A Course based Project Report On

Assessment of Water Quality Parameters: A Review

Submitted in partial fulfilment of
requirement for the completion of the
Engineering Chemistry Laboratory course.

B. Tech ELECTRONICS AND INSTRUMENTATION ENGINEERING

of

VNRVJIET

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DECLARATION

We hereby declare that this Project Report titled **“Assessment of Water Quality Parameters: A Review”** submitted by us of **ELECTRONICS AND INSTRUMENTATION ENGINEERING** in **VNR Vignana Jyothi Institute of Engineering and Technology,** is a bonafide work undertaken by us and it is not submitted for any other certificate/course or published any time before.

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CERTIFICATE

This is to certify that the project entitled **"Assessment of Water Quality Parameters: A Review"** submitted in partial fulfilment for the course of Engineering Chemistry Laboratory being offered for the award of B.Tech (**EIE-A**) by **VNR VJIET** is a result of the bonafide work carried out by **23071A1006, 23071A1014, 23071A1015, 23071A1019, 23071A1026** during the year **2023-2024**. This has not been submitted for any other certificate or course.

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ACKNOWLEDGEMENT

An endeavor over a long period can be successful only with the advice and support of many well-wishers. We take this opportunity to express our gratitude and appreciation to all of them.

We wish to express our profound gratitude to our honourable **Principal,** and **HOD, ELECTRONICS AND INSTRUMENTATION ENGINEERING, VNR Vignana Jyothi Institute of Engineering and Technology** for their constant and dedicated support towards our career moulding and development.

With a great pleasure we express our gratitude to the internal guides, **Dr. A. Sri Charitha, Assistant Professor, Chemistry (H&S), Dr. T. Lakshmi Viveka, Assistant Professor, Chemistry (H&S),** for their timely help, constant guidance, cooperation, support, and encouragement throughout this project as it has urged us to explore many new things.

Finally, we wish to express our deep sense of gratitude and sincere thanks to our parents, friends and all our well-wishers who have technically and non-technically contributed for the successful completion of this course-based project.

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ABSTRACT

The assessment of water quality is critical for ensuring the sustainability of aquatic ecosystems and human health. This review synthesizes current methodologies and findings related to the evaluation of key water quality parameters. The parameters assessed include physical, chemical, and biological indicators, such as temperature, pH, dissolved oxygen, turbidity, nutrient concentrations (nitrogen and phosphorus), heavy metals, and microbial content. The review highlights the significance of each parameter in reflecting the overall health of water bodies.

Recent advances in water quality monitoring technologies, including remote sensing, biosensors, and advanced analytical techniques, are discussed for their potential to enhance the accuracy and efficiency of water quality assessments. The application of Geographic Information Systems (GIS) and statistical models in spatial and temporal analysis of water quality data is also examined. Furthermore, the review addresses the integration of traditional and modern methods to develop comprehensive water quality monitoring frameworks.

The impact of anthropogenic activities, such as industrial discharge, agricultural runoff, and urbanization, on water quality is a focal point of the review. The correlation between these activities and the degradation of water quality parameters is explored, underscoring the need for stringent regulatory measures and sustainable management practices. Case studies from various regions demonstrate the practical challenges and solutions in water quality management, emphasizing the role of community involvement and interdisciplinary approaches in addressing water pollution issues.

The review concludes by identifying gaps in current research and suggesting future directions for water quality assessment. Emphasis is placed on the need for standardized protocols, continuous monitoring, and the development of predictive models to anticipate water quality trends under changing environmental conditions. The integration of emerging technologies and community-based monitoring initiatives is recommended to enhance the resilience of water quality management systems.

Overall, this review underscores the complexity of water quality assessment and the importance of adopting a multifaceted approach to safeguard water resources. By consolidating recent advancements and identifying critical areas for improvement, it provides a comprehensive overview for researchers, policymakers, and practitioners engaged in water quality management.

INTRODUCTION

Water is an indispensable resource for life on Earth, essential for the survival of all living organisms. It plays a critical role in human health, agriculture, industry, and ecological balance. However, the increasing anthropogenic activities, rapid industrialization, and urbanization have significantly impacted the quality of water resources. Consequently, the assessment of water quality has become a paramount concern for scientists, environmentalists, and policymakers worldwide.

Importance of Water Quality

The quality of water directly influences human health and the environment. Contaminated water can lead to severe health issues, including waterborne diseases such as cholera, dysentery, and typhoid. Additionally, poor water quality affects agricultural productivity, disrupts aquatic ecosystems, and can lead to the loss of biodiversity. Therefore, maintaining and monitoring water quality is crucial for sustainable development and public health.

