STEP-BY-STEP MONITORING METHODOLOGY FOR INDICATOR 6.3.2

PROPORTION OF BODIES OF WATER WITH GOOD AMBIENT WATER QUALITY[1]

1. INTRODUCTION TO INDICATOR 6.3.2

Target 6.3 **By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally**

Indicator 6.3.2 **Proportion of bodies of water with good ambient water quality**

The indicator is defined as the proportion of all water bodies in the country that have good ambient water 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. Consequently, it enables the impact of human development on ambient water quality to be evaluated over time and it provides an indication of the services that can be obtained from the aquatic ecosystems, such as clean water for drinking, preserved biodiversity, sustainable fisheries, water for irrigation, etc. The indicator is also directly linked to indicator 6.3.1 on wastewater treatment because inadequate wastewater treatment leads to degradation in quality of the waters receiving the wastewater effluents. It directly informs progress towards target 6.3 and is strongly linked to target 6.6 on water-related ecosystems.

This indicator provides a mechanism for determining whether water quality management measures are contributing to the improvement of water quality in inland water bodies. At the national level, more water bodies should achieve good water quality with increasing levels of wastewater treatment and reuse of wastewaters. Integrated management of river and lake catchments will also contribute to better water quality. Good ambient water quality is essential for preserving aquatic ecosystems and the services they provide, such as fisheries. It is also essential for protecting human health during recreational use and in situations where the water is used for drinking and domestic activities without prior treatment. It is, therefore, in the interests of national authorities, to aim for all water bodies to be classified as being of “good water quality”. This methodology suggests a process for introducing regular monitoring of water bodies in order to determine their quality status. Over time, or with increased availability of resources, the monitoring programme can be expanded to give a more detailed description of water quality that will provide better information for management and the development of water-related policy.

[1] This is an unofficial translation. To view the original document in English, please visit www.sdg6monitoring.org/news?category=Resources. For any questions or feedback, please contact hartwig.kremer@un.org

The indicator relies on water quality data derived from *in situ* measurements and the analysis of samples collected from surface and groundwaters. Water quality is assessed by means of core physical and chemical parameters that reflect natural water quality related to climatological and geological factors, together with major impacts on water quality. The measured values are used to classify the quality of water as either good, or not good. The critical need for real world *in situ* water quality data at the global scale will play an increasingly important role in the coming years. These data are essential to enable validation of, and to maximise the potential for, the greater spatial coverage achievable with earth observation technology. In situ measurements of water quality are also needed to validate water quality models.

The methodology recognises that countries have different capacity levels to monitor water quality, with many developed countries operating extensive and complex programmes that collect and report data to existing reporting frameworks beyond the scope of this methodology. For these countries it is recognised that this methodology will not contribute to improving their water quality; however it must be sufficiently flexible to capture data from existing monitoring frameworks without burdening countries with additional reporting obligations. Conversely, many of the least developed countries currently do not monitor water quality or operate very limited monitoring programmes. The methodology must therefore allow these countries to contribute to the global indicator, according to their national capacity and available resources.

The development of the methodology builds on best practice for water quality monitoring promoted by the UN Environment GEMS/Water programme since 1978 together with testing by several pilot countries during the Integrated Monitoring Initiative Proof of Concept phase of 2016, and external review by experts and international organizations. This led to revision of the original methodology, which was then further tested through the 2017 global data drive. The feedback received has contributed to the present refined methodology.

Indicator 6.3.2 can only be reported if countries operate national ambient water quality monitoring programmes, which include field operations, analysis of samples, data management structures, and a capacity to assess and report on the water quality data produced. By requesting countries to report indicator 6.3.2, capacity deficits may be highlighted. Indirectly this will help build water quality monitoring capacity to a level that is sufficient to provide the necessary data for assessment, and ultimately to “improve water quality”. As a result, many other SDGs which rely directly or indirectly on good ambient water quality, such as sources of safe drinking water, food security and ecosystem health will be supported. Where capacity deficits exist, this methodology highlights areas where engagement with the GEMS/Water programme can help countries to meet these capacity needs.

2. MONITORING METHODOLOGY

This methodology produces an indicator which is globally comparable, by prescribing the measurement of simple core parameters. National interests can be maintained by allowing expansion and adaptation to meet national and regional water quality pressures. The methodology uses a water quality index which combines data from the analysis of basic core water quality parameters. Some of these parameters are direct measures of water quality for ecosystem or human health, and the others are included to characterise the water body. Deviation from normal ranges (in the case of electrical conductivity and pH), or values which exceed (phosphate and nitrogen), or fall below expected (dissolved oxygen) target values may be symptomatic of impacts on water quality.

The methodology proposes that river basins are used as the unit of disaggregation from national reporting. This is preferable because it allows spatial patterns across a country to be discerned. Furthermore, each river basin is subdivided into smaller hydrological “water body” units which help illustrate intra-basin patterns in water quality. The river basin approach is beneficial for integrated management of water resources, especially for those crossing international borders. The concept provides a more useful unit to assess water quality, and provides the basis to apply management measures.

The indicator to be reported is the "*proportion of bodies of water with good ambient water quality".* The long-term objective would be for the proportion of **all** bodies of water in the country meeting the criteria for "good quality" to be known. To achieve this it would be necessary to measure the quality of water for all water bodies. However, this may not be realistic initially and therefore it is suggested that, unless full national coverage is possible, monitoring effort focuses on selected key water bodies for which reliable, scientifically-sound data can be obtained.

The steps of this methodology are briefly described in the following sections. However, it is recommended that before implementation the associated expanded methodology document which is available via UN Water is consulted.

