Reliable measurement of water quality for human health

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Key messages

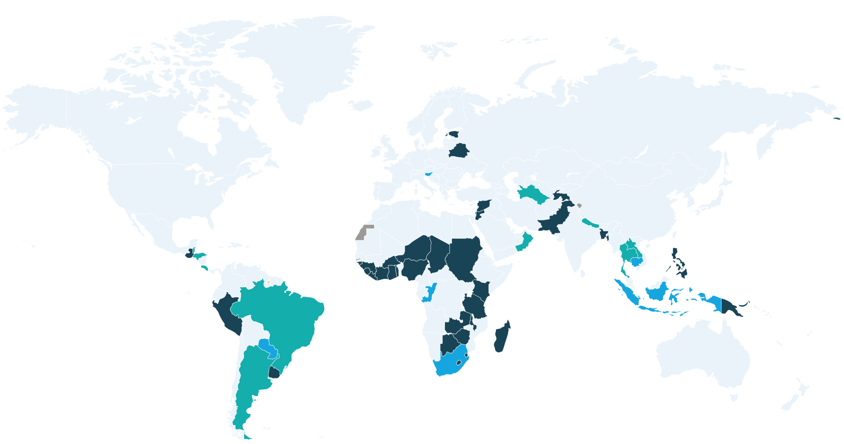
- Water quality is measured by such factors as bacteria levels and the concentration of dissolved oxygen.
- It is important to invest in national metrology systems to ensure that measurements are accurate and traceable to national and international standards, and to provide quality water to people everywhere.
- Good quality water is indispensable for all life forms.
- Metrology can support water quality measurement to ensure that all measurements performed are accurate and reliable.

What's the issue?

Without access to clean water, humanity cannot thrive. Water is indispensable for all life forms; central to every ecosystem on Earth. The United Nations identified the need for "Clean Water and Sanitation" as Goal 6 of the Sustainable Development Goals.[1] Within that goal, the UN identified eight specific targets. Achieving the first four of these relies on reliable and accurate measurement of water quality and quantity, such as indicator 6.1.1 which focuses on safely managed drinking water services. Unfortunately, according to the 2022 Sustainable Development Report, achieving those indicators remains a major challenge in many countries in the Asia-Pacific region.[2]

For example, China, India, Indonesia, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand, and Vietnam share a common issue – too little of their anthropogenic wastewater is treated for reuse. In addition, a number of countries such as India, Sri Lanka, and Pakistan still lack clean water for basic consumption. The 2022 Global Analysis and Assessment of Sanitation and Drinking-Water from UN-Water states that "while 45 % of countries are on track to achieve their national drinking-water coverage (SDG) targets, only 25% of countries are on track to achieve their national sanitation coverage targets" (Figure 1).[3]

Figure 1: Status of progress needed to reach national sanitation coverage targets (from GLAAS Report, page 19)



No Data
Not Applicable

On track (n=16)
Argentina, Belize, Brazil, Cabo Verde, Costa Rica, Dominican Republic, Honduras, Jarnaica, Lao People's Democratic Republic, Lesotho, Montenegro, Nepal, Oman, Seychelles, Thailand, Turkmenistan.

Almost on track (n=8)
Bahrain, Cambodia, Congo, El Salvador, Hungary, Indonesia, Paraguay, South Africa.

Acceleration needed (n=40)
Albania, Bangladesh, Belarus, Bhutan, Bosnia & Herzegovina, Boswana, Burkina Faso, Burundi, Chad, Côte d'lvoire, Cuba, Ethiopia, Georgia, Ghana, Guinea, Jordan, Lebanon, Liberia, Madagascar, Malawi, Maldives, Mauritania, Mauritius, Niger, Nigeria, Pakistan, Papua New Guinea, Peru, Philippines, Sao Thome & Principe, Sierra Leone, Sudan, Syrian Arab Republic, Tajikistan, Togo, United Republic of Tanzania, Uruguay, Zambia, Zimbabwe.

Why is this important?

Although 70 % of the Earth surface is covered in water, just 3 % of it is freshwater suitable for consumption. As such, water is regarded as non-renewable resource. Water contamination that poses physical health risks to human beings is therefore a challenge relevant to us all. To thrive, humanity needs 'quality water' – this term refers to the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose.

Water quality is measured by such factors as the concentration of dissolved oxygen, bacteria levels, the amount of salt (or salinity), or the amount of material suspended in the water (turbidity).

In some water regulations, the concentration of microscopic algae and quantities of pesticides, herbicides, heavy metals, and other contaminants may also be measured and included in descriptions of water quality. The World Health Organization has previously described 'adequate safeguards' or 'good practice' in guidelines for water standards, as seen in Figure 2.[4]

According to the 2022 UN World Water Development Report, groundwater pollution is a huge challenge to the ecosystems that serve to sustain human life, and there are many anthropogenic sources of groundwater pollution.[5] Once polluted, it is virtually impossible to restore groundwater to its original state. For example, unchecked agricultural pollution from pesticide use deposits large quantities of nitrate, pesticides and other agrochemicals residues into the water system, where they remain for years. In addition, groundwater and surface water surfaces are at an ever-increasing risk of saltwater intrusion thanks to effects of climate change; namely, rising sea levels, changing water demands and droughts. [6]

