Manual on the Basic Set of Environment Statistics

of the FDES 2013

Freshwater Quality Statistics

(Topic 1.3.2: Freshwater quality of the Basic Set of Environment Statistics of the FDES 2013)

*Elaborated by the Environment
Statistics Section
of the United Nations Statistics
Division,
in collaboration with the
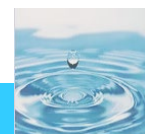Expert Group on Environment Statistics*

Version 1.0
8 August 2023

Acknowledgement

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2. Introduction/Relevance

Freshwater resources are used everywhere. We use them as drinking water, for food preparation, and for washing. We also depend on these resources for irrigation, for recreation, to assimilate our wastewater, for power generation and to support multiple industries. Terrestrial and freshwater ecosystems contribute to these resources, in particular, to water supply and water purification defined as ecosystem services (see SEEA-EA)[1], but their ability to continue to do so is under threat. Pressures from human activities cause damage to these fragile ecosystems. Damaging activities include the release of untreated effluent (liquid waste and sewage) and changes to the surrounding catchment area that include agricultural intensification, deforestation and mining.

Seeing is believing, yet often it is not possible to see the quality of freshwater. By monitoring and generating water quality data and by sharing them using reports, maps and data portals, we can see if rivers can be used to irrigate our crops, if lakes can support healthy fisheries, and if an aquifer can be used to supply safe drinking water. Monitoring water quality makes the invisible become visible and provides evidence to implement management measures.[2]

In practice the monitoring of freshwater quality is complicated. There are thousands of substances that can be measured in freshwaters. Topic 1.3.2 of the FDES contributes to prioritizing the most applicable ones by offering a selection of 18 statistics proposed on the bases of their relevance, methodological soundness and data availability. The quality of freshwater can be described based on concentrations of nutrients and chlorophyll, organic matter, pathogens, metals and organic contaminants, and by physical and chemical characteristics in surface water and groundwater. Pollutants found in groundwater are important but systematic measurements are often difficult.[3] The state of freshwater quality is determined by performing assessments which take into account certain (often context specific) thresholds, baseline values and/or trends for each of the above parameters.

The measured concentrations vary constantly over space and time, which makes it difficult to determine whether water quality is in its natural state or is impacted by human activity. Other complicating factors are the diversity of the aquatic ecosystems, how they are interconnected, how substances in them interact with each other, and what the ultimate (health) effects are on humans and ecosystems. This asks for a well-designed monitoring system to assess freshwater quality and to take measurements whenever needed. Such a monitoring system will provide, on a regular basis, the measurements of substance concentrations in groundwater and surface waters. Knowing the measured concentrations is certainly helpful, but not sufficient to determine what causes a sudden (or prolonged) increase (or decrease) in a time series of a measured concentration. To take the right policy measures one needs to know from what sources (diffuse or point) the measured pollutant concentrations originate.

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[1] United Nations Statistics Division, System of Environmental-Economic Accounting – Ecosystem Accounting, page 131, Table 6.3, https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf (accessed 8 August 2023).
[2] AN INTRODUCTION TO SDG INDICATOR 6.3.2:PROPORTION OF BODIES OF WATER WITH GOOD AMBIENT WATER QUALITY, https://communities.unep.org/display/sdg632/Documents+and+Materials?preview=/32407814/106758333/SDG632_Introduction%20to%20the%20Methodology_20230420.pdf (accessed 8 August 2023).
[3] United Nations Statistics Division, Framework for the Development of Environment Statistics, p. 42: https://unstats.un.org/unsd/environment/FDES/FDES-2015-supporting-tools/FDES.pdf (accessed 8 August 2023).

The pollutants in agricultural and natural soils will partly be transferred to surface waters by run-off and leaching processes. Some of the pollutants are accumulated in the soils, transferred to the groundwater, or disintegrated before they would reach the surface waters. All kinds of natural processes play a role here, including transboundary inflows. The modelling of such complex processes, not only in soils but also in air, are normally done by research institutes. In agricultural areas, however, statisticians may facilitate the scientific modelling efforts by compiling the agricultural nutrient inputs (like fertilizers and animal feed) and outputs (like crop and animal production). The difference, 'inputs minus outputs', is discharged to the interconnected soil/air system, and will ultimately be measured in the surface waters. The agricultural gross nutrient balance can be compiled at individual farm level or country level (with intermediate aggregates). The results at individual farm level can be linked to ambient concentration measurements. In a similar sense, aggregates of such measurements can be linked to regional and national agricultural gross nutrient balances.

Statistical methods, in particular SEEA Ecosystem accounting, can be applied in this area. In the context of accounting for physical flows, measures of natural inputs from the environment will be aligned with measures of ecosystem services. Also, the measures of residual flows (e.g., flows of particulate matter, excess nitrogen) can be related to flows of ecosystem services that concern, for example, water purification. Residual flows will also often indicate environmental pressures that can be related to changes in ecosystem condition (SEEA-EA).[4]
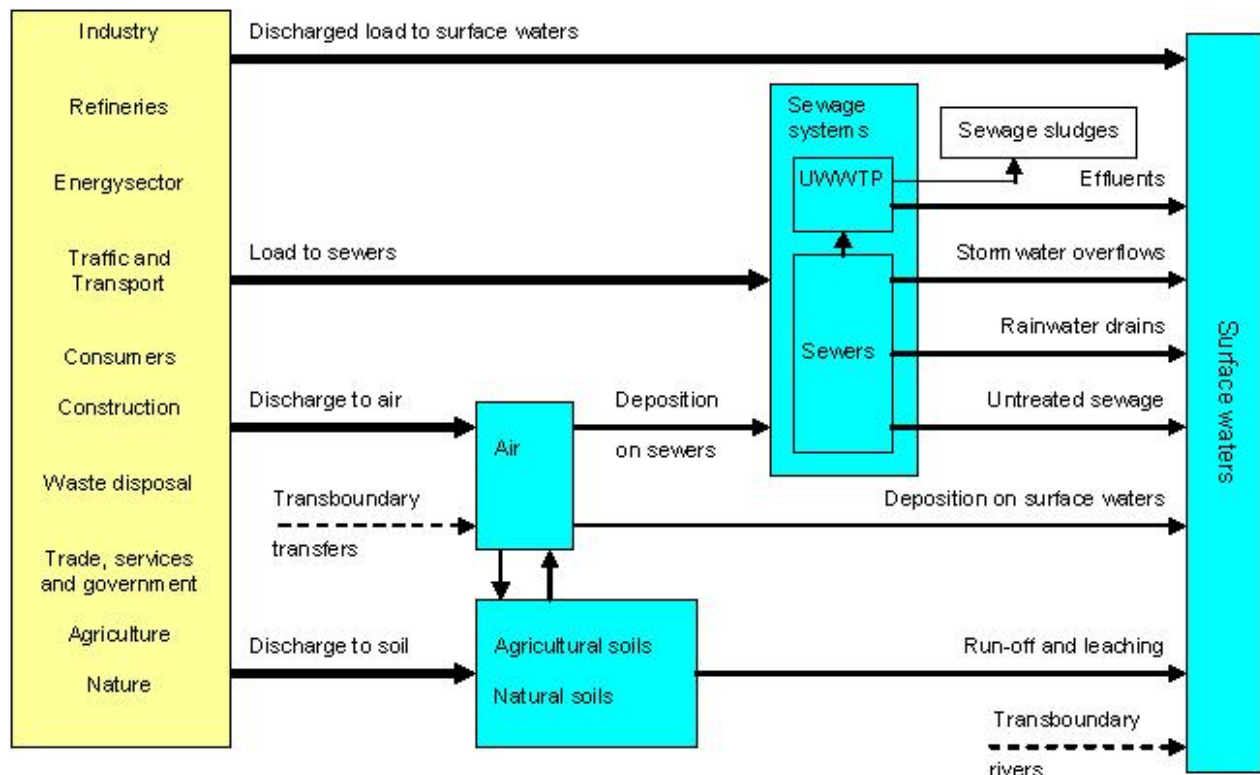

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[4] United Nations Statistics Division, System of Environmental-Economic Accounting – Ecosystem Accounting, page 131, Paragraphs 1.35-36, https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf (accessed 8 August 2023). The thickness of the arrows varies depending on the practices in a country.

Figure: 2.1 Discharged load from several sources, direct and indirect, to surface waters. [5]

Figure 2.1 shows the full picture. It demonstrates anthropogenic impacts which impact water quality in surface water bodies. On the right-hand side, the freshwater quality of surface waters could be monitored by measuring the concentrations of the pollutants and other freshwater quality aspects (like pH/acidity/alkalinity, temperature, and plastic waste). Going from right to left, the results of a well-designed monitoring system could be linked to the sources of water pollution. Particular attention could be given to the interconnected air/soil system, including the measurements of pollutant concentrations in groundwater as well as the compilation of agricultural gross nutrient balances at individual farm level (and higher aggregates). Not all the pollutants discharged from a source end up directly and completely in surface waters. A significant part of the load is treated, e.g., using bacteria, in urban wastewater treatment plants (UWWTP). The contaminants that are left behind in an UWWTP are removed as sewage sludge. The treated wastewater discharged from an UWWTP to surface water is known as effluent. However, effluent is not restricted to that coming from WWTPs. For example, effluent can originate from an industrial process with no treatment.

