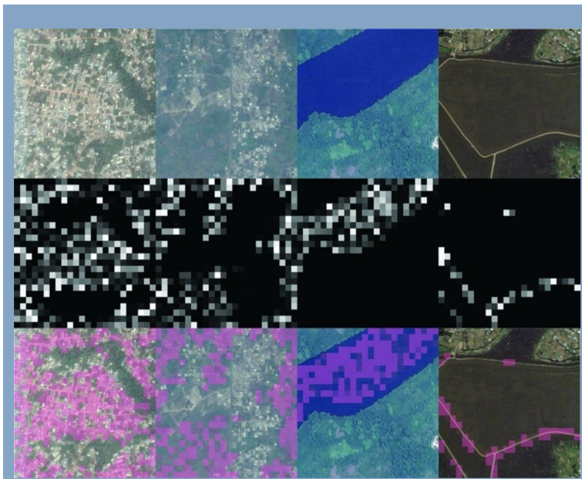


Figure 4. Combining satellite imagery and machine learning to predict poverty.
From Jean et al. 2016[87]. By column: Four different convolutional filters (which identify, from left to right, features corresponding to urban areas, nonurban areas, water, and roads) in the convolutional neural network model used for extracting features. Each filter "highlights" the parts of the image that activate it, shown in pink. By row: Original daytime satellite images from Google Static Maps, filter activation maps, and overlay of activation maps onto original images.

While the notion of using satellites to observe changes in land use is well-established, perhaps the most intriguing aspect is the potential of using data from satellites to assess aspects of human life that we would not expect to see from orbit, such as poverty.

Today, with satellites with resolutions of less than 0.5^2 per pixel[88], and with technology on board that can tell us whether a body of water is being polluted, we have a new game in town to think about how to populate indices. This may grow in importance particularly in many developing countries that cannot devote the resources required to routinely collect and verify the data that they would need to put into more traditional indicators. Even if only some of these data can be collected by satellites then it would help a lot.

While Earth observation and technology provides great potential, we should not get carried away. Earth observation provides new potential ways for populating indicators and indices, and even a way of complementing and confirming data collected on the ground. But it is clearly not a panacea.

Indices will not achieve a positive change by themselves. We need people in the position to make decisions to use indices to bring about those positive changes. To foster that change we need to think in innovative ways, where **innovation goes beyond technological innovation.**

Using an analogy to the healthcare system, innovation goes beyond improving medicines, vaccines, medical devices and data collection to consider prevention, treatment, and the broader healthcare delivery and organization. It means creating equipment capable of assisting in the diagnosis of diseases, developing medical devices for health monitoring and treatment, and conceiving customized management and protocols for implementation for each country. All of this is highly context dependent, and we have seen this in action, for example, with the Covid-19 pandemic.

The information we provide to policy and decision makers in the form of indices, will always be looked through a lens of culture, biases, history, views, values and priorities. Hence, we need to invest more efforts on how to present information to policy makers in forms that enable them to identify trends, trade-offs and make quick and informed decisions from local to national levels with the best possible information at their fingertips. There are three potential conditions or approaches to achieve that goal.

First, whilst the MBI may serve the goal of simplifying communications and ‘capturing hearts and minds’ for biodiversity conservation and policy action, **a broader integrated Biodiversity Information System (BIS) with standards concepts definitions and classifications that speaks to the economic and social system** is needed.

Second, for a BIS to be impactful and useful, taking as an example of the formative power of information for policy change the United Nations' Standard System of National Accounts, it would need to account for different ways of synthetizing information. A visualisation system would play a fundamental role on that respect as technology offers new possibilities for big data visualisation. But most importantly, we would need to adopt **a systems approach to investigate and analyze interactions between wider and relevant socio-economic indicators used for policymaking**. For example, the Stockholm Environment Institute method provides a useful way of think about investigating interactions using SDG indicators (see Global Sustainable Development Report (Box 1-2)). There already exist initiatives that the MBI could feed into, such us the System of Environmental-Economic Accounting (SEEA), a framework with internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics that integrates economic and environmental data. It provides a more comprehensive and multipurpose view of the interrelationships between the economy and the environment.

Thirdly, and echoing Stefan Schweinfest's words, Director of the UN Statistics Division, **a global data architecture** is needed, where global indicators produced by, for example, academic and scientific communities or international and UN agencies are only the tip of the iceberg. In this global data architecture, data are produced at the local and national levels, reviewed for validity and then transported effectively to the various decision nodes. This requires **a data revolution harnessed by national statistical systems** operating increasingly as part of a larger, **emerging *data ecosystem***, which is made up of multiple communities of data producers and users including civil society; the private sector; academic and scientific communities; as well as regional, international and UN agencies; and specialised data producers. But what do we need to get there? To be effective in stimulating data use and evidence-based decision and policy making, we need to invest in new technology, production processes and to establish partnerships with new actors. We need new methodologies and technical capacity building and a transformation of national statistical systems to enable national statistical offices to play their new role as *chief data managers*, which includes co-ordinating and validating national information beyond official statistics and integrating different data sources, including unconventional and big data sources as mentioned above.

From stimulating research, to working in collaboration with legislative in-country branches, to advocate broad and well-informed biodiversity policies, we target the MBI to make an important contribution to fostering the use of this dynamic and new data ecosystem to better inform decisions on biodiversity`. At least, an Index for biodiversity health may give us a seedling or starting point with reliable and readily available biodiversity data, and we do have to start from somewhere.

4 THE PATH AHEAD

Developing a globally applicable and nationally relevant MBI framework is both a technical and a political process. Hence, the design of the final conceptual framework and analytical approach for the MBI demands political commitment to provide policy steer, and the active engagement of scientists to provide scientific input. We show in Figure 5 a roadmap towards the implementation of an MBI for biodiversity health calling for immediate, mid- and long-term actions, as well as key actors and workflows for the implementation and use of national MBIs.

The four-step approach showed in Figure 5 creates four fundamental conditions for the Index: 1) to be relevant to national biodiversity policies and socio-ecological contexts; 2) to be based on robust science, 3) to be responsive to positive changes and 4) to be used as the new frame of reference for national biodiversity health assessments.

Immediate actions should focus on implementing an inclusive co-production process with decision-makers, experts and relevant stakeholders to enable diverse perspectives and priorities to be incorporated. These consist of two necessary steps.

The first step is to undertake a consultative process with experts and end-users to ensure that the framework addresses policy obligations and decision-making requirements for biodiversity conservation (i.e. countries are clear about their reasons and necessities for a national MBI).

The second step is to develop a robust scientific methodology and test the Index through use cases to foster accountability, policy acceptance, and to surface design improvements. The Index should be robust and based on the best available science and data, which requires inter-operability through existing networks and stakeholder engagement for data mobilisation and integration. Each use case must be coordinated by a network of experts working at different scales and governance levels to contribute statistical national data and indicators. We illustrate the testing of the MBI framework through four steps (Figure 3);

- **i)** dialogue and consultation to define context specificities and incorporate public priorities,
- **ii)** data contribution and mobilisation including the identification of scientifically validated potential indicators that countries can use to quantify objectives,
- **iii)** data integration and MBI production and,
- **iv)** MBI applications and use.

The third step consists of implementing mid-term actions aiming to surface improvements on the framework and methodology to ensure the utility, effectiveness and responsiveness of the Index to positive changes, so that there are incentives to use and implement the Index as a biodiversity policy tool. This should be an iterative process so future improvements are incorporated with successive iterations, and new knowledge integrated as it emerges.

The fourth step consists of long-term actions aiming to promote dialogue, capacity building and support policymakers in developing more effective biodiversity policies that are grounded in multidimensional measures of biodiversity health. This aims to ensure that the Index is used for national biodiversity and ecosystem assessments, and relevant intergovernmental policy processes including the SDGs and the CBD. These actions consist of building partnerships and fostering a formal uptake by governments, statistical commissions and/or intergovernmental agencies as potential custodian agencies.

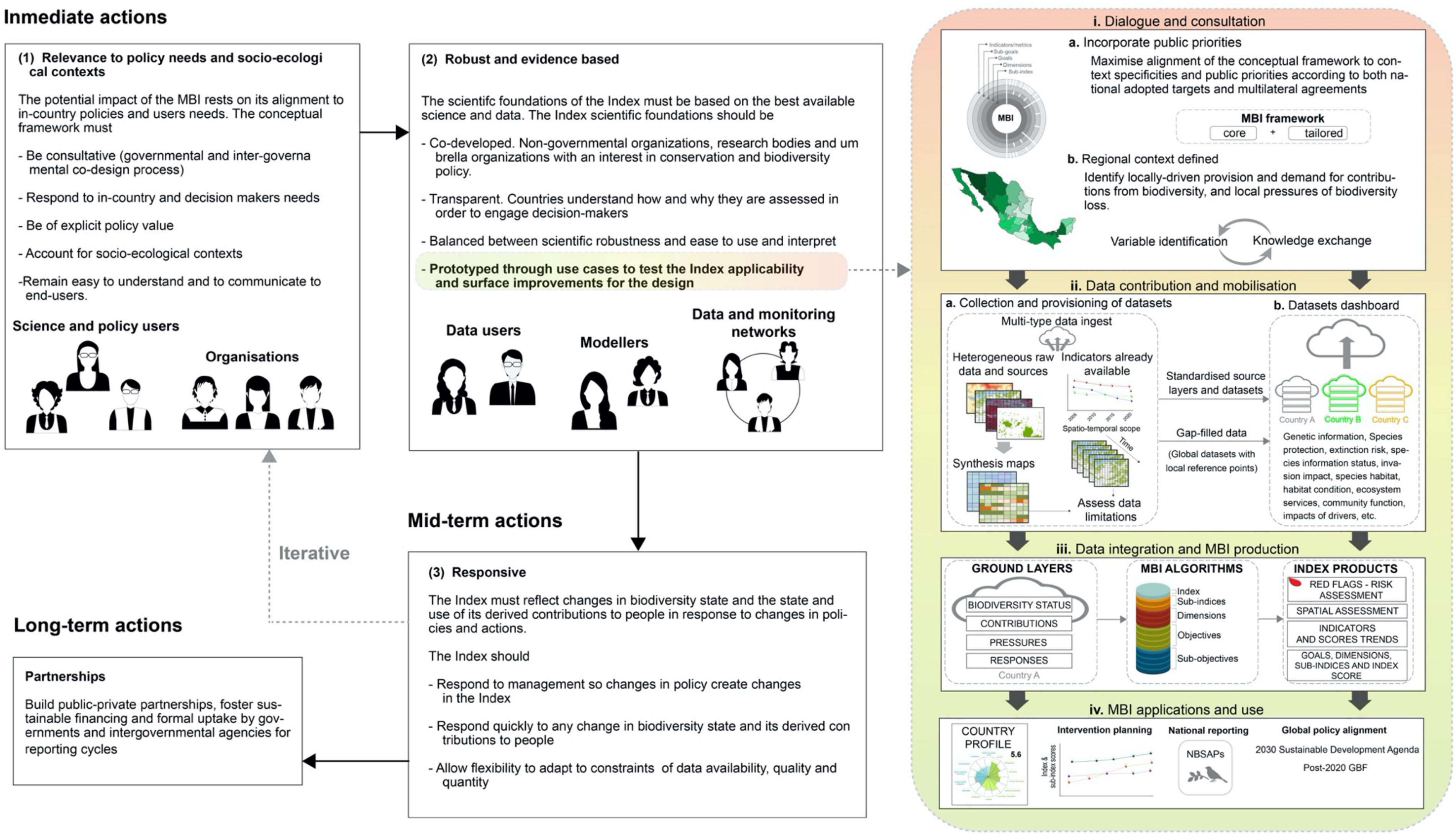


Figure 5. Roadmap to a Multidimensional Biodiversity Index calling for immediate, mid- and long-term actions.

5 CONCLUSIONS AND RECOMMENDATIONS

In this report we have addressed a long-term debate and key issue which, arguably, might be hindering the interface between biodiversity science and policy making: **the lack of a headline index for biodiversity**.

There is demand among policymakers for such an index, but biodiversity measures remain siloed and fragmented. Here, we have discussed how such an overall index for biodiversity health, if realised, could help to transform biodiversity loss from an abstract notion into a tangible entity that national governments can understand and act on.

In this report we have discussed that, given the complexity of biodiversity, the lack of fungibility between its facets and components, and the divergent nature of the two main goals on safeguarding biodiversity (to preserve ecological integrity and to use sustainably the flows of contributions to people that ecosystems provide) we need to measure changes in biodiversity from a multidimensional perspective to effectively contribute to shape biodiversity policy.

The MBI framework is intended to provide national governments and decision-makers the opportunity to pack biodiversity information into 'blueprint' or knowledge products (Box 2). This can help informing the range of areas for intervention and opportunities to simultaneously achieve the goals of enhancing biodiversity and delivering sustainable use of its derived contributions to human development and well-being.

Finally, we offer nine (non-prescriptive) recommendations as a way to implement the next steps discussed in Chapter 8.

On the conceptual framework and MBI model

The MBI framework outlined in Figure 2 (see Chapter 6) provides an ideal for countries to aspire to. It aims to represent a unified framework to assess biodiversity health for countries to aim for and work towards. Nevertheless, some of the objectives described in the framework might not be measurable yet or have existing data for many countries. Hence, the following actions are necessary to help maximise the utility and feasibility of the Index, and future policy uptake:

(i) The Index should recognise linkages between human societies and ecosystems, and that people are part of an integrated and healthy system. This is important if the goal is for biodiversity conservation and its sustainable use to be considered as an essential foundation for sustainable development, and not a barrier to growth.

(ii) The core MBI framework should be finalised and agreed through a consultative process (government consultation) involving experts and end-users. This will enhance the practical utility of the index in policy-decision making and will help understanding the national and regional contexts that influence biodiversity policies. The type of consultations could be in the form of an online survey facilitated by the Secretariat of the Biodiversity Indicators Partnership (BIP) in UNEP-WCMC, a consultation with focal government points in pilot countries (Switzerland, Mexico, Vietnam and a fourth pilot country to be decided yet), in-country stakeholder workshops and/or international expert meetings. This will help to discuss advantages and disadvantages and to decide on best approaches to calculate MBI scores using; a) a top-down approach (only global data); b) a bottom-up approach (only national data) or c) a hybrid approach (global and national data).

(iii) The experience of designing and implementing the pilot case studies in close collaboration with key in-country agencies (e.g. focal points for the reporting on international agreements such as the Convention on Biological Diversity and the Sustainable Development Goals) should be used to inform and surface improvements for the MBI framework, and these should be implemented reiteratively in the next phase of the project.

On the methodology and criteria for selection and development of indicators

(iv) A focus on sustainability and coupled human-biodiversity system should drive the methods for calculating a score for each biodiversity health objective, which means that both ecological and social data drive the final score. The process of defining the Index methodology should entail a stepwise scientific approach and a consultative process involving experts to understand the complexity and multidimensionality of biodiversity. Preliminary insights into potential analytical approaches are presented in Annex 1.10, based on an adaptation of methodological foundations of welfare economics and the Ocean Health Index[52]. It consists of calculating biodiversity health scores as a function of current and likely-near-future state, as well as pressures and cumulative value of policy responses (actions) to reverse biodiversity loss. Nevertheless, this approach may result too complicated and difficult to implement and used by individual countries, so it must be further defined and assessed for its feasibility. A simpler approach is also discussed in Annex 1.10 based on using indicators or metrics for which a numeric target can be identified.

(v) We recommend building on indicators proposed for use under the post-2020 global biodiversity framework, and those already in use or being developed for the SDGs, to define the core MBI indicator framework. This will ensure global policy alignment of the Index to the post-2020 global biodiversity framework and the environmental dimension of the 2030 Agenda. The use of indicators which align with the SDG indicators has the added benefit of the statistical rigor which is the foundation of the SDGs. This will improve the temporal and spatial comparability of the index and it will ensure that there is a global and national commitment to continue to collect the data which underlies the Index. We suggest some additional criteria for the selection of indicators to populate the core MBI framework such as:

> **v (a)** Global relevance and applicability to a broad range of country settings. In particular, they allow for the definition of quantitative performance thresholds that signify SDGs and post-2020 targets achievement.
>
> **v (b)** The indicators selected represent reliable measures (statistical adequacy) and they represent the best available measure, or proxy, for a specific biodiversity health goal. They derive from official national or international sources such as national statistical offices or international organizations, or other reputable sources, such as peer-reviewed publications.
>
> **v (c)** The indicators selected are up to date and published with reasonably timeliness.
>
> **v (d)** Data has a considerably high coverage and it is available for a decent number of UN Member States.

(vi) Whilst the core MBI provides a frame of reference for calculating biodiversity health that allows for inter-country comparisons, the Index should be designed to be flexible enough to accommodate different scales and geographies of interest and different and new types of data. This will be crucial to allow for countries to calculate their own *national scorecards* on biodiversity health. Hence, the implementation of pilot case studies will play a fundamental role on the testing and national applicability of the MBI framework.

(vii) The reporting units are yet to be defined, but we recommend considering different regional models, from, for example, strictly ecological basis (e.g. eco-regions or watersheds) to more administrative models like management units, municipalities or states. The MIB framework should be able to adapt to any of those, which is the benefit of including spatially explicit information where possible.

On the case studies in pilot countries

(viii) The main goal of the case studies is to pilot the prototype version of the MBI, surface improvements on the design and implementation, define leading practices and areas for improvement, and provide policy steer by assessing the potential contributions of the MBI to in-country biodiversity national policy processes and biodiversity assessments in the pilot countries. This will inform wider applicability, implementation and future uptake. It will also help to develop guidelines on how to implement and calculate independently led MBI scorecards for countries.

(ix) Development should follow a collaborative and co-design approach, engaging a large variety of stakeholders and partners and fostering continuous stakeholder interactions, through, if and where possible, in-country workshops, country visits and consultations.

6 ANNEXES

1.9 Examples of global indicators to inform the core MBI indicator framework

We offer an indicative (non-exhaustive) list of indicators available (currently in use or under active development) to inform the core MBI indicator framework. This list includes indicators relevant to the themes of the previous Aichi Biodiversity Targets in the Strategic Plan for Biodiversity 2011-2020, indicators in the Biodiversity Indicators Partnership (BIP) https://www.bipindicators.net/, core indicators of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Tier I and II indicators from the updated Tier Classification as per April 2020 by IAEG-SDG Members. Whilst these can inform the core MBI indicator framework, individual countries may supplement the core MBI with additional objectives, sub objectives and therefore national level indicators and data. Nevertheless, the inclusion of widely applied and globally available indicators as part of the MBI core structure will be essential to allow for inter country comparisons and to develop a global version of the MBI. Additionally, for the implementation of the MBI framework at national scales, it may prove useful to fill data gaps when national statistical data and indicators for particular objectives are not available, as for baseline information until better national data becomes available. Criteria for selection of indicators to include in the MBI indicator framework should include a) global coverage of the indicator with national data, b) publicly available methodologies, and c) indicators where a numeric target can be identified.

