SDG Indicator 6.3.2 Technical Guidance Document No. 2:

Target Values

This document focusses on the target value concept which is central to the SDG indicator 6.3.2 methodology. 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 technical documents were created in response to feedback received following the baseline data drive of 2017. These and other resources are available on the Indicator 6.3.2 Support Platform (https://communities.unep.org/display/sdg632).

This document is aimed at practitioners seeking further clarification on how to implement the methodology in their own country. This document:

1. expands on the target value concept presented in the step-by-step methodology;
2. outlines the challenges to setting meaningful target values;
3. suggests approaches to setting and/or adapting existing target values from other jurisdictions for national use; and
4. provides examples of targets used in different world regions.

What are target values?

Measuring physico-chemical parameters, such as nutrient or oxygen concentrations is one way to test whether water quality can be classified as good or not. This is achieved by comparing the measured value to a numerical concentration limit that represents water of good ambient quality.

Target values are specific to each water quality parameter and represent concentrations that aim to preserve these ecosystems or to return them to their natural or near-natural condition. The targets must also ensure that human health is not directly threatened by consumption or use of the water.

Target values may be water quality standards that are defined by national legislation or they may be less binding and derived from information on the natural or reference condition of a water body. Establishing a harmonised approach, and applying a common strategy to setting targets, helps to ensure the global comparability of the indicator.

Target Value Essentials

Below are explanations of key concepts of the target-based approach used in SDG indicator 6.3.2. This document focusses on the five core parameter groups of Level 1 monitoring (oxygen, salinity, nitrogen, phosphorus and acidification).

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Human or Ecosystem Health?

The process to define target values for classification of water bodies should consider both ecosystem and human health. Freshwater quality is influenced by the natural characteristics of the catchment, such as the geology, the climate and the topography. An aquatic ecosystem in its natural condition is adapted to the water quality at that location but this does not necessarily mean this water quality is suitable to maintain human health. In certain cases, water quality in its natural state may be harmful and not suitable for direct human use without prior treatment. For example, nitrate concentrations from groundwater sources can naturally exceed the 50 mg L^{-}NO$_3$ L guideline concentration recommended by the World Health Organization for drinking water supplies (WHO, 2017). Also, water can naturally have concentrations of compounds that are known to be toxic at low levels such as arsenic (Herath *et al*., 2016) and fluoride (WHO, 2017). In these cases, the natural water quality may be perfectly suited to the ecosystem, but human health may be at risk.

The opposite may also be true. Targets based on human health alone may overlook the requirements of ecosystem health. Using again the WHO example of nitrate in drinking water, nitrate concentrations below this threshold are safe for human consumption but may have consequences for ecosystem health. If this value was applied as a target for a water body which has very low natural, background concentration of nitrate, a slight elevation may lead to impairment of ecosystem function. In this situation, it would be preferable to set a much lower ecosystem-based target value that reflects the naturally low background nitrate level. This concept is demonstrated in Figure 1 below. The ecosystem health-related target would have identified the rising trend in nitrate concentration much earlier than the human health-related target and, possibly, in time to initiate an effective management action to reverse the rising trend. As a general principle, the target value that projects the most sensitive requirements (ecosystem or human health) should be used. In situations where target values for both ecosystem and human health are relevant for a particular water body, it is the most stringent that should be applied for indicator 6.3.2. There are some water bodies that may never achieve "good ambient water quality" classification because the natural water quality may not ever be suitable for human use without prior treatment.

Tip: if there are both ecosystem and human health-based target values that could be applied, it is the most stringent that should be used

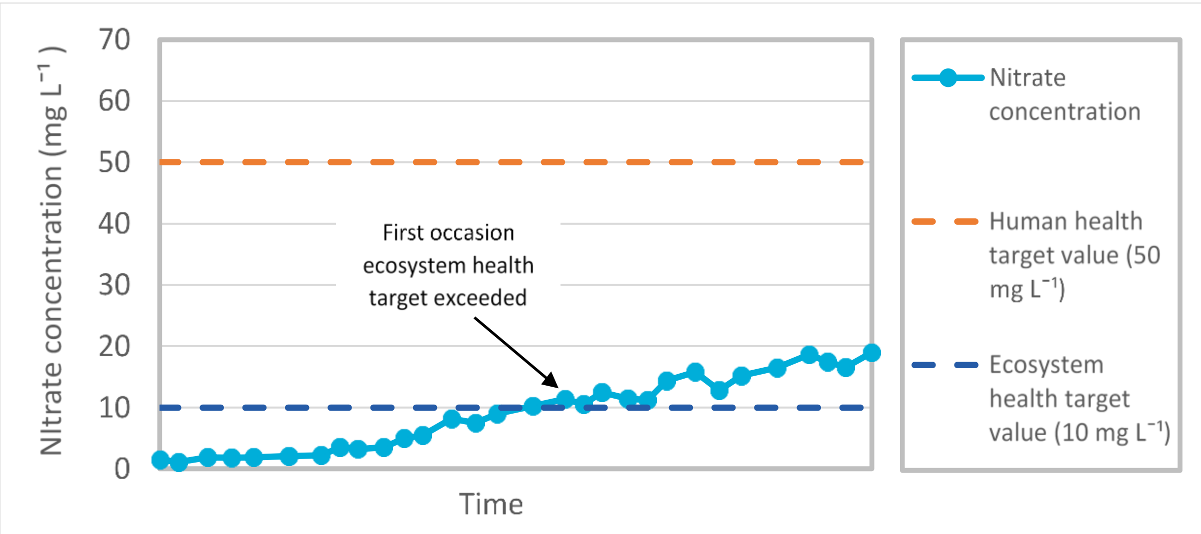


Figure 1: Example of a human health-based target value being too high to identify a rising nitrate trend over time, whereas the trend would be highlighted by an ecosystem-based target.

Reference Conditions

Water quality measurements for water bodies in a natural or near natural condition, that are without disturbance or are exposed to minimal disturbance, should fall within ranges that reflect *reference conditions*. For example, some rivers may have high dissolved oxygen concentration, low nutrients, and have pH and electrical conductivity values that are related to the underlying geology and the proximity to the coast. Measuring repeatedly at the same location over time will produce a *range* for each parameter that can be defined statistically within which the majority of measurements should fall for that location. There could also be diurnal or seasonal patterns in the data, for example a drop in dissolved oxygen over night when photosynthesis ceases, or a drop in dissolved phosphorus concentrations in temperate lakes during the Summer growing season, but there should not be any upward or downward trend over time. All measurements should fall within the expected range.

Target values are not the same as reference conditions, but they are closely linked. A target value may be derived from a known or estimated reference condition, assuming that a slight deviation from the reference condition does not harm ecosystem function.

Each water body is unique and differs by location, geology, climate, topography and biology. The way these factors affect natural conditions are listed in Table 2 below.

Table 1: Description of key natural influences on water quality that may define reference conditions.