The discharged pollutants that are not collected by the sewage system may end up directly in surface waters, or indirectly, if first discharged to air and soil. The pollutants in air will partly be transferred to surface waters by atmospheric deposition. This refers to the phenomenon through which pollutants, including gases and particles, are deposited from the atmosphere in the form as dust or in precipitation, ultimately entering freshwater systems. This process allows pollutants to be deposited far from their source, making it difficult to determine their specific source.

The Brazilian example shown in Figure 2.2 displays those stages of the water cycle. Such a detailed description of the water cycle may help inform where to prioritise measurement of water quality. Usually, water quality status and trends are expressed through concentration measurements, but for major rivers in a country, annual loads of key constituents, such as nutrients and sediments, can also provide valuable information for analysis. Measuring annual loads can also solve some problems associated with seasonality.

Further, Figure 2.2 includes groundwater in its scope. Although to a layperson observer, groundwater may often be considered 'invisible', especially relative to surface water, groundwater is of paramount importance in many countries, and represents 98% of Earth's unfrozen freshwater.[6] For some countries (e.g., those on the Persian Gulf) marine water is also in scope, i.e., where desalinated plants are used as a freshwater resource.

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[5] Adapted and translated from Statistics Netherlands, Belasting van en emissies naar water: begrippen en definities | Compendium voor de Leefomgeving (clo.nl) (accessed 8 August 2023).

[6] United Nations Educational, Scientific and Cultural Organization (UNESCO), Groundwater, available at: https://en.unesco.org/themes/water-security/hydrology/groundwater (accessed 8 August 2023).

Figure 2.2: The Water Cycle (Brazilian example)[7]
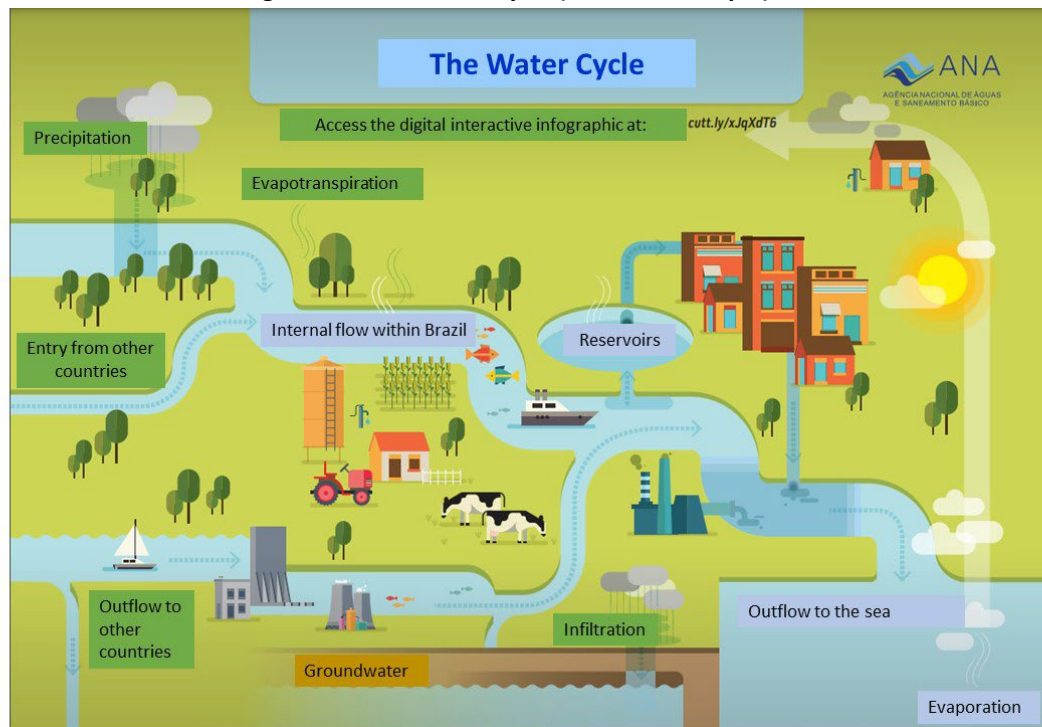
This methodology sheet on freshwater quality is closely related to several other sheets which were published on the UNSD website on wastewater, water resources, and marine water quality. For agricultural areas the methodology sheet on crops and livestock statistics is relevant. The definitions, classifications and terminologies used throughout this methodology sheet on freshwater quality have taken into consideration those applicable to SDG indicator 6.3.2: Proportion of bodies of water with good ambient water quality. The UN World Water Development Reports also contain relevant information to understand the state, use and management of the world's freshwater resources, and design better water policies, although generally no statistics are included. Each year describes a new topic. The 2022 version described groundwater aspects, the 2021 version the valuing of water, and the 2020 version was on water and climate change.

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[7] Agencia Nacional De Aguas E Saneamento Básico (Brazil), Conjuntura Brasil: Recursos Hidricos – 2021, available at: https://www.snirh.gov.br/portal/centrais-de-conteudos/conjuntura-dos-recursos-hidricos/conjuntura_2021_pdf_final_revdirec.pdf (accessed 8 August 2023).

3. Definitions and description of the statistics

The following **generic terms** apply to the topic of freshwater quality:

- **Freshwater:** Naturally occurring water having a low concentration of salt which allows for safe use as drinking and irrigation water (usually considered to be less than 500 ppm).[8]

- **Freshwater quality:** Ambient water quality refers to natural, untreated water in rivers, lakes and groundwaters and represents a combination of natural influences together with the impacts of all anthropogenic activities.[9]

- **Agricultural gross nutrient balance:** The calculated difference between the total quantity of nutrient inputs entering an agricultural system and the quantity of nutrient outputs leaving the system.[10]

  Wastewater: Wastewater is water which is of no further value to the purpose for which it was used because of its quality, quantity or time of occurrence.[11]

- **Nitrogen removal:** Facility of a wastewater treatment plant to bring the efficiency for nitrogen elimination to a high level. This can be done by creating special process conditions to stimulate nitrification and denitrification.[12]

- **Phosphorus removal:** Facility of a wastewater treatment plant to bring the efficiency for the elimination of phosphorous to a higher level. This can be done using chemical and/or biological processes.[13]

- **Water monitoring systems:** A water quality monitoring system is defined as a complete integrated system that consists of hardware units and programs for monitoring multiple water quality parameters. Water quality monitoring is a fundamental tool in the management of freshwater resources.[14]

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[8] The Groundwater Foundation, Groundwater Glossary:
https://web.archive.org/web/20060428102341/http://www.groundwater.org/gi/gwglossary.html#F (accessed 8 August 2023)
[9] United Nations Environment Programme, SDG indicator metadata (indicator 6.3.2: Proportion of bodies of water with good ambient water quality), https://unstats.un.org/sdgs/metadata/files/Metadata-06-03-02.pdf (accessed 8 August 2023).
[10] See item 16a on page 8, REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on statistics on agricultural input and output and repealing Regulations (EC) No 1165/2008, (EC) No 543/2009, (EC) No 1185/2009 and Council Directive 96/16/EC,
https://www.europarl.europa.eu/RegData/commissions/agri/inag/2022/07-05/AGRI_AG(2022)734382_EN.pdf (accessed 8 August 2023).
[11] United Nations Statistics Division, UNSD/UNEP Questionnaire 2022 on Environment Statistics (water section), available at:
https://unstats.un.org/unsd/envstats/Questionnaires/2022/q2022_Water_English.pdf (accessed 8 August 2023).
[12] Organisation for Economic Cooperation and Development/ Eurostat, 2020: Questionnaire on the State of the Environment: Inland Waters. (not available publicly).
[13] *Ibid.*
[14] World Meteorological Organization (2006), Technical Regulations, Vol. III, Hydrology, available at:
https://library.wmo.int/doc_num.php?explnum_id=11293 (accessed 8 August 2023).

3A.   Nutrients and chlorophyll (FDES 1.3.2.a)

Concentration level of nitrogen (FDES 1.3.2.a.1)

In relation to a water sample, it is the total concentration of all forms of nitrogen found in the water sample.[15] It is proposed that the concentration of nitrogen is measured in mg/L.

Remark:

There are multiple forms of nitrogen measurement including total nitrogen, dissolved inorganic nitrogen, nitrogen in particulate organic matter, dissolved organic nitrogen, and Kjeldahl nitrogen. These various forms of measurement differ in that total nitrogen measures all of the nitrogen present; dissolved inorganic nitrogen is the sum of nitrite, nitrate and ammonia; atmospheric nitrogen deposition indicates the amount of nitrogen entering a freshwater body from surrounding air.

Concentration level of phosphorous (FDES 1.3.2.a.2)

In relation to a water sample, it is the total concentration of all forms of phosphorus found in the water sample.[16] It is proposed that the concentration of phosphorus is measured in mg/L.

Remark:

Similar to nitrogen measurements, there are several forms of phosphorus that can be monitored including total, particulate, dissolved, organic and inorganic forms. They differ in that total phosphorus measures all of the phosphorus present in the sample, and is a sum of that bound to particulate matter or dead plant and animal residues, as well as dissolved inorganic phosphates. Each form can also be measured independently.

Concentration level of chlorophyll A (FDES 1.3.2.a.3)

The amount of chlorophyll A is applied as a concentration to indicate phytoplankton productivity and biomass.

