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Assessing Fluoride and Chloride Levels in Punganur Water Resources: A Comprehensive Experimental Investigation

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Abstract: This study focuses on the evaluation and analysis of water quality in Punganur Mandalam, located in the Chittoor district of Andhra Pradesh, highlighting the growing need for sustainable water management amid rising pollution from urban, industrial, and agricultural activities. Water, being vital for both human life and ecosystem balance, requires constant monitoring to ensure its safety and suitability for use. The research investigates key physicochemical parameters such as fluoride concentration, chloride content, pH level, and temperature across thirty sampling stations within the study area. Laboratory-based testing, complemented by Geographic Information System (GIS) tools, was employed to assess and visualize spatial variations in these parameters. The results provide a clear picture of the region's water quality, identifying potential areas of concern and trends affecting resource sustainability. By integrating experimental findings with spatial analysis, the study offers valuable insights into the dynamics of water composition and contamination. The conclusions drawn support better decision-making for water resource management, emphasizing the need for corrective measures to ensure clean and safe water access. Ultimately, this research contributes to the formulation of effective conservation strategies and sustainable practices for maintaining public health and environmental balance.

Keywords: Reversible logic gates, Pipelined ALU, Verilog, FPGA, High Performance computing.

1. Introduction

Water is an essential resource for life and plays a crucial role in various human activities, including drinking, agriculture, industry, and sanitation. Ensuring the quality and safety of water is paramount for protecting public health and safeguarding the environment. To address this need, surveys of water samples are conducted to assess the chemical, physical, and microbiological characteristics of water from different sources.

Fluoride is naturally present in most water sources, primarily derived from the dissolution of minerals such as fluorite, fluorapatite, and cryolite in geological formations. The World Health Organization (WHO) recommends a fluoride concentration of 0.5 to 1.5 mg/L in drinking water for optimal dental health, as fluoride helps prevent tooth decay. However, excessive fluoride intake [1], particularly above 1.5 mg/L, can lead to dental fluorosis, skeletal fluorosis, and other adverse health effects. Studies have reported wide variations in fluoride levels across different water sources, influenced by factors such as geological characteristics, pH, temperature, and human activities like industrial discharge and agricultural runoff. Groundwater, particularly from aquifers rich in fluoride-bearing minerals [2], tends to have higher fluoride levels compared to surface water sources. In regions with volcanic activity or fluoride-rich bedrock [3], groundwater fluoride concentrations can exceed the WHO guideline limits, posing significant health risks to populations dependent on such water sources.

Chloride, primarily originating from the dissolution of salt deposits, seawater intrusion, and anthropogenic sources such as road salt and industrial effluents [4], is another common constituent of water. While chloride is essential for various physiological functions in humans and animals, excessive chloride intake through hypertension and cardiovascular problems [7]. The concentration of chloride in water sources varies widely, with coastal regions and areas with intensive agricultural practices or urbanization often exhibiting higher chloride levels [6]. Surface water sources, especially those influenced by seawater intrusion or runoff from chloride-laden soils, tend to have elevated chloride concentrations compared to groundwater [5]. Additionally, anthropogenic activities

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such as road de- icing and industrial discharge can significantly contribute to chloride contamination in water bodies.

2. Related Work

Fawell, J.K. (2016):-"Fluoride in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality". World Health Organization. Retrieved 6 May 2016. This paper depicts the fluoride removal from drinking water can be accomplished by different methods, for example, coagulation [9]- precipitation, membrane separation process, ion exchange, adsorption techniques and so on. Among these procedures, membrane and ion exchange processes are not extremely regular because of its high establishment and support price.

V.Krishna Kumar(2019) Ecotoxicology Safety , Yadav, Kumar, Sandeep, Pham, Quoc Bao, Gupta, Neha, Rezamia, Amardeep Kour(2003) has worked on Hydrologival investigation Shahabaldin; Kamyab, Hesam; Yadav, Shalini; Vymazal, Jan Kumar, Vinit; Tri, Doan Quang; Talaiekhozani, Amirreza; Prasad, Shiv; Reece, Lisa M.; Singh, Neeraja; Maurya, Pradip Kumar; Cho, Jinwoo (October 2019) [15]. "Fluoride contamination, health problems and remediation methods in Asian groundwater: A comprehensive review [8].

Res Jour Mangat Socio Human (2016) has worked on Fluoride and chloride, Fluriod is a component that remains in a certain amount in water. On crossing this certain limit, fluoride contaminates the water [15]. Excessice fluoride concentrations have been reported in ground waters of more than 20 developed and developing countries including India where 17 states are facing acute fluorosis problems. Persons once attacked by this are never cured of this [9].