Characteristic	Description	Example of mechanism for influence
Location	latitude/longitude; elevation; depth below ground (for groundwaters) and proximity to coast	Latitude: defines seasonality with differences observed between tropical and temperate surface waters.
Geology	the structure and lithology of rock matrix underlying the catchment area	Chemical weathering: underlying geology with high solubility may lead to surface and groundwaters with higher concentrations of dissolved compounds compared with less soluble lithologies.
Climate	the long-term trends of precipitation, temperature, wind and humidity of an area	Temperature: the solubility of gases in water decreases with increasing temperature. This is especially relevant for dissolved oxygen which is required by aquatic animals and plants for respiration.
Topography	the arrangement and shape of the physical landscape	Gradient and length of slope: determines velocity of river flow. Higher velocity water also has higher concentrations of dissolved oxygen, due to turbulence at the surface.
Biology	the ecosystems within the catchment area and the biological interactions within the water body	Wetlands: these ecosystems can directly affect water quality by trapping sediment, uptake of nutrients, reducing velocity of water flow and release of dissolved organic carbon downstream.

Information on reference conditions may not always be available for water bodies where "pre-disturbance" water quality data records are scarce. In these circumstances, it is advised to estimate reference conditions by either using data from undisturbed locations that have similar characteristics, or by relying on expert opinion.

It may not be possible for certain water bodies that have been exposed to human activity for centuries to attain a natural or near natural condition. For these water bodies, countries can decide whether they set targets using a reference condition and accept that they will always be classified as "not good", or alternatively, apply the 'best attainable condition' approach (UN Environment 2017). This approach acknowledges that these water bodies are impacted and that, with good management, they could attain a much-improved condition but never reach a natural or reference condition. The targets applied to such water bodies should reflect this and be less stringent than for water bodies where the long-term objective is to achieve a much higher water quality status. Countries choosing this option should report this information along with their indicator submission so that these less stringent targets can be noted.

Tip: if countries decide that the natural or near natural condition is not practically feasible to achieve, they may choose to follow the 'best attainable condition' approach. This approach encourages efforts to improve water quality but acknowledges that certain water bodies may never achieve a natural or near natural condition.

Upper, Lower or Range Values

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. For example, a target value of 20 µg P L^{-1} may be defined for total phosphorus, and measurements greater than this value would fail to meet the target. Some will be **lower** target values, meaning the measured value should not be below the target. For example, a target value of 80 per cent saturation may be applied to dissolved oxygen in rivers. Lastly, some parameters will have a target **range** which represents the normal acceptable upper and lower measurement limits. For example, a pH range between 6 and 9 may reflect the normal variation of a river during different flow conditions, but a deviation from this range may be symptomatic of a water quality issue that may need further investigation.

Transboundary Target Values

Countries that share transboundary waters are encouraged to collaborate to set target values. Different target values in neighbouring countries may lead to different classifications of the same water body, for example if Country A sets more lenient target values than Country B. This may lead to water of the same quality being classified as good on one side of an international border, and not good on the other.

The water quality and water quantity of transboundary waters are inextricably linked. Collaborative efforts to set target values for transboundary waters are often recognised in bilateral and multilateral agreements, or other formal arrangements, between riparian countries. Such efforts provide a framework for cooperation and form part of the report for SDG indicator 6.5.2 on transboundary water cooperation. Existing transboundary arrangements, such as river basin organisations and regional reporting frameworks, provide a platform to help align hydrological reporting units and coordinate target-setting efforts. Consultation with these organisations and bodies could provide useful direction and insight to ensure harmonisation of cross-border target setting.

Specificity of Target Values

During the 2017 baseline data drive, many countries chose to apply target values that applied to all water bodies of one type in the country. This approach is more straightforward to apply than setting specific targets for individual water bodies and can be useful for certain parameters, such as dissolved oxygen or pH. However, such broad targets do not take account of the natural diversity of water bodies and, therefore, may fail to protect water quality, thereby hindering progress towards SDG Target 6.3.

Countries are encouraged to generate specific targets where resources and information are available. Figure 2 demonstrates the full levels to which specific targets. These are summarised as:

- The national level - a single numerical value (or range) for each waterbody type, for each parameter reported. For example, a single value for rivers, another for lakes and a third for groundwaters.
- Reporting Basin District (RBD) level – a set of targets defined specifically for each RBD. A country may decide that RBDs are sufficiently different to warrant their own target values.
- Typology[2] level – a set of targets for each type of water body identified in the country. For example, an upland river in an area of high annual rainfall, or an aquifer of a particular lithology.
- Water body level – a set of targets for each specific water body.
- Monitoring station level – specific target values for monitoring stations. This would only be necessary in cases where the natural water quality is highly spatially variable. In these cases, it is advised that the water body is divided into more units with homogeneous water quality.

In reality, a combination of levels may be appropriate within a country. In some cases, it may prove to be most effective to define a national target for certain parameters, whereas for others, specific targets may be preferable to ensure water quality is protected. In practice, the most specific level applied is usually the type of water body, but there may be cases where greater specificity is needed.

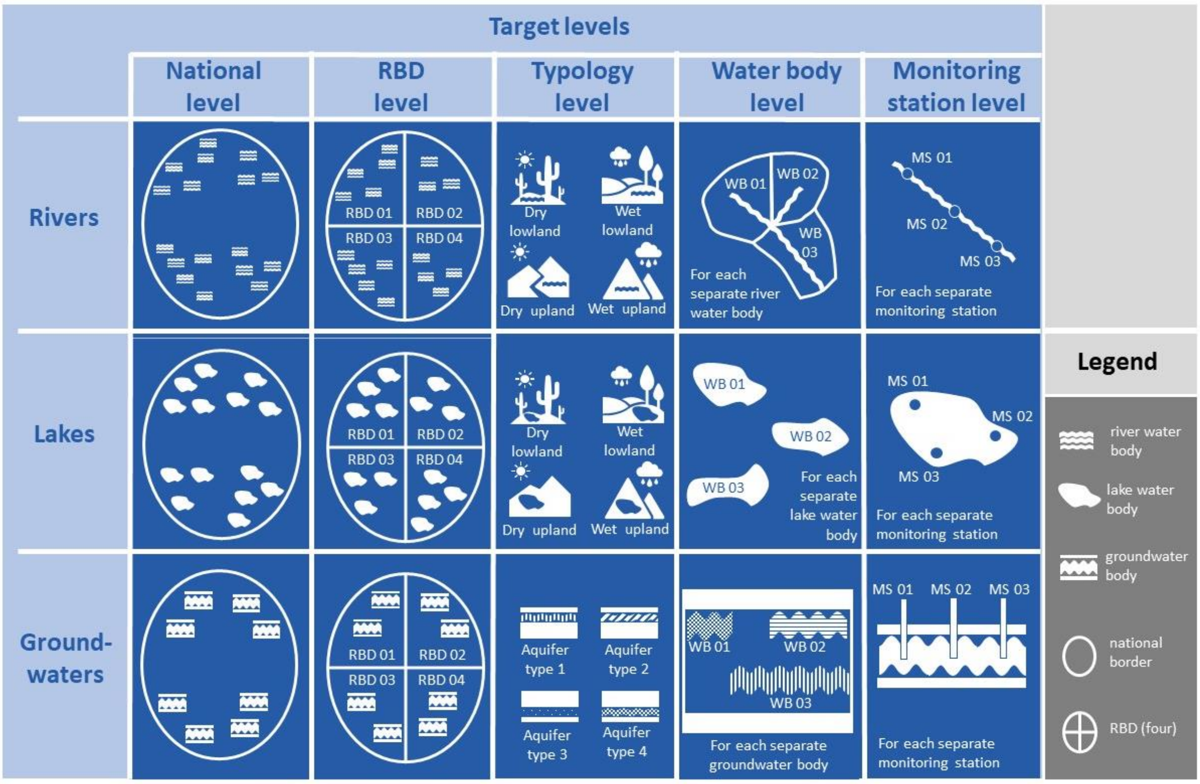


Figure 2: Example of different levels of specific target levels in water bodies s that can be applied to monitoring levels from the most generic at the national level to the most specific at the monitoring station level