Remark:

- Chlorophyll A is typically measured in milligrams of chlorophyll per litre of water.
- Chlorophyll A concentration is an essential part of understanding eutrophication and therefore it is recommended to monitor and report on the levels in all countries.
- In-situ spectrometry of colorimetric methods provide the most accurate measurements. In addition, remote sensing from satellite images is increasingly used for estimating Chlorophyll A concentrations. The main advantages of remote sensing, compared to *in situ* methods, are i): high temporal and spatial coverage; and ii: low technology and resource capacity requirements.[17]

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[15] Australian Water Information Dictionary, http://www.bom.gov.au/water/awid/id-538.shtml (accessed 8 August 2023).
[16] Australian Water Information Dictionary, http://www.bom.gov.au/water/awid/id-539.shtml (accessed 8 August 2023).
[17] UN Environment Programme, Global Manual on Ocean Statistics – Towards a definition of indicator methodologies, available at: https://wesr.unep.org/media/docs/statistics/egm/global_manual_on_ocean_statistics_towards_a_definition_of_indicator_methodologies.pdf (accessed 8 August 2023).

3B.   Organic matter (FDES 1.3.2.b)

Biochemical oxygen demand (BOD) (FDES 1.3.2.b.1)

BOD is a measurement of dissolved oxygen required by organisms for the aerobic decomposition of organic matter present in water.[18]

BOD refers to the amount of oxygen in water consumed over a period of five days to understand the oxygen levels over time and determine the impact of decaying matter in an ecosystem. This measure shows how much oxygen is needed by bacteria to break down organic matter.[19]

Remark:
- BOD is most relevant in waters rich in organic matter.
- BOD is specific to the amount of oxygen consumed by microbial oxidation.
- BOD does not measure the oxygen-consuming potential of cellulose, but it is measured in the COD test discussed below.

Chemical oxygen demand (COD) (FDES 1.3.2.b.2)

COD measures the potential of water to consume oxygen during the oxidation of inorganic chemicals and decomposition of organic matter.[20]

Remark:
- BOD and COD do not measure the same types of oxygen consumption.
- COD measurements are always higher than those of BOD because BOD is included in COD.

3C.   Pathogens (FDES 1.3.2.c)

Concentration levels of faecal coliforms (FDES 1.3.2.c.1)

Pathogens are micro-organisms that can cause disease in other organisms. They may be present in sewage, run-off from animal farms, swimming pools, and so forth.[21]

Levels of faecal coliforms are reported in concentrations of the number of colonies per a 100 mL sample. This is measured by taking a sample and pumping it through a membrane filter before incubating it to allow the colonies to grow and become coloured with the dye, so a count can be retrieved from the sample.[22] There is currently a focus to collect more data on faecal coliform concentrations moving forward to better understand water quality.

Remark:

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[18] United Nations Statistics Division, Glossary of Environment Statistics: https://unstats.un.org/unsd/envstats/glossary.cshtml/ (accessed 8 August 2023).

[19] Water Education Foundation. (2019). Biochemical Oxygen Demand. https://www.watereducation.org/aquapedia-background/biochemical-oxygen-demand#:~:text=The%20biochemical%20oxygen%20demand%20(BOD,break%20down%20the%20organic%20matter (accessed 8 August 2023).

[20] The Laboratory People. (2009). COD or Chemical Oxygen Demand. https://camblab.info/272/ (accessed 8 August 2023).

[21] United Nations Statistics Division, Glossary of Environment Statistics: https://unstats.un.org/unsd/envstats/glossary.cshtml/ (accessed 8 August 2023).

[22] Water Research Center, Fecal Coliform Bacteria in Water, https://www.knowyourh2o.com/outdoor-4/fecal-coliform-bacteria-in-water (accessed 8 August 2023).

- To determine guidelines for concentrations in recreational water, experts selected key studies delineating the health impacts and then completed a risk assessment to understand the connection between the health impacts and concentration levels. This approach was employed to ensure a progressive set of guidelines and to create the ability for local authorities to assess their level of risk and remain within standards according to that risk.

3D. Metals (e.g., mercury, lead, nickel, arsenic, cadmium) (FDES 1.3.2.d)

Concentration levels in sediment and freshwater (FDES 1.3.2.d.1)
Measuring the concentration levels of metals such as lead or mercury in sediment and freshwater takes several forms including gravimetric, volumetric, colorimetric, nuclear and Atomic Absorption Spectrometer (AAS) analysis techniques. The last of these is popular for its speed, sensitivity, simplicity and ability to analyse complex mixtures.[23] Preparing for the AAS analysis involves: preparing samples - for sediment samples, they are dried to a constant mass, then weighed and digested before being cooled and diluted to finally be filtered, and sent for AAS analysis where the amount of heavy metals present is recovered.[24]

Remark:
- Due to the many methods, it is important to coordinate best practices and share knowledge regarding which method is best suitable to particular areas.
- Concentrations are often reported in mg/L for liquids, but if sediments, then per gram.

Concentration levels in freshwater organisms (FDES 1.3.2.d.2)
Similar methodologies used for the concentration levels of metals in sediments and freshwater can be applied for the concentration levels of metals in freshwater organisms. The main difference involves preparing the sample because the media is different as flesh instead of water or sediment. A particular threat to organisms comes from bioaccumulation within the food chain. A species higher in the food chain that consumes smaller organisms will ingest the concentrations of metals within each smaller organism it consumes along with the concentrations it is exposed to in the environment. This is especially threatening to human populations because these species are most often consumed in human diets.

Remark:
- Concentrations are reported in mg/g.
- The WHO provides guidelines of acceptable limits of metals found in foods that vary by metal type and are between 0.05 and 2 mg/g.[25]

3E. Organic contaminants (e.g., PCBs, DDT, pesticides, furans, dioxins, phenols, radioactive waste) (FDES 1.3.2.e)

Concentration levels in sediment and freshwater (FDES 1.3.2.e.1)

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[23] Biney, C. et al. (2019). Review of Heavy Metals. http://www.fao.org/3/v3640e/V3640E04.htm (accessed 8 August 2023).

[24] Chakraborty, S. and Owens, G. (2014) Metal distributions in seawater, sediment and marine benthic macroalgae from the South Australian coastline. Int. J. Environ. Sci. Technol. 11:1259–1270 DOI 10.1007/s13762-013-0310-4 http://www.bioline.org.br/pdf?st14123 (accessed 8 August 2023).

[25] Adebayo IA (2017). Determination of Heavy Metals in Water, Fish and Sediment from Ureje Water Reservoir. J Environ Anal Toxicol 7: 486. Doi: 10.4172/2161-0525.1000486 https://www.researchgate.net/publication/319081528_Determination_of_Heavy_Metals_in_Water_Fish_and_Sediment_from_Ureje_Water_Reservoir (accessed 8 August 2023).

Methods for finding concentration levels of organic contaminants in sediment and freshwater include: various forms of chromatography, mass spectrometry, separatory funnel liquid-liquid extraction, Soxhlet extraction, ultrasonic extraction and clean-ups (using various solutions).[26] Each of these methods involve a way to separate the organic contaminants from the sample in order to determine concentration.

Remark:
- The concentration of organic contaminants in sediments is reported as nanograms per gram of the dry weight of the sediment.
- The concentration of organic contaminants in freshwater is reported as nanograms per litre of sample.
- Organic contaminants include a wide variety of specific pollutants including polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), hexachlorocyclohexane (HCH), lindane and more and have varying harmful impacts including carcinogenic impacts, endocrine-disrupting effects and many other harms that destabilize the ecosystem.

Concentration levels in freshwater organisms (FDES 1.3.2.e.2)
Methods for finding concentration levels of organic contaminants in freshwater organisms are similar to those for finding the concentration levels in sediments and freshwater. Therefore, they also include: various forms of chromatography, mass spectrometry, separatory funnel liquid-liquid extraction, Soxhlet extraction, ultrasonic extraction and clean-ups (using various solutions).

Remark:
- The concentration or organic contaminants in freshwater organisms is reported as nanograms per gram.
- Similar to as stated above, this type of pollutant is highly harmful to freshwater life.

3F.   Physical and chemical characteristics (FDES 1.3.2.f)

pH/Acidity/Alkalinity (FDES 1.3.2.f.1)
Value of pH measures the acidity or alkalinity of a liquid. A pH value in the range of 0 to 7 indicates acidity, a pH value in the range of 7 to 14 indicates alkalinity, and a pH value of 7 signifies neutrality.[27] Changes of the pH/acidity/alkalinity of a freshwater body may affect the stability of the water chemistry and above certain thresholds may impair the stability of entire freshwater ecosystems.

Remark:
- Acidity and alkalinity are measurements in their own right. Alkalinity is usually reported as milliequivalent (mEq) per litre.

Temperature (FDES 1.3.2.f.2)
The temperature in a freshwater body explains vital information about its state. It shares basic information such as the state of the water (ice, water, vapour), but also shares more complex fluctuations such as the water's movement

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[26] United States Environment Protection Agency, Method 3500C: Organic Extraction and Sample Preparation, available at: https://www.epa.gov/sites/default/files/2015-12/documents/3500c.pdf (accessed 8 August 2023).

[27] United Nations Statistics Division, Glossary of Environment Statistics: https://unstats.un.org/unsd/envstats/glossary.cshtml/ (accessed 8 August 2023).

because cold water is denser than warm water, so it sinks, the amount of dissolvable gases in the water (cold water holds more) and the productivity of freshwater life.[28]

Total suspended solids (TSS) (FDES 1.3.2.f.3)
TSS is a measure of the total suspended solids in water bodies. It is determined through various tests.[29] It can be measured from a sample using the dry weight of suspended particles captured by a filter. It also can be estimated using remote sensing technology, however these estimates require *in situ* measurements for calibration and validation.

