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Data opportunities and challenges for calculating a global Strong Environmental Sustainability (SES) index

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Abstract
The Environmental Sustainability Gap (ESGAP) framework sets the basis to measure countries' environmental sustainability performance, based on standards meant to represent the situation at which natural capital can maintain its functions over time. It is composed of 22 indicators, all supported by scientific standards of environmental sustainability, that can ultimately be aggregated into a single index that represents absolute environmental sustainability performance or progress over time, the Strong Environmental Sustainability (SES) index.
Here we present the results of a review of global environmental data to assess the feasibility of implementing the ESGAP framework in all countries, at different stages of development. We assess feasibility in terms of the availability of global environmental data, and in the absence of data used for the SES indicators suggest related proxy indicators that are supported by global environmental data. This use of proxy indicators permits the construction for each country of a globally applicable SES index.

Keywords
Indicators of sustainability, operationalisation of sustainability, sustainability gap, sustainability standard, sustainability indicators, environmental SDG

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Résumé
Cet article explore les évolutions Le ESGAP (Environmental Sustainability Gap) établit un cadre pour mesurer les performances des pays en matière de soutenabilité environnementale. Il se base sur des normes de soutenabilité représentant le niveau de santé permettant au capital naturel de maintenir ses fonctions au fil du temps. Le cadre ESGAP est composé de 22 indicateurs, tous soutenus par des normes scientifiques de soutenabilité environnementale, qui peuvent in fine être agrégés en un seul indice (l'indice de soutenabilité environnementale forte (SES)) qui représente la performance absolue en matière de soutenabilité environnementale ainsi que sa progression au fil du temps. Nous présentons ici les résultats d'un état des lieux des données environnementales mondiales visant à évaluer la faisabilité de la mise en œuvre du cadre ESGAP dans tous les pays, à différents stades de développement. Nous évaluons la disponibilité des données environnementales mondiales et, en leur absence, nous suggérons des indicateurs de substitution ou proxys pour lesquels on dispose de données au niveau mondiales. L'utilisation d'indicateurs de substitution permettrait à priori de construire l'indice SES au niveau global.

Mots-clés
Indicateurs de soutenabilité, opérationnalisation de la soutenabilité, écart de soutenabilité, norme de soutenabilité, indicateurs de soutenabilité, ODD environnementaux

Contents

1. Introduction

The Environmental Sustainability Gap (ESGAP) framework sets the basis to measure countries' environmental sustainability performance, based on standards meant to represent the situation at which natural capital can maintain its functions over time. It is composed of 22 indicators, all supported by scientific standards of environmental sustainability, that can ultimately be aggregated into a single index that represents absolute environmental sustainability performance or progress over time (see [1] for a detailed description of the framework and the indices). Currently the Strong Environmental Sustainability (SES) index is being calculated for the 28 Member States of the European Union (EU) in preliminary work, using environmental data made available by the European Environment Agency, the European Commission, Eurostat and academic sources [2]. The indicators supported by this European data are hereafter called the SES indicators, and their aggregation at national level the SES index for European countries. This work illustrates the feasibility of implementing the ESGAP framework for countries for which a wide range of high-quality environmental datasets are available. However, the feasibility of calculating the SES index for countries that lack such long-term and formalised environmental monitoring initiatives as the EU, is not well-understood.

To achieve global relevance alongside the numerous existing environmental indicator initiatives such as the Sustainable Development Goals (SDGs), the Convention on Biological Diversity (CBD), and The Paris Agreement, the implementation of the ESGAP framework needs to be feasible at the global scale. Here we present the results of a review of global environmental data to assess the feasibility of implementing the ESGAP framework in all countries, at different stages of development. We assess feasibility in terms of the availability of global environmental data, and in the absence of data used for the SES indicators suggest related proxy indicators that are supported by global environmental data. This use of proxy indicators permits the construction for each country of a globally applicable SES (gSES) index, which is closely related to the SES index for European countries.

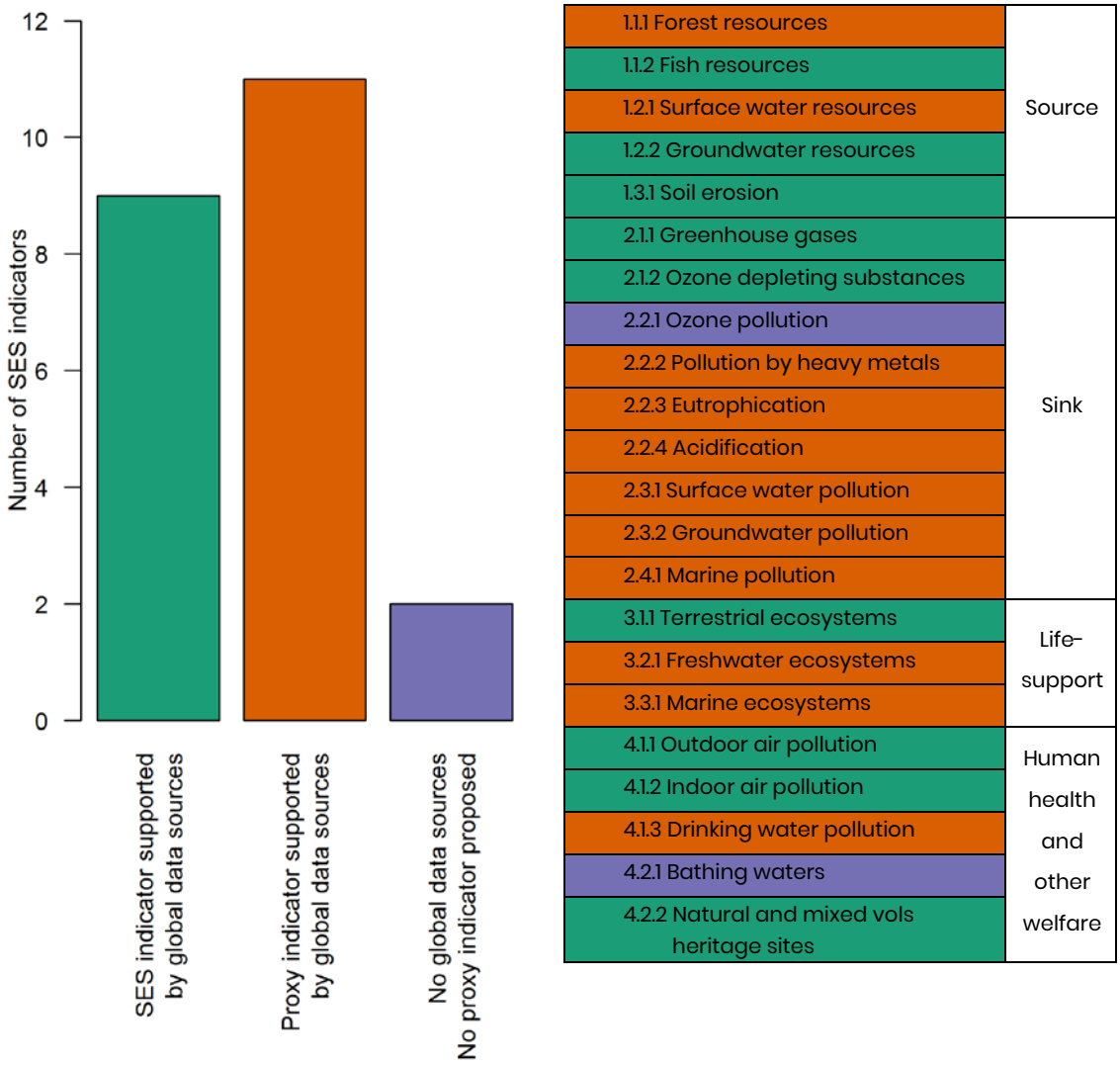
We also review existing international and regional environmental data, statistics and indicator initiatives, which may offer opportunities to increase the capacity of countries to produce the gSES index. To decrease the burden on countries to report on multiple indicator initiatives, we also assess the complementarity of the indicators used to compute the SES index in Europe to the SDG indicators. We identify synergies between the two indicator initiatives, and highlight opportunities for aligning the calculation of SES indicators with countries' existing efforts to calculate the SDG indicators. Finally, we highlight some emerging opportunities to collaborate with United Nations Environment Programme (UNEP) to fill data gaps that support both the ESGAP and SDG indicator initiatives.

The structure of the SES index used here follows the structure detailed in [2] which was presented at the *Second Meeting of the ESGAP Advisory Group* on 14th January at the European Environment Agency, Copenhagen.

2 Assessing the feasibility of implementing the ESGAP framework in all countries

We have identified sources of global data to support nine SES indicators (Figure 1). This includes **1.1.2 Fish resources**, **1.2.2 Groundwater resources**, **1.3.1 Soil erosion**, **2.1.1 Greenhouse gases**, **2.1.2 Ozone depleting substances**, **3.1.1 Terrestrial ecosystems**, **4.1.1 Outdoor air pollution**, **4.1.2 Indoor air pollution** and **4.2.2 Natural and mixed world heritage sites**. These data sources are described in detail in Section 2.1 and Annex 1.

Figure 1. Status of the 22 SES indicators in terms of global data sources



Note: Each indicator is classified into one of three groups: 1. SES indicators that are supported by global data sources (green), 2. SES indicators for which global data sources are available to support a proxy indicator (red), and 3. SES indicators for which no global data sources are available to support either a SES or a proxy indicator (blue).

For 11 SES indicators no global data sources exist to support the indicator, but we suggest that proxy indicators that utilise relevant global data sources are used to calculate related indicators for all countries (Figure 1). These indicators include **1.1.1 Forest resources**, **1.2.1 Surface water resources**, **2.2.2 Pollution by heavy metals**, **2.2.3 Eutrophication**, **2.2.4 Acidification**, **2.3.1 Surface water pollution**, **2.3.2 Groundwater pollution**, **2.4.1 Marine pollution**, **3.2.1 Freshwater ecosystems**, **3.3.1 Marine ecosystems**, **and 4.1.3 Drinking water pollution**. For some SES indicators, sources of global data exist for a subset of the parameters used in the European index, and we suggest a proxy indicator composed of this subset of parameters. For example, the proxy indicator for **4.1.3 Drinking water pollution** is limited to the measurement of one drinking water quality parameter (*E.coli*) using data produced by the WHO/UNICEF global drinking water monitoring programme [3]. For other indicators, we suggest that a relevant SDG indicator is used as a proxy indicator, when we have identified a relevant SDG indicator that is supported by global datasets. For example, we suggest that SDG 6.4.2 (Water withdrawal as a proportion of freshwater resources) is used as a proxy for the SES **1.2.1 Surface water resources indicator**. In Section 2.2 and Annex 1 we describe the global datasets to support these proxy indicators.

There are two SES indicators for which no global data sources exist to support their calculation (Figure 1). There are also no relevant global datasets that could support a proxy indicator. These indicators include **2.2.1 Ozone pollution** and **4.2.1 Bathing waters**. We discuss the data limitations of these indicators in Section 2.3 and Annex 1.

Beyond the absolute number of indicators for which global data sources are available, it is important to understand the number of indicators available for each broad environmental function category (Source, Sink, Life-support, and Human health and other welfare) (Figure 1). The SES indicators that can be applied globally are three indicators from the Source function (**1.1.2 Fish resources**, **1.2.2 Groundwate**r resources and **1.3.1 Soil erosion**), two indicators from the Sink function (**2.1.1 Greenhouse gases** and **2.1.2 Ozone depleting substances**), one indicator from the Life-support function (**3.1.1 Terrestrial ecosystems**), and three indicators from the Human health and other welfare function (**4.1.1 Outdoor air pollution**, **4.1.2 Indoor air pollution**, and **4.2.2 Natural and mixed world heritage sites**). The proxy indicators add two indicators from the Source function (**1.1.1 Forest resources** and **1.2.1 Surface water resources**), six indicators from the Sink function (**2.2.2 Pollution by heavy metals**, **2.2.3 Eutrophication**, **2.2.2 Acidification**, **2.3.1 Surface water pollution**, **2.3.2 Groundwater pollution** and **2.4.1 Marine pollution**), two indicators from the Life-support function (**3.2.1 Freshwater ecosystems** and **3.3.1 Marine ecosystems**), and one indicator from the Human health and other welfare function (**4.1.3 Drinking water pollution**). The gSES therefore comprises five Source indicators, eight Sink indicators, three Life-support indicators, and four indicators of Human health and other welfare. Beyond data sources, it should be noted that environmental standards might need to be adapted or alternative ones might need to be found when the proxy indicators chosen for the gSES differ from those used in the calculation of the European SES index.

2.1 Sources of global data to support SES indicators

Fish resources

Indicator: Fish stocks within safe biological limits

To produce the European SES indicator, data on landings, fishing pressure and stock size is used [4, 5]. Relevant global data is collated and reported by the Food and Agriculture Organisation of the United Nations (FAO). The FAO publish information on fish stock abundance and stock exploitation rates, which is used to assess the sustainability of exploitation rates of fish stocks. This data forms the basis of the FAO's biannual reviews of the state of the world's fisheries [6]. Estimates of stock abundance and exploitation rate are produced by the FAO but only reported at the scale of fishing areas (e.g. the Mediterranean and Black Sea area) rather than for countries which may make it more difficult to calculate this indicator [7]. It should be noted that the EU and the FAO use different criteria to assess stock status, but in principle both can be considered a science-based target.