2.1 Progressive Monitoring Approach

The progressive monitoring approach for indicator 6.3.2 is divided into two levels: Level 1 uses a water quality index comprised of core physico-chemical water quality parameters; and Level 2 includes monitoring of additional parameters and approaches such as biological, microbiological or earth observation. It is widely accepted that many countries are unable to reach Level 1, and these countries are encouraged to engage with GEMS/Water to identify where capacity development may be required to develop monitoring programmes.

Level 1 reporting uses parameters which are commonly collected globally and are straightforward and relatively inexpensive to measure. Level 1 data can be extracted from reporting frameworks already being used by countries employing more advanced methods of water quality assessment. For countries struggling to implement monitoring programmes, Level 1 presents fewer challenges when compared with more exhaustive assessments of water quality.

The core indicator of Level 1 cannot fully represent all pressures to water quality, and the progressive steps of Level 2 monitoring ensures the balance between global and national relevance is met. Level 1 provides the framework upon which more targeted monitoring programmes can be built. Level 2 monitoring can be advanced by expanding the parameters measured or by using additional approaches to monitoring water quality.

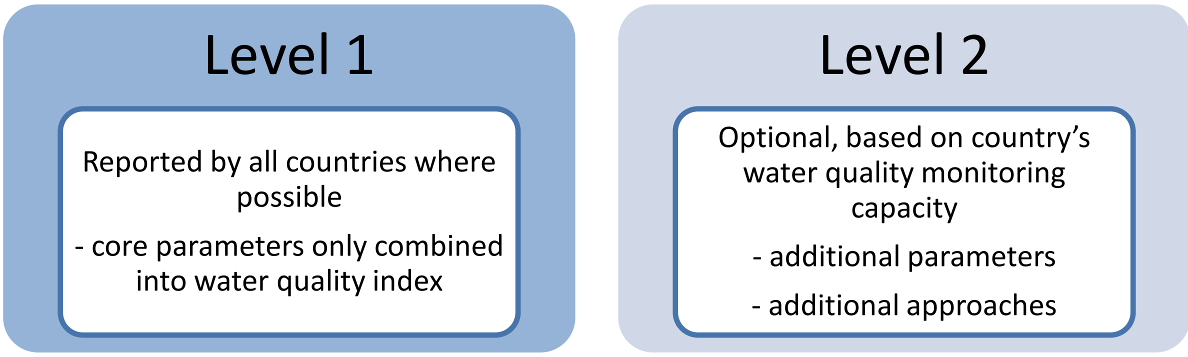


Figure 2.1: Schematic of Level 1 and Level 2 monitoring

2.2 Level 1 Monitoring

Options are offered for each step of Level 1 monitoring. They fall into two broad categories: countries can either use their own capacity to undertake the tasks prescribed or alternatively, they can engage directly with GEMS/Water for guidance and support. During the 2017 data drive it was recognized that many countries struggled with the implementation of several steps of the methodology. Countries are encouraged to engage with GEMS/Water at each step regardless of whether the capacity is present in the country to ensure the final global indicator calculated fulfills the indicator objectives and is globally comparable.