Indicator	Custodian Agency / Institution / Source	Currently available (X) or Under active development (D)	SDG indicator	BIP Indicator (Y/N)	Relation to MBI (State (S), Threat (P), Action (M)) *refer to Annex 1.12
Forest area as a proportion of total land area	FAO	X	Tier I	Y	Objective G6 (S)
Tree cover loss	WRI (Global Forest Watch)	D		N	Objective G6 (P)
Trends in forest extent (tree cover)	University of Maryland	X		N	Objective G6 (S)
Primary forest deforestation	WRI (Global Forest Watch)	D		N	Objective G6 (P)
Forest intactness index*	WCS	D		N	Objective G5 (S)
Species Habitat Index*	Yale University	X		N	Objective G6 (S)
Biodiversity Habitat Index*	CSIRO	X		Y	Objective G5 (S)
Biodiversity Intactness Index*	GEO BON - PREDICTS	X		Y	Objective G5 (S)
Red List of Ecosystems	IUCN	D		N	Objective G6 (S)
Change in Ecosystem composition, structure and function	NASA/JPL	D		N	Objective G5 (S)
Continuous Global Mangrove Forest Cover	Salisbury University	X		Y	Objective G6 (S)
Global Ecosystem Restoration Index*	GEO BON - iDiv	X		N	Objective G6 (M)
Protected Area Connectedness Index (PARC-Connectedness) *	CSIRO	X		Y	Objective G5 (S)
Measures for connectivity (e.g. Protected Connected (ProtConn)	European Commission	X		Y	Objective G5 (S)
Protected area coverage	UNEP-WCMC	X		Y	Objective G5 (M)
Area of forest under sustainable management: total FSC and PEFC forest management certification	PEFC, FSC	X		Y	Objective G11 (M)
Protected Area Coverage of Key Biodiversity Areas	BirdLife International, UNEP-WCMC & IUCN	X		Y	Objective G3 (M)
Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type	BirdLife International, UNEP-WCMC & IUCN	X		Y	Objective G6 (M)
Protected Area Representativeness Index*	CSIRO	X		Y	Objective G6 (M)
Protected Areas Management Effectiveness	UNEP-WCMC	X		Y	Objective G6 (M)

Indicator	Custodian Agency / Institution / Source	Currently available (X) or Under active development (D)	SDG indicator	BIP Indicator (Y/N)	Relation to MBI (State (S), Threat (P), Action (M)) *refer to Annex 1.12
Red List Index (forest specialist species, impacts of utilisation and impacts of internationally traded species) *	IUCN / BirdLife International	X	Y	Y	Objective G3 (S)
Red List Index (wild relatives of domesticated animals) *	IUCN / BirdLife International	X		Y	Objective G1 (S)
Living Planet Index (LPI) for utilised species*	ZSL	D			Objective G4 (S)
Trends in the numbers of invasive alien species introduction events	IUCN Species Survival Commission Invasive Species Specialist Group				Objective G5 (P)
Proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of invasive alien species	IUCN		Tier II		Objective G5 (M)
Red List Index (impacts of invasive alien species)	BirdLife International and IUCN				Objective G5 (P)
Prevalence of undernourishment	FAO	X	Tier I		Objective G10 (P)
Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size	FAO	D	Tier II		Objective G11 (S)
Proportion of agricultural area under productive and sustainable agriculture	FAO	D	Tier II		Objective G10 (S)
Number of plant and animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities	FAO	X	Tier I		Objective G10 (M)
The agriculture orientation index for government expenditures*	FAO	X	Tier I		Objective G10 (M)
Mortality rate attributed to household and ambient air pollution	WHO	X	Tier I		Objective G8 (P)
Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment	UNESCO-UIS	D	Tier II		Objective G12 (M)
Proportion of population using safely managed drinking water services	WHO, UNICEF	D	Tier II		Objective G7 (S)
Proportion of domestic and industrial wastewater flows safely treated	WHO,	D	Tier II		Objective G7 (S)

Indicator	Custodian Agency / Institution / Source	Currently available (X) or Under active development (D)	SDG indicator	BIP Indicator (Y/N)	Relation to MBI (State (S), Threat (P), Action (M)) *refer to Annex 1.12
	UN-Habitat, UNSD				
Change in water-use efficiency over time	FAO	X	Tier I		Objective G7 (S)
Degree of integrated water resources management implementation (0–100)	UNEP	X	Tier I		Objective G7 (M)
Change in the extent of water-related ecosystems over time	UNEP, Ramsar	X	Tier I		Objective G6 (S)
CO2 emission per unit of value added	UNIDO, IEA	X	Tier I		Objective G8 (S)
Total expenditure (public and private) per capita spent on the preservation, protection and conservation of natural heritage, level of government (national, regional and local/municipal), type of expenditure (operating expenditure/investment) and type of private funding (donations in kind, private non-profit sector and sponsorship)	UNESCO-UIS	D	Tier II		Objective G12 (M)
Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities	UN-Habitat	D	Tier II		Objective G12 (S)
Food loss index* and Food waste index*	FAO, UNEP	D	Tier II		Objective G10 (P)
Amount of fossil-fuel subsidies per unit of GDP (production and consumption)	UNEP	X	Tier I		Objective G8 (S)
Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	UNDRR	D	Tier II		Objective G9 (S)
Progress towards sustainable forest management	FAO	X	Tier I		Objective G11(S)
Proportion of land that is degraded over total land area	UNCCD	X	Tier I		Objective G6 (P)
Coverage by protected areas of important sites for mountain biodiversity	UNEP-WCMC, UNEP, IUCN	X	Tier I		Objective G5 (M)

Indicator	Custodian Agency / Institution / Source	Currently available (X) or Under active development (D)	SDG indicator	BIP Indicator (Y/N)	Relation to MBI (State (S), Threat (P), Action (M)) *refer to Annex 1.12
Red List Index*	IUCN	X	Tier I		Objective G3 (S)
Proportion of traded wildlife that was poached or illicitly trafficked	UNODC, CITES	D	Tier II	N	Objective G4 (P)
Amount of monetary benefits (in United State dollars) received from the utilization of traditional knowledge associated with genetic resources					Objective G10 (M)
Trends in potentially environmentally harmful elements of government support to agriculture (producer support estimate)	OECD	X		Y	Objective G10 (P)
Ecological Footprint	Global Footprint Network	X		Y	Objective G6 (P)
Human Appropriation of Net Primary Production (HANPP)	Institute of Social Ecology (SEC), University of Natural Resources and Life Sciences, Vienna	X		Y	Objective G6 (P)
Area of forest under sustainable management: total FSC and PEFC forest management certification	Forest Stewardship Council (FSC) Programme for the Endorsement of Forest Certification (PEFC)	X		Y	Objective G11 (M)
Biodiversity Barometer	Union for Ethical Biotrade	X		Y	Objective G12 (S)
Biodiversity Engagement Indicator	Conservation International	X		Y	Objective G12 (S)
Growth in Species Occurrence Records Accessible Through GBIF	GBIF	X		Y	Objective G12 (M)
Water Footprint (Human appropriation of fresh water)	Water Footprint Network	X			Objective G7 (P)
Total wood removals	FAO	X		Y	Objective G11 (P)
Nitrogen Use Efficiency	Yale University (Environmental Performance Index)	X			Objective G7 (S)
Nitrogen + Phosphate Fertilizers (N+P205 total nutrients)	FAO	X		Y	Objective G7 (P)
Trends in pesticide use	FAO	X		Y	Objective G10 (P)
Proportion of local breeds, classified as being at risk, not-at-risk or unknown level of risk of extinction	FAO	X			Objective G10 (S)

Indicator	Custodian Agency / Institution / Source	Currently available (X) or Under active development (D)	SDG indicator	BIP Indicator (Y/N)	Relation to MBI (State (S), Threat (P), Action (M)) *refer to Annex 1.12
Proportion of known species assessed through the IUCN Red List	IUCN	X		Y	Objective G3 (M)
Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	FAO	X	Tier I		Objective G7 (P)
Change in water use efficiency over time	FAO	X	Tier I		Objective G7 (S)
Areas of agricultural land under conservation agriculture	FAO	X			Objective G10 (S)
Proportion of bodies of water with good ambient water quality	UNEP	D	Tier II		Objective G7 (S)

**The inclusion of indices must be further discussed to avoid issues related to double counting in the calculation of MBI scores, and due to the difficulty of target setting for those indicators.*

1.10 Methodological framework - Calculating MBI scores

This section provides preliminary insights into potential analytical approaches to measure biodiversity health for all nations. Nevertheless, the scientific foundations to develop a Multidimensional Biodiversity Index must be co-designed as described in Chapter 8.

As a first alternative, we suggest that principles and methodological foundations of welfare economics and the economic valuation of nature[89] could be explored and adapted to assess biodiversity health and to calculate national MBI scores. In this section we provide a first conceptualisation for this approach.

The foundations of welfare economics commonly include the definition of a utility function as an indication of preferences among a set of goods and services and therefore people's level of satisfaction, happiness, or wellbeing[90].

The proposed function is as follows:

$$U = U(X) \ s.t. \ P' \cdot X \leq M$$

where U is the subject's utility, X is a vector of indicators determining individual biodiversity health goal G_i, P represents an ecological pressure vector (constraint) related to G_i and M refers to a vector of cumulative value of policy responses (actions) to reverse biodiversity loss (where each element is addressing its counterpart in the vector of ecological pressures P_i, reduce ecological pressures and increase resilience for a given goal G_i.

The constraint P could be defined as a set of pressures that can't be exceeded and M as a set of policies or actions to stimulate ecosystem health, or increase resilience, and the continued provision of contributions to people.

We suggest four analytical steps (Figure 1) to calculate an overall MBI score aggregated at country levels.

Figure 1. Proposed aggregation structure for the MBI. The figure represents how each biodiversity health objective G_i is a function of its current and likely near future status, which in turn is calculated based on the recent trend, cumulative pressures and cumulative responses to G_i (adapted from[52]).

MBI	BI	D1	G1
			G2
			G3
		D2	G4
		D3	G5
			G6
	BCPI	D4	G7
			G8
			G9
		D5	G10
			G11
		D6	G12

Objective score	Current status	Present / Reference
	+	
	Likely near future	Trend
		Pressures (cumulative threats)
		Resilience (cumulative policy actions)

1. Biodiversity health objectives and sub objectives. Each biodiversity health objective of the MBI framework is calculated such that,

$$U_i = U_i(G_i) \ s.t. \ P_{ij} \leq M_{ij} \quad \forall \ i \in 1, \ldots, n \ \ \forall j \in 1, \ldots, k$$

where U_i is the score of each individual biodiversity health goal G_i, $\mathrm{P_i} = [\mathrm{p_{i1}}, \ldots, \mathrm{p_{ik}}]$ is a vector of ecological pressures known to affect a given goal G_i, $\mathrm{M_i} = [\mathrm{m_{i1}}, \ldots, \mathrm{m_{ik}}]$ is a vector of responses (i.e., policy measures) to reverse or reduce corresponding ecological pressures and increase resilience of the element measured by a given goal G_i, and n is the number of biodiversity health goals defined in the MBI framework.

We propose to construct the vector $\mathrm{P_i} = [\mathrm{p_{i1}}, \ldots, \mathrm{p_{ik}}]$ by assessing five broad, globally relevant categories of ecological pressures: 1) land-use change and habitat loss, 2) unsustainable use/overexploitation, 3) pollution, 4) invasive alien species and 5) climate change.

We propose to construct the response vector $\mathrm{M_i} = [\mathrm{m_{i1}}, \ldots, \mathrm{m_{ik}}]$ through the assessment of (spatial and non-spatial) objective-specific regulations in place related to: 1) legal and regulatory instruments (e.g. protected areas designated, prioritization of invasive alien species in NBSAPs, area of land for food and energy production, wildlife trade bans or ex-situ conservation of biological material); 2) financial instruments (e.g. tax negative environmental impacts); 3) rights-based and equity approaches (extent of areas managed and/or controlled by indigenous people and local communities (IPLCs), gender equity at all levels of implementation of conservation policies, conservation of broadly shared values such as the protection of cultural heritage and sacred places); and/or 4) information- and market-based instruments (e.g. education for awareness, citizen science or certifications).

Following a similar approach to the calculation of sustainability goal scores in the OHI model we propose to calculate the score for each biodiversity health objective *Gi*, as a function of its present and likely near-term future status.

Likely near-term future status is a function of four dimensions: present status, recent trend (over the past ~5 years or the last number of years with biodiversity data available) normalized to a reference value, current cumulative pressures *P* to the objective *Gi*; and current cumulative responses or actions *M* to negative pressures on the objective *Gi*.

The inclusion of pressures and responses to calculate each biodiversity objective score is meant to improve understanding of the current and likely near-term future condition by incorporating those factors that negatively affect a goal and those that increase resilience, respectively.

Each biodiversity health objective *Gi* score is calculated following four sub steps.

1a. Set reference values and weights (optionally) for each biodiversity health objective *Gi* and normalize scales by reference values.

For each unit of analyses and objective, we propose determining reference values either, 1) spatially by means of comparison with another region within a country (i.e. based on the best performance within the actual data (e.g., region X represents the best performance theoretically feasible)), 2) temporally using a past benchmark (e.g., historical habitat extent), and/or 3) benchmarking via known or established targets. Past benchmarks can either be a fixed point in time or a moving target (e.g., five years prior to most current data). Arguably, whilst using different methods may increase sensitivity of the overall MBI score to different benchmarking approaches and jeopardise inter-comparability between countries, it may also maximise relevance to context-specificities within countries.

1b. Calculate the present status of each biodiversity health objective *Gi* as a ratio of its present and its reference value such that,

$x_i = X_i / X_{i,R}$

where X_i is the present value of biodiversity health objective *Gi* and $X_{i,R}$ is the reference value for the biodiversity health objective *Gi.*

1c. Estimate likely near-future status $\hat{x}_{i,F}$ of each biodiversity health objective *Gi* as a function of

i. its present status value X_i,

ii. its recent trend (over the past ~5 years) normalized to reference value $t_{i,5} = \frac{T_{i,5}}{X_{i,R}}$

iii. its current cumulative pressures P_i,

iv. its resilience (using policy measures as proxy) to negative pressures M_i

v. the corresponding reference value $X_{i,R}$

$$\hat{X}_{i,F} = f(X_i, t_i, P_i, M_i)$$

1d. Lastly, calculate each biodiversity health objective score as a weighted arithmetic mean of present and likely near-future status such that,

$$U_i = U_i(G_i) = \frac{x_i + \hat{x}_{i,F}}{2} = \frac{\frac{X_i}{X_{i,R}} + \frac{f(X_i, t_{i,5}, P_i, M_i)}{X_{i,R}}}{2} \qquad \text{(step 1)}$$

An extra analytical and aggregation step needs to be pursued if a biodiversity health objective *i* is disaggregated on *n* sub objectives.

2. From objectives to dimensions. The second step is to aggregate biodiversity health objectives by dimensions using a weighted geometric mean of normalised scores such that,

$$D_j = \left(\prod_{i=1}^{N_j} \alpha_{ji} \cdot U_{ji}\right)^{\frac{1}{N_j}} \qquad \forall j \in 1, \dots, l \qquad \text{(step 2)}$$

$$\sum_{i=1}^{N_j} \alpha_{ji} = 1 \qquad \forall j \in 1, \dots, l$$

where D_j is a biodiversity dimension j, N_j is the number of goals contained in that biodiversity dimension, l is the number of dimensions, and U_{ji} with α_{ji} are the score and weight of an objective i in dimension j, respectively. By default, $\alpha_{ji} = \frac{1}{N_j}$ for $\forall j \in 1, \dots, l$.

We suggest using a geometric mean as an aggregation method as 1) it reflects the essential and complementary nature of objectives contained in each dimension. Since each objective is indispensable, the dimension score will reflect a critically low value of any of its components in the resulting score and 2) it rewards balance of scores across goals.

3. From dimensions to sub-indices. The third step is to aggregate dimensions using a weighted geometric mean of normalised scores such that,

$$I_k = \left(\prod_{i=1}^{N_k} \beta_{ki} \cdot D_{ki}\right)^{\frac{1}{N_k}} \qquad \forall k \in \{BI, BCPI\} \qquad \text{(step 3)}$$

$$\sum_{i=1}^{N_k} \beta_{ki} = 1 \qquad \forall k \in \{BI, BCPI\}$$

where I_k represents a specific sub-index (BI or BCPI) and its score, N_k is the number of dimensions in sub-index k, and D_{ki} with β_{ki} is the value and weight of a dimension j in sub-index k, respectively.

We argue that a geometric mean to calculate the sub-index score BI is reasonable since we consider all dimensions of the BI as indispensable for biodiversity health (defined as ecological integrity). Also, geometric mean allows for low scores in any dimension to be directly reflected in the score, and it accounts for the potential inflation in *M* and *P* if the same pressures and actions are used to calculate different biodiversity health objectives scores *i.* Arguably, using an arithmetic mean to calculate BCPI scores seems more appropriate to reflect the compensatory nature of the biodiversity health goals of the BCPI framework on underpinning human well-being.

4. From sub-indices to overall MBI score. The *MBI* overall score at country *i* is determined by a weighted geometric mean of the two sub-indices scores, *BI* and *BCPI*, and the appropriate weights for each of those such that:

$$MBI_i = \sqrt{\gamma_1 BI_i \cdot \gamma_2 BCPI_i}, \ where\ \gamma_1 + \gamma_2 = 1$$

It can be seen that the MBI can be easily extended to include (any set of) additional or different sub-indices. Note that the score of the MBI, as well as the scores of its sub-indices and values of all the sub-index dimensions are in the range between 0 and 1, thanks to the normalization of individual goal scores and deployment of the geometric mean concept.

Every unit of assessment within the scope of our analysis (i.e. spatial units within an individual or combinations of ecologically and/or administrative meaningful areas such as ecoregions or administrative areas) must have a value for each data layer included in the assessment. A possible solution to deal with missing data could be to merge different datasets from different parts of a given country or region to create a single ground layer. In general, the goal scores and values of dimensions, sub-indices and MBI itself are calculated at the national level but, where relevant, results can be analysed and spatially referred to subnational and finer scale resolutions. Additionally, the MBI can be desegregated geographically as the calculation of a goal can be done as the average of scores of spatial units of analysis.

The above proposed MBI approach quantifies biodiversity health in its current state and likely near future state based on the best available data (data sources spanning more than a single year). It is intended to provide nations with a summary measure of current and near-term biodiversity health from a coupled perspective to inform biodiversity policy, but not to predict future status at any given time in the future. This is beyond the scope of the approach as it would require modelling socio-ecological systems mechanistically to run predictive scenarios on likely near- and distant-future trends. The MBI will not provide either a cost-benefit analyses of biodiversity policies.

This methodology outlined above must be further defined and assessed for its feasibility. We acknowledge that this approach may result too complicated and difficult to implement and used by individual countries. Hence, a simpler approach to be explored would be, for each biodiversity health objective *Gi*, to calculate the gap between the current status and the ideal status (as a percentage), and consequently average these percentages using a geometric mean following the same four analytical levels of aggregation at outlined above. To follow this approach, it is important that the MBI indicator framework include indicators or metrics for which a numeric target can be identified.

Also, regressions models, given its potential to integrate additional variables to account, for example, for variations between countries, threats and responses, should be explored at different levels of aggregation to calculate MBI scores.

1.11 Socio-economic indices

Human Development

1. Human Development Index (HDI)

1a. Definition

A summary measure on achievements in the living standards of a population as a function of different quality-of-life attributes, such as educational attainment and life expectancy at birth. It focuses on the quality of people's lives – what they succeed in being and doing – as the epicenter of development.

Institution(s):

Human Development Report Office (HDRO) of the United Nations

Platform of dissemination:

UN System's agencies

Relevant website:

http://www.hdr.undp.org/en/home

1b. Justification

Traditional measures of development focus on income, commodities, and wealth, and whilst these are instrumental to attain human development, they are insufficient to capture the multi-faceted aspects of well-being.

There are enormous variations involved in converting income into attained well-being. Differences in needs can be expressed through, for example, household income adjusted by size and age-sex composition of its members, and price indices can be used to correct regional and temporal differences. Nevertheless, income is unable to account for individual differences in morbidity, mortality or disability [91].

Public goods such as environment, infrastructure, electricity, transport or epidemiological protection cannot be capture by household's income.

It was also devised as a simple index to rival the Gross National Product (GNP).

1c. Dimensions

Dimension	Indicator	Dimension Index
Long and healthy life	Life expectancy at birth	Life expectancy index I_{health}
Knowledge	Expected years of schooling Mean years of schooling	Education index $I_{education}$
Decent standard living	(natural log) GNI per capita (PPP $)	GNI index I_{income}

Source: UNDP (2018)

1d. Index structure and Methodology

The HDI is the geometric mean of the tree dimensional indices:

$$HDI = (I_{health} \cdot I_{education} \cdot I_{income})^{1/3}$$

Set minimum and maximum values (goalposts) to transform indicators in different units into indicators between 0 and 1.

Calculate the dimension indices as,

$$Dimension\ index = \frac{actual\ value - minimum\ value}{maximum\ value - minimum\ value}$$

For the knowledge dimension, the dimension index equation is applied to each indicator separately, and then the arithmetic mean of the two resulting indices is taken. Using the arithmetic mean allows perfect substitutability between mean years of schooling and expected years of schooling.

Aggregate the dimensional indices as the geometric mean to produce the HDI.

It uses equal weighting.

1e. Advantages and limitations

Advantages	Limitations
• Simple and easy to calculate and interpret • Flexible framework to adapt to evolving conceptions of well-being and development • The geometric mean used for its calculation accounts for differences in achievements across dimensions. There is no perfect sustainability across dimensions. That is, low achievements in one dimension is not anymore linearly compensated by high achievements in other. The geometric mean reduces the level of substitutability between dimensions and it also ensures that 1% decline in health, education, or income have the same impact on the overall score. • Enables comparability across units of analysis and sub-groups • It can be disaggregated by population subgroups • It can be tailored to context specific conditions by adding new dimensions and indicators, changing indicators-specific weights or values to reflect national priorities • It can also be used for country specific conditions and so, indicators can be adapted. • It shows useful insights for long-term trend analysis	• Too few dimensions • Correlation among indicators • Static indicators: Monitoring in the short run because life expectancy and literacy change slowly. This can be solved by using more dynamic indicators such as % of population with access to health services, employment rate, etc. • Mixing stock and flow indicators • One dimension in the lower end can pull down the index score drastically due to its multiplicative effects.