Groundwater resources

Indicator: Groundwater bodies in good quantitative status

Data to support the European SES indicator is collected and reported by countries. This includes data on available groundwater and average annual rate of abstraction per groundwater body [8]. The FAO produce country statistics on total renewable groundwater and fresh groundwater withdrawal which is made available on their AQUASTAT platform [9]. Data come from government representatives and/or publications from within each respective country and are collected by questionnaire. The total renewable groundwater data are long-term average annual values and therefore remain the same over the years. The update frequency of the fresh groundwater withdrawal data depends on the country's compilation of the AQUASTAT annual questionnaire. Statistics are produced for 200+ countries and for different regions over an extensive time period (from 1960 to 2017).

Soil erosion

Indicator: Area with tolerable soil erosion

Global maps of soil erosion have been produced for 2001 and 2012 at a 25km spatial scale for 202 countries [10]. This data is accessible through the European Soil Data Centre (https://esdac.jrc.ec.europa.eu/content/global-soil-erosion).

Greenhouse gases

Indicator: Per-capita GHG/CO2 emissions

Global data on greenhouse gas (GHG) emissions is available form a number of sources. Most countries report GHG emission data to the UN Framework Convention on Climate Change (UNFCCC) [11]. The International Energy Agency produce annual CO2 emissions from fuel combustion and industrial activities for 190 countries plus regional aggregates [12]. The Atmosphere Monitoring Service as part of the Copernicus Programme provides daily forecasts of carbon dioxide up to five days in advance [13].The environmental standard would need to be adjusted depending on the emission sources (e.g. whether emissions from

agriculture, forestry and other land uses are considered) and GHGs covered in the emission dataset.

Ozone depleting substances

Indicator: Stratospheric ozone depleting substances

Global data is compiled and reported by the UN Environment Programme Ozone Secretariat [14]. Parties to the Montreal Protocol report annually to the Ozone Secretariat on consumption of controlled substances outlined in the Protocol.

Terrestrial ecosystems

Indicator: Terrestrial area with acceptable biodiversity levels

The PREDICTS project—Projecting Responses of Ecological Diversity In Changing Terrestrial Systems (www.predicts.org.uk)—has collated from published studies a large, reasonably representative database of comparable samples of biodiversity from multiple sites that differ in the nature or intensity of human impacts relating to land use [15]. Using this data statistical models have been developed to understand the relationship between biodiversity and land use [16]. These models remain under development, but are increasingly used, and will be updated as their assumptions are tested.

Outdoor air pollution

Indicator: Population exposed to safe levels of PM2.5

The World Health Organisation (WHO) collates data on particulate matter 2.5 concentrations from countries, measured by fixed-site, population-oriented monitors, to produce PM exposure indicators [17]. Modelling is used to overcome issues of variable spatial coverage of monitors, using satellite remote sensing, population estimates, topography and ground measurements. Since this indicator measures the same as the indicator used for the European SES index, there is no need to alter the environmental standard.

Indoor air pollution

Indicator: Population using clean fuels and technologies for cooking

The WHO collate and report global data on the proportion of households in a country relying mainly on polluting fuels and technologies for cooking [18], which they use as a proxy indicator for estimating population exposure to household air pollution.

Natural and mixed world heritage sites

Indicator: Natural and mixed world heritage sites in good conservation outlook

The International Union for Conservation of Nature (IUCN) World Heritage Outlook evaluates the conservation outlook of all World Heritage Sites using desk-based research [19]. The Conservation Outlook Assessments undertaken in 2014 established a baseline for monitoring the conservation outlook of sites over time. 2017 represents the first update of these assessments [20], and provides the first opportunity for comparison, and for tracking changes in the conservation outlook of natural World Heritage sites since 2014. The 2020

assessment is ongoing. This is the same dataset used in the calculation of the European SES index, so the standard would not be altered.

2.2 Sources of global data to support proxy SES indicators

Forest resources

Indicator: Forest utilization rate

To produce the European SES indicator, data on growing stock, increment and fellings is used [21]. Unfortunately, no global data on growing stock, increment and fellings is available. As a proxy, we suggest an indicator that makes use of global datasets on forest cover, which would align with the SDG indicator **15.1.1 Forest area**. A proxy standard could be no net loss of forest cover, with an aspiration to move towards a standard of net positive increase of forest cover. Nonetheless, the standard would need to be confirmed by experts. Relevant global datasets include the FAOs Global Forest Resources Assessments (FRA) [22] which are produced every five years in an attempt to provide a consistent approach to describing the world's forests and how they are changing. The Assessment is based on two primary sources of data: Country Reports prepared by National Correspondents and remote sensing that is conducted by FAO together with national focal points and regional partners. The compiled national assessment information provides a global dataset of forest cover. An alternative source of global forest cover data from satellite data alone has been produced for a fixed time period (2000-2012) [23]. This method could be used to supplement the FRA data if required.

Surface water resources

Indicator: Freshwater bodies not under water stress

The European SES indicator quantifies how much water is seasonally consumed (abstraction minus returns) as a proportion of freshwater availability at the level of the sub-basin [24]. Global data on water abstraction is available, but it is unclear whether global data is available on water return. The FAO compile relevant country-level data which is published on AQUASTAT [9], and produce a range of related but not identical indicators, which includes: 1. Total water withdrawals; 2. Total freshwater withdrawals; and 3. SDG 6.4.2 Water Stress. There is also data on precipitation, internal/external/exploitable water resources. An additional source of relevant global water data is produced by the United Nations Statistics Division (UNSD) who compile data from country questionnaires on freshwater abstraction, renewable freshwater resources, and precipitation [25].

With global data only available for water abstraction and not on water return, a proxy indicator that is focused on water abstraction at the country level can be used with a proxy standard of 20%, as used to be the case in the European Union until more detailed data was made available. This can nonetheless be problematic, because the same standard has been historically applied to define conditions of water stress independently from whether water abstraction or water consumption has been used in the numerator.

A potentially relevant SDG indicator is **6.4.2 Water withdrawal as a proportion of freshwater resources**. In this case, available freshwater resources represent total availability minus environmental flow requirements, the latter of which can be estimated in different ways. This indicator does not have a standard.

Pollution by heavy metals

Indicator: Ecosystems not exceeding the critical loads of cadmium / lead / mercury

Global mercury emissions, release and transport statistics are reported by the UN Environment Global Mercury Assessment [26] which provides the most recent information available for mercury at the global scale. National and regional air mercury monitoring networks and long-term research programs produce the data to analyse global spatial and temporal trends. There is potential that some national and regional data are available in countries that are not reported by the Assessment, and there is a lack of coverage in some world regions (i.e., Africa, Latin America and the Caribbean, Russia). Unfortunately, there are no sources of data on cadmium or lead at a global scale. It is also highly unlikely that critical load estimates have been produced for all countries. Therefore we suggest that a proxy indicator of **Mercury emissions** is used, with a proxy standard of zero emissions giving a directional target. This would need to be discussed with experts. There are also implications related to the normalisation process that should be considered.

Eutrophication

Indicator: Ecosystems not exceeding the critical loads of eutrophication

There is no global data available for eutrophication. However, there are ongoing international efforts to produce global eutrophication data. This provides options for supporting proxy indicators with novel methods. To support the **SDG Target 6.6 Water-related ecosystems**, UNEP is developing new strategies to measure the quality of water in ecosystems using remote sensing [27]. Data products from the Sentinel satellites are being used to quantify the trophic state of >30m lakes, whereby changes in trophic state will be used as a proxy for eutrophication. This approach may also support **SDG indicator 14.1.1 Coastal eutrophication**. UNEP has set a standard for this measurement at 50% deviation of trophic state from a defined baseline, and plan to test the validity of this standard and of the use of tropic state as a proxy for eutrophication [28]. To align with these efforts, we suggest that a proxy indicator for the SES could be **Lakes not exceeding the critical threshold of trophic state change** with a threshold value of 50% used until UNEP complete their assumptions testing of this methodology.

Acidification

Indicator: Ecosystems not exceeding the critical loads of acidification

There is no global data available for acidification. However, there are global datasets available on nitrogen and sulphur concentration and deposition data. This provides options for supporting proxy indicators with novel methods. Temporally limited global datasets have been produced for wet and dry deposition of inorganic nitrogen [29], and sulphate/sulphur dioxide concentration and deposition data [30]. Modelling has been used to estimate wet and dry deposition of inorganic nitrogen globally at a spatial resolution of

2° × 2.5° for 12 individual years in the period from 1984 to 2016. By collating and modelling sulphur dioxide and sulphate concentration and deposition data from different regional and global networks, in total 365 sites, global sulphur concentration and deposition trends and maps have been produced. However, it is highly unlikely that critical load estimates have been produced for all countries, which would hamper the estimation of their exceedance. Therefore we suggest that a proxy indicator of **Deposition of inorganic nitrogen / sulphur dioxide and sulphate** is used. An appropriate proxy standard needs to be discussed with experts.

Surface water pollution

Indicator: Surface water bodies in good chemical status

The general chemical elements included for monitoring the European SES indicator include: transparency, thermal conditions, oxygenation conditions, salinity, nutrient conditions, acidification status, pollution by priority substances and pollution by other substances identified as being discharged in significant quantities [8]. Global data for some, but not all, of these chemical elements are available from a range of sources. The UN Environment GEMStat portal [31] reports a large number of parameters from river, lake, reservoir and wetland monitoring stations that are relevant to this indicator, including: transparency, turbidity, dissolved oxygen, pH, salinity, and a large number of organisms/chemicals that may be relevant to nutrient content and/or pollution. The spatial coverage of monitoring stations which collect the data that is reported on GEMStat is highly spatially variable. The Copernicus Global Land Service produce turbidity data for medium and large-sized lakes [32]: turbidity, which describes water clarity, is a proxy for transparency. These satellite data products provide a semi-continuous observation record for a large number (nominally 1,000) of medium and large-sized lakes, according to the Global Lakes and Wetlands Database (GLWD) or otherwise of specific environmental monitoring interest. Data is available from 2002 to date.

Using these datasets a proxy indicator based on a limited set of parameters could be produced for all countries. The proxy indicator could be **Surface water bodies in good chemical status in terms of transparency, turbidity, dissolved oxygen, pH, salinity, pollution by priority substances and pollution by other substances identified as being discharged in significant quantities**. GEMStat could supply the data on the majority of parameters. In the case of turbidity, data for lakes of more consistent spatial coverage could be sourced from the Copernicus Global Land Service. The reference values that would grant surface water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.

Groundwater pollution

Indicator: Groundwater bodies in good chemical status

The general chemical elements included for monitoring the European SES indicator include: oxygen content, pH value, conductivity, nitrate, and ammonium [8]. Global data for some, but not all, of these chemical elements are available from a range of sources. The UN Environment GEMStat portal [31] reports global scale groundwater quality data from in-situ

groundwater monitoring stations. Relevant parameters include: dissolved oxygen, salinity, and nitrate. No data on pH or ammonium is reported. The spatial coverage of groundwater data is highly variable. Using this dataset a proxy indicator based on a limited set of parameters could be produced for all countries. The proxy indicator could be **Groundwater bodies in good chemical status in terms of oxygen content, conductivity and nitrate**. The reference values that would grant groundwater bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.

Marine pollution

Indicator: Coastal water bodies in good chemical status

The general chemical elements included for monitoring the European indicator include: transparency, thermal conditions, oxygenation conditions, salinity, nutrient conditions, acidification status, pollution by priority substances and pollution by other substances identified as being discharged in significant quantities [8]. Global data for some, but not all, of these chemical elements are available from the Copernicus Marine Environment Monitoring Service In Situ Thematic Assembly Centre [33]. The service provides access to a wide range of global datasets covering parameters including: sea temperature, salinity, electrical conductivity, sea density, sound velocity, horizontal current speed, other current components, sea level, wave parameters, dissolved oxygen, oxygen saturation, CO2 partial pressure, chlorophyll-a, total chlorophyll, turbidity, suspended matter, nitrate, and nitrite [34]. Using these datasets a proxy indicator based on a limited set of parameters could be produced for all countries. The proxy indicator could be **Coastal water bodies in good chemical status in terms of temperature, salinity, oxygenation conditions, turbidity, nitrate and nitrite**. The reference values that would grant marine water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed. An alternative proxy indicator may be **SDG 14.1.1 Index of coastal eutrophication and floating plastic debris density** which includes a number of chemical elements of the European SES indicator such as nutrient condition (including nitrogen, phosphate, silica and chlorophyll-a) and pollution substances (limited to plastic pollution). The methodology for producing this SDG indicator is currently under development and will be published in 2020 [35].