Water Quality Parameters

Water quality is determined by a variety of physical, chemical, and biological parameters. These parameters provide comprehensive information about the health of water bodies and the potential risks to human and environmental health. Key water quality parameters include:

1. **Physical Parameters**: These include temperature, turbidity, color, taste, and odor. Physical characteristics of water can affect its usability for drinking, recreational, and industrial purposes.
2. **Chemical Parameters**: Chemical constituents of water, such as pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrates, phosphates, heavy metals (like lead, mercury, and cadmium), and organic pollutants, are critical indicators of water quality. These parameters help in identifying pollution sources and understanding the chemical interactions within water bodies.
3. **Biological Parameters**: Biological indicators, such as coliform bacteria, algae, plankton, and macroinvertebrates, provide insight into the biological health of water ecosystems. The presence of pathogens or excessive growth of certain microorganisms can indicate pollution and potential health hazards.

4. **Physicochemical Parameters**: These parameters encompass both physical and chemical characteristics and are crucial in understanding the overall quality and suitability of water for various uses. They include factors such as pH, temperature, conductivity, turbidity, dissolved oxygen (DO), total dissolved solids (TDS), and hardness.

Methods of Water Quality Assessment

Water quality assessment involves systematic monitoring, sampling, and analysis of water samples. Various methods and technologies are employed to measure and analyze water quality parameters. These methods can be categorized into field-based assessments and laboratory-based analyses.

1. **Field-Based Assessments**: Field tests provide immediate results and are useful for on-site water quality monitoring. Portable devices and kits can measure parameters like pH, temperature, turbidity, and dissolved oxygen. Remote sensing technologies and Geographic Information Systems (GIS) are increasingly used for large-scale water quality monitoring and mapping.
2. **Laboratory-Based Analyses**: Laboratory analyses offer detailed and accurate measurements of water quality parameters. Advanced techniques such as spectrophotometry, chromatography, mass spectrometry, and molecular biology methods are used to detect and quantify chemical and biological contaminants. These methods require specialized equipment and trained personnel but provide comprehensive data for water quality assessment.

Key Physicochemical Parameters

1. **pH**: The pH level of water is a measure of its acidity or alkalinity. It affects the solubility of nutrients and metals and the biological functions of aquatic organisms. Water with extremely high or low pH can be harmful to aquatic life and unsuitable for drinking and irrigation.
2. **Temperature**: Temperature influences chemical reactions, biological processes, and the solubility of gases in water. It is a crucial parameter in assessing the ecological health of water bodies. Changes in temperature can affect the metabolic rates of aquatic organisms and the overall ecosystem balance.
3. **Conductivity**: Conductivity measures the ability of water to conduct electrical current, which is directly related to the concentration of dissolved ions. High

conductivity indicates the presence of high levels of dissolved salts, which can affect water quality and suitability for various uses.

4. **Turbidity**: Turbidity is a measure of the cloudiness or haziness of water caused by suspended particles. High turbidity can reduce light penetration, affecting photosynthesis in aquatic plants, and can be an indicator of pollution from runoff, wastewater, or industrial discharges.
5. **Dissolved Oxygen (DO)**: Dissolved oxygen is critical for the survival of aquatic organisms. Low levels of DO can indicate pollution and organic matter decomposition, leading to hypoxic conditions that can be detrimental to aquatic life.
6. **Total Dissolved Solids (TDS)**: TDS is a measure of all inorganic and organic substances dissolved in water. High TDS levels can affect water taste, cause scaling in pipes, and harm aquatic organisms.
7. **Hardness**: Hardness is primarily caused by the presence of calcium and magnesium ions. It affects the suitability of water for domestic and industrial use. Hard water can cause scaling in pipes and appliances, while very soft water can be corrosive.

Challenges in Water Quality Assessment

Despite advancements in technology and methodologies, water quality assessment faces several challenges. These include:

1. **Spatial and Temporal Variability**: Water quality can vary significantly across different locations and over time. Regular and extensive sampling is required to obtain representative data, which can be logistically and financially challenging.
2. **Emerging Contaminants**: The detection and assessment of emerging contaminants, such as pharmaceuticals, personal care products, and microplastics, pose new challenges. These contaminants are not always included in standard water quality monitoring programs and require specialized analytical techniques.
3. **Data Management and Interpretation**: The vast amount of data generated from water quality monitoring needs to be effectively managed and interpreted. Advanced data analysis tools and models are essential to understand trends, identify pollution sources, and predict future scenarios.
4. **Regulatory Standards and Compliance**: Different countries and regions have varying water quality standards and regulations. Ensuring compliance with these standards and implementing effective water quality management practices can be complex and require robust legal and institutional frameworks.