1f. Impact and Policy use

The HDI has been used since its launch for intercountry comparisons, as a policymaking instrument, and as a reliable platform for public debates on national priorities.

On a snapshot:

- It has guided 20 years of Human Development Reports.
- It has generated the production of more than 600 National Human Development Reports undertaken in different countries and regional focus reports supported by the UNDP and UN system.
- It has promoted the creation of country specific HDI and strengthening the capacity of national statistics offices in developing countries.
- It galvanized the understanding of development and profoundly affected the way policymakers, public officials, the news media, economists, and social scientists conceived societal advancement.
- It has fostered significant academic debate around human development and related topics

Examples of policy use at national, regional and local levels

- Mongolia developed an HDI in 2003 by urban and rural residency, and by provinces and cities. The report's recommendations were incorporated in the Mongolia State Population Development Policy, which led to increased support to regional centres and the promotion of intensive livestock herding [93].
- Argentina created the Extended Human Development Index (EHDI) to inform public policies. The EHDI widened the HDI with dimensions to include infant mortality, unemployment and employment rates and quality of education in order to reveal context specific conditions (OPHI 2011). The EHDI was utilised during the design and implementation of policies and strategies for local development [93].
- Colombia developed a violence adjusted HDI. The index enabled comparison across various sub-national departments. Local authorities in Medellin or Antioquia adopted the recommendations from the analysis for prevention of guerrilla recruitment, mine actions and the strengthening of local institutions.
- Brazil Ministry of Planning's Institute of Applied Economic Research and UNDP developed a Human Development Atlas and database of indicators serving as inputs and complementary information for the Municipal HDI. The index is used as a policy tool to identify areas in need of intervention, identify challenges, and to inform resource allocation (PNUD Brasil and IPEA 2019).
- The Ministry of Planning in Chile reviews the HDI to prioritize and allocate funds.
- Mexico designed an HDI adjusted for inequalities which influences the allocation of public expenditure at the state level – in 2005, the Federal Government allocated special resources to the indigenous municipalities with the lowest HDI, which was extended in 2007 to the 100 municipalities with the lowest HDI. The index is sensitive to inequalities in income, education and health. In later applications, municipal data allowed to decomposition of inequality indices to identify sources and regions contributing to overall HDI inequality. Finally, using projections based on both census and income-expenditure surveys data, the HDI was disaggregated at the household and individual level.

- Egypt ranks governorates by HDI scores and use them to inform decisions on resource allocation.
- India's government uses the HDI and related human development data disaggregated at the state-level to inform planning, budget allocation and policy monitoring. In January 2010, the Maharashtra State Planning Department announced that each county in the district would receive budget allocations based on its HDI.
- Bulgaria municipal-level HDI estimates influence funding allocation by the Ministry of Regional Development.

Examples of policy use at international level

- Inter-country comparisons, and prioritization and allocation of funds of international organizations.
- The HDI has also been used by development agencies and NGOs to inform programming, including by the Australian aid agency AusAID and Oxfam.

2. Social Progress Index (SPI)

2a. Definition

The index captures social progress independent of economic indicators. It measures the capacity of society to meet the basic needs of its citizens, to establish the building blocks to enable a good quality of life, and to create the opportunities to reach their full potential [56]. It is based on a framework that includes multiple dimensions on social and environmental performance of societies. It focuses on outcomes that matter to people's lives.

Institution(s):

Social Progress Imperative

Platform of dissemination:

The Social Progress Network in Action: It is a network of national partners that encourages leaders in governments, business, and civil society to catalyze action.

Relevant website:

https://www.socialprogress.org/

2b. Justification

GDP per capita is an incomplete measure of a country's overall social progress performance. There is a need to integrate social and environmental measurements into assessments of national performance.

2c. Dimensions

Dimension	Component
Basic Needs	Nutrition and basic medical care Water and sanitation Shelter

	Personal safety
Foundations of well-being	Access to basic knowledge Access to information and communication Health and wellness Ecosystem sustainability
Opportunity	Personal rights Personal freedom and choice Tolerance and Inclusion Access to advanced education

** For details on indicators refer to Porter, Stern, and Green (2014)*

2d. Index structure and methodology

The SPI is the arithmetic mean of its three dimensions:

$$SPI\ score = 1/3 \sum_{i} Dimension\ score_{\ d}$$

There are five core steps for calculating the SPI [96]:

1. Address missing values by imputation.

2. Standardize indicators to ensure comparability using the three following steps:

i. Set best- and worst- case scenarios to provide concrete boundaries on both ends of the scale that are based on theoretical or historical values.

ii. Invert indicators when increasing values reflect lower social progress.

iii. Standardize the indicators into z-scores.

3. Use Principal Component Analysis (PCA) to aggregate indicators into a component score.

4. Indicator aggregation into a principal component, where c refers to the SPI component an i to an indicator.

$$Componenet\ value_{\ C} = \sum_{i} w_i *\ indicator_{\ i}$$

Min-max formula to convert the principal component into a component score on a scale of 0 to 100

$$Componenet\ score_{\ C} = \frac{(x_j - Worst\ Case)}{Best\ Case - Worse\ Case} * 100$$

Calculate dimension by averaging components.

Each dimension is the arithmetic mean of its four components

$$Dimension_{\ d} = 1/4 \sum_{i} component\ score_{\ C}$$

5. Calculate overall Social Progress Index by dimensions by averaging dimensions.

The SPI uses PCA at the lowest level of aggregation to assign weights to each indicator to ensure indicators are meaningfully contributing to a component score, while accounting for similarities between them.

Equal weighting is used to aggregate each component into dimension and dimensions into the overall index. This implies that each factor is equally important and assumes perfect substitutability.

2e. Advantages and Limitations

Advantages	Limitations
• Simple and easy to calculate • Allows for intercountry comparability • Focus directly on performance outcomes rather than inputs • It covers a wide range of aspects of social progress • It can be tailored according to national specific contexts • It can be adapted to any geographical scale or sector • It is based on aspects relevant to countries of different development levels • All indicators are influential at the component to the overall index level • The PCA approach results in weights that maximise the representation of the indicators in the components [97]	• Arithmetic average obscures differences and distribution across sub-units • The three dimensions are strongly correlated among each other which may imply potential redundancy of information due to the three dimensions measuring similar concepts. • Highly correlated indicators may provide redundant information • Components may also be redundant [97]

2f. Impact and Policy use

The index provides an overview of a country's social progress performance that informs policies and investments. It has been used by national and local governments as a cross-sectoral coordination tool to promote stakeholder's engagement. Also, some countries have used it to track progress towards the SDGs.

Examples of policy use (from Social Progress Imperative 2018)

- Paraguay's government adopted the SPI as a national planning tool embedded into its National Development Plan 2030. It is used to allocate public and private resources.
- Costa Rica adopted the index as the basis to guide the national social innovation strategy: "Costa Rica Propone." Costa Rica has also created SPI Tourism Destinations that generates valuable insights on the effect of tourism on social and economic progress. The index is also part of the set of tools to measures and report implementation progress towards the SDGs.
- Salta (Argentina) developed a SPI comprising indicators aligned with the SDGs. The index provided guidance to design the provincial government sustainable strategy "Plan Salta 2030". Additionally, the Social Progress Network led by the Secretariat of Planning is conducting a mapping of measurements to monitor progress towards the SDGs.
- Barking and Dagenham London Borough Council (United Kingdom) has adopted the index as a planning tool to ensure no resident is left behind.

- Rio de Janeiro (Brazil) municipal administration's information production and development planning unit created a SPI for Rio in collaboration with public and private stakeholders. The index is used as a decision-making tool for the local government. It also provides information to citizens on the challenges faced by different parts of the city and whether the resources are being allocated adequately.
- In 2014, Coca-Cola and Natura in partnership with Ipsos created a community-level SPI in Brazil (SPI Amazonia). The index development counted with the participation of citizens, civil society, business and the governments and served as the base and guidance for a development program. This resulted in the improvement of intercommunity transportation and water and sanitation infrastructures.

3. OECD Better Life Index (BLI)

3a. Definition

It measures well-being outcomes of OECD countries along with Brazil and the Russian Federation. The index is available as an online interactive tool allowing users to create their index and assign weights to each of the 11 dimensions. It focuses on households and individuals, well-being outcomes as opposed to drivers, distribution of well-being across individuals, and objective and subjective aspects of well-being.

Institution(s)

Organization for Economic Co-operation and Development

Platform of dissemination

OECD's Better Life Initiative: Measuring Well-Being and Progress

Relevant website

http://www.oecdbetterlifeindex.org/

3b. Justification

Insufficiency of GDP to measure adequately well-being since GDP only offers a partial perspective on the factors that matter to people's lives.

"Measuring well-being" is high on the statistical and political agendas at both the national and international level.

3c. Dimensions

	Domain	Dimension	Indicator
Current well-being	Material living conditions	Income and wealth	Household net adjusted disposable income Household net wealth
		Jobs and earnings	Employment rate Long-term unemployment rate

			Average gross annual earnings of full-time employees/ personal earnings Labor market insecurity
		Housing conditions	Number of rooms per person Dwellings without basic facilities Housing expenditure
	Quality of life	Health status	Life expectancy at birth Self-reported health status
		Work-life balance	Employees working very long hours Time devoted to leisure and personal care
		Education and skills	Educational attainment Student's cognitive skills Expected years in education Competences in adult population
		Social connections	Social network support
		Civic engagements and governance	Stakeholder engagement for developing regulations Voter turnout
		Environmental quality	Air pollution Satisfaction with water quality
		Personal security	Homicide rates Self-reported victimization
		Life satisfaction	Life satisfaction

3d. Index structure and Methodology

$$BLI = \sum_{d=1}^{11} w_d * \text{ } dimension \text{ } score \text{ }_d$$

The index is calculated as the weighted average of its eleven dimensions [99] as follows:

Define the minimum and maximum values for each indicator observed in the OECD region.

Normalize each indicator using the min-max formula to scale scores between 0 and 10:

$$indicator \text{ } score = \frac{x_i - min(x)}{max(x) - min(x)} * 10$$

If an indicator reduces well-being outcomes as it intensifies, revert

$$indicator \text{ } score = \frac{max(x) - x_i}{max(x) - min(x)} * 10$$

Calculate a dimension score as the arithmetic mean of the normalised of the indicators that compose it.

Calculate the overall index score by aggregating a weighted average of the dimensions. (Weights are selected by the user).

The developers use an equal weighting at the dimension level whereas unrestricted weighting based on user' decision is used for the overall index calculation.

3e. Advantages and Limitations

Advantages	Limitations
• Simple and easy to communicate • Wide range of dimensions • Robust to the use different weights • Interactive tool available for any type of audience	• Limited scope of analysis. • Arbitrary assumptions for weighting at each aggregation level made according to users' value judgement. • It is not distribution sensitive. • It cannot be compared over time

3f. Impact and Policy use

Since 2011 up to 2019, more than 150,000 users from 180 countries have used the BLI interactive tool and created their own indices. It has engaged the general public and other stakeholders such as governments and academics in debating what aspects of life matter to people and shape the quality of their lives.

4. Genuine Progress Indicator (GPI)

4a. Definition

It is also known as *Index of Sustainable Economic Welfare* (ISEW) and *Sustainable Net Benefit Index* (SNBI) (Lawn and Sanders 1999; Neumayer 2000).

It is used to measure the economic growth of a country as an alternative to the Gross Domestic Product (GDP). The GPI includes the same elements than GDP and adds other elements representing the costs of the negative effects of economic activity (e.g., the cost of crime, cost of ozone depletion and cost of resource depletion).

The GPI considers both (positive and negative) effects of economic growth and can be considered a national-level measure of economic growth and prosperity, and economic growth from the perspective of green or social economics.

It focuses on the welfare and sustainability generated by economic activity (Daily and Cobb 1989). GPI measures how the environmental impact and social costs of economic production and consumption impact overall health and well-being of a country.

Institution(s):

Redefining progress

4b. Justification

An indicator of economic growth should be based on the theories of ecological economics, which perceive the economic market as a component of ecosystems.

4c. Dimensions

Dimension	Impact	Indicator
Economic	+	Personal Consumption Expenditures Value of Consumer Durables
	/	Income Inequality
	-	Cost of Consumer Durables Cost of Underemployment
	+/-	Net Capital Investment
	(PCE/ IDI)*100	Adjusted Personal Consumption
Environmental	-	Cost of Water Pollution Cost of Air Pollution Cost of Noise Pollution Loss of Wetlands Loss of Farmland, Soil Quality or Degradation Loss of Primary Forest and Damage from Logging Roads CO_2 Emissions Cost of Ozone Depletion Depletion of Non-Renewables
Social	+	Value of Housework Parenting Value of Volunteer Work Value of Higher Education Value of Highways and Streets
	-	Cost of Family Changes Cost of Crime Cost of Household Pollution Abatement Loss of Leisure Time Cost of Commuting Cost of Auto Accidents

4d. Index structure and Methodology

$$GPI = A + B - C - D + I$$

A: Income weighted private consumption

B: Value of non-market services generating welfare

C: Private defensive cost of natural deterioration

D: Cost of deterioration of nature and natural resources

I: Increase in capital stock and balance of international trade

GPI is measured as sum of (positive and negative) indicators.

4e. Advantages and Limitations

Advantages	Limitations
• Calculated using simple formula so results that are easy to interpret • It combines factors that can be all interpreted as (positive or negative) costs • Better measure of the sustainability of an economy than GDP as it incorporates the same elements than GDP and accounts for other factors such as pollution. • It attempts to incorporate the final benefits and costs of utilizing nature.	• Unlike GDP that is relatively straightforward to measure, GPI combines things that are according to some economists incommensurable. • Supporters of GDP as a measure of societal well-being claim that competing measures such as GPI are more vulnerable to political manipulation. • It adopts of increasing replacement costs of non-renewable resources and cumulative cost of losses of natural capital since marketplaces do not reflect absolute scarcity. However, this costs very high. • Substitutability between natural and human-made capital

4f. Impact and Policy use

Since 1995, the GPI has increased in acceptance and it is used, among others, in Canada, US and European Union.

5. Index of Human Progress (IHP)

5a. Definition

IHP is a measure of human development based on unadjusted GDP and measurements from 1975 through 1999. It focuses on human development.

Institution(s):

Fraser Institute

Platform of dissemination:

Fraser Institute

Relevant website:

https://www.fraserinstitute.org/sites/default/files/MeasuringDevelopmentIHP.pdf

5b. Justification

It was developed to address two major weaknesses of the Human Development Index (HDI):

i. The arbitrary adjustment of the GDP per capita that limits its impact in the index. This drawback is especially pronounced for countries with high GDP per capita.

ii. Historical trends. HDI can be considered a snapshot of development as it focusses on single year of data.

5c. Dimensions

Dimension	Indicator	Weight
Health	Life Expectancy	0.25
	Infant Mortality (per 1000 live births)	0.25
	Mortality of Children under 5 years (per 1000 live births)	0.25
	Adult Mortality Rate (number of adults, per 1000 adults, not expected to survive to age 60)	0.25
Education	Literacy Rate	0.5
	Combined Enrolment Ratio	0.5
Technology	Number of Televisions (per 1000 persons)	1/3
	Number of Radios (per 1000 persons)	1/3
	Telephone Service (per 1000 persons)	1/3
GDP	GDP per Capita in 1995 US Dollars	1

5d. Index structure and Methodology

$$IHP = \sum_{i=1}^{10} \frac{CountryValue_i - MinValue_i}{MaxValue_i - MinValue_i} \cdot weight_i$$

IHP uses 10 development indicators (HDI uses only 4) and all 4 dimensions are weighted equally.

Some caveats, limitations or assumptions include:

i. Missing indicators. No score is calculated, when data are unavailable for an indicator within a sub-index.

ii. Proximal data. Missing data points can be replaced by data coming from within two years of the indicated year.

iii. Indicators in the Health sub-index. It is not desirable to have high values for three of the indicators in the Health sub-index (mortality rate for infants, high mortality rate for children under five, and rate of people dying before age 60). Values of these indicators are assigned by calculating the general formula and, then, subtracting the obtained result from 100 (I think 100 should be replaced by 1).

5e. Advantages and Limitations

Comparing to the HDI, IHP provides a more complete view of the recent history and current state of development throughout the world.

Using more indicators than HDI allows IHP to draw clearer distinctions among countries. The main limitation is the increased complexity on its calculation given the higher number of indicators.

6. Weighted Index of Social Progress (WISP)

6a. Definition

WISP is a composite index/score of quality of life at the country level. It aimed to better capture the multidimensionality of social progress and quality of life using an exhaustive set of indicators and a flexible formula to measure social progress.

Institution(s):

Management Institute for Quality-of-Life Studies (MIQOLS)

6b. Dimensions

Sub-index	Impact	Indicator
Education	+	Public Expenditures on Education as Percentage of GDP
	+	Primary School Completion Rate
	+	Secondary School Net Enrollment Rate
	+	Adult Literacy Rate
	+	Adult Literacy Rate
Health	+	Life Expectation at Birth
	-	Infant Mortality Rate
	-	Under-Five Child Mortality Rate
	+	Physician Per 100,000 Population
	-	Percent of Population Undernourished
	+	Public Expenditure on Health as Percentage of GDP
Women Status	+	Female Adult Literacy as Percentage of Male Literacy
	+	Contraceptive Prevalence among Married Women
	-	Maternal Mortality Rate
	+	Female Secondary School Enrollment as Percentage of Male Enrollment
	+	Seats in Parliament Held by Women as Percentage of Total
Defense Effort	-	Military Expenditures as Percentage of GDP
Economy	+	Per Capita Gross National Income as Measured by PPP
	+	Percent Growth in GDP
	-	Unemployment Rate
	-	Total External Debt as Percentage of GDP
	-	GINI Index Score
Demography	-	Average Annual Rate of Population Growth
	-	Percent of Population Aged < 15 years
	+	Percent of Population Aged > 64 Years
Environment	+	Percentage of Nationally Protected Area
	-	Average Annual Number of Disaster-Related Death
	-	Per Capita Metric Tons of Carbon-Dioxide Emissions
Social Chaos	-	Violations of Political Rights
	-	Violations of Civil Liberties
	-	Number of Internally Displaced Persons Per 100,000 Population
	-	Number of Externally Displaced Person Per 100,000 Population
	-	Estimated Number of Deaths from Armed Conflicts
	-	Perceived Corruption Index
Cultural Cohesion	+	Largest Percentage of Population Sharing the Same or Similar Racial/Ethnic Origins
	+	Largest Percentage of Population Sharing the Same or Similar Religious Beliefs
	+	Largest Share of Population Sharing the Same Mother Tongue

Welfare Effort	+	Age First National Laws-Old Age, Invalidity & Death
	+	Age First National Laws-Sickness & Maternity
	+	Age First National Laws-Work Injury
	+	Age First National Laws-Unemployment
	+	Age First National Laws-Family Allowance

6c. Index structure and Methodology

For the 2018 WISP scores, the sub-indices were grouped into 4 factors and calculated as follows:

$$WISP = 0.456 \times F_1 + 0.169 \times F_2 + 0.128 \times F_3 + 0.245 \times F_4 + 50$$

Factor 1: Adequacy of Social Provision

$$F1 = 0.9 \times S_1 + 0.9 \times S_2 + 0.89 \times S_3 + 0.73 \times S_4 + 0.55 \times S_5$$

S_1: Health Status
S_2: Women Status
S_3: Demography
S_4: Education
S_5: Welfare Effort

Factor 2: National Environment and Diversity Resources

$$F_2 = -0.84 * S_6 + 0.81 * S_7$$

S_6: Environmental
S_7: Cultural Diversity

Factor 3: Defense and Military Expenditures

$$F_3 = 0.97 * S_8$$

S_8: Defense Effort

Factor 4: Economic Resources and Stress

$$F_4 = 0.92 \times S_9 + 0.75 \times S_{10}$$

S_9: Social Chaos
S_{10}: Economy

The sub-index weights are the product of the factor weights and the individual sub-index weights. For example, the health status weight is calculated from the product of the factor 1 weight and the health status sub-index weight. When new weights are selected, the values are scaled based on the ratio of the sum of the original WISP weights and the new weights so that the WISP values remain comparable in magnitude. For more information refer to Estes (2010).

6d. Advantages and Limitations

Advantages	Limitations
• Flexible indicator as its formula can be possibly adjusted from year to year. • Takes into account a comprehensive set of factors. • Simple to calculate as its formula contains only addition and multiplication.	• Not necessarily comparable across the time as its formula may be different in different years. • In given year, the formula is constant for all the countries, which may be eventually unfair. • Challenging to assign appropriate weights to large number of indicators.

	• Its value may be difficult to interpret as its formula combines factors that are not necessarily commensurable.