Freshwater ecosystems

Indicator: Surface water bodies in good ecological status

For the European SES indicator, the ecological status classification for the surface body of water is represented by the lower of the values for the biological and physico-chemical monitoring results which include: biological: phytoplankton, other aquatic flora, macro invertebrates, and fish, and physico-chemical: thermal conditions, oxygenation, salinity, nutrient status, acidification status [8]. Global data for some, but not all, of these ecological elements are available from a range of sources. The Copernicus Global Land Service produces the following relevant data for medium and large-sized lakes [32]: the trophic state index is an indicator of the productivity of a lake in terms of phytoplankton, and indirectly (over longer time scales) reflects the eutrophication status of a water body. The

UN Environment GEMStat portal [31] reports a phytoplankton parameter and a number of physico-chemical parameters including: dissolved oxygen, salinity, pH, and a large number of organisms/chemicals that may be relevant to nutrient content and/or pollution. There is no global data on thermal conditions, other aquatic flora, macro invertebrates or fish parameters. Using these datasets a proxy indicator based on a limited set of parameters could be produced for all countries. The proxy indicator could be **Surface water bodies in good ecological status in terms of oxygenation, salinity, nutrient status, acidification status and phytoplankton**. GEMStat could supply the data on the majority of parameters. In the case of phytoplankton, data for lakes of more consistent spatial coverage could be sourced from the Copernicus Global Land Service. The reference values that would grant surface water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed. The SES indicator is closely aligned with **SDG indicator 6.3.2 Water quality** and could be supported by the same datasets from the UN Environment GEMStat portal [31]. Therefore, it may also be possible to use SDG indicator 6.3.2 as a proxy indicator.

Marine ecosystems

Indicator: Coastal water bodies in good ecological status

The general elements included for monitoring the European indicator include: Biological elements (Composition, abundance and biomass of phytoplankton, Composition and abundance of other aquatic flora, and Composition and abundance of benthic invertebrate fauna), Hydro morphological elements supporting the biological elements (Morphological conditions: depth variation, structure and substrate of the coastal bed, structure of the intertidal zone. Tidal regime: direction of dominant currents, wave exposure) [8]. Global data for some, but not all, of these parameters are available from the Copernicus Marine Environment Monitoring Service In Situ Thematic Assembly Centre [33] and the Plymouth Marine Laboratory OceanColour platform [36]. The Copernicus Marine Environment Monitoring Service provides access to a wide range of global datasets covering parameters including: sea temperature, salinity, electrical conductivity, sea density, sound velocity, horizontal current speed, other current components, sea level, wave parameters, dissolved oxygen, oxygen saturation, CO2 partial pressure, chlorophyll-a, total chlorophyll, turbidity, suspended matter, nitrate, nitrite [34]. Global data on phytoplankton parameters are available from the Plymouth Marine Laboratory OceanColour platform. Using these datasets a proxy indicator based on a limited set of parameters could be produced for all countries. The proxy indicator could be **Coastal water bodies in good ecological status in terms of phytoplankton, current and wave parameters**. The reference values that would grant marine water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.

Drinking water pollution

Indicator: Samples that meet the drinking water criteria

The European SES indicator requires that 48 parameters are monitored and tested, including microbiological parameters (Escherichia coli and Enterococci), chemical

parameters (e.g. cyanide, benzene, mercury) and other indicator parameters (e.g. pH, ammonium, iron) [37]. Global data on drinking water is very limited in terms of these parameters. The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) [3] is collecting national data on a global scale on E.coli contamination of drinking water, which would meet one of the two microbiological parameters of the European indicator. Rather than monitor the presence of individual pathogens, faecal indicators are used to identify contamination. The bacteria species Escherichia coli (E. coli) is the most commonly recommended faecal indicator. The JMP use a standard that **No E. coli should be found in a 100 mL sample of drinking water** which is the same as the standard adopted in the European Drinking Water Directive [38]. Using this data, we recommend that a proxy indicator that is limited to a single microbiological parameter (E.coli) is used: **Samples that meet the drinking water criteria for E. coli**, based on the standard adopted by the JMP and the European Drinking Water Directive.

2.3 No global data sources to support SES or proxy indicators

Ozone pollution

Indicator: Cropland and forest area exposed to safe ozone levels

A monitoring station network in Europe produces the ozone deposition data that supports the European SES indicator [39-42]. There are no global datasets of ground-level ozone deposition. Global data on ozone concentrations in the atmosphere (starting at ~4km above ground level) are produced by the Copernicus Programme [43] and the National Oceanic and Atmospheric Administration (NOAA) [44], but this data would not be suitable for measuring exposure at ground-level.

Bathing waters

Indicator: Recreational water bodies that meet the 'excellent' quality criteria

The European SES indicator is based on water sample data collected by local authorities at officially identified bathing sites [45]. The samples are analysed for two types of bacteria (Intestinal Enterococci and Escherichia Coli) that indicate pollution from sewage or livestock. Depending on the levels of bacteria detected, the bathing water quality is classified as 'excellent', 'good', 'sufficient' or 'poor'. Despite there being water quality data on surface water at global scale, there is currently no water quality data collected at water bodies classified as 'recreational' at a global scale. Therefore, this indicator cannot be produced for all countries.

2.4 Data availability

We assessed the availability of the global data sources identified to support the SES and SES proxy indicators in terms of the number of UN Member States with publicly available data from at least two separate years, following the criteria used to calculate the European SES index [2]. Based on the percentage of UN Member States with data meeting this criteria, we classified each SES indicator into one of three groups: All (Publicly available data for at least two years for all UN Member States), Majority (Publicly available data for at least two years for >50% UN Member States), and Minority (Publicly available data for at least two years for <50% UN Member States). In the case of the **Natural and mixed world heritage sites** indicator, data is only available for the subset of UN Member States that contain a World Heritage Site (n=107). In this case we adjusted the data availability criteria to take this into account by calculating the percentage of UN Member States with data based on the total UN Member States containing a World Heritage Site. We exclude the **Fish resources** indicator from this assessment as the relevant global data is published at the scale of fishing areas rather than at the country scale.

Of the SES and proxy SES indicators supported by global data sources (n=20), 13 indicators are supported by data available for all UN Member States (Table 1). Two indicators are supported by data that is available for the majority (>50%) but not all of UN Member States, and four indicators are supported by data available for only a minority of UN Member States (<50%). This assessment reveals that the data that is available for the fewest countries tend to be those that support the SES indicators on surface water and groundwater. For these indicators it may be necessary to seek out regional and national datasets to support the calculation of these indicators in countries.

Table 1. Availability assessment of global data sources to support the SES and proxy SES indicators

SES Indicator	Percentage (number) of UN Member States	Data availability
1.1.1 Forest resources (P)	100 (193)	All
1.1.2 Fish resources*	-	-
1.2.1 Surface water resources (P)	83 (161)	Majority
1.2.2 Groundwater resources	40 (77)	Minority
1.3.1 Soil erosion	193 (100)	All
2.1.1 Greenhouse gases	69 (134)	Majority
2.1.2 Ozone depleting substances	100 (193)	All
2.2.1 Ozone pollution (N)	-	-
2.2.2 Pollution by heavy metals (P)	100 (193)	All
2.2.3 Eutrophication (P)	100 (193)	All
2.2.4 Acidification (P)	100 (193)	All
2.3.1 Surface water pollution (P)	A range of 1-38% (2-73) depending on which parameters are included in the indicator	Minority
2.3.2 Groundwater pollution (P)	A range of 10-19% (20-36) depending on which parameters are included in the indicator	Minority
2.4.1 Marine pollution (P)	100 (193)	All
3.1.1 Terrestrial ecosystems	100 (193)	All
3.2.1 Freshwater ecosystems (P)	A range of 1-38% (2-73) depending on which parameters are included in the indicator	Minority
3.3.1 Marine ecosystems (P)	100 (193)	All
4.1.1 Outdoor air pollution	100 (193)	All
4.1.2 Indoor air pollution	100 (193)	All
4.1.3 Drinking water pollution (P)	100 (193)	All
4.2.1 Bathing waters (N)	-	-
4.2.2 Natural and mixed world héritage sites	100 (107)	All

Note: P indicates the SES indicators for which proxy indicator data sources were assessed. N indicates SES indicators for which no global data sources are available and which are excluded from this assessment. **Fish resources** is highlighted with an * and excluded from this assessment as global data to support the indicator is not published at the country scale.

3 Capacity building for compilation and use of the SES

The SES is a proposed headline index designed to benchmark the performance of a country against science-based targets for 'strong' environmental sustainability.

Discussions concerning the ESGAP framework and the SES index are taking place in a wider context of proliferating efforts to (1) improve access and availability of data related to environmental sustainability, and (2) embed use of such data into national and local planning, development processes, poverty reduction strategies and other governance processes.

This Section summarises: (1) the practical capacity requirements for compilation and use of the SES indicators with a particular focus on the needs of low and middle income countries, (2) the extent to which these requirements are met globally in the context of relevant regional and global capacity building efforts concerning environmental data and sustainable development policy; and (3) practical next steps (and associated questions for discussion) to address capacity challenges concerning the implementation of the ESGAP framework.

3.1 Capacity requirements for the ESGAP and associated challenges

As a composite indicator that covers a wide range of topics, compilation of the SES index and its sub-indicators requires access to—and processing capacity for—a broad base of environmental data. Compilation and reporting of a consistent and comparable SES index across regular time intervals (e.g. annually) depends on a "value-chain" of underlying data and statistical accounting systems that meet international quality control standards (e.g. such as the Fundamental Principles of Official Statistics [46]).

An additional layer of institutional and governance processes is required to ensure that the SES index and indicators are integrated into public decision-making concerning the environment, and social and economic development more broadly in line with SDG 15.9 and 17.191. Table 2 summarises key activities required to compile and use the SES indicators, and associated capacity challenges at multiple levels of detail (high level: the SES index → low level: underlying national and global data-sets relevant to compilation of sub-indicators).

1 Text of SDG 15.9: "By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts." Text of SDG 17.19: "By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries."

Table 2. Activities and challenges of calculating the SES index

Compilation activities	Capacity challenges for compilation	Use activities	Capacity challenges for use
SES headline index	— Training and awareness raising on **compilation of headline indicator** from underlying sub-indicators	— **Public reporting** alongside other headline indicators (e.g. GDP) — **Internal reporting** as part of governance processes (e.g. national planning)	— Awareness / profile raising for the ESGAP framework with **political and senior policy stakeholders** — Mainstreaming of the ESGAP framework into **cross-cutting development processes, reporting and policy**
SES sub-indicators: n=22 currently	— Training and awareness raising on **compilation of sub-indicators** from underlying systems	— **Sector-specific public reporting** by line ministries (e.g. environmental performance) — **Sector-specific internal reporting** as part of relevant policy and governance processes	— Awareness / profile raising for the SES indicators with **specialist policy analysts & advisors** — Mainstreaming of the SES indicators into **sector-specific policies and governance processes**: e.g. fisheries, forestry, climate change, pollution control, agriculture, etc.
Statistical and accounting systems	— Incorporating SES input data into **national accounting systems** — Incorporating SES input data into **environmental statistics systems** — Processes and institutional frameworks for **regular updates of input data**	— **Technical analysis** of policy outcomes and options — **Preparation of summary reports and briefings** for senior leadership	— Training and awareness raising on **compilation and analysis of the SES indicators as a summary presentation** of underlying accounts / national statistics and/or global data sets.
Environmental data-sets	— Training and awareness raising on use of **global environmental datasets** — National **data inventories and acquisition plans** — **Data sharing arrangements** with key producers (e.g. universities, NGOs, IGOs, etc.) — **Data aggregation and processing**	— **Compilation of accounts** and other quality-controlled statistics from datasets relevant to the scope of the ESGAP	— Data **aggregation and processing** — **Interaction with low-level data platforms** and **data access**

Table 2 highlights that compilation and use of the SES index and indicators relies on a range of activities, skills and resources, that span multiple levels of analysis and decision-making. Undertaking all of these falls beyond the current capacity of many countries, in particular low- and middle- income countries. However current capacity challenges are increasingly surmountable given the proliferating range of environmental data initiatives that have close synergies with the ESGAP framework, as explained below.