The natural variation of water bodies means that local, more specific, target values are more effective at protecting water quality than broad national-level targets. Specific targets are more sensitive to local differences in water quality. For example, if underlying geology changes along a river course, this may be reflected in a rise

[2] A system of categorising water bodies based on characteristics such as catchment size, underlying geology, altitude, climate, and slope. The Framework for Freshwater Ecosystem Management (UN Environment, 2017), provides specific guidance to define typologies.

in electrical conductivity (EC) measurements as the river passes from upland to lowland. A high EC target value that is relevant for lowland sites may not be appropriate for upland sites. The best approach in this circumstance would be to set two separate target values that reflect the naturally different baseline EC values: a low one for upland water bodies and monitoring stations, and a higher one for lowland sites. A good example of this approach is shown in Table 2. This example from Australian and New Zealand Environment and Conservation Council is an extract from the water quality guidelines produced in 2000 (ANZECC/ARMCANZ, 2000). The two countries were divided into broad geographical regions and then further divided based on climatic zones and administrative areas. Within each defined area, a set of default guideline values were produced that can be used in place of specific local information. Table 2 shows the values defined for south-east Australia.

Table 2: Default water quality trigger values for South-East Australia for the five core parameter groups

Ecosystem type	TP (µg L^{-1})	TN (µg L^{-1})	DO (% saturation)		pH		EC (µS cm^{-1})	
			lower limit	upper limit	lower limit	upper limit	lower limit	upper limit
Upland river (>150 m)	20	250	90	110	6.5	7.5	30[a]	350[a]
Lowland river	50	500	85	110	6.5	8.0	125[b]	2200[b]
Lakes and reservoirs	10	350	80	110	7	8.5	20[c]	30[c]

[a] Conductivity in upland streams will vary depending upon catchment geology. Low values are found in Vic. Alpine regions (30 µS cm^{-1}) and eastern highlands (55 µS cm^{-1}), and high values (350 µS cm^{-1}) in NSW rivers. Tasmanian rivers are mid-range (90 µS cm^{-1}).

[b] Lowland rivers may have higher conductivity during low flow periods and if the system receives saline groundwater inputs. Low values are found in eastern highlands of Vic. (125 µS cm^{-1}) and higher values in western lowlands and northern plains of Vic (2200 µS cm^{-1}). NSW coastal rivers are typically in the range 200–300 µS cm-1.

[c] Conductivity in lakes and reservoirs is generally low but will vary depending upon catchment geology. Values provided are typical of Tasmanian lakes and reservoirs.

Source: ANZECC/ARMCANZ (2000).

The approach used the statistical distribution of reference data collected within each of the five geographical regions for slightly to moderately disturbed ecosystems for each of the parameters shown. The 80th and/or 20th percentiles of the reference data were used to define the values listed. Further details and a full discussion of the methods can be found at ANZECC/ARMCANZ (2000).

The natural trophic status of surface waters (Thomas *et al.*, 1996) is another important consideration when setting target values. Natural eutrophication is a process that takes centuries in lakes and is marked by the slow change in the productivity and associated increase in biomass and sediment. This should not be confused with artificial or cultural eutrophication induced by human activities. Very few of the world's lakes are free from anthropogenic inputs, and in the absence of pre-disturbance water quality data, the best approach is to use expert opinion on the natural trophic status of a lake. To demonstrate the range in target values that could be applied to surface waters of different trophic status, Table 3 lists the different ranges of total phosphorus associated with each trophic status in Canadian lakes and rivers (CCME, 2004).

Table 3: Example of classification of Canadian surface waters based on total phosphorus concentrations (CCME, 2004)

Trophic Status	Total phosphorus (µg P L^{-1})
Ultra-oligotrophic	< 4
Oligotrophic	4-10
Mesotrophic	10-20
Meso-eutrophic	20-35
Eutrophic	35-100
Hyper-eutrophic	> 100

Source (CCME, 2004)

Optional Target Values

This section was developed in response to requests from countries to provide more complete guidance for global target values for each of the core parameter groups. This section recognises that, although defining numerical values that reflect good water quality at the global level is possible, these values are unlikely to be the most appropriate and may fail to protect human and ecosystem health at national or local levels. Adopting a *"one size fits all"* approach fails to recognise the natural water quality variation described above, but the optional targets offered here can be used in the short-term, in the absence of national targets. They provide a benchmark against which national target values can be compared.

This section recommends target value *ranges* for each of the core parameter groups. These ranges are derived from several sources: the FFEM (UN Environment 2017), those used in other jurisdictions, and from scientific journal articles. Countries with target values in place are encouraged to compare their own with these ranges if they are in general agreement or to see how far they deviate. Countries that currently do not have targets in place, can adopt these values in the short-term until sufficient data are available to generate more relevant, and therefore more appropriate, targets.

The proximity of the targets reported by countries to these optional target values will provide a better picture of the different approaches taken by countries and how flexible their classification of water bodies was. It is expected that the majority of target values reported by countries will fall within, or be close to, these optional values, but it is also recognised that there will of course be exceptions. Countries may be asked to provide additional information on their target values choice during the post-data drive assessment period in 2021, in order to provide greater insight into the approaches taken.

Table 4: Optional target values for the different water body types

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

Source: derived from multiple sources (Figures 3 to 9), refer to Annex 1 for full details

Oxygen Status

During the 2017 data drive, **oxygen status** was most commonly measured and reported using dissolved oxygen. High dissolved oxygen (DO) concentrations are essential for the good health of aquatic ecosystems in order to support the respiration of all aerobic biota. Biochemical and chemical oxygen demand (BOD and COD respectively) are suggested as alternatives within this parameter group, but they are more useful for classification of waters that receive effluents. Ideally, DO is measured *in situ* using an oxygen sensor, but methods are available where the oxygen in the water sample is chemically fixed for analysis in the laboratory (Ballance, 1996).

Levels of DO fluctuate naturally with temperature, salinity and with biological activity. Turbulence at the surface of a river, at riffles, or at waterfalls can increase oxygen concentrations. Photosynthetic activity of aquatic flora and respiration by aquatic organisms can also affect concentrations diurnally and seasonally. Even a short-term drop in DO can affect the functioning and survival of aquatic communities. For example, a drop below 2 mg L^{-1}, may lead to the death of most fish (Chapman and Kimstach, 1996).

Targets for DO are rarely listed for human use or consumption, although consumers may report taste and odour problems in water supplies with low concentrations. In contrast, DO is universally included as a measure of water quality for ecosystem health due to its impact on many biological and chemical processes. Setting per cent saturation targets can be more meaningful than concentrations (mg L^{-1}) because of the influence of salinity, temperature and atmospheric pressure on the measured concentration.

Understanding the major influence that temperature has on the saturation of oxygen in freshwaters is critical when setting DO targets. The impact of temperature on oxygen saturation is shown is Table 5. The measured DO concentration of 6.8 mg L^{-1} in water at 25 °C equates to 82.4 per cent saturation, whereas in colder water of 10 °C, this same concentration would equate to a saturation of 60.3 per cent. In water of 10 °C, the measured DO concentration would have to be 9.3 mg L^{-1} to exceed 80 per cent saturation. The per cent saturation indicates the oxygen available to biota rather than the concentration.