Various technologies are being used to remove fluoride from water but still. approach involves treatment processes, chemical system design in treatment plants and hydraulics, surge, and water quality analysis and modelling in water distribution and wastewater collection systems [7].

Maria Garcia (2012) is Focusing on water quality monitoring and contamination assessment. Dr. Garcia's research includes surveys of fluoride and chloride levels in urban water supplies and rural communities [10].

Lisa Patel (2016) is worked on the Environmental Protection Agency[17], coordinating the US Government's efforts on clean air and safe drinking water projects in South Asia in collaboration with the World Health Organization. Realizing the critical and inextricable links between children's health and environmental issues, she obtained her medical degree from Johns Hopkins University and completed her residency in pediatrics at UCSF (University of California, San Francisco) [11].

Prof. Christopher Lee Institute (2017) is Focusing on the geochemical processes affecting fluoride and chloride mobility in groundwater systems. Prof. Lee's research combines field surveys with laboratory experiments to elucidate water-rock interactions [12].

These researchers have made significant contributions to the understanding of fluoride and chloride levels in water through their surveys, analyses [13], and publications. Their work forms a crucial part of the broader scientific effort to assess and manage water quality for human health and environmental sustainability.

Shashi Anand (2009) has worked on Fluoride in drinking water ha a profound effect on teeth and bones. Up to a small level (1–1.5 mg/L) this strengthens the enamel [14].

Concentrations in the range of 1.5–4 mg/L result in dental fluorosis whereas with prolonged exposure at still higher fluoride concentrations (4–10 mg/L) dental fluorosis progresses to skeletal fluorosis. High fluoride concentrations in groundwater, up to more than 30 mg/L, occur widely, in many parts of the world [15]. This review article is aimed at providing precise information on efforts made by various researchers in the field of fluoride removal for drinking water.

Has been carried out in Bishanh Tehsil of Jammu district, J&k to determine the mean concentration of fluoride in surface and groundwater bodies [16].

Various other water quality parameters such as temperature, Ph, Calcium(Ca), Magnesium (Mg), Total Hardness (TH), Chlorides (Cl) and bicarbonate ion concentrations were also measured. Eleven water samples were collected from different locations viz. handpumps, wells, tubewells, electrically operated pumps and boreholes in the study area [3].

The groundwater of the study area was found to be slightly alkaline in nature which favors the problem has not been rooted out. This paper gains its importance by highlighting the causes of fluoride contamination in ground water.

Michael Wang (2014) has analyzed fluoride and various design waste water treatments He specializes in hydraulic modeling and design of water and wastewater treatment facilities. His holistic the dissolution of fluoride in it. A systematic calculation of correlation coefficient of physiochemical parameters with fluoride was also performed [20].

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3. Experimental System

Due to Fluoride and chloride values Phase I: Identify the different areas Phase II: Identify the different water resources Phase III: Study on Testing equipment Phase IV: Samples collection Phase V: Populate different areas fluoride and chloride values [16].

