SDG Indicator 6.3.2 Technical Guidance Document No. 4:

Level 2 Reporting

This document provides guidance on Level 2 of SDG indicator 6.3.2 reporting. It is a companion document to the Step-by-Step Methodology and forms part of a series that provide detailed technical guidance on specific aspects of the indicator methodology. These resources are available through the *SDG Water Quality Hub*.

This document is aimed at practitioners seeking further information on Level 2 and how it is relevant for their country's SDG indicator 6.3.2 submission. This document:

1. expands on the Level 2 concept presented in the Step-by-Step Methodology;
2. replaces the guidance document provided in 2020; and,
3. details the Level 2 indicator calculation process.

Level 2 Overview

The optional Level 2 reporting workflow provides the scope for countries to report on water quality beyond the limitations of Level 1, in a manner that may more closely reflect national water quality pressures. Level 1 reporting is essential because it provides global comparability which is essential for all SDG indicators, but to capture local pressures and to utilise other relevant water quality information beyond the scope of Level 1 - greater flexibility is needed. Level 2 provides this flexibility and takes reporting on water quality beyond the constraints of Level 1.

The Level 2 concept was created and developed in response to feedback received from country focal points and international experts following the 2017 and 2020 data drives (UNEP GEMS/Water 2019; UNEP GEMS/Water2022). Incorporating this feedback ensures the national relevance of this indicator is maximised. 2023 will be the first time that countries are given the opportunity to report at Level 2.

Level 2 is both optional and unconstrained. Any water quality data that can be used to classify a water body as either good or not good ambient quality is relevant. A Level 2 submission can include the Level 1 physico-chemical parameter groups as a reporting component (oxygen, salinity, nitrogen, phosphorus and acidification), but Level 2 allows additional parameters and approaches to monitoring to be used to provide an assessment with greater national relevance. In the absence of any Level 1 data, a Level 2 submission can rely solely upon Level 2 data sources.

Countries that report at Level 2 will have two national indicator scores and currently, it is only the Level 1 score that is forwarded to the United Nations Statistical Division (UNSD). UNSD is the UN organisation that collates all SDG information. Level 2 information will be gathered and shared through UNEP's *SDG Water Quality Hub*.

This document was prepared by Stuart Warner United Nations Environment Programme's Global Environment Monitoring System for Freshwater (GEMS/Water). March 2023.

When calculating this indicator at Level 2, the same general principles apply as those at Level 1. This means that water bodies are classified as either good or not good based on compliance of water quality measurements to their respective targets. Also, where possible, countries are encouraged to report at Level 2 using the same water body and Reporting Basin District (RBD) hydrological units that are used for Level 1 reporting. This helps ensure spatial comparability between the two indicator scores, but the reporting workflow allows for instances where this is not possible. These situations are described in this document below.

Countries that choose to report at Level 2 can do so either in parallel or in sequence to their Level 1 submission. Reporting at Level 2 is achieved through a separate reporting template that is structurally similar to the that of Level 1. This can be found on the *SDG Water Quality Hub.*

Level 2 Essentials

The differences between Level 1 and Level 2 are illustrated in Figure 1.

- **Data Collection** - Level 1 is limited to *in situ* data only. Water quality is either measured at the monitoring location or a sample is collected for subsequent analysis. Whereas Level 2 data can be collected by remote methods such as satellite-based Earth observation or other remote sensing approaches.
- **Data Type** - Level 1 is constrained to the five core physico-chemical parameter groups (oxygen, salinity, nitrogen, phosphorus and acidification), whereas Level 2 can include additional physico-chemical parameters as well as include pathogen, biological or ecosystem approaches to water body classification. Countries may combine one or several additional data types in their Level 2 submission.
- **Data Source** – Level 1 data are constrained to being derived from national monitoring programmes such as those implemented by national agencies responsible for monitoring, but may include other national sources such as academic or private sector organisations or citizen initiatives. Level 2 differs because it provides countries with the opportunity to use these same sources as Level 1, but to also incorporate additional data sources such as those derived from Earth observation or modelled products.