Table 5: The influence of temperature on the saturation of oxygen in freshwaters

Measured DO concentration (mg L^{-1})*	Water temp (^{o}C)	Per cent saturation (%)
6.8	25	82.4
6.8	10	60.3
9.3	10	82.5

* calculated using a barometric pressure of 760 mm Hg, and electrical conductivity of 500 µS cm^{-1}

Source: https://water.usgs.gov/software/DOTABLES/)

Figure 3 shows various DO target values, in mg L^{-1}, from countries in different world regions. It also summarises the values reported during the 2017 data drive shown as a median of the lower target values reported. Note that Canada applies a target of 6 mg L^{-1} for warm waters and a target of 9.5 mg L^{-1} for cold waters (definition of warm and cold not provided).

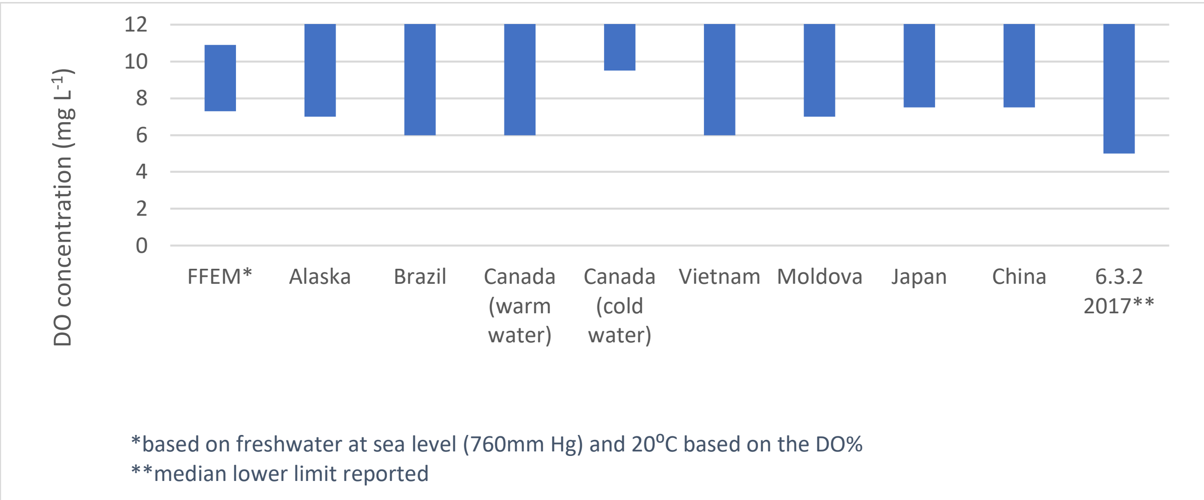


Figure 3: Examples of dissolved oxygen concentration targets used in several countries and a summary of those reported during the 2017 data drive (Source: data from multiple sources, refer to Annex 1)

Figure 4 shows various examples of percentage saturation targets used in various jurisdictions and a summary of those used during the 2017 data drive. The figure also shows the optional target range of **80 to 120 per cent saturation**. This target range aligns with the FFEM (UN Environment, 2017).

Optional target range for dissolved oxygen is between 80 and 120 per cent saturation

The suggested DO target range of 80 and 120 per cent saturation may be too broad to protect pristine waters. More stringent target ranges may be applicable based on the review of historical data, or as data are gathered over time.

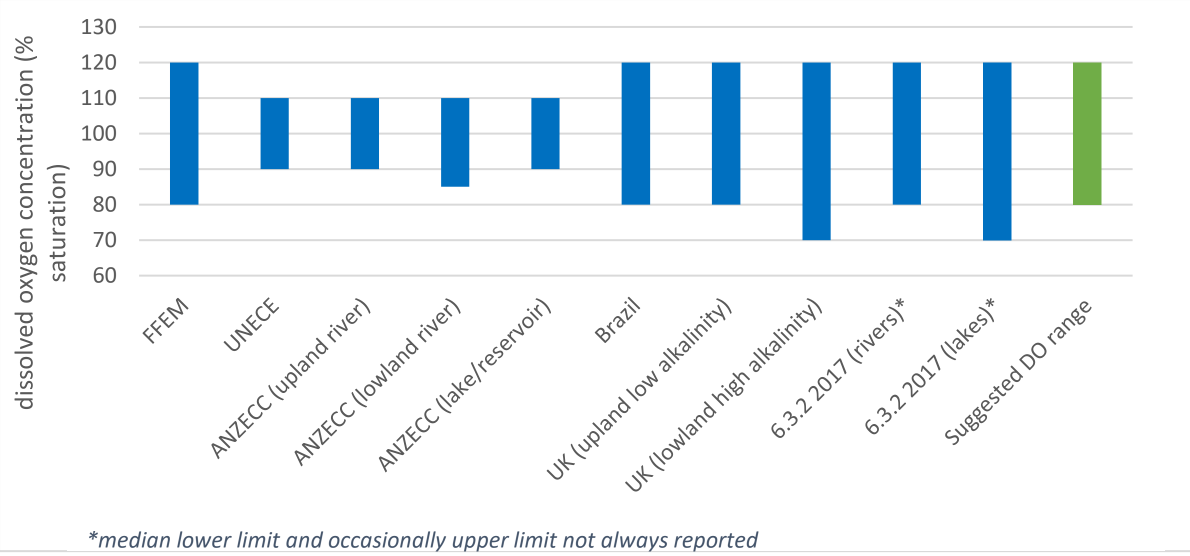


Figure 4: Examples of percentage saturation targets for oxygen used in several countries, a summary of those reported during the 2017 data drive, and a suggested range (Source: data from multiple sources, refer to Annex 1)

Salinity

The most common parameter reported for the salinity parameter group in 2017 was electrical conductivity (EC). Electrical conductivity data help to characterise a water body, and long-term data provide information on whether salinisation is an issue. Salinisation is particularly relevant for groundwater bodies in coastal zones where over-abstraction can lead to saltwater intrusion. Additionally, EC can serve as a proxy for effluent discharges that contain ionic compounds, as well as other anthropogenic inputs from agricultural sources.

Naturally, freshwater EC concentrations can vary between 10 and 1000 µS cm^{-1} (Chapman and Kimstach, 1996), but there are exceptions. The lithology of the catchment's underlying bedrock and the proximity to the coast are the primary determinants of EC. Bedrock which is more prone to weathering will lead to greater dissolution of minerals in the rocks, leading to higher EC concentrations. Similarly, coastal catchments can have higher EC concentrations because they are exposed to greater atmospheric salt deposition.

There are very few examples of EC concentrations in national environmental quality standards for ambient waters. This is explained by the large natural range of EC concentrations where high or low values simply reflect the natural catchment characteristics. This is unrelated to whether a water body is impacted or not. For this reason, setting a national target value for EC is discouraged and instead countries are urged to set more specific targets and to take a deviation from this reference condition as a target failure. This approach has been used in South Africa where targets are defined as *15 per cent deviation from the unimpacted* condition (DWAF, 1996). A more recent, detailed case study is available on the Indicator 6.3.2 Support Platform.