STNO	ST NAME	TEMPERATURE	COLOR	PH	CHLORIDE (mg/lit)	FLOURIDE (mg/lit)
S1	RAMPLALLI	27.05	COLOR LESS	7.2	289.11	1.22
S2	ETHUR	27.62	COLOR LESS	7.7	286.35	1.23
S3	EDAGAPLLI	28.97	COLOR LESS	7.8	348.62	0.81
S4	SUGALMITA	28.91	COLOR LESS	8.0	45.91	0.82
S5	DANDUPALYAM	28.75	COLOR LESS	8.1	40.64	0.55
S6	MELAPATULA	29.50	COLOR LESS	7.4	75.20	1.71
S7	ARADIGUNTA	29.82	COLOR LESS	7.5	80.50	2.00
S8	BHEMIGANPALLI	29.67	COLOR LESS	8.4	88.12	1.96
S9	BANDLAPALLE	28.70	COLOR LESS	7.0	156.01	3.01
S10	MANGALAM	28.96	COLOR LESS	7.8	124.98	1.97
S11	MELUMODOODD	26.25	COLOR LESS	7.4	250.02	1.01
S12	NEKKONDI	29.85	COLOR LESS	7.5	232.84	1.85
S13	PALYAMPALLE	27.50	COLOR LESS	8.4	157.27	1.97
S14	RAGANIPALLE	28.60	COLOR LESS	7.0	98.58	1.67
S15	VANAMALADINE	28.58	COLOR LESS	7.8	89.69	1.46
S16	NSPET OH TANK	29.55	COLOR LESS	7.2	258.05	1.38
S17	GOKUL OH TANK	27.72	COLOR LESS	7.7	249.87	1.22
S18	VBHS OH TANK	28.87	COLOR LESS	7.8	246.89	1.25
S19	KK PALYAM	29.85	COLOR LESS	8.0	236.25	0.36
S20	KK STREET	27.05	COLOR LESS	8.1	238.92	0.48
S21	AN KUNTA	27.62	COLOR LESS	7.4	222.98	1.22
S22	LAKKUNTA	28.97	COLOR LESS	7.5	224.95	1.35
S23	NAKABANDA	28.91	COLOR LESS	8.4	196.25	1.17
S24	GUDURPALLI	28.75	COLOR LESS	7.7	187.25	1.79
S25	DHOBICOLONY	29.50	COLOR LESS	7.4	211.96	1.58
S26	NGPALYAM	29.82	COLOR LESS	7.5	210.02	1.76
S27	HS STEET	29.67	COLOR LESS	8.4	208.52	1.82
S28	BODEVARIPALLI	28.70	COLOR LESS	7.0	196.26	1.95
S29	CHADALI	28.96	COLOR LESS	7.8	190.29	1.42
S30	ETAVAKAILI	27.02	COLOR LESS	8.2	198.43	1.14

Phase I: Identify the different areas Punganur Mandal is a region characterized by diverse water sources, including groundwater, surface water bodies, and municipal supplies.

The availability and quality of water in this region are influenced by various natural and anthropogenic factors, such as geological formations, land use practices, and industrial activities. Understanding the quality of water in Punganur Mandal is essential for sustainable water management and safeguarding the health and well-being of its residents.

Phase II: Identify the different water resources Designing a sampling strategy to ensure representative samples are collected from different water sources within Punganur Urban and Rural. This may involve selecting a diverse range of source [17].

Phase III: Study on Testing equipment Water Testing Equipment's Benchtop pH Meter, Conductivity Meter, Dissolved Oxygen Analyzer, Humidity Meter; Spectrophotometer, Ion-selective electrode (ISE) meters, Titration equipment.

Phase IV: Samples collection Designing a sampling strategy to ensure representative samples are collected from different water sources within Punganur Mandal. This may involve selecting a diverse range of sources such as wells, borewells (BW), hand pumps (HP), ponds, and tap water [18].

Phase V: Analysis of Hazards and diseases due to Fluoride and chloride values Excessive fluoride and chloride in water resources can lead to various health issues. Here are some disorders associated with their excess intake

4. Results and Conclusion

In recent years, concerns regarding water quality have become increasingly prevalent due to the rise in industrialization, urbanization, and agricultural activities. One critical aspect of water quality assessment involves the analysis of chloride and fluoride concentrations [19], as their presence in water sources can have significant implications for human health and the environment. In response to these concerns, our group embarked on a comprehensive study to evaluate chloride and fluoride levels in water resources across the Punganur area. The findings from this analysis provide valuable insights into the extent of contamination and aid in the development of strategies to mitigate potential risks associated with these contaminants [20].

According to recent studies conducted in the Punganur Mandal area, it has been found that approximately 26% of water sources contain fluoride levels exceeding the recommended safe limits [21]. This concerning revelation underscores the urgent need for improved water quality management and intervention strategies to mitigate the health risks associated with excessive fluoride consumption. The presence of elevated fluoride levels in such a significant portion of the water sources raises