Figure 2: Indicators and good practice requirements for water standard by guideline area (WHO report, page 4)

Guideline area	Indicators	Good practice requirements
Drinking-water quality	Value stipulated for faecal coliforms, with recommendations in turbidity, pH and disinfection (chlorination)	- Groundwater source protection - Treatment proportional to (surface) water quality - Sanitary inspection as part of surveillance and control
Safe use of wastewater and excreta in agriculture and aquaculture	- Faecal coliforms (unrestricted irrigation) - Intestinal helminth counts (restricted and unrestricted irrigation) - Trematode egg counts (aquaculture)	Involvement of adequate treatment chains
Safe recreational water environments	Numerical values for indicators (faecal streptococci/ enterococci) related to defined levels of risk	'Annapolis Protocol' proposes a series of interventions

The role of metrology

Water quality parameters can be measured by several methods using lab-based analytical instruments. All of these instruments are supported by metrology – the science of measurement – which acts as a common, globally-recognized language for science and technology. It enables measurements to be benchmarked internationally.

Metrology institutes provide calibration services for instruments, as well as chemical measurement standards known as Certified Reference Materials (CRMs) for testing laboratories. Metrology institutes also support testing laboratories – including those focused on water testing – by providing Proficiency Testing (PT) programs that act as external quality assurance. Measurement of water pollutants can be conducted in physical, inorganic, and organic laboratories, which require advanced measurement tools and technologies.

These laboratories need quality assurance to ensure reliability of the test results, such as ISO/IEC 17025 and CRMs for calibration of measuring equipment.

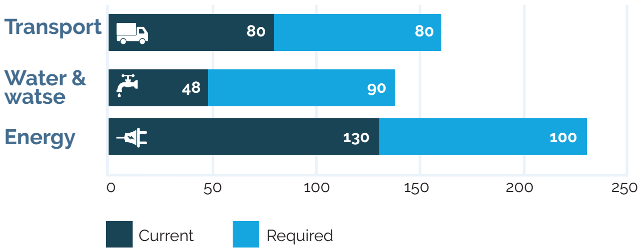
In this way, metrology supports water quality analysis, and ensures that all measurements performed are accurate and reliable. Ultimately, this determines whether water is safe to drink or not, which has widespread implications for human health, the environment, and industrial activities.

What should policy makers do?

A report commissioned by the European Investment Bank in May 2022 suggests that, at a regional level, improvements in water quality and/or the potential to recover additional resources and materials from wastewater will provide new opportunities.[7]

The same report suggests that by 2030, investments in wastewater treatment in the European Union will need to increase considerably if such systems are to remain fit-for-purpose. The OECD estimates a total additional spend of €289 billion is needed "…for the 28 Member States to comply with the Urban Wastewater Treatment Directive and the drinking water directive." (Figure 3).

Figure 3: Annual investment needs for sustainable development in the European Union, in € billions (Wastewater as a Resource Report, page 23)



At a national level, it is critically important that testing laboratories can continue to provide accurate and reliable measurements of the standardised water quality metrics used in the management of water quality.
The provision of such services relies on support from policymakers, who can ensure that national metrology systems receive sufficient investment to operate. This includes the national metrology institute, a source for certified reference material development, a proficiency testing program, and inter-laboratory comparison exercises.

A good metrology system will benefit the measurement of water quality, and ultimately help to ensure that a country's water and sanitation systems are fit-for-purpose. By supporting the development and maintenance of a national metrology system, policymakers can ensure that quality water is provided to everyone who needs it, and ultimately, save lives.

Local example: Thailand

NMIT, the National Institute of Metrology (Thailand) was established in 1998 as a metrological centre for Thailand. NIMT provides calibration services for measurement instruments for a range of sectors across the country, as well acting as a source of CRM and PT for testing laboratories.

Many testing laboratories – including those working in water analysis (approximately 100 ISO/IEC 17025 accredited laboratories) – used to import CRMs. In Thailand, this typically cost over 3 million USD (100 million Baht) annually.

In addition to this, laboratories are expected to participate in a Proficiency Testing program as part of quality assurance schemes. Before the establishment of NIMT, this was often done by overseas providers.

By creating a dedicated home for metrology in Thailand, NIMT is estimated to have saved the economy up to 50 million USD (1,500,000 Baht) each year.

References

1 UN Sustainable Development Goal 6: *Ensure availability and sustainable management of water and sanitation for all* https://sdgs.un.org/goals/goal6

2 2022 Sustainable Development Report member rankings https://dashboards.sdgindex.org/rankings

3 UN Water, *2022 Global Analysis and Assessment of Sanitation and Drinking-Water* https://www.unwater.org/sites/default/files/2022-12/GLAAS_2022_REPORT.pdf

4 World Health Organization, *Water quality: guidelines, standards and health: assessment of risk and risk management for water-related infectious diseases*, edited by Lorna Fewtrell and Jamie Bartram https://apps.who.int/iris/handle/10665/42442

5 UN Water, *2022 World Water Development Report* https://www.unwater.org/publications/un-world-water-development-report-2022

6 EPA, *Climate Adaptation and Saltwater Intrusion* https://www.epa.gov/arc-x/climate-adaptation-and-saltwater-intrusion

7 European Investment Bank, Wastewater as a resource (May 2022) https://www.eib.org/attachments/publications/wastewater_as_a_resource_en.pdf