3.2 Environmental data initiatives relevant to the ESGAP framework

- SDG indicators - the SDG initiative is driving developments in the production of environmental data and indicators, with each indicator having a custodian agency responsible for developing methodologies to produce the indicators and maintain their timely production and reporting. In addition to the activities of the indicator custodians, the Global Partnership for Sustainable Development Data (http://www.data4sdgs.org/) implements and supports a number of initiatives to improve data, data sharing and use to support sustainable development and the SDGs. There are various synergies between the ESGAP and the SDG indicators across multiple tiers (as reviewed in Section 4). I.e. several SES indicators can function as inputs to the compilation of SDG indicators, and a number of SDG indicators can be used as proxy indicators for the SES indicators.
- System of Environmental Economic Accounting (SEEA) [47] — is a standardised framework maintained by UN Statistics Division (UNSD) that integrates economic and environmental data to provide a more comprehensive and multipurpose view of the interrelationships between the economy and the environment and the stocks and changes in stocks of environmental assets, and associated flows of benefits. The SEEA Central Framework (SEEA CF) contains internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics and accounts. It follows a similar accounting structure as the System of National Accounts (SNA) and is designed to be inter-operable with the SNA. To date there are 86 countries (41 developed, 45 developing) that have compiled and/or published SEEA CF accounts [48]. These accounts form the basis of the statistical and accounting systems from which the SES index and sub-indicators can be compiled on a regular basis. Indicators are not currently specified in the SEEA CF methodology, and a suite of indicators are currently being tested in five pilot countries: Brazil, China, India, Mexico and South Africa [49, 50]. The SEEA promotes the integration of national environmental data which is typically disparate and poorly harmonized. However, the biggest barriers to the compilation of accounts in developing countries has been reported to be the availability and quality of data and a lack of consistent financial support from governments to support long-term implementation [51].
- UN SEEA Experimental Ecosystem Accounting (SEEA EEA) - is part of the SEEA and has been developed to monitor and report on ecosystem change and use, using the same accounting approach, concepts, and classifications as the SNA [52]. The methodology is currently under development, which is driving interesting research on methods to monitor ecosystems. For example, Earth Observations For Ecosystem Accounting is an initiative developing methods and tools to facilitate the use of earth observation data in ecosystem accounting (https://www.eo4ea.org/).
- Framework for Development of Environment Statistics (FDES)[53] — a flexible, multi-purpose conceptual and statistical framework, maintained by UNSD, that provides an organising structure to guide collection and compilation of environmental statistics at the national level. FDES is broader in scope than the SEEA with the latter focusing on relationships between the environment and economy from a national accounting perspective. National environmental statistics data is compiled by UNSD from country

questionnaires, UN agencies and other international sources [54]. These statistics are used to produce the UN's Environmental Indicators [55] which complement to some degree the SDG indicators [56]. Along similar lines to the SEEA, ongoing FDES implementation efforts in several countries could provide capacity needed to compile the SES for input data that falls beyond the scope of the SEEA.

- Group on Earth Observations (GEO) — is a partnership of 100+ national governments and 100+ Participating Organizations focused on better integration of observing systems, and sharing of data by connecting existing infrastructures using common standards. The wide range of ongoing GEO activities can reinforce capacity for compilation and use of the components of the SES index that rely on spatially explicit remote sensing data.
- UNEP initiatives on environmental aspects of sustainable development — including those undertaken in UNEP's capacity as custodian agency for 26 SDG indicators [57], and strategic initiatives such as the ongoing exploration of options and opportunities to establish a Digital Ecosystem for the Environment [58].
- The Food and Agriculture Organisation of the United Nations (FAO) - compiles and reports national, regional and global data and statistics on water, fisheries and agriculture, and supports countries to produce environmental data for reporting. FAO has been designated as the custodian agency for 21 SDG indicators, and it also contributes to a further four indicators. The FAO provide support to national statistics offices on how to produce timely and reliable data to monitor the SDG indicators under FAO custodianship through in-country support and e-learning resources [59].
- The UN Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) [60] - helps build national capacity to implement national forest monitoring systems. This involves developing satellite land monitoring systems to periodically collect spatial data on land cover and/or land use and its changes including deforestation and forest degradation, national forest inventories to collect information on forest carbon stocks and changes, and GHG estimates [61]. This data is used to support national SDG indicator production for Goals 13 (Climate Action) and 15 (Life on Land) in particular.
- UN Regional Commissions - are the regional outposts of the United Nations. Stationed in five regions of the world, they share the key objectives of aiming to foster economic integration at the sub-regional and regional levels, promoting the regional implementation of internationally agreed development goals, and to support regional sustainable development by contributing to bridging economic, social and environmental gaps among their member countries and sub-regions. They provide capacity building and technical assistance to countries to help them achieve their sustainable development ambitions, which includes environmental data production, management, use and dissemination. They also produce and report progress of their member countries in terms of the SDGs.
- The World Bank — leads an indicator initiative to broaden national wealth reporting from Gross Domestic Product (GDP) to indicators of comprehensive wealth which are calculated globally [62]. The Wealth Accounting and the Valuation of Ecosystems Services Partnership (WAVES) [63] aims to promote sustainable development by

ensuring that natural resources are mainstreamed in development planning and national economic accounts, focusing in particular on compilation and use of SEEA accounts. The Partnership has to date focused primarily on capacity building and analysis in Botswana, Colombia, Costa Rica, Guatemala, Indonesia, Madagascar, Philippines, Rwanda, Uganda, and Zambia.

- Global Ocean Accounts Partnership [64] — a newly established inter-governmental and multi-stakeholder partnership focused on developing a shared technical framework for environmental-economic accounting for oceans, associated headline indicators, and related capacity building.
- Regional and international development banks - provide medium- and long-term capital for productive investment, often accompanied by technical assistance. Banks such as the African Development Bank (www.afdb.org), Asian Development Bank (https://www.adb.org/), and the Inter-American Development Bank (www.iadb.org/) include the environment as a topic that they are able to finance and have committed to supporting the 2030 Agenda [65]. An example of work on indicators is the African Development Bank's work on Gender, Poverty and Environmental Indicators on African Countries [66].
- Capacity building in the Pacific region - there are a number of regional organisations that are particularly relevant to the location of the AFD first pilot project of the ESGAP in New Caledonia. This includes the UN Economic and Social Commission of Asia and the Pacific (UN ESCAP, https://www.unescap.org/) which is the relevant UN Regional Commission for New Caledonia. In addition, the Pacific Community (SPC, http://www.spc.int/) and the Secretariat of the Pacific Regional Environment Programme (SPREP, https://www.sprep.org/) both promote sustainable development in the Pacific region. SPREP focuses specifically on protecting and managing the environment and natural resources of the Pacific, while the SPC has a broader remit of development which includes a wide range of environmental topics including fisheries, climate change, land, geoscience and energy. These organisations are likely to support projects and initiatives that produce environmental data and have an interest in supporting the SDGs, with a particular focus on SDG 14 (Life under water).
- Convention on Biological Diversity (CBD) — including capacity building for monitoring of progress towards the Aichi Targets, and capacity building envisaged in the zero-draft of the post-2020 Global Biodiversity Framework relating specifically to the indicators referred to in the Framework [67]. These are particularly relevant to the ecological status components of the SES index.
- Paris Agreement on Climate Change — including the wide range of capacity building initiatives associated with the development of Nationally-Determined Contributions (NDC) by the States Parties to the agreement, and monitoring, reporting and verification (MRV) of these NDCs [68].
- Non-governmental organisations (NGO) - these actors are relevant to national-scale environmental initiatives. NGOs are often commissioned by national governments to deliver projects related to sustainable development, which may produce environmental data and feed into environmental indicator initiatives. For example, the World Wide Fund for Nature (WWF) was commissioned by the Government of Myanmar

to conduct a natural capital assessment [69], which led to the production of environmental data on ecosystem services which could feed into the production of a national environmental indicator. A wide range of projects are delivered by NGOs that produce environmental data, statistics and indicators. NGO activities across countries are heterogeneous and will be specific to the context of each country.

3.3 Practical next steps

In the above context, capacity for compilation and use of the SES index and indicators could be reinforced through coordination with the existing initiatives listed above (and others), exploiting the following synergies:

- Utility of the SES index as a headline indicator that can summarise lower level data and statistics (e.g. those developed through SEEA, FDES, GEO initiatives, etc.). For example, ongoing efforts by UNSD and WAVES have focused predominantly on the technical and capacity challenges associated with SEEA implementation, with less attention devoted to development of "front-end" headline indicators that could be derived from environmental-economic accounts.
- Utility of SES indicators as inputs to broader processes, such as ongoing efforts to compile SDG indicators, indicators associated with the CBD, and MRV processes for NDCs. In this case targeted efforts to compile the SES indicators can add value to broader processes, which unlocks opportunities for resourcing capacity building as a sub-component of wider processes.

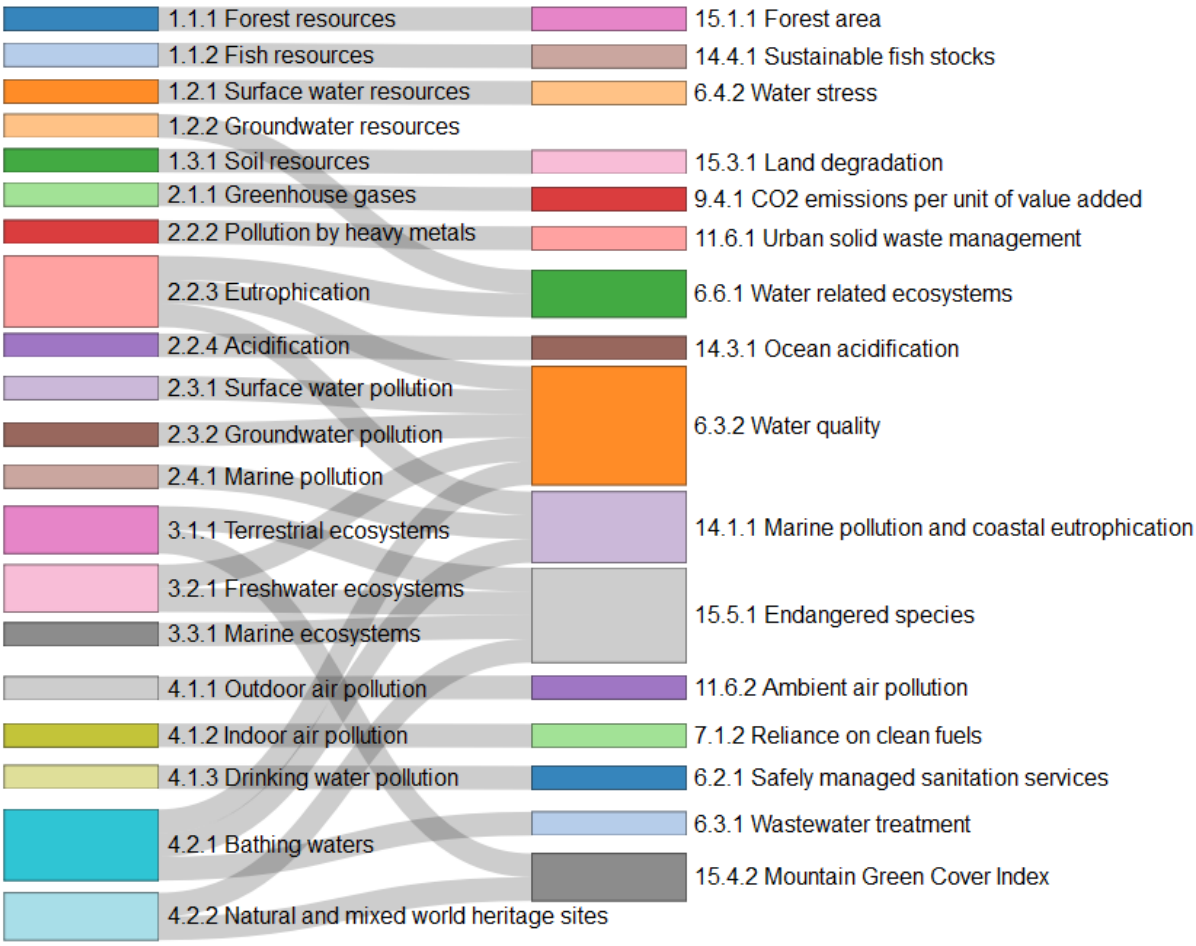
Capitalising on these synergies will depend, fundamentally, on ongoing and iterative dialogue between proponents of the ESGAP framework and the above listed initiatives.

4 Relationships between the SES and SDG indicators

4.1 Overview

Most SES indicators are related to one or more of those SDG indicators which measure the state of or pressures on the natural environment (e.g. 15.1.1 Forest area, 14.1.1 Marine pollution and coastal eutrophication) (Figure 2). Those SDG indicators focused on policy responses to environmental degradation (e.g. 11.4.1 Investment in cultural and natural heritage) may affect the SES in due course, but are less directly related to it. Twenty SES indicators are related in this sense to one or more SDG indicators, while two SES indicators have no such relation with the SDG indicators, namely **Ozone depleting substances** and **Ozone pollution**. The SES and proxy indicators have related indicators from eight of the 17 SDGs (Annex 2). They include **Goals 6. Water**, **7. Energy**, **9. Industry**, **11. Sustainable cities**, **13. Climate action** (the greenhouse gas indicator of which rather bizarrely is located under **SDG 9. Industry**), **14. Life below water**, and **15. Life on land**. Each of these SDGs is monitored by SDG indicators that are related to one or more SES indicators, except for Goal 13 whose environmental indicators are policy or human response focused so do not fulfil our inclusion criteria. See Annex 3 for details of the global data sources that support the SES-relevant SDG indicators. [70] and [71] provide a useful overview of the data that supports all the environmental SDG indicators.

Figure 2. Related SES (left) and SDG (right) indicators



4.2 Using SDG indicators as proxies and working with UNEP

Here we detail the suitability of SDG indicators for use as proxy SES indicators and the opportunities to work with the UN Environment Programme (UNEP) to produce global environmental data that could support the SES indicators. Information on the custodians of the relevant SDG indicators is sourced from [57].