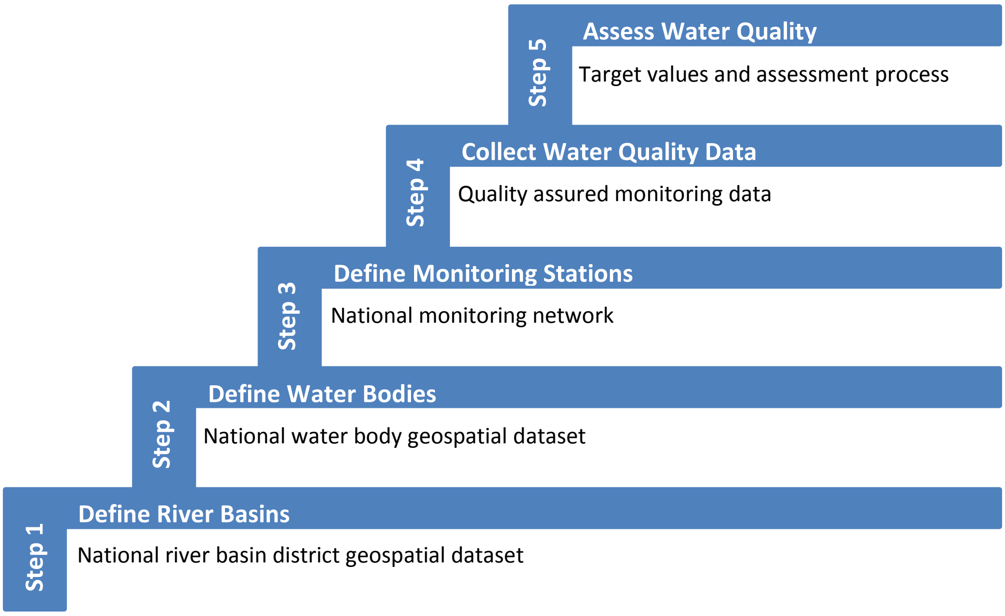


Figure 2.2: Level 1 Indicator steps with requirements for each step

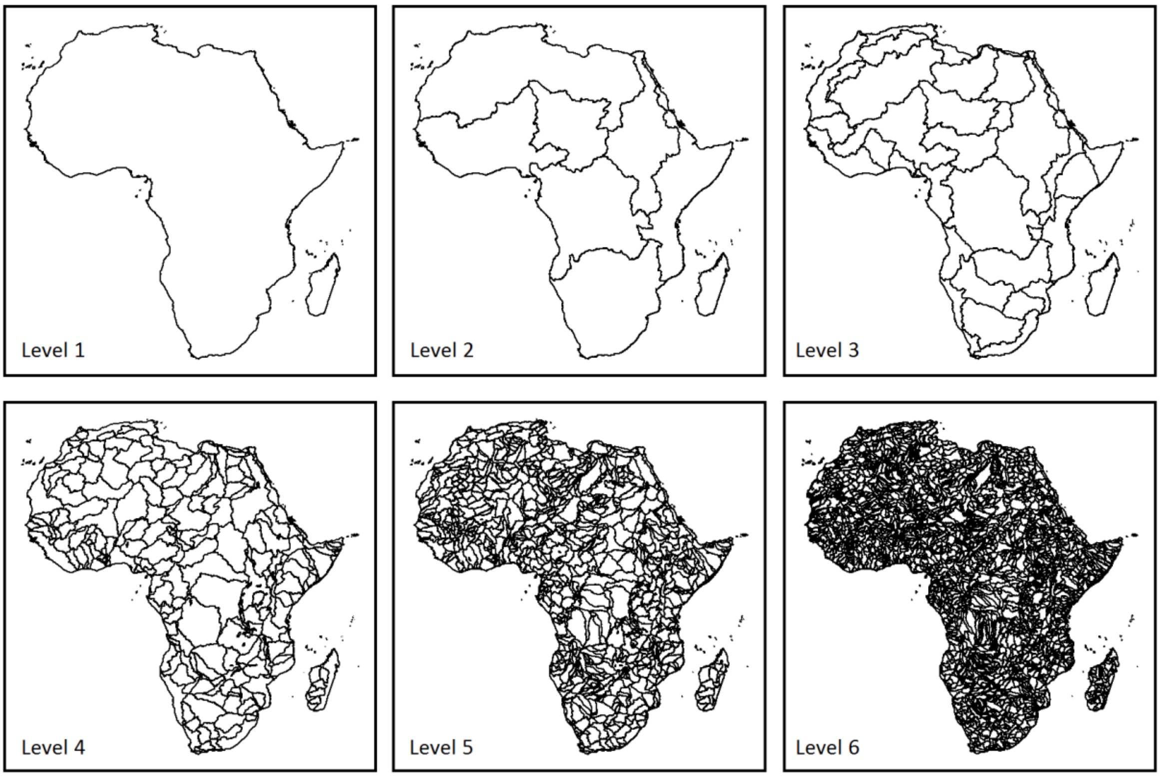
2.2.1 Step 1: Define River Basins

Option 1 – Country defines river basin districts based on existing national or regional water quality assessment

Option 2 – Engage with GEMS/Water to define suitable river basin districts

The river basin district is the unit of disaggregation from the national indicator score. It is the area of land, made up of one or more neighbouring river basins or national portion of transboundary river basins, together with their associated groundwater bodies. The national indicator score is a useful tool for global comparisons, but in terms of management of water resources, especially for transboundary waters, the river basin district concept provides a more practical unit to assess water quality, and provides the basis to apply management strategies.

Countries choosing option 2, will be provided with preliminary river basins for their country derived from the HydroBASINS global dataset (Lehner and Grill, 2013) (see example in Figure 2.3) and the transboundary river basins of the UNEP-GEF Transboundary Waters Assessment Programme (TWAP) data portal available at http://twap-rivers.org/indicators/ (UNEP-DHI and UNEP, 2016). These preliminary basins will serve as a starting point and will be validated by the country to align with reporting units used already. The final national river basin output will contribute to a seamless global basins reporting dataset that could be used for future SDG water-related indicators, which recognises the significance of both transboundary basins and the hydrological units used in countries.



Lehner, B. 2014 HydroBASINS Global watershed boundaries and sub-basin delineations derived from HydroSHEDS data at 15 second resolution Technical Documentation Version 1.c (with and without inserted lakes). Available at: http://www.hydrosheds.org/images/inpages/HydroBASINS_TechDoc_v1c.pdf

Figure 2.3: Example of HydroBasins Data for African Continent of Levels 1 to 6

2.2.2 Step 2: Define Water Bodies

Option 1 – Country applies water body units used in national or regional water quality assessment

Option 2 – Engage with GEMS/Water to define suitable water bodies (based on HydroBASINS and HydroSHEDS)

Within each river basin, the first level of categorisation is between surface and groundwaters. The surface waters should be divided into water bodies according to their type (i.e. river or lake). If, for example, a river is interrupted by a lake in its course, the boundaries between the lake and the river stretches upstream and downstream of the lake would act as boundaries between three individual water bodies.

Physical characteristics, including hydrological and geomorphological features, climatic factors and geochemical characteristics, as well as pollution from point and non-point sources, can result in large spatial differences in water quality in river systems, lakes and aquifers. This variability should be reflected in the water bodies that are considered within the scope of indicator 6.3.2. A sub-division of water bodies of different categories into discrete units with similar characteristics is recommended to allow for a meaningful assessment of their quality. Many countries have developed frameworks for water body types based on physical, chemical and related characteristics that can be applied for the delineation of water bodies. Where no framework is in place, information on the physical characteristics of the water bodies, pressures from pollution sources and designated uses can be used to further sub-divide large water bodies.

Delineation of River Water Bodies

Hydromorphological features, such as river confluences are suggested as suitable boundaries for sub-division of river water bodies. This approach of using river confluences as boundaries between hydrological units is the basis of the HydroBASINS dataset. Countries exploring options to delineate and develop their own river water bodies could use this dataset as an initial starting point. HydroBASINS is one of a suite of products of the HydroSHEDS project which are available at http://www.hydrosheds.org/. GIS datasets for lakes (Messager *et al.*, 2016) and a modelled river network are also available.

