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A Review on Water Quality Monitoring System

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ABSTRACT

India is rich in water sources, being gifted with number of rivers and streams that can meet a range of water requirements of the country. Maintaining the quality of this water would benefit the whole ecosystem. But the quality of water today, has declined i.e. water has become polluted due to the release of unprocessed sewage and industrial effluents. Water pollution is the major problem that all the living beings are facing today. To prevent this water pollution, first we have to estimate the water parameters like pH, turbidity, dissolved oxygen, etc, as the variations in the values of these parameters point towards the presence of pollutants. This paper gives a review about the current water parameters estimation technique in India and the various advanced technologies which can be incorporated in future.

Keywords: *Real time, water parameter monitoring, WSN.*

[1] INTRODUCTION

21st century is century of pollution, global warming, insecurity and vulnerable health factors. Water pollution is the major problem in front of world today. It is nothing but the contamination of water bodies. Water pollution occurs when contaminants are discharged directly or indirectly into water bodies. Water pollution affects plants and creatures living in these bodies of water. Also human health is affected by polluted water.

Water Pollution is a major global problem which requires ongoing valuation and modification of water resource guiding principle at the levels of international down to individual wells. It has been surveyed that water pollution is the leading cause of deaths and diseases worldwide. The records show that more than 14,000 people die daily worldwide. In India predictable 580 people die of water pollution related illness every day.

In many developing countries, dirty or contaminated water is being used for drinking without any proper former treatment. One of the reasons for this happening is the unawareness of public and administration and the lack of water quality monitoring system which creates serious health issues. Also natural phenomena such as volcanoes, algae tints, rainstorms, and earthquakes also change the quality and ecological status of water. As water is the most important factor for all living organisms it is very important to protect it. And water quality monitoring is one of the first steps required in the rational development and management of water resources.

2. CENTRAL WATER COMMISSION'S ACTIVITIES IN WATER QUALITY MONITORING

Central Water Commission monitors water quality, covering all the main river basins of India at 371 key locations [1]. CWC has a three tier Laboratory system for the study of the water parameters. The Level-I Laboratories are located at 258 stations on various rivers of India where physical parameters such as temperature, colour, odour, specific conductivity, total dissolved solids, pH, turbidity and DO of river water are measured. 24 Level-II Laboratories are located at selected Division Offices which investigate 25 number of physical-chemical characteristics and bacteriological parameters of river water. Level-III / II+ Laboratories consist of 4 stations that are running at Varanasi, Delhi, Hyderabad and Coimbatore where 41 parameters including heavy metals / toxic parameters and pesticides are being observed [1].

The list of parameters and the corresponding desirable equipment provided in the Level-I, Level-II & Level-III/II+ Laboratories for the analysis of these parameters [2], [3] is given in Table 1 below:

Table 1. Water Quality Parameter and the Equipment required for analysis in Lab Level-I, II, II+/ III [2],[3],[4],[5],[6]

Sr. No.	Parameter	Equipment Required for Analysis
Level- I Lab		
1.	Temperature	Thermometer
2.	Colour	Visual / colour kit
3.	Odour	Physiological Sense
4.	Electrical Conductivity/ Total Dissolved Solids (TDS)	Conductivity Meter
5.	pH	pH Meter
6.	Dissolved Oxygen	Titration
7.	Turbidity	Turbidity Meter

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Level-II Lab (Along with Level-I Parameters)		
1.	Temperature	Thermometer/ Water Analysis Kit
2.	pH	pH Meter/ Water Analysis kit
3.	Electrical Conductivity/ Total Dissolved Solids (TDS)	Conductivity Meter/ Water Analysis kit
4.	Calcium	Complexometric Titration
5.	Magnesium	Complexometric Titration
6.	Sodium	Flame Photometer
7.	Potassium	Flame Photometer
8.	Iron	Spectrophotometer
9.	Carbonate	Titration
10.	Bicarbonate	Titration
11.	Sulphate	Nephelometer / Turbidity meter
12.	Chloride	Argentometric Titration
13.	Fluoride	U.V.Visible Spectrophotometer/ Ion Meter
14.	Nitrate	U.V.Visible Spectrophotometer/ Ion Meter
15.	Nitrite	U.V.Visible Spectrophotometer/ Ion Meter
16.	Silicate	U.V.Visible Spectrophotometer/ Ion Meter
17.	Phosphate	U.V.Visible Spectrophotometer/ Ion Meter
18.	Boron	U.V.Visible Spectrophotometer
19.	Dissolved Oxygen	Titration/ Water Analysis Kit
20.	Biochemical Oxygen Demand (B.O.D.)	Incubation followed by Titration
21.	Chemical Oxygen Demand (C.O.D.)	C.O.D. digester
22.	Total Plate Count	Colony Counter
23.	Total Coliform	By Culture Technique
24.	E. Coliform	
25.	F. Coliform	
Level-II+ /Level-III (Along with Level-I & II Parameters)		
1.	Total Kjeldhal Nitrogen	Kjeldahl Apparatus
2.	Cyanide	Ion Meter
3.	Ammonia (Nitrogen)	U.V.Visible Spectrophotometer/ Ion Meter
4.	T.O.C. (Total Carbon Analyser)	T.O.C.Analyser