7. Human Opportunity Index (HOI)

7a. Definition

HOI was proposed by Barros et al. (2008) as an adaptation of the welfare function suggested by Amartya Sen (1976). It follows the same logic as GDP per capita and inequality indicators in Sen's welfare function. It measures:

i. How individual circumstances (e.g., place of residence, gender, and education of the household head), that should not determine access to basic goods and services, can affect a child's access to basic opportunities such as water, education, electricity, Internet and sanitation.

ii. How equitably children, age 16 and under, have access to opportunities needed for a productive life.

It is a synthetic economic indicator that combines coverage rates and equality in a single measure, and it focuses on; distance of a society from universal access to essential goods and services; and equality of the distribution of this access across individuals (circumstance groups). An increase in the index can be associated with either an increase in coverage or with a more equitable opportunities distribution.

Institution(s):

World Bank

Relevant website:

http://documents.worldbank.org/curated/en/482361468224408372/pdf/656560PUB0EPI2065717B09780821386996.pdf

https://www.worldbank.org/en/topic/poverty/lac-equity-lab1/equality-of-opportunities/hoi

http://www1.worldbank.org/poverty/visualizeinequality/Files/Documentation/HOI-Methodology.pdf

http://documents.worldbank.org/curated/en/338181468074334140/Human-Opportunity-Index-HOI-national-equality-of-childrens-opportunities-in-Pakistan

https://www.worldbank.org/en/news/infographic/2016/10/24/infografia-indice-de-oportunidades-humanas

7b. Justification

It was developed to account for the average coverage of given opportunities and the inequality of their distribution when assessing human access to opportunities.

7c. Dimensions

Dimension	Indicator	Age
Education	Finished sixth grade on time	12 – 16
	School enrollment	10 – 14
Housing	Water access	0 – 16
	Electricity access	0 – 16
	Sanitation access	0 – 16
Information and Communication Technologies	Internet access	0 – 16

7d. Index structure and Methodology

$$HOI = (1 - D) \times C$$

C: Overall coverage of opportunity

$(1 - D)$: Coverage inequality

Overall coverage:

Coverage of a particular opportunity can be measured by the percentage of the population that has access to it.

Coverage inequality:

$$D = \frac{1}{2C} \sum_{k=1}^{m} \alpha_k |C - C_k|$$

m: Number of circumstance groups

α_k: Share of group k in total population

C_k: Coverage of the circumstance group k

Inequalities in opportunity access are averaged and then used to penalize the overall coverage rate.

Examples:

If all possible groups have the same opportunity access, this penalization is zero.

If one group has full access while another has null access, the penalization reduces the HOI.

The change in the HOI between two selected years can be decomposed into:

Composition effect: Changes in the distribution of circumstances.

Coverage effect: Changes in the coverage rates of different circumstance groups.

Scale effect: Proportional changes of all circumstance groups.

Equalization effect: Positive changes of groups with below-average coverage rates compensated by negative changes of groups with above-average coverage rates.

The nearest year is used for countries with unavailable data for a particular year and the index uses equal weighting for all its components.

7e. Advantages and Limitations

Advantages	Limitations
• Easy to calculate • Takes into consideration both the ratio of a population having access to particular opportunities, and the distribution of this access among different subgroups of this population.	• Multiplying coverage with its distribution can make the resulting value difficult to interpret, which can have consequences on its usage and uptake by policy makers and to support comparative studies.

8. Indices of Social Development (ISD)

8a. Definition

ISD are a set of measures to track how different societies perform along six dimensions of social development. The indices are available for 193 countries, over the period from 1990 to 2010, and are updated as new data becomes available. ISD estimates the effects of social development on indicators like economic growth, human development, and governance.

Institution(s):

International Institute of Social Studies (ISS)

Platform of dissemination:

International Institute of Social Studies (ISS)

Relevant website:

http://www.indsocdev.org/

8b. Dimensions

Dimension	Description
Civic Activism	Use of media and protest behavior
Clubs and Associations	Membership in local voluntary associations
Intergroup Cohesion	Ethnic and sectarian tensions, and discrimination
Interpersonal Safety and Trust	Perceptions and incidences of crime and personal transgressions
Gender Equality	Gender discrimination in home, work and public life
Inclusion of Minorities	Levels of discrimination against vulnerable groups such as indigenous peoples, migrants, refugees, or lower caste groups

ISD synthetizes/brings together 200 indicators

8c. Index structure and Methodology

The index is calculated as the weighted arithmetic mean of its dimensions and are aggregated using the ‘matching percentiles’ method, which is based on:

i. Arrange indicators (with values between 0 and 1) from the most to least reliable and representative.

ii. Match scores from the second to the first indicator based on ranking of shared countries; these are combined with the first indicator to produced refined scores.

iii. Repeat through all indicators, reducing random error with each iteration to arrive at a final score

Indicators are weighted by incremental contribution to changes in scores.

For more information refer to De Haan et al. (2011).

8d. Advantages and Limitations

Advantages	Limitations
• Enable to monitor social development over time • Enable to measure invisible dimensions of development at the meso and macro level: Levels of social cohesion/capital, degree of discrimination, extent of social exclusion, governance. • Suitable as a variable in macro level policy evaluation	• Not applicable under national level scales. • Does not distinguish between social development changes arising from aid and other external factors

Happiness

9. Gross National Happiness (GNH)

9a. Definition

It measures collective happiness and well-being within a population.

Institution(s):

Kingdom of Bhutan

Platform of dissemination:

The Government of Bhutan’s Centre for Bhutan Studies

Centre for Bhutan & GNH Studies

Relevant website:

https://ophi.org.uk/policy/national-policy/gross-national-happiness-index/

https://www.grossnationalhappiness.com/

9b. Dimensions

It is composed by 4 pillars: 1) Sustainable and equitable socio-economic development, 2) Environmental conservation, 3) Preservation and promotion of culture and 4) Good governance and 9 domains which are: Psychological well-being; Health; Time use; Education

Cultural diversity and resilience; Good governance; Community vitality; Ecological diversity and resilience; Living standards.

Each domain is composed of subjective (survey-based) and objective indicators. The domains are adjusted based on a person's GDP. For example, one person whose working conditions are not favorable but who has enough time to spend quality time with friends and family may have a higher score than a one person whose life is consumed with work having barely any time to spend with friends and family.

9c. Index structure and Methodology

The index follows the dual-identification and aggregation steps of the Alkire-Foster method. GNH is calculated using 33 indicators categorized under nine domains.

Within each domain, two to four indicators are selected that seem likely to remain informative across time, have high response rates, and are relatively uncorrelated.

The 2011 GNH index, for example, identifies four groups of people. Groups identified as ‘extensively’ or ‘deeply’ happy must reach sufficient achievements in 66% of the weighted indicators, whichever domains they come from.

Domains are weighted equally but the indicators within each domain differ by weight.

Within each domain, the objective indicators are given higher weights while the subjective and self-reported indicators are assigned lower weights.

For more information refer to Dasho, Alkire and Zangmo 2012

9d. Advantages and Limitations

Advantages	Limitations
• GNH is specifically focused on happiness, a concept that is not necessarily captured by most of the indicators measuring economic output or growth. • It takes into account a large number of factors impacting human well-being. • Calculation of GNH allows 2 different countries to achieve the same result despite having very different values in particular domains.	• Happiness is a subjective phenomenon difficult to cover by unique definitions as its meaning may be different in different contexts and societies. • Even within a single society the definition of happiness may vary significantly, and therefore, ranking countries/regions based on this index may not necessarily provide a meaningful result.

9e. Impact and Policy use

Besides the policy impact within Bhutan, the index has inspired efforts to develop and use measures of happiness around the world, including promotion through high level events organized by the United Nations.

The GNH index supports policymaking within Bhutan. Policy tools are used to review the potential effects of proposed policies on GNH and the results of the GNH index will be tracked over time to evaluate interventions. This ‘GNH Policy Lens’ requires that the policy consequences on all relevant dimensions be considered prior to implementation. In addition, project screening tools are to be implemented in nearly twenty project areas, including agriculture, forestry, trade and manufacturing, media and information, youths, as well as projects that focus on each of the nine dimensions. The stated goal is that all government projects and policies work together to maximize GNH.

10. World Happiness Report Ranking of Happiness (WHRRH)

10a. Definition

WHRRH is an annual landmark survey/publication of the state of global happiness that ranks 156 countries by how happy their citizens perceive themselves to be.

The World Happiness Report contains articles and rankings of national happiness based on respondent ratings of their own lives. Each report includes updated evaluations and a range of commissioned chapters on special topics digging deeper into the science of well-being and happiness in specific countries and regions. Its focus is on measuring the level of happiness not by indirect indicators but by how it is perceived by people themselves.

Institution(s):

UN Sustainable Development Solutions Network in partnership with the Ernesto Illy Foundation

Platform of dissemination:

UN Sustainable Development Solutions Network

Relevant website:

https://worldhappiness.report/

http://unsdsn.org/happiness/

10b. Dimensions

The index is composed of 1 dimension (Happiness) and 6 indicators on Log GDP per capita;

Social support; Healthy life expectancy; Freedom to make life choices; Generosity; and Perceptions of corruption

10c. Index structure and Methodology

The rankings of national happiness are based on the *Cantril ladder survey* according to which nationally representative samples of respondents are asked to think of a ladder and the best possible life for them being a 10, and the worst possible life being a 0. They are then asked to rate their own current lives on that 0 to 10 scale and the results are correlated with various life factors. The coefficients are used to calculate how much better life is for having a higher value of each variable, than a fictional country which has the world’s lowest national average values of each of the variables.

In the reports, experts in economics, psychology, survey analysis, and national statistics, describe how measurements of well-being can be used effectively to assess the progress of nations. Each report is organized by chapters that delve deeper into issues related to happiness, including mental illness, the objective benefits of happiness, the importance of ethics, policy implications, the OECD approach to measuring subjective well-being and other international and national efforts.

Weights are given by the relative coefficients from regressing happiness scores on each of the 6 indicator variables.

10d. Advantages and Limitations

Advantages	Limitations
• WHRRH assesses happiness level through people's perception instead of using indirect indicators. • The ranking construction is simple as WHRRH uses limited number of indicators and does not use any complex function.	• Being questioned about overall life status may lead humans to overweight income concerns. • Ranking results may be counterintuitive in some dimensions. For example, if suicide rate was used as a metric to measure unhappiness, then some of the countries which are ranked among the happiest in the world would also feature among the unhappiest. • Based on a limited set of indicators. • Does not use an Index function. • Happiness surveys may lead to contradictory results because of discrepancies in adopted methodologies. • Surveys may be inherently flawed. • From a philosophical perspective, measuring happiness of a group or nation may be misleading as happiness is an individual matter. For Dalai Lama, Gandhi, Tolstoy, etc., happiness is an individual choice that is independent of the society, its structures and enabling conditions (i.e. one cannot really talk of a happy or unhappy nation but only of happy or unhappy individuals).

10e. Impact and Policy Use

The index released attracts considerable press and media attention. It is used to examine country rankings of life evaluations and tracing the evolution since 2005 of life evaluations. It can be used to link average national happiness to government quality.

Poverty

11. Global Hunger Index (GHI)

11a. Definition

GHI measures and tracks hunger globally, by region, and by country. It is a multidimensional measure assigning a numerical score based on several determining factors for hunger. It allows to rank countries by score and compare current scores with past results. It is calculated annually, and its results appear in the GHI report issued each year. Besides presenting GHI scores, each year the GHI report includes an essay addressing one particular aspect of hunger.

Institution(s):

International Food Policy Research Institute

Welthungerhilfe

Concern Worldwide

Platform of dissemination:

Compact2025

Relevant website:

https://www.globalhungerindex.org/

http://www.ifpri.org/book-8018/ourwork/researcharea/global-hunger-index

11b. Dimensions

Component/Indicator	Data Source	Note
Proportion of the undernourished as a percentage of the population	Food and Agriculture Organization of the UN (FAO)	Data include authors' estimates
Proportion of children under the age of 5 suffering from wasting, a sign of acute undernutrition	UNICEF, WHO, World Bank, MEASURE DHS, Indian Ministry of Women and Child Development	Data include authors' estimates
Proportion of children under the age of 5 suffering from stunting, a sign of chronic undernutrition	UNICEF, WHO, World Bank, MEASURE DHS, Indian Ministry of Women and Child Development	Data include authors' estimates
Mortality rate of children under the age of 5	UN Inter-agency Group for Child Mortality Estimation	

The data and projections used for the 2019 GHI are from the period from 2014 to 2018—the most recent available data for the GHI components.

11c. Index structure and Methodology

$$GHI = \frac{1}{3}\ Standarized\ undernourished\ pop. + \frac{1}{6} Standarized\ wasting\ in\ children + \frac{1}{6} Standarized\ stunting\ in\ children + \frac{1}{3}\ Standarized\ child\ mortality$$

GHI ranks countries on a 100-point scale, with 0 being the best score (no hunger) and 100 being the worst, although neither of these extremes is reached in practice.

Standardized scores are aggregated to calculate the GHI score per country, with each of the three dimensions (inadequate food supply; child mortality; and child undernutrition) given equal weight.

For further details on methodology: https://www.globalhungerindex.org/pdf/en/2019/appendix-a.pdf

11d. Advantages and Limitations

Advantages	Limitations
• Allows to compare countries and track a change of a hunger across the time. • Based on globally available and annually published data sources. • Transparent clearly interpretable results.	• Combines multiple dimensions into a single score, which can make difficult to identify the exact impacts of implemented policies. • It is not comparable across time

11e. Impact and Policy use

It encourages governments to design and implement context-specific adaptation strategies that will strengthen food and nutrition security and food sovereignty, to help prepare and respond stakeholders to disasters, especially in the new context of climate change. Additionally, it can also serve to allocate resources to the portion of the population that needs the most. The index can also serve to track progress towards SDG2.

IFPRI is one of the partners in Compact2025, a partnership that develops and disseminates evidence-based advice to politicians and other decision-makers aiming at ending hunger and undernutrition.

12. Hunger and Commitment Index (HANCI), 2012

12a. Definition

HANCI measures political commitment to reduce hunger and undernutrition. It allows ranking and comparing government performance in 45 developing countries and it was created to provide greater transparency and public accountability by measuring what actions governments take, and what they fail to do, in addressing hunger and undernutrition. Addressing hunger is ultimately a matter of political priorities and at the global level, there is no independent body, which audits the implementation of these commitments. Measuring commitment may help to scale up efforts and to promote uptake of necessary measures.

Institution(s):

Institute of Development Studies

Irish Aid

Platform of dissemination:

Institute of Development Studies

Relevant website:

http://www.hancindex.org/

https://www.ids.ac.uk/projects/hunger-and-nutrition-commitment-index-hanci/

http://www.fao.org/fileadmin/templates/ess/global_strategy/PPTs/NM_PPTs/EM4-6_Dolf_te_Lintelo_IDS-FAO_metrics_workshop.pdf

https://www.ids.ac.uk/files/dmfile/HANCI_2012_reportv2.pdf

https://reliefweb.int/sites/reliefweb.int/files/resources/ER78%20HANCI.pdf

12b. Dimensions

Dimension	Number of indicators	Themes
Hunger Reduction	10	Legal frameworks Policies and programmes Public expenditures Government functioning
Undernutrition Reduction	12	Legal frameworks Policies and programmes Public expenditures Government functioning

HANCI is based on 22 indicators of political commitment. In both dimensions (the indicators are grouped under four themes:

i. **Legal frameworks** (level of constitutional protection of the right to food)

ii. Policies and programmes (extent to which nutrition features in national development policies/ strategies)

iii. Public expenditures (percentage of government budgets spent on agriculture)

iv. Government functioning

12c. Index structure and Methodology

i) The Index is calculated following four steps:
ii) Normalize indicators into 0-1 scale using the min-max formula.
iii) Aggregate indicators into 2 dimensions containing each 3-dimension sub-indices using an arithmetic mean.
iv) Calculate the overall index using the Borda Rank.

12d. Advantages and Limitations

Advantages	Limitations
• Make meaningful comparisons. • Draw conclusions assessing implemented policies. • Support government initiatives.	• HANCI takes into account huge number of indicators that can make its calculation complex and its results hard to interpret.

• Compare levels of commitments and performance.	

12e. Impact and Policy Use

The index has received significant media attention. The HANCI project works with civil society partners in 5 countries (Bangladesh, Malawi, Tanzania, Nepal and Zambia) to support advocacy efforts, improve government action and provide a voice for those communities directly affected by hunger and undernutrition. For details, visit the following link: http://www.hancindex.org/the-index-in-action/community-voices/

Vulnerability

13. World Risk Index

13a. Definition

WRI measures the exposure to natural hazards and assesses the inherent vulnerability of countries to suffer the impacts when facing these hazards. It is a product of close cooperation between scientists and practitioners developed by Birkmann and Welle for the Bündnis Entwicklung Hilft (The Alliance Development Works). It focuses on exposure to natural hazards and vulnerability to suffer the impacts when facing them and prioritizes hazards that are widely spread around the globe and account for major harm in terms of fatalities, which are floods, storms, earthquakes, droughts and sea level rise. These hazards accounted for 81% of all events and 83% of all reported fatalities in the period from 1980 to 2010 (CRED EM-DAT 2012).

Additionally, 13% of current world population is living in coastal areas that are less than 10m above sea level (UNHABITAT 2011) which may be affected due to climate change and sea level rise.

Institution(s):

Bündnis Entwicklung Hilft (The Alliance Development Works)

UNU-EHS

Relevant website:

https://www.researchgate.net/publication/283087679_The_World_Risk_Index_-_An_Approach_to_Assess_Risk_and_Vulnerability_on_a_Global_Scale

https://en.wikipedia.org/wiki/List_of_countries_by_natural_disaster_risk

https://www.ireus.uni-stuttgart.de/en/institute/world_risk_index/

http://www.irdrinternational.org/2016/03/01/word-risk-index/

http://www.uni-stuttgart.de/ireus/Internationales/WorldRiskIndex/

13b. Dimensions

Dimensions
Exposure E
Susceptibility S
Lack of Coping Capacity $LoCC$
Lack of Adaptive Capacity $LoAC$

13c. Index structure and Methodology

$$WorldRiskIndex = E \times (1/3) \times (S + LoCC + LoAC)$$

$$E = \frac{A + B + C + (0.5 \times D + E)}{population\ number}$$

$$S = (2/7) \times \big(0.5 \times (A + B)\big) + (1/7) \times C + (2/7) \times \big(0.5 \times (D + E)\big) + (2/7) \times \big(0.5 \times (F + G)\big)$$

$$LoCC = 1 - \Big(0.45 \times \big(0.5 \times (A + B)\big)\Big) - \Big(0.45 \times \big(0.5 \times (C + D)\big)\Big) - (0.1 \times E)$$

$$LoAC = 1 - \Big(0.25 \times \big(0.5 \times (A + B)\big)\Big) - \Big(0.25 \times \big(0.5 \times (C + D)\big)\Big) - \Big(0.25 \times \big(0.25 \times (E + F + G + H)\big)\Big) - \Big(0.25 \times \big((1/3) \times (I + J + K)\big)\Big)$$

13d. Advantages and Limitations

Advantages	Limitations
• WRI takes into account natural hazards accounting for most of the natural risk-related events and fatalities.	• The WRI formula combines together diverse phenomena (exposure, susceptibility, lack of coping capacity and lack of adaptive capacity) that are not necessarily commensurable, and hence, can make its resulting value hard to interpret.

14. Global Food Security Index (GFSI), 2012

14a. Definition

GFSI measures vulnerability to food insecurity and risks associated to this vulnerability. It provides a comprehensive assessment of the state of food security, including the food safety index, through a quantitative and qualitative benchmarking model that measures drivers across 113 developing and developed countries. GFSI can be interpreted as a food security environment rating that looks to the underlying factors affecting food insecurity beyond hunger.

It includes an adjustment factor on natural resources and resilience that helps to assess a country's exposure to the impacts of climate change, susceptibility to natural risks and adaptation to these risks. It focuses on food security determinants (food supply, food share in total expenditure, poverty, nutritional policies, access to financial services, corruption, political stability) rather than on food security outcomes. GFSI was designed to serve as scientific evidence and guidance for investors to direct investments towards food safety systems.

Institution(s):

The Economist's intelligence unit

Corteva Agriscience, the Agriculture Division of DowDuPont

Platform of dissemination:

Economist Intelligence Unit

Relevant website:

https://foodsecurityindex.eiu.com/

https://www.agrilinks.org/post/food-quality-and-safety-global-food-security-index-0

https://ec.europa.eu/jrc/en/publication/use-global-food-security-index-inform-situation-food-insecure-countries

14b. Dimensions

GFSI is constructed using 26 indicators and it examines food security across 4 internationally established dimensions.