Although the above mentioned criteria alone are sufficient for the identification of water bodies, there are further considerations that could help with refinement of surface water bodies to enable an accurate monitoring of the progress towards SDG target 6.3. For this, areas with designated pressures and impacts (e.g. diffuse source of nutrient input from agriculture or point source of industrial water discharge) could be taken into account, as well as areas designated for specific uses (e.g. drinking water, recreational waters and fishery). Furthermore, the identification of water bodies could incorporate special areas for the protection of nature (UN Environment, 2017). In many countries, these considerations already are an integral part of the water management and monitoring strategies and can therefore be reflected in the SDG indicator 6.3.2 reporting process.

Delineation of Lakes

Delineation is limited to the surface area of the water body. Lake water bodies which occur in a series, inter-connected by rivers, or as an expansion in water width along the course of a river, such as artificial reservoirs behind dams, will need careful consideration and are not as clearly defined as those with a single input and output. Similarly, lake water bodies which fluctuate in depth and extent seasonally, will also need a systematic approach to delineation: what appears as one water body during the wet season may divide into several during the dry season.

Lake water bodies encompassing several distinct basins, may be divided into separate waterbodies especially if the characteristics of each basin varies. For example, one basin may be much shallower than another and may naturally exhibit different physico-chemical attributes. For large transboundary lakes, a harmonised approach should be adopted to ensure that each country classifies the lake in the same manner.

Delineation of Groundwater Bodies

The elements identified as bodies of groundwater should allow for an appropriate description of the general and chemical status of groundwater. Therefore, the extent of a groundwater body should be confined by groundwater flow divides, using surface water catchments and geological boundaries as proxies where information is limited. If a further sub-division is necessary it should be based on groundwater level or on groundwater flow lines, where necessary.

For groundwater bodies which cross river basin boundaries, the groundwater body should be divided along the boundary. Each portion of the groundwater body should be classified as good or not good using the water quality data from each river basin respectively.

2.2.3 Step 3: Define Monitoring Locations

Option 1 – Select existing operational stations, where data are available

Option 2 – Engage with GEMS/Water to define or select suitable monitoring stations

Countries may have many hundreds of monitoring locations, and it may prove advantageous to select a subset of key locations rather than using all stations available. Monitoring locations should be distributed throughout the river network, including headwater sites which are typically less impacted by anthropogenic activities, mid-catchment locations which may be exposed to a variety of pressures, and at the most downstream confluence with another river, lake or estuary. A minimum of one monitoring location is suggested per river water body, but this is dependent on the water body size. One location may, be insufficient to represent water quality in large and diverse systems, and additional locations may be needed. For example, two in headwater locations, two mid-catchment with each representing a major tributary and one at the most downstream point may be more appropriate.

The number of samples needed to assess the water quality of a lake is heavily dependent on the size and depth. Small, shallow lakes can be assessed using a single mid-lake sample, whereas large, deep lakes require an understanding of the bathymetry and water residence time. It may be necessary to sample at numerous locations and multiple depths.

The relative importance of groundwaters as a proportion of a country's water resources varies widely. This should be assessed in determining the resources allocated to groundwater monitoring. To be effective, national groundwater quality monitoring programmes require a full understanding of the hydrogeology of the country. If existing monitoring wells are in place, the characteristics of the well must be known, such as the depth, depth to perforated casing, length of perforated casing and well recharge rate. In the absence of existing monitoring wells, springs or existing drinking water wells can be used.

It is recommended that, in the absence of an existing monitoring network, countries should design a network at the national scale. If the resources available do not allow collection of data from the entire "ideal" monitoring network, it can serve as a target for future monitoring activities as resources become available.

2.2.4 Step 4: Collect Water Quality Data

Option1 – Select data collected as part of national monitoring programmes

Option 2 – Initiate a water quality monitoring programme

To facilitate global comparability of the indicator, a number of physico-chemical core parameters have been suggested for the different water body types. These parameters do not reflect all pressures on water quality for every country, and a high water quality index score does not confirm suitability of the water for any one specific use. However, water quality that meets the target values for these parameters, measured as part of a well-designed monitoring programme, does indicate that the water is not impacted by major sources of water pollution: domestic and industrial wastewaters, agricultural runoff and saltwater intrusion. The justification for inclusion and a description of each recommended parameter is given below.

Table 2.1: Core monitoring parameters for each type of water body

Parameter group	Parameter	River	Lake	Groundwater
Oxygen	**Dissolved oxygen**	x	x	
	Biological oxygen demand, Chemical oxygen demand	x		
Salinity	**Electrical conductivity** *Salinity, Total dissolved solids*	x	x	x
Nitrogen*	**Total oxidised nitrogen** *Total nitrogen, Nitrite, Ammoniacal nitrogen*	x	x	
	Nitrate**			x
Phosphorous*	**Orthophosphate** *Total phosphorous*	x	x	
Acidification	**pH**	x	x	x
* 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				

The minimum data requirements for calculating this indicator are measurements obtained by analysing water samples for all of the core parameters appropriate to the type of water body. Table 2.1 contains recommended core parameters (bold) as well as alternative core parameters (italic) that can be used depending on data availability and applicability for the specific water body types.

Samples should be taken routinely, at prescribed intervals, or the same time of year each year, from the same locations. Even if new monitoring stations are introduced, data should continue to be collected from the original locations. This ensures that results are comparable from year to year, thereby enabling trends to be established over time. The monitoring data needed for the indicator calculation may be collected by different monitoring programmes involving different agencies and organizations. It is therefore important to establish and maintain centralized data repositories at the national level that collate the data from the various stakeholders, ensuring compatibility in reporting units between all agencies submitting data. Data should be compiled for each core parameter at each sampling location in order to calculate the indicator.

