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ITU-T L.1500 series – Requirements for water sensing and early warning systems

ITU-T L-series Recommendations – Supplement 15

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Supplement 15 to ITU-T L-series Recommendations

Supplement to ITU-T L.1500 series
Requirements for water sensing and early warning systems

Summary

Supplement 15 to ITU-T L-series Recommendations provides a general overview of the requirements for water sensing and early warning systems. This Supplement illustrates the different technologies for sensing water quality indicators, in addition to early warning systems. The Supplement also demonstrates the most commonly measured water parameters and associated sensing technologies.

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Supplement 15 to ITU-T L-series Recommendations

Supplement to ITU-T L.1500 series
Requirements for water sensing and early warning systems

1 Introduction

The increasing worldwide contamination of water sources with thousands of industrial and agricultural chemical compounds is one of the fundamental environmental challenges facing global societies. Almost 89% (6.1 billion people) of the total global population had access to an improved water source in 2010. However, approximately 884 million people of the global population were still relying on unimproved drinking water sources. Provision of improved water sources in urban areas remained at 83% between 1990 and 2008.

Furthermore, this is linked to over 35% of all deaths in developing countries. The World Health Organization (WHO) cites waterborne illnesses as a major factor in 1.8 million deaths each year of which 88% are children in developing countries.

Many water sources are polluted with microbiological organisms from the disposal of excreta, impairing human health through waterborne diseases such as diarrhoea, cholera, trachoma, schistosomiasis and others. Water-related vector-borne diseases, such as malaria, are also a major health concern.

Different water sources and aquatic systems that receive contamination from industrial waste and sewage treatment plants, storm water systems, and run-off from urban and agricultural lands need to be assessed via reliable, accurate and effective techniques. The assessment system can provide early warnings with the obtained water quality data, thus necessary actions and proper control can be taken in time to protect the quality of water sources. It is very important to supervise the quality of water resources through effective water sensing and early warning systems.

2 Scope

Supplement provides a general overview of the requirements for water sensing and early warning systems. This Supplement illustrates the different technologies for sensing water quality indicators, in addition to early warning systems. The Supplement also demonstrates the most commonly measured water parameters and associated sensing technologies.

3 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

AHP	Analytic Hierarchy Process
BOD	Biological Oxygen Demand
CAP	Common Alerting Protocol
COD	Chemical Oxygen Demand
ISO	International Organization for Standardization
ITS	Intelligent Transport System
KPI	Key Performance Indicator
LED	Light-Emitting Diode
MS	Mass Spectrometry
ORP	Oxidation-Reduction Potential

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SSC	Smart Sustainable Cities
SWB	Subjective Well-Being
SWM	Smart Water Management
TEN	Trans-European Network
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TR	Technical Report
TS	Technical Specification
TSS	Total Suspended Solids
TTC	Telecommunication Technology Committee (TTC) of Japan
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-Habitat	United Nations Human Settlements Programme
UV-Vis	UltraViolet-Visible
WG	Working Group
XML	Extensible Markup Language

4 Overview

4.1 Water quality parameters

Water resources are constantly subject to ever increasing risks of pollution, thus water quality must be closely supervised to ensure that it responds fully to safety requirements associated with its different uses. A water system is very complicated and there are many parameters which influence water quality. These parameters are the basis for water sensing as water quality indicators.

Environmental water quality assessments are based on the analysis of the physical, chemical and bacteriological parameters of the water. Examples for the physical characteristics include temperature, conductivity and turbidity. Chemical parameters are: pH, oxygen, alkalinity, nitrogen and phosphorus compounds, while bacteriological contaminants look for the abundance of certain biological taxa. Monitoring could also include tests for toxins and direct measurements of pollutants such as heavy metals or hydrocarbons. It has been reported that in daily use there are up to 70000 known and emerging chemicals that might be present in various water resources, including for drinking water production.

Notably, approximately 860 active compounds are currently formulated in pesticide products. The chemical and physical properties of these pesticides can differ significantly which deem them relevant to be detected by various analytical methods. For example, they might include heteroatoms such as halogens, phosphorous, sulphur or nitrogen.

Quality indicators, especially in waste water include the biological oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC) and total suspended solids (TSS).

Most natural waters contain small quantities of organic compounds. Aquatic microorganisms consume some of these organic compounds as food by oxidizing the organic compounds, thus releasing energy used further for growth and reproduction. The problem is that these microorganisms' microbial metabolisms consume dissolved oxygen in the water, which might

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threaten aquatic life if the rate of dissolved atmospheric oxygen does not compensate for the oxygen depletion process. The BOD represents the amount of oxygen required for the microbial metabolism of the organic compounds in the water and is used as an indicator of the degree of organic contamination of water.

The presence of nutrients (e.g., nitrates and phosphates) and heavy metals (e.g., lead) in water is a serious threat to human health. Phosphorus is widely used as an agricultural fertilizer and this can be found most notably in agricultural runoffs. It can also be found in domestic detergents. Phosphates can generally be grouped within three broad classes: orthophosphates, condensed phosphates (pyro-, meta- and poly-) and organic phosphorus depending on the nature and source of the discharge. Phosphates in water cause eutrophication, a severe threat to marine life. Nitrate fertilizers on the other hand can have a threatening effect on human health since they can be reduced to nitrite by bacteria in the stomach and furthermore become incorporated into carcinogenic N- nitrosamine compounds.

Heavy metals, on the other hand, such as zinc, lead, copper, mercury and nickel are common in the earth's crust. Some, in trace amounts, are even essential to human health. However, due to natural erosion, runoff from industrial and other sources, and corrosion in water-bearing pipes, contaminate the water sources and water supplies to toxic levels.

The most commonly used surface water quality parameters are shown in Table 1. These parameters are generally adopted by many countries or international associations such as WHO, EU, US EPA and Chinese National Standard.

Table 1 – Most common water quality parameters for general designated use categories

Physical parameters	Conductivity, temperature, total dissolved solids (TDS), TSS, turbidity, oxidation-reduction potential (ORP)
Chemical parameters	pH, BOD, COD, dissolved oxygen, ammonia nitrogen, arsenic, chloride, cyanide, fluoride, nitrate, sulfate, total phosphorus (TP), total nitrogen (TN), aluminium, antimony, dadmium, chromium, copper, iron, lead, manganese, nickel, mercury, selenium, zinc, oil (extracted from petroleum ether), volatile phenol, benzo(a) pyrene, anionic surfactant, permanganate index, TOC
Biological parameters	Escherichia coli, coliform bacteria, EPT (ephemeroptera, plecoptera and trichoptera) index

4.2 Meters and sensors

Meters and sensors are currently being intensively applied to regulate different activities of water distribution systems such as hydraulic pressure and flow, water quality, head losses, and water and energy consumptions. The major aim of water utilities is to convey water from one place to another effectively with a minimal compromise to its quality and quantity.

Water quality sensors help to detect and address problems related to the quality of water before affecting consumers. Water quality monitoring inside the distribution or the network system helps in addressing problems and providing related operational management activities. An application of different water quality sensors provides verified information that leads to informed decisions related to the observed water quality change. An advanced water quality sensor measures the water pH, dissolved oxygen, temperature, turbidity, salinity, and conductivity.

In May 2007, the European Parliament proposed increasing from 33 to 61 the toxic products covered by European legislation on water quality. Forty-five of these were classified as priority substances and should no longer be used by 2015. There is an acute need in high sensitive low cost on-line sensors that are able to detect the excess of pollutants established by the official water quality regulations. As an example, the EU pesticide standard is set at 0.1 micro grams/L.

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