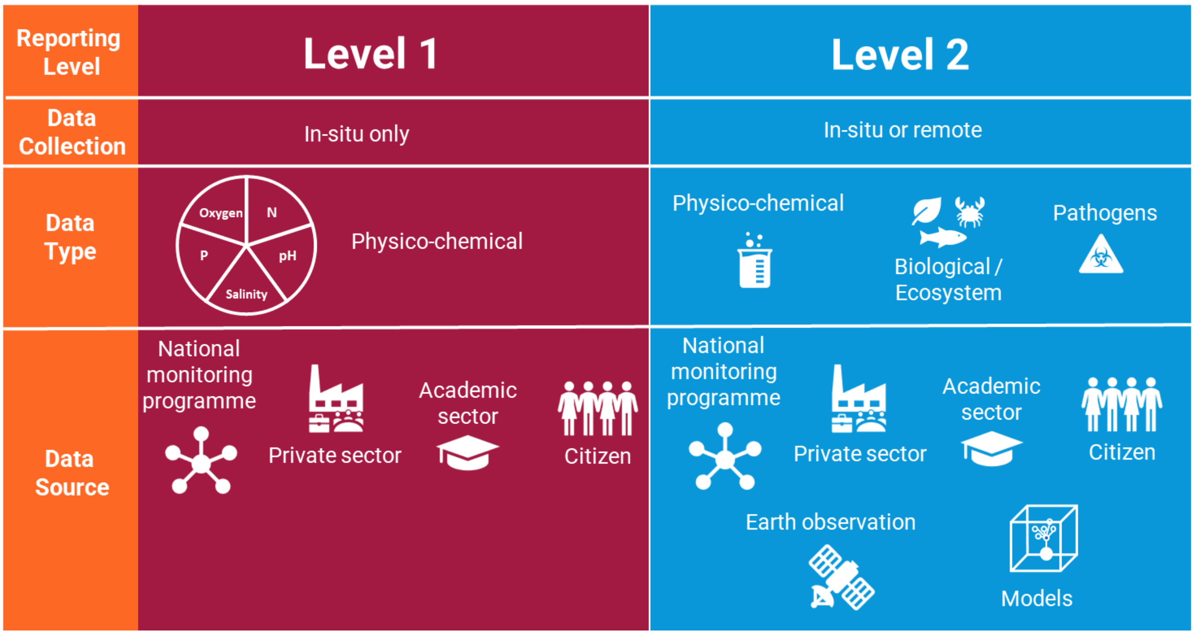


Figure 1: Level 1 and Level 2 data types and sources that can be used for SDG indicator 6.3.2 reporting

Level 2 sub-indicators that countries may include in their submission are shown in Figure 2. This is a non-exhaustive list and there may be other cases that countries may wish to include, but those shown cover commonly used data types.

Efforts to increase the amount of information available to those tasked with reporting for their country will include UNEP and partners packaging global water quality products for national indicator reporting. For example, outputs from global Earth observation approaches or modelled data may be disaggregated at the national and reporting basin district level and shared through the *SDG Water Quality Hub*.