Quality assurance and effective quality control procedures during sampling, analyses and data handling are essential to produce reliable monitoring data for the indicator. International standards should be applied at all stages depending on applicability and availability. The central data repository should also keep all relevant metadata associated with the water quality measurements. This includes the location of the monitoring station, described with geographical co-ordinates for each site from which samples are taken within a water body. The type of water body should be recorded together with other information that might affect the analytical results obtained (e.g. unusual water levels or disturbance of the water body).

Rivers

Dissolved oxygen (DO) is important for aquatic organisms. Levels of dissolved oxygen fluctuate naturally with temperature and salinity. Turbulence at the surface of a river, at riffles, or at waterfalls can increase dissolved oxygen concentrations. Photosynthetic activity of aquatic flora and respiration by aquatic organisms can also affect concentrations diurnally and seasonally. Very low oxygen concentrations may suggest the presence of biodegradable organic matter, such as sewage. Ideally, DO is measured *in situ* using an oxygen probe, but methods are available where the oxygen in the water sample is chemically fixed for analysis in the laboratory.

Electrical conductivity (EC) is a simple measure of dissolved substances, such as salts, that help characterise the water body. Values of EC change naturally, especially during periods of increased flow. The inclusion of EC as a core parameter is due to its simplicity of measurement and because deviation from normal ranges can be used as an indicator of pollution, such as wastewater inputs to the water body. The most accurate method to measure EC is using a conductivity probe *in situ*, because values can change during the time between collection in the field and analysis in the laboratory.

pH is included as a core parameter because, like EC, it is useful to help characterise the water body. pH is one of the most widely measured parameters due to its influence on many biological and chemical processes. It is a measure of the activity of the hydrogen ion in the water which can fluctuate naturally especially with changing hydrological conditions as they are influenced by groundwater, subsurface flows and surface runoff during rain events. Changes outside of natural ranges indicate possible pollution from industrial or other wastewater sources. pH is most accurately measured *in situ* using a potentiometric probe because values can change during the time between collection in the field and analysis in the laboratory.

Orthophosphate (OP) is a bioavailable dissolved inorganic form of phosphorus, which is an essential nutrient for aquatic life. Additional inputs from human activities, such as wastewaters or agricultural run-off, can increase concentrations such that they support excessive plant and algal growth which affects the ecological balance of the aquatic ecosystem and impairs water quality for human uses. Orthophosphate can be measured in the field using test kits, but the greatest accuracy and limits of detection are achieved in the laboratory. The concentrations of OP can change over time if the sample is not fixed, and therefore it is suggested that samples are analysed within 24 hours.

Total oxidised nitrogen (TON) is a combined measure of both nitrate and nitrite, which are both forms of dissolved inorganic oxidised nitrogen. Like phosphorus, nitrogen is a nutrient essential for aquatic life and additional inputs can have detrimental impacts on freshwater ecosystems. Total Oxidised Nitrogen, rather than nitrate, is suggested because the analytical method is more straightforward and doesn't require the reduction step needed to measure nitrate alone. In most instances the nitrite fraction of TON in surface waters comprises less than one percent of the total, so for practical purposes, total oxidised nitrogen and nitrate are the same. As with OP, there are kits available for *in situ* monitoring of TON.

Note on nutrient analyses - There are many fractions of phosphorus and nitrogen which countries may be already routinely monitoring, including inorganic, organic, particulate and dissolved forms. For example, total phosphorus (TP) can be a more useful measure of water quality affected by wastewater discharges than orthophosphate but it is more complex to measure because a digestion phase is needed during analysis. Countries can choose to measure the fraction which is most relevant in the national context but orthophosphate and TON are included here as recommendations for the global indicator.

Lakes

The core parameters for lakes are the same as for rivers but the results need careful interpretation if the lake stratifies. Temperature, DO and EC measured through a vertical profile of the lake will identify whether the lake is stratified. A vertical profile monitoring design, integrating samples from fixed depths at regular frequencies is preferred (Chapman, 1996).

Groundwaters

EC and Salinity are included together because the method of measurement is often the same but in most cases only one is relevant for a particular groundwater body. As with surface water bodies, EC is useful for characterising groundwaters. For many countries saltwater intrusion into groundwater is a problem and in these cases measuring salinity is more useful if the water is used for drinking or irrigation. For the most accurate results both EC and salinity are measured at the wellhead.

Nitrate has been suggested for groundwaters rather than TON, because there are specific health concerns associated with nitrate if the water body is used as a drinking water source. Under usual conditions, the majority of the oxidised nitrogen measured as TON is in the form of nitrate, with nitrite making up a small fraction of the total, but for the purposes of accuracy it is recommended that nitrate alone is measured rather than TON. The nitrate ion is highly mobile and readily reaches groundwater bodies. Elevated nitrate concentrations may arise from agricultural sources; hence it is included as a core parameter because it may be useful to establish baseline nitrate conditions.

Special note on Groundwaters: The relative importance of groundwaters and surface waters differs globally, with some countries relying entirely on groundwater resources. Groundwater monitoring programmes include all the elements of surface water monitoring programmes, but require a high degree of expertise to implement, and the results are more difficult to interpret. This is compounded by a shortage of qualified groundwater specialists and experienced well-drilling technicians in low- and middle-income countries, and efforts are need to address this capacity deficit (Alley et al, 2017).