Global Perspectives on Water Quality

Globally, water quality is a pressing issue that varies greatly depending on geographical, economic, and social factors. Developing countries often face significant challenges in managing water quality due to limited resources, inadequate infrastructure, and lack of technical expertise. In contrast, developed countries may have better water quality management systems but still face issues related to industrial pollution, agricultural runoff, and emerging contaminants.

International organizations such as the World Health Organization (WHO), the United Nations Environment Programme (UNEP), and the International Water Association (IWA) play crucial roles in promoting global water quality standards and practices. They provide guidelines, technical assistance, and support to countries in developing and implementing effective water quality monitoring and management programs.

Case Studies in Water Quality Assessment

Several case studies highlight the importance of water quality assessment and the various approaches used to address water quality issues:

1. **The Flint Water Crisis (USA)**: The lead contamination in Flint, Michigan, underscored the critical need for regular water quality monitoring and stringent regulatory compliance. The crisis highlighted the health risks associated with poor water quality and led to significant policy changes and infrastructure improvements.
2. **Ganga River Basin (India)**: The Ganga River is one of the most polluted rivers in the world due to industrial discharge, agricultural runoff, and domestic sewage. The Indian government's Namami Gange program aims to rejuvenate the river by implementing comprehensive water quality monitoring, wastewater treatment, and pollution control measures.
3. **Lake Victoria Basin (East Africa)**: Lake Victoria, the largest lake in Africa, faces severe water quality issues due to agricultural runoff, industrial pollution, and invasive species. Regional cooperation among the East African countries and support from international organizations are crucial for addressing the lake's water quality challenges.

IMPORTANCE OF WATER QUALITY ASSESSMENT

Water is one of the most vital resources on Earth, essential for the survival of all living organisms. It plays a crucial role in sustaining human life, supporting agriculture, driving industrial processes, and maintaining ecological balance. Despite its importance, water quality is under increasing threat from various anthropogenic activities, including industrialization, urbanization, and agricultural practices. These activities introduce a wide range of pollutants into water bodies, adversely affecting the quality of water and posing significant risks to human health and the environment.

The assessment of water quality has become a paramount concern for scientists, environmentalists, and policymakers globally. Understanding the status and trends of water quality is essential for developing strategies to protect water resources, ensure safe drinking water, support agricultural productivity, and maintain healthy ecosystems. Water quality is determined by a variety of physical, chemical, and biological parameters, which provide comprehensive information about the health of water bodies and the potential risks they pose.

Ensuring Safe Drinking Water

One of the most critical real-time applications of water quality assessment is ensuring the provision of safe drinking water. Contaminated drinking water is a major public health concern and can lead to outbreaks of diseases such as cholera, dysentery, and typhoid. Regular monitoring of water quality parameters like pH, turbidity, dissolved oxygen (DO), and the presence of harmful microorganisms is essential to detect contamination early and prevent health hazards. Advanced real-time water quality monitoring systems can provide immediate alerts to water treatment facilities and public health authorities, allowing for swift action to address contamination issues.

Agricultural Productivity and Food Safety

Agriculture relies heavily on water for irrigation, and the quality of this water directly affects crop health and yield. High levels of dissolved salts, heavy metals, or pathogens in irrigation water can harm crops, reduce productivity, and ultimately impact food safety. By continuously monitoring physicochemical parameters such as pH, conductivity, and the presence of nitrates and phosphates, farmers can ensure that the water used for irrigation is of high quality. Real-time data can help in adjusting irrigation practices and water sources promptly to maintain optimal growing conditions and prevent soil degradation.

Industrial Processes and Compliance

Industries require water for various processes, including manufacturing, cooling, and cleaning. The quality of water used in these processes can affect product quality, equipment lifespan, and operational efficiency. Additionally, industrial effluents must meet regulatory standards before being discharged into the environment. Real-time water quality monitoring enables industries to continuously assess the quality of incoming and outgoing water. By tracking parameters such as chemical oxygen demand (COD), biological oxygen demand (BOD), and the concentration of specific pollutants, industries can ensure compliance with environmental regulations, avoid fines, and minimize their environmental footprint.

