

### 3.17 Metal concentration or load

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Water Quality: Metal concentration or load	Water Management
<p><b>Description and justification</b></p>	<p>Metals and metalloids (herein referred to simply as metals) are ubiquitous in the natural environment and can potentially accumulate to toxic levels for the aquatic environment and humans as metals do not degrade with time. As such, metals can have a significant impact on water quality and its fit-for-purpose use. Natural sources of metals include weathering of geologic materials (rocks and soil) and volcanic activity. The primary reservoir of metals is geological substrate. Human activity has greatly accelerated natural biogeochemical cycles, resulting in anthropogenic emissions of metals to the atmosphere one to three orders of magnitude greater than natural fluxes. Anthropogenic sources of metals include point sources such as mining and industrial activities, and non-point sources such as fossil fuel combustion and agricultural activities. Stormwater may transport heavy metals from industries, municipalities and urban areas at different quantities, which are accumulated in soil, sediments and water bodies. Removal can be achieved by appropriately designed NBS.</p> <p>Some of the more common metal pollutants are: aluminium (Al), arsenic (As), barium (Ba), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), molybdenum (Mo), nickel (Ni), lead (Pb) and mercury (Hg), selenium (Se), vanadium (V) and zinc (Zn).</p>
<p><b>Definition</b></p>	<p>Metal pollutants in surface water and/or groundwater (% expressed as total annual metal pollutant load and/or reduction of maximum annual concentration).</p> <p><math display="block">\frac{\text{Concentration of heavy metals before NBS treatment} - \text{Concentration of heavy metals after NBS treatment}}{\text{Concentration of heavy metals before NBS treatment}} \times 100</math></p>
<p><b>Strengths and weaknesses</b></p>	<p>+ ICP analyses are highly precise and accurate to very low concentrations</p>

	<ul style="list-style-type: none"> <li>- ICP analyses can be quite costly and with the high number of metals (Cd, Cr, Pb, Hg, Ni, Zn, Cu...) some of which could be at very low concentration levels, this can add to the expense.</li> <li>- There is usually a significant delay between the time of sample collection and receipt of water quality data from the laboratory</li> <li>+ Test kits and ion selective electrodes (ISEs) can provide rapid results</li> <li>+ ISEs can be installed in-situ to take measurements at regular intervals</li> <li>- A separate kit or ISE is required for each element of interest, and the limit of detection for a given element of interest may be substantially higher than the respective accredited laboratory analysis technique</li> <li>- Analysis of individual metals using field test kits can be time-intensive and/or require trained personnel to conduct the tests</li> </ul>
<p><b>Measurement procedure and tool</b></p>	<p>Metals in water samples are typically quantified in an accredited laboratory using a suite of standardised analyses. Ion-coupled plasma spectrophotometry (ICP) coupled with atomic emission spectrometry (MS), with or without pre-treatment/pre-concentration, is a well-recognised analytical method for the quantification of trace metals in waters. Multiple elements can be analysed from a single sample. Methods may vary depending on the water matrix and metals to be analysed, but generally the method comprises the following steps:</p> <ul style="list-style-type: none"> <li>• Sample preparation which may include weighing of the sample, solubilisation of the solids with acids with/without heat (for total recovery analysis), separation of undissolved material</li> <li>• Calibration of the equipment</li> <li>• Sample analysis</li> </ul> <p>The nature of ICP analyses means that the analysed samples represent a single point in time (the time at which the sample was collected), and metal concentrations may vary substantially in urban waters due to the contribution of run-off from urban surfaces.</p> <p>Field test kits are available for on-site testing of some metals (e.g., As, Cd, Cu, Pb, Mo, etc.) whilst other metals can be detected using an ion-selected electrode (ISE; e.g., Cd, Pb, Zn, etc.). Field test kits vary greatly and range from semi-quantitative paper test strips for multiple metals, to quantitative colourimetric-type analyses. Some field test kits may involve the use of portable laboratory</p>

	equipment such as a photometer, fluorometer or similar. With ISEs there is a potential to install a testing unit in-situ to take measurements at regular intervals and save results to a data logger or upload to a central data repository.
<b>Scale of measurement</b>	Plot scale to district scale, depending on location of sampling point for concentrations ranging from ng/L to mg/L
<b>Data source</b>	
<b>Required data</b>	Water samples. Relatively small sample volume is required (typically 100 mL or less)
<b>Data input type</b>	Quantitative and semi-quantitative
<b>Data collection frequency</b>	Daily, weekly, monthly or annually
<b>Level of expertise required</b>	Low to Moderate for sampling High for analysis
<b>Synergies with other indicators</b>	Synergies with the other water quality indicators in the <i>Water management</i> indicator group
<b>Connection with SDGs</b>	SDG 6 Clean water and sanitation, SDG 13 Climate action, SDG 14 Life below water
<b>Opportunities for participatory data collection</b>	Participatory data collection possible with test kits and ion selective electrodes under supervision
<b>Additional information</b>	
<b>References</b>	<p>Chaturvedi, A., Bhattacharjee, S., Mondal, G.C., Kumar, V., Singh, P.K., &amp; Singh, A.K. (2019). Exploring new correlation between hazard index and heavy metal pollution index in groundwater. <i>Ecological Indicators</i>, 97, 239-246.</p> <p>Chaturvedi, A., Bhattacharjee, S., Singh, A.K., &amp; Kumar, V. (2018). A new approach for indexing groundwater heavy metal pollution. <i>Ecological Indicators</i>, 87, 323-331.</p> <p>European Parliament, Council of the European Union. (2000). EU Water Framework Directive: Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy. Retrieved from <a href="http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02000L0060-20140101">http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02000L0060-20140101</a></p> <p>International Organization for Standardization (ISO). 2004. <i>International Standard ISO 17294-1:2004 Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS) — Part 1: General guidelines</i>. International Organization for Standardization, Geneva.</p> <p>International Organization for Standardization (ISO). 2016. <i>International Standard ISO 17294-2:2016 Water quality — Application of inductively coupled plasma mass spectrometry</i></p>

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### 3.18 Total faecal coliform bacteria

**Project Name:** UNaLab (Grant Agreement no. 730052) and PHUSICOS (Grant Agreement no. 776681)

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Total faecal coliform bacteria in NBS effluents	Water Management
<p><b>Description and justification</b></p>	<p>Faecal coliform bacteria are a subgroup of a larger total coliform group referring to the Gram-negative, rod-shaped bacteria. Faecal coliform bacteria denote a group of thermotolerant coliform organisms, optional aerobic or anaerobic, which grow at <math>44 \pm 0.5</math> °C and ferment lactose to produce acid and gas (Bartram &amp; Pedley, 1996; Doyle &amp; Erickson, 2006). Although coliform bacteria are easy to detect, their presence does not imply the faecal contamination due to the natural occurrence of some faecal coliform organisms of non-faecal origin. Thus, the pathogenic strains of <i>Escherichia coli</i> (<i>E. coli</i>) are usually analysed to determine the sanitary contamination of water</p>