Groundwater flow systems are often very heterogeneous, so that samples from wells in close proximity can produce very different results, especially if samples are taken from different depths. Additionally, groundwater monitoring results are strongly influenced by the sampling methods and protocols and, therefore field personnel need to be trained to a high level of competence to ensure representative samples are obtained. Groundwater bodies need to be recognised as receiving water bodies that require protection against polluting discharges and inappropriate land-uses. Once polluted, the potential for groundwater resources to remain so for decades or even centuries, highlights the importance for implementing effective groundwater monitoring programmes. In addition to routine monitoring, extensive experience gained from other regional and national groundwater monitoring programmes clearly illustrates that reliable interpretation of groundwater status and trends requires periodic intensive surveys on a systematic aquifer-by-aquifer basis, with supporting data on anthropogenic pressures and aquifer dynamics, in addition to regular monitoring of a few selected long-term monitoring stations to improve interpretation (Alley et al, 2017).

2.2.5 Step 5: Assess Water Quality

Option 1 – Monitoring data are assessed by the country

Option 2 – Monitoring data and associated metadata sent to GEMS/Water for assessment and returned to country for validation

The assessment process uses the quality assured monitoring data in conjunction with associated metadata. These metadata include sample location and the time each sample was collected. Water quality is assessed by comparison with target values, and whether Option 1 or Option 2 is selected, the target values will need to be carefully defined. These targets do not necessarily need to be legally binding water quality standards, but can be based on knowledge of the water bodies. Target values can be national values that apply to all water bodies of one type, for example an annual average phosphate concentration of 0.035 mg P/l applies for rivers in Ireland (See Annex 7.2). Alternatively target values can be water body or site specific. For example, a national target value for phosphate of 0.035 mg P/l may not be achievable in all water bodies due to local geological characteristics, and therefore a number of samples would be needed from sites unimpacted by anthropogenic sources of phosphate to derive an achievable local target value. Published water quality target values from other jurisdictions can be used as an alternative, but they may not be completely appropriate at the national level. Additionally, efforts should be made to align target values for transboundary water bodies amongst all riparian countries. If Country A, uses a different target to Country B for the same transboundary water body, the assessment of water quality will vary even if the measured water quality is the same. Examples of published water quality guidelines and targets are included in Annex 7.2.

Countries choosing option 2 need to provide quality-assured monitoring data, as well as metadata on river basin districts, water bodies, and target values to GEMS/Water. This information is required to enable classification of the water quality of the water bodies and calculation of the indicator at river basin district and national scale.

Countries may fall into one of three potential categories which are outlined in Figure 2.4 below: (i) national ambient water quality standards exist for all parameters; (ii) data exist but national target values do not; (iii) insufficient water quality data are available to generate target values.

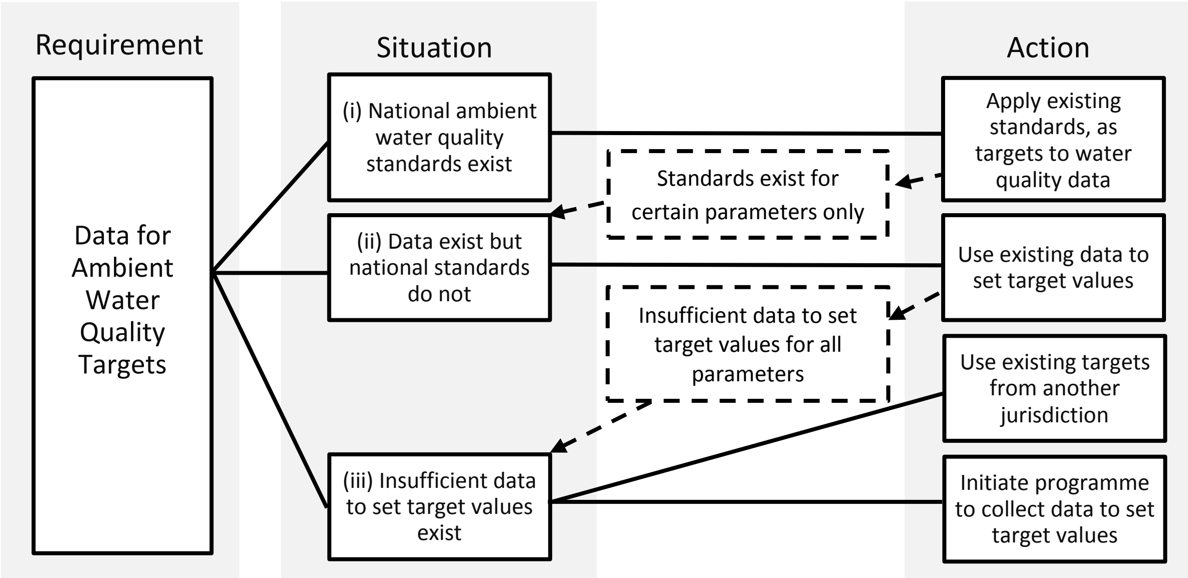


Figure 2.4: Schematic of ambient water quality standards and target situations and suggested actions

If countries fall into the first category, this step of the indicator 6.3.2 methodology is not necessary and existing water quality standards can be used as target values. If countries fall into the second category and water quality data are available for the core parameters, a systematic review is needed to determine whether sufficient data exist to set nationally relevant target values. Countries in the third category will need to use target values from another jurisdiction or, implement a water quality monitoring programme to collect sufficient data to generate target values. In reality, countries may find themselves between categories. Countries may have target values for certain parameters and not for others or, in the absence of any target values, sufficient data may exist to set target values for some but not all parameters.

Collect Data to Set Target Values

A minimum of one year's data is needed to generate target values using water samples collected during different seasons and hydrological regimes. A minimum of twenty data points are recommended, but a more statistically robust target value would be generated if a greater number of data values are used. As with any monitoring programme, it is imperative to note the hydrological conditions during sampling because atypical hydrological conditions can affect some parameter results.

