Série grise

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Defining standards of good ecological condition for computing the ESGAP in developing countries

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1. INTRODUCTION

While approaching Rio+50 and after several Earth Summits, world leaders have acknowledged the degradation of natural capital and the urgent need to protect the environment and thus guarantee human well-being. Yet, it is still difficult to assess the condition of our natural capital and to define exactly what kind of objectives of good condition should we aim at. There is currently no widely agreed satisfactory approach that would tell decision-makers or experts whether or not a country is moving towards environmental sustainability. Most existing instruments have an incomplete definition of environmental sustainability, lack relevant indicators, or fail to define appropriate targets towards good environmental condition (Uubiaga- Liaño & Ekins, 2021a).

The ESGAP framework

AFD launched a research program in 2018 to develop a strong environmental sustainability diagnostic tool and promote the sustainable management of all components of natural capital. The Environmental Sustainability GAP (ESGAP) (for Environmental Sustainability Gap) framework makes it possible to communicate in a synthetic manner on all the issues related to environmental sustainability and the protection of natural capital at the scale of a territory or country (Usubiaga-Liaño & Ekins, 2021b). The ESGAP provides the conceptual foundation to compute a physical measure of the state of natural capital, and the gap between it and known standards of good ecological status. The ESGAP further proposes two aggregate indexes, the SESI (for Strong Environmental Sustainability Index) and SESPI (for Strong Environmental Sustainability Progress Index). ESGAP pilots have been conducted in New Caledonia (Comte et al., 2021), Kenia (NEMA and UCL, 2021) and Vietnam (ISPONRE and UCL, 2021), and ESGAP estimates have been computed for all EU countries (Usubiaga- Liaño & Eknis, 2021b). See also the Annex A for a more detailed presentation of the ESGAP framework.

Standards of good environmental condition

For all the identified critical components of natural capital, the ESGAP framework computes the gap between the current state and a sustainable state, compatible with a sustained functioning of the underlying critical processes necessary for preserving life, human activities and welfare. These states, or "standards of good environmental condition" are conceptually related to the "science-based targets" developed in the wake the Paris Agreement for climate (Andersen et al., 2020). The ESGAP uses broad sustainability principles as a provisional way of deriving environmental standards across a wide range of relevant environmental and resource issues, with the standards expressed in most cases as indicators of the state of the natural capital or as the pressure exerted upon it (Usubiaga- Liaño & Eknis, 2021b; Usubiaga- Liaño & Eknis, 2020). Setting environmental standards is not a straightforward task, and in the ESGAP studies, even if 23 standards were found (at least one per subtopic), more environmental standards need to be set (Usubiaga-Liaño et al., 2019).

Existing data sources and standards of good condition

While there is an abundance of new conventional or unconventional sources of data that could be relevant for environmental assessments, there is a relative sparsity of data when all countries are considered, including developing countries (Fairbrass & Ekins, 2020; Fairbrass et al., 2020). In a recent UNEP report, the analysis highlights the underlying data sparsity for the environmental dimension of the Sustainable Development Goals (SDGs) (UNEP, 2021). Gaps are found not only in the underlying data, but also in the tools and analytical methodologies for understanding the state of the environment, as well as interactions within the environmental dimension of the SDGs.

2. OBJECTIVES OF THIS REPORT

This report seeks to prove the feasibility of an "all-countries" ESGAP, the implementation of the framework and computation of the ESGAP metrics for as many countries in the world as possible. A preliminary step before implementing the ESGAP is to identify relevant sources for data and, more problematically, the relevant sustainability standards for each component of the ESGAP.

This global approach is therefore not about the precise analysis of sustainability issues in specific countries, but rather about trying to generalize the concept of "standard of good ecological condition" and applying it in a cross-country comparison.

The absence of suitable standards for many critical contributions of natural capital and in many countries is one of the most notable shortcomings identified in the ESGAP pilots. This study identifies the missing standards for one or more ESGAP components. It discusses possible strategies for developing appropriate standards in the event that no appropriate standards are available globally.

The results are presented in a spreadsheet in annex D. It result from the analysis of all the standards developed in the various ESGAP studies to date (see references in bold in the bibliography), along with the descriptions of possible global standards and databases provided in Fairbrass et al. (2020). This spreadsheet contains all the analysis provided for each indicator of the ESGAP to attempt to define global standards.

3. METHODOLOGY

This project builds upon the ESGAP framework, presented in more details in Annex A below. Annexes also include other resources for this project: a list of relevant data sources already identified (Annex B), and relevant publications published during the course of the ESGAP projects or related to the topic (Annex C).

While the scope of the analysis is a subset of the ESGAP components, the relevant work to be reviewed includes the literature on planetary boundaries, reference values in the System of Environmental Economic Accounting (SEEA) accounts and scenarios in "science-based target" like studies (Andersen et al., 2020).

The first steps taken were to collect the standards described in the different ESGAP studies. We also looked at the standards described in Fairbrass et al. (2020) and updated the references if new materials were available.

A grid was then developed to analyze the different standards proposed in order to characterize if they could be relevant to be proposed here as global standard that would allow the compilation of a ESGAP at the national level across the world (Table 1).

The first criterium is consistency. We compared similarities and their differences in the choice of standards across ESGAP studies, and classified them as:

1. Same standard, same reference value (>50% reports use this value)

2. Same standard, different reference value (<50% reports use this value)

3. Different standard, different reference value

4. Standard not applicable (because underlying indicator is not used here)

The grid was also used to analyze the source of the standard, to understand if it came from the scientific literature, from international norms and treaties, from regional treaties, or from national policies. As the goal of this report is to help produce a globally consistent ESGAP, the source is important as it will be easier to produce datasets and comparisons for indicators that come from global sources (treaties or global scientific efforts). It could be possible to explore the global availability of standards that come from regional or national sources if all the regions or nations provide similar standards. This is not fully investigated here.

As the goal is to facilitate the task of statisticians to aggregate various datasets, we also looked to see if the standard was supported by international organizations that would be custodian agencies responsible to report on the indicators.

Table 1: Criteria used to classify the standards for ESGAP indicators

Criteria	Categories
Consistency across ESGAP studies	1., 2., 3., 4.
Standard	Scientific literature, International treaty, Regional treaty, National policies
Scope	Global, regional, national
Covered by international treaty/organization	Yes, No
Identified custodian (nb of countries covered)	Name/list (number)

Consistency was the primary filter to explore standards. For the standards belonging in the category 1), we directly explored who are the custodians and looked if the data was accessible to produce a global database. For the standards belonging in the category 2), we surveyed the literature to understand if a single reference value could make sense, and why. For the standards belonging in the category 3), we had to look deeper into the literature to attempt to find a proxy or a new standard that could be widely applicable. We did not explore further the indicators in the category 4)

4. RESULTS

The results of this desk study are divided in three sections. First, we report broadly on the assessment of similarities and differences across the ESGAP pilot projects. Second, we discuss for each indicator the possibility to come-up with a globally applicable standard, and potential databases available to compute a global ESGAP for these indicators. Finally, we synthetize the results and suggest ways forward towards the implementation of a global ESGAP.

3.1 ESGAP STANDARDS INDENTIFIED AND USED IN THE DIFFERENT ESGAP PILOT PROJECTS

This first analysis reviews the relevance of ESGAP standards from the different ESGAP pilot projects, in the perspective of using them in non-European and developing countries.

Only few of the standards and reference levels are used across the ESGAP studies (Figure 1). This is mostly the case for Human health and welfare function for which there are internationally recognized standards. The life support function has no common standard across ESGAP pilot projects. The two others have mixed standards and references across studies.

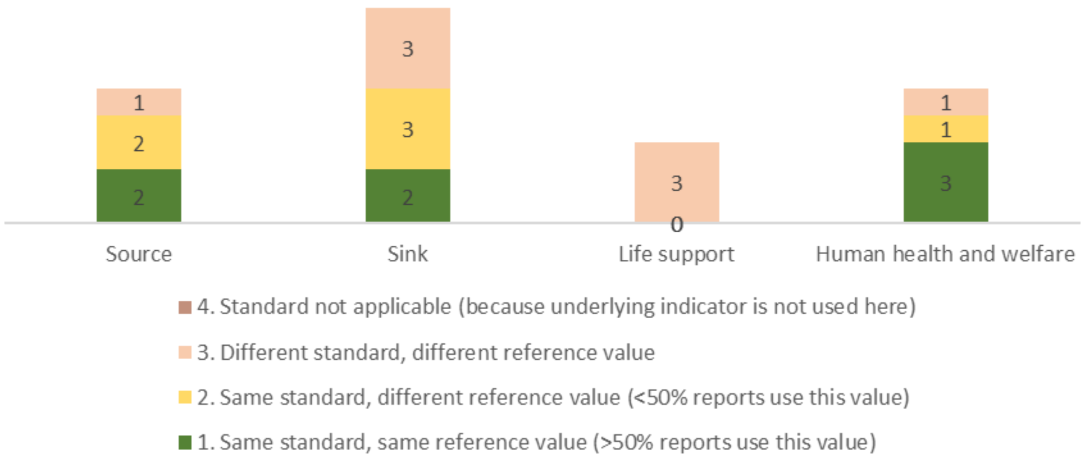

Figure 1: Number of indicators for each ESGAP function categorized in terms of similarities and their differences in the choice of standards across ESGAP studies

In addition to this first quantitative assessment of the similarities across ESGAP pilot projects, there are also qualitative insights that can be drawn. The different reports on ESGAP feasibility studies in developing country settings compare their standards with the ones developed in the ESGAP European setting, also referred to as "gold standard". This is the case mainly because the ESGAP framework was originally conceptualized and tested in Europe, but it is problematic as the development of the ESGAP framework in the European setting is inspired by the regulations and statistical arrangements of that particular region. For example, the amenities topic is using the good status of bathing waters as a standard. This indicator is not particularly relevant outside of Europe, where regulations do not exist or where this is not identified as a priority. More generally, Europe is the most advanced region in setting standards on environmental sustainability. While this could be something that is a target for all regions of the world, and European standards may influence the development of international standards in treaties and scientific studies, there are many technical and political gridlocks to be overcome before that happens.

Beyond the comparison of standards, there are also differences in the indicators that compose the four functions of the ESGAP. Two indicators are solely present in a single study: human-induced fires for the sink function in the ESGAP New-Caledonia study, and an indicator on access to green areas for the Human health and welfare study function in the European ESGAP study. In this report, we do not investigate whether these two indicators could be suitable for a global ESGAP, nor whether globally-applicable standards may apply.

3.2 OPTIONS AND APPROACHES FOR DEFINING SUSTAINABILITY STANDARDS

For each topic of the ESGAP framework (use of renewable resources, use of non-renewables, global processes, critical pollution loads for ecosystems, maintain biodiversity (especially species and ecosystems), standards for human health, landscape and amenity conservation), we assess the different options and approaches for defining sustainability standards based on the available literature.