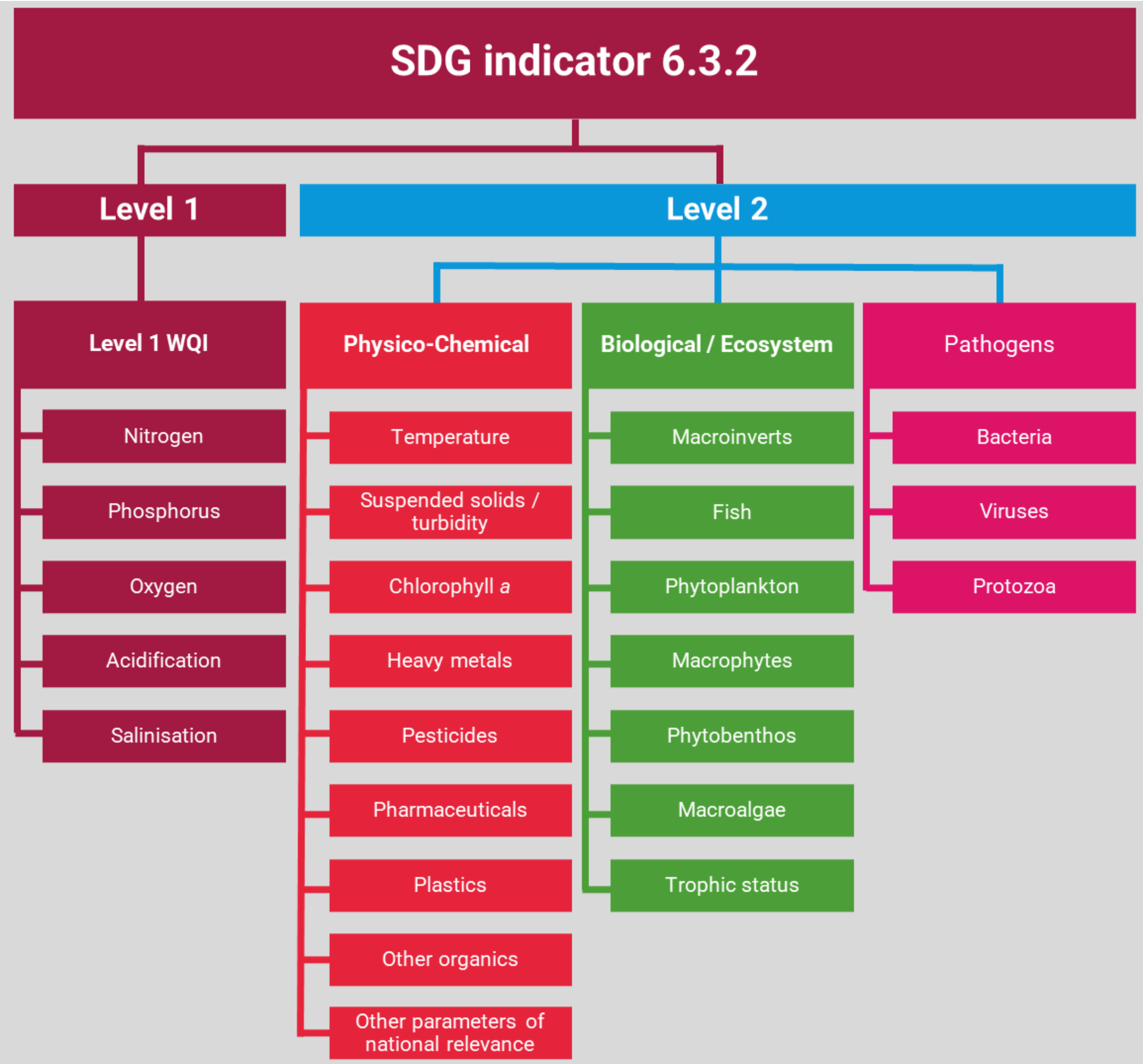


Figure 2: Schematic of Level 1 and Level 2 Sub-indicators

Level 2 Data Types

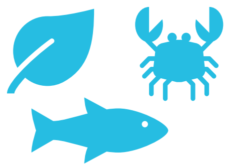
The three Level 2 data types are described in more detail below. One or several additional data types may be packaged and included in a Level 2 submission as separate reporting components.

Physico-chemical parameters

Many countries already routinely collect ambient water quality data on parameters beyond those required for Level 1 reporting that reflect national monitoring objectives. They may include physical or chemical parameters such as temperature, turbidity, colour, silicate or suspended solids. They may also include toxic substances that occur naturally from a geological origin, or that may be related to pollution from activities such as agriculture or mining.

Data on any other physical or chemical parameter can be included which is collected as part of a routine monitoring programme. The effect of the parameter on the freshwater ecosystem and human health, will determine how the data are integrated. This is discussed in more detail below.