Forest resources

SES indicator: Forest utilization rate

Related SDG indicators: 15.1.1 Forest area

Using the SDGs as proxy indicators: The related SDG indicator could be a reasonable proxy for the SES indicator. A proxy standard could be no net loss of forest cover, with an aspiration to move towards a standard of net positive increase of forest cover. Nonetheless, the standard would need to be confirmed by experts.

Working with UNEP on data: FAO is the custodian of the related SDG indicator.

Fish resources

SES indicator: Fish stocks within safe biological limits

Related SDG indicators: 14.4.1 Proportion of fish stocks within biologically sustainable levels

Using the SDGs as proxy indicators: The related SDG indicator is supported by the same global data that would support the SES indicator [7]. The related SDG indicator is closely aligned to the SES indicator and may be a suitable proxy.

Working with UNEP on data: FAO is the custodian of the related SDG indicator.

Surface water resources

SES indicator: Freshwater bodies not under water stress

Related SDG indicators: 6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

Using the SDGs as proxy indicators: The SES indicator is closely aligned with SDG indicator 6.4.2 but it does not include water return. If SDG indicator 6.4.2 is used as a proxy indicator it should be made clear that water return is not included.

Working with UNEP on data: FAO is the custodian of the related SDG indicator.

Groundwater resources

SES indicator: Groundwater bodies in good quantitative status

Related SDG indicators: 6.6.1 Change in the extent of water-related ecosystems over time

Using the SDGs as proxy indicators: The relevant SDG indicator does not include a measure of groundwater availability and therefore would not be a suitable proxy.

Working with UNEP on data: There is ongoing work to develop data to support SDG indicator 6.6.1, but UNEP acknowledge that this work is unlikely to produce global data on groundwater availability.

Soil erosion

SES indicator: Area with tolerable soil erosion

Related SDG indicators: 15.3.1 Proportion of land that is degraded over total land area

Using the SDGs as proxy indicators: The method of producing the relevant SDG indicator is focussed on soil condition (carbon) rather than erosion/degradation and therefore would not be a suitable proxy.

Working with UNEP on data: The UN Convention to Combat Desertification is the custodian of the related SDG indicator.

Greenhouse gases

SES indicator: Per-capita GHG/CO2 emissions

Related SDG indicators: 9.4.1 CO2 emission per unit of value added

Using the SDGs as proxy indicators: The related SDG indicator is based on CO2 emissions per unit per value added, rather than per-capita, and therefore is not a suitable proxy.

Working with UNEP on data: The UN Industrial Development Organisation and the International Energy Agency are the custodians of the related SDG indicator.

Ozone depleting substances

SES indicator: Per-capita consumption of ozone depleting substances

Related SDG indicators: No related SDG indicators.

Ozone pollution

SES indicator: Cropland and forested area exposed to safe ozone levels

Related SDG indicators: No related SDG indicators.

Pollution by heavy metals

SES indicator: Ecosystems not exceeding the critical loads of cadmium / lead / mercury

Related SDG indicators: 11.6.1 Urban solid waste management

Using the SDGs as proxy indicators: The relationship between this SES indicator and the related SDG indicator is fairly weak and we would not recommend it as a proxy.

Working with UNEP on data: UN-Habitat and UNSD are the custodians of the related SDG indicator.

Eutrophication

SES indicator: Ecosystems not exceeding the critical loads of eutrophication

Related SDG indicators: 6.3.2 Proportion of bodies of water with good ambient water quality; 6.6.1 Change in the extent of water-related ecosystems over time; 14.1.1 Index of coastal eutrophication and floating plastic debris density

Using the SDGs as proxy indicators: SDG indicator 6.3.2 uses data collected from in-situ sensors. To supplement this and to support SDG indicators 6.6.1 (Water-related ecosystems) and 14.1.1 (Coastal eutrophication) UNEP are developing methods using Sentinel satellite data to measure trophic state deviation of lakes >30m in size [27]. UNEP are using trophic state as the proxy indicator of eutrophication, and want to assess the validity of this proxy. In the future they will develop a method for quantifying eutrophication potential. In terms of a standard, they have set a threshold of 50% deviation of trophic state from a defined baseline, the assumptions of which need to be tested.

Working with UNEP on data: UNEP is the custodian of the related SDG indicators.

Acidification

SES indicator: Ecosystems not exceeding the critical loads of acidification

Related SDG indicators: 14.3.1 Average marine acidity (pH) measured at agreed suite of representative sampling stations

Using the SDGs as proxy indicators: To produce SDG indicator 14.3.1 ocean pH is measured by in-situ sensors and used to model global ocean acidity. National data is reported annually to the custodian of this indicator (UNESCO Intergovernmental Oceanographic Commission (IOC)) from a number of sources including National Statistical Offices, IOC national focal points, National Oceanographic Data Centres and other data providers [72]. The related SDG indicator is focused on the marine environment and therefore if used as a proxy would only cover a subset of the ecosystems included in the European SES indicator.
Working with UNEP on data: The UNESCO Intergovernmental Oceanographic Commission is the custodian of the related SDG indicator.

Surface water pollution

SES indicator: Surface water bodies in good chemical status

Related SDG indicators: 6.3.2 Proportion of bodies of water with good ambient water quality

Using the SDGs as proxy indicators: The parameters measured by SDG indicator 6.3.2 are not related to the SES indicator and we do not recommend that it is used as a proxy indicator.

Working with UNEP on data: UNEP is the custodian of the related SDG indicators.

Groundwater pollution

SES indicator: Groundwater bodies in good chemical status

Related SDG indicators: 6.3.2 Proportion of bodies of water with good ambient water quality

Using the SDGs as proxy indicators: The parameters measured by SDG indicator 6.3.2 are not related to the SES indicator and we do not recommend that it is used as a proxy indicator.

Working with UNEP on data: UNEP is the custodian of the related SDG indicators.

Marine pollution

SES indicator: Coastal water bodies in good chemical status

Related SDG indicators: 14.1.1 Index of coastal eutrophication and floating plastic debris density

Using the SDGs as proxy indicators: SDG indicator 14.1.1 and its sub-indicators 14.1.1a Index of Coastal Eutrophication and 14.1.1b Marine plastic debris are highly relevant to this SES indicator and could be used as a proxy indicator. Sub-indicator 14.1.1a includes the measurement and modelling of three nutrients (nitrogen, phosphate and silica) to produce an index of coastal eutrophication potential, alongside modelling of chlorophyll-a, using data from in-situ monitoring and remote sensing [35]. Sub-indicator 14.1.1b is focused on marine plastic pollution. These chemical elements and pollution substances cover a subset of the chemical elements included in the European SES indicator and therefore SDG 14.1.1 may be a reasonable proxy for the SES in all countries.

Working with UNEP on data: UNEP is the custodian of the related SDG indicator.

Terrestrial ecosystems

SES indicator: Terrestrial area with acceptable biodiversity levels

Related SDG indicators: 15.4.2 Mountain Green Cover Index; 15.5.1 Endangered species

Using the SDGs as proxy indicators: The Mountain Green Cover Index measures the changes of the green vegetation in mountain areas - i.e. forest, shrubs, trees, pasture land, crop land, etc. [73]. As this indicator is focused on land cover rather than biodiversity levels it would not be a suitable proxy indicator. The data underlying the Red List Index are compiled under the authority of the IUCN Red List Committee, through application of the IUCN Red List Categories & Criteria [74]. A wide range of species have been assessed using this methodology. It may be possible to use this data to produce a proxy indicator, although a scientific standard based on the Red List Index does not currently exist.

Working with UNEP on data: FAO and IUCN are the custodians of the related SDG indicators.

Freshwater ecosystems

SES indicator: Surface water bodies in good ecological status

Related SDG indicators: 6.3.2 Proportion of bodies of water with good ambient water quality; **15.5.1 Red List Index**

Using the SDGs as proxy indicators: The SES indicator is closely aligned with SDG indicator 6.3.2 and could be supported by the same datasets from the UN Environment GEMStat portal [31]. Therefore, it may be possible to use SDG indicator 6.3.2 as a proxy indicator. The data underlying the Red List Index are compiled under the authority of the IUCN Red List Committee, through application of the IUCN Red List Categories & Criteria [74]. A wide range of species have been assessed using this methodology including freshwater species. It may be possible to use this data to produce a proxy indicator, although a scientific standard based on the Red List Index does not currently exist.

Working with UNEP on data: UNEP and IUCN are the custodians of the related SDG indicators.

Marine ecosystems

SES indicator: Coastal water bodies in good ecological status

Related SDG indicators: 15.5.1 Red List Index

Using the SDGs as proxy indicators: The data underlying the Red List Index are compiled under the authority of the IUCN Red List Committee, through application of the IUCN Red List Categories & Criteria [74]. A wide range of species have been assessed using this methodology including marine species. It may be possible to use this data produce a proxy indicator, although a scientific standard based on the Red List Index does not currently exist.

Working with UNEP on data: IUCN are the custodians of the related SDG indicator.

Outdoor air pollution

SES indicator: Population exposed to safe levels of PM2.5

Related SDG indicators: 11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)

Using the SDGs as proxy indicators: Sources of data to support the related SDG indicator include ground measurements from monitoring networks, collected for 3,000 cities and localities around the world, satellite remote sensing, population estimates, topography, information on local monitoring networks and measures of specific contributors of air pollution [75]. The related SDG indicator is limited to urban areas and includes both PM2.5 and PM10. It uses the same source of data from the WHO as we recommend to support the SES indicator. Therefore it may constitute a suitable proxy for this indicator.

Working with UNEP on data: WHO are the custodians of the related SDG indicator.

Indoor air pollution

SES indicator: Population using clean fuels and technology for cooking

Related SDG indicators: 7.1.2: Proportion of population with primary reliance on clean fuels and technology

Using the SDGs as proxy indicators: Primary household fuels and technologies, particularly for cooking, is routinely collected at the national levels in most countries using censuses and surveys [76]. The WHO has responsibility for compiling a database of statistics on access to clean and polluting fuels and technologies harvested from the full global body of household surveys for cooking, heating and lighting. The same dataset that supports the SES indicator also supports the related SDG indicator. Therefore the related SDG indicator would be a suitable proxy indicator.

Working with UNEP on data: WHO are the custodians of the related SDG indicator.

Drinking water pollution

SES indicator: Samples that meet the drinking water criteria

Related SDG indicators: 6.2.1: Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water

Using the SDGs as proxy indicators: We suggest that data collected by the WHO/UNICEF Joint Monitoring Programme is used to support a proxy SES indicator in the absence of global data on the full suite of parameters included in the European SES indicator. Data from the JMP also supports the related SDG indicator. Therefore the related SDG indicator may be a suitable proxy.

Working with UNEP on data: WHO, UN-Habitat, UNSD and UNEP are the custodians of the related SDG indicators.

Bathing waters

SES indicator: Recreational water bodies that meet the 'excellent' quality criteria

Related SDG indicators: 6.3.1 Proportion of wastewater safely treated; 6.3.2 Proportion of bodies of water with good ambient water quality; 14.1.1 Index of coastal eutrophication and floating plastic debris density

Using the SDGs as proxy indicators: The classification of recreational water bodies is not included in the data underlying the related SDG indicators and we do not recommend them as proxies for the SES indicator.

Working with UNEP on data: UNEP, WHO, UN-Habitat and UNSD are the custodians of the related SDG indicators. UNEP are the custodians of SDG indicator 6.3.2 and are conducting ongoing research into developing datasets to support it using in-situ sensors, remote sensing and citizen science data.

Natural and mixed world heritage sites

SES indicator: Natural and mixed world heritage sites in good conservation outlook

Related SDG indicators: 15.4.2 Mountain Green Cover Index; 15.5.1 Endangered species

Using the SDGs as proxy indicators: The Mountain Green Cover Index measures the changes of the green vegetation in mountain areas - i.e. forest, shrubs, trees, pasture land, crop land, etc. [73]. The data underlying the Red List Index are compiled under the authority of the IUCN Red List Committee, through application of the IUCN Red List Categories & Criteria [74]. A wide range of species have been assessed using this methodology. The IUCN methodology of conservation outlook assessment used to produce the data that supports the SES indicator uses expert evaluation which draws on multiple information sources [20]. It is possible that the data supporting the related SDG indicators may be information sources that are drawn on in these assessments. However it is likely that this information constitutes only one of many information sources used in the assessments. Therefore the scope of the the related SDG indicators is likely to be too narrow for them to be suitable proxies for the SES indicator.

Working with UNEP on data: FAO and IUCN are the custodians of the related SDG indicators.

5 Summary and conclusions

Here we report on the feasibility of calculating the SES index for all countries. We find that nine of the 22 SES indicators are supported by global data and therefore could be calculated at a global scale. In addition, we recommend proxy indicators that are supported by global data for 11 SES indicators. Unfortunately, environmental data is not available at a global scale to calculate two SES indicators and therefore it is unlikely that these could be calculated for all countries. We detail a number of environmental data and indicator initiatives at the global, regional and national scales, with which collaboration would increase the capacity of countries to produce the SES index. We review the relationships between the SES and the SDG indicator initiatives, and report that the majority (n=20) of SES indicators are relevant to one or more SDG indicators, covering eight of the SDGs. This provides opportunities to reduce the burden on countries of calculating indicators for multiple initiatives, when efforts to produce indicators for the SDGs can also support SES indicator calculations. However, there are a number of challenges that limit the application of the SES indicators to all countries, including the lack of scientific standards for a number of proxy and SDG indicators, and limited availability of some global datasets.