The water parameters are measured with the help of the tools mentioned in Table 1. The values of these parameters are compared with the WHO standards and Indian standards given in Table 2 below:

Table 2. Water quality parameters with guideline values as per WHO and Indian standards [7],[8],[9],[10]

Sr. No.	Parameter	WHO standard	Indian standard
1.	Temperature	-	-
2.	Colour	-	5 Hazen units
3.	Odour	Unobjectionable	Unobjectionable
4.	Electrical conductivity	-	-
5.	pH	6.5 – 8.5	6.5 – 8.5
6.	Turbidity	10 NTU	10 NTU
7.	Dissolved oxygen	-	-
8.	Total Hardness	200 ppm	300 ppm
9.	Alkalinity	-	200 ppm
10.	Acidity	-	-
11.	Ammonia	0.3 ppm	0.5 ppm
12.	Bi carbonate	-	-
13.	Biochemical oxygen demand (BOD)	6	30
14.	Carbonate	-	-
15.	Chemical oxygen demand (COD)	10	-
16.	Chloride	250 ppm	250 ppm
17.	Magnesium	150 ppm	30 ppm
18.	Nitrate	45 ppm	45 ppm

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19.	Nitrite	3 ppm	45 ppm
20.	Potasium	-	-
21.	Sodium	200 ppm	180 ppm
22.	Sulphate	250 ppm	200 ppm

If the water parameters are beyond the standard values mentioned in Table 2 then it has various effects on human being, domestic purpose as well as industrial use. Such as human beings, get affected due to existence of different bacteria and heavy metals in water. It may affect different body organ and may cause physiological disorder. Hard water is not appropriate for domestic use such as washing, bathing, cooking as well as other purpose. Hard water is also not appropriate for industrial and agricultural use. It damages the machineries and affects the quality, stability and glossiness of the final product. Imbalance of these water parameters has various effects which are given in Table 3 below:

Table 3. Water parameters used for testing water quality with their source of occurrence and potential effect [11]

Sr. No.	Parameter	Source of Occurrence	Potential effect
1.	Colour	Due to presence of dissolved salts	-
2.	Odour	Due to biological degradation	Bad odour unpleasant
3.	Electrical conductivity	Due to different dissolved solids	High conductivity increases corrosive nature of water
4.	pH	pH is changed due to different dissolved gases and solids	Affects mucous membrane; bitter taste; corrosion
5.	Turbidity	Soil runoff	Higher level of turbidity is associated with disease causing bacteria's.
6.	Dissolved oxygen	Presence due to dissolved oxygen.	D.O. corrodes water lines, boilers and heat exchangers, at low level marine animals cannot survive.
7.	Total Hardness	Presence of calcium (Ca2+) and magnesium (Mg2+) ions in a water supply.	Poor lathering with soap; deterioration of the quality of clothes; scale forming.
8.	Barium	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits.	Increase in blood pressure
9.	Biochemical Oxygen Demand (B.O.D.)	Organic material contamination in water.	High BOD decreases level of dissolved oxygen.
10.	Chloride	Water additive used to control microbes, disinfect.	Eye/nose irritation; stomach discomfort. Increase corrosive character of water.
11.	Nitrate	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural deposits.	Effect on Infants below the age of six months. Symptoms include shortness of breath and blue-baby syndrome.
12.	Sulphate	Due to dissolved Ca/Mg/Fe sulphates	Taste affected; gastro-intestinal irritation.

The following procedure is followed in CWC for classification of stations, frequency of monitoring, identification of parameters and their analysis [2][3][6]:

Classification:

Stations are classified as Base, Trend and Flux Stations or Impact Stations and are defined as follows:

- A Base Station. means the monitoring location whether there is no control of human activities on water quality.
- A Trend Station. means a monitoring location designed to show how a particular point on a water course varies over time due, normally, to the impact of man's activities.
- A Flux Station or Impact Station. means the location for measuring the mass of particular pollutant on main river stem for measuring the extent of pollution due to human obstruction or environmental feature at any point of time and is necessary for measuring impact of pollution control measures adopted.