Remark:
- TSS provides a perspective on water turbidity and light penetration in water. This can contribute to understanding interferences with freshwater life and disturbances in the water.

Salinity (FDES 1.3.2.f.4)
Salinity is the salt content of environmental media.[30] It is measured as the total amount of dissolved salts in water, expressed in parts per thousand (or g per kg).

Remark:
- Salinity can be measured as "salinity" practical salinity units.
- There are other related parameters such as electrical conductivity (EC), chloride, and specific conductance.
- EC is the most widely measured parameter.

Dissolved oxygen (DO) (FDES 1.3.2.f.5)
DO measures the amount of oxygen dissolved in the water. This can show decreases in oxygen levels which can trigger hypoxia leading to eutrophication following the excess of oxygen-consuming organisms that results from increased nutrient levels. DO concentrations are dependent on both temperature and barometric pressure. Measuring percent saturation accounts for both of these factors and provides a better indication of the oxygen available to aquatic organisms.

3G.   Plastic waste and other freshwater debris (FDES 1.3.2.g)

Amount of plastic waste and other debris (FDES 1.3.2.g.1)
The amount of plastic waste and other debris in freshwater bodies is measured specific to locations. The statistics to match a given monitoring location include: plastic debris washed on banks, plastic debris on the water body floor and plastic ingested by biota.

Plastics are described as 'synthetic polymers with thermo-plastic or thermo-set properties (synthesized from hydrocarbon or biomass raw materials), elastomers (e.g. butyl rubber), material fibres, monofilament lines, coatings

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[28] Science Learning Hub (2019). Ocean Temperature. https://www.sciencelearn.org.nz/resources/707-ocean-temperature (accessed 8 August 2023).

[29] Organisation for Economic Cooperation and Development (2007). Total Suspended Solids. https://stats.oecd.org/glossary/detail.asp?ID=7219 (accessed 8 August 2023).

[30] United Nations Statistics Division, Glossary of Environment Statistics: https://unstats.un.org/unsd/envstats/glossary.cshtml/ (accessed 8 August 2023).

and ropes'[31] by the GESAMP Report 2019. Furthermore, plastics can be described as two types including: 'thermoplastics (capable of being deformed by heating), which include polyethylene, polypropylene and polystyrene; and, thermoset (non-deformable), which include polyurethane, paints and epoxy resins.'

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[31] Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (2019). Guidelines or the monitoring and assessment of plastic litter and microplastics in the ocean (Kershaw P.J., Turra A. and Galgani F. editors), (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP/ISA). Rep. Stud. GESAMP No. 99, 130p
https://environmentlive.unep.org/media/docs/marine_plastics/une_science_dvision_gesamp_reports.pdf (accessed 8 August 2023).

4. International sources and recommendations

4A. Classifications and groupings

The parameter catalogue offered by UNEP's GEMStat categorizes some 247 parameters into mutually exclusive groupings. The top level, group 1, comprises biological, chemical and physical parameters. Groupings include dissolved solids, dissolved gases, metal, nitrogen, phosphorus, etc.[32] Refer below for a screenshot of how these parameters are downloadable from GEMStat in Microsoft Excel format:

Biological	Indicator Organism	Indicator Organism	Coliforms	Escherichia Coli	ECOLI	Gram-negative, facultatively anaerobic, rod-shaped, coliform bacterium of the genus Escherichia.
Biological	Indicator Organism	Indicator Organism	Coliforms	Fecal Coliform	FECALCOLI	Facultative anaerobic, gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose with gas and acid formation within 48h at 44 +/-0.5°C.
Biological	Indicator Organism	Indicator Organism	Coliforms	Total Coliform	TOTCOLI	Facultative anaerobic, gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose with gas and acid formation within 48h at 35°C.
Biological	Indicator	Indicator	Fecal Streptococci	Faecal Streptococci	FECALSTREP	Coccoid-shaped, chain-forming, gram-positive bacteria of intestinal origin.
Biological	Indicator	Indicator	Salmonella	Salmonella	SALM	Genus of rod-shaped gram-negative bacteria of the Enterobacteriaceae family.
Biological	Phytoplankton	Phytoplankton	Phytoplankton	Phytoplankton Biomass	Phyt-B	
Biological	Phytoplankton	Phytoplankton	Phytoplankton	Phytoplankton Count	Phyt-N	
Biological	Pigment	Pigment	Chlorophyll A	Chlorophyll A	Chl-a	$C_{55}H_{72}MgN_4O_5$, [(2E,7R,11R)-3,7,11,15-tetramethylhexadec-2-en-1-yl (22R,17S,18S)-7-ethyl-21,22,17,18-tetrahydro-22-(methoxycarbonyl)-3,8,13,17-tetramethyl-21-oxo-12-ethenylcyclopenta[at]porphyrin-18-propanoato(2-)]magnesium
Chemical	Inorganic	Bulk Property	Electrical	Electrical Conductance	EC	Measure of the ability of water to carry an electric current.
Chemical	Inorganic	Bulk Property	Hardness	Hardness - Calcium	H-Ca	Measure of the calcium ion (Ca+2) concentration in water, expressed as calcium carbonate in milligrams per liter.
Chemical	Inorganic	Bulk Property	Hardness	Hardness - Magnesium	H-Mg	Measure of the Magnesium ion (Mg+2) concentration in water, expressed as calcium carbonate in milligrams per liter.
Chemical	Inorganic	Bulk Property	Hardness	Hardness - NonCarbonate	H-NC	Amount of water hardness that is not generated by carbonates and bicarbonates of magnesium and calcium, but by their sulfates and chloride salts instead. Expressed as calcium carbonate in milligrams per liter.

As per many other themes within environment statistics, if and when identification of source industry may be of interest, and for the sake of making water quality statistics coherent with economic statistics and other policy frameworks, application of the International Standard Industrial Classification of All Economic Activities (ISIC), rev. 4 is strongly recommended.[33]

4B. Reference to international statistical recommendations, frameworks and standards

- Further methodological guidance on those statistics relevant to **SDG indicator 6.3.2**: Proportion of bodies of water with good ambient water quality is available in this SDG indicator's metadata sheet.[34]

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[32] The GEMStat parameter catalogue is downloadable into Excel format via: https://gemstat.org/about/data-availability/ (accessed 8 August 2023).

[33] United Nations, International Standard Industrial Classification of All Economic Activities (ISIC), rev. 4, available at: https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf (accessed 8 August 2023).

[34] United Nations Statistics Division, SDG indicator metadata for SDG indicator 6.3.2: Proportion of bodies of water with good ambient water quality, available at: https://unstats.un.org/sdgs/metadata/files/Metadata-06-03-02.pdf (accessed 8 August 2023).

- **Framework for the Development of Environment Statistics (FDES 2013)**[35]: Chapter 1, Component 1, Topics 1.3.2: Freshwater Quality, and 1.3.3: Marine Water Quality. This includes statistics on concentration levels of nutrients and chlorophyll, organic matter, metals, etc. in freshwater bodies.
- **Manual on the Basic Set of Environment Statistics of the FDES 2013 - Water Resources Statistics**[36]: This is a related methodology sheet to this one which focuses on water resources statistics.
- **Manual on the Basic Set of Environment Statistics of the FDES 2013 - Wastewater Statistics**[37]: This is a related methodology sheet to this one which focuses on wastewater statistics.
- **Water Quality for Ecosystem and Human Health**[38]: This text contains a chapter focused upon measuring water quality, including physical and chemical characteristics, major ions, nutrients, metals, organic matter, etc.
- **The Global Set of Climate Change Statistics and Indicators** includes an indicator 'Water quality' within the topic of Freshwater resources. For its compilation, the indicator calls for several statistics from the basic set which were determined to be especially sensitive to climate change impacts: Total suspended solids; pH/acidity/alkalinity; Salinity; BOD; COD; Concentration level of chlorophyll A. The metadata for this indicator and the underlying statistics can be accessed here (p. 103): https://unstats.un.org/unsd/statcom/53rd-session/documents/BG-3m-Globalsetandmetadata-E.pdf. Other indicators are also closely related to the subject of water quality. These are 'Proportion of domestic and industrial wastewater flows safely treated', 'Proportion of population using safely managed drinking water services', 'Customer price of drinking water', 'Water production cost', 'Water use per capita', 'Freshwater abstracted as a proportion of renewable freshwater resources'.

The European Union Water framework directive, requires all member states to report on their progress to achieve good water quality for addressing a number of indicators as illustrated in the latest publication by the European Environment Agency:

[35] United Nations Statistics Division, Framework for the Development of Environment Statistics, 2013, available at: https://unstats.un.org/unsd/environment/fdes/FDES-2015-supporting-tools/FDES.pdf (accessed 8 August 2023).
[36] United Nations Statistics Division, Manual on the Basic Set of Environment Statistics of the FDES 2013 - Water Resources Statistics, https://unstats.un.org/unsd/environment/FDES/MS%202.6%20Water%20Resources.pdf (accessed 8 August 2023).
[37] United Nations Statistics Division, Manual on the Basic Set of Environment Statistics of the FDES 2013 - Wastewater Statistics, https://unstats.un.org/unsd/envstats/fdes/MS3.2_Wastewater.pdf (accessed 8 August 2023).
[38] United Nations Environment Programme, Water Quality for Ecosystem and Human Health, available at: https://wedocs.unep.org/handle/20.500.11822/12217 (accessed 8 August 2023).

