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Review: Groundwater Quality Using Water Quality Index

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Abstract : Water quality is crucial for human health and is affected by excessive fertilizer application and unhygienic conditions. Researchers are investigating water quality using various statistical methods, including Cluster Analysis, Principal Component Analysis, Factor Analysis, Geographical Information System, and Analysis of Variance. The paper presents the significance of each method, its usage, and its advantages and disadvantages. Principal Component Analysis and Factor Analysis are widely explored techniques. Water quality is influenced by both natural and human factors. Modern issues like population growth, sewage disposal, industrial waste, and radioactive waste have led to water pollution in 75% of rivers and streams worldwide. Eutrophication, a prevalent global issue, is the most prevalent problem. Poor water quality directly impacts water quantity, reducing its use for drinking, bathing, industry, and agriculture.

I. INTRODUCTION

This research evaluates the quality of groundwater in Anantapur district, Andhra Pradesh, for drinking and irrigation purposes. Samples were collected during the post-monsoon season and analyzed for various parameters. The results were compared with WHO water quality standards. The data was mapped using Arc-GIS. The water quality index showed 69% of samples were very poor, and 31% unfit for drinking due to ion leaching, over-exploitation, and agricultural impact. Most samples were moderately suitable for irrigation, but some had higher contamination levels due to human activity. Building disasters in developing nations often result from poor design, insufficient monitoring, and substandard materials. This study explores alternative water sources for concrete production, revealing both beneficial and detrimental effects. It emphasizes the importance of carefully examining water elements, particularly for non-drinking water, to prevent disasters and ensure safe concrete production.

The study assessed ground water quality in Mangalam, India, analyzing samples from 8 areas. Results showed some areas were polluted and not suitable for drinking, indicating the need for purification before consumption. The findings were compared with World Health Organisation standards.

This study assesses groundwater parameters in Tirupati area to develop water quality and suitability for domestic and irrigation purposes. Analyzing samples for pH, EC, TDS, carbonates, alkalinity, chlorides, sulfates, hardness, fluoride, calcium, magnesium, sodium, and potassium, the results indicate most water is Ca-Mg-HCO3 and Ca-Mg-Cl types, making most suitable for domestic and irrigation purposes.

Water quality is crucial for coordinating water demand and supply, and pollution is increasing. The Water Quality Index (WQI) is a popular tool for assessing water quality, but its potential for monitoring and management is limited. Environmental factors like location and sampling periods influence WQI estimation. WQI is a single value, simplifying data and aiding decision-making for water resource managers and scientists.

This study uses Principal Component Analysis (PCA) to develop a novel Water Quality Index (WQI) model for four Dhaka-based rivers, Buriganga, Turag, Balu, and Shitalakhya. The dataset includes 12 water quality parameters from 19 sites. The model's sub-indexing was introduced using the National Sanitation Foundation's WQI model and modified rating curves. The WQI values ranged from 36 (Bad) to 82 (Good), with 70% in the medium or bad category. The study minimizes subjectivity and bias in developing WQI models, contributing to future models and river pollution control strategies.

II. METHODOLOGY

The Water Quality Index (WQI) is a widely used method for evaluating surface water quality, transforming abundant data into a single, comprehensible measurement. Over 35 WQI models have been introduced globally, but traditional methods require significant resources and are limited to sporadic point measurements. Remote sensing technology has emerged as a promising approach for water quality monitoring, but challenges remain. Physical indicators, such as water color and transparency, can cause anomalies in physical indicators, such as chlorophyll-a content. Water color, which reflects the aesthetic value of water scenes, can also be used to evaluate water quality. Studies have shown a strong correlation between physical and chemical indicators, making

remote sensing technology feasible for assessing water quality status. However, the moderate resolution imaging spectroradiometer (MODIS) faces challenges due to its spatial resolution and complex optical properties of inland water bodies.

Water Quality Index (WQI)

Water Quality Index (WQI) is a quantitative tool used to assess water quality, classifying water sources based on physical, chemical, and biological attributes. It has been popular since the 1960s and has been used in over 35 models to evaluate surface water quality. The Irish Water Quality Index model effectively assessed water quality in Ireland, demonstrating its ability to effectively assess spatial-temporal trends.

This study uses data-driven root mean squared (RMS) models to evaluate groundwater quality (GWQ) in the coastal Bhola district of Bangladesh. The model uses eleven indicators and XG Boost machine learning to enhance reliability. The results show that the RMS-WQI model accurately predicts GWQ, with an average of 65.2. The model's sensitivity and minimal uncertainty make it an effective tool for regional environmental managers and strategic planners in monitoring and managing coastal GW resources.

NATURAL RESOURCE

Groundwater (GW) is a crucial natural resource, supplying one-third of the world's fresh water supply. However, pollution from human activities and climate change, particularly in coastal areas, threatens its quality. Factors such as industrial discharge, agricultural runoff, improper waste disposal, and urban development contribute to GW pollution. Climate change also exacerbates these issues by altering precipitation patterns, causing shifts in GW recharge areas, and promoting sea-level rise. Addressing these challenges requires a holistic approach to sustainable GW resource management.

Climate change and economic development

Climate change and economic development have impacted global lake and reservoir water quality. Remote sensing techniques have limited understanding of large spatiotemporal scale changes. This study developed a new remote sensing assessment model using MODIS imagery to assess water quality status. The model improved sensitivity to water quality states and improved accuracy. The model was used to assess 180 large lakes in China from 2000 to 2022. Results showed 76.11% of lakes had excellent and good water quality, with stability and improvement trends in western and eastern regions. The research supports rapid assessment of water quality status and sustainable resource management, highlighting the potential of remote sensing technology in monitoring water quality.

The Global Risks Report 2020 highlights water crises, including water scarcity and pollution, as a top ten risk. Monitoring and assessing lakes and reservoirs is crucial for understanding environmental changes, but only a small fraction are regularly monitored.

BIOLOGICAL CAPTURE

This review discusses the capture, recovery, and reuse of organic carbon from municipal wastewater for bioenergy production. It highlights the need for a comprehensive evaluation of technical advances and energy recovery potential. The review suggests that biological capture methods may not achieve good effluent quality when treating wastewater with high organic content. Chemical coagulants or membranes can aid carbon capture, while fermentation-centered bioprocessing platforms can convert captured carbon into versatile products. The review also examines challenges in achieving sustainable municipal water pollution control.

This paper presents results from fractionation and characterisation of two distinct wastewaters, revealing potential for resource recovery through cellulose recovery and biofuel production. The wastewater was divided into 10 size fractions, with carbohydrates dominating in particulate fractions larger than 100µm. Polymeric and colloidal fractions had low COD content, likely due to sewer system degradation. Biodegradation rates increased with decreasing size, but not in polymeric fractions. Analytical validation showed below filter cut-off retention of particles and polymers.

The study investigated the chemical composition of organic matter (OMs) in domestic wastewater, aiming to provide a scientific basis for COD fractions of activated sludge models and wastewater treatment management. Results showed fibers as the largest OM group, followed by proteins and sugars. Ten endocrine disrupting chemicals were found, with volatile fatty acids, soluble proteins, and sugars accounting for 30% of total COD.

III. CONCLUSION

Research compares various Water Quality Indexes (WQIs) to assess water quality differences. WQIs should be connected to scientific advancements, such as Pearson correlation and multivariate statistical approaches, to determine interactions between parameters. Future studies should use GIS techniques, fuzzy logic technology, and cellphone-based sensors for water quality monitoring, ensuring a more comprehensive and ecologically accurate WQI.

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