Dimension	Indicator
Affordability	Food consumption as a share of household expenditure Proportion of population under the global poverty line Gross domestic product per capita Agricultural import tariffs Presence of food safety-net programs Access to financing for farmers
Availability	Sufficiency of supply Public expenditure on agricultural R&D Agricultural infrastructure Volatility of agricultural production Political stability risk Corruption Urban absorption capacity Food loss
Quality & Safety	Diet diversification Nutritional standards (national dietary guidelines, national nutrition plan or strategy, and nutrition monitoring and surveillance) Micronutrient availability (dietary availability of vitamin A, dietary availability of animal iron and dietary availability of vegetal iron) Protein quality Food safety (agency to ensure the safety and health of food, percentage of population with access to potable water and presence of formal grocery sector)
Natural Resources & Resilience	Exposure Water Land

	Oceans Sensitivity Adaptive capacity Demographic stress

The parameters that it uses are:

- Nutritional standards
- Urban absorption capacity
- Food consumption as a share of household expenditure
- Food loss
- Protein quality
- Agricultural import tariffs
- Diet diversification
- Agricultural infrastructure
- Volatility of agricultural production
- Proportion of population under global poverty line
- Gross domestic product per capita (US$ PPP)
- Presence of food safety net programmes
- Access to financing for farmers
- Public expenditure on agricultural R&D
- Corruption
- Political stability risk
- Sufficiency of supply
- Food safety

14c. Index structure and Methodology

The index is calculated as the arithmetic mean of dimensional sub-indices as follows:

i. Select indicators (by experts)

ii. Normalize indicators to a 0-1 scale using min-max formula

iii. Aggregate using the weighted arithmetic mean into dimensional sub-indices.

iv. Rescale dimension's score to a arrange of 0-100.

v. Calculate overall score using arithmetic mean.

Weightings are based on the opinion of a panel of experts

14d. Advantages and Limitations

Advantages	Limitations
• GFSI exhibits important statistical properties. It is statistically coherent and robust to changes in the weight and aggregation methods.	• In order to assess food security and nutrition situation in food insecure countries it is recommended to use the GFSI with other indicators, namely those measuring outcomes of food security in

• Data coverage is comprehensive and the effect of outliers on the final score is not significant. • GFSI provides a worldwide perspective and is based on data from reliable international organizations including WHO, FAO, UND, WTO, OECD, World Resources Institute and the World Bank.	terms of food consumption and nutritional status of the population.

14e. Impact and Policy use

The index has relevant press coverage and it is covered in the Global Food Security Index report

15. Economic Vulnerability Index (EVI)

15a. Definition

EVI measures the economic vulnerability of low-income countries with population smaller than 75 million inhabitants. It serves as one of 3 criteria to identify the least developed countries (LDCs) that are allowed to receive some preferential treatment in aid and trade matters. It was developed to identify and rank developing countries that need preferential international aid, in addition to traditional measures of economic performance and growth.

Institution(s):

UN Committee for Development Planning, an advisory body of UN Economic and Social Council

Platform of dissemination:

UN Committee for Development Planning

Relevant website:

https://www.un.org/development/desa/dpad/least-developed-country-category/evi-indicators-ldc.html

https://www.wider.unu.edu/publication/economic-vulnerability-index

https://ferdi.fr/en/indicators/a-retrospective-economic-vulnerability-index

15b. Dimensions

Component
Population size
Remoteness
Merchandise export concentration
Share of agriculture, forestry and fisheries in gross domestic product
Homelessness owing to natural disasters
Instability of agricultural production
Instability of exports of goods and services
The share of population living in low elevated coastal zone

15c. Index structure and Methodology

The index is calculated as a weighted arithmetic mean of its dimensions.

15d. Advantages and Limitations

Advantages	Limitations
• EVI measures a phenomenon omitted by indicators evaluating economic performance and growth.	• EVI combines a large number of potentially incommensurable indices, which may render its value hard to interpret. • It is recommended to combine EVI with other economic indicators in order to provide meaningful information.

15e. Impact and Policy Use

The UN Committee for Development Planning uses the index as one criterion to classify Least Developed Countries.

Gender Inequality

16. Gender Inequality Index (GII)

16a. Definition

GII is a composite index introduced in 2010 that measures the human development costs of gender inequality. The higher the GII value the more disparities between females and males; the lower the GII value the lower the risks for that country's development potential arising from gender inequality. GII shows the percentage of potential human development loss due to gender inequality and ranges from 0 (no lost opportunity) to 1 (complete opportunity loss).

It is built on the same framework as the IHDI—to better expose differences in the distribution of achievements between women and men. As there is no country with perfect gender equality, all countries suffer some loss of human development due to gender inequality. There is a correlation between GII ranks and human development distribution. According to the UNDP, countries that exhibit high gender inequality also show inequality in distribution of development, and vice versa. It was developed to address the issue that gender inequality remains a major barrier to human development. Often women and girls are discriminated in areas such as health, education, political representation and labor market, which has negative consequences for development of their capabilities and their freedom of choice.

Institution(s):

UN Development Programme

Platform of dissemination:

Human Development Report Office of the UNDP

Relevant website:

http://hdr.undp.org/en/composite/GII

16b. Dimensions

GII measures gender inequalities in three aspects of human development:

Dimension	Indicator
Reproductive health	Maternal mortality ratio
	Adolescent birth rates
Empowerment	Parliamentary seats occupied by females
	Proportion of adult females and males aged 25+ years with at least some secondary education
Economic status	Labour force participation rate of female and male populations aged 15+ years.

16c. Index structure and Methodology

The index is calculated as the unweighted harmonic mean across genders. The GII calculation method is unconnected with absolute development achievement as it only assesses a country's current gender achievement and distance from the baseline of equality.

The GII measures inequalities using multiple correspondence analysis (MCA) to avoid aggregation problems. The analytical steps to calculate GII scores are as follows:

i. Treat extreme values by truncating at minimum and maximum.

ii. Aggregate across dimensions within each gender group, using geometric mean.

iii. Aggregate obtained geometric means across gender groups, using a harmonic mean to capture the inequality between females and males.

iv. Calculate the geometric mean of the arithmetic means for each indicator to obtain the reference standard, aggregate female and male indices using equal weights, and then aggregate them across dimensions. Reproductive health is not aggregated as average of female and male indices but as a half the distance from the norms established.

v. Calculate the Gender Inequality Index by comparing the equally distributed gender index from Step 3 to the reference standard from Step 4.

Equal weights are assigned to males' and females' indices.

16d. Advantages and Limitations

Advantages	Limitations
• GII is association-sensitive and responsive to distributional changes across dimension. • Its components highlight areas in need of policy intervention. • GII yields insights into gender gaps in major areas of human development and it stimulates proactive thinking and public policy to overcome systematic disadvantages of women.	• GII may inadequately capture gender inequality by leaving out important aspects or including unnecessary dimensions. • Complex indicator (various non-linear procedures are applied to the data that can make GII difficult to interpret or understand). • GII is meant to represent a loss of human development, but the standard against which the losses are measured is not formally stated. The UNDP claims that the complexity of the calculation is needed in order to maintain the association-sensitivity, however, alternative indices that are much less complex have also shown to be association sensitive. • Mix of indices • GII combines potentially incommensurable factors (e.g. well-being and empowerment) in ways that negatively impact its complexity and transparency, and it suffers from the problem of using an arithmetic mean of ratios. • GII combines absolute and relative indicators within the same formula. For example, the MMR is considered unequal if it is higher than 0.0001, however, parliamentary representation is considered unequal only if there is a deviation higher than 50 percent. • Regional relevance • GII uses the same set of indicators across all regions • For less-developed countries the use of the MMR and AFR in the dimension of reproductive health may be penalizing, although, the loss may not be entirely explained by gender inequality. • Less-developed countries' performance in the reproductive health dimension may differ regionally and/or locally. Access to or use of health services can be influenced by socioeconomic levels, public health policies, or social and cultural practices. • In developed countries, specifically European countries, gender inequality levels are not very robust to alternative specifications of gender-related indicators. Therefore, analysts and policy makers may choose specific methods to yield desired results. • Choice of variables • GII does not capture the informal work and unpaid domestic or care work where women are primarily over-represented.

	• In many underdeveloped societies women spend the majority of their time in domestic work whereas men spend far less, if any.

17. Global Gender Gap Index (GGGI)

17a. Definition

GGGI is a measure of gender gap. It was designed to measure gender-based gaps in access to resources and opportunities rather than the actual levels of the available resources and opportunities. It measures women's disadvantage compared to men instead of the gender gap equality. GGGI assesses countries on how well they are dividing their resources and opportunities among their male and female populations, regardless of the overall levels of these resources and opportunities.

The GGGI Report addresses a need for comprehensible framework for assessing and comparing global gender gaps. By revealing the countries that may serve as role models in dividing the resources equitably between women and men, the GGGI Report serves as a catalyst for greater awareness as well as greater exchange between policymakers.

Institution(s):

World Economic Forum

Platform of dissemination:

World Economic Forum

Relevant website:

http://www3.weforum.org/docs/WEF_GGGR_2018.pdf

https://tcdata360.worldbank.org/indicators/af52ebe9?country=BRA&indicator=27959&viz=line_chart&years=2006,2018

https://www.wherewomenwork.com/Career/640/Global-Gender-Gap-WorldEconomicForum

https://www.imf.org/external/pubs/ft/fandd/2019/03/global-gender-gap-report-infographic-wef-picture.htm

17b. Dimensions

GGGI ranks countries according to the gender gap between women and men in four key areas to gauge the state of gender equality in a country:

i. Economic participation and opportunity (salaries, participation levels and access to high-skilled employment).

ii. Educational attainment (access to basic and higher-level education)

iii. Political empowerment (representation in decision-making structures)

iv. Health and survival (life expectancy and sex ratio). In this case parity is not assumed, there are assumed to be fewer female births than male (944 female for every 1,000 males), and men are assumed to die younger. Provided that women live at least six percent longer than men, parity is assumed. But if it is less than six percent it counts as a gender gap.

Thirteen out of the fourteen variables used to create the index are from publicly available "hard data" indicators from international organizations, such as the International Labour Organization, UNDP, and WHO.

Dimension	Variable	Limit	Weight	Max Value
Economic participation and opportunity	Labour force participation	1.0	0.199	0.199
	Wage equality for similar work	1.0	0.310	0.310
	Estimated earned income	1.0	0.221	0.221
	Legislators, senior officials and managers	1.0	0.149	0.149
	Professional and technical workers	1.0	0.121	0.121
Educational attainment	Literacy rate	1.0	0.191	0.191
	Enrolment in primary education	1.0	0.459	0.459
	Enrolment in secondary education	1.0	0.229	0.229
	Enrolment in tertiary education	1.0	0.121	0.121
Health and survival	Sex ratio at birth	0.944	0.693	0.654
	Healthy life expectancy	1.060	0.307	0.345
Political empowerment	Women in parliament	1.0	0.310	0.310
	Women in ministerial positions	1.0	0.247	0.247
	Years with female head of state	1.0	0.443	0.443

18c. Index structure and Methodology

The index is calculated as the arithmetic mean of its four dimensions as follows:

i. Express indicators as female to male ratios.

ii. Truncate the ratios to the “equality benchmark”. 1 score is given to a country that achieved equality between genders.

iii. Normalize ratios by equalizing their standard deviations.

iv. Aggregate the ratios into dimensional sub-indices using arithmetic mean

v. Calculate the index as the arithmetic mean of the dimensions scores.

18. Women's Economic Opportunity Index (WEO)

18a. Definition

WEO measures the enabling environment for women's economic participation in 128 countries.

It uses a quantitative and qualitative scoring model measuring specific attributes of the environment related to women employees and entrepreneurs. Conventional economic indices do not capture the phenomena as women's participation. Hence, the WEO index was developed to meet that need.

Institution(s):

Economist Intelligence Unit

Platform of dissemination:

Economist Intelligence Unit

18b. Dimensions

WEO is based on 29 indicators that measure country's laws, regulations, practices, customs and attitudes that allow women to participate in the workforce under conditions roughly equal to those of men, whether as wage-earning employees or as owners of a business.

Category	Sub-Category
Labour policy and practice	Labour policy
	Labour practice
Access to finance	
Education and training	
Women's legal and social status	
General business environment	

18c. Index structure and Methodology

The index is calculated as the arithmetic mean of its dimensions.

Each category or sub-category features several underlying indicators. Category scores are calculated as the arithmetic mean of underlying indicators and rescaled to 0-100, where 100 = most favorable. The overall score (0-100) is then calculated as an average of the unweighted category scores.

Sustainable Development

19. Sustainable Development Goals Index and Dashboards (SDG Index)

19a. Definition

The index assesses the performance of countries in terms of their progress towards each of the 17 Sustainable Development Goals (SDGs). The global SDG Index score (and individual goal scores) can be interpreted as the percentage of achievement out of the best possible outcome across the 17 SDGs that a country has achieved.

Institution(s):

The Bertelsmann Stiftung Foundation and the Sustainable Development Solutions Network (SDSN)

Platform of dissemination:

UN

SDSN

Relevant website(s):

https://www.sdgindex.org/

https://www.bertelsmann-stiftung.de/en/our-projects/sustainable-development-goals-index/

19b. Dimensions

Dimension (SDG)	Number of Indicators
SDG1 No poverty	2
SDG2 Zero Hunger	7
SDG3 Good Health and Wellbeing	14
SDG4 Quality Education	3
SDG5 Gender Equality	4
SDG6 Clean Water and Sanitation	5
SDG7 Affordable and Clean Energy	3
SDG8 Afford Decent work and Economic Growth	5
SDG9 Industry, Innovation and Infrastructure	6
SDG10 Reduced Inequality	1
SDG11 Sustainable Cities and Communities	3
SDG12 Responsible Consumption and Production	6
SDG13 Climate Action	4
SDG14 Life Below Water	4
SDG15 Life on Land	5
SDG16 Peace and Justice	9
SDG17 Partnerships to achieve the Goal	4

For details on the indicators refer to [101]

19c. Index structure and Methodology

$$I_i\left(N_i, N_{ij}, I_{ijk},\right) = \left(\sum_{j=1}^{N_i} \frac{1}{N_i} \sum_{k=1}^{N_{ij}} \frac{1}{N_{ij}} I_{ijk}\right)$$

I_i is the SDG index overall score for country i, $N_i$is the number of SDGs for which the country has available data, N_{ij} the number of indicators for SDG j, and I_{ijk} is the score of indicator k for SDG j for country i.

Scores are calculated as follows:

i. Remove outliers from the distribution of each indicator

ii. Set lower and upper bund values

iii. Normalize data from 0 to 100 using the min-max method:

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

iv. Aggregate indicators for each SDG

$$I_{ij}\left(N_{ij}, I_{ijk}, \rho\right) = \left(\sum_{k=1}^{N_{ij}} \frac{1}{N_{ij}} I_{ijk}\right)$$

I_{ij} is the SDG index score for SDG j and country i. I_{ijk} refers to the score of the indicator k of the SDG j for country i. The index use the standard constant-elasticity-of-substitution (CES) function with elasticity of substitution $\sigma = \infty, \rho = -1$. This implies that the components of the index are perfect substitutes. Hence, The CSE function has equal weights across components and takes the form of the arithmetic mean. This fits the purpose of the SDG index since each goal describe complementary policies.

v. Calculate the overall index as the arithmetic average of each SDG score

The SDG Index is calculated using equal weighting at the components level. Similarly, at the goal level, this is justified by the fact that all SDGs are considered as having equal importance as part of the 2030 Agenda.

19d. Advantages and limitations

Advantages	Limitations
• Easy to interpret. • Useful as a tool to monitor progress for the SDGs as a whole but also individually at the national level and global level. • Data availability and coverage is good. • Coherence statistical structure with respect to the concept • Allows intercountry comparability • It identifies areas where efforts must be assigned	• Arithmetic mean aggregation strategy allows perfect compensability between the variables, whereby a high score on one variable can fully offset low scores in other variables. This may not necessarily fit with the concept of sustainable development where having a high social sustainability should not come at the cost of low environmental sustainability [102]. • Indicators are unevenly distributed across goals. For instance, SDG3 has 14 indicators whereas SDG10 only 1. This means that individuals components of the SDDG3 weight less than the indicators of SDG10.

19e. Impact and Policy use

It is a useful tool to identify sectors in need for action and to contribute to the growing momentum towards the implementation of the 2030 Agenda 2030 for Sustainable Development. It also serves as a snapshot of countries' performance for the UN summit and beyond and as a practical tool for mobilising governments, academia, civil society and business by tracking progress and ensure accountability.

Examples from the Sustainable Development Report 2019:

- SDG Index is adopted by SDSN in 2016.
- The index has been launched at the G20 Summit and High-Level Political Forum of the United Nations
- SDSN Spain launched Spanish SDG Index and Dashboard in 2016 to show government officials, regional and local administrators and business sectors an overview of their performance in terms of the implementation of the SGDs.
- The Spanish Parliament adopts a resolution to align national policies to the 2030 Agenda for sustainable development in 2018. The resolution indicates the SDG Index and Dashboards as a useful tool to analyse Spain's challenges.
- SDSN designed the US Cities SDG index and ranks them according to sustainability performance. The initiative seeks to show opportunities o how to address the American cities' challenges through the lenses of the SGDs.
- SDG Index is presented at African Great Lakes Conference in Rwanda in occasion of the launch of the African SDG Center.
- Ample media coverage of the Sustainable Development Report

20. Inclusive Wealth Index (IWI)

20a. Definition

The index measures sustainability based on natural, manufactured, human, and social forms of capital over 25 years. It is a multipurpose, multitarget, integrated index capable of measuring traditional stocks of wealth and those intangible (educational levels, skill sets, health care, etc.) as well as environmental assets and key ecosystem services that form the backbone of human-wellbeing and ultimately set the parameters for sustainable development [104].

The justification for its development was based on the fact that neither GDP nor the HDI reflect the state of the natural environment and both focus on the short-term, with no indication of whether current well-being can be sustained.

Institution(s):

United Nations Environment Programme (UNEP)

Platform of dissemination:

United Nations Environment Programme (UNEP)

United Nations University International Human Dimensions Programme (UNU-IHDP)

UNESCO

World Health Organization

The World Bank

United Nations System

Urban Institute

Relevant website:

http://www.managi-lab.com/iwp/iwp_home.html

20b. Dimensions

Dimension	Variable
Manufactured capital	Investment Deprecation rate Assets lifetime Output growth Population Productivity
Natural capital	Non-renewable: Fossil fuels -Reserves, production, prices, rental rate Minerals -Reserves, production, prices, rental rate Renewables: Forest resources Forest stocks, forest stock commercially available, wood production, rental rate, forest area, value of non-timber forest benefits (NTFB), percentage of forest area used for the extraction of NTTBF Agricultural land Quantity of crops produced, price of cops produced, rental rate, harvested area in crop, discount rate, permanent cropland area, permanent pastureland area Fisheries Fishery tocks, value of capture fishery, quantity of capture fishery, rental rate
Human capital	Educational attainment Population by age and gender Mortality probability by age and gender Interest rate Discount rate Employment Employment compensation Labor force by age and gender

20c. Index structure and Methodology

The index is the weighted aggregation of the social value of manufactured, human, and natural capital.

$$IWI = P_K * K + P_H * H + P_N N$$

Where K corresponds to produced capital, $H$is human capital, and N refers to natural capital and P_K, P_H, P_N are the corresponding shadow prices of the above-mentioned assets (marginal contributions to the intertemporal well-being of an additional unit of capital) [105].

Health capital measured separately. The index can be adjusted for carbon damages from climate change, oil capital gains, and total factor productivity).

Scores are calculated as follows:

i. Compute produced capital following the perpetual inventory method (PIM) by setting an initial capital estimate.

ii. Compute human capital (following Klenow and Rodríguez-Clare 1997) as a function of educational attainment and of life-long returns on education. The shadow price of a unit of human capital is equal to the discounted sum of the wages it would receive (the rental price) over the expected number of working years remaining.

iii. Natural valuation is resource-specific, it "shares a relatively common accounting method, where total wealth is estimated by multiplying the physical amount available of the asset by its corresponding resource rent. (..) The resource rent is represented by the average market value of one unit of natural capital over the years 1990–2008" (UNU-IHDP and UNEP, 2012: 32).

The IWI is adjusted with variables liable to affect the productive base. Changes in health capital are mainly captured by changes in the individuals' life expectancy. The shadow price of health capital is assumed to be constant over time and is taken from the Value of the Statistical Life. The IWI includes the changes in the terms of trade that might arise due to oil prices fluctuations. To adjust for population growth, the IWI per capita is computed. Finally, the accounting of technological changes is obtained by adding TFP growth to the IWI.

For further details refer to UNEP's Inclusive Wealth Report Methodological Annex 2018.