We highlight a number of opportunities for using data produced by existing global data initiatives to support the calculation of the SES index in all countries. This includes nationally reported data collated by international organisations such as the forest cover and fisheries data compiled by the FAO [22, 77]. It also includes information extracted from remote sensing data such as the water quality data produced by the Copernicus Programme [32]. We report that there are exciting opportunities to collaborate with UNEP as they develop new methods to calculate SDG indicators, such as the use of satellite data to measure surface water eutrophication to calculate **SDG indicators 6.6.1 Water-related ecosystems** [27], and in-situ monitoring combined with remote sensing to calculate **SDG indicator 14.1.1 Marine pollution and coastal eutrophication** [35]. There are a number of SES indicators that have good links with some SDG indicators which illustrates the complementarity between these two indicator initiatives.

There are also a number of challenges to calculating the SES index in all countries. The most prominent is the two indicators for which we have found no global data to support their calculation in all countries. These indicators cover important environmental issues including ground-level ozone and recreational water quality. It is unlikely that data will become available at a global scale to support these indicators without developing new environmental data initiatives on these topics. Our assessment of data availability reveals that the data sources available for the fewest UN Member States tend to be those that support the SES indicators on surface water and groundwater. For these indicators it may be necessary to seek out regional and national datasets to support the calculation of these indicators in countries. We have reservations about some of the proxy indicators that we have suggested in terms of their methodology, standards and datasets. For example we have suggested a number of proxy indicators based on the availability of a limited set of parameters for water resources (**2.3.1 Surface water pollution**, **2.3.2 Groundwater pollution**, **2.4.1 Marine pollution**, and **3.2.1 Freshwater ecosystems**), but we are unsure how the status of water bodies can be classified as 'good' based on this limited parameter set. Likewise, it

would be recommendable to validate the selection of the proxies by checking the correlation between the SES indicators in the European version of the SES index and the proposed proxies.

The four environmental functions that structure the SES are associated with at least one indicator each that could be calculated for all countries using existing global datasets (**Source**: 1.1.2 Fish resources, 1.2.2 Groundwater resources, 1.3.1 Soil resources, **Sink**: 2.1.1 Greenhouse gases, 2.1.2 Ozone depleting substances, **Life-support**: 3.1.1 Terrestrial ecosystems, and **Human health and other welfare**: 4.1.1 Outdoor air pollution, 4.1.2 Indoor air pollution and 4.2.2 Natural and mixed world heritage sites). This bodes well for being able to say something about each of the four environmental functions in all countries, but it is unclear the extent to which these indicators are representative of the function. A statistical test using the European dataset could shed light into this. In principle, with the proxy indicators, 20 indicators closely related to the SES indicators could be used to calculate a globally applicable gSES index for all countries.

An important challenge is the capacity for all countries to calculate the SES index. There are a number of organisations and initiatives producing environmental data, statistics and indicators at the global, regional and national scales that could be drawn on to support national efforts to implement the ESGAP framework. This includes the environmental-economic accounting work of the UN SEEA initiative, the UN's environmental statistics work, the different UN agencies and Regional Commissions, international organisations such as the World Bank, international and regional development banks, and NGOs. Considering the location of the proposed AFD ESGAP pilot in New Caledonia, there are a number of relevant regional organisations that should be considered including the UN Economic and Social Commission of Asia and the Pacific (UN ESCAP), the Pacific Community (SPC) and the Secretariat of the Pacific Regional Environment Programme (SPREP). Aligning with the efforts of other organisations and initiatives will increase the capacity of countries to implement the ESGAP framework. Ultimately, pilot testing the implementation of the framework in a range of non-European countries is crucial to understand the capacity of countries to use the data sources that we have outlined.

To achieve global relevance alongside the numerous existing environmental indicator initiatives such as the SDGs, the CBD, and the Paris Agreement, the implementation of the ESGAP framework needs to be feasible at the global scale. We propose that two versions of the SES index are taken forward: 1. The European SES index, based on indicators and datasets available in Europe [2], and 2. The globally applicable gSES index composed of a subset of indicators from the European version and proxy indicators that use available global datasets. The gSES index will be based on a methodology that allows producing a national measure of strong environmental sustainability that is comparable across countries. If environmental data is available for a country or region that facilitates the production of some but not all of the SES indicators then it may be desirable to develop a country or region-specific version of the SES index which exploits high-quality environmental data when it is available. However it may be wise to continue to calculate the baseline gSES index to maintain comparability with other countries and regions.

This leads us to the conclusion that the ESGAP provides a framework with which to measure countries' environmental sustainability performance based on scientific standards. A

number of the framework's indicators could be calculated for all countries using global environmental data sets. There are also opportunities where proxy indicators could be used to make the most of existing environmental data streams and to align with the ongoing international efforts to produce the Sustainable Development Goal indicators. There remain a number of challenges to calculating the full suite of indicators in the ESGAP framework for all countries. Collaboration with international organisations such as UNEP could help to fill data gaps and pilot testing in a range of countries with less developed statistical systems is crucial to understand the capacity barriers to calculating the SES index in these countries.

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7 Annexes

Annex 1. SES indicators

- **Forest resources**

Indicator	Forest utilization rate
Status	Proxy indicator proposed supported by global data
European data source	EEA. 2017. Forest: growing stock, increment and fellings. Copenhagen: European Environment Agency.
Description of European data source	Data on growing stock, increment and fellings
Global data source	Hansen, M.C., et al., (2013) 'High-Resolution Global Maps of 21st-Century Forest Cover Change', Science, 342(6160): p. 850-853; Food and Agriculture Organisation of the United Nations. Global Forest Resources Assessments. 2019
Description of global data	Hansen et al. examined global Landsat data at a 30-meter spatial resolution to characterize forest extent, loss, and gain from 2000 to 2012. A range of datasets including forest cover loss, gain, and % tree cover are available at https://earthenginepartners.appspot.com/science-2013-global-forest. The data can be viewed at https://www.globalforestwatch.org/. The Global Forest Resources Assessments (FRA) are now produced every five years in an attempt to provide a consistent approach to describing the world's forests and how they are changing. The Assessment is based on two primary sources of data: Country Reports prepared by National Correspondents and remote sensing that is conducted by FAO together with national focal points and regional partners. The scope of the FRA has changed regularly since the first assessment published in 1948.
Limitations of global data	No global data on growing stock, increment and fellings.
Proxy indicator	Forest cover change
Proxy standard	To be defined. An appropriate standard needs to be discussed with experts. Suggestions: No net loss of forest cover
Related SDG indicators	15.1.1 Forest area as a proportion of total land area

- **Fish resources**

Indicator	Fish stocks within safe biological limits
Status	SES indicator supported by global data
European data source	EEA. 2018. Status of the assessed European fish stocks in relation to Good Environmental Status per regional sea. Copenhagen: European Environment Agency; EEA. 2019. Status of the assessed European commercial fish and shellfish stocks in relation to Good Environmental Status (GES) per EU marine region in 2015-2017. Copenhagen: European Environment Agency.
Description of European data source	Data used include landings from the International Council for the Explorations of the Sea (ICES), Eurostat and FAO, and stock assessments from ICES which include sustainable exploitation and full reproductive capacity, which are measured by fishing pressure and stock size in combination with a Maximum Sustainable Yield-based reference value. Indicator updated annually.
Global data source	FAO. Fisheries and Resources Monitoring System (FIRMS). 2020
Description of global data	The FAO publish information on fish stock abundance and stock exploitation rates, which is used to assess the sustainability of exploitation rates of fish stocks.
Limitations of global data	Estimates of stock abundance and exploitation rates are produced by the FAO but only reported at the scale of fishing areas (e.g. the Mediterranean and Black Sea area) rather than for countries which may make it more difficult to calculate this indicator.
Proxy indicator	
Proxy standard	
Related SDG indicators	14.4.1 Proportion of fish stocks within biologically sustainable levels

- **Surface water resources**

Indicator	Freshwater bodies not under water stress
Status	Proxy indicator proposed supported by global data
European data source	EEA. 2018. Use of freshwater resources. Copenhagen: European Environment Agency.
Description of European data source	The Water Exploitation Index+ (WEI+) provides a measure of the total water use as a percentage of the renewable freshwater resources for a given territory and time scale. The WEI+ is an advanced and geo-referenced implementation of the WEI. It quantifies how much water is monthly or seasonally abstracted and how much water is returned after use to the environment via basins. The difference between water abstraction and return is regarded as water use.
Global data source	Food and Agriculture Organisation of the United Nations. AQUASTAT - FAO's Global Information System on Water and Agriculture. 2019
Description of global data	The FAO compile relevant data which is published on AQUASTAT, and produce three relevant indicators: 1. Total water withdrawals; 2. Total freshwater withdrawals; and 3. SDG 6.4.2. Water Stress. There is also data in precipitation, internal/external/exploitable water resources.
Limitations of global data	The update frequency depends on the country's compilation of the AQUASTAT annual questionnaire. It is not clear if the FAO collect data on water return after use to the environment which would be required to produce the SES indicator. The standard of 20% water abstraction has been historically applied to define conditions of water stress independent from whether water abstraction or water consumption has been used in the numerator.
Proxy indicator	Water abstraction
Proxy standard	20% as it used to be the case in the European Union until more detailed data was made available.
Related SDG indicators	6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

- **Groundwater resources**

Indicator	Groundwater bodies in good quantitative status
Status	SES indicator supported by global data
European data source	EEA. 2018. European waters. Assessment of status and pressures 2018. No 7/2018. Copenhagen: European Environment Agency. EEA Report.
Description of European data source	Data collated by WISE-SoW database and reported by countries. Likely data to assess the quantitative status are: Available groundwater and average annual rate of abstraction.
Global data source	Food and Agriculture Organisation of the United Nations. AQUASTAT - FAO's Global Information System on Water and Agriculture. 2019
Description of global data	Country statistics on total renewable groundwater and fresh groundwater withdrawal produced by the FAO and made available on AQUASTAT. Statistics are produced for 200+ countries and for different regions over an extensive time period (from 1960 to 2017).
Limitations of global data	The update frequency depends on the country's compilation of the AQUASTAT annual questionnaire.
Proxy indicator	
Proxy standard	
Related SDG indicators	6.6.1 Change in the extent of water-related ecosystems over time

- **Soil resources**

Indicator	Area with tolerable soil erosion
Status	SES indicator supported by global data
European data source	Borrelli, P., D. A. et al. 2017. An assessment of the global impact of 21st century land use change on soil erosion. Nature Communications 8(1): 2013.
Description of European data source	An assessment of global soil erosion for 2001 and 2012 at 25km resolution.
Global data source	Same as European data
Description of global data	Same as European data
Limitations of global data	Data is only available for two years (2001 and 2012).
Proxy indicator	
Proxy standard	
Related SDG indicators	15.3.1 Proportion of land that is degraded over total land area

- **Greenhouse gases**

Indicator	Per-capita GHG/CO2 emissions
Status	SES indicator supported by global data
European data source	Eurostat. 2019. Greenhouse gas emissions by source sector. Luxembourg: Eurostat.
Description of European data source	The European Union (EU) as a party to the United Nations Framework Convention on Climate Change (UNFCCC) reports annually its greenhouse gas inventory for the year t-2 and within the area covered by its Member States.
Global data source	United Nations Framework Convention on Climate Change (UNFCCC). GHG data from UNFCCC. 2019; International Energy Agency (IEA), CO2 emissions from fuel combustion. 2019 edition. IEA: Paris, France; Atmosphere Monitoring Service (AMS). Global forecasts of greenhouse gases - carbon dioxide. 2019
Description of global data	Most countries report GHG emission data to the UNFCCC. The IEA produce annual CO2 emissions from fuel combustion and related indicators for 190 countries plus regional aggregates. The AMS as part of the Copernicus Programme provides daily forecasts of carbon dioxide up to five days in advance.
Limitations of global data	The environmental standard would need to be adjusted depending on the emission sources (e.g. whether emissions from agriculture, forestry and other land uses are considered) and GHGs covered in the emission dataset.
Proxy indicator	
Proxy standard	
Related SDG indicators	9.4.1 CO2 emission per unit of value added

- **Ozone depleting substances**

Indicator	Stratospheric ozone depleting substances
Status	SES indicator supported by global data
European data source	Ozone Secretariat United Nations Environment Programme. 2019. Data centre. Secretariat for The Vienna Convention for the Protection of the Ozone Layer & The Montreal Protocol on Substances that Deplete the Ozone Layer.
Description of European data source	Parties to the Montreal Protocol report annually to the Ozone Secretariat on consumption of controlled substances outlined in the Protocol.
Global data source	Same as European data
Description of global data	Same as European data
Limitations of global data	
Proxy indicator	
Proxy standard	
Related SDG indicators	