During the 2017 data drive, the EC target values reported varied markedly, and some countries chose to report total dissolved solids (TDS) rather than EC. These two parameters are related, and a correlation between the two can be derived by multiplying EC by a value of between 0.55 and 0.75, but this factor is specific to each water body (Chapman and Kimstach, 1996).

An optional target value of **500 µS cm^{-1}** is proposed in the absence of more specific information to guide targets. This value is lower than the majority of those reported during the 2017 data drive (median target for surface water RBDs was 800 µS cm^{-1}) but, in the absence of better information on the water body reference conditions, it can be used as an interim target value. This target value agrees with that suggested by Carr and Rickwood (2008) and Srebotak *et al*. (2012) and also aligns with the global EC mean of approximately 220 µS cm^{-1} (converted from total dissolved solids concentration) reported for rivers globally (Weber-Scannell and Duffy, 2007). However, it is not suitable for water bodies for which the natural EC concentrations are much higher or lower, but in the absence of historical or reference information this value serves as an appropriate interim target.

In the absence of sufficient data, a target of below 500 µS cm^{-1} for electrical conductivity is suggested.

It is preferable and recommended that more specific targets are defined using a range between the 10th and 90th percentiles from a reference monitoring period or location.

NITROGEN

Nitrogen is an essential nutrient for aquatic life, but inputs from anthropogenic sources above natural levels can have detrimental impacts on freshwater ecosystems. Certain forms of nitrogen can also have direct toxic effects on species, such as very low concentrations of unionised ammonia on freshwater fish (Ip *et al*., 2001)

To fulfil the reporting requirements of the nitrogen parameter group, countries can choose to report any form of nitrogen that exist in freshwaters such as inorganic, organic, particulate or dissolved forms. All these forms can be monitored individually, or alternatively reported as total nitrogen (TN) or other combination forms such as Kjeldahl Nitrogen (TN minus nitrate and nitrite).

Inorganic nitrogen exists in a range of oxidation states that include nitrate, nitrite, ammonia and molecular nitrogen, and undergo numerous biological and non-biological conversions as part of the nitrogen cycle. The form of nitrogen chosen for monitoring depends on the objectives of the monitoring programme, but Total Oxidised Nitrogen (TON) is recommended in the methodology because it is more straightforward to measure analytically than other forms, including nitrate (NO_3) alone. In most instances, the nitrite (NO_2) fraction of TON in surface waters comprises less than one per cent of the total so, for practical purposes, TON and nitrate are the same. There are kits available for *in situ* monitoring of TON, but analysis of samples under laboratory conditions provides improved accuracy and precision.

TN is monitored by many jurisdictions and is often included in ambient water quality guidelines because it gives the total concentration of all forms of nitrogen in a sample. This provides information on the overall nitrogen budget of aquatic systems. The drawback is that TN is more challenging to measure analytically than dissolved inorganic forms.

Optional target value for TN is **700** µg N L^{-1} for rivers and **500** µg N L^{-1} for lakes. For TON it is **250** µg N L^{-1} for rivers and lakes

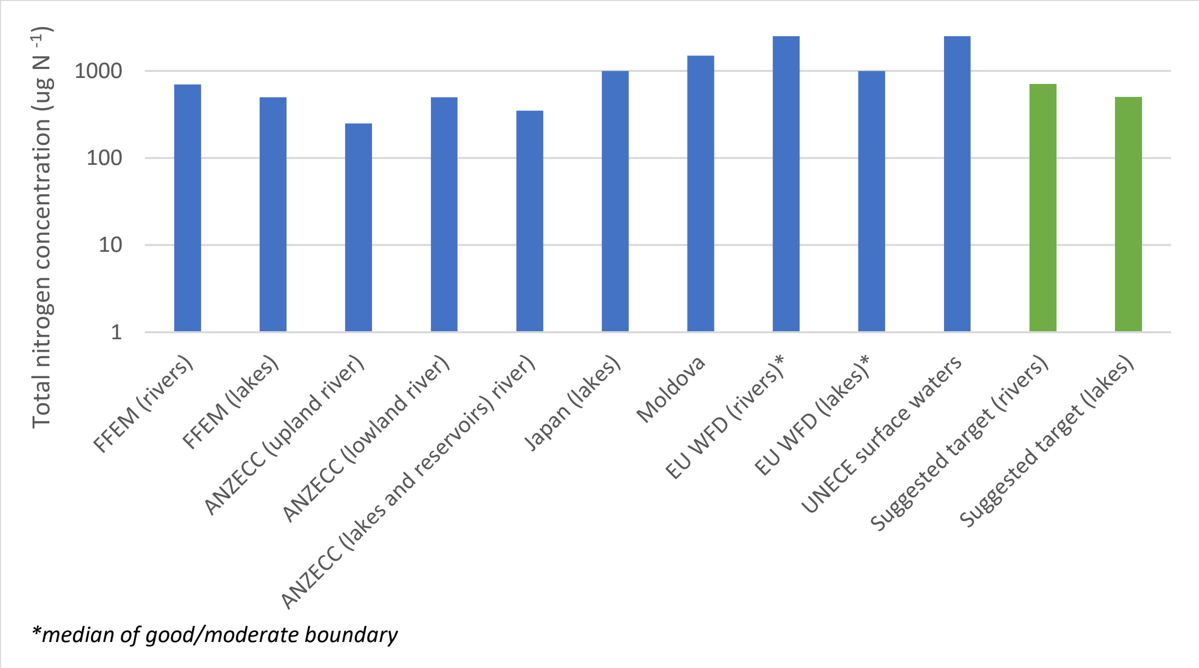


Figure *5* and Figure 6 below show the various TN and oxidised nitrogen concentrations that are used in selected countries.

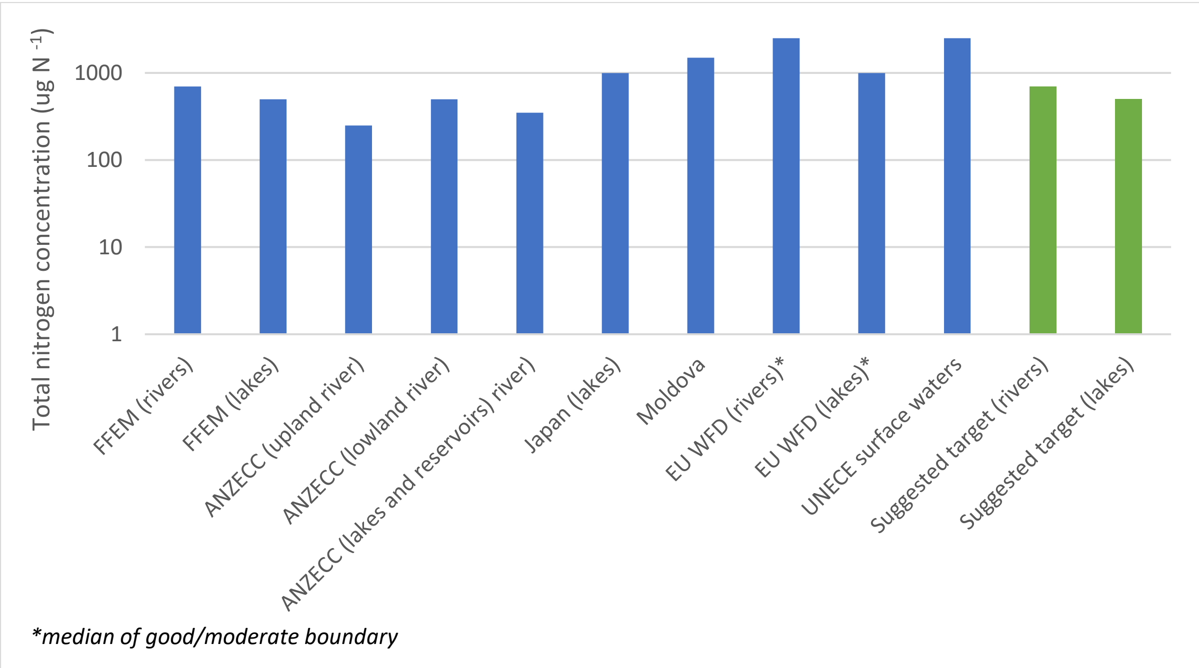


Figure 5: Examples of total nitrogen concentration targets used in countries (Source: data from multiple sources, refer to Annex 1)