3.2.1 Renewable resources

Forest resources

Standard & Reference

The indicator for this standard is the forest utilization rate, a ratio between the annual volume felled and the volume of annual growth in the stock of living trees, which is used to assess the current and future availability of wood (EEA, 2018a). This indicator depends directly on the volume of annual growth calculated as the increase in growing stock volume over a year and resulting from maturing forests and an increase in forest area. According to the European Environment Agency (EEA), the diameter and/or age class distributions should be taken into account in the assessment of the volume of growing stock, data that is not available in a harmonised way today. This indicator describes only partially a sustainable management of the forest and doesn't indicate whether biodiversity and ecosystem services are maintained.

Moreover, there is no alignment in the ESGAP studies about this indicator's standard, and different propositions are made:

- For Fairbrass et al., 2020: no net loss of forest cover has been suggested with an aspiration to move towards a standard of net positive increase of forest cover;
- For Usubiaga-Liaño & Ekins, 2021: 70-100 % of forest utilization rate;
- For Comte et al., 2021: 100% of forest surface non exploited ;
- For NEMA & UCL, 2021: 10% of forest area as a proportion of total land area.

To determine a global standard, a few options can be considered. The first possibility is to align with Usubiaga-Liaño & Ekins, 2021 and focus on a ratio of forest utilization rate below 100 %, which indicates that the growing stock, or timber reserve, is stable. It would be aligned with the ESGAP indicator but the data is difficult to find, especially for non-European countries.

The second option is to follow recommendations of Fairbrass et al., 2020 which is only a proxy of forest cover but for which there are databases available. This option however only defines quantity, not quality of resource use.

Database

According to the different studies, there are no global data available on growing stock, increment and fellings. Looking through the literature, we found the World Resources Institute (WRI) which gives access to an online platform called Global Forest Review[1] (GFR). The GFR indicators aim to provide data-driven and global-scale monitoring and relies on geospatial data produced by independent researchers. Those indicators concern: forest extent (extent, tree cover loss, primary forest loss, forest gain, etc.), forest condition (degradation and recovery), forest designation (protected forest, production forest, for conversion), biodiversity and ecological services (forest carbon stock, biodiversity conservation, etc.) and social and governance issues (at-risk population, indigenous and community forest, etc.). WRI's Global Forest Watch (GFW) is an online platform that display those indicators and allows free access near real-time information about forest in all regions across the globe.

Another relevant global dataset is the Food and Agriculture Organization (FAO)'s Global Forest Resources Assessments (FRA). 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. FRA 2020[2], the latest assessment, examines the status and trends of over 60 forest-related variables in 236 countries and territories for the period 1990-2020. For each country, following information are detailed: forest extent, characteristics and changes, forest growing stock, biomass and carbon, forest designation and management, forest ownership and management rights, forest disturbances, forest policy and legislation.

To conclude, until the FRA data is homogenized for all countries, the WRI data base should be considered because it provides key data for the calculation of this indicator as a proxy (forest cover) and is applicable to the global South.

Marine resources

Standard & Reference

The global standard for the sustainable use of marine resources is well established. Fish stocks within safe biological limits, measured with Maximum Sustainable Yield (MSY), is used in the ESGAP study in New-Caledonia, Vietnam and Europe. In Kenya and Vietnam, total capture is used as a proxy to MSY. It is also one of the SDG targets (SDG indicator 14.4.1), but this data source also only contains information at the global and regional levels, as fisheries data have not yet been reported at the country level for the reporting of fish stocks (UNEP, 2021). As mentioned in Fairbrass et al., 2020, the EU and the FAO use different criteria to assess stock status, but both can be considered a science-based target.

Database

The issue with this global standard is the availability of datasets, with estimates of stock abundance and exploitation rates reported at the scale of fishing areas rather than for countries by the FAO. It could therefore be possible to use this standard and database at the regional level, as there are 15 regional fishing areas covered by the FAO[3], and for several years, so that an SESP indicator can be developed as well. In addition, FAO seems to be starting to report this data at country level, with so far data reported in 13 countries. Contacting the custodian agency will be necessary to know more about future reporting of this indicator at the country scale.

Surface water resources

There is a global alignment of all studies on the proxy "Freshwater withdrawal as percentage of total actual renewable water resources". At this point, the numerator does not subtract environmental flow requirements. Because environmental flows are important for aquatic ecosystems, this indicator can only be considered a proxy of freshwater resource scarcity.

[1] Global Forest Review (2021)
[2] FAO (2020)
[3] https://www.fao.org/sustainable-development-goals/indicators/1441/en/

Standard & Reference

Regarding the threshold value for this indicator, consumption over mean runoff exceeding 20% is commonly used to distinguish water stressed bodies. Indeed, some authors suggest considering a withdrawal rate of 20% as the threshold of water stress (Raskin 1997, Rijsberman 2006). OECD defines water stress as "a measure of the total annual average demand of a river basin (or a sub-basin) compared to the average water available annually (precipitation minus evapotranspiration) in that basin. Typically, these are grouped into four categories: < 10% = no stress, 10-20% Low stress; 20-40%= medium stress and > 40% = severe stress" (OECD, 2015).

These thresholds are not quite aligned with the FAO's ones. Indeed, according to FAO[4], a low level of water stress is considered at 25% and indicates a situation where there is a little impact on the resources or on the potential competition between users. A high level of water stress at 75% indicates a situation where there is potentially larger impacts on the resources and the environment and potential situations of conflicts and competition between users.

To conclude, this study will consider a threshold at 25% to stay aligned with FAO.

Database

The FAO produces country statistics on total renewable groundwater and fresh groundwater withdrawal which is made available on their AQUASTAT platform. Statistics are produced for 200+ countries and for different regions. This platform compiles relevant data and produces relevant indicators, such as water stress[4]. This "water stress" indicator provides an estimate of pressure by all sectors on the country's renewable freshwater resources. It describes how much water is left and available in the environment[5]. As described in the FAO's Guidelines for a minimum standard method for global reporting on water stress[4], the equation to calculate it is:

$$\text{Water Stress (\%)} = \frac{TFWW}{TRWR - EFR} * 100$$

TFWW: Total freshwater withdrawal. TFWW is the volume of freshwater extracted from its source (rivers, lakes, aquifers). It is estimated at the country level for the three main sectors: agriculture, municipalities and industries (including cooling of thermoelectric plants). It does not include direct use of non-conventional water, such as treated wastewater, agricultural drainage water and desalinated water. TFWW can, naturally, change with time and is estimated for any given year.

TRWR: Total renewable water resources. TRWR includes internal (generated within a country) and external (generated outside but made available within a country) renewable freshwater resources. TRWR is the long-term average annual flow of rivers and recharge of groundwater measured as a volumetric unit (km3/year) and taking into consideration any overlap between them.

EFR: Environmental Flow Requirements. The EFR is synonymous with Environmental Flows (EF) - established to protect the basic environmental services of freshwater ecosystems. In the indicator formula, EFR is also measured in volumetric units or flows, to be compatible with TRWR. To generate the country EF data, FAO's Guidelines[4] provides a minimum standard method, principally based on the Global Environmental Flows Information System (GEFIS)[6]. Features are also available at a basin scale.

Groundwater resources

Standard & Reference

This ESGAP indicator (Usubiaga-Liaño & Ekins, 2021b) suggests the European legislation as a reference. Concerning the threshold, the Water Framework Directive[7] of the European Commission requires good quantitative status to be achieved by ensuring that the available groundwater

[4] AQUASTAT database (fao.org)
[5] FAO. 2019.
[6] http://eflows.iwmi.org
[7] River basin management - Water - Environment - European Commission (europa.eu)

resource is not exceeded by the long-term annual average rate of abstraction. It gives a description for a groundwater body to be of good quantitative status each of the following criteria need to be met:

- available groundwater resource is not exceeded by the long term annual average rate of abstraction;
- no significant diminution of surface water chemistry and/or ecology resulting from anthropogenic water level alteration or change in flow conditions that would lead to failure of environmental quality objectives for any associated surface water bodies;
- no significant damage to groundwater dependent terrestrial ecosystems resulting from an anthropogenic water level alteration;
- no saline or other intrusions resulting from anthropogenically induced sustained changes in flow direction.

Databases

The European Environment Agency (EEA) database provides a global score for every European country aligned with the European legislation. There are no global references available.

Regarding other countries, Fairbrass et al., (2020) mentions the Aquastat database which provides the following indicators:

- Total renewable groundwater. This is the sum of the internal renewable groundwater resources and the total external renewable groundwater resources[8].

Total renewable groundwater (10^9 m3/yr) = Groundwater produced internally + Groundwater: accounted inflow

- Fresh groundwater withdrawal (10^9 m3/yr). Annual gross amount of water extracted from aquifers. It can include withdrawal of renewable groundwater, as well as water from over-abstraction of renewable groundwater or withdrawal from fossil groundwater.

Soil erosion

Standard & Reference

The Revised Universal Soil Loss Equation (RUSLE), an empirical method described in IECA (2008), measures soil erosion and has the following form:

$$A = R \cdot K \cdot LS \cdot C \cdot P$$

where A is the **annual soil loss due to erosion [t/ha year]**; R the rainfall erosivity factor; K the soil erodibility factor; LS the topographic factor derived from slope length and slope gradient; C the cover and management factor; and P the erosion control practice factor.

This is the same model that was used for the European version of the ESGAP. For this version, based on several scientific reports (such as Verheijen et al., 2009, Jones et al., 2005, Huber et al. 2008) an average tolerable erosion rate of 1 t/ha/year was adopted for Europe under a precautionary approach[9]. An update of the EU assessment of soil loss by water erosion was made by the European Soil Data Centre (ESDAC) for the year 2016 where they recommended sustainable threshold of 2 t/ha/year[10].

However, in order to take into account local characteristics, the definition of regional or even local or site-specific threshold levels of erosion would be valuable. For example, the ESGAP pilot in New-Caledonia uses downscaled RUSLE model with a threshold of 12t/ha/year (this report allowed us to

[8] http://www.fao.org/nr/water/aquastat/data/wrs/readPdf.html?f=AFG-WRS_eng.pdf
[9] Establishing Environmental Sustainability Thresholds and Indicators – final report https://ec.europa.eu/environment/enveco/waste/pdf/thresholds_final_report.pdf
[10] https://esdac.jrc.ec.europa.eu/themes/rusle2015

identify a typo in the New-Caledonian report: the standard unit should read t/ha/year not t/km²/year).

More research is needed to set more appropriate national/local standards. The Borrelli, P., et al. 2017 report with a global approach proposes a soil loss threshold of 10 t /ha/year (Figure 2, the dotted yellow line).