Natural water bodies

Heavily modified and artificial water bodies

Legend: Bad | Poor | Moderate | Unknown | Good | High
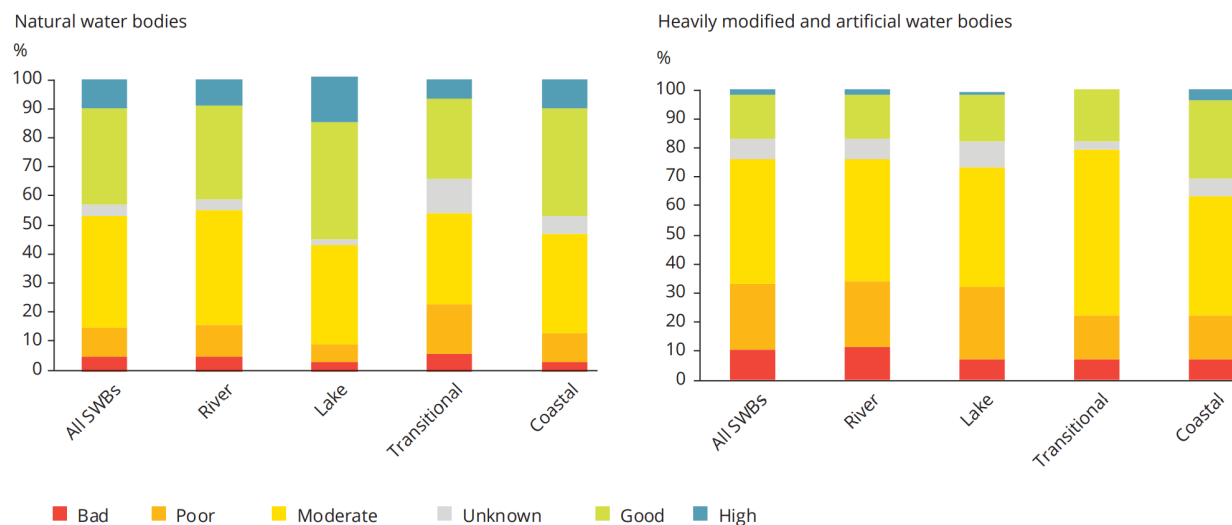
4C. Sources of global and regional environment statistics and indicators series

The GEMStat portal maintained by the United Nations Environment Programme hosts a large variety of water quality data from countries worldwide.[39] Many measurements on water quality are publicly available not only at region (per UNEP regions such as Africa; Asia and the Pacific; etc.) and country level, water body type, river basin district, and even to the very measuring station where the station name, number, longitudinal and latitudinal coordinates and catchment are provided. Data are available for some 247 parameters (e.g. phosphorus, nitrogen, mercury, lead, pH level, etc.) from approximately 13,000 measuring stations in approximately 80 countries. By referencing a source such as the GEMStat portal, one can gain an understanding of what can be expected when measuring various phenomena related to water quality.

Although the GEMStat portal is the most comprehensive tool available at international level for measuring water quality across countries, its data availability is far from complete with more than 100 UN member states contributing no data at all. Countries are able to submit data to the GEMStat portal on a voluntary basis.[40]

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[39] UN Environment Programme, GEMStat, GEMStat data portal, available at: https://gemstat.org/data/data-portal/ (accessed 8 August 2023).
[40] For information on submitting data to the GEMStat portal, refer: https://gemstat.org/data/data-submission/ (accessed 8 August 2023).

5. Data collection and sources of data

5.A Data collection: monitoring systems

To measure freshwater quality, well-designed monitoring systems are needed to measure the concentrations of the pollutants and other aspects like pH/acidity/alkalinity, temperature, and plastic waste. The measurements using these monitor systems provide inputs for data portals like GEMStat (see section 4.3). To ensure the availability, reliability, and accuracy of data from water monitoring, the World Meteorological Organisation (WMO) identified five essential elements of a hydrological monitoring programme.[41] These five elements are briefly described below, including some references to freshwater quality aspects from a statistical point of view.

I. Data Management
The processing of water monitoring data is complex. It is frequently ignored how the data are managed after the acquisition. A data management system must preserve the full history of the data processing (acquisition, storage, validation, analysis, and reporting), including who did what, when, how and why. As a best practice, raw data must be preserved intact and all changes must be recorded and be reversible, if needed. Also, informative metadata should be provided about the quality and status of the data.

II Training
To acquire water monitoring data requires several technological skills that need to be trained to reduce the frequency of mistakes in the data collection. The further data processing requires statistical skills (e.g., trend estimates and methodology standardization). Investments in training these skills will improve the data quality.

III Technology
Freshwater quality measurements are generally too complex to be applied by statistical offices. The statisticians, however, need to have some basic knowledge on the used technology, e.g., to validate the quality and relevance of the acquired data.

IV Network design
Network design is an ongoing process with new measurement stations being established and existing stations being discontinued as priorities and funding evolve. This implies some statistical consequences, if the new stations are located in areas where some pollution is expected (a high priority to measure there), whereas the cancelled stations were on rather clean locations (good reason to stop the funding there). Consequently, the population of the stations does not resemble a random sample, as statisticians prefer. This might lead to several aggregation problems. Also, the time series may not be consistent if the population of stations is continuously changing.

Setting up a well-designed monitoring system depends on the measurement objective. A good station location is one where the variation in discharge is sensitive to the phenomena of interest. This is illustrated with a Dutch example. The Netherlands uses three official monitoring systems to measure nitrate concentrations. One focuses on groundwater and the other two on surface waters in which discharges from agricultural activities are the main focus. The network designs for the two surface water monitoring systems differ. In the first one the locations of the stations were chosen such that one may assume that agriculture is the only discharge source. In the second one, the station

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[41] World Meteorological Organization, The 5 Essential Elements of a Hydrological Monitoring Programme, available at: https://public.wmo.int/en/bulletin/5-essential-elements-hydrological-monitoring-programme (accessed 8 August 2023).

locations are explicitly linked to the farms that are in the Dutch sample of the Farm Accountancy Data Network (FADN).[42] The measured nitrate concentrations around these FADN farms are linked to the gross nitrogen balance that can be compiled using the FADN-data. The FADN-results can be compared with the gross nitrogen balance at the national level, as compiled by Statistics Netherlands, which is based on several official agricultural statistics. For more details, see NL Nitrate report 2020 (EU Nitrates Directive Action Programme).[43]

V Quality Management System
A Quality Management System includes a set of standard operating procedures that govern the data production process to ensure that the data are of consistent, known quality and that it is linked with the data needs of the end users, like the statistical community. A commitment to international accepted standards, technical and statistical, provides a basis for inter-comparability of data. It should also be prevented, through further standardization, that different networks use different parameters as similar indicators (like phosphate versus total P and thermotolerant coliforms versus E. coli).

5B. Data collection: specific statistical aspects

In section 5A some general statistical aspects were given that are related to the collection of data using monitoring systems. This section presents additional statistical aspects belonging to the measurement of freshwater quality.

Scope of Statistics
Freshwater ecosystems in a country: groundwater and surface water.

Statistical Unit
Freshwater quality data is typically expressed in terms of concentration, but occasionally is measured as a volume. In specific cases the results are expressed with categories like 'poor, sufficient, good, or excellent', e.g., see Article 5 in the EU Directive on bathing water quality.[44] The EU Water Framework Directive uses similar categories.[45] Countries can be ranked by the percentage of stations in the specified categories.

Measurement Unit

a. Nutrients and chlorophyll	1. Nitrogen	Milligrams (mg) per litre (l)
	2. Phosphorous	Milligrams (mg) per litre (l)
	3. Chlorophyll A	Milligrams (mg) per litre (l)
b. Organic matter	1. Biochemical oxygen demand (BOD)	Milligrams of oxygen consumed per l
	2. Chemical oxygen demand (COD)	Milligrams of oxygen consumed per l
c. Pathogens	1. Faecal coliform levels	Number of colonies per 100 ml
d. Metals	1. In sediment and freshwater	Milligrams per l or per g
	2. In freshwater organisms	Milligrams per gram (g)
e. Organic contaminants	1. In sediment and freshwater	Nanograms (ng) per l or per g
	2. In freshwater organisms	Nanograms per gram (g)
f. Physical and chemical characteristics	1. pH/Acidity/Alkalinity[46]	Number on pH scale
	2. Temperature	Degrees Celsius

[42] European Commission, Farm accountancy data network, https://agriculture.ec.europa.eu/data-and-analysis/farm-structures-and-economics/fadn_en (accessed 8 August 2023).
[43] Ministry of Health, Welfare and Sport (The Netherlands), Agricultural practices and water quality in the Netherlands: status (2016-2019) and trends (1992-2019), available at: https://www.rivm.nl/bibliotheek/rapporten/2020-0184.pdf (accessed 8 August 2023).
[44] European Union, EU Directive on bathing water quality, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&qid=1662737576916&from=NL (accessed 8 August 2023).
[45] European Commission, The EU Water Framework Directive, available at: https://ec.europa.eu/environment/water/water-framework/index_en.html (accessed 8 August 2023).
[46] Alkalinity is usually reported as mq/L rather than a pH

	3. Total suspended solids (TSS)	Parts per million (ppm)
	4. Salinity	Parts per thousand
	5. Dissolved oxygen (DO)	Percent saturation or mg/l
g. Plastic waste and other freshwater debris	1. On banks and on water body floor	Tonnes
	2. Ingested by freshwater organisms	Grams per stomach

Data sources and institutions
The data portal GEMStat (see section 4.3) is a valuable data source and can also show which institutions are involved. To monitor freshwater quality completely the sampling should not only focus on concentrations in the water itself, but for metals and organic contaminants also on the concentrations in sediments and in freshwater organisms. For plastic waste and other freshwater debris, the monitoring should cover the clean-ups of banks and the water body floor, and also what is ingested by freshwater organisms.