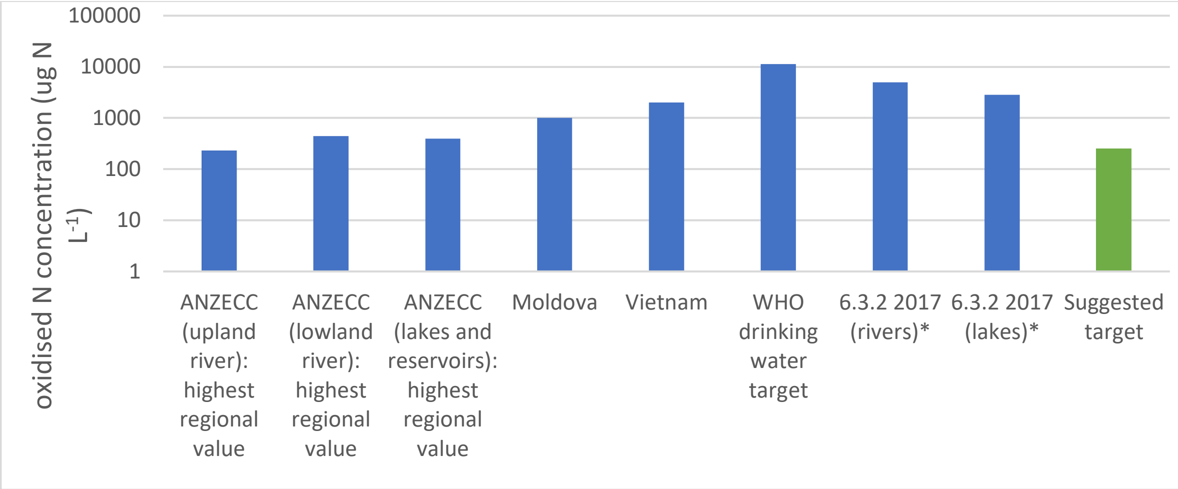


Figure 6: Examples of oxidised nitrogen concentration targets used in countries and a summary of those reported during the 2017 data drive (Source: data from multiple sources, refer to Annex 1)

Phosphorus

Phosphorus is an essential nutrient for all biota. In aquatic systems it occurs in several forms: dissolved inorganic forms such as orthophosphate ions (PO_4^{3-}); bound to particulate matter; bound to organic particulates; or in dissolved organic forms. The form which is most readily available to aquatic plants for direct use is the inorganic dissolved form.

In most freshwater ecosystems that are in a natural or near natural condition, phosphorus is often the limiting nutrient for primary productivity. In these systems, only small increases in phosphorus concentration can lead to dramatic increases in algal growth, whereas similar increases in nitrogen concentration alone may fail to have a similar effect.

For indicator data collection, orthophosphate (OP) is the most straightforward form of phosphorus to measure. There are several types of field test kit available, but the greatest accuracy and limits of detection are achieved in the laboratory. The concentrations of phosphorus in a sample can change over time if the sample is not fixed, and therefore to avoid changes in the forms of phosphorus, it is suggested that samples are analysed within 24 hours.

Many jurisdictions already include total phosphorus (TP) in their monitoring programmes. Total Phosphorus includes all forms of phosphorus that are present in a sample. It is measured by converting them in a chemical digestion under high pressure and temperature to inorganic forms which are then subsequently measured. The total amount of phosphorus contained in a sample can indicate the potential for long-term impacts from phosphorus bound to particulate matter that may settle as sediment, and then serve as a phosphorus source if remobilised in the future.

The optional targets for TP shown here in Figure 7 draw from the work of the FFEM (UN Environment, 2017).

> Optional target value for TP is **20** µg P L^{-1} for rivers and **10** µg P L^{-1} for lakes. For orthophosphate it is **10** µg P L^{-1} for rivers and **5** µg P L^{-1} for lakes

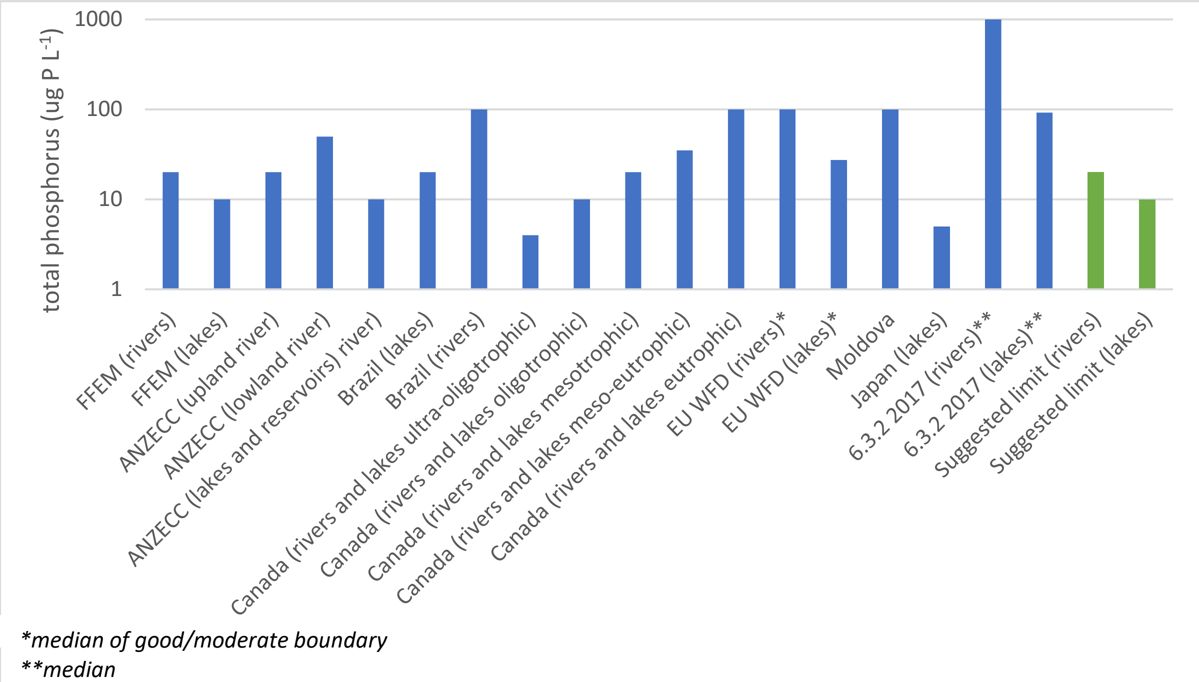


Figure 7: Examples of phosphorus concentration targets used in countries and a summary of those reported during the 2017 data drive (Source: data from multiple sources, refer to Annex 1)