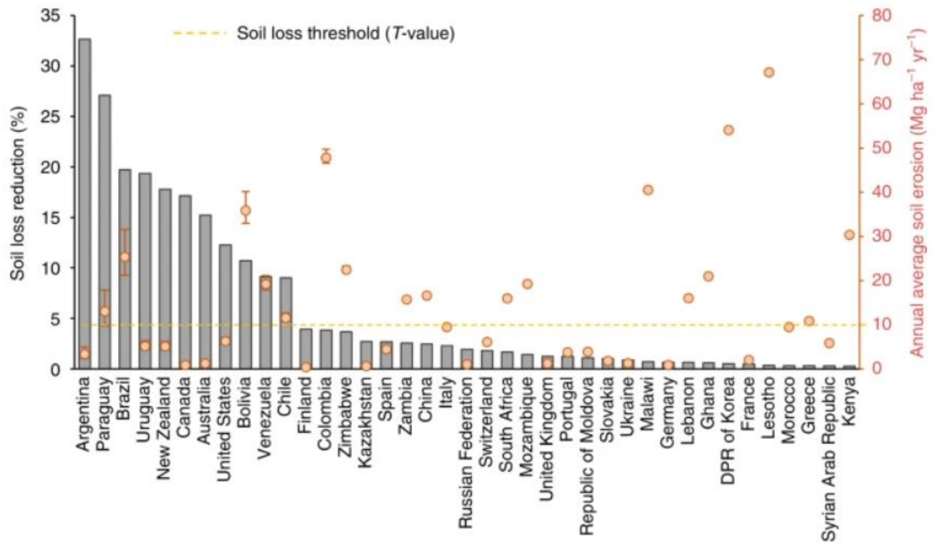

Figure 1: global approach proposes a soil loss threshold of 10 t /ha/year (The Borrelli, P., et al. 2017)

The RAMsoil (Risk Assessment Methodologies for Soil threats) research project also illustrates disparities between risk assessments methodologies in the EU.

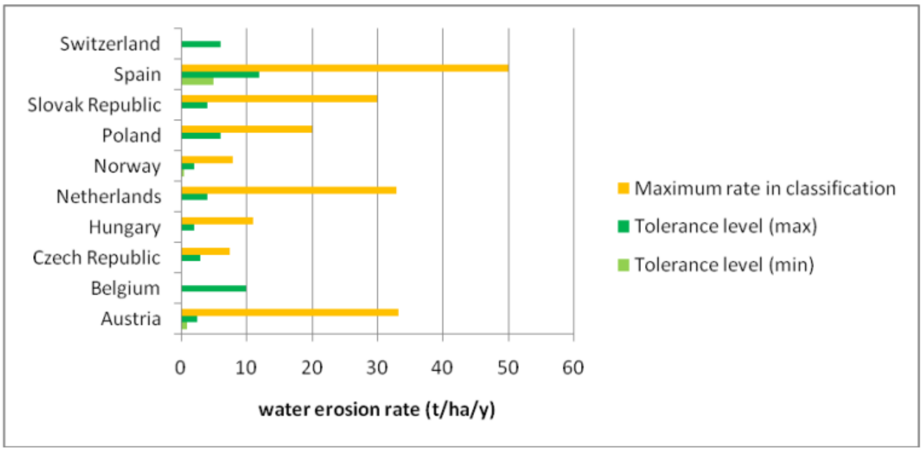

Figure 2. Tolerance levels for soil erosion by water in some European countries (Christy van Beek and Gergely Tóth, European Commission 2012)

Levels of thresholds considered tolerable by the stakeholders differ from each European country but are generally below 10 t/ha/year while the maximum erosion rates figuring in their risk classification systems are significantly higher.

In conclusion, rates for soil erosion considered as tolerable can widely differ depending on specific site environmental conditions and vulnerability to soil erosion. This, in addition to the lack of global scientific research **does not allow us to set a science-based global threshold yet**.

Database

Concerning databases, a *Global Soil Erosion dataset* provided by the European Soil Data Center (ESDAC) and calculated with the RUSLE formula is available for 2001 and 2012 at a 25 km resolution for 202 countries[11]. Another soil erosion by water assessment with a resolution of 100m for 2010 and 2019 in European countries using the RUSLE 2015 model (a modified version of the RUSLE) is available.

Also, the Harmonized World Soil Database (HWSD) can allow an improved assessment of the risks of land degradation such as soil erosion. It is a global soil database, framed within a Geographic Information System, containing up-to-date information on world soil resources[12].

3.2.2 Global processes

Greenhouse gases emissions

Standard & Reference

Among the different ESGAP studies, the standard for Greenhouse gases (GHG) emission reaches a consensus with the IPCC values, which reflects a science-based target. However, while the standard is defined, its scope is not clear. The result depends on the emission sources considered (e.g. with or without agriculture, forestry and other land uses).

Database

Below, on Table 2 a quick presentation of the most robust databases to estimate GHG emissions for countries is presented.

The Emission Database for Global Atmospheric Research (EDGAR) is identified here as the most relevant to produce this indicator. Indeed, EDGAR provides independent emission estimates compared to what is reported by European Member States or by Parties under the UNFCCC, using international statistics and a consistent IPCC methodology. It also allows the integration of data for almost all of the following sectors:

- Energy (manufacturing, fugitive emissions, electricity & heat)
- Transport
- Residential, commercial, institutional
- AFF (Agriculture, Forestry, Fishing)
- AFOLU (Land Use change and forestry)
- Industrial processes and product use
- Waste
- Other sectors

[11] https://esdac.jrc.ec.europa.eu/content/global-soil-erosion
[12] https://iiasa.ac.at/models-and-data/harmonized-world-soil-database

Table 2: List of databases and their characteristics to produce a global indicator for GHG emissions.

Databases	General information	Geographical perimeter	Temporal coverage
EDGAR (Emissions Database for Global Atmospheric Research)	EDGAR provides independent emission estimates compared to what reported by European Member States or by Parties under the UNFCCC, using international statistics and a consistent IPCC methodology.https://edgar.jrc.ec.europa.eu/ **Table 4.** Main activities included in EDGAR emissions estimation. **Fossil CO2:** **Power Industry:** power and heat generation plants (public and auto-producers) **Other industrial combustion:** combustion for industrial manufacturing and fuel production **Buildings:** small scale non-industrial stationary combustion **Transport:** road, non road, domestic and international aviation, inland waterways and international shipping **Other sectors:** industrial processes, agriculture soils (urea fertilization and lime) and waste **CH4, N2O, F-Gases:** **Power Industry:** power and heat generation plants (public and auto-producers) **Other industrial combustion:** combustion for industrial manufacturing and fuel production **Buildings:** small scale non-industrial stationary combustion **Transport:** road, non road, domestic and international aviation, inland waterways and international shipping **Other sectors:** agriculture livestock (enteric fermentation, manure management), agriculture soils (fertilisers, lime application, rice cultivation, bread and paper production), field burning of agricultural residues and waste **CO2 LULUCF:** **Forest Remaining Forest** **Land converted to Forest** **Deforestation** **Organic Soil** **Other:** cropland, grassland and settlements Source: JRC, 2021.	**** 190 countries	**** Last update: 2021
FAO	The FAO Emissions-Land Use dataset includes estimates of CO2 emissions by sources and removal by sinks from forest land, cropland, and grassland, as well as emissions of CO2 and non-CO2 from fires of biomass and organic soils https://www.fao.org/faostat/fr/#home	**** 245 pays	Last update: 2017-2020
UNFCCC (United Nations Framework Convention on Climate Change)	The inventory data are provided in the annual GHG inventory submissions by Annex I Parties and in the national communications and biennial update reports by non-Annex I Parties. Details by categories and by gas https://di.unfccc.int	** Annex 1, many countries missing	* Last update: 2019 for Annex 1 and 2013 for non-Annex 1
IEA	Provides a full analysis of historical country-level emissions stemming from energy use, and has become an essential tool for analysts and policy makers. https://www.iea.org/articles/greenhouse-gas-emissions-from-energy-data-explorer	*** 140 countries	**** Last update: 2021
Copernicus	Daily forecasts of carbon dioxide up to five days in advance thanks to it Atmosphere Monitoring Service (AMS). Global forecasts of greenhouse gases - carbon dioxide. The AMS as part of the Copernicus Programme provides daily forecasts of carbon dioxide up to five days in advance.	/	** Last update: 2019
Eurostat	Greenhouse gas emissions by source sector http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_gge	* Only for european countries	** Last update: 2019

Stratospheric ozone depleting substances

Standard & Reference

There is a global alignment across ESGAP studies to evaluate the consumption of ozone depleting substances: consumption of hydrofluorocarbures (HCFC). To determine whether a substance depletes the ozone layer, the so-called "Ozone Depletion Potential (ODP)" is used. This is a relative measure of a chemical's ability to destroy ozone, normalized to the destructive potential of CFC-11, which by convention has an ODP of 1.

HCFCs became the leading indicator due to the implementation of the Montreal Protocol and the ban of the use of CFC. But these substances have also a high ODP[13]. Thus, at the 19th Meeting of the Montreal Protocol, it was agreed to accelerate the phase-out of HCFCs in both developed and developing countries. Countries agreed to reduce HCFC production and consumption by 75% in 2010, 90% in 2015 and to complete this accelerated phase-out by 2020 while allowing maintenance use at 0.5% of 2007 levels until 2030.

A threshold that could be used for every country is a level of production and consumption between 0% and 0,5% based on the 2007 level.

However, the use of HCFCs will decrease and its use forbidden. Therefore, it is for now a good indicator to use, but we must already think about its replacement because it is an indicator that tends to lose its relevance.

Database

As for the studies Usubiaga-Liaño-Liano & Ekins (2021) and Fairbrass et. al (2020), it is recommended to refer to the consumption of controlled substances outlined in the Montreal Protocol reported annually to the Ozone Secretariat. Indeed, global data is compiled and reported by the UN Environment Programme Ozone Secretariat on substances that deplete the ozone layer.

Ozone pollution

Standard & Reference

In Usubiaga-Liaño & Ekins (2021), a threshold is provided based on AOT40 suggestions. Indeed, AOT40 gives an indication of accumulated ozone exposure, expressed in µg m-3 h, over a threshold of 40 ppb. It is defined as the sum of the differences between hourly concentrations > 80 µg m-3 (40 ppb) and 80 µg m-3 accumulated over all hourly values measured between 08:00 and 20:00 (Central European Time) between May and July.

The environmental standard for cropland is linked to a 5% decrease in yield in wheat and for forested areas is linked to a 5% decrease in biomass. EEA recently referred to those values and no other study contradicts it. This is why we propose to stay aligned with Usubiaga-Liaño & Ekins, (2021) proposition. As there are no other regional or global values for ozone pollution, the relevance of this threshold has to be scientifically tested for other settings. No recommendation for its global use can be proposed at this stage.

Database

Concerning databases, no global datasets of ground-level ozone deposition was found, which reflects what Fairbrass et al. (2020) indicated.

Pollution by heavy metals

Standard & Reference

This ESGAP indicator is defined as "Ecosystems not exceeding the critical loads of heavy metals". Across all the ESGAP studies analysed, only two (ISPONRE & UCL, 2021 and Fairbrass et al. 2020) consider this indicator as a proxy: Zero mercury emissions.

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[13] Ozone Secretariat – United nation Environment Program (Unep). https://ozone.unep.org/ozone-and-you

There are about ten heavy metals classified as toxic, however, mercury, lead and cadmium are subject to a particular attention because of their toxicity (effects on health)[14] and have a very long life span. Mercury is of greater concern because of its high volatility, which explains why the studies cited above focus on this element.