The relative weight of capital assets is formalised as their marginal contributions to social well-being. That is, weights are given by the shadow prices for each capital. For details on the procedures to calculate shadow prices for each type of capital, refer to UNEP's Inclusive Wealth Report Methodological Annex 2018.

20d. Advantages and Limitations

Advantages	Limitations
• It measures stocks rather than flows. • It measures determinants rather constituents of well-being. • It incorporates sustainability and natural capital.	• It does not provide information on how current well-being is attained. • Data availability with gaps in data collection occurring in natural capital.

20e. Impact and Policy Use

It helps countries to measure the full array of assets they can bring to achieve sustainable development, monitor if economic growth is sustainable, and guide policymakers to follow a sustainable path within planetary boundaries.

It is useful for national economic planning agencies when considering macroeconomic fiscal policies. Changes in the various capital assets and their contribution towards the inclusive wealth of a country can provide information on where future investments should be targeted to get the best returns for increasing the best productive base of a country.

The inclusion of environmental damage in the accounts can be useful cross-country compensations and guide for international negotiations on the consideration of transboundary assets. It also helps countries to recognize tradeoffs associated with decisions related to sustainable development.

21. Genuine Savings (GS)

21a. Definition

GS measures whether we are dis-saving, that is, whether we allow appreciation of total capital to exceed investment in all forms of capital. Genuine Savings measures the dollar-valued change in social welfare. If $G < 0$ then utility (C) must be falling over some future interval of time. This is the theory underpinning the empirical work of Pearce and Atkinson (1993) on measuring sustainability using net saving adjusted for damage and depletion.

Institution(s):

World Bank

Platform of dissemination:

World Bank

21b. Dimensions

Dimensions
Investment in produced capital
Depreciation of natural capital
Investment in human capital
Damage from pollution

For details about indicators see Hamilton and Clemens (1999) and Bolt, Matete, and Clemens (2002).

21c. Index structure and Methodology

$$GS = Net\ investment\ in\ produced\ capital - net\ depreciation\ of\ natural\ capital + investment\ in\ human\ capital$$

The WB operationalizes a simplified GS called Net Adjusted Savings (NAS):

$$NAS = investment\ in\ manmade\ capital - net\ foreign\ borrowing + net\ official\ transfers - depreciation\ of\ manmade\ capital - net\ depreciation\ of\ natural\ capital + current\ education\ expenditure$$

The GS formula for real data is as follows

$$NAS = GNS - D_k + CSE - \sum R_{ni} - CD$$

where GNS is gross national savings (which is calculated as Gross National Product - Consumption). D_k is the depreciation of produced capital, CSE refers to current (non-fixed) educational expenditure,

R_{ni} corresponds to rent from depletion of natural capital, CD is damage from carbon. For details please refer to [107]

Scores are calculated as follows:

i. Obtain Investment in produced capital, net foreign borrowing and net official transfers from the national accounts. Derived depreciation of produced from data on produced capital formation.

ii. Net depreciation of natural capital can be divided at a basic level into resource extraction on the one hand and environmental pollution on the other. The WB estimates resource extraction for a range of fossil fuels (oil, natural gas, hard coal and brown coal), minerals (bauxite, copper, iron, lead, nickel, zinc, phosphate, tin, gold and silver), and one renewable resource (forests). Depreciation of these resources is computed as the product of price minus average costs of extraction multiplied by the volume of extraction.

iii. Environmental pollution is conceptualised as the use of sink capacity in order for it to be equivalent to capital depreciation. Until recently, environmental pollution was taken to be the estimated damage cost of carbon dioxide emissions where each ton of carbon emitted is valued at US$20 per metric tonne of carbon (from Fankhauser, 1995). In its most recent estimation (2003), it added the damage costs of particulates in the air.

iv. Investment in human capital is calculated as net educational expenditures. This includes both capital expenditures as well as current expenditures that are counted as consumption rather than investment in the traditional national accounts. This is certainly rather crude, but it is difficult to see how investment in human capital could be estimated otherwise for so many countries over such a long-time horizon. Dasgupta (2001a, p.C9f.) argues that it is an overestimate since human capital is lost when people die. But part of the human capital stock might be passed on when people die or, to be precise, leave the workforce. In any case, such a correction would be difficult to undertake.

Scores are "weighted" by the prices/costs contained in each dimension.

21d. Advantages and Limitations

Advantages	Limitations
• Defines wealth more broadly that the traditional national accounts. • It deducts value of depletion of natural resources and pollution damages. • It treats expenditure on education as savings rather than consumption. • Deducts net foreign borrowing and add net official transfer.	• Depreciation rate are assumed without considering asset's lifetime • Depletion is estimated as the difference between extraction value and total cost of production • Forest depletion is calculated of resource rents times the difference between harvest rates and natural growth of forest • Carbon emissions' damage are controversial, local air and water pollution are not included. • Investment in human capital does not consider spending on education. • It is only concern with weak sustainability • Positive GS may conceal unsustainable trends

	• It does not make reference to ecological thresholds, intrinsic value of nature, and property rights. • GS calculations depart from GDP figures. Nations with high levels of GDP tend to have positive GS and vise-versa. • It only provides general policy guidance

21e. Impact and Policy Use

The index is a key tool for policy advice on sustainable development. The index is featured in two of the Banks annual publications: *The Little Green Data Book* and *The World Development Indicators*.

It is a good alternative to the GDP providing its weak sustainability standards. It can also be considered a great extension to the system of national accounts and support for the development of System of Environmental-Economic Accounts.

22. Environmental Performance Index (EPI)

22a. Definition

EPI measures the performance of nations in terms of human health and ecosystem's protection as policy goals [49]. Data-driven and empirical approach to environmental protection helps identifying of problems, tracking trends, evaluating policy, detecting best practices, and optimizing gains from investments in environmental protection [49]. UN's SDGs require government to report quantitatively their performance in terms of pollution and natural resource sustainable management.

Institution(s):

Yale Center for Environmental Law & Policy (YCELP)

Center for International Earth Science Information Network (CIESIN) at Columbia University

World Economic Forum

Platform of dissemination:

Yale Center for Environmental Law & Policy

Relevant website:

https://epi.envirocenter.yale.edu/

22b. Dimensions

Dimension (Policy objective)	Issues area	Indicator
Environmental health (40%)	Air quality (26%)	PM_{25} Exceedance (7.8%) PM_{25} Exposure (7.8%) Household solid fuels (10.4%)
	Water and sanitation (12%)	Drinking water (6%)

		Sanitation (6%)
	Heavy metals (2%)	Lead exposure (2%)
Ecosystem vitality (60%)	Air pollution (6%)	SO_2 emissions (3%) NO_x emissions (3%)
	Water and resources (6%)	Wastewater treatment (6%)
	Agriculture (3%)	Sustainable nitrogen management (3%)
	Forests (6%)	Tree cover loss (6%)
	Fisheries (6%)	Fish stocks status (3%) Regional marine trophic index (3%)
	Climate and energy (18%)	CO_2 emissions – total (9%) CO_2 emissions – power (3.6%) Methane emissions (3.6%) N_2O emissions (0.9%) Black carbon emissions (0.9%)
	Biodiversity and Habitat (15%)	Marine protected areas (3%) Biome protection (national) (3%) Biome protection (global) (3%) Species protection index (3%) Representativeness index (1.5%) Species habitat index (1.5%)

Percentages corresponds to the weights within the different levels of aggregation from indicator to issue area, issue area to dimensions, and overall index.

The index uses proximity-to-targeted method based on international treaties, scientific thresholds, and analysis of best performance.

22c. Index structure and Methodology

$$EPI = \sum_{\alpha=1}^{2} w_\alpha * policy\ score_{\ \alpha}$$

Scores are calculated as follows:

i. Deal with missing data, or measurements not applicable to a country

ii. Normalize data sets in order to allow for intercountry comparability by dividing by country's area, population, size of the economy, calculating rate of change, developing trends over time, or taking weighted averages of several variables.

iii. Scrutinize skewness of datasets, usually using logarithmic transformation

iv. Rescale the data into 0-100 score using the following generic formula:

$$Indicator\ score = \frac{x - \underline{x}}{\overline{x} - \underline{x}} * 100$$

where x is a country's value, $\overline{x}$ refers to the best performance, $\underline{x}$ is the worst performance.

iv. Aggregate indicator scores into an issue category by simple weighted arithmetic mean.

v. Aggregate issue category scores into policy objectives scores by simple weighted arithmetic mean.

vi. Aggregate policy objectives into the EPI by simple weighted arithmetic mean.

The EPI assigns a weight of 0.4 and 0.6 to the objectives of environmental health and ecosystem vitality, correspondently. These weights reflect equal importance between the two policy objectives which are informed by the variance of each. Equal weights will not accomplish this since they will obscure the variation of ecosystem vitality and give more influence on environmental health. Each level of aggregation is executed using the weighted arithmetic mean. All weights assigned are data driven.

For details refer to [108].

22d. Advantages and Limitations

Advantages	Limitations
• Easy to calculate and interpret • Flexible framework that make it tailorable to national priorities • Allows intercountry comparability • Useful policy tool • Statistically coherent	• Data quality and availability limits the use of more relevant indicators, specifically in the areas of forest and fisheries [109]. • The choice of aggregation function at the policy objectives level was found to be the main driver of the variation in country ranks, accounting for a much greater share of the observed variance in country ranks. This suggested that future deliberations on the index's methodology should focus primarily on the choice of aggregation function. [109].

22e. Impact and Policy Use

The EPI has been used or adjusted by many countries to evaluate environmental performance at national and sub-national levels. Tailored versions of EPI to national priorities have used by countries to address their own urgent environmental issues.

Examples (Hsu, A. et al. 2016):

- China adopted and modified the EPI by adding a new dimension; economic sustainability which is alignment with the country's green-growth aims.
- India created its own EPI focusing on population pressures, waste management, and environmental budgets.
- Malaysia designed an EPI incorporating indicators measuring urban environmental performance and governance.
- The Basque Country launched an EPI in order to compare itself with other European countries.
- Abu Dhabi Emirate conducted and EPI assessment to obtain a detailed evaluation of water and air quality.

23. Happy Planet Index (HPI)

23a. Definition

It indicates the ecological efficiency with which human-wellbeing is delivered and ranks countries on how many long and happy lives they produce per unit of environmental input [111]. It makes no explicit use of income or income-adjusted measures, it utilizes both objective and subjective data, and it combines fundamental inputs (natural resources) and ultimate ends (well-being). It is an alternative to GDP and those indices that depart from GDP and subtract environmental costs to create measures of economic success.

Institution(s):

NEF

Platform of dissemination:

NEF

Relevant website:

http://happyplanetindex.org/

23b. Dimensions

Dimensions
Well-being
Life expectancy
Inequality of outcomes
Ecological footprint

23c. Index structure and Methodology

$$Happy\ Planet\ Index = \varphi * \frac{(experienced\ wellbeing_{\ ia} - \alpha\ Life\ expectancy_{\ ia}) + \pi}{Ecological\ footprint + \beta}$$

Where ia is inequality adjusted, α = 0.158, $\beta = 2.067$, $\pi = 3.951$, and $\varphi = 0.452$

Scores are calculated as follows:

i. Multiply the mean life expectancy of a country's resident by mean experienced well-being

ii. Calculate inequality-adjusted life expectancy:

Calculate Atkinson index for life expectancy:

$$Atkinson\ index\ of\ life\ expectancy = 1 - \frac{Geometric\ mean\ of\ life\ expectacy}{Mean\ life\ expectancy}$$

Calculate inequality-adjusted life expectancy:

$$Inequality - adjusted\ life\ expectancy$$
$$= (1 - Atkinson\ index\ of\ life\ expectancy) * Mean\ life\ expectancy$$

iii. Calculate inequality-adjusted experienced well-being

Calculate Atkinson index of experienced well-being:

$$Atkinson\ index\ of\ experienced\ well - being = 1 - \frac{Geometric\ mean\ of\ experienced\ well - being}{Mean\ of\ experienced\ well - being}$$

Calculate inequality-adjusted experienced wellbeing

$$Inequality - adjusted\ experienced\ well - being$$
$$= (1 - Atkinson\ index\ of\ experienced\ well - being) * Meanof\ experienced\ well - being$$

iv. Adjust the inequality-adjusted experienced well-being scores so that their coefficient of variance is equivalent to the coefficient of variance of the inequality-adjusted life expectancy scores. In effect, this involves subtracting a constant from the inequality-adjusted experienced wellbeing of each country α. This ensures that each of these two variables contribute the same amount of variance to the product term, which is inequality adjusted Happy Life Years. This can be understood as ensuring that the Happy Life Years measure is equally sensitive to changes in inequality-adjusted life expectancy and inequality-adjusted experienced wellbeing.

v. Adjust the Ecological Footprint scores so that their coefficient of variance is equivalent to that of the Happy Life Years measure by adding a constant to the Ecological Footprint β. This can be understood as ensuring that the overall Happy Planet Index score is equally sensitive to changes in the Happy Life Years measure and in the Ecological Footprint.

vi. Incorporate two scaling constants ϕ and π such that an HPI score of 100 would indicate excellent performance on all three indicators.

vii. Divide the average number of inequality-adjusted Happy Life Yeats by the country's Ecological Footprint to obtain the average number of inequality-adjusted Happy Years of Life produced per unit of demand on the natural environment from the country's residents.

For more details on the methodology refer to NEF (2016)

23d. Advantages and Limitations

Advantages	Limitations
• It integrates environmental limits to measures of well-being.	• Tuning the parameters $\alpha, \beta, \pi, \varphi$, and the cut-off age of life expectancy, scores vary given rise to different ranking of countries [113].

24. Wellbeing Index

24a. Definition

The Wellbeing index combines human and ecosystem well-being to assess countries in terms of the quality of life and the environment. It was developed to address the fact that human well-being is more than the strength of the economy whereas ecosystem well-being is more than low resource consumption.

Institution(s):

International Union for the Conservation of Nature (IUCN)

International Development Research Centre (IDRC)

Platform of dissemination:

International Union for the Conservation of Nature (IUCN)

24b. Dimensions

	Sub-system	Dimensions
Wellbeing index	Human wellbeing	Health and population
		Wealth
		Knowledge and culture
		Community
		Equity
	Ecosystem wellbeing	Land
		Water
		Air
		Species and genes
		Resource use

Levels of aggregation: indicator to issue, issue to dimension, dimension to sub-system, sub-system to system.

24c. Index structure and Methodology

The index is the arithmetic mean of the Human Wellbeing Index (the average of 36 equally weighted socio-economic indicators) and the Ecosystem Wellbeing Index (the average of 51 equally weighted environmental indicators [114]. Scores are calculated as follows:

i. Rescale the indicators using the max-min (or min-max) formula.

ii. If the indicators are considered equally important, take the arithmetic mean of them to calculate the score for the issue level of aggregation. If indicators are considered of difference importance, they need to be weighted according to the relative importance before averaged. In case there is a critical indicator, it can be given a veto function, overriding the remaining elements.

iii. Follow the same procedure to aggregate issues into a dimension score.

iv. Calculate sub-system score using the same procedure to obtain the Human wellbeing index and Ecosystems wellbeing index.

v. Calculate the average of these to indices to obtain the Wellbeing index.

Equal weightings are assigned at all levels of aggregation.

For further details, refer to [115].

24d. Advantages and Limitations

Advantages	Limitations
• The index has a flexible framework allowing users to accommodate indicators according to their needs. It allows direct users to define their own indicators, dimensions, and variables so they can assess their own sustainability and well-being. • It can be disaggregated at different levels of aggregation which may give policy guidance about specific issues.	• • Arithmetic mean can produce artificial results, as low performance of some indicators can be compensated by good performance of others. • Data availability may become an issue • Since it has not been recalculated, its long performance is unknown

24e. Impact and Policy Use

The index has not been recalculated since 2001 and has not been used by other researches, despite its potential.

The methodology was applied at the local level in India, Zimbabwe, and Nicaragua. It can be used for (a) evaluating and monitoring sustainable development projects over time, and (b) identifying the key areas for policy and program interventions for development and conservation efforts as well as ensuring a substantial level of local support for such interventions. [116]

25. Environmental Sustainability Index (ESI)

25a. Definition

The ESI score quantifies the likelihood that a country will be able to preserve valuable environmental resources effectively over the period of several decades (Esty et al.2005). It focuses on progress towards environmental sustainability and it was developed to meet the need of a tool for shifting pollution control and natural resource management towards a mechanism for making environmental management more quantitative, empirically grounded, and systematic. It was the predecessor to the Environmental Performance Index.

Institution(s):

Yale Center for Environmental Law and Policy (YCEL)

Center for International Earth Science Information Network (CIESIN) – Columbia University

World Economic Forum (WEF)

Joint Research Centre (JCR) European Union

Platform of dissemination:

YCEL

Relevant website:

https://sedac.ciesin.columbia.edu/data/collection/esi/

25b. Dimensions

Dimension	Indicator
Environmental systems	Air quality Biodiversity Land Water quality Water quantity
Reducing Environmental Stresses	Reducing air pollution Reducing ecosystem stress Reducing population pressure Reducing waste and consumption pressures Reducing water stress Natural resources management
Reducing Human Vulnerability	Environmental health Basic human sustenance Reducing environment-related natural disaster vulnerability
Social and Institutional Capacity	Environmental governance Eco-efficiency Private sector responsiveness Science and technology
Global Stewardship	Participation in international collaboration efforts Greenhouse gas emissions Reducing transboundary environmental pressures

The index is composed 5 components, 21 indicators and 76 datasets. For details, please refer to Esty et al. (2005)

25c. Index structure and methodology

Scores are calculated as follows:

i. Standardized data sets to allow for international comparisons

ii. Deal with extreme values by replacing with values closer to the mean(winsorized)

iii. Estimate missing values.

iv. Construct a “z-score” for each variable that preserves the relative position of each country for each variable while providing a neutral way to aggregate the variable into indicators.

v. Average the “z-scores” of the 76 variables into the 21 indicators using arithmetic mean.

vi. Repeat the process for the indicator to component level

vii. Calculate the arithmetic mean of 5 components to obtain the overall index score which range from 0 (unsustainable) to 100 (sustainable).

It uses equal weighting across levels of aggregation.

For further details on the methodology, refer to Esty et al. (2005)

25d. Advantages and Limitations

Advantages	Limitations
• It is easy to calculate • It provides information of the relative performance of nations in the short and medium term • It provides a benchmark for performance and highlights good and bad performance. • The index can be disaggregated to identify areas of improvements.	• • The index is composed is composed by complex data which interaction may not be capture by linear relationships. • The index itself contains variables that are indices that overlap with other variables, creating issues of double-counting and weighting issues. • Unclear definition of benchmarks. • There is a need to transform the past, present and future performance in common metrics.

25e. Impact and Policy Use

It serves to alert national environmental protection programs and societies of areas that require more attention, identify the trade-offs a country faces. The ESI also provides policymaker's guidance to pollution control and natural resource management challenges, highlighting where resources will optimally be allocated as measures of policy performance are an important mechanism for budgeting and priority setting.

Additionally, the index identifies good and bad performers. Paying attention to leading nations may help to identify best practices.

26. Sustainable Society Index (SSI)

26a. Definition

The SSI measures the sustainability of a nation in terms of economic viability and environmental and socially soundness. It is comprised of three dimensions of wellbeing: human, environmental, and economic.

Institution(s):

Sustainable Society Foundation (SSF)

Platform of dissemination:

Sustainable Society Foundation (SSF)

Relevant website:

http://www.ssfindex.com/

26b. Dimensions

Dimension	Category	Indicator	Variable
Human wellbeing	Basic needs	Sufficient food	Number of undernourished as percentage of the population

		Sufficient to drink	Number of people in %of total population, with access to an improved water source
		Safe sanitation	Number of people in % of total population, with sustainable access to improved sanitation
	Health	Healthy Life	Life expectancy at birth in number of healthy life years
		Education	Gross enrolment ratio for primary, secondary, tertiary education
		Gender equality	Gender gap index
	Personal ad social development	Income distribution	Ratio of income of the richest 10% to the poorest 10%people in a country
		Population growth	5-year change in total population size (% of total population)
		Good governance	Sum of the six Worldwide Governance Indicators
Environmental wellbeing	Natural resources	Biodiversity – forest area	10 years change in forest area
		Biodiversity – protected area	Size of protected land area (in %of total land area)
		Renewable water resources	Annual water withdrawals (cubic meters per capita as %of renewable water resources
		Consumption	Ecological footprint minus Carbon footprint
	Climate and energy	Energy use	Energy use (tones of oil equivalent per capita)
		Energy savings	Change in energy use over 4 years (%)
		Greenhouse gases	Carbon dioxide emissions per person per year
		Renewable Energy	Consumption of renewable energy as %of total energy consumption
Economic wellbeing	Transition	Organic farming	Area of organic farming in %of total agricultural area of a country
		Genuine savings	Genuine Savings (Adjusted Genuine Savings) as %of GNI)
	Economy	GDP	Gross Domestic Product per capita, PPP, current international $
		Employment	Number of unemployed people in %of total labor force
		Public debt	The total level f public debt in a country in %of GDP

26c. Index structure and Methodology

The index is the geometric mean of the three dimensions, and it is calculated as follows:

i. Clean data and deal with outliers.

ii. Estimate missing data using outliers.

iii. Normalize indicators using the min-max formula (consider the direction of the effect) to express them in a scale from 1 to 10.

iv. Assign equal weights to all indicators within dimensions.

v. Calculate the score of the dimensions as the geometric mean of all indicators.