The institutional setting differs in each country. In Armenia, water quality is collected, processed and published by only one organisation (hydrometeorology and monitoring center; agency of the Ministry of Environment in Armenia). As part of the statistical annual work programme the water quality indicators (for rivers, lakes, and groundwater) are disseminated by the Armenian statistical office (see ArmStatBank; Environment; Water resources). In the Netherlands different organisations are involved, dependent on the specific objectives of the water quality measurements, usually with negligible involvement of the Dutch statistical office. In general, statistical offices do not carry out the complex water quality measurements. Other institutions are better prepared for such scientific activities.

Aggregation, trend estimation methods, and validation

Data produced by different agencies, or even within the same agency, should have similar accuracy and precision. The acquired data should also lead to similar conclusions, if similar data processing has been done. Differences may occur if the used trend estimation methods differ (every statistician has a 'scientific' preference) and/or if the aggregation of local data to national data was performed differently. The aggregation may not be trivial, since the ever-changing measurement station locations may be risk-driven and not randomly distributed. It is even further complicated due to the different soil types at the location of the monitoring stations. The measured water pollution in a sand, clay or peat region may not count equally in the aggregation process.

The sequence of the data processing steps may also cause differences, i.e., first aggregating the local data and then a trend estimation at national level may lead to different conclusions compared to first local trend estimations and then aggregating to a national level. Moreover, the way the statistical output is presented (e.g., average or median concentration) may cause different conclusions. For instance, a policy to clean only the few extremely dirty water systems may show a significant effect on the average concentration, whereas the median may remain the same.

One way to solve this is to use more than one trend estimation method in the data analysis and to apply different aggregation methods, including a change of the sequence of the data processing steps. Subsequently, it is easier to validate the conclusions drawn from the measured data. Concerning the trend estimation methods, one could denote a higher preference to the ones which also provide uncertainty margins.

The different time series lengths, as a result of the entering and disappearing of measurement stations, can be considered by calculating the trends in two ways: aggregation of all measurements (method 'all') and to compare it with the aggregation of only the time series which cover at least 80% of the full period (method 'beauties'). Another aspect that should be taken into account is the seasonal effect caused by rain and other precipitation. Preference

for an annual average, or winter and summer averages should be determined. Addressing seasonal effects should also be considered.

Metadata

For each freshwater quality measurement, the below should be described:
- The data set being used;
- The specific characteristics of the acquired data;
- Any pre-processing which has been performed;
- The statistical methods (trend estimation and aggregation) used;
- Any post-processing which has been performed;
- How the results are visualized (average, median, with or without error margin); and
- How the results and conclusions are validated (do not trust one single method; apply more than one, where possible).

It should also indicate the institutional setting by identifying which institutions are accountable for the full data processing, and whether or not other institutions are involved.

6. Uses and dissemination

6A. Potential presentation/dissemination formats

Figure 6.1: Colour-coded maps aggregated to a common level (e.g. country, in this example)[47]

Global status of indicator 6.3.2 Level 1 Proportion of bodies of water with good ambient water quality (2017-2020) ⓘ
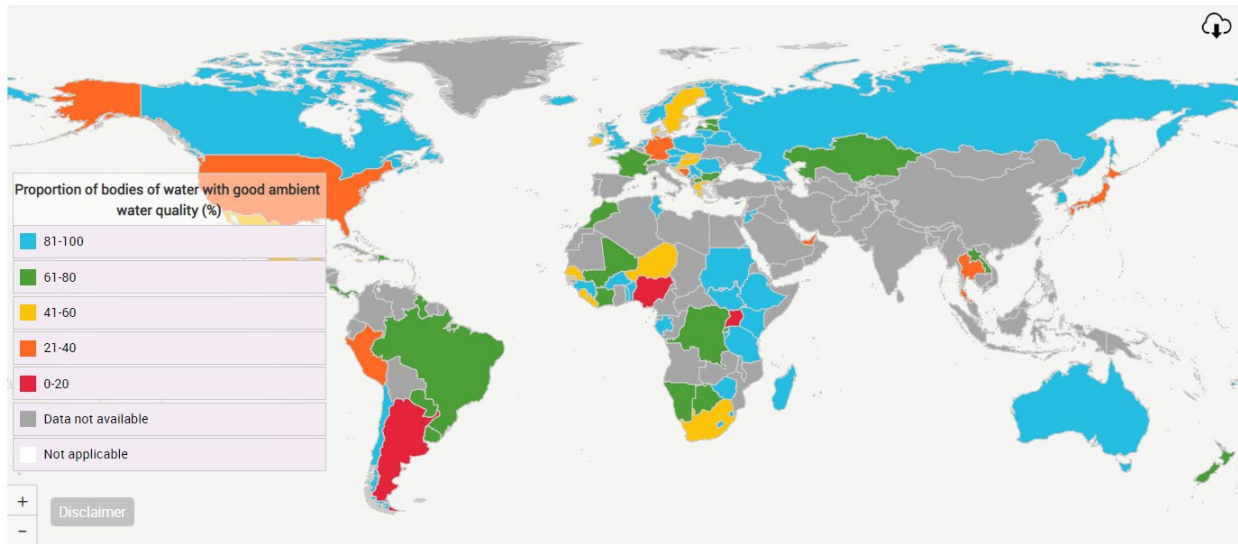
Figure 6.2: Time series line chart[48]

Figure 6.5: Biochemical oxygen demand in rivers, EU, 2000–2019
(mg O_2 per litre)
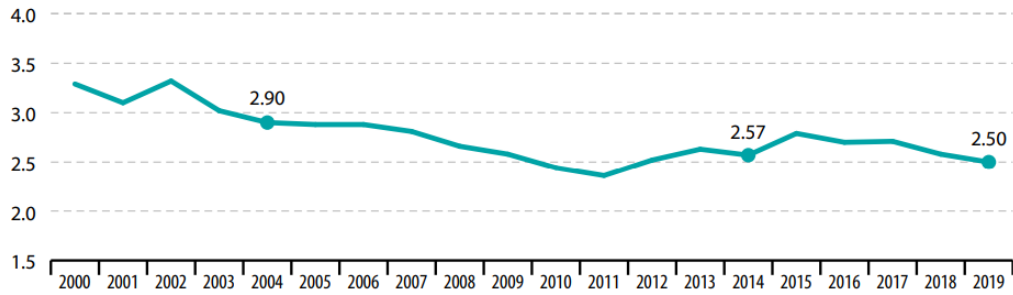
Note: 'EU' refers to an aggregate based on 18 Member States.
Compound annual growth rate (CAGR): – 1.0% per year in the period 2004–2019; – 0.6% per year in the period 2014–2019.
Source: EEA (Eurostat online data code: sdg_06_30)

Figure 6.3: Comparative time series line chart[49]

Nitrates in upper groundwater under agricultural land
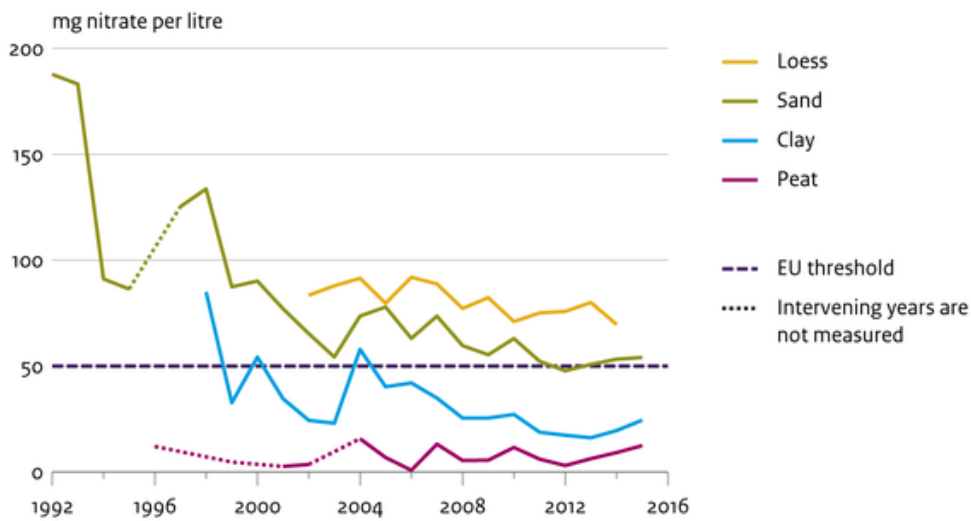
Source: RIVM-LMM

PBL/aug16
www.clo.nl/en027110

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[48] Eurostat, Sustainable Development in the European Union: Monitoring report on progress towards the SDGs in an EU context (2022 edition), available at: https://ec.europa.eu/eurostat/documents/3217494/14665254/KS-09-22-019-EN-N.pdf/2edccd6a-c90d-e2ed-ccda-7e3419c7c271?t=1654253664613 (accessed 8 August 2023).

[49] Government of The Netherlands, Nature, Landscape and Biodiversity, available at: https://www.clo.nl/en/indicators/en027110-nitrates-in-upper-groundwater-under-agricultural-land (accessed 8 August 2023).