Concerning threshold values, there were not clearly identified in those studies. Though, Jessica Briffa et al., (2020) summarize the threshold values for all heavy metals, which are considered in this study. For example, threshold presented for mercury, lead and cadmium pollution:

Database

Concerning databases, according to Fairbrass et al. (2020), there are no sources of data on cadmium or lead at a global scale but global mercury emissions, release and transport statistics are reported by the UN Environment Global Mercury Assessment[15]. However, this assessment that provides the most recent information available for mercury at the global scale presents a lack of coverage in some world regions (i.e., Africa, Latin America and the Caribbean, Russia).

Eutrophication & acidification

Standard & Reference

The main sources of eutrophication are emissions of nitrogen (N) compounds (i.e. nitrogen oxide, ammonia) to the atmosphere. According to Wim de Vries & Lena Schulte-Uebbing, (2020) “the exceedances in critical N inputs in relation to eutrophication of aquatic ecosystems are mainly determined by variations in the total fertilizer and N manure input and the precipitation surplus and leaching (denitrification) fraction mainly determining the critical N inputs”[12]. In this study, Wim de Vries & Lena Schulte-Uebbing explain that the assessment of the planetary N boundary was based on a critical NH3 concentration in air, in relation to biodiversity decline in terrestrial ecosystems, and a critical N concentration in runoff in relation to eutrophication of aquatic ecosystems.

As an N-indicator for the eutrophication of aquatic ecosystems, critical concentrations of dissolved total N in surface water have been identified in the range of 1.0-2.5 mg N l-1. This range used in Wim de Vries & Lena Schulte-Uebbing is based on (i) an extensive study on the ecological and toxicological effects of inorganic N pollution (Camargo and Alonso, 2006), (ii) an overview of maximum allowable N concentrations in surface waters in national surface water quality standards (Liu et al., 2011) and (iii) different European objectives for N compounds (Laane, 2005). **The upper limit of 2.5 mg N l-1** is considered in this study as a threshold for eutrophication.

This ESGAP indicator is based on the definition in European legislation of “good chemical status” to not exceeding the critical loads of eutrophication. Critical load is a 'quantitative estimate of an exposure to one or more pollutants, below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge' (UNECE, 2015). Deposition loads of eutrophying airborne pollutants above the critical loads are termed an 'exceedance' and are ecosystems and local conditions dependent (EEA, 2018b). The exposure of ecosystems to eutrophication is estimated as the average accumulated exceedance of the critical loads for eutrophication (mol nitrogen per hectare per year). The EEA use spatially explicit models assuming that current legislation is fully implemented to calculate and map the reduction in areas of ecosystems exposed to eutrophication, i.e. areas where eutrophication critical loads are exceeded[16].

Concerning acidification, the proxy indicator proposed by Fairbrass et al., 2020, which is deposition of inorganic nitrogen / sulphur dioxide and sulphate, is considered here.

Database

There is a database available for eutrophication and acidification at European level (United Nations Environment Programme SDG 6.6 and SDG 14.1), as studied in Faibrass et al (2020), but not at a global level.

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[14] Métaux lourds : cadmium, mercure et plomb Exposition aux substances chimiques - notre-environnement.gouv.fr

[15] Global Mercury Assessment 2018 | UNEP - UN Environment Programme

[16] https://www.eea.europa.eu/airs/2018/natural-capital/eutrophication-of-terrestrial-ecosystems

Surface Water and Groundwater Pollution

Standard & Reference

With the ESGAP indicator, surface water and groundwater pollution are evaluated thanks to their chemical status.

According to the European Environment Agency (EEA), to meet the objective of good chemical status, hazardous substances should be prevented from entering surface water and groundwater, and the entry of all other pollutants (e.g. nitrates) should be limited[17]. The European Legislation define a good chemical status of surface water and groundwater by the concentration of certain pollutants. The list of priority substances is defined by the European Legislation in the Directive 2013/39/EU of the European Parliament and of the Council[18]. It includes 45 priority substances, of which 20 are designated as priority hazardous substances. Some of the substances listed: lead, mercury, nickel. The entire list: L_2013226EN.01000101.xml (europa.eu). The European Commission submits proposals for (1) the emission controls (ECs) for point sources and (2) the environmental quality standards (EQSs) (water, sediment, biota).

This indicator ("chemical status") cannot be used to assess the quality of surface water and groundwater all over the world. The list is very long and specific to European countries. Not all countries report the same substances or have developed a method of collection or analysis of those substances. It is therefore difficult to use the "chemical status" of waters to evaluate their quality.

In the framework of SDG #6 "Clean water and sanitation[19]", UNEP is working to develop a consistent approach to measuring water quality. One Indicator of interest used by UNEP is the *6.3.2 "Proportion of bodies of water with good ambient water quality"*. The indicator tracks the percentage of water bodies in a country with good ambient water quality. "Good" indicates an ambient water quality that does not damage ecosystem function and human health according to core ambient water quality parameters and is set at the national level. This includes monitoring of 5 core parameters:

- Oxygenation (surface water)
- Salinity (surface water and groundwater)
- Nitrogen (surface water and groundwater)
- Phosphorus (surface water)
- Acidification (surface water and groundwater)

The calculation methodology developed by the United Nations requires in situ measurements of these groups of water quality parameters. The measured values are compared to the national target levels for the different parameters, and if the values reach the defined target, the water body is classified as good.

Each country has its water quality targets depending on their own specificity. But optional target values have been developed by UNEP for countries that wanted more comprehensive guidance on global target values for each of the core parameter groups and those that in the short term did not have national target values. These optional target values also provide a reference point against which to compare national values.

[17] https://www.eea.europa.eu/

[18] Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013L0039&from=EN

[19] Methodology_632_An Introduction to SDG Indicator 6.3.2 (2020)

Table 1: Optional target values for the different water body types (Source: SDG indicator 6.3.2 – Technical guidance document no.2)

Parameter Group	Parameter	Target type	Surface Waters		Groundwaters
			Rivers	Lakes	
Oxygenation	Dissolvedoxygen	range	80 – 120 (% sat)	80 – 120 (% sat)	-
Salinity	Electrical conductivity	upper	500 µS cm^{-1}	500 µS cm^{-1}	500 µS cm^{-1}
Nitrogen	Total Nitrogen	upper	700 µg N l^{-1}	500 µg N l^{-1}	-
	Oxidisednitrogen	upper	250 µg N l^{-1}	250 µg N l^{-1}	250 µg N l^{-1}
Phosphorus	Total phosphorus	upper	20 µg P l^{-1}	10 µg P l^{-1}	-
	Orthophosphate	upper	10 µg P l^{-1}	5 µg P l^{-1}	-
Acidification	pH	range	6 – 9	6 – 9	6 – 9

The Global Environment Monitoring Systems (GEMS) supports the collection data on water quality for UNEP.

However, this indicator does not allow to measure the quality of coastal waters in the whole world (focus on Europe). One proposal could be to use the indicator used by UNEP for SDG 6.3.2 "Proportion of bodies of water with good ambient water quality" which is based on the *General - Chemical and physico-chemical elements supporting the biological elements* also used by the European legislation to determine the quality.

To conclude, it could be interesting to use the 5 core parameters of UNEP SDG indicator 6.3.2 as an indicator to measure surface and ground water pollution. This indicator will make a parallel between data that could be collected thought the European Legislation. Also, it will be easier to collect the data from all the countries.

Database

Global data for some, but not all of the chemical elements considered, are available from a range of sources. The most relevant database is the UN Environment GEMStat portal (Global Environment Monitoring System for water). This portal reports a large number of parameters from river, lake, reservoir and wetland monitoring stations that are useful to calculate this indicator.

Marine Pollution

Standard & Reference

Marine Pollution is evaluated with the ESGAP indicator "Coastal water bodies in good chemical status". A "good chemical status" means that the concentration of priority substances does not exceed the relevant environmental quality standards specified in the European legislation, which are intended to protect the most sensitive species from direct toxicity, including predators and humans via secondary poisoning.

This Indicator is based on a good ecological status as defined in The European legislation which correspond to biological, physicochemical and hydromorphological parameters.

The European legislation in the Directive n°2000/60/CE of the European Commission[20] use the following quality elements for ecological status classification:

Biological elements

- Composition, abundance, and biomass of phytoplankton
- Composition and abundance of other aquatic flora
- 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

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

Database

In the framework of SDG #14, UNEP is working to develop a consistent approach to measuring the state of the oceans and to promote the measurement of oceanic SDGs. One indicator of interest used by UNEP is the 14.1.1(a) "Index of coastal eutrophication"[21]. Chlorophyll-a concentration (surface waters) is used as an indicator for eutrophication called "indicator for coastal eutrophication potential (ICEP)" expressed in kilograms of carbon from algae biomass per square kilometer of river basin area per day (kg C km-2 day-1).

A number of different data portals provide freely accessible data on Chlorophyll-a as well as links to other relevant databases; examples include: the Copernicus Marine Environment Monitoring Service (CMEMS)[22], NOAA (National Oceanic and Atmospheric Administration)

20 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

21 Metadata-14-01-01.pdf (un.org)

22 Data | Copernicus Marine

CoastWatch/OceanWatch[23], the NASA (National Aeronautics and Space Administration) OceanColor Web[24] and the ChloroGIN data portals[25].

3.2.3 Maintain biodiversity

For the ESGAP topic on biodiversity, describing terrestrial, aquatic, and marine biodiversity, challenges remain in defining meaningful reference levels and collecting information at the global scale. Here, we build on the various ESGAP reports available, as well as the document produced by Arkaitz Usubiaga-Liaño on the life support function (Usubiaga-Liaño, 2021). Following the conclusions proposed in Usubiaga-Liaño (2021), we focus on species and ecosystem biodiversity and do not go further on genetic diversity.

Synthesis of efforts to date within ESGAP projects

The ESGAP project in Europe initially started with the use of the Biodiversity Intactness Index (BII) for terrestrial ecosystems but ended up using the State of Nature in the European Union, produced by the European Environment Agency (Röschel et al., 2020). In New Caledonia, the BII was used, with standards downscaled for this particular ecoregion.

For freshwater biodiversity, a standard was available for aquatic ecosystems, the good ecological status of waters, coming from the Water Framework Directive in Europe. Paralleling the assessment of a standard for terrestrial biodiversity, nothing similar can be found outside of Europe.

Regarding the marine environment, the Marine Strategy Framework Directive sets good ecological status of marine waters, but these are indirectly linked to biodiversity, and only available in the context of the European Union. The ESGAP study in New-Caledonia used the health status of coral reefs as the standard for marine biodiversity. This categorical index is produced locally by an non-governmental organization, based on a global standard from the Global Coral Reef Monitoring Network (GCRMN)[26]. To the best of our knowledge, the global reports of GCRMN only include trends in coral cover and algae cover, and do not provide health metrics that can be used as a standard in the context of the global ESGAP. Contacting the custodian entity of this global initiative will be needed to understand the availability of a coral reef health standard at the global level. Furthermore, coral reefs, while a critical marine ecosystem, are not representative of the whole marine biodiversity.

In Vietnam, the only identified indicator linked to the marine environment is SDG 14.1 on the proportion of marine waters covered by a marine protected area. This indicator is not suitable as this is an indicator of the means to reach a sustainability standard, not a biophysical standard in itself. There is no direct relationship between reaching a proportion of area under protection and the good ecological status of marine ecosystems (while there are obviously indirect links). This is also true for the aquatic and terrestrial realms.