- **Ozone pollution**

Indicator	Cropland and forest area exposed to safe ozone levels
Status	No global data available. No proxy indicator proposed
European data source	Horálek, J., P. d. et al. 2015. European air quality maps of PM and ozone for 2012 and their uncertainty. 2014/4. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.; Horálek, J., P. d. et al. 2016a. European air quality maps for 2014 PM10, PM2.5, Ozone, NO2 and NOx spatial estimates and their uncertainties. 2016/6. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.; Horálek, J., P. d. et al. 2016b. European air quality maps of PM and ozone for 2013 and their uncertainty. 2015/5. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.; Horálek, J., P. d. et al. 2018. European air quality maps for 2015 PM10, PM2.5, Ozone, NO2 and NOx spatial estimates and their uncertainties. 2017/7. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.
Description of European data source	Monitoring station network in Europe produces ozone deposition data, which is interpolated with a model. Other variables used in the model includes altitude, meteorological parameters land cover and road type.
Global data source	
Description of global data	
Limitations of global data	
Proxy indicator	
Proxy standard	
Related SDG indicators	

- **Pollution by heavy metals**

Indicator	Ecosystems not exceeding the critical loads of cadmium / lead / mercury
Status	Proxy indicator proposed supported by global data
European data source	Hettelingh, J.-P. et al. 2015. Critical Loads of Cadmium, Lead and Mercury and Their Exceedances in Europe. In Critical Loads and Dynamic Risk Assessments: Nitrogen, Acidity and Metals in Terrestrial and Aquatic Ecosystems, edited by W. de Vries, et al. Dordrecht: Springer Netherlands.
Description of European data source	Data is produced from nationally reported monitoring data and modelled projections. Input data to the model include meteorological information, emission data and geophysical information (land cover distribution, soil properties etc.).
Global data source	United Nations Environment, Global Mercury Assessment 2018, 2019, United Nations Environment Programme, Chemicals and Health Branch: Geneva, Switzerland
Description of global data	National and regional air mercury monitoring networks and long-term research programs produce the data to analyse global spatial and temporal trends.
Limitations of global data	There is a lack of coverage in some world regions (i.e., Africa, Latin America and the Caribbean, Russia) in the UNEP Global Assessment of Mercury. It is highly unlikely that critical load estimates have been produced for most developing countries. No global datasets of cadmium or lead are available.
Proxy indicator	Mercury emissions
Proxy standard	Zero emissions giving a directional target. This would need to be discussed with experts. There are also implications related to the normalisation process that should be considered.
Related SDG indicators	11.6.1 Urban solid waste management

- **Eutrophication**

Indicator	Ecosystems not exceeding the critical loads of eutrophication
Status	Proxy indicator proposed supported by global data
European data source	Hettelingh, J.-P. et al. 2017. European critical loads: database, biodiversity and ecosystems at risk. CCE Final Report 2017. RIVM Report 2017-0155. Bilthoven: Coordination Centre for Effects.
Description of European data source	National data is provided by a few countries in Europe. There is also a database of data on all European countries. The following data is used to calculate critical loads of N and S: Land cover, soil properties, forest regions, distance to coast, altitude, habitat suitability, meteorology and hydrology, and soil chemical variables.
Global data source	United Nations Environment Programme. SDG 6.6.1 Water-Related Ecosystems. 2020 Available: https://www.sdg661.app/
Description of global data	UNEP collate data using in-situ sensors to support SDG Indicator 6.3.2. To support SDG Indicators 6.6.1 and 14.1.1 UNEP are developing methods using Sentinel satellite data to measure trophic state deviation of lakes >30m in size.
Limitations of global data	There is a lack of evidence to support the use of trophic state as a proxy measure for eutrophication. It is highly unlikely that critical load estimates have been produced for most developing countries, which would hamper the estimation of their exceedance.
Proxy indicator	Trophic state change of lakes
Proxy standard	To be defined. UN Environment has set a standard for this measurement at 50% deviation of trophic state from a defined baseline, and plan to test the validity of this standard and of the use of tropic state as a proxy for eutrophication.
Related SDG indicators	6.6.1 Water-related ecosystems: Wetland extent trend index; 6.3.2 Proportion of bodies of water with good ambient water quality; 14.1.1 Index of coastal eutrophication and floating plastic debris density

- **Acidification**

Indicator	Ecosystems not exceeding the critical loads of acidification
Status	Proxy indicator proposed supported by global data
European data source	Hettelingh, J.-P. et al. 2017. European critical loads: database, biodiversity and ecosystems at risk. CCE Final Report 2017. RIVM Report 2017-0155. Bilthoven: Coordination Centre for Effects.
Description of European data source	National data is provided by a few countries in Europe. There is also a database of data on all European countries. The following data is used to calculate critical loads of N and S: Land cover, soil properties, forest regions, distance to coast, altitude, habitat suitability, meteorology and hydrology, and soil chemical variables.
Global data source	Ackerman, D. et al. (2019) 'Global Estimates of Inorganic Nitrogen Deposition Across Four Decades', Global Biogeochemical Cycles, 33(1): p. 100-107; Aas, W., et al., (2019) 'Global and regional trends of atmospheric sulfur', Scientific Reports, 9(1): p. 953
Description of global data	Ackerman et al. use modelling to estimate wet and dry deposition of inorganic nitrogen globally at a spatial resolution of 2° × 2.5° for 12 individual years in the period from 1984 to 2016; Aas et al. collate and model SO2 and sulphate concentration and deposition data from different regional and global networks, in total 365 sites, to produce global sulphur concentration and deposition trends and maps
Limitations of global data	Ackerman et al. (2019): Data is only available up to 2016. Aas et al. (2019): Data is only available up to 2015.
Proxy indicator	Deposition of inorganic nitrogen / sulphur dioxide and sulphate
Proxy standard	To be defined. An appropriate proxy standard needs to be discussed with experts
Related SDG indicators	14.3.1 Ocean acidification

- **Surface water pollution**

Indicator	Surface water bodies in good chemical status
Status	Proxy indicator proposed supported by global data
European data source	EEA. 2018. European waters. Assessment of status and pressures 2018. No 7/2018. Copenhagen: European Environment Agency. EEA Report.
Description of European data source	The Water Framework Directive states general chemical elements for monitoring including: transparency, thermal conditions, oxygenation conditions, salinity, nutrient conditions, acidification status, pollution by priority substances and pollution by other substances identified as being discharged in significant quantities. Water body status is monitored using in-situ monitoring stations.
Global data source	European Commission. Copernicus Global Land Service. Lake Water Quality. 2019; UN Environment. GEMStat Data Portal. 2019
Description of global data	Copernicus Programme provides turbidity data for medium and large-sized lakes. GEMStat report a large number of parameters from river, lake, reservoir and wetland monitoring stations that are relevant to this indicator, including: transparency, turbidity, dissolved oxygen, pH, salinity, and a large number of organisms/chemicals that may be relevant to nutrient content and/or pollution.
Limitations of global data	Copernicus data is limited to lakes and only one relevant parameter (turbidity). Spatial coverage of GEMStat global monitoring stations is variable. The reference values that would grant surface water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.
Proxy indicator	Good chemical status in terms of transparency, turbidity, dissolved oxygen, pH, salinity, pollution by priority substances and pollution by other substances identified as being discharged in significant quantities.
Proxy standard	To be defined. An appropriate standard needs to be discussed with experts.
Related SDG indicators	6.3.2 Proportion of bodies of water with good ambient water quality

- **Groundwater pollution**

Indicator	Groundwater bodies in good chemical status
Status	Proxy indicator proposed supported by global data
European data source	EEA. 2018. European waters. Assessment of status and pressures 2018. No 7/2018. Copenhagen: European Environment Agency. EEA Report.
Description of European data source	Parameters for the determination of this indicator are: oxygen content, pH value, conductivity, nitrate, and ammonium. Water body status is monitored using in-situ monitoring stations.
Global data source	UN Environment. GEMStat Data Portal. 2019
Description of global data	National water quality data which includes data from in-situ groundwater monitoring stations. Relevant parameters include: dissolved oxygen, salinity, nitrate. No data on pH or ammonium.
Limitations of global data	The spatial coverage of groundwater data is not very comprehensive, and only three of the five parameters used by the European indicator are reported. The reference values that would grant groundwater bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.
Proxy indicator	Groundwater bodies in good chemical status in terms of oxygen content, conductivity and nitrate
Proxy standard	To be defined. An appropriate standard needs to be discussed with experts.
Related SDG indicators	6.3.2 Proportion of bodies of water with good ambient water quality

- **Marine pollution**

Indicator	Coastal water bodies in good chemical status
Status	Proxy indicator proposed supported by global data
European data source	EEA. 2018. European waters. Assessment of status and pressures 2018. No 7/2018. Copenhagen: European Environment Agency. EEA Report.
Description of European data source	The Water Framework Directive advises for coastal waters, parameters include: Chemical and physico-chemical elements supporting the biological elements (General: Transparency, Thermal conditions, Oxygenation conditions, Salinity, Nutrient conditions. Specific pollutants: Pollution by all priority substances identified as being discharged into the body of water, Pollution by other substances identified as being discharged in significant quantities into the body of water). Water body status is monitored using in-situ monitoring stations.
Global data source	Copernicus Marine In Situ Tac Data Management Team. CMEMS In Situ TAC. Copernicus Marine Environment Service In Situ Thematic Assembly Centre. 2020
Description of global data	Data available from the Copernicus Marine Environment Monitoring Service on sea temperature, salinity, oxygenation conditions, turbidity, nitrate and nitrite.
Limitations of global data	The reference values that would grant surface water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.
Proxy indicator	Coastal water bodies in good chemical status in terms of temperature, salinity, oxygenation conditions, turbidity, nitrate and nitrite.
Proxy standard	To be defined. An appropriate standard needs to be discussed with experts.
Related SDG indicators	14.1.1 Index of coastal eutrophication and floating plastic debris density

- **Terrestrial ecosystems**

Indicator	Terrestrial area with acceptable biodiversity levels
Status	SES indicator supported by global data
European data source	Usubiaga-Liaño, A. et al. 2019. Limits to agricultural land for retaining acceptable levels of local biodiversity. Nature Sustainability 2(6): 491-498.
Description of European data source	The PREDICTS project—Projecting Responses of Ecological Diversity In Changing Terrestrial Systems (www.predicts.org.uk)—has collated from published studies a large, reasonably representative database of comparable samples of biodiversity from multiple sites that differ in the nature or intensity of human impacts relating to land use. Using this data statistical models have been developed to understand the relationship between biodiversity and land use.
Global data source	Same as European data
Description of global data	Same as European data
Limitations of global data	Model is based on assumptions that may not hold, such as the relationship between biodiversity and land use being constant across biomes. These assumptions are likely to be tested in the future and the model remains under development.
Proxy indicator	
Proxy standard	
Related SDG indicators	15.4.2 Mountain Green Cover Index; 15.5.1 Endangered species

- **Freshwater ecosystems**

Indicator	Surface water bodies in good ecological status
Status	Proxy indicator proposed supported by global data
European data source	EEA. 2018. European waters. Assessment of status and pressures 2018. No 7/2018. Copenhagen: European Environment Agency. EEA Report.
Description of European data source	The Water Framework Directive advises for surface water, the ecological status classification for the body of water shall be represented by the lower of the values for the biological and physico-chemical monitoring results which include: biological: phytoplankton, other aquatic flora, macro invertebrates, and fish, and physico-chemical: thermal conditions, oxygenation, salinity, nutrient status, acidification status. Water body status is monitored using in-situ monitoring stations.
Global data source	European Commission. Copernicus Global Land Service. Lake Water Quality. 2019; UN Environment. GEMStat Data Portal. 2019
Description of global data	The Copernicus satellite produces the following relevant data for medium and large-sized lakes: The trophic state index is an indicator of the productivity of a lake in terms of phytoplankton, and indirectly (over longer time scales) reflects the eutrophication status of a water body. GEMStat report a phytoplankton parameter and a number of physico-chemical parameters including: dissolved oxygen, salinity, pH, and a large number of organisms/chemicals that may be relevant to nutrient content and/or pollution. No global data on thermal conditions, other aquatic flora, macro invertebrates and fish.
Limitations of global data	No global data on thermal conditions, other aquatic flora, macro invertebrates and fish. GEMStat spatial data coverage is highly variable. The reference values that would grant surface water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.
Proxy indicator	Surface water bodies in good ecological status in terms of oxygenation, salinity, nutrient status, acidification status and phytoplankton (medium and large-sized lakes only)
Proxy standard	To be defined. An appropriate standard needs to be discussed with experts.
Related SDG indicators	6.3.2 Proportion of bodies of water with good ambient water quality