Target values can be of three types depending on the parameter being measured. Some parameters will have "upper" target values meaning the value should not be exceeded. As an example, in Ireland, a phosphate target concentration of 0.035 mg P/l should not be exceeded. Others will be "lower" target values, meaning the measured value should not fall below the target. An example would be dissolved oxygen in rivers where a target value of 9.5 mg/l is a lower target value for waters below 20 °C. Lastly some parameters will have a "range", which is the normal acceptable range of values for that parameter. For example, a range of pH between 6 and 9 may be acceptable for a particular lake, and a deviation from this range may be symptomatic of a water quality issue which may need further investigation.

Data from an unimpacted monitoring location can be used to set a target value which can then be applied to other monitoring locations within the same water body. Unimpacted monitoring locations, which are relatively free from pressures on water quality such as, agriculture, wastewater effluent or mining, can represent "background" or "reference" water quality and can be used to define target values for all monitoring stations regardless of the pressures on their water quality.

Some detailed examples of the derivation of national targets and guidelines have been published (e.g. ANZECC and ARMCANZ, 2000) and are available on-line at http://agriculture.gov.au/SiteCollectionDocuments/water/nwqms-guidelines-4-vol1.pdf.

Classification of Water Quality

Using the target values, a simple index based on the compliance of the monitoring data with the selected target values is used to classify the quality of individual water bodies. For all monitoring locations within a water body, the monitoring values are compared with the target values. The index is defined as the percentage of monitoring values that comply with the target values:

$$C_{wq} = \frac{n_c}{n_m} \times 100$$

Where

C_{wq} is the percentage compliance [%];
n_c is the number of monitoring values in compliance with the target values;
n_m is the total number of monitoring values.

A threshold value of 80% compliance is defined to classify water bodies as “good” quality. Thus, a body of water is classified as having a good quality status if at least 80% of all monitoring data from all monitoring stations within the water body are in compliance with the respective targets.

Calculation of Indicator

The results of the classification of single water bodies with respect to their general status as described above are aggregated to the national level by calculating the proportion of classified water bodies classified as having a good quality status to the total number of classified water bodies expressed in percentage:

$$WBGQ = \frac{n_g}{n_t} \times 100$$

Where

$WBGQ$ is the percentage of water bodies classified as having a good quality status;
n_g is the number of classified water bodies classified as having a good quality status;

n_t is the total number of monitored and classified water bodies

2.3 Level 2 Monitoring

The progressive steps of Level 2 monitoring ensures the balance between global and national relevance is met. Level 2 monitoring can be advanced by measuring additional parameters such as those associated with specific pressures or by using additional approaches to monitoring water quality such as biological or earth observation.

2.3.1 Additional Parameters

Progressive monitoring parameters, such as emerging contaminants or biological indices, can be included depending on national capacities and requirements, and according to country-specific legislation, or regional and local requirements in relation to specific pressures or pollutants. These additional parameters can be reported separately, and analysed over time to identify the improvement or degradation of water quality.

The parameters selected for progressive monitoring should be based on national objectives and implemented as capacity increases. These chosen parameters could be tailored to reflect the use of the water body. Microbiological parameters have been omitted from the core parameters because, although they are of particular concern for human health, they are not routinely monitored in ambient water quality programmes in many countries. However, where water bodies are used directly for drinking water without treatment, inclusion of microbiological parameters is highly recommended.

Progressive monitoring parameters can also be included to reflect particular pressures on water quality in each country. For example, if mining is of particular relevance, a programme which monitors downstream concentrations of heavy metals may be appropriate to determine the degree and extent of the pollution. In lakes, additional parameters such as chlorophyll a are needed to assess trophic status or quality requirements for particular uses such as drinking water or recreation.

If compounds that pose a risk to human health and aquatic life, especially toxic compounds, are included it is recommended that target values are used that reflect their negative effects.

Two parameters of particular concern for groundwaters that are used for drinking, are arsenic and fluoride. These are not included in the core parameters because they are of regional concern, and are derived from geogenic sources rather than anthropogenic activities.

2.3.2 Additional Approaches

Although the use of biological and ecological approaches is introduced here as an advanced step in the progression of monitoring water quality, it is acknowledged that many countries already have such methods in place on which they base their judgement of water quality. Some of these have been modified and improved over many years (e.g. Dickens and Graham 2002; WFD-UKTAG 2014). In a few countries, the results of biological approaches are combined with physical and chemical measurements to obtain an overall judgement of water quality (EPA 2008). All countries are encouraged to consider developing a biological system, where resources are available, and to include such methods when assessing water quality for rivers and lakes. No single method has been tried and tested at a global level, but there are some general approaches that can be used to develop indices that are useful for spatial or temporal evaluation of water quality (Chapman and Jackson 1996).

The use of Earth Observation (EO) data for water quality monitoring is currently advancing but limited to optically detectable water quality parameters like turbidity and chlorophyll, and only in relatively large bodies of water such as lakes and wide rivers. Given the high spatial and temporal resolution of current and upcoming satellite missions, EO data could provide an important and cost-effective additional data source for monitoring of large rivers and lakes in the near future.

There is significant interest in the potential of Citizen Science to deliver a greater spatial coverage of water quality monitoring data than is possible with traditional laboratory-based monitoring networks (e.g. FreshWaterWatch, 2018). The core parameters for this indicator can all be measured using a range of cheap and simple field techniques. Thus, where data submission can be captured electronically by the responsible organisation, Citizen Science networks may provide a useful additional source of data for indicator 6.3.2. It is, however, recommended that training is provided to the citizen groups and that data collection and analysis is co-ordinated by a designated central organisation.

3. Reporting of the Indicator

The national Level 1 core indicator provides a global comparison of water quality. This indicator is reported by countries to UN Environment. Following a validation process by GEMS/Water the indicator is then reported to UN Statistical Division (UNSD) for global comparison.