The index's overall score is not calculated since there is negative correlation between Human and Environmental Wellbeing [118].

For further details refer to Saisana and Philippas (2012) and Sustainable Society Foundation (2016).

26d. Advantages and Limitations

Advantages	Limitations
• The SSI is a sustainability index and hence using geometric mean is advantageous since implies only partial substitutability, i.e. poor performance in one indicator cannot be fully compensated by good performance in another, (b) rewards balance by penalizing uneven performance in the underlying indicators, (c) provides incentives for improvement in the weak dimensions: the geometric mean considers that the lower the performance in a particular indicator, the more urgent it becomes to improve achievements in that indicator Saisana and Philippas (2012).	• The dimensions of the index of human and environmental wellbeing are negatively correlated, impeding the overall aggregation into an index score.

26e. Impact and Policy Use

The index is updated biannually. It has been used for research and educational purposes to raise people's awareness about the (un)sustainability of a society, and also as an instrument to engage different sectors of society, to compare countries and learn from each other's good practices [121].

Governance

27. World Governance Indicators (WGI)

27a. Definition

WGI measures the quality of governance of a country which broadly comprises the traditions and institutions by which authority is exercised in a country. It also includes governments election process, monitoring and replacement; government's capacity to design and implement effective policies; respect for citizens and the state for the institutions that govern economic and social interactions among them. The index summarizes the views on the quality of governance provided by firms, citizen and expert survey respondents in industrial and developing countries.

Institution(s):

Natural Resource Governance Institute (NRGI) and Brookings Institution

World Bank Development Research Group

Platform of dissemination:

World Bank

Relevant website:

http://info.worldbank.org/governance/wgi/

27b. Dimensions

Dimensions
Voice and accountability
Political stability and absence of violence
Governance effectiveness
Regulatory quality
Rule of law
Control of Corruption

For details to data sources of all indicators of the dimensions refer to the Documentation tab of www.govindicators.org

27c. Index structure and Methodology

Each dimension's score y_{jk} can be expressed as the observed score of country j on indictor k as a linear function of unobserved governance in country j, g_j. ε_{jk} is the disturbance term. α_k and β_k are parameters that map unobserved governance into observed data.

$$y_{jk} = \alpha_k + \beta_k(g_j + \varepsilon_{jk})$$

Governance is estimated as the weighted average of the rescaled scores for each country:

$$E[g_j \,|y_{j1}, \dots\, y_{jk}|] = \sum_{k=1}^{K} w_k \frac{y_{jk} - \alpha_k}{\beta_k}$$

w_k refer to weights given to each indicator k. The details on how to calculate weights are found in Kaufmann, Kraay, and Mastruzzi (2010).

Scores are calculated as follows:

i. Assign data from individual sources to the six aggregate indicators.

ii. Normalize individual source data to a scale from 0 to 1.

iii. *Use the Unobserved Components Model (UCM) to construct a weighted average of the individual indicators for each source.* The composite measures of governance generated by the UCM are in units of a standard normal distribution, with mean zero, standard deviation of one, and running from approximately -2.5 to 2.5, with higher values corresponding to better governance. We also report the data in percentile rank term, ranging from 0 (lowest rank) to 100 (highest rank).

Weights are assigned using the UCM. The UCM assigns greater weight to data sources that tend to be more strongly correlated with each other.

For further details on the methodology refer to Kaufmann, Kraay, and Mastruzzi (2010).

27c. Advantages and Limitations

Advantages	Limitations
• Data is available annually in the index' website. • It allows for intercountry comparisons	• Systematic bias in perceptions data. • Subjective assessments of governance my be influenced by other factors different from governance such as economic performance, development status, etc. • Perceptions of some groups maybe influenced by other group. • It is a very complex index. • Indicators may not relate to possible paths of actions • It is not tailorable. The index cannot capture the uniqueness of country-specific contexts.

27d. Impact and Policy Use

It provided one of first few sources of governance measures. Donor agencies, financial institutions may use the index to link their aid according to governance performance, as countries with better governance use more effectively development assistance. The index's individual indicators may provide inputs for the construction of other indices such as the case of the Ocean Health Index.

28. Democracy Index

28a. Definition

The index measures the state of a country's democracy based on five dimensions and 60 indicators and classifies nations into four different type of regimes; full democracy, flawed democracy, hybrid regime, and authoritarian regime [123].

Institution(s):

The Economist Intelligence Unit

Platform of dissemination:

The Economist

Relevant website:

https://www.eiu.com/topic/democracy-index

28b. Dimensions

Dimensions
Electoral process and pluralism
Civil liberties
Functioning of government
Political participation
Political culture

28c. Index structure and Methodology

The index is the arithmetic mean of the five dimensions and it is calculated as follows:

i. Provide indicators' scores-based o dichotomous 1-0 basis 3-point basis.

ii. Calculate dimension indices as the sum of the indicator scores in the dimension and converted to a 0-10 scale

iii. Calculate the overall index as the arithmetic mean of the five sub-indices.

28d. Advantages and Limitations

Advantages	Limitations
• Easy to calculate and interpret. • It allows for intercountry comparability.	• Subjective perceptions within the index as data relies on surveys.

28e. Impact and Policy Use

It is used for inter-country comparisons mainly by the media.

29. Index of Economic Freedom

29a. Definition

The index measures the economic freedom of countries around the world. Economic freedom is understood as freedom to work, produce, consume, and invest in any way they please without unnecessary restrictions by the government. The Index of Economic Freedom documents the positive relationship between economic freedom and a variety of positive social and economic goals. It focuses on four key aspects of the economic and entrepreneurial environment over which governments typically exercise policy control: rule of law, government size, regulatory efficiency and market openness The index was designed 25 years ago to demonstrate progress, or the lack thereof, in efforts by countries to implement the policy mix that would best promote rapid and sustainable growth in alignment with the Washington Consensus' priorities.

Institution(s):

The Heritage Foundation

Platform of dissemination:

The Heritage Foundation

Relevant website:

https://www.heritage.org/index/

29b. Dimensions

Dimension	Indicator
Rule of law	Property rights Judicial effectiveness Government integrity
Government size	Tax burden Government spending Monetary freedom
Regulatory efficiency	Business freedom Labor freedom Monetary freedom
Market openness	Trade freedom Investment freedom Financial freedom

For details in the sub-variables of each indicator refer to Miller, Kim, and Roberts (2019) in *2019 Index of Economic Freedom Report's Methodology* section.

29c. Index structure and Methodology

The index is calculated as the arithmetic mean of all the indicators as follows:

i. Each of the 12 indicators are graded in a scale from 0-100 according to arithmetic mean of the sub-variables that comprise each of the individual indicator. Each sub-variable is derived from normalized datasets using the min-max formula and then multiplied by 100.

ii. The index is calculated as the arithmetic mean of 12 indicators.

The 12 indicators are equally weighted

29d. Advantages and Limitations

Advantages	Limitations
• Easy to calculate and interpret. • Transparent.	• Perfect substitutivity across indicators.

• It allows for intercountry comparability • It tracks progress and tendencies.	

29e. Impact and Policy Use

The index has widespread press coverage. Also, Presidents and Prime Ministers from around the world, including from countries like Poland, Taiwan, Estonia, Chile, Tunisia, Ghana, and Mexico, have referred to the Index as an important guide for economic policy [124].

The Index has become institutionalized within organizations such as USAID and the Millennium Challenge Corporation, the World Bank, and commercial credit rating and investment agencies as a valuable resource [124].

30. Bertelsmann Stiftung's Transformation Index (BTI): Governance Index

30a. Definition

The index analyzes and evaluates whether and how developing countries and countries in transition are steering social change towards democracy and a market economy. It evaluates in the governance quality of a country while taking into consideration the level of difficulty. It focuses on how effectively policymakers facilitate and steer development and transformation processes.

Institution(s):

Bertelsmann Stiftung

Platform of dissemination:

Bertelsmann Stiftung

Relevant website:

https://www.bti-project.org/en/home/

30b. Dimensions

Dimension: Governance
Steering capability
Resource efficiency
Consensus-building
International cooperation

30c. Index structure and Methodology

The index is calculated as the average criteria scores multiplied by a factor derived from the level of difficulty. It is based on a qualitative expert survey from which assessments are transformed into numerical ratings and examined through several experts lead review processes using a codebook country. The ratings are standardized to make them comparable across countries.

The index is composed of 20 indicators which are aggregated into the criteria composing the single dimension; Governance. At both levels equal weighting is used.

For details on the composition of the criteria, visit the following link: https://www.bti-project.org/en/about/project/methodology/

30d. Advantages and Limitations

Advantages	Limitations
• Simple and easy to interpret • It allows to compare countries' performance and progress towards democracy and market economy. • It considers the opinion of country's experts	• Qualitative surveys bring subjectivity to the analysis. • Not reproducible

30e. Impact and Policy Use

By examining and evaluating decision-makers' reform policies, the BTI sheds light on those factors determining success and failure on the path towardso democracy and a market economy.

31. Bertelsmann Stiftung's Transformation Index (BTI): Status Index

31a. Definition

The index analyzes and evaluates whether and how developing countries and countries in transition are steering social change toward democracy and a market economy.

Institution(s):

Bertelsmann Stiftung

Platform of dissemination:

Bertelsmann Stiftung

Relevant website:

https://www.bti-project.org/en/home/

31b. Dimensions

Dimension	Criterion
Political Transformation	Stateness Political participation Rule of law Stability of democratic institutions Political and social integration

Economic transformation	Level of socio-economic development Organization of the market and competition Currency and price stability Private property Welfare regime Economic performance Sustainability

For details on the composition of the criteria visit the following link: https://www.bti-project.org/en/about/project/methodology/

31c. Index structure and Methodology

The index is calculated as the average score of both dimensions. It is based on a qualitative expert survey from which assessments are transformed into numerical ratings and examined through several experts lead review processes using a codebook country. The ratings are standardized to make them comparable across countries.

The index is composed of sub-indicators which are aggregated into the criteria composing the each of the two dimensions. At both levels equal weighting is used.

In accordance with the Transformation Index's comprehensive concept of democracy, seven threshold values marking minimum requirements are considered.

31d. Advantages and Limitations

Advantages	Limitations
• Simple and easy to interpret • It allows to compare countries' performance and progress towards democracy and market economy. • It considers the opinion of country's experts	• Qualitative surveys bring subjectivity to the analysis. • Not reproducible

31e. Impact and Policy use

The index can be used to classify countries into democracies or autocracies. It also assesses the overall state of development of a country's political, economic, and socio-economic aspects.

Technology and innovation

32. Global Innovation Index (GII)

32a. Definition

The GII indicates the capacity of countries to succeed and innovate. It provides valuable insight into the multidimensional facets of innovation-driven growth and has evolved into a valuable benchmarking tool that can facilitate public-private dialogue and where policy-makers, business leaders, and other stakeholders can evaluate innovation progress on an annual basis [125]. Each year the GII tracks global innovation in a particular theme.

Institution(s):

Cornell University

INSEAD

World Intellectual Property Organization

Platform of dissemination:

Cornell University

INSEAD

World Intellectual Property Organization

Relevant website:

https://www.globalinnovationindex.org/gii-2019-report

32b. Dimensions

Dimension	Pillar	Weight
Innovation input	Institutions Human capital and research Infrastructure Market sophistication Business sophistication	0.2 0.2 0.2 0.2 0.2
Innovation output	Knowledge and technology outputs Creative outputs	0.5 0.5

The index is comprised of 2 dimensions, 7 pillars, 21 sub-pillars, 80 indicators. Visit the following link for more details on the sub-pillars: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2016-annex1.pdf

32c. Index structure and Methodology

The index is calculated as the weighted mean of its dimensions. Indicators are normalized using the min-max method. Each sub-pillar score is calculated as the weighted average of its individual indicators. Each pillar score is calculated as the weighted average of its sub-pillar scores [126].

32d. Advantages and Limitations

Advantages	Limitations

• Statistical sound and balanced; each sub-pillar makes a similar to the variation of its respective pillar. • The "distance to the efficient frontier" measure calculated with Data Envelopment Analysis can be used as a measure of efficiency, and a suitable approach to benchmark economies' multidimensional performance on innovation without imposing a fixed and common set of weights that may not be fair to particular economy [127].	• The lack of imputation of missing data may impact negatively scores of some economies [127].

32e. Impact and Policy Use

The index has become a primary reference for innovation benchmarking; has been used as a tool to facilitate dialogue between policymakers, businesses and other stakeholders; used to highlight the importance of innovation policy [125].

33. Knowledge Economy Index (KEI)

33a. Definition

The KEI is a composite indicator attempting to capture the overall development of a country in the Knowledge Economy context. Country performance are based in the Knowledge Economy Framework. It focuses on knowledge, innovation, and economic growth.

Institution(s):

World Bank

Platform of dissemination:

World Bank

33b. Dimensions

Dimension (Pillar)
Economic incentive and institutional regime
Educated and skilled workers
Effective innovation system
Modern and adequate information infrastructure

33c. Index structure and Methodology

The index is calculated as the normalized arithmetic mean of the 12 knowledge indicators comprising the basic scorecard as follows:

i. Rank countries according to performance from best to worst using the scorecards.

ii. Calculate the number of countries that rank below a country of interest.

iii. Normalize their scores to rescale them from 0-10 using the following formula:

$$Normalized\ (u) = 10\left(\frac{Nw}{Nc}\right)$$

Nc the total number of countries.

iv. Calculate the overall KEI as the arithmetic mean of the normalized scores of the indicators.

33d. Advantages and Limitations

Advantages	Limitations
• Simple to calculate and interpret • Flexible as the index is designed to allow users to customize combinations of variables, create own scorecards to compare with desired country or regions or any of the 800 variables included in the Knowledge Assessment Methodology (KAM).	• There is perfect sustainability among indicators. • It does not capture intra-country variation • Variables may not be as relevant for developing countries as they are for developed ones.

33e. Impact and Policy Use

The index provides assessment of countries' readiness for the knowledge economy, and identifies sectors or specific areas where policymakers may need to focus more attention or future investments [128]. The World Bank uses the index as a tool to engage in conversation with clients (governments) related to the development of their knowledge economies [128]

34. Technology Achievement Index (TAI)

34a. Definition

The index measures technological progress and assess the technological achievements of a

country as an aid to policy makers in identifying policy priorities. The TAI does not rank global technology development leadership but focuses on how a country participates, creates and use technology. It focuses on technology and innovation. The index focuses on outcomes and achievements rather than on effort or inputs such as numbers of scientists, R&D expenditures, or policy environments [129]. It was developed to meet the need of measuring disparities and difficulties across countries to compete in the technology-based global economy.

Institution(s):

Human Development Report Office of the UNDP

Platform of dissemination:

Human Development Report Office of the UNDP

34b. Dimensions

Dimension	Indicator

Creation of technology	Number of patents granted per residents per capita Receipts of royalties and license fees from abroad per capita
Diffusion of recent innovations	Number of internet hosts per capita Share of high and medium technology exports in total exports
Diffusion of old innovations	Telephones per capita Electricity consumption per capita
Human skills	Mean years of schooling in population aged 15 and above Gross tertiary science enrolment ratio

34c. Index structure and Methodology

The index is calculated as the arithmetic mean of its dimensions as follows:

i. Normalize the individual indicators to scale them from 0-1 using the min-max method.

ii. Calculate the index of each dimension as the arithmetic mean of its indicators.

iii. The TAI is calculated as the arithmetic mean of the dimensions.

For further details on the methodology refer to Desai et al. (2002)

34d. Advantages and Limitations

Advantages	Limitations
• It is simple and easy to calculate • It is useful for policymaking	• The index has a limited scope of analysis [129]: • The index measures technological achievements but specifically that contributes to human well-being. • The index does not incorporate a comprehensive range of technological achievement. For instance, it neglects technological development in agriculture, medicine, and manufacturing. • It does not include innovations in the informal sector and those of indigenous communities.

34e. Impact and Policy Use

The TAI was used once and appeared in the Human Develop Report 2001 in order to promote the diagnosis of a country's technological achievement and define strategies. The index emphasizes a country's areas of strength and weakness and hence serve to design and implement policies [129].

35. ICT Development Index (IDI)

35a. Definition

The index measures countries' performance with regard to ICT infrastructure, use and skills. The main objectives of the IDI are to measure a) the level and evolution over time of ICT developments within countries and the experience of those countries relative to others; progress in ICT development in both developed and developing countries; b) the digital divide, i.e. differences between countries in terms of their levels of ICT development; and c) the development potential of ICTs and the extent to which countries can make use of them to enhance growth and development in the context of available capabilities and skills [130].

Institution(s):

United Nations International Telecommunication Union (ITU)

Platform of dissemination:

United Nations International Telecommunication Union (ITU)

Relevant website:

https://www.itu.int/net4/ITU-D/idi/2017/index.html

35b. Dimensions

Dimension	Indicator	Weight
ICT access	Fixed-telephone subscription Mobile-cellular telephone subscriptions International internet bandwidth Households with a computer Households with internet access	40%
ICT use	Percentage of individuals using internet Fixed-broadband subscriptions Mobile broadband subscriptions	40%
ICT skills	Mean years of schooling Secondary gross enrolment ratio Tertiary gross enrolment ratio	20%

35c. Index structure and Methodology

The index is calculated as the weighted mean of its three dimensions as follows:

i. Impute missing data.

ii. Normalize indicators to rescale them to arrange from 0-100.

iii. Dimension sub-indices are calculated as the weighted average of its corresponding indicators.

iv. Calculate the overall index as the summation of the weighted dimensions.

Weights are obtained performing a Principal Component Analysis.

For further details on the methodology, visit the following link: https://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2017/methodology.aspx

35d. Advantages and Limitations

Advantages	Limitations

• Statistically robust and reliable • Countries ranking are very robust to changes in normalization and weightings (JCR 2015). • It summarizes ICT development more efficiently than the 11 indicators independently (JCR 2015).	• There are highly correlated indicators in the IDI that may inflate their influence in the overall index (JCR 2015).

35e. Impact and Policy Use

The index is considered the most accurate measure of ICT development and is widely acknowledged by governments and agencies of the UN system. It is used to rank the performance of countries in ICT development and guide policymaking and strategies.