Ecosystem Health and Biodiversity

Aquatic ecosystems are highly sensitive to changes in water quality. Pollutants such as heavy metals, excess nutrients, and organic matter can disrupt the balance of these ecosystems, leading to issues like algal blooms, hypoxia, and loss of biodiversity. Real-time monitoring of water quality parameters is crucial for protecting and managing aquatic environments. By providing timely data on factors like dissolved oxygen levels, nutrient concentrations, and temperature, real-time systems can help environmental agencies and conservationists take proactive measures to mitigate pollution and preserve biodiversity.

Disaster Management and Response

Natural disasters such as floods, hurricanes, and industrial accidents can have severe impacts on water quality. Contaminants can enter water bodies suddenly, posing immediate risks to human health and the environment. Real-time water quality monitoring systems play a vital role in disaster management by providing continuous data during and after such events. This information helps authorities to quickly identify contaminated areas, assess the extent of pollution, and coordinate emergency responses to ensure the safety of affected populations and ecosystems.

Recreational Water Safety

Water quality is also essential for recreational activities such as swimming, boating, and fishing. Contaminated water in recreational areas can pose health risks to the public and deter tourism. Real-time monitoring of water quality in lakes, rivers, and coastal areas can help in maintaining safe conditions for recreational activities. By tracking parameters like coliform bacteria levels, turbidity, and temperature, authorities can provide timely information to the public, issue advisories, and take necessary actions to ensure the safety and enjoyment of recreational water bodies.

Urban Water Management

Urban areas face significant challenges in managing water quality due to pollution from various sources, including stormwater runoff, sewage discharge, and industrial effluents. Real-time water quality monitoring is integral to urban water management strategies. Smart water networks equipped with sensors can continuously monitor water quality in rivers, reservoirs, and distribution systems. This data helps in detecting pollution incidents, optimizing water treatment processes, and ensuring the delivery of clean water to urban populations.

Enhancing Research and Development

Real-time water quality data is invaluable for scientific research and technological development. Continuous monitoring provides researchers with comprehensive datasets to study the dynamics of water quality, understand the impacts of different pollutants, and develop innovative solutions for water management. Such data can also be used to calibrate and validate water quality models, improve predictive capabilities, and enhance our overall understanding of aquatic systems.

Conclusion

The assessment of water quality parameters through real-time monitoring systems is crucial for a wide range of applications that directly impact human health, environmental sustainability, and economic development. Ensuring safe drinking water, optimizing agricultural productivity, maintaining industrial compliance, protecting ecosystems, managing disasters, ensuring recreational safety, and enhancing urban water management are just a few of the many critical areas where real-time water quality monitoring plays an essential role. By leveraging advanced technologies and continuous data collection, we can address water quality challenges more effectively, safeguard public health, and promote sustainable development in a rapidly changing world.

OBJECTIVES

The primary objective of assessing water quality parameters is to safeguard public health and ensure the sustainability of aquatic ecosystems. This comprehensive review aims to elucidate the key objectives of water quality assessment, highlighting its critical importance in various contexts.

1. **Protecting Public Health**

   The foremost objective is to ensure that water used for drinking and domestic purposes meets health standards. Monitoring parameters such as pH, turbidity, microbial content, and chemical contaminants helps in identifying potential health hazards and taking timely corrective actions to prevent waterborne diseases.

2. **Supporting Agricultural Productivity**

   Water quality directly impacts agricultural productivity. Assessing parameters like salinity, nutrient levels, and the presence of harmful chemicals ensures that irrigation water supports optimal crop growth without causing soil degradation or affecting crop health.

3. **Ensuring Industrial Compliance**

   Industries rely on water for various processes and are also significant sources of water pollution. Monitoring water quality parameters such as chemical oxygen demand (COD), biological oxygen demand (BOD), and heavy metals helps industries comply with environmental regulations and mitigate their impact on water bodies.

4. **Preserving Aquatic Ecosystems**

   Healthy aquatic ecosystems are vital for biodiversity. Assessing parameters such as dissolved oxygen, temperature, and nutrient levels is essential for maintaining the ecological balance and preventing phenomena like algal blooms, which can lead to hypoxia and loss of aquatic life.

5. **Facilitating Disaster Management**

   Natural disasters and industrial accidents can severely impact water quality. Real-time monitoring allows for rapid assessment and response, helping to mitigate the effects of contaminants introduced during such events and protecting public health and ecosystems.

6. **Enhancing Urban Water Management**

   Urban areas face challenges from stormwater runoff, sewage discharge, and industrial effluents. Monitoring water quality parameters in urban water bodies supports effective management strategies, ensuring clean water supply and safe recreational waters.