Biological and Ecosystem



There are many biological and ecological approaches to monitoring ambient water quality, but no single method has been tried and tested globally. Most have been developed for a country or region, and then adapted for use in another country. For example, the Biological Monitoring Working Party (BMWP) method developed in the UK (Biological Monitoring Working Party, 1978) was adapted for the South African Scoring System (SASS) and developed into the most recent version SASS5 (Dickens and Graham, 2002).

Many biological methods work on the principle that aquatic organisms respond to changes in their environment in measurable ways. In response to poor water quality, species may not be able to survive or will move to a different location to avoid the unfavourable conditions. Less severe responses include a reduction in reproduction or growth rates (Friedrich *et al.*, 1996). Macroinvertebrates are commonly used to monitor the quality of streams and wadeable rivers. Some methods rely on the identification of indicator species (presence/absence) or look at the diversity and abundance of the species found. Certain species are more sensitive to poor water quality and are not found where oxygen levels are continuously or periodically low, whereas the abundance of more tolerant species is higher.

When biological approaches have been established, they are often more economical to operate than those that employ techniques that measure physical and chemical characteristics of water. They are not useful for providing information on whether specific parameter target values have been exceeded or not, but they provide a better overall assessment of water quality if implemented correctly

Pathogens

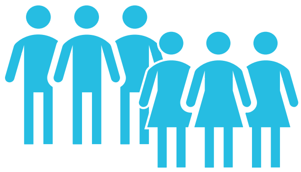
Untreated domestic sewage effluent is one of the most serious and prevalent forms of water pollution globally. Pathogens carried in the wastewater can lead to serious health issues and contribute to high child mortality rates in many least-developed countries. Access to safely managed drinking water services is measured by SDG indicator 6.1.1. In 2020, the indicator team found that only 74 per cent of the world's population had access to a safely managed drinking water supply (WHO and UNICEF, 2021).

There are many bacterial, viral and protozoan pathogens that can be found in freshwaters. Some of these are included in routine monitoring of drinking water sources but not necessarily in dedicated ambient water monitoring programmes. Microbiological approaches may look for the presence or absence of indicator bacteria that suggest the presence of bacteria that may be harmful to humans. Examples are thermotolerant coliforms, such as *Escherichia coli*, which can be used as an indicator of faecal contamination of water.

DATA SOURCE

Many countries use sources of water quality information that go beyond the Level 1 *in situ* approach included as part of their national water quality assessment. Three innovative data sources are described below.

CITIZEN APPROACHES



Citizen and community engagement offers real opportunity for data collection and for identifying and implementing measures to protect and restore water quality. Recent developments in information and communications technology have fuelled the growth and popularity of citizen and community approaches for environmental data collection (Fraisl et al. 2022) and for contributing to the SDGs (Fritz et al. 2019).

There is significant interest in the potential of citizen science (CS) to deliver greater spatial and temporal coverage of water-quality monitoring data than that which is possible with traditional monitoring programmes. One often cited limitation of citizen data is that they lack accuracy or precision compared with laboratory-based analyses performed by trained specialists. This may well be true, but these approaches have the advantage of being able to collect data at many more locations and at a greater frequency than conventional monitoring (Quinliven *et al*., 2020). In addition, collecting highly accurate or precise data may not be absolutely necessary to determine whether a water body is of good or not good quality. More frequently collected measurements that may be less accurate or precise can still provide valuable and robust trend information (Bishop et al. 2021; Fraisl et al. 2022).

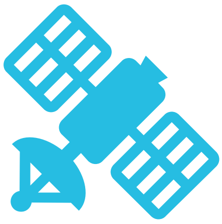
The 2020 Level 2 guidance document limited the use of citizen data to Level 2 reporting. This has been updated and GEMS/Water is now actively encouraging countries to explore the opportunities available to incorporate citizen and community data sources for both Level 1 and Level 2 reporting. To support these efforts, GEMS/Water is working with partners to explore and test various methods to integrate national monitoring programme data with that generated by citizen or community groups[2].