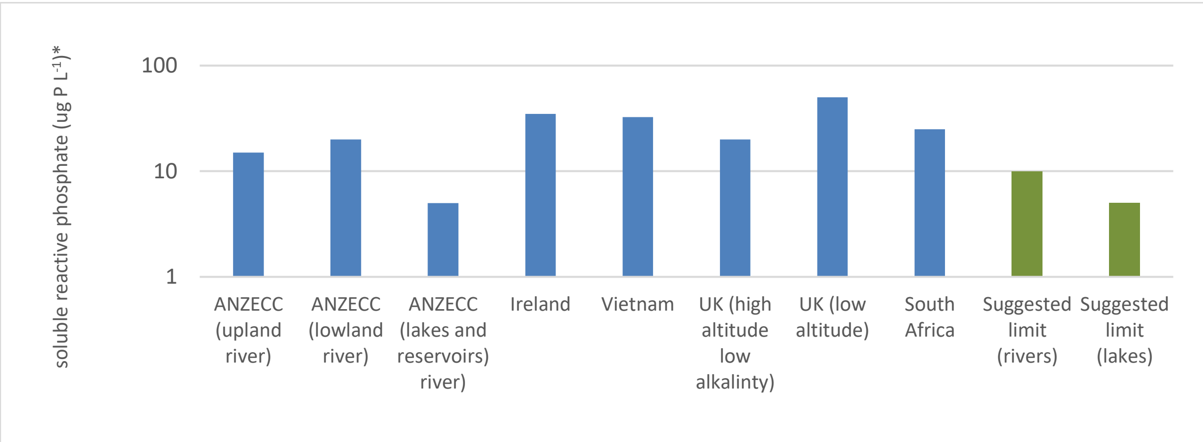


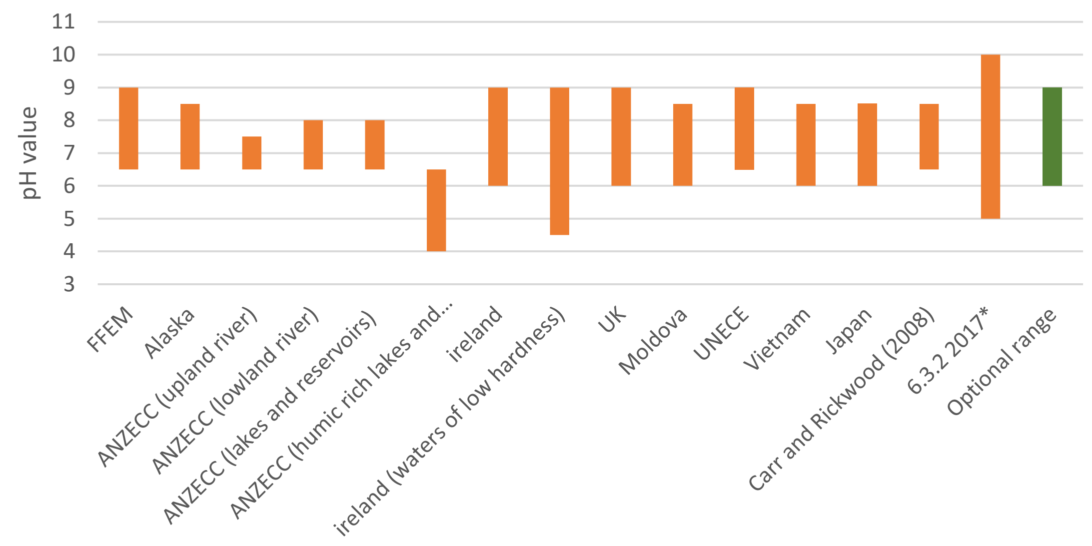
Figure 8: Examples of soluble reactive phosphate concentration targets used in countries (Source: data from multiple sources, refer to Annex 1)

ACIDIFICATION

The **acidification** parameter group is most commonly reported using the parameter pH. pH is one of the most widely measured ambient water quality 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. Measuring pH is useful to help characterise the water body and provides information over time on whether a water body is subject to acidification. Atmospheric deposition of sulphur and nitrogen-containing compounds can lead to the acidification of surface waters. This is a concern in areas where fossil fuel combustion by industrial and domestic sources is high. Point sources of pollution, such as industrial effluents or acid mine drainage, can also lead to detectable acidification of freshwaters. Acidification can be of greatest concern in water bodies in areas where there is a low buffering capacity, for example in areas where water is naturally of low hardness and alkalinity.

The majority of freshwaters are naturally near neutral (pH 7) but they can naturally be acidic downstream of peat bogs or other wetlands, or slightly alkaline if the underlying geology is calcareous. The pH of a flowing water body can vary dramatically over very short time periods in response to changing hydrological conditions. The degree to which pH may vary for a particular water body can be better understood from the analysis of long-term datasets that include data collected during high and low flow conditions. This will help to define what is "normal" for a water body.

Figure 9 summarises target pH ranges used in various jurisdictions designed for the protection of ecosystems and aquatic life. Also shown are the pH range suggested in the FFEM (UN Environment, 2017), a summary of the values reported during the 2017 data drive, and the optional range of **pH 6.0 to pH 9.0** that countries could adopt for the 2020 data drive.



**the 6.3.2 2017 values include the maximum and minimum of all values reported*

Figure 9: Examples of targets for pH. Each column represents the upper and lower targets for each jurisdiction/framework (Source: data from multiple sources, refer to Annex 1)

The suggested pH range of pH **6.0 to 9.0** may be either too broad, or too stringent, to be applied nationally and it may be justified to adapt it to local circumstances. Where water quality may routinely fall below this level (for example, where waters are known to be of low hardness and therefore of a low buffering capacity), measurable changes in occur in response to rainfall that is naturally acidic. In Ireland, for example, a lower limit of pH 4.5 is applied to water bodies that naturally experience low pH values (Minister for the Environment, 2009).

> Optional target range for pH is between **6.0 and 9.0**

Comparison of Individual measurements, means, medians or percentiles?

The SDG indicator 6.3.2 methodology suggests that each single measured value is compared with its respective target. Other approaches include comparing the annual mean, maximum, median or high percentiles (90-95th percentiles) against a target. This should be kept in mind when considering SDG indicator 6.3.2 target values and water quality standards used in different jurisdictions. For example, the soluble reactive phosphorus target concentration for a river to be classified as "good status" listed in Figure 8 of 35 µg P L^{-1}, is to be applied to mean data collected over a 12-month period (Minister of the Environment, 2009). Comparison with means and percentiles is useful if there are sufficient data available, but in many parts of the world this is not the case. By comparing each individual value to its target, the methodology can still be applied with very few data records.

The value-by-value approach is designed to be an inclusive model and ensures that countries with scarce resources allocated to collect monitoring data are not discouraged from reporting. It also identifies where national environmental monitoring needs to be strengthened and serves as a tool to identify where capacity development resources would be of benefit. Minimum data requirements are stipulated in the methodology (four measurements per year for surface waters and one for groundwaters over a three-year period), but countries are encouraged to collect data more frequently where resources allow. Classifications of water body status that are made using less than the minimum data required are assigned a lower “confidence rating” in the analysis of the submissions received by UNEP to ensure it is clear where classifications have been made using few data records.