7. **Advancing Scientific Research**

   Continuous assessment provides valuable data for scientific research, aiding in the understanding of water quality dynamics and the development of new technologies and methods for water quality management.

By focusing on these objectives, the assessment of water quality parameters serves as a cornerstone for sustainable water resource management, public health protection, and environmental conservation. This review will delve into the methodologies, challenges, and advancements in water quality assessment, underscoring its multifaceted importance in our rapidly evolving world.

BROAD ANALYSIS OF TOPIC

Water is a fundamental resource essential for life, economic development, and environmental health. With the increasing pressures from anthropogenic activities, the quality of water resources has become a critical issue globally. Industrial discharge, agricultural runoff, urbanization, and climate change are some of the major factors contributing to the degradation of water quality. Consequently, the assessment of water quality parameters is crucial for the protection of public health, the sustainability of ecosystems, and the overall well-being of societies.

P. J. Puri, M. K. N. Yenkie, et al [01] have studied the water quality index (WQI) has been calculated for different surface water resources especially lakes, in Nagpur city, Maharashtra (India), for the session January to December 2008; comprising of three seasons, summer, winter and rainy season. Sampling points were selected based on their importance. The water quality index was calculated using the water quality index calculator given by the National Sanitation Foundation (NSF) information system. The calculated (WQI) for various studied lakes showed fair water quality in the monsoon season which then changed to medium in winter and poor for the summer season. Gorewada Lake showed a medium water quality rating in all seasons except monsoon season. Futala, Ambazari, and Gandhisagar lakes have also declined in aesthetic quality over the past decade following the invasion of aquatic weeds such as hydrilla and water primrose, so the reasons to import water quality change and measures to be taken up in terms of surface water (lakes) quality management are required.

B. N. Tandel, Dr. J. Macwan, and C. K. Soni [02] have studied, the water quality index is a single number that expresses the quality of water by integrating the water quality variables. Its purpose is to provide a simple and concise method for expressing the water quality for different uses. The present work deals with the monitoring of variations of the seasonal water quality index of some strategically selected surface water bodies. The index improves the comprehension of general water quality issues, communicates water quality status, and illustrates the need for and the effectiveness of protective practices. In all cases, the change in WQI value follows a similar trend throughout the study period. The lake water is found to be of good quality (WQI - 67.7 to 78.5) during both seasons. However, it is found that the water quality of the lake deteriorates slightly from winter to summer season on account of the increase in microbial activity as well as an increase in pollutant concentration due to water evaporation.

S. Chandra, A. Singh and P. K. Tomar [03] have described, lake water as a source of drinking and domestic use water for rural and urban populations of India. The main goal of the present study was to assess the drinking water quality of various lakes i.e. Porur Lake Chennai, Hussain Sager Hyderabad, and Vihar Lake Mumbai in India. For this, water samples were collected from six different sites. Composite samples prepared were analyzed for pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH)and calcium hardness (Ca-H), chemical oxygen demand (COD), biochemical oxygen demand (BOD), dissolved oxygen (D.O.), sulphate (as SO_4^{2-}), nitrate (as NO_3) and chloride (Cl^-) levels. Some heavy metals like Iron, Zinc, Cadmium, Mercury, Nickel, and Chromium were also analyzed in these samples. There were variations for EC (141-1041 "#$%&), turbidity (2-9 NTU), TDS (107.1–935.8 mg/L), SO_4^{2-} (4–8 mg/L), TA (42–410 mg/L), TH (41-280 mg/L), Ca–H (1410 mg/L), BOD (5-9mg/L), COD (4–32 mg/L) NO_3 (1.1-3.6 mg/L) and Cl- (49-167 mg/L) levels at different sites. Water pollution indicates that these parameters were manifold higher than the prescribed limit by the WHO & BIS standards.

Wu-Seng Lung, A. M. Asce [04] has studied, a two-layer time-variable model developed to quantify seasonal variations of pH and alkalinity levels in acidic lakes. The model incorporates the CO_2 / HCOJ/ CO_5 equilibria with internal sources and sinks of alkalinity and acidity in the water column. External alkalinity and $C0_2$ acidity loadings are also incorporated. The modelling framework is applied to the Bickford Reservoir in Massachusetts and Woods Lake and Panther Lake in Adirondack Park, New York. In general, in-lake alkalinity generation by reduction processes in the Bickford Reservoir during the summer months is simulated by the model. The observed response to snowpack release in Woods Lake and Panther Lake during the spring months is also reproduced by the model. All three model applications are efficiently run on a personal computer system.