Figure 6.4: Colour-coded maps of a country (firstly, the Netherlands, and secondly, Finland) addressing natural water bodies and irrespective of state or provincial borders[50, 51]

Beoordeling ecologische kwaliteit, Kaderrichtlijn Water, 2019

Kwaliteit
- Goed
- Matig
- Ontoereikend
- Slecht
- Niet bekend
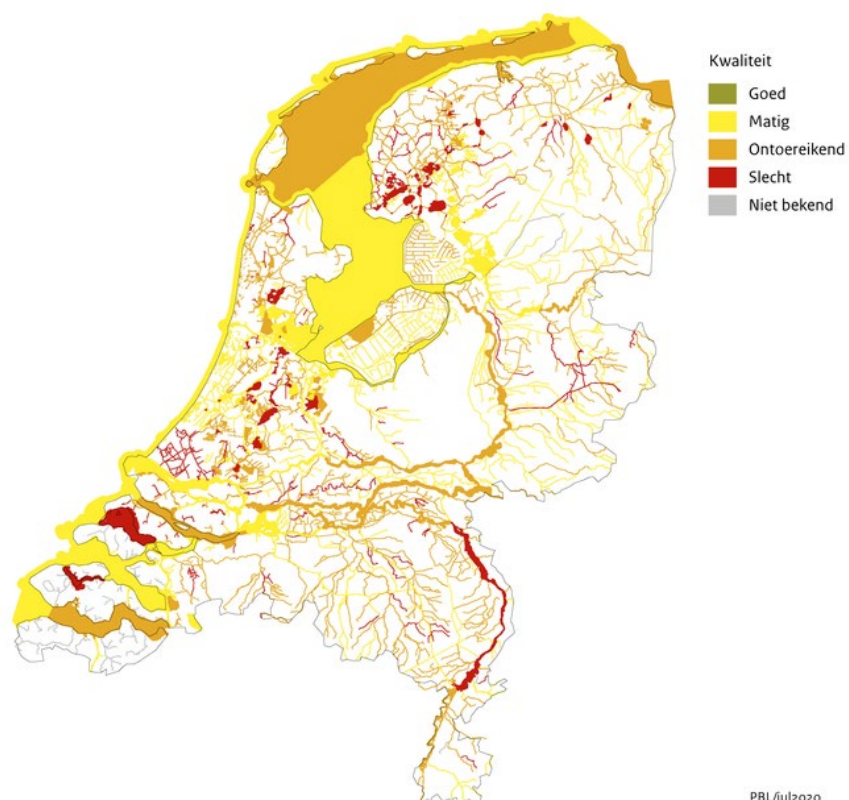
Bron: IHW (waterschappen, RWS); bewerkt door PBL

PBL/jul2020
www.clo.nl/nl143808

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[50] Government of The Netherlands, Waterkwaliteit KRW, 2019, available at: https://www.clo.nl/indicatoren/nl1438-kwaliteit-oppervlaktewater-krw (accessed 8 August 2023).

[51] Finish Environment Institute, Assessment of the status of Finland's waters: Status of lakes and rivers about the same as before, coastal waters have deteriorated, available at: https://www.syke.fi/en-US/Current/Assessment_of_the_status_of_Finlands_wat%2851413%29 (accessed 8 August 2023).

Ecological status of surface waters 2019

■ (blue)	High
■ (green)	Good
■ (yellow)	Moderate
■ (orange)	Poor
■ (red)	Bad
■ (gray)	No Data
■ (dark red)	Heavily Modified or Artificial

0 25 50   100 km

Classification is based on data from years 2012-2017.
© SYKE, Luke, ELY-centres, Ålands landskapsregering, NLS
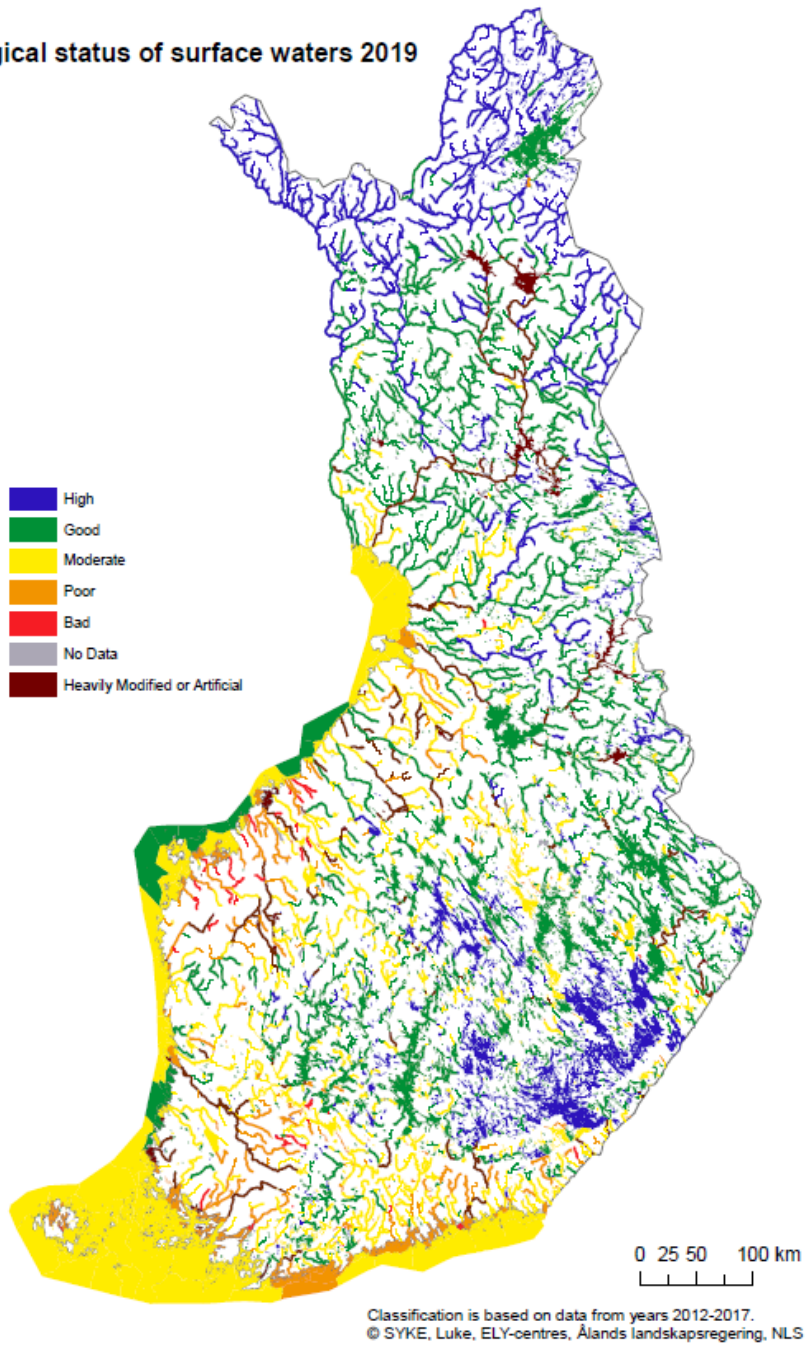
Figure 6.5: Bar charts fragmented by specified characteristics[52]

Status of surface waters in England, 2019

This indicator takes an overview of the condition of surface water bodies in England in 2019; it relates to rivers, lakes, estuaries and coastal waters. For rivers, invertebrates and the combined test for macrophytes and phytobenthos (plants and algae) are reported to indicate biological quality, where 76% and 45% of tests carried out passed for the water bodies assessed respectively. For lakes, the representative biological element shown is phytoplankton with 52% of water bodies assessed passing. Saltmarsh is shown for estuaries and coasts and reflects the extent of habitat and show 36% and 50% of water bodies monitored, pass the test respectively.
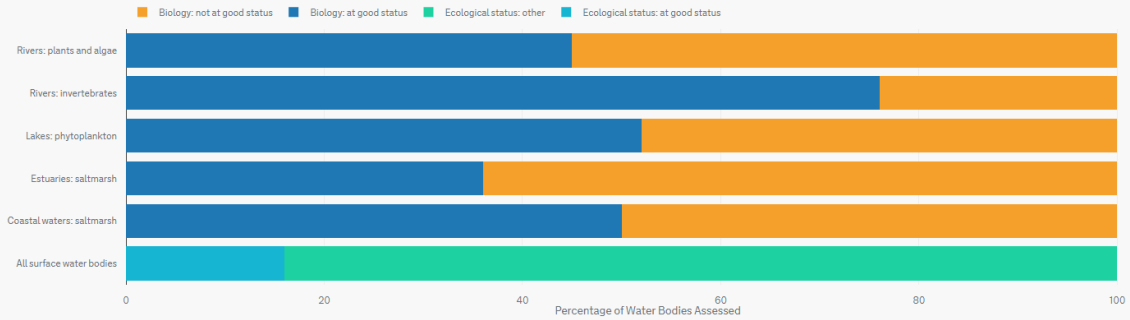
Source: Department for Environment, Food & Rural Affairs

. Results are based on the numbers of water bodies assessed and represent the achievement of good or better status. Ecological status is assigned using various water, habitat and biological quality tests. Failure of any one individual test means that the whole water body fails to achieve good or better ecological status (the "one out all out" rule).