Survey of other possible sources

The SEEA-EA

Biodiversity monitoring and standard setting is very much linked to ongoing international accounting efforts. First, the System of Environmental Economic Accounting – Ecosystem Accounting (SEEA-EA) has been adopted, for its biophysical components, as an international standard by the United Nations Statistics Division in 2021 (United Nations et al., 2021). These ecosystem accounts describe the extent and condition of ecosystems, as well as the supply of ecosystem services. Ecosystem extent is the size of the different ecosystem types present within the accounting area. Ecosystem condition is the quality of these ecosystem types, including abiotic and biotic factors, and is linked to the concept of ecosystem integrity (Pimentel & Edwards, 2000).

The concept of standards within the ESGAP is linked with what the SEEA calls reference levels. Reference levels are upper and lower bond that enable transformation of condition data into standardized indicators, similar to the ESGAP indicators. They apply in the SEEA exclusively to the condition indicators using reference conditions. The reference condition is defined in the SEEA-EA as "the condition against which past, present and future ecosystem condition is compared to in order to measure relative change over time." (United Nations et al., 2021, p. 93). It further details

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[23] Gap filled Chlorophyll-a | NOAA CoastWatch & OceanWatch
[24] NASA Ocean Color
[25] ChloroGIN Earth
[26] https://gcrmn.net/

reference condition linked to a so-called natural state but remains vague into its actual definition and allows for other "anthropogenically-defined" reference conditions (Keith et al., 2020). The SEEA differentiates between setting standards for mainly natural ecosystems versus for mainly anthropogenic ecosystems. They propose to set standards based on historical conditions, disturbance levels, or management/practices targets. The issue of setting reference conditions within the SEEA-EA is very much ongoing and should not be resolved in the near future.

One recent paper found that humans have been shaping ecosystems for 12000 years (Ellis et al., 2021), which implies that historical standards that set human disturbance at the time of the industrial revolution may not be appropriate. Another proposal attempts to drive reference levels from the definition of standards and norms based on "good ecological status" (Comte et al., 2020). This approach feeds on the ESGAP conception of environmental standards and may yield interesting results in the future.

Since the multiplicity of choices and settings available, SEEA-EA accounts will probably not be usable as biodiversity indicators for a global ESGAP before many years. They may be used for national studies when available and depending on how reference levels have been set. The SEEA EA itself lists other international initiatives linked to the monitoring of ecosystems (Annex C).

<u>The CBD</u>

Second, the undergoing negotiations at the Convention on Biological Diversity (CBD) around the post-2020 framework for biodiversity is another international framework with implications for the monitoring of biodiversity. The possible science-based targets or monitoring and reporting mechanisms are still open for negotiations.

<u>Planetary Boundaries</u>

Third, the planetary boundaries list biodiversity loss as one of its nine boundaries. They use two indicators to measure it, first a global species extinction rates with a standard of 10 extinction per million species-years (E/MSY) (Steffen et al. 2015; described in Usubiaga-Liaño, 2021), with other metrics being discussed, particularly percentage of remaining species abundance (similar to BII, Mace, etc.).

While difficulties have been listed to downscaling planetary boundaries, new research has reviewed this literature, and looked at different ethical ways of downscaling boundaries to countries (Ryberg et al., 2020). While most of the standards and datasets we are looking for here are the ones available at global scale for every country, it could be interesting to investigate the ways to disaggregate global standards and datasets if they are not yet downscaled at the country level. This is particularly the case for biodiversity, for which standards and datasets, when available, are mostly global.

<u>Biodiversity Intactness Index</u>

In their commentary in Nature, Mace et al. (2018), suggest three already-existing indicators to act as headline indicators to set goals and track progress towards a global biodiversity framework. These indicators are the Red List Index for species extinction, the Living Planet Index for species abundance, and the Biodiversity Intactness Index for the integrity of the biosphere. The latter one is the most proximate one to what the ESGAP intends to measure for the life-support function. Mace et al. (2018) suggest two appropriate scales to record the BII: biomes and ecoregions, and thresholds at these two scales: "that 100% of biomes and 70% of ecoregions should meet the 90% target in 2050." The issue here is that biomes and ecoregions do not align with administrative units (States boundaries). Nonetheless, a recent publication has attempted to produce spatially explicit BII estimates that can be aggregated or disaggregated at the regions or the national scales (Sanchez-Ortiz et al., 2019). This can be used to populate the global ESGAP indicator for terrestrial biodiversity.

3.2.4 Human health and Welfare

Outdoor air pollution

Standard & Reference

The estimation of outdoor air pollution standard is defined as the percentage of population exposed to safe level of PM2.5 for which two indicators are necessary:

- The critical level of PM2.5 (μg/m3)

- The exposure of the population (%)

The standard refers to the lowest level at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to long-term exposure to PM2.5.

The threshold value reaches a consensus across the ESGAP studies, aligned with the World Health Organization (WHO) values, which reflects a science-based target. Since the Fairbrass (2020) report, an update in 2021 shows an evolution in the recommended levels of air quality guidelines, as described below (Table4). Therefore, the new threshold value for PM2.5 is 5 µg/m3.

Table 2: Updated recommended outdoor air quality standard (WHO 2021)

Recommended 2021 AQG levels compared to 2005 air quality guidelines

Pollutant	Averaging Time	2005 AQGs	2021 AQGs
$PM_{2.5}$, µg/m^3	Annual	10	5
	24-hour[a]	25	15
PM_{10}, µg/m^3	Annual	20	15
	24-hour[a]	50	45
O_3, µg/m^3	Peak season[b]	-	60
	8-hour[a]	100	100
NO_2, µg/m^3	Annual	40	10
	24-hour[a]	-	25
SO_2, µg/m^3	24-hour[a]	20	40
CO, mg/m^3	24-hour[a]	-	4

To complete the indicators that could be used towards the full description of outdoor air pollution, other tolerable limit values are fixed by WHO, including:

- PM10 (particulate matter with a diameter of 10 microns or less) concentrations of 15 µg/m3 annual mean.
- Ozone (O3) concentrations of 100 µg/m3 8-hour mean.
- Nitrogen dioxide (NO2) concentrations of 10 µg/m3 annual average.
- Sulphur dioxide (SO2) concentrations of 40 µg/m3 24-hour mean.
- Carbon monoxide (CO) concentrations of 7 µg/m3 24-hour mean.

These indicators (particularly PM10 and NO2), have been mentioned in the original ESGAP framework proposed by Usubiaga-Liaño and Ekins, but have not been retained for the construction of the dashboard of indicators.

Database

The WHO collate data on particulate matter concentrations (PM10 and PM2.5) for many countries, it represents therefore the most complete database useable to calculate this indicator.

Drinking water

Standard & Reference

According to European legislation the drinking water standard is defined as follows: the water supplied must be free of Escherichia coli (E.coli) and enterococci. For the WHO, all water intended for drinking, E. coli must not be detectable in any 100-ml sample (WHO 2017).

The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) collects national data on Escherichia coli contamination of drinking water at the global level, which would meet one of the two microbiological parameters of the European ESGAP indicator. It is therefore recommended to use a surrogate indicator that is limited to one microbiological parameter: Escherichia coli. For each country, the programme identifies the proportion of the population with access to a drinking water safely managed. Drinking water from an improved source that is on-site, always available, and free of faecal and priority chemical pollution contamination.

The proportion of the population with access to a drinking water safely managed services is the global indicator for SDG target 6.1 (achieving universal access to safely managed services by 2030). The number of countries with estimates available for SDG 6.1.1 is 138 (UNICEF JMP WHO 2022).

Database

By using this JMP database27, a proxy indicator would be used that would not meet 100% of the previously established criteria. However, we would still be using a database from a working group led by the WHO. This would give credibility to the results and allow us to have objectives based on science even if the basic criterion is not respected.

The next step would be to look for a more comprehensive indicator that would allow to predict 100% whether a water is safe to drink or not depending on the country. The JMP recognizes that looking at this criterion alone is not the best way to ensure the quality of water in a country. However, in their view, this criterion is the only way we currently have to monitor water safety globally. Indeed, at present only a few countries have all the data that would be necessary to prove whether or not a water is really safe to drink.

Bathing waters

Standard & Reference

The quality criterion for bathing waters defined in the European legislation is based on the WHO threshold values for faecal enterococci and Escherichia coli. This concerns only two microbiological parameters. The precise data are as follows:

- Escherichia coli: up to 250 germs/100ml are tolerated; and the threshold must not be exceeded is 500 germs/100ml
- Enterococcus: up to 100 germs/100ml are tolerated, and the threshold must not be exceeded is 200 germs/100ml[28]

The relevance of this criterion is questionable. The quality of coastal waters is already a criterion taken into account for the good status of marine ecosystems, where we look at both the ecological and chemical status of coastal water bodies. Moreover, indicators for good bathing water quality are almost nonexistent in most developing countries. This is a problem that is much more common in developed countries (e.g. Europe), where databases are available. It is therefore very difficult to gather figures that allow for a global comparison, including developing countries, on this criterion.

Database

The European Environment Agency provides data on the state of bathing waters for all European countries based on the quality criteria defined in the European legislation. However, this database does not exist at a global scale.

World Natural Heritage Sites

Standard & Reference

This indicator is covered by a global standard described in Osipova et al. (2017). In 2017, there were 241 natural sites currently listed in 107 countries. Since the last ESGAP studies, a new report has been published by the International Union for the Conservation of Nature (IUCN) in 2020 (Osipova et al., 2020)29. Compared to the assessment in 2017, there are 11 new sites (252 in total), 16 sites have deteriorated, and 8 sites have improved their conservation outlook.

Database

The data is reported directly in (and can be extracted from) the UICN reports.

[27] https://washdata.org/data/household#!/
[28] https://baignades.sante.gouv.fr/baignades/editorial/fr/controle/exemple.html
[29] https://portals.iucn.org/library/node/49134

3.3 ASSESSING THE FEASIBILITY OF IMPLEMENTING THE ESGAP, OR PARTS OF THE ESGAP, IN DEVELOPING COUNTRIES

Thes ESGAP framework was first developed with principles, topics, and indicators of critical natural capital that suited the European context. The description of standards defined by AFD for the ESGAP (Annex A) should be updated reflecting on the findings presented in this report and in the complementary Excel Spreadsheet. In particular, the use of standards described "as defined in European Legislation" needs to be updated by global definitions.

Out of the 22 indicators investigated, we attempted to provide a standard and reference level for 16 indicators. For 8 indicators, we did not find enough robust information to propose a globally applicable standard. Further scientific advances may arise in the future to better populate the framework. One possibility would be to organize workshops to attempt to determine an acceptable standard. This could be the case for soil erosion where there seems to be a possible convergence on the type of standard that could be used. We identified 13 datasets available to compute these indicators at the global scale and provided the source and link to access these publicly available databases.