Manjesh Kumar and Ramesh Kumar [05] Conducted experimental work on Physico-Chemical Properties of Ground Water of U.P., (India). The study deals with an evaluation of granite mines situated in Jhansi (Goramachia) for their status regarding physicochemical contamination of groundwater. Six different sites are selected for sample testing collected from mines and urban areas. Three samples have been taken at various distances on the site. This location is 10Km above from Jhansi city. The physic-chemical parameters such as pH, D.O., E.C., T.D.S., alkalinity, turbidity, Ca (calcium) and Mg (magnesium) hardness, total hardness, NO3 (nitrate), F (fluoride), Fe^{+3} (iron) and Cl^- (chloride) have been tested. It has been found that parameters are not in limit when compared with W.H.O. standards.

John hall, Alan d. zaffre, Randall b. Marx, Paul C. Kefauver, E. Radha Krishnan, Roy C. Haught, and Jonathan G. Herrmann[06] have sensor investigated several waters. Several water quality sensors were investigated in terms of their response following exposure to a contaminant that could be intentionally introduced into water. The sensors identified for evaluation are continuous online monitoring devices. Such monitors were selected because response time is critical for achieving the project objective of contamination warning. No single chemical sensor responded to all of the contaminants used in this study, yet some sensors responded better to the introduction of a larger number of contaminants than others. The table below summarizes the response of the sensors in terms of which sensors showed a response of greater magnitude than baseline fluctuations. The table also indicates whether the value of the response was greater than or less than the baseline value. The table does not indicate the absolute magnitude of the change. Although the absolute magnitude may be part of a detailed quantitative analysis, qualitative observations were the focus of this study. When performing a quantitative analysis, it is not only the absolute magnitude of the change that is important but also the magnitude relative to the size and fluctuations in the baseline along with the slope of the change (i.e., to determine whether the changes occur over several hours or several minutes). Thus, quantitative evaluation makes use of signal-to-noise principles, which are difficult to generalize and are location-specific.

Contaminant	Sensor Response: Increase From Baseline	Sensor Response: Decrease From Baseline
Wastewater	Chloride Specific conductance Turbidity TOC	Free chlorine ORP
Potassium ferricyanide	Free chlorine (DPD) * TOC Chloride Nitrate–nitrogen Ammonia–nitrogen ORP	
Glyphosate formulation	TOC Chloride	Free chlorine ORP
Malathion formulation	TOC Turbidity	Free chlorine ORP
Aldicarb	TOC Turbidity	Total chlorine Free chlorine ORP
Escherichia coli in Terrific Broth	TOC Ammonia–nitrogen Turbidity	Total chlorine Free chlorine
Terrific Broth	Turbidity TOC	Total chorine Free chlorine ORP
Arsenic trioxide	Turbidity Ammonia-nitrogen	Total chlorine Free chlorine Nitrate–nitrogen ORP
Nicotine	TOC Ammonia–nitrogen Chloride	Free chlorine Nitrate–nitrogen ORP

DPD—*N-N*-diethyl-*p*-phenylenediamine, ORP—oxidation reduction potential, TOC—total organic carbon

*Potassium ferricyanide injected, which was yellow in color, may have masked the DPD colorimetric method, creating an increased reading from the baseline.

Certain contaminants that did not create detectable changes in water quality parameters were omitted for security concerns. Several more-detailed reports of this research are available on the secure WaterISAC website.

Devendra Dohare, Shriram Deshpande, and Atul Kotiya[07] carried out studies on groundwater status by water quality index of borewells in Indore city (India). Water quality is dependent on the type of pollutant added and the nature of minerals found at a particular zone of the bore well. Monitoring of the water quality of groundwater is done by collecting representative water samples and analyzing of physicochemical characteristics of water samples at different locations of Indore City. Estimation of water quality index through the formulation of appropriate using method and evaluate the quality of tube well water by statistical analysis for post and pre-monsoon seasons i.e. from Nov. to Feb. and March to May. Results of the water quality assessment showed that most of the water quality parameters are slightly higher in the wet season than in the dry season. Correlations the physicochemical characteristics of water pollutants by appropriate statistical method.