Figure 6.6: Descriptive and colour-coded stock and flow diagrams[53]

Figure 1.1   Assessment of status of surface waters and groundwater according to the WFD

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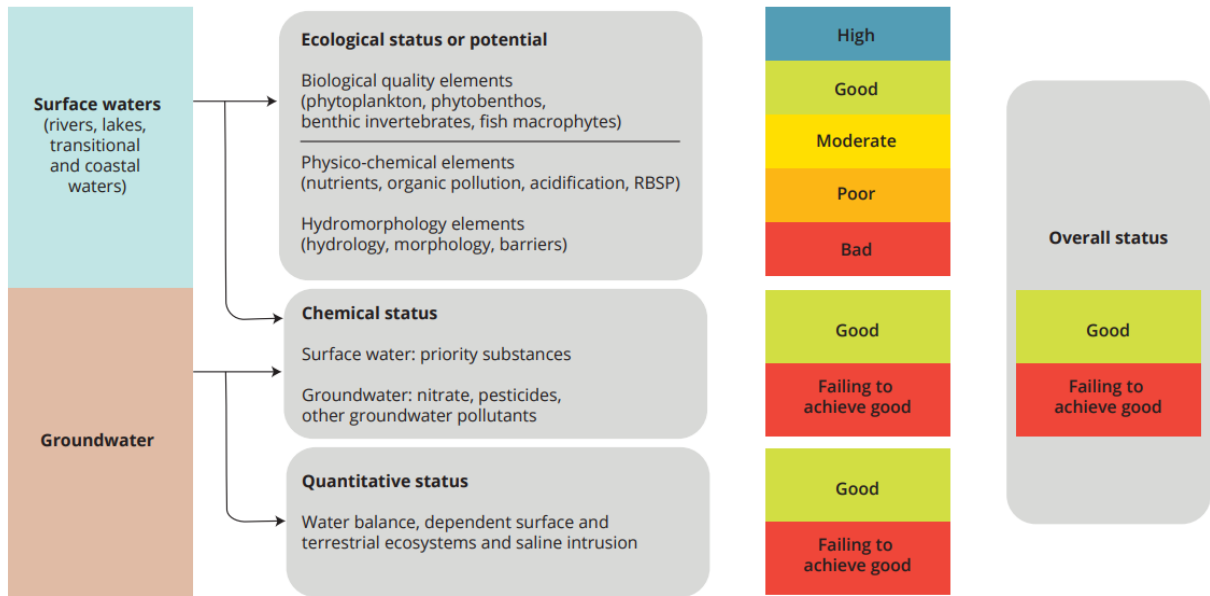
[52] UK Government, Climate Change Statistics, available at: https://climate-change.data.gov.uk/ (accessed 8 August 2023).
[53] European Environment Agency, European Waters: Assessment of status and pressures 2018, available at: https://www.eea.europa.eu/publications/state-of-water (accessed 8 August 2023).

For fine level analysis and to invite further research of statistical disseminations on water quality, Jordan gives a clear example of how large-scale tabulations may be disseminated online.

Figure 6.7: Example of dissemination via tabulations from the Department of Statistics, Jordan[54]

6B. SEEA accounts/tables that use these statistics

SEEA Ecosystem Accounting refers to water quality in the context of ecosystem condition accounts, e.g. chemical state characteristics (p. 90):

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[54] Department of Statistics, Jordan, Interactive Database – Environment, available at: https://jorinfo.dos.gov.jo/Databank/pxweb/en/Environment/ (accessed 8 August 2023).

Table 5.1: The SEEA Ecosystem Condition Typology (ECT)

ECT groups and classes

Group A: Abiotic ecosystem characteristics

    Class A1. Physical state characteristics: physical descriptors of the abiotic components of the ecosystem (e.g., soil structure, water availability)

    Class A2. Chemical state characteristics: chemical composition of abiotic ecosystem compartments (e.g., soil nutrient levels, water quality, air pollutant concentrations)

Group B: Biotic ecosystem characteristics

    Class B1. Compositional state characteristics: composition / diversity of ecological communities at a given location and time (e.g., presence / abundance of key species, diversity of relevant species groups)

    Class B2. Structural state characteristics: aggregate properties (e.g., mass, density) of the whole ecosystem or its main biotic components (e.g., total biomass, canopy coverage, annual maximum normalized difference vegetation index (NDVI))

    Class B3. Functional state characteristics: summary statistics (e.g., frequency, intensity) of the biological, chemical, and physical interactions between the main ecosystem compartments (e.g., primary productivity, community age, disturbance frequency)

Group C: Landscape level characteristics

    Class C1. Landscape and seascape characteristics: metrics describing mosaics of ecosystem types at coarse (landscape, seascape) spatial scales (e.g., landscape diversity, connectivity, fragmentation)

6C. Commonly used indicators that incorporate these statistics

The European Union Water Framework Directive was adopted in 2000 to address integrated river basin management in the member states.[55]

Pertaining to the use of water for bathing (also known as recreational swimming), the European Union Water Framework Directive designates that recreational waters, including those areas designated as bathing waters, are considered protected areas.[56] The European Union's Bathing Water Directive suggests metrics which can be applied and from which bathing water quality can be assessed and classified into one of: poor, sufficient, good, or excellent.[57]

6D. SDG indicators that incorporate these statistics

With regard to drinking water, SDG indicator, **SDG 6.1.1: Proportion of population using safely managed drinking water services** calls for statistics on drinking water quality.[58] Conditions such as the drinking water being accessible on premises, available when needed, and free from faecal and priority chemical contamination are defined in the

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[55] European Commission, The European Union Water Framework Directive. Available at: https://ec.europa.eu/environment/water/water-framework/index_en.html (accessed 8 August 2023).
[56] *Ibid.*
[57] European Union, EU Directive on bathing water quality, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&qid=1662737576916&from=NL (accessed 8 August 2023).
[58] United Nations Statistics Division, SDG Indicator metadata: Metadata-06-01-01, available at: https://unstats.un.org/sdgs/metadata/files/Metadata-06-01-01.pdf (accessed 8 August 2023).

indicator's methodology. Further guidelines on drinking water quality are available from the World Health Organization.[59] Issues that have been analysed in researching for this indicator, for example, include time taken for people to access drinking water, and intermittent availability of drinking water.

SDG indicator 6.3.2: Proportion of bodies of water with good ambient water quality. The indicator tracks the percentage of water bodies (rivers, lakes and groundwater) in a country with good ambient water quality. "Good" indicates an ambient water quality that does not damage ecosystem function or human health according to core ambient water quality parameter groups that are relevant globally.

Significant improvements have been made to data availability for SDG indicators since their commencement in 2015, however data gaps remain. The UN Statistics Division hosts an SDG data portal where country profiles can be generated which show as much data as is available spanning all 17 SDGs, and inclusive of all SDG indicators.[60]

For the purpose of global reporting (level 1 of the indicator), overall water quality is estimated based on an index, which incorporates data on five core parameter groups, which inform on major water quality impairments present in many parts of the world:
- oxygen (surface water)
- salinity (surface water and groundwater)
- nitrogen (surface water and groundwater)
- phosphorus (surface water)
- acidification (surface water and groundwater)[61]

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[59] World Health Organization, Drinking-water guidelines, available at: https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/water-safety-and-quality/drinking-water-quality-guidelines (accessed 8 August 2023).
[60] United Nations Statistics Division, Global SDG indicators data platform, available at: https://unstats.un.org/sdgs/dataportal/ (accessed 8 August 2023).
[61] UN Water, Indicator 6.3.2: "Proportion of bodies of water with good ambient water quality", available at https://www.sdg6monitoring.org/indicator-632/ (accessed 8 August 2023).

Table 1 of SDG methodology:[62]

Table 1: Level 1 parameter groups, suggested parameters (in bold), the relevant water body types and reasons for inclusion in the global indicator

Parameter group	Parameter	River	Lake	Ground-water	Reason for Inclusion / Pressure
Oxygen	**Dissolved oxygen**	●	●		Measure of oxygen depletion
	Biological oxygen demand, Chemical oxygen demand	●			Measure of organic pollution
Salinity	**Electrical conductivity** *Salinity, Total dissolved solids*	●	●	●	Measure of salinisation and helps to characterises the water body
Nitrogen*	**Total oxidised nitrogen** *Total nitrogen, Nitrite, Ammoniacal nitrogen*	●	●		Measure of nutrient pollution
	Nitrate**			●	Health concern for human consumption
Phosphorous *	**Orthophosphate** *Total phosphorous*	●	●		Measure of nutrient pollution
pH status	**pH**	●	●	●	Measure of acidification and helps to characterises the water body
* Countries should include the fractions of N and P which are most relevant in the national context					
** Nitrate is suggested for groundwater due to associated human health risks					

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[62] United Nations Environment Programme, An Introduction to SDG indicator 6.3.2: Proportion of bodies of water with good ambient water quality, https://communities.unep.org/display/sdg632/Documents+and+Materials?preview=/32407814/38306458/SDG_632_Introduction%20to%20the%20Methodology_EN%20(3).pdf#DocumentsandMaterials-Intro Pg 3 of 9 (accessed 8 August 2023).

Figure 6.8: Schematic of similarities and differences between mandatory Level 1 and optional Level 2 reporting in terms of data collection, data type and data source that can be used for SDG6.3.2 methodology.[63]

[63] UNEP, GEMS Water, An introduction to SDG Indicator 6.3.2: Proportion of bodies of water with good ambient water quality. https://communities.unep.org/display/sdg632/Documents+and+Materials?preview=/32407814/106758333/SDG632_Introduction%20to%20the%20Methodology_20230420.pdf#DocumentsandMaterials-Intro (accessed 8 August 2023).