- **Marine ecosystems**

Indicator	Coastal water bodies in good ecological status
Status	Proxy indicator proposed supported by global data
European data source	EEA. 2018. European waters. Assessment of status and pressures 2018. No 7/2018. Copenhagen: European Environment Agency. EEA Report.
Description of European data source	The Water Framework Directive advises for coastal waters, parameters include: Biological elements (Composition, abundance and biomass of phytoplankton, Composition and abundance of other aquatic flora, and Composition and abundance of benthic invertebrate fauna), Hydromorphological elements supporting the biological elements (Morphological conditions: depth variation, structure and substrate of the coastal bed, structure of the intertidal zone. Tidal regime: direction of dominant currents, wave exposure). Water body status is monitored using in-situ monitoring stations.
Global data source	Plymouth Marine Laboratory. OceanColour - CCI. 2020; Copernicus Marine In Situ Tac Data Management Team. CMEMS In Situ TAC. Copernicus Marine Environment Service In Situ Thematic Assembly Centre. 2020
Description of global data	Data available from Plymouth Marine Laboratory on: phytoplankton. Data available from the Copernicus Marine Environment Monitoring Service on: currents and wave parameters
Limitations of global data	No global data to support the hydromorphological parameters. The reference values that would grant surface water bodies a status of 'good' are likely to be body-specific. Therefore information that classifies water bodies according to their specific status rather than values of the parameters in relation to general thresholds is needed.
Proxy indicator	Coastal water bodies in good chemical status in terms of phytoplankton, current and wave parameters.
Proxy standard	To be defined. An appropriate standard needs to be discussed with experts.
Related SDG indicators	15.5.1 Endangered species

- **Outdoor air pollution**

Indicator	Population exposed to safe levels of PM2.5
Status	SES indicator supported by global data
European data source	Horálek, J., P. d. et al. 2015. European air quality maps of PM and ozone for 2012 and their uncertainty. 2014/4. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.; Horálek, J., P. d. et al. 2016a. European air quality maps for 2014 PM10, PM2.5, Ozone, NO2 and NOx spatial estimates and their uncertainties. 2016/6. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.; Horálek, J., P. d. et al. 2016b. European air quality maps of PM and ozone for 2013 and their uncertainty. 2015/5. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.; Horálek, J., P. d. et al. 2018. European air quality maps for 2015 PM10, PM2.5, Ozone, NO2 and NOx spatial estimates and their uncertainties. 2017/7. Bilthoven: European Topic Centre on Air Pollution and Climate Change Mitigation. ETC/ACM Technical Paper.
Description of European data source	Air quality station monitoring data is modelled to produce air quality maps for a range of pollutants including PM10, PM2.5, ozone, nitrogen dioxide and nitrogen.
Global data source	World Health Organisation. Global Health Observatory (GHO) data. 2019
Description of global data	The WHO collate data on particulate matter concentrations (PM10 and PM2.5) from countries, measured by fixed-site, population-oriented monitors, to produce PM exposure indicators. Modelling is used to overcome issues of variable spatial coverage of monitors, using satellite remote sensing, population estimates, topography and ground measurements.
Limitations of global data	Spatial coverage of monitors is variable.
Proxy indicator	
Proxy standard	
Related SDG indicators	11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)

- **Indoor air pollution**

Indicator	Population using clean fuels and technologies for cooking
Status	SES indicator supported by global data
European data source	World Health Organisation, Percentage of the population using clean and polluting fuels and technologies for cooking, 2018, World Health Organisation: Geneva, Switzerland
Description of European data source	Information on the types of technologies and fuels used by households for cooking is regularly collected on nationally representative household surveys or censuses. WHO regularly collects and compiles such household energy data in the WHO Household energy database.
Global data source	Same as European data
Description of global data	Same as European data
Limitations of global data	
Proxy indicator	
Proxy standard	
Related SDG indicators	7.1.2 Proportion of population with primary reliance on clean fuels and technology

- **Drinking water pollution**

Indicator	Samples that meet the drinking water criteria
Status	Proxy indicator proposed supported by global data
European data source	EC. 2016. Synthesis Report on the Quality of Drinking Water in the Union examining Member States' reports for the 2011-2013 period, foreseen under Article 13(5) of Directive 98/83/EC. COM(2016) 666 final. Brussels.
Description of European data source	The Directive sets standards for the most common potentially harmful organisms and substances that can be found in drinking water. A total of 48 essential parameters must be monitored and tested regularly. This includes microbiological (Escherichia coli and Enterococci), chemical (e.g. cyanide, benzene, mercury) and indicator (e.g. pH, ammonium, iron) parameters. Drinking water samples are tested and reported by Member States according to the Directive.
Global data source	WHO/UNICEF, Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines, 2017, World Health Organization (WHO) and the United Nations Children's Fund (UNICEF): Geneva, Switzerland
Description of global data	The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) collects national data on a global scale on E.coli contamination of drinking water, which would meet one of the two microbiological parameters of the European indicator. The bacteria species Escherichia coli (E. coli) is the most commonly recommended faecal indicator. The JMP use a standard that No E. coli should be found in a 100 mL sample of drinking water which is the same as the standard adopted in the European Drinking Water Directive
Limitations of global data	JMP only collect data on a single parameter
Proxy indicator	Samples that meet the drinking water criteria for E. coli
Proxy standard	No E. coli should be found in a 100 mL sample of drinking water
Related SDG indicators	6.2.1: Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water

- **Bathing waters**

Indicator	Recreational water bodies in excellent status
Status	No global data available. No proxy indicator proposed
European data source	EEA. 2019. Country reports 2018 bathing season. Copenhagen: European Environment Agency.
Description of European data source	Local authorities collect water samples at officially identified bathing. The samples are then analysed for two types of bacteria that indicate pollution from sewage or livestock (Intestinal Enterococci and Escherichia Coli). Depending on the levels of bacteria detected, the bathing water quality is classified as 'excellent', 'good', 'sufficient' or 'poor'.
Global data source	
Description of global data	
Limitations of global data	
Proxy indicator	
Proxy standard	
Related SDG indicators	6.3.1 Proportion of wastewater safely treated; 6.3.2 Proportion of bodies of water with good ambient water quality; 14.1.1 Index of coastal eutrophication and floating plastic debris density

- **Natural and mixed world heritage sites**

Indicator	Natural and mixed world heritage sites in good conservation outlook
Status	SES indicator supported by global data
European data source	Osipova, E. et al. 2014. IUCN World Heritage Outlook 2014: A conservation assessment of all natural World Heritage sites. Gland: International Union for the Conservation of Nature.; Osipova, E. et al. 2017. IUCN World Heritage Outlook 2: A conservation assessment of all natural World Heritage sites. Gland: International Union for the Conservation of Nature.
Description of European data source	The IUCN World Heritage Outlook evaluates the conservation outlook of all World Heritage Sites using desk-based research. The Conservation Outlook Assessments undertaken in 2014 established a baseline for monitoring the conservation outlook of sites over time. 2017 represents the first update of these assessments, and provides the first opportunity for comparison, and for tracking changes in the conservation outlook of natural World Heritage sites since 2014. The 2020 assessment is ongoing. Good conservation outlook based on three elements: the current state and trend of values, the threats affecting those values, and the effectiveness of protection and management.
Global data source	Same as European data
Description of global data	Same as European data
Limitations of global data	
Proxy indicator	
Proxy standard	
Related SDG indicators	15.4.2 Mountain Green Cover Index; 15.5.1 Endangered species

7 Annexes

Annex 2. How the SES indicators relate to the Sustainable Development Goals

Table A1. SES and proxy indicators are reported alongside related SDG indicators

SDGs	SES indicators supported by global data	Proxy SES indicators supported by global data	SES indicators without global data or proxy indicators	SDG indicators relating to natural capital
	No SES indicators			
	No SES indicators			
	No SES indicators			
	No SES indicators			
	No SES indicators			
		1.2.1 Surface water resources; 1.2.2 Groundwater resources; 2.2.3 Eutrophication; 2.3.1 Surface water pollution; 2.3.2 Groundwater pollution; 3.2.1 Freshwater ecosystems; 4.1.3 Drinking water pollution	4.2.1 Bathing waters	6.1.1 Safe drinking water; 6.2.1: Safely managed sanitation services; 6.3.1 Wastewater treatment; 6.3.2 Water quality; 6.4.2 Water stress; 6.6.1 Water related ecosystems
	4.1.2 Indoor air pollution			7.1.2 Reliance on clean fuels
	No SES indicators			

	2.1.1 Greenhouse gases			9.4.1 CO2 emissions per unit of value added
	No SES indicators			
	4.1.1 Outdoor air pollution	2.2.2 Pollution by heavy metals		11.6.1 Urban solid waste management; 11.6.2 Ambient air pollution
	No SES indicators			
	2.1.1 Greenhouse gases			9.4.1 CO2 emissions per unit of value added
	1.1.2 Fish resources	2.2.3 Eutrophication; 2.2.4 Acidification; 2.4.1 Marine pollution; 3.3.1 Marine ecosystems	4.2.1 Bathing waters	14.1.1 Marine pollution and coastal eutrophi-cation; 14.3.1 Ocean acidification; 14.4.1 Sustainable fish stocks
	1.3.1 Soil resources; 3.1.1 Terrestrial ecosystems; 4.2.2 Natural and mixed world heritage sites	1.1.1 Forest resources; 3.2.1 Freshwater ecosystems; 3.3.1 Marine ecosystems		15.1.1 Forest area; 15.3.1 Land degradation; 15.4.2 Mountain Green Cover Index; 15.5.1 Endangered species
	No SES indicators			
	No SES indicators			

7 Annexes

Annex 3. Global data sources that support related SDG indicators

Table A2. Information on global data sources to support the SDG indicators from [70].

SES indicator	Related SDG indicators	Global data sources supporting the SDG indicators
1.1.1 Forest utilization rate	15.1.1 Forest area as a proportion of total land area	FAOSTAT (http://www.fao.org/faostat), Food and Agriculture Organization of the United Nations (FAO)
1.1.2 Fish stocks within safe biological limits	14.4.1 Proportion of fish stocks within biologically sustainable levels	FAOSTAT (http://www.fao.org/faostat), Food and Agriculture Organization of the United Nations (FAO)
1.2.1 Freshwater bodies not under water stress	6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	AQUASTAT (http://www.fao.org/nr/aquastat), Food and Agriculture Organization of the United Nations (FAO)
1.2.2 Groundwater bodies in good quantitative status	6.6.1 Change in the extent of water-related ecosystems over time	Global Surface Water Explorer (https://global-surface-water.appspot.com/) United Nations Environment Programme (UNEP) - although this dataset is not relevant for monitoring groundwater
1.3.1 Area with tolerable soil erosion	15.3.1 Proportion of land that is degraded over total land area	No data is available
2.1.1 Per-capita GHG/CO_2 emissions	9.4.1 CO2 emission per unit of value added	INDSTAT (https://stat.unido.org/), International Energy Agency (IEA), United Nations Industrial Development Organization (UNIDO)
2.1.2 Per-capita consumption of ozone depleting substances	No related SDG indicators	
2.2.1 Cropland and forested area exposed to safe ozone levels	No related SDG indicators	
2.2.2 Ecosystems not exceeding the critical loads of cadmium / lead / mercury	11.6.1 Urban solid waste management	UN-Habitat Urban Data (http://urbandata.unhabitat.org/), United Nations Human Settlements Programme (UN Habitat)
2.2.3 Ecosystems not exceeding the critical loads of eutrophication	6.3.2 Proportion of bodies of water with good ambient water quality 6.6.1 Change in the extent of water-related ecosystems over time 14.1.1 Index of coastal eutrophication and floating plastic debris density	Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP); Global Surface Water Explorer (https://global-surface-water.appspot.com/) United Nations Environment Programme (UNEP)
2.2.4 Ecosystems not exceeding the critical loads of acidification	14.3.1 Ocean acidification	No data is available
2.3.1 Surface water bodies in good chemical status	6.3.2 Proportion of bodies of water with good ambient water quality	Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP)
2.3.2 Groundwater bodies in good chemical status	6.3.2 Proportion of bodies of water with good ambient water quality	Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP)

2.4.1 Coastal water bodies in good chemical status	14.1.1 Index of coastal eutrophication and floating plastic debris density	No data is available
3.1.1 Terrestrial area with acceptable biodiversity levels	15.4.2 Mountain Green Cover 15.5.1 Red List Index	FAO Collect Earth (http://www.openforis.org), Food and Agriculture Organization of the United Nations (FAO)
3.2.1 Surface water bodies in good ecological status	6.3.2 Proportion of bodies of water with good ambient water quality 15.5.1 Red List Index	Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP)
3.3.1 Coastal water bodies in good ecological status	15.5.1 Red List Index	No data is available
4.1.1 Population exposed to safe levels of PM2.5	11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)	Global Health Observatory Data Repository (https://www.who.int/gho), World Health Organization (WHO); WHO Global Ambient Air Quality Database (https://www.who.int/airpollution/data), World Health Organization (WHO)
4.1.2 Population using clean fuels and technology for cooking	7.1.2: Proportion of population with primary reliance on clean fuels and technology	No data is available
4.1.3 Samples that meet the drinking water criteria	6.2.1: Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water	Not classified as an environmental SDG indicator in [70].
4.2.1 Recreational water bodies that meet the ‘excellent’ quality criteria	6.3.1 Proportion of wastewater safely treated 6.3.2 Proportion of bodies of water with good ambient water quality 14.1.1 Index of coastal eutrophication and floating plastic debris density	Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP)
4.2.2 Natural and mixed world heritage sites in good conservation status	15.4.2 Mountain Green Cover 15.5.1 Red List Index	FAO Collect Earth (http://www.openforis.org), Food and Agriculture Organization of the United Nations (FAO)

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