Whether data from CS approaches can be added to Level 1 data or Level 2 will depend on the design and objectives of the CS programme. Citizen data that are repurposed from an existing programme, may not be integrated as easily as data from a programme designed specifically for SDG indicator 6.3.2 reporting. It may be possible to combine CS physico-chemical data directly with data generated by a national agency, if the core parameter groups are represented and the data are suitably accurate and precise.

UNEP GEMS/Water are actively testing approaches to combine national monitoring programme data with that derived from citizen initiatives[2]

[2] https://my.ltb.io/www/#/stack/ABRER

Earth Observation



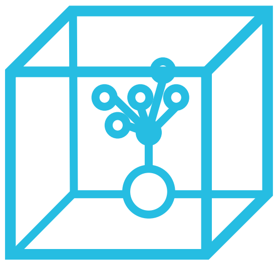
The most common interpretation of the term "Earth Observation" is restricted to remotely sensed, satellite-derived data and products. Strictly speaking the term has a much broader definition that includes data collected by *in situ* instruments and manual methods as well as by aerial remote sensing methods which use planes or drones.

Earth Observation satellite data are increasingly being used for water-quality monitoring. However, they are limited to optically-detectable water quality parameters, such as turbidity, chlorophyll and total suspended solids; and to date, no single method has been adopted as the global standard. The technology is currently most suitable for relatively large bodies of water, such as lakes and wide rivers, because the spatial resolution available from current satellite images for global applications is not fine enough for smaller water bodies. Given the extensive spatial and temporal coverage of current and upcoming satellite missions, satellite data could prove to be an important additional data source for monitoring large rivers and lakes in the near future.

SDG indicator 6.6.1 on freshwater ecosystem extent, uses a satellite-based EO method to provide a global dataset of water quality of large lakes[3].

The Copernicus Global Land Service[3] provides historic (2002-2012) and operational (since 2016) lake water quality monitoring data products for about 1000 medium and large-sized lakes for lake surface reflectance, turbidity and a chlorophyll-based trophic state index at spatial resolutions of 300 and 1000 meters.

Modelled Data



Mathematical models have been used to estimate pollutant concentrations and distribution for several decades and can be used to assess the effectiveness of management measures aimed at improving water quality. The complexity of models has increased considerably over the last 50 years (Whitehead *et al.*, 2019), with some addressing pollutant fate, transport and degradation of a compound within a water body, while others model the movement of pollutants from land-based sources to a water body. Calibration and validation using real-world data are essential steps for any model to ensure that it gives an accurate representation of the situation or scenario.

Water quality models use data on variables such as climate, population, ground/surface water interactions, reaction kinetics of the compound being modelled, land use characteristics and topography. The quality of the model output is entirely dependent on the quality of the data used in the model and also the suitability of the model with regards to approach and calibration.

Models can be specific and applied to national-scale for individual parameters. For example, a map of fluoride concentrations in groundwater in India was produced using a combination of real-world data and information on geology, climate and soil types. The model predicts areas where the fluoride concentration is likely to be over 1.5 mg L^{-1} (Podgorski *et al.*, 2018).

When considering incorporating model outputs for SDG indicator 6.3.2 reporting, it is important to ensure that outputs are current and updatable on a regular basis. Models that rely on historical data or that are generated on a one-time basis are unable to track progress on water quality improvement and are therefore unsuitable for this indicator.

[3] https://land.copernicus.eu/global/
[4] https://www.sdg661.app/map

Level 2 Calculation Process

It is important to note that using Level 1 information as part of a Level 2 submission is encouraged, but in the absence of any Level 1 data, a Level 2 submission can rely upon Level 2 data sources only.

Below are options and guidelines on Level 2 indicator calculation. It is important to reiterate that the same general principles apply for Level 2 as to Level 1. This is relevant for the spatial hydrological units used (water bodies and RBDs); the target concept when working with quantitative values; and, the binary classification system.