To ensure the data provided are globally comparable, it is recommended that only data from the preceding five years be used to ensure that the results are up-to-date and globally comparable. Therefore, the next reporting period in 2020, data from 2015 to 2019 would be most suitable. If data covering all five years are not available, using data from a single year within this period is acceptable. The reporting cycle is every five years; the next reporting year will be 2025.

Countries are encouraged to report Level 2 data to UN Environment in parallel to the Level 1 data, but there are no constraints to Level 2 reporting and this can be reported to UN Environment in any year. All reported data will be used to inform regional and global water quality assessment and reports.

4. SUMMARY

This document provides background information and context for the implementation of SDG indicator 6.3.2. It outlines the requirements and steps for Level 1 reporting of the methodology with guidance on each step, and also for Level 2 monitoring for countries with a greater water quality monitoring capacity. Further resources available at the UN-Water site including two online tutorials, a recorded webinar (translated into five other UN languages), and a link to the UN Environment Helpdesk: http://www.sdg6monitoring.org/indicators/target-63/indicators632/. All queries should be directed to the Helpdesk.

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7. Annexes

7.1 Glossary

The concepts and definitions used in the methodology have been based on existing international frameworks and glossaries (WMO 2012) unless where indicated otherwise below.

Aquifer: Geological formation capable of storing, transmitting and yielding exploitable quantities of water.

Classification of water quality: The index results for each water body are classified to provide a water body status of “good” or “not good”. If at least 80% of the monitoring values in a water body comply with their respective target values, the water body is classified as having a “good” water quality status**.**

Groundwater: Subsurface water occupying the saturated zone.

Groundwater body: A distinct volume of groundwater within an aquifer or aquifers (EU, 2000) Groundwater bodies that cross river basin district boundaries should be divided at the boundary with each separate portion of the groundwater body being reported separately along with its respective RBD.

Lake: Inland body of standing surface water of significant extent.

Non-point-source pollution: Pollution of water bodies from dispersed sources such as fertilizers, chemicals and pesticides used in agriculture practices.

Parameter: Water quality variable or characteristic of water quality, also called determinand in SEEA-Water.

Point source pollution: Pollution with a precisely located origin.

Pollution (of water): Introduction into water of any undesirable substance which renders the water unfit for its intended use.

Pollutant: Substance which disrupts and interferes with the equilibrium of a water system and impairs the suitability of using the water for a desired purpose.

Reservoir: Body of water, either natural or man-made, used for storage, regulation and control of water resources.

River: Large stream which serves as the natural drainage for a basin.

River basin: Geographical area having a common outlet for its surface runoff.

River basin district: Area of land, made up of one or more neighbouring river basins together with their associated groundwaters. (EU, 2000)

River water body: A coherent section of a river that is discrete (does not overlap with another water body) and is significant rather than arbitrarily designated.

Stream: Flowing body of water in a natural surface channel.

Surface water: Water which flows over, or lies on, the ground surface. Note: Indicator 6.3.2 does not include the monitoring of water quality in wetlands under monitoring level 1.

Target value: A value (or range) for any given water quality parameter that indicates the threshold for a designated water quality, such as good water quality rather than acceptable water quality.

Toxic substance: Chemical substance which can disturb the physiological functions of humans, animals and plants.

Transboundary waters: Surface or ground waters which mark, cross or are located on boundaries between two or more States; wherever transboundary waters flow directly into the sea, these transboundary waters end at a straight line across their respective mouths between points on the low-water line of the banks (UNECE, 1992)

Water quality index: The measured water quality results for all parameters are combined into a numeric value for each monitoring location. These scores are then aggregated over the time of the assessment period. The index score can range between zero (worst) to 100 (best).

7.2 Examples of Target Values

Country/State	Alaska	Australia and New Zealand	Canada	Ireland [2]	South Africa
Purpose of regulations	Fish and aquatic life	Protection of aquatic ecosystems [1]	Protection of aquatic life	Good ecological status	Good quality aquatic ecosystems
pH	6.5 - 8.5	6.0-8.0	6.5-9.0	4.5 or 6.0 [3] – 9.0	Max 5% deviation from background
Dissolved oxygen (% saturation)	< 110	80-120		80-120	80-120
Dissolved oxygen (mg/)l	7 - 17				
Total ammonia-N (mg/l)				0.065	.007
Unionized ammonia NH_3 (µg/l)			19		
Ammonium NH_4^+ (µgN/l)		6 - 100			
Nitrate (NO_3^-) mg/l			13		
Total N (µg/l)					500-2500
upland rivers		100 - 480			
lowland river		200 - 1200			
lakes		350			
Phosphate (mg/l)		0.004 – 0.040		0.035 [4]	0.005 – 0.025
Total P (µg/l)					
upland rivers		10 – 30			
lowland river		10 – 100			
lakes		10 – 25			
Conductivity (µS/cm)					Max 15% deviation from unimpacted
rivers		20 – 2200			
lakes		90 – 1500			

Phytoplankton chlorophyll a (µg/l)					
rivers and streams		3 – 5			
lakes and reservoirs		3 – 5		<9.0 or <10.0 [5]	
Source reference	Department of Environmental Conservation (2016)	ANZECC and ARMCANZ (2000)	CCME (undated)	Minister for the Environment (2009)	Department of Water Affairs and Forestry (1996)

[1] Default trigger values. Different regions have specific ranges for different water bodies within the overall range given here; [2] Based on the EU Water Framework Directive requirements for good status in rivers and lakes (EU 2000); [3] Depends on water hardness; [4] Applies to rivers only [5] Depending on lake type