Countries that collect data more frequently than the minimum required may choose to adopt one of the other methods of classification, but in order to maintain global comparability they are encouraged to use the value-by-value approach. Countries that have extensive data records can, and a thorough understanding

SUMMARY

Target values are central to the SDG indicator methodology, which provide a straightforward method of water body classification. One limitation of the approach is that the classification assigned is very sensitive to the choice of target value used. The indicator score reported could be either more positive or negative than the reality. As knowledge is collected over time, the targets can be refined and applied retrospectively to historical data to ensure that the most current information is used to classify water bodies and to calculate the indicator score.

The optional target values suggested here provide a starting point for countries looking to develop new targets and a benchmark against which to compare existing targets. They draw from global examples and published scientific literature, but their value in each national context can only be defined by each country.

The targets used for indicator reporting are recorded by UNEP. Countries are asked to submit this information along with the indicator score. This allows UNEP to keep track of the different approaches used by countries and to assess their comparability.

Efforts to set more specific target values will lead, in time, to a more robust classification of water bodies and, subsequently, to more efficient allocation of resources to improve water quality. It will provide clearer and more reliable understanding of which water bodies are under threat.

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Annexes

Annex 1: Table of Source Documents and References Used in Figures 3 to 9

Country / Document	Figure							Reference
	3	4	5	6	7	8	9	
Alaska	•	•						Department of Environmental Conservation (2016)
Australia / New Zealand	•		•	•	•	•	•	ANZECC/ARMCANZ (2000)
Brazil	•	•	•			•		Brazil Resolution CONAMA 357 (2005)
Canada						•		CCME (2004)
China		•						MEPPRC (2002)
EU WFD				•		•		Poikane *et al*. (2019)
Ireland	•						•	Minister for the Environment (2009)
Japan	•	•		•		•		MoEJ (1997)
Moldova	•	•		•	•	•		OECD (2007)
FFEM	•	•	•	•		•		UN Environment (2017)
South Africa							•	DWAF (1996)
UNECE	•		•	•				UNECE (1994)
United Kingdom	•		•				•	UK TAG WFD (2008)
Vietnam	•	•			•		•	MONRE (2015)
World Health Organisation					•			WHO (2017)

Annex 2: Example of using data from Reference Period or Location

Below is a worked example showing how data from a reference period or location can be used to classify a monitoring station. Unimpacted monitoring locations, which are relatively free from pressures on water quality such as, agriculture, wastewater effluent or mining, can represent the "background" or "reference" water quality.

Figure 10 below shows an example of how data collected from a reference period or from a reference location can be used to help define target values. In this example, the reference data were used to calculate median, 10th and 90th percentile values. The 10th and 90th percentiles define the lower and upper ends of the target range respectively and represent the "reference conditions" for electrical conductivity (EC) concentration. Any measurement that deviates outside this range would fail to meet this target. In this example, the 10th percentile is 410 µS cm^{-1} and the 90th is 542.5 µS cm^{-1}. These values, as shown in Figure 10, are plotted as horizontal lines for both the reference and classification periods.

The reference period could be either a period of time when the water body being considered was known to be free from human influence or, alternatively, from a different water body that is comparable in terms of geology, location and climate, and that is also known to be free from significant human influence.

The indicator methodology prescribes that 80 per cent or more of measured values should meet the target for a water body to be classified as "good". If the EC values in this example are unchanged over time, and there is no drift in the measured values, then the water body will consistently be classified as "good" because 80 per cent of the data statistically will fall within the 10th and 90th percentiles.

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** is recommended, but a more statistically robust target would be generated by using a greater number of data values. In this example, monthly measurements over a four-year period were used (48 measurements).

In this example, the classification data represent monitoring over 12 years, which equates to four discrete three-year SDG 6 indicator reporting cycles. Over this 12-year period the data show a gradual rise in EC concentrations, which then fall again. Applying the indicator classification method to these EC data alone would result in a "good classification for the first three-year period, followed by two "not good" classification periods, and a final "good" classification (Figure 10). This return to a "good" classification may have been due to management action to reverse the upward trend. In a real-world situation, there are of course many factors that contribute to such a trend, but this simple example shows how the reference data may be used to define meaningful, specific targets.

Some detailed examples of the derivation of national targets and guidelines have been published (e.g. ANZECC and ARMCANZ, 2000) have been collated in the Indicator 6.3.2 Support Platform.

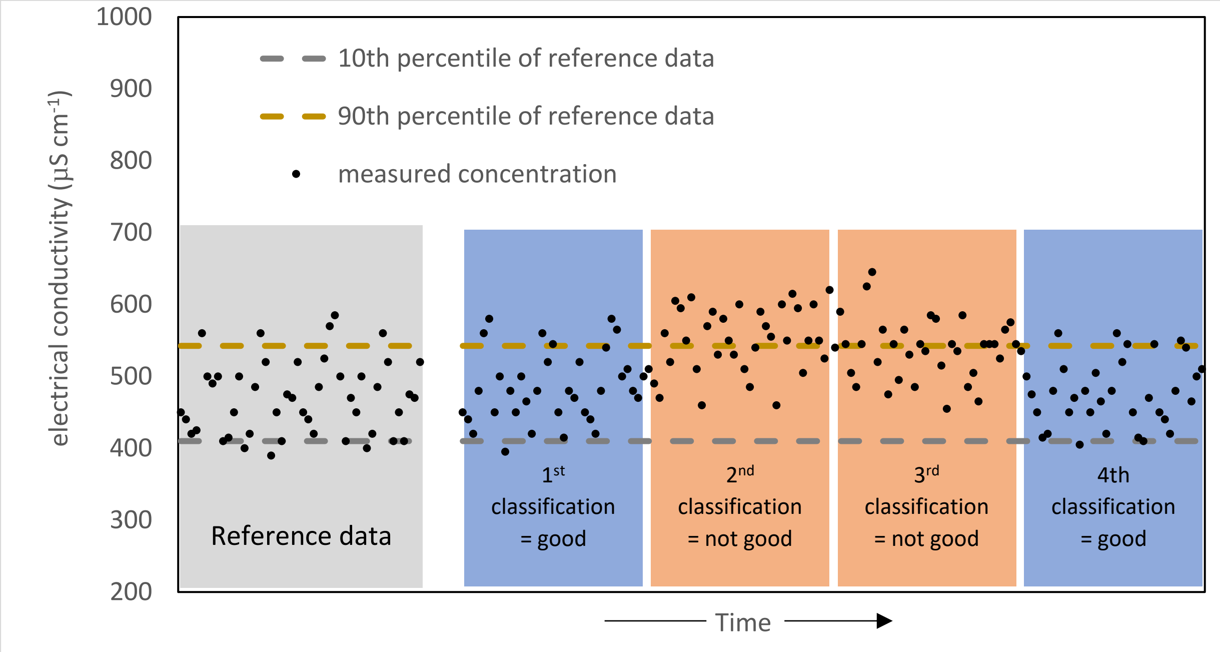

Figure 10: Example of how data from a reference period or site can be used to define upper and lower target ranges for the classification of water quality