A classification system that includes more gradations than the binary approach can be used, but a binary conversion (to good vs not good) must be incorporated to align with the reporting framework. For example the European Water Framework Directive (WFD) uses five categories: high, good, moderate, poor and bad. In this case, water bodies classed as either high or good quality would qualify as 'good'.

A Level 2 classification can be calculated by one of three mechanisms. Level 2 data can be used: to **expand spatial coverage** and fill gaps in the data record; used in a '**one out, all out**' approach; or, by **extending the parameter list** beyond the five core Level 1 parameters. For those that intend or would like to report at Level 2, Figure 3 illustrates how the type of data available determines the most suitable approach.

In circumstances where more than one data type is being integrated and no single integration approach is suitable, the above decision tree can be applied to each data type individually. For example, a country may intend to **extend spatial coverage** by adding satellite-based Earth observation data for lakes, whilst simultaneously **extend the parameter list** by adding a general physico-chemical parameter such as turbidity, as well apply a **one out, all out** approach for a toxic reporting component such as a heavy metal.. This information on how the data are integrated is captured in the Level 2 Reporting Template.

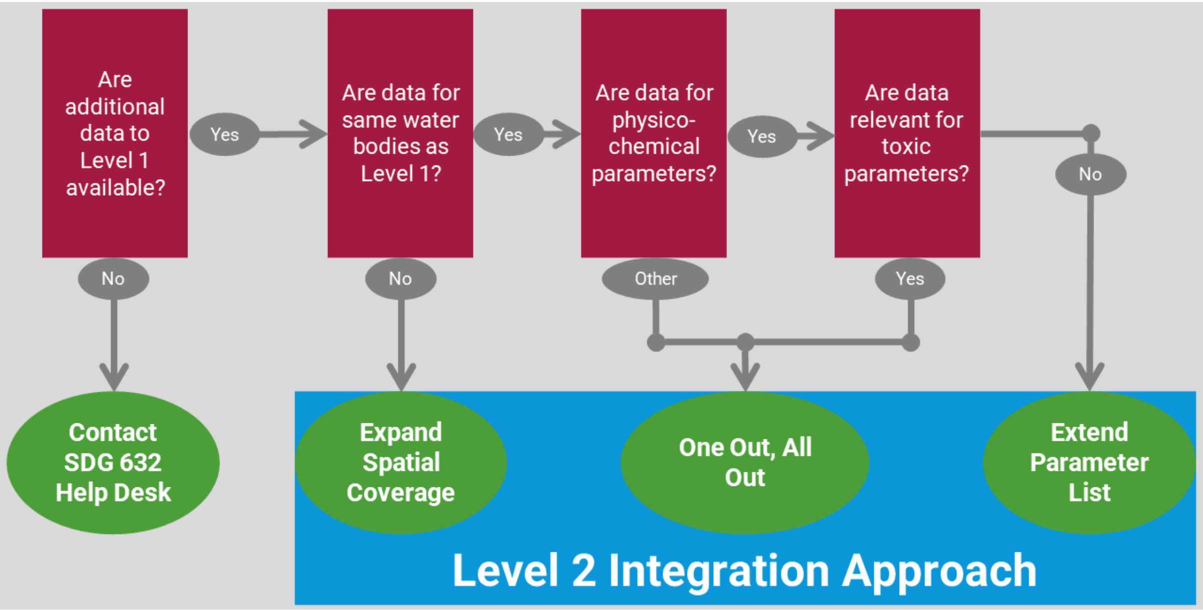


Figure 3: SDG Indicator 6.3.2 Level 2 Submission Decision Tree

Expand spatial coverage

Expanding the spatial coverage approach is applicable if Level 2 data are available to supplement Level 1 data spatially by filling gaps in the data record. For example, Level 1 data may be available for river and groundwater bodies, yet unavailable for lakes and reservoirs. In this case, satellite-based Earth observation data of lakes and reservoirs would be combined with the Level 1 data for rivers to provide a more comprehensive national indicator score which is based on all water body types rather than just the rivers and groundwaters alone. Table 1 below shows how this could work.