S. P. Gorde1 and M. V. Jadhav [08] have analyzed lakes in India concluding that seasonal values of WQI indicate that during the summer season, lake water is more affected than during winter. This could be because the microbial activity gets reduced due to low temperature, thereby keeping the DO level at a very satisfactory range during the entire winter season. The suggested measures to improve the lake water quality include a total ban on the activities that cause pollution. The result of the water quality assessment clearly showed that most of the water quality parameters were slightly higher in the wet season than in the dry season. 4. Water quality is dependent on the type of pollutant added and the nature of the self-purification of water.

PHYSICOCHEMICAL CHARACTERISTICS OF LAKE WATER IN INDIA

Sr No	Parameter	BIS specification
1	Appearance	Clear
2	Colour	5 Hazen max
3	Turbity	5 NTU max
4	PH	6.5-8.5
5	EC	Not mentioned
6	Alkalinity	200 mg/L max
7	Fluoride	1 mg/L max
8	Chloride	250 mg/L max
9	Phosphate	Not mentioned
10	Sulphate	200 mg/L max
11	T H	300 mg/L max
12	Ca H	75 mg/L max
13	Mg H	30 mg/L
14	TDS	500 mg/L max
15	Silica	Not mentioned
16	FRC	0.2 mg/L
17	Hydrazine	Not mentioned
18	COD	Not mentioned
19	BOD	Not mentioned
20	DO	Not mentioned
21	SO3	Not mentioned
22	NO3	50 g/L

Shweta Tyagi, Bhavtosh Sharma, Prashant Singh, Rajendra Dobhal[09] reviewed the water quality indexes[WQI]. After the study of different water quality indices, it may be inferred that WQI aims to give a single value to the water quality of a source along with reducing a higher number of parameters into a simple expression resulting in easy interpretation of water quality monitoring data. Moreover, this is an effort to review the important indices used in water quality vulnerability assessment and also provides information about indices composition and mathematical forms. These indices utilize various physicochemical and biological parameters and have resulted as an outcome of efforts and research and development carried out by different government agencies and experts in this area globally. Despite all the efforts and different discussed indices being used globally, no index has so far been universally accepted and the search for a more useful and universal water quality index is still going on, so that water agencies, users, and water managers in different countries may use and adopted it with little modifications.

Arjun Ram, S. K. Tiwari, H. K. Pandey, et al [10] conducted a study on groundwater quality assessment using the water quality index (WQI) under a GIS framework. The study was conducted in the hard rock terrain of Bundelkhand massif, particularly in District Mahoba, Uttar Pradesh, India. The WQI was applied to categorize the water quality as excellent, good, poor, etc. The overall WQI in the study area indicates that the groundwater is safe and potable except for a few localized pockets in Charkhari and Jaitpur Blocks.

Jaydip Dey& Ritesh Vijay [11] published a critical and intensive review on the assessment of water quality parameters through geospatial techniques. The review emphasized the advance of remote sensing for the effectiveness of spectral analysis, bio-optical estimation, empirical methods, and the application of machine learning for water quality assessment.

A study on water quality assessment and monitoring in Pakistan [12] was conducted. This paper provided a comprehensive review of the published scientific studies on monitoring, determining, and methodologies related to water quality. The focus of much of this study was on surface water, drinking water, and groundwater sources.

M. S. Islam, B. S. Ismail, et al [13] have studied, the purpose of this study was to assess the hydrological properties and water quality characteristics of Chini Lake in Pahang, Malaysia. A total of seven sampling stations were established at the main Feeder Rivers of Chini Lake for measurement of stream flow. A total of 10 monitoring stations covering the study area were selected for water sampling. Fourteen water quality parameters were analyzed based on in-situ and ex-situ analysis for two seasons and laboratory analyses were carried out according to the HACH and APHA methods. Stream flow from the seven Feeder Rivers into the Chini Lake was relatively slow, ranging from 0.001 to 1.31 m/s 3 or an average of 0.21 m /s. According to the INWQS (Interim National Water Quality

Standards, Malaysia) 3 classification, the temperature was within the normal ranges; conductivity, total suspended solids (TSS), nitrate, sulphate and total dissolved solids (TDS) were categorized under class I, while turbidity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen and phosphate came under class II and pH under class III. Furthermore water quality in Chini Lake varied temporally and spatially and the most affected parameters were pH, TSS, turbidity, DO, ammoniacal nitrogen, phosphate and conductivity. Based on the Malaysian Water Quality Index (WQI), the water in the Chini Lake was classified under class II, meaning it is suitable for recreational activities and safe for body contact.