The next step to produce an all-country standard involves, for indicators with "standards to be defined by experts" from Fairbrass 2020, to look at who could be the experts and how to engage with them to define a globally applicable standard. This depends on if there is one globally recognized authority (like WHO for pollution or FAO for fisheries), or if the indicator is developed by different teams of scientists or organizations. In any case, the definition of science-based targets at the global level would be a resource-intensive endeavor that goes beyond the scope of this report. Future work could also focus on reviewing the state of knowledge and options about defining standards from non-conventional sources such as geospatial data, big earth data, etc. For instance, the ARIES project linked to the compilation of ecosystem accounts within the framework of the SEEA-EA could be an interesting source.

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6. ANNEX A: PRESENTATION OF THE ESGAP FRAMEWORK

ESGAP metrics measure two key aspects of environmental sustainability: (1) the ratio between the current state of essential and critical environmental functions and their sustainable state, defined by environmental sustainability standards, and (2) the ratio between observed trends and sustainable trends, the latter being the progress required to achieve environmental standards at a given point in time. Environmental standards represent the targets to be maintained or reached in order to preserve the environmental functions of the territory or country (see list below). An operational sustainability standard combines a good scientific knowledge of the ecological dynamics at work with a political appropriation of its societal stakes. This is the case, for example, of the maximum sustainable yield for fisheries resources, or of the 1.5° limit for global warming. Protective responses or measures, such as the extent of protected areas, are not good standards.

Initially developed by Paul Ekins' team at UCL, ESGAP consists of a scorecard of 12 components broken down into 21 indicators, representing the list of essential and critical environmental functions currently identified as having an adequate standard of sustainability. This scorecard allows the calculation of two composite indicators representing the performance against the standards and the evolution of the trend (the progress over time) compared to a desired trend. ESGAP can also be used on an international scale to evaluate and rank the performance of countries with respect to these standards, and to make comparisons between territories, provided that sufficiently detailed data are available at these scales (see below the application to European countries by UCL).

Function	Principle	Topic
Source	Renew renewable resources	Biomass
		Freshwater
	Use non-renewables prudently	Soil
Sink	Prevent global warming, ozone depletion	Earth System
	Respect critical levels and critical loads for ecosystems	Terrestrial ecosystems
		Freshwater ecosystems
		Marine ecosystems
Life support	Maintain biodiversity (especially species and ecosystems)	Terrestrial ecosystems
		Freshwater ecosystems
		Marine ecosystems
Human health and welfare	Respect standards for human health	Human health
	Conserve landscape and amenity	Recreation

Structure of the ESGAP. The four main functions of natural capital are operationalized and then broken down into several components, which are themselves composed of several indicators.

Function	Principle	Topic	Subtopic	Pressure/State	Standard	ESGAP Indicator
Source	Renew renewable resources	Biomass	Forest resources	Annual fellings	Fellings / Net Annual Increment	Forest utilization rate
			Fish resources	Condition of fish stocks	Fishing mortality consistent with Maximum Sustainable Yield Spawning stock biomass consistent with Maximum Sustainable Yield	Fish stocks within safe biological limits
		Freshwater	Surface water resources	Blue water consumption	Blue water consumption / Mean quarterly flows	Freshwater bodies not under water stress
			Groundwater resources	Status of groundwater body	Good quantitative status as defined in European legislation	Groundwater bodies in good quantitative status
	Use non-renewables prudently	Soil	Soil erosion	Soil erosion rate	Tolerable soil erosion rate	Area with tolerable soil erosion
Sink	Prevent global warming, ozone depletion	Earth System	Greenhouse gases	Greenhouse gas emissions	Long-term CO_2 emissions consistent with a 1.5-2ºC increase in global mean temperature compared to pre-industrial levels.	Emissions / annual allowance
			Stratospheric ozone depleting substances	Consumption of ozone depleting substances	ODS consumption consistent with reducing the ozone hole	Emissions / annual allowance
	Respect critical levels and critical loads for ecosystems	Terrestrial ecosystems	Ozone pollution	Concentration of air pollutants in terrestrial ecosystems	Critical levels of tropospheric ozone	Cropland and forest area exposed to safe ozone levels
			Pollution by heavy metals	Load of air pollutants in terrestrial ecosystems	Ecosystems not exceeding the critical loads of heavy metals (cadmium / lead / mercury)	Critical load of heavy metals
			Eutrophication	Load of air pollutants in terrestrial ecosystems	Good chemical status as defined in European legislation	Ecosystems not exceeding the critical loads of eutrophication
			Acidification	Load of air pollutants in terrestrial ecosystems	Good chemical status as defined in European legislation	Ecosystems not exceeding the critical loads of acidification
		Freshwater ecosystems	Surface water pollution	Chemical status	Pollution-related elements of good environmental status as defined in European legislation	Surface water bodies in good chemical status
			Groundwater pollution	Chemical status	Favourable conservation status based on range, area, structure and function.	Groundwater bodies in good chemical status
		Marine ecosystems	Marine pollution	Chemical status	Good ecological status as defined in European legislation based on biological, physicochemical and hydromorphological parameters	Coastal water bodies in good chemical status
Life support	Maintain biodiversity (especially species and ecosystems)	Terrestrial ecosystems	Functional diversity	Terrestrial habitats in favourable conservation status	Favourable conservation status based on range, area, structure and function.	Terrestrial area with acceptable biodiversity levels
		Freshwater ecosystems	Ecological status	Ecological status	Good ecological status as defined in European legislation based on biological, physicochemical and hydromorphological parameters	Surface water bodies in good ecological status
		Marine ecosystems	Ecological status	Ecological status	Good ecological status as defined in European legislation based on biological, physicochemical and hydromorphological parameters	Coastal water bodies in good ecological status
Human health and welfare	Respect standards for human health	Human health	Outdoor air pollution	Concentration of air pollutants	Critical levels of $PM_{2.5}$	Population exposed to safe levels of $PM_{2.5}$
			Indoor air pollution	Concentration of air pollutants	Critical levels of $PM_{2.5}$	Population using clean fuels and technologies for cooking
			Drinking water pollution	Water samples	Safe drinking water criteria as defined in European legislation based on microbiological, chemical and other parameters	Samples that meet the drinking water criteria
	Conserve landscape and amenity	Amenity	Bathing waters	Concentration of bacteria	'Excellent' quality criteria as defined in European legislation based on the concentration of Intestinal Enterococci and Escherichia Coli in recreational waters	Recreational water bodies in excellent status
			Natural and mixed world heritage sites	Conservation outlook	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	Natural and mixed world heritage sites in good conservation outlook

7. ANNEX B: LIST OF DATA SOURCES ALREADY IDENTIFIED

System of Environmental-Economic Accounting (UN SEEA) and Experimental Ecosystem Accounting (UN SEEA EEA) (https://seea.un.org/)

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/)

ARIES is another tool facilitating natural accounting

The UN compile national environmental statistics for all countries, which is structured around the Framework for the Development of Environment Statistics (FDES) https://unstats.un.org/unsd/envstats/fdes.cshtml

These statistics are used to produce the UN's Environmental Indicators; https://unstats.un.org/unsd/envstats/qindicators.

the Global Partnership for Sustainable Development Data (http://www.data4sdgs.org/) implements and supports a number of initiatives

FAOSTAT (http://www.fao.org/faostat)

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 http://www.fao.org/3/CA3009EN/ca3009en.pdf

The UN Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD, https://www.un-redd.org/) helps build national capacity to implement national forest monitoring systems. This involves developing satellite land monitoring systems (SLMS) http://www.fao.org/3/CA1741EN/ca1741en.pdf

FAO Collect Earth (http://www.openforis.org), Food and Agriculture Organization of the United Nations (FAO)

Global Surface Water Explorer (https://global-surface-water.appspot.com/) United Nations Environment Programme (UNEP) - although this dataset is not relevant for monitoring groundwater

AQUASTAT (http://www.fao.org/nr/aquastat), Food and Agriculture Organization of the United Nations (FAO)

INDSTAT (https://stat.unido.org/), International Energy Agency (IEA), United Nations Industrial Development Organization (UNIDO):

UN-Habitat Urban Data (http://urbandata.unhabitat.org/), United Nations Human Settlements Programme (UN Habitat)

Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP)

FAO Collect Earth (http://www.openforis.org), Food and Agriculture Organization

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)

Global Partnership for Sustainable Development Data (GPSDD): a global network on data for SDGs, broad list of partners, and access to more country data operations. It will be great to have a discussion with them on ways they can contribute to stimulate curation of data.

8. ANNEX C: LIST OF INITIATIVES COMPLEMENTARY TO THE SEEA EA (SOURCE: UNITED NATIONS ET AL., 2021, PP.11-12)

Monitoring of the Sustainable Development Goals (SDGs), in particular progress towards Goals 14 and 15;

The Post-2020 Global Biodiversity Agenda of the Convention on Biological Diversity (CBD) and its monitoring framework;

The measurement of land degradation under the United Nations Convention to Combat Desertification (UNCCD);

The measurement of greenhouse gas emissions and removals by the Land Use, Land Use Change and Forestry (LULUCF) under the United Nations Framework Convention on Climate Change (UNFCCC) and associated Nationally Determined Contributions (NDC);

The regional and global assessments of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) including the IPBES values assessment;

The development of wealth accounting encompassing measures of the value of natural capital (World Bank, UNEP);

International Union for the Conservation of Nature (IUCN) assessment frameworks including the Red List of Species, Red List of Ecosystems, and Key Biodiversity Area guidelines; and knowledge products such as the World Database on Protected Areas (UNEP-WCMC and IUCN);

The Global Earth Observation (GEO) programs of work on biodiversity (GEOBON) including the listing of essential biodiversity variables (EBV) and essential ecosystem services variables (EESV), and the earth observation for ecosystem accounting (GEO EO4EA).