Alternatively, if a country does not have an *in situ* monitoring capacity, Earth observation data could be used alone as a Level 2 submission.

Table 1: Example of how Level 2 data can be used to supplement Level 1 data

Water body type	Number of water bodies		
	Level 1	Level 2	Total
River	1000	0	1000
Lake	0	200	200
Groundwater	100	0	100

One Out, All Out

This approach is relevant if: Level 2 data are available for the same water bodies as Level 1 data; if Level 2 data include toxic parameters; if pathogens are included in the calculation; or if an approach other than a physico-chemical one is used, such as a biological assessment.

To classify a water body using this approach, water quality data are grouped into reporting components and assessed separately. For example, if both physico-chemical Level 1 data, and biological Level 2 data are available for the same river water body, water quality is classified for each reporting component separately and this information feeds into the overall classification. An overall 'good' classification is only returned if both reporting components return a positive result. If either one or both do not, the water body is classified as 'not good' (Figure 4).

A limitation of this approach is that for countries which are actively expanding their monitoring capacity, over time it may appear that water quality is degrading. In reality, the apparent degradation may simply reflect the additional monitoring effort, an effect of "the more you look, the more you will find" phenomenon. This effect can be countered if Level 1 reporting is maintained and considered separately. The robustness and simplicity of Level 1 reporting ensures that efforts to improve ambient water quality are reflected in the indicator score over time. The Level 2 information provides critical information on pressures to water quality that can help guide management decisions.

Figure 4: Example of Level 2 data integration with Level 1 using a one out, all out approach

Combining pathogen or toxic compound data with Level 1 data should follow the 'one out, all out' approach of classification. Especially if water bodies are used directly for drinking water without treatment. If a water body does not meet good status due to pathogenic contamination or due to the presence of a toxic compound it should be classified as not good.

Extend Level 1 Parameter List

This approach to Level 2 reporting is relevant when adding a non-toxic parameters to the five Level 1 parameters. These may include parameters such as temperature, suspended solids, turbidity or alkalinity. The same classification process is applied as for Level 1, but the percentage compliance calculation relies on more measurements from a broader range of parameters.

Table 2 shows the calculation for a single water body where at Level 1, in this example 41 of 50 measurements were compliant with their targets resulting in a compliance ratio of 82 per cent. Using Level 1 data alone this water body would be classified as 'good'. When suspended solids and chlorophyll measurements were added to the parameter list, only 49 of the 70 measurements were compliant, resulting in a compliance ratio of 69 per cent. The Level 2 classification for this water body would be 'not good'.

Table 2: Example of how additional parameters can be used to supplement Level 1 parameters

Reporting Level	Level 1					Level 2	
Parameters	Dissolved oxygen	Electrical conductivity	Nitrogen	Phosphorus	pH	Suspended solids	Chlorophyll
Number of measurements	10	10	10	10	10	10	10
Number of measurements met target	10	8	8	8	7	3	4
Water body classification	(Total = 41 of 50 measurements met targets = 82 %) **Level 1 Water body classification = Good**						
	(Total = 49 of 70 measurements met targets = 69 %) **Level 2 Overall Water body classification = Not good**						

Summary

Reporting at Level 2 is optional and can be undertaken either in parallel or in sequence to Level 1 reporting. Twenty twenty three is the first time that countries have the opportunity to report at Level 2, and based on the interest and submissions received, this guidance may be updated in the future to better meet the needs of those tasked with reporting.

The flexibility built into Level 2 reporting will result in varied submissions that will make comparison between different countries' indicator scores difficult. But a global comparison is not the main driver for this reporting workflow. Level 2 reporting was developed in response to feedback received from countries that highlighted the limitations of Level 1 reporting.

The information reported will help develop insight into national monitoring and assessment capacity in different world regions and provide a platform for peer-to-peer learning and engagement. It will facilitate targeted capacity development to those initiating or expanding their monitoring and assessment capacities, and ultimately, help fill the significant data gaps reported in the 2020 data drive (UNEP 2021).

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