Rajankar P. N. et. al (2013) [14] carried out evaluation of tube well water quality using W.Q.I. in Wardha (India). Using W.Q.I. Some tehsile of district Wardha were evaluated. It is calculated by parameters, such as pH, turbidity, Temp., D.O., B.O.D. in the residential, commercial and agricultural area. Some Other physico-chemical parameters are E.C., Total hardness, calcium hardness (as $CaCO_3$), SO_4 (sulphate), chlorides (as Cl^-), Na^+ (sodium) and K^+ (potassium) etc. Final parameters are compared with B.I.S. (Bureau of Indian Standard).

K. Elangovan (2010) [15] carried out characteristics of tube well water for district Erode (India) states that ground water quality of 60 locations in Erode district during pre-monsoon and post monsoon seasons. Ground water samples were tested for 11 physico-chemical parameters following the standard methods and procedures. World Health Organization (WHO) standards were adopted for calculation of water quality index (WQI) by using the methods proposed by Horton and modified by Tiwari and Mishra.

R. M. Khan, M. J. Jadhav, I. R. Ustad [16] have explained, in order to understand the water quality of Triveni Lake, Physico-chemical parameters were studied and analyzed for the period of one year i.e. December 2010 to November 2011. Various physicochemical parameters, such as water temperature, air temperature, pH, humidity, conductivity, free CO_2, total solid, dissolved oxygen, Total alkalinity, Total hardness, $CaCO_3$, Ca^{++}, Mg^{++} were studied. The results revealed that there was significant seasonal variation in some physicochemical parameters and most of the parameters were in normal range and indicated better quality of lake water. It has been found that the water is best for drinking purpose in winter and summer seasons.

CONCLUSION

The assessment of water quality parameters is indispensable for ensuring the health and sustainability of both human and natural systems. With the escalating pressures from industrialization, urbanization, and climate change, the need for accurate, real-time water quality monitoring has never been more critical. This comprehensive evaluation, encompassing physical, chemical, and biological parameters, provides essential insights into the state of water bodies and the potential risks they pose to public health and ecosystems.

By safeguarding public health through the provision of safe drinking water, supporting agricultural productivity, ensuring industrial compliance, preserving aquatic ecosystems, facilitating disaster management, enhancing urban water management, and advancing scientific research, water quality assessment plays a pivotal role in modern society. The integration of advanced technologies such as IoT devices, real-time sensors, and data analytics into water quality monitoring systems represents a significant advancement, enabling timely detection of contamination events and more informed decision-making.

The extensive body of research published in scientific journals underscores the complexity and importance of this field. Studies on physicochemical parameters, biological indicators, emerging contaminants, and technological advancements provide a solid foundation for ongoing improvements in water quality assessment methodologies.

In conclusion, the continuous development and implementation of effective water quality assessment strategies are crucial for protecting public health, ensuring sustainable development, and preserving the environment. By leveraging both traditional methods and innovative technologies, we can address the challenges posed by water pollution and contribute to a healthier, more resilient future for all.

FUTURE SCOPE

The field of water quality assessment is rapidly evolving, driven by the increasing complexity of water pollution challenges and the advancements in technology. The future scope of water quality assessment encompasses several promising directions that aim to enhance our ability to monitor, understand, and manage water resources effectively.

Integration of Advanced Technologies

1. **Internet of Things (IoT) and Smart Sensors**: The deployment of IoT-enabled smart sensors for real-time water quality monitoring is expected to become more widespread. These sensors can provide continuous data on various water quality parameters, enabling immediate detection of contamination and facilitating timely interventions. The integration of IoT with cloud computing and data analytics will allow for more sophisticated data management and analysis, improving the accuracy and reliability of water quality assessments.

2. **Remote Sensing and GIS**: The use of remote sensing technologies and Geographic Information Systems (GIS) will expand, offering large-scale and detailed monitoring of water bodies. These tools can help in tracking changes in water quality over time and space, identifying pollution sources, and assessing the impact of environmental policies and management practices.

3. **Artificial Intelligence (AI) and Machine Learning**: AI and machine learning algorithms will play a significant role in analyzing complex water quality data. These technologies can help in predicting trends, identifying patterns, and making informed decisions based on historical and real-time data. AI-driven models can also be used to simulate various scenarios and assess the potential impacts of different management strategies.

The future scope of water quality assessment is vast and multifaceted, driven by the need to address complex and evolving water quality challenges. By integrating advanced technologies, addressing emerging contaminants, enhancing community engagement, strengthening policies, promoting sustainable practices, and adapting to climate change, we can significantly improve our ability to monitor and manage water resources. These efforts will ensure the provision of safe, clean water for all and contribute to the health and sustainability of our ecosystems and communities.

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