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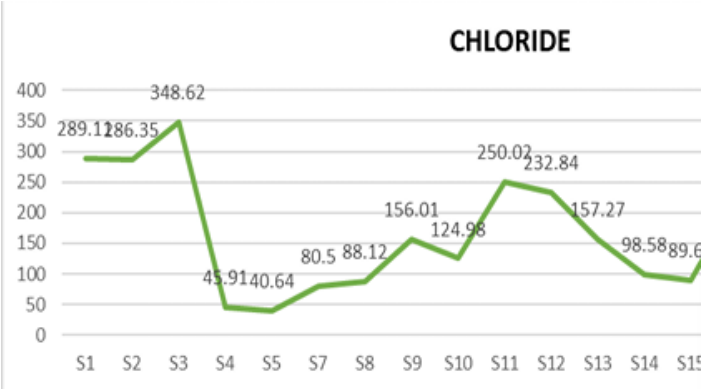
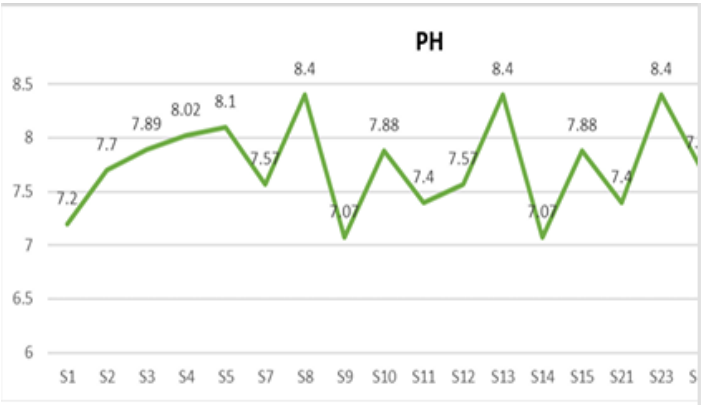
serious public health concerns, as prolonged exposure to high levels of fluoride can lead to various adverse health effects, including dental fluorosis and skeletal fluorosis.



Addressing this issue requires collaborative efforts between local authorities [20], health agencies, and communities to implement effective measures such as water treatment facilities.

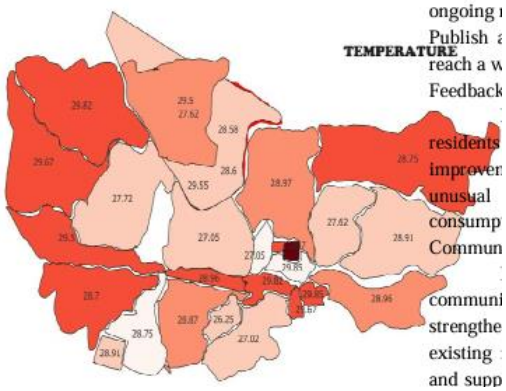


Public awareness campaigns, and regular monitoring programs to ensure access to safe and clean drinking water for all residents of the Punganur Mandal area [15]. Failure to address this issue promptly could have detrimental consequences for the health and well-being of the population, highlighting the importance of prioritizing water quality management initiatives in the region [21].

5. Conclusion and future scope

5.1. QUANTUM GEOGRAPHIC INFORMATION SYSTEM(QGIS)

After conducting a comprehensive survey of fluoride and chloride levels in various water sources across Punganur Mandalam, Chittoor District, utilizing QGIS (Quantum Geographic Information System), several significant findings have emerged. This survey aimed to assess the quality of water sources in the region, particularly in terms of fluoride and chloride content, which



Public Awareness Campaigns Organize public awareness campaigns in collaboration with local authorities, health departments, and community leaders. Encourage active participation from residents to raise concerns, ask questions, and share information about local water sources.

Digital Platforms Utilize digital platforms such as social media, community websites, and local news portals to disseminate information about water quality. Share updates on fluoride and chloride levels, water testing results, and health advisories to reach a broader audience. Collaboration with Health Professionals Collaborate with healthcare providers, doctors, and public health agencies to incorporate water quality information

into health education programs. Ensure that healthcare professionals are informed about the potential health risks associated with high fluoride and chloride levels in water and can provide guidance to patients.

School Outreach Programs Implement educational programs in schools to teach students about water quality, environmental conservation, and health-related issues. Incorporate interactive activities, demonstrations, and experiments to engage students in learning about the importance of clean water. Local Media Coverage Work with local newspapers, radio stations, and television channels to disseminate information about water quality and ongoing monitoring efforts. Publish articles, interviews, and public service announcements to reach a wider audience across different demographics.

Feedback Mechanisms Establish feedback mechanisms to gather input from residents about water quality concerns and suggestions for improvement. Encourage community members to report any unusual tastes, Odors, or health symptoms related to water consumption for prompt investigation. Partnerships with NGOs and Community Organizations: Partner with non-governmental organizations (NGOs), community-based organizations, and environmental groups to strengthen outreach efforts and mobilize resources. Leverage existing networks and grassroots initiatives to amplify messaging and support community-led initiatives for water quality monitoring and advocacy. By implementing these dissemination strategies, you can effectively communicate information about fluoride and chloride levels in water resources of Punganur, empower the community to take proactive measures for water safety, and foster collaboration among stakeholders to address water quality challenges effectively.

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