1.12 Biodiversity indices

Indicator name	Responsible institution	SDG target	BIP Indicator	IPBES	Aichi target
Agriculture orientation index for government expenditures	FAO	2.a			
Beyer intactness index	WCS/UQ/UNBC		N		
Bioclimatic Ecosystem Resilience Index (BERI)	CSIRO				15
Biodiversity Habitat Index	CSIRO		Y		5
Biodiversity Intactness Index	Natural History Museum London			Y	12
Biotic Integrity Index	UNEP-WCMC		N	N	
Coastal protection index	NatCap		N		
Ecoregions Intactness Index	WCS		N	N	
Food loss index	FAO	12.3			
Food waste index	FAO	12.3			
Forest Health Index	WCS and partners		N		
Forest Intactness Index	WCS		N	N	
Global Ecosystem Restoration Index	GEO BON - iDiv		N		15
Human Footprint Index	WCS/UQ/UNBC/NGS		N		
Index of Coastal Eutrophication (ICEP) and Floating Plastic debris Density	UN Environment	14.1	N		8
Index of Linguistic Diversity	Terralingua				18
Living Planet Index	ZSL		Y		12
Living Planet Index (trends in target and bycatch species)	ZSL				6
Living Planet Index (utilised species)					14
Living Planet Index (forest specialists)	ZSL				5, 12
Living Planet Index (farmland specialists)	ZSL				7
Marine Trophic Index	Sea Around Us			Y	6
Mountain Green Cover Index	FAO, UNEP	15.4			
Ocean Health Index	National Centre for Ecological Analysis and Synthesis (NCEAS)		Y		14
Protected Area Connectedness Index (PARC-Connectedness)	CSIRO		Y	Y	11
Protected Area Representativeness Index (PARC-Representativeness)	CSIRO		Y		11
Red List Index	IUCN / BirdLife International	15.5	N	Y	12
Red List Index (impacts of fisheries)	IUCN / BirdLife International		Y		6

Red List Index (forest specialist species)	IUCN / BirdLife International		Y		5
Red List Index (impacts of utilisation)	IUCN / BirdLife International		Y		4
Red List Index (impacts of internationally traded species).	IUCN / BirdLife International		Y		4
Red List Index (impacts of pollution)	IUCN / BirdLife International				8
Red List Index (impacts of invasive alien species)	IUCN / BirdLife International	15.5			9
Red List Index (reef-building corals)	IUCN / BirdLife International				10
Red List Index (wild relatives of domesticated animals)	IUCN / BirdLife International		Y		13
Red List Index (pollinator species)	IUCN / BirdLife International				14
Red List Index (species used for food and medicine)	IUCN / BirdLife International		Y		14
Reef Fish Thermal Index	Reef Life Survey; Integrated Marine Observing System				10
Species Habitat Index	Yale University: Environmental Performance Index		N		5, 13, 14
Species Protection Index	GEO BON - Map of Life			Y	11, 12, 13
Species Status Information Index	GEO BON - Map of Life			Y	19
Temporal biodiversity Intactness Index for all land use types	UNEP-WCMC and NGS		N		
Water Quality Index for Biodiversity	UNEP, GEMS Water				8
Wetland Extent Trends Index	Ramsar Convention				5
Wild Bird Index (forest & farmland specialist birds)	RSPB				7, 12
Wildlife Picture Index in tropical forest protected areas	Tropical Ecology Assessment and Monitoring Unit				11, 12

7 REFERENCES

1. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. *The Assessment Report on Land Degradation and Restoration (IPBES, 2018).* (2018). doi:10.4324/9781315640051-105

2. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A, G. 56 pages. *IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.*

3. United Nations Environment Programme. *UNEP frontiers 2016 report : Emerging issues of environment concern.* (2016).

4. Tittensor, D. P. *et al.* A mid-term analysis of progress toward international biodiversity targets. *Science* **346**, 241–244 (2014).

5. *Global Biodiversity Outlook. Secretariat of the Convention on Biological Diversity* **25**, (2014).

6. CONFERENCE OF THE PARTIES TO THECONVENTION ON BIOLOGICAL DIVERSITY. UNEP/CBD/COP/DEC/X/2. Strategic plan for biodiversity (2011-2020) and the Aichi biodiversity targets. doi:10.1007/978-90-481-9659-3_119

7. Heurtebise, J. Y. Sustainability and ecological civilization in the age of Anthropocene: An epistemological analysis of the psychosocial and 'culturalist' interpretations of global environmental risks. *Sustain.* **9**, (2017).

8. Hansen, M. H., Li, H. & Svarverud, R. Ecological civilization: Interpreting the Chinese past, projecting the global future. *Glob. Environ. Chang.* **53**, 195–203 (2018).

9. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A, and C. N. Z. (eds.). *IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.*

10. Blicharska, M. *et al.* Biodiversity's contributions to sustainable development. *Nat. Sustain.* **2**, 1083–1093 (2019).

11. Díaz, S. *et al.* Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science* **366**, (2019).

12. Report, I. *The Dasgupta Review – Independent Review on the Economics of Biodiversity*. (2020).

13. Folke, C., Biggs, R., Norström, A. V, Reyers, B. & Rockström, J. Social-ecological resilience and biosphere-based sustainability science. *Ecol. Soc.* **21**,

14. Díaz, S. *et al.* Assessing nature's contributions to people. *Science* **359**, 270 LP – 272 (2018).

15. Cardinale, B. J. *et al.* Biodiversity loss and its impact on humanity. *Nature* **486**, 59–67 (2012).

16. *Measuring Progress: Towards Achieving the Environmental Dimension of the SDGs.* (2019).

17. V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. W. (eds.). *IPCC, 2018: Summary for Policymakers. In: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context*

of strengthening the global. (2018).

18. Food Security Information Network (FSIN). 2019 - Global Report on Food Crises. *Fao.Org* 1–202 (2019).

19. *Convention on Biological Diversity. CBD/WG2020/2/4 29. Report of the Open-Ended Working Group on the post-2020 Global Biodiversity Framework on its second meeting.* doi:10.1017/CBO9781107415324.004

20. *United Nations (1992). Convention on Biological Diversity. New York, NY: United Nations.*

21. Mace, G. M. *et al.* Aiming higher to bend the curve of biodiversity loss. *Nat. Sustain.* **1**, 448–451 (2018).

22. Pereira, H. M. *et al.* Essential Biodiversity Variables. *Science* **339**, 277 LP – 278 (2013).

23. 2019, U. How to Build a National Multidimensional Poverty Index (MPI): Using the MPI to inform the SDGs. 160 (2019).

24. Dasgupta, P. *Human well-being and the natural environment*. (Oxford University Press, Oxford; New York, 2001).

25. Bandura, R. *Measuring country performance and state behavior: A survey of composite indices. Technical report.* (2005).

26. Bandura, R. *A survey of composite indices measuring country performance: 2008 update. Technical report.* (2008).

27. Bandura, R. *Composite indicators and rankings: Inventory 2011. Technical report.* (2011).

28. Yang, L. *An inventory of composite measures of human progress, Technical report.* (2014).

29. Greco, S., Ishizaka, A., Tasiou, M. & Torrisi, G. On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness. *Soc. Indic. Res.* **141**, 61–94 (2019).

30. Saltelli, A. Composite Indicators between Analysis and Advocacy. *Soc. Indic. Res.* **81**, 65–77 (2007).

31. Gerlitz, J. Y. *et al.* The Multidimensional Livelihood Vulnerability Index–an instrument to measure livelihood vulnerability to change in the Hindu Kush Himalayas. *Clim. Dev.* **9**, 124–140 (2017).

32. United Nations Development Programme. *Human Development Report 2019: Beyond income, beyond averages, beyond today*. (2019).

33. UNDP & OPHI. Global Multidimensional Poverty Index 2019 Illuminating Inequalities. 1–26 (2019).

34. Becker, F. G. *et al.* The Global Slavery Index 2018. *Procedia Comput. Sci.* **2**, 1–5 (2018).

35. *2019 ITUC Global Rights Index. The World's Worst Countries for Workers*.

36. *Corruption Perceptions Index 2019*.

37. UNDP. UNDP Strategic Plan, 2018-2021. *Exec. Board United Nations Dev. Program. United Nations Popul. Fund United Nations Off. Proj. Serv.* **18438**, 1–24 (2017).

38. Vanoli, A. On the Report by the Commission on the Measurement of Economic Performance and Social Progress (2009). *SSRN Electron. J.* (2012). doi:10.2139/ssrn.1714428

39. Costanza, R. *et al.* Time to leave GDP behind. *Nature* **505**, 283–285 (2014).

40. Raworth, K. *Doughnut economics : seven ways to think like a 21st-century economist*. (London : Random House, 2017., 2017).

41. Mazzucato, M. *The Value of Everything : Making and Taking in the Global Economy*. (Penguin Books Ltd, 2019).

42. Zenghelis, D., Agarwala, M., Coyle, D., Felici, M., Lu, S., and J. W. *Valuing Wealth, Building Prosperity. Wealth Economy Project first year report to LetterOne*.

43. Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. & Fuller, G. SDG Index and Dashboards Report 2018: Global Responsibilities. *Glob. Responsab. Implement. Goals* 1–476 (2018).

44. Usubiago-Liano, A. & Ekins, P. Developing a novel index of strong environmental sustainability : preliminary results. *Https://Sustainability.Sciencesconf.Org/* 1–38 (2019).

45. Acosta, L. A. *Metadata: Green Growth Index Concept, Methods and Applications. Green Growth Performance Measurement (GGPM) Program, Global Green Growth Institute, Seoul, Republic of Korea. [Contributors: C.K. Gregorio, E. Eugenio, H. Peyriere, and J. Sales]*. (2019).

46. *United States. Bureau of Foreign and Domestic Commerce, Seventy-Third Congress, 1933-1935 and Kuznets, Simon, 1901-1985. National Income, 1929-1932 , Washington: U.S. Government Printing Office, 1934.*

47. Alkire, Sabina, and Foster, James. 2007. Counting and Multidimensional Poverty Measurement. Oxford, UK.

48. Sabina Alkire, J. F. Counting and Multidimensional Poverty Measurement. *J. Public Econ.* **95**, 476–87 (2011).

49. Wendling, Z. A., Emerson, J. W., Esty, D. C., Levy, M. A., de Sherbinin, A., et al. *2018 Environmental Performance Index.* (2018). doi:10.13140/RG.2.2.34995.12328

50. University, Y. C. for E. L. and P.-Y.-Y., University, C. for I. E. S. I. N.-C.-C., WEF, W. E. F.- & Commission, J. R. C.-J. R. C.-E. Pilot 2006 Environmental Performance Index (EPI). (2006).

51. UN University, I. H. D. P. on G. E. C. and U. *Inclusive Wealth Report 2012 – Measuring Progress Toward Sustainability. International Journal of Sustainability in Higher Education* **13**, (Cambridge, UK: Cambridge University Press., 2012).

52. Halpern, B. S. *et al.* An index to assess the health and benefits of the global ocean. *Nature* **488**, 615–620 (2012).

53. Rees, W. E. Ecological footprints and appropriated carrying capacity: What urban economics leaves out. *Environ. Urban.* **4**, 121–130 (1992).

54. Wackernagel, M. Ecological Footprint and Appropriated Carrying Capacity: A Tool for Planning Toward Sustainability. The University of British Columbia. Doctoral Thesis. (1994).

55. UNDP. *Human Development Report 1990. Concept and measurement of human development. 0-19-506481-X* (1990). doi:0-19-506481-X

56. Michael Porter, Scott Stern, M. G. *Social Progress Index 2014*. (2014). doi:10.5860/choice.192006

57. *OECD Organisation for Economic Co-operation and Development. 2011. OECD Better Life Initiative: Your Better Life Index.* (Springer Netherlands). doi:10.1007/978-94-007-0753-5_3623

58. Max Lawson, M. M. *The Commitment to Reducing Inequality Index: A new global ranking of governments based on what they are doing to tackle the gap between rich and poor*. (2017).

59. *UNDP 2010. Human Development Report 2010 (20th Anniversary Edition)- The Real Wealth of Nations: Pathways to Human Development. New York, New York, USA.* doi:10.2307/2137795

60. Hausmann, Ricardo, Laura D. Tyson, and S. Z. *The Global Gender Gap Report 2006*. (2006).

61. International Trade Union Confederation (ITUC). *ITUC Global Rights Index: The World's Worst Countries for Workers.* (2014).

62. *Walk Free Foundation. 2013. Global Slavery Index 2013.*

63. *Cornell University, INSEAD, and World Intellectual Property Organization. 2007. Global Innovation Index Report 2007 (1st Edition).*

64. Porter, Michael E., Klaus Schwab, and X. S.-I.-M. *Global Competitiveness Report 2004-2005*. (Palgrave Macmillan; 2004 edition, 2004).

65. Agrast, Mark David, Juan Carlos Botero, Alejandro Ponce-Rodríguez, and C. D. *The World Justice Project Rule of Law Index: Measuring Adherence to the Rule of Law around the World.* (2008).

66. *Transparency International. 1995. Corruption Perceptions Index.*

67. Collen, B. *et al.* Monitoreo del cambio en la abundancia de vertebrados: El 'Indice del planeta viviente. *Conserv. Biol.* **23**, 317–327 (2009).

68. Elfes, C. T. *et al.* A regional-scale ocean health index for Brazil. *PLoS One* **9**, (2014).

69. Angulo, R., Díaz, Y. & Pardo, R. The Colombian Multidimensional Poverty Index: Measuring Poverty in a Public Policy Context. *Soc. Indic. Res.* **127**, (2016).

70. Alkire, S. & Jahan, S. The New Global MPI 2018: Aligning with the Sustainable Development Goals. *United Nations Dev. Program.* 1–21 (2018).

71. Duarte, C. M., Poiner, I. & Gunn, J. Perspectives on a global observing system to assess ocean health. *Front. Mar. Sci.* **5**, 1–9 (2018).

72. WWF. *Living Planet Report - 2018: Aiming higher. Environmental Conservation* **26**, (2018).

73. Vorster, C. *et al.* Development of a new continental-scale index for freshwater assessment based on dragonfly assemblages. *Ecol. Indic.* **109**, 105819 (2020).

74. Larned, S. T., Snelder, T. H., Whitehead, A. L. & Fraser, C. *Water quality state and trends in New Zealand lakes: analyses of national data ending in 2017. Prepared for Ministry for the Environment.* (2018).

75. Worker, J. and Lalanath De Silva. 2015. "The Environmental Democracy Index." Technical Note. Washington, D.C.: World Resources Institute. Available online at: www.environmentaldemocracyindex.org.

76. Borucke, M. *et al.* Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework. *Ecol. Indic.* **24**, 518–533 (2013).

77. WCS, W. C. S.- & University, C. for I. E. S. I. N.-C.-C. Last of the Wild Project, Version 2, 2005 (LWP-2): Global Human Influence Index (HII) Dataset (Geographic). (2005).

78. Ibrahim, F. H. *et al.* How to develop a comprehensive Mangrove Quality Index? *MethodsX* **6**, 1591–1599 (2019).

79. Venter, O. *et al.* Global Terrestrial Human Footprint Maps for 1993 and 2009. *Sci. Data* 160067 (2016).

80. NOAA STAR Center for Satellite Applications and Research. 2018. Global Vegetation Health Products. Accessed through Resource Watch, (date). www.resourcewatch.org.

81. Biodiversity International. *Agrobiodiversity Index Report 2019: Risk and Resilience*. (2009). doi:10.1016/b978-0-323-01199-0.50226-7

82. Simon Bell, S. M. *Routledge Handbook of Sustainability Indicators*. (Routledge, 2018).

83. Bell, S. & Morse, S. Sustainability indicators past and present: What next? *Sustain.* **10**, 1–15 (2018).

84. Morse, S. *The Rise and Rise of Indicators Their History and Geography*. (Routledge, 2019). doi:https://doi.org/10.4324/9781315226675

85. GWG. *Assessing use of scanner data for compiling the Consumer Price Index, Big Data Project Inventory, United Nations Global Working Group. https://unstats.un.org/bigdata/inventory/?selectID=201431.* (2017).

86. Rose, G. *Visual Methodologies: An Introduction to Researching with Visual Materials*. (Sage, 2011).

87. Jean, N. *et al.* Combining satellite imagery and machine learning to predict poverty. *Science* **353**, 790–794 (2016).

88. Andries, A. *et al.* Translation of Earth observation data into sustainable development indicators: An analytical framework. *Sustain. Dev.* **27**, 366–376 (2019).

89. Bartkowski, B. *Economic Valuation of Biodiversity An Interdisciplinary Conceptual Perspective*. (Routledge, 2019).

90. Varian, H. R. *Intermediate MicroeconomicsA Modern Approach*. (University of California, Berkeley), 2010).

91. Sen, A. & Anand, S. *Human Development Report Office Occasional Papers Human Development Index: Methodology and Measurement*. (1994).

92. United Nations Development Programme (UNDP). *Human Development Indices and Indicators 2018 Statistical Update: 2018 Annex Technical Notes*. *Data: Calculating the Indices* (2018).

93. Pagliani, P. *Human Development Research Paper 2010/19 Infuence of Regional, National and Sub-national HDRs*. (2010).

94. Oxford Poverty & Human Development Initiative (OPHI). *Training Material for Producing National Human Development Reports: HDI Construction & Analysis*. (2011).

95. PNUD Brasil & Institute of Applied Economic Research (IPEA). Atlas of Human Development in Brazil. (2019).

96. Stern, S. & Epner, T. *2019 Social Progress Index Methodology Summary*. (2019).

97. Hedvig, N. & Caperna, G. *The JRC Statistical Audit of the Social Progress Index (SPI) PUBSY No. JRC 113130*. (2018).

98. Social Progress Imperative. The Global Agenda Requires Rigorous Measurement: The Contribution of the Social Progress Index to the 2030 Agenda. (2018).

99. OECD. OECD Regional Well-being - User's Guide: Using data to build better communities. (2018).

100. Barros, R. P. de, Ferreira, F. H. G., Vega Molinas, J. R. & Chanduv Saavedra, J. *Measuring Inequality of Opportunities in Latin America and the Caribbean*. (2008).

101. Lafortune, G., Fuller, G., Moreno, J., Schmidt-Traub, G. & Kroll, C. SDG Index and Dashboards Detailed Methodological Paper. (2018).

102. Papadimitriou, E., Neves, A. R. & Becker, W. *JRC Statistical Audit of the Sustainable Development Goals Index and Dashboards*. (2019). doi:10.2760/723763

103. Sustainable Development Report. News and Insights. (2019).

104. Kumar, P. This Index Measures Progress and Sustainability Better Than GDP. *State of the Planet - Earth Institute Columbia University* (2018).

105. UNEP. *Inclusive Wealth Report 2018 Methodological Annex: Conventional Approach*. (2018).

106. Hamilton, K. & Clemens, M. Genuine Savings Rates in Developing Countries. *World Bank Econ.*

Rev. **13**, 333–356 (1999).

107. Bolt, K., Matete, M. & Clemens, M. Manual for Calculating Adjusted Net Savings. (2002).

108. Center for Environmental Law and Policy. Environmental Performance Index Methodology. *2018 EPI Report* (2018).

109. Athanasoglou, S. & Weziak-Bialowolska, Dorota Saisana, M. *Environmental Performance Index 2014 - JRC Analysis and Recommendations*. (2014). doi:10.2788/64170

110. Hsu, A. et al. *Environmental Performance Index*. (2016).

111. New Economic Foundation (NEF). *The Happy Planet Index: An index of Human Well-being and Environmental Impact*. (2006).

112. New Economic Foundation (NEF). *Happy Planet Index 2016 Methods Paper*. (2016).

113. Bondarchik, J., Jabłońska-Sabuka, M., Linnanen, L. & Kauranne, T. Improving the Objectivity of Sustainability Indices by a Novel Approach for Combining Contrasting Effects: Happy Planet Index Revisited. *Ecol. Indic.* **69**, 400–406 (2016).

114. Prescott-Allen, R. *The Wellbeing of Nations: a Country-by-country Index of Quality of Life and the Environment*. (Island Press, 2001).

115. Prescott-Allen, R. Barometer of Sustainability: Measuring and Communicating Wellbeing and Sustainable Development. (1997).

116. Wilson Center. The Wellbeing of Nations: Developing Tools for Measuring Sustainable Development. *Environmental Change and Security Program* (2001).

117. Esty, D. C., Levy, M., Tanja, S. & Sherbinin, A. *Environmental Sustainability Index: Benchmarking National Environmental Stewardship*. (2005).

118. Sustainable Society Foundation. Calculation Methodology. *Sustainable Society Index - your compass to sustainability* (2016).

119. Saisana, M. & Philippas, D. *Sustainable Society Index (SSI): Taking societies' pulse along social, environmental and economic issues - The Joint Research Centre audit on the SSI*. (2012).

120. Sustainable Society Foundation (SSF). *Calculation formulas of the Sustainable Society Index, SSI-2016*. (2016).

121. Van de Ker, G. & Manuel, A. R. A Comprehensive Index for a Sustainable Society: The SSI – the Sustainable Society Index. *Ecol. Econ.* **66**, 228–242 (2008).

122. Kaufmann, D., Kraay, A. & Mastruzzi, M. *The Worldwide Governance Indicators: Methodology and Analytical Issues*. (2010).

123. The Economist Intelligence Unit (EIU). Democracy Index 2018. (2018).

124. Miller, T., Kim, A. B. & Roberts, J. M. *2019 Index of Economic Freedom - 25th Anniversary Edition*. (2019).

125. Cornell University, INSEAD & WIPO. *The Global Innovation Index 2018: Energizing the World with Innovation*. (2018).

126. Cornell University, INSEAD & WIPO. *The Global Innovation Index 2015: Effective Innovation Policies for Development*. (2015).

127. Saisana, M., Domínguez-Torreiro, M., Vértesy, D. & Alvarez, M. *Joint Research Centre (JCR) Statistical Audit of the 2019 Global Innovation Index*. (2019).

128. Chen, D. H. C. & Dahlman, C. J. *The Knowledge Economy, the KAM Methodology and World Bank Operations*. (2006).

129. Desai, M., Fukuda-Parr, S., Johansson, C. & Sagasti, F. *Measuring Technology Achievement of Nations and the Capacity to Participate in the Network Age*. (2002).

130. ITU. The ICT Development Index (IDI): Conceptual Framework and Methodology. *Measuring the Information Society Report 2017* (2017).

131. Joint Research Centre (JCR) - European Commission. *JRC Statistical Assessment of the 2015 ICT Development Index*. (2015).

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