9. ANNEX D: SYNTHESIS SPREADSHEET

Function	Principle	Topic	Subtopic	Pressure/ state	ESGAP Indicator (previous reports)	Description Indicator (All countries ESGAP)
Source	Renew renewable resources	Biomass	Forest resources	Annual fellings	Forest utilization rate	Fellings / Net Annual Increment
Source	Renew renewable resources	Marine	Fish ressources	Condition of fish stocks	Fish stocks within safe biological limits	Fishing mortality consistent with Maximum Sustainable Yield Spawning stock biomass consistent with Maximum Sustainable Yield
Source	Renew renewable resources	Freshwater	Surface water resources	Blue water consumption	Freshwater bodies not under water stress	Blue water consumption / Mean quarterly flows
Source	Renew renewable resources	Freshwater	Groundwater resources	Good quantitative status as defined in European legislation	Groundwater bodies in good quantitative status	Good quantitative status as defined in European legislation
Source	Use non-renewables predently	Soil	Soil erosion	Tolerable soil erosion rate	Area with tolerable soil erosion	Tolerable soil erosion rate
Sink	Prevent global warming, ozone depletion	Earth System	GHG	Greenhouse gas emissions	Emissions / annual allowance Fairbrass: Per-capita GHG/CO2 emissions	Long-term CO2 emissions consistent with a 1.5-2°C increase in global mean temperature compared to preindustrial levels.
Sink	Prevent global warming, ozone depletion	Earth System	Stratospheric ozone depleting substances	Consumption of ozone depleting substances	Emissions / annual allowance	ODS consumption consistent with reducing the ozone hole

Function	Principle	Topic	Subtopic	Pressure/ state	ESGAP Indicator (previous reports)	Description Indicator (All countries ESGAP)
Sink	Respect critical levels and critical loads for ecosystems	Terrestrial ecosystems	Ozone pollution	Concentration of air pollutants in terrestrial ecosystems	Cropland and forest area exposed to safe ozone levels	Critical levels of tropospheric ozone
Sink	Respect critical levels and critical loads for ecosystems	Terrestrial ecosystems	Pollution by heavy metals	Load of air pollutants in terrestrial ecosystems	Ecosystems not exceeding the critical loads of heavy metals	Critical load of heavy metals
Sink	Respect critical levels and critical loads for ecosystems	Terrestrial ecosystems	Eutrophication	Load of air pollutants in terrestrial ecosystems	Ecosystems not exceeding the critical loads of eutrophication	Good chemical status as defined in European legislation
Sink	Respect critical levels and critical loads for ecosystems	Terrestrial ecosystems	Acidification	Load of air pollutants in terrestrial ecosystems	Ecosystems not exceeding the critical loads of acidification	Good chemical status as defined in European legislation
Sink	Respect critical levels and critical loads for ecosystems	Freshwater ecosystems	Surface water pollution	chemical status	Surface water bodies in good chemical status	Pollution-related elements of good environmental status as defined in European legislation
Sink	Respect critical levels and critical loads for ecosystems	Freshwater ecosystems	Groudwater pollution	chemical status	Groundwater bodies in good chemical status	Favourable conservation status based on range, area, structure and function.
Sink	Respect critical levels and critical loads for ecosystems	Marine ecosystems	Marine pollution	chemical status	Coastal water bodies in good chemical status	Good ecological status as defined in European legislation based on biological, physicochemical and hydromorphological parameters

Function	Principle	Topic	Subtopic	Pressure/ state	ESGAP Indicator (previous reports)	Description Indicator (All countries ESGAP)
Life support	Maintain biodiversity (especially species and ecosystems)	Terrestrial ecosystems	Functional diversity	Local Biodiversity Intactness Index	Terrestrial area with acceptable biodiversity levels	Good environmental status as defined in European legislation based on biological, physicochemical and hydromorphological parameters
Life support	Maintain biodiversity (especially species and ecosystems)	Freshwater ecosystems	Ecological status	Ecological status	Surface water bodies in good ecological status	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
Life support	Maintain biodiversity (especially species and ecosystems)	Marine ecosystems	Ecological status	Ecological status	Coastal water bodies in good ecological status	Groundwater bodies in good chemical status in terms of oxygen content, conductivity and nitrate
Human health and welfare	Respect standards for human health	Human health	Outdoor air pollution	Concentration of air pollutants	Population exposed to safe levels of PM2.5	Critical level of PM2.5
Human health and welfare	Respect standards for human health	Human health	Indoor air pollution	Concentration of air pollutants	Population using clean fuels and technologies for cooking	Critical level of PM2.5
Human health and welfare	Respect standards for human health	Human health	Drinking water pollution	Water samples	Samples that meet the drinking water criteria	According to European legislation the drinking water standard is defined as follows: The water supplied must be free of escherichia coli (e.coli) and enterococci. The bacteriological quality of the drinking water must be ensured under all circumstances and cannot be tolerated.
Human health and welfare	Conserve landscape and amenity	Amenity	Bathing waters	Concentration of bacteria	Recreational water bodies in excellent status	Excellent' quality criteria as defined in European legislation based on the concentration of Intestinal Enterococci and Escherichia Coli in recreational waters

Function	Principle	Topic	Subtopic	Pressure/ state	ESGAP Indicator (previous reports)	Description Indicator (All countries ESGAP)
Human health and welfare	Conserve landscape and amenity	Amenity	Natural and mixed world heritage sites	Conservation outlook	Natural and mixed world heritage sites in good conservation outlook	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

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Fellings / Net Annual Increment	Forest cover	No net loss	ha	year	country	Fairbrass et al. (2020), EEA (2017)	WRI 2021 FAO, FRA 2020
Fishing mortality consistent with Maximum Sustainable Yield Spawning stock biomass consistent with Maximum Sustainable Yield	Maximum Sustainable Yields	MSY	stock	year	Regional fisheries/ countries	FAO	FAOSTAT (http://www.fao.org/faostat), Food and Agriculture Organization of the United Nations (FAO)
Blue water consumption / Mean quarterly flows	Water stress (%) : how much water is left and available in the environment	25	%	annual	Country & basin	FAO, Aquastat, GEFIS	AQUASTAT (http://www.fao.org/nr/aquastat), Food and Agriculture Organization of the United Nations (FAO) FAO: Global data on water abstraction is available. United Nations Statistics Division (UNSD) GEFIS (http://eflows.iwmi.org) : Global Environmental Flows Information System

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Good quantitative status as defined in European legislation	Good quantitative status : available groundwater resource is not exceeded by the long-term annual average rate of abstraction	available groundwater resource < long-term annual average rate of abstraction	/	annual	Country	FAO, Aquastat, EEA	Global Surface Water Explorer (https://global-surface-water.appspot.com/) The FAO produce country statistics on total renewable groundwater and fresh groundwater withdrawal which is made available on their AQUASTAT platform
Tolerable soil erosion rate	Annual soil loss due to erosion	2	t/ha year	anual	Country	European Soil Data Centre (ESDAC)	Global Soil Erosion dataset by the European Soil Data Center (ESDAC) World Soil Database (HWSD)
Long-term CO2 emissions consistent with a 1.5-2°C increase in global mean temperature compared to preindustrial levels.	Carbon budget available per capital compatible with the Paris Agreement	1.5 - 2	tCO2/capita	Annual	Country	IPCC	EDGAR (Emissions Database for Global Atmospheric Research) https://edgar.jrc.ec.europa.eu/
ODS consumption consistent with reducing the ozone hole	Consumption of HCFC (ozone depleting potential) per capita	Between 0% and 0,5% compared to 2007	HCFC production consumption per capita	Annual	Country	UN Environment Programme Ozone Secretariat	Global data is compiled and reported by the UN Environment Programme Ozone Secretariat

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Critical levels of tropospheric ozone	accumulated ozone exposure	3 (6000) for cropland 5 (10000) for forested areas	ppm h (µg m-3 h)	hour	local	AOT40, EEA	Fairbrass et al., 2020: There are no global datasets of ground-level ozone deposition. Global data on ozone concentrations in the atmosphere are produced by the Copernicus Programme and the National Oceanic and Atmospheric Administration (NOAA), but this data would not be suitable for measuring exposure at ground-level.
Critical load of heavy metals	Concentration of mercury, lead & cadmium		cf. report			Jessica Briffa, et al. (2020)	Global mercury emissions, release and transport statistics are reported by the UN Environment Global Mercury Assessment
Good chemical status as defined in European legislation	Nitrate concentration	2.5	mg N l-1	annual	Lakes	Wim de Vries & Lena Schulte-Uebbing (2020)	There is a database available for eutrophication at European level (UNEP) but not at a global level.
Good chemical status as defined in European legislation	PH, N concentration	PH : 4,4 N concentration : 1	mgNL-1	annual	country	EEA, Maximilian Posch et al 2014	There is no global data available for acidification. However, there are global datasets available on nitrogen and sulphur concentration and deposition data

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Pollution-related elements of good environmental status as defined in European legislation	Proportion of bodies of water with good ambient water quality	See table : "Optional target values for the different water body types" from the Technical guidance document no.2 of SDG indicator 6.3.2 "clean water and sanitation"	Status defined by : oxygen, conductivity, nitrogen/nitrate, phosphorus, pH	annual	Country and bassin	The Global Environment Monitoring Systems (GEMS) supports the collection data on water quality for the SDG #6 "Clean water and sanitation"	Global data for some, but not all, of these chemical elements are available from a range of sources. The UN Environment GEMStat portal reports a large number of parameters from river, lake, reservoir and wetland monitoring stations that are relevant to this indicator Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP)
Favourable conservation status based on range, area, structure and function.	Proportion of bodies of water with good ambient water quality	Good status vs bad status	Status defined by : conductivity, nitrogen/nitrate, pH	annual	Country and bassin	The Global Environment Monitoring Systems (GEMS) supports the collection data on water quality for the SDG #6 "Clean water and sanitation"	Global data for some, but not all, of these chemical elements are available from a range of sources. The UN Environment GEMStat portal 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. Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP) EEA 2009

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Good ecological status as defined in European legislation based on biological, physicochemical and hydromorphological parameters	Measure water eutrophication	Same as the subtopic eutrophication (colon J11)	Nitrogen	annual	Country	Data collection for the SDG #14 indicator (UNEP)	Using Copernicus, a proxy indicator based on a limited set of parameters could be produced for all countries. 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.The proxy indicator could be Coastal water bodies in good chemical status in terms of temperature, salinity, oxygenation conditions, turbidity, nitrate and nitrite. The methodology for producing this SDG indicator was published in 2020
Good environmental status as defined in European legislation based on biological, physicochemical and hydromorphological parameters			cf. report § 3.2.3.				The PREDICTS project 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 Newbold, T., et al. (2016)

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
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			cf. report § 3.2.3.				Fairbrass et al., 2020: The Copernicus Global Land Service produces relevant data for medium and large-sized lakes. The UN Environment GEMStat portal reports a phytoplankton parameter and a number of physico-chemical parameters. There is no global data on thermal conditions, other aquatic flora, macro invertebrates or fish parameters. The proxy indicator could be Surface water bodies in good ecological status in terms of oxygenation, salinity, nutrient status, acidification status and phytoplanktonGlobal Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP) Usubiaga-Liano & Ekins, 2021: There are no absolute environmental standards applicable across water bodies, so the ecological status is defined based on the extent to which current values deviate from those attributable to undisturbed conditions

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Groundwater bodies in good chemical status in terms of oxygen content, conductivity and nitrate	cf. report § 3.2.3.						Fairbrass et al., 2020: Global data for some, but not all, of these parameters are available from the Copernicus Marine Environment Monitoring Service In Situ Thematic Assembly Centre and the Plymouth Marine Laboratory OceanColour platform Usubiaga-Liano & Ekins, 2021: There are no absolute environmental standards applicable across water bodies, so the ecological status is defined based on the extent to which current values deviate from those attributable to undisturbed conditions

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Critical level of PM2.5	Population exposed to safe levels of PM2.5	- safe level = 5 - population exposed: 0	- µg/m3 - %	Annual	Country	WHO https://apps.who.int/iris/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1&isAllowed=y	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)
Critical level of PM2.5							The WHO collate and report global data on the proportion of households in a country relying mainly on polluting fuels and technologies for cooking, which they use as a proxy indicator for estimating population exposure to household air pollution. World Health Organisation (WHO) (2018)
According to European legislation the drinking water standard is defined as follows: The water supplied must be free of escherichia coli (e.coli) and enterococci. The bacteriological quality of the drinking water must be ensured under all circumstances and cannot be tolerated.	The proportion of the population with access to a drinking water safely managed	100% of the population with acess to a drinking water safely managed	%	Year	Country (World)	Joint Monitoring Program WHO/UNICEF - https://washdata.org/data/household#!/	The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) 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. Recommandation 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. It's proxy indicator.