CWC has 164 Base stations, 179 Trend stations and 28 Flux stations.

Frequency of Monitoring:

- Base Station. One sample is collected every two months i.e. six samples in a year.

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- Trend Stations. Samples are collected only once in every month.
- Flux Stations. Samples are collected three times in a month. However toxic and trace metal are analyzed once in a month.

Special Experiments:

Special experiments on longitudinal deviation and depth deviation for D.O. and B.O.D of various pollutants are carried out once in year at all flux and trend stations.

Methodology for Sampling:

- Samples for Base line and Trend stations shall be collected from well mixed section of the river or main stem 30 cm below the water surface using a Dissolved Oxygen (DO) sampler or weighted bottle.
- Samples for Impact stations shall be collected from the point of interest, such as bathing ghat, downstream of point discharge, water supply intakes and other sources.
- The dissolved Oxygen (DO) in the sample shall be fixed immediately after collection and Dissolved oxygen (DO) analysis shall be done either in the field or in laboratory.
- For longitudinal surveys, the samples are collected from the river in the affected reaches particularly, which have city drain inlets.

Thus it can be summarized that CWC monitors water quality, by collecting samples from representative locations within the processing & distribution system. These samples are analyzed at the well equipped laboratories. At these laboratories samples from raw water, filter water and treated water are taken for analysis. The estimation of water parameters like turbidity, pH, dissolved oxygen, etc is done with the help of meters. So the disadvantages [12] of this existing system are that; there is no continuous and remote monitoring, human resource is required, less reliable, no monitoring at the source of waters i.e. no on field monitoring and the frequency of testing is very low. Due to these disadvantages of the existing system it is required to develop a system that will allow real time and continuous monitoring of water quality.

3. ADVANCED WATER QUALITY MONITORING SYSTEMS

Various advanced technologies for monitoring water quality have been proposed. Some of them are summarized in this paper.

Li Zhenan et al. (2013) [13] has proposed the structure of the wireless sensor networking in which a number of sensor nodes are located in a lake. A much smaller number of UAVs also watch the lake and they are controlled by the central monitoring station (CMS). The sensor nodes and UAVs are both movable whereas the CMS is fixed. The CMS collects the information from the sensors and process them.

Tahmina Ajmal et al. (2012) [14] proposed to develop a framework for monitoring water quality by incorporating bacterial contamination of water for open water bodies using WSN (consisting of sensors for sensing parameters of interest), UV Light to probe the contamination of water and Fluorescence as a monitoring tool.

Kamal Alameh et al. (2011) [15] presents a web based wireless sensor network [16], [17] for monitoring water pollution by means of Zigbee and WiMax technologies. This system would have a local Zigbee network that will be capable of measuring various water quality parameters, a WiMax network and web based monitoring with the help of a controlling computer. The system is intended to collect and process information, thus making decisions in real time via a remote web server. The data is directed through the Zigbee gateway from sensor nodes to the web server by means of a WiMax network, thus permitting users to distantly monitor the water quality from their place instead of gathering data from the scene. Experimental results revels that the system is capable of monitoring water pollution in real time.

Stephen Brosnan et al. (2007) [19] investigate a wireless sensor network arrangement for monitoring water quality. Author has proposed WSN to collect real time water quality parameter's values together with the amount of water being pumped out in the area.

Kulkarni Amruta M. et al. (2013) [20] has suggested an idea of 'Underwater Wireless Sensor Network' (UWSN) for water quality monitoring using wireless sensor network (WSN) [16], [17] technology powered by solar panel. She has suggested a system with a number of nodes, base station and remote base station. The nodes and base station are connected through Zigbee technology. Data from various sensors is collected at the node side such as pH, turbidity and oxygen level and are directed via WSN to the base station. Data collected from the distant site can be displayed in image format as well as it can be processed using different simulation tools at base station. This system has advantages such as low cost, low power consumption, more flexible to deploy at distant location and so on.

4. CONCLUSIONS

This paper presents a survey of the existing water quality monitoring system which is not completely efficient to monitor the quality of water. It has certain drawbacks that include no real time monitoring and low frequency of

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testing. This paper also gives the survey of various systems that over comes the drawbacks of the existing system.

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