Description Indicator (All countries ESGAP)	Type	Thresholds	Units	Temporal scale	Spatial scale	Source (standards & norms)	Databases
Excellent' quality criteria as defined in European legislation based on the concentration of Intestinal Enterococci and Escherichia Coli in recreational waters	Proportion of a country's bathing waters with excellent quality status. Also gives the proportion of bathing waters with at least sufficient status, and the proportion of bathing waters that are of poor quality.	This concerns only two microbiological parameters : - Escherichia coli: up to 250 germs/100ml are tolerated; and the threshold must not be exceeded is 500 germs/100ml - Enterococcus: up to 100 germs/100ml are tolerated, and the threshold must not be exceeded is 200 germs/100ml	germs/100ml	Year	Country (Europe)	Environment european agency - https://www.eea.europa.eu/themes/water/europes-seas-and-coasts/assessments/state-of-bathing-water/state-of-bathing-waters-in-2020	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
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	Good conservation outlook	Good with some concerns	Conservation outlouk	3 years	Sites (World)	https://portals.iucn.org/library/node/49134	The data is reported directly in (and can be extracted from) the UICN reports.

Description Indicator (All countries ESGAP)	Databases	Consistency across ESGAP studies	Standard	Covered by international treaty/ organization	Scope	Identified custodian (nb countries covered)
Fellings / Net Annual Increment	WRI 2021 FAO, FRA 2020	3. Different standard, different reference value	Scientific literature	Yes	National	FAO (+200 countries)
Fishing mortality consistent with Maximum Sustainable Yield Spawning stock biomass consistent with Maximum Sustainable Yield	FAOSTAT (http://www.fao.org/faostat), Food and Agriculture Organization of the United Nations (FAO)	1. Same standard, same reference value (>50% reports use this value)	Scientific literature	Yes	Regional	FAO (15 regions, 13 countries)
Blue water consumption / Mean quarterly flows	AQUASTAT (http://www.fao.org/nr/aquastat), Food and Agriculture Organization of the United Nations (FAO) FAO: Global data on water abstraction is available. United Nations Statistics Division (UNSD) GEFIS (http://eflows.iwmi.org) : Global Environmental Flows Information System	1. Same standard, same reference value (>50% reports use this value)	Scientific literature	Yes	National	FAO (+200 countries)
Good quantitative status as defined in European legislation	Global Surface Water Explorer (https://global-surface-water.appspot.com/) The FAO produce country statistics on total renewable groundwater and fresh groundwater withdrawal which is made available on their AQUASTAT platform	2. Same standard, different reference value (<50% reports use this value)	Scientific literature	No	National	FAO (+200 countries)
Tolerable soil erosion rate	Global Soil Erosion dataset by the European Soil Data Center (ESDAC) World Soil Database (HWSD)	2. Same standard, different reference value (<50% reports use this value)	Scientific literature	No	Global	European Soil Data Center (ESDAC) (202 countries)

Description Indicator (All countries ESGAP)	Databases	Consistency across ESGAP studies	Standard	Covered by international treaty/ organization	Scope	Identified custodian (nb countries covered)
Long-term CO2 emissions consistent with a 1.5-2°C increase in global mean temperature compared to preindustrial levels.	EDGAR (Emissions Database for Global Atmospheric Research) https://edgar.jrc.ec.europa.eu/	1. Same standard, same reference value (>50% reports use this value)	International treaty	Yes	Global	TBD (multiple sources possible)
ODS consumption consistent with reducing the ozone hole	Global data is compiled and reported by the UN Environment Programme Ozone Secretariat	1. Same standard, same reference value (>50% reports use this value)	Scientific literature	Yes	Global	UNEP Ozone Secretariat (all countries)
Critical levels of tropospheric ozone	Fairbrass et al., 2020: There are no global datasets of ground-level ozone deposition. Global data on ozone concentrations in the atmosphere are produced by the Copernicus Programme and the National Oceanic and Atmospheric Administration (NOAA), but this data would not be suitable for measuring exposure at ground-level.	3. Different standard, different reference value	Scientific literature	No	National	no data
Critical load of heavy metals	Global mercury emissions, release and transport statistics are reported by the UN Environment Global Mercury Assessment	2. Same standard, different reference value (<50% reports use this value)	Scientific literature	Yes	Global	Lack of data for some regions
Good chemical status as defined in European legislation	There is a database available for eutrophication at European level (UNEP) but not at a global level.	3. Different standard, different reference value	Scientific literature	No	National	UNEP (all countries)
Good chemical status as defined in European legislation	There is no global data available for acidification. However, there are global datasets available on nitrogen and sulphur concentration and deposition data	3. Different standard, different reference value	Scientific literature	No	National	Maximilian Posch et al 2014 (Europe & China)

Description Indicator (All countries ESGAP)	Databases	Consistency across ESGAP studies	Standard	Covered by international treaty/ organization	Scope	Identified custodian (nb countries covered)
Pollution-related elements of good environmental status as defined in European legislation	Global data for some, but not all, of these chemical elements are available from a range of sources. The UN Environment GEMStat portal reports a large number of parameters from river, lake, reservoir and wetland monitoring stations that are relevant to this indicator Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP)	2. Same standard, different reference value (<50% reports use this value)	Scientific literature	No	National	UNEP (all countries)
Favourable conservation status based on range, area, structure and function.	Global data for some, but not all, of these chemical elements are available from a range of sources. The UN Environment GEMStat portal 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. Global Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP) EEA 2009	2. Same standard, different reference value (<50% reports use this value)	Scientific literature	No	National	UNEP (all countries)
Good ecological status as defined in European legislation based on biological, physicochemical and hydromorphological parameters	Using Copernicus, a proxy indicator based on a limited set of parameters could be produced for all countries. 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.The proxy indicator could be Coastal water bodies in good chemical status in terms of temperature, salinity, oxygenation conditions, turbidity, nitrate and nitrite. The methodology for producing this SDG indicator was published in 2020	2. Same standard, different reference value (<50% reports use this value)	Scientific literature	No	National	UNEP (all countries)

Description Indicator (All countries ESGAP)	Databases	Consistency across ESGAP studies	Standard	Covered by international treaty/ organization	Scope	Identified custodian (nb countries covered)
Good environmental status as defined in European legislation based on biological, physicochemical and hydromorphological parameters	The PREDICTS project 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 Newbold, T., et al. (2016)	3. Different standard, different reference value	Scientific literature	Yes	Please select an option	x
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	Fairbrass et al., 2020: The Copernicus Global Land Service produces relevant data for medium and large-sized lakes. The UN Environment GEMStat portal reports a phytoplankton parameter and a number of physico-chemical parameters. There is no global data on thermal conditions, other aquatic flora, macro invertebrates or fish parameters. The proxy indicator could be Surface water bodies in good ecological status in terms of oxygenation, salinity, nutrient status, acidification status and phytoplanktonGlobal Environment Monitoring System for Water (GEMS/Water) (https://gemstat.org), United Nations Environment Programme (UNEP) Usubiaga-Liano & Ekins, 2021: There are no absolute environmental standards applicable across water bodies, so the ecological status is defined based on the extent to which current values deviate from those attributable to undisturbed conditions	3. Different standard, different reference value	Scientific literature	No	Please select an option	x

Description Indicator (All countries ESGAP)	Databases	Consistency across ESGAP studies	Standard	Covered by international treaty/ organization	Scope	Identified custodian (nb countries covered)
Groundwater bodies in good chemical status in terms of oxygen content, conductivity and nitrate	Fairbrass et al., 2020: Global data for some, but not all, of these parameters are available from the Copernicus Marine Environment Monitoring Service In Situ Thematic Assembly Centre and the Plymouth Marine Laboratory OceanColour platform Usubiaga-Liano & Ekins, 2021: There are no absolute environmental standards applicable across water bodies, so the ecological status is defined based on the extent to which current values deviate from those attributable to undisturbed conditions	3. Different standard, different reference value	Scientific literature	No	Please select an option	x
Critical level of PM2.5	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)	1. Same standard, same reference value (>50% reports use this value)	International treaty	Yes	National	WHO (200 countries)
Critical level of PM2.5	The WHO collate and report global data on the proportion of households in a country relying mainly on polluting fuels and technologies for cooking, which they use as a proxy indicator for estimating population exposure to household air pollution. World Health Organisation (WHO) (2018)	1. Same standard, same reference value (>50% reports use this value)	International treaty	Yes	Please select an option	x
According to European legislation the drinking water standard is defined as follows: The water supplied must be free of escherichia coli (e.coli) and enterococci. The bacteriological quality of the drinking water must be ensured under all circumstances and cannot be tolerated.	The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) 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. Recommandation 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. It's proxy indicator.	3. Different standard, different reference value	International treaty	Yes	National	WHO- UNICEF (+200 countries)

Description Indicator (All countries ESGAP)	Databases	Consistency across ESGAP studies	Standard	Covered by international treaty/ organization	Scope	Identified custodian (nb countries covered)
Excellent' quality criteria as defined in European legislation based on the concentration of Intestinal Enterococci and Escherichia Coli in recreational waters	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	2. Same standard, different reference value (<50% reports use this value)	National policies	No	National	EEA (only europe)
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	The data is reported directly in (and can be extracted from) the UICN reports.	1. Same standard, same reference value (>50% reports use this value)	International treaty	Yes	Global	UNESCO/IUCN

About Agence Française de Développement

AFD Group implements France's policy in the areas of development and international solidarity. The Group includes Agence Française de Développement (AFD), which finances the public sector and NGOs, as well as research and education in sustainable development; its subsidiary Proparco, which is dedicated to private sector financing; and Expertise France, a technical cooperation agency. The Group finances, supports and accelerates transitions towards a fairer, more resilient world.

With our partners, we are building shared solutions with and for the people of the Global South. Our teams are at work on more than 4,000 projects in the field, in the French Overseas Departments and Territories, in 115 countries and in regions in crisis. We strive to protect global public goods – promoting a stable climate, biodiversity and peace, as well as gender equality, education and healthcare. In this way, we contribute to the commitment of France and the French people to achieve the Sustainable Development Goals (SDGs). Towards a world in common.

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Defining standards of good ecological condition for computing the ESGAP in developing countries

This report seeks to demonstrate the feasibility of an "all-country" ESGAP, the implementation of the framework and the calculation of ESGAP parameters for as many countries as possible around the world. A preliminary step in implementing ESGAP is to identify the relevant data sources and, more problematically, the relevant sustainability standards for each ESGAP component.

This holistic approach is therefore not about analysing sustainability issues in specific countries, but rather about trying to generalise the concept of a 'good ecological status standard' and apply it in a cross-country comparison.

The lack of appropriate standards for many key contributions of natural capital and in many countries is one of the most notable gaps identified in the ESGAP pilot projects. This study identifies the missing standards for one or more ESGAP components. It discusses possible strategies for developing appropriate standards in the event that no appropriate standards are available globally..

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