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Systematic Qualitative Analysis Of Water Pollution For Water Quality Management In Nalanda District

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Abstract:
Effective water quality management in the Nalanda district necessitates a thorough qualitative analysis of water pollution, aiming to identify contamination sources and assess their impacts. This assessment enables the evaluation of existing management practices and the implementation of targeted measures. The district faces diverse water pollution challenges, with agricultural activities, especially the excessive use of fertilizers and pesticides, emerging as significant contributors. Runoff from fields transports pollutants into nearby water bodies, resulting in eutrophication and water quality deterioration. Additionally, inadequate waste management practices, including untreated sewage discharge, pose health risks due to bacterial contamination.
Industrial activities, particularly in urban areas, also play a role in water pollution. Effluents from industries such as textile mills and tanneries contain toxic chemicals that contaminate water sources, adversely affecting aquatic life. Poor regulations and enforcement contribute to improper industrial waste disposal, aggravating the pollution problem.
To tackle these issues, effective water quality management strategies are imperative. This involves enforcing stricter regulations for agricultural practices, promoting organic farming methods, and raising awareness among farmers about responsible pesticide and fertilizer use. Improved waste management, including the establishment of sewage treatment plants and the adoption of proper sanitation practices, is crucial to reducing contamination from domestic sources.
Collaboration among government agencies, environmental organizations, and local communities is crucial for sustainable water quality management in the Nalanda district. Regular monitoring programs, public education campaigns, and the promotion of sustainable practices are essential for ensuring the long-term health and availability of clean water resources for both human and ecological needs.
***Key Word**: Contamination of water sources, Runoff from Agriculture, Untreated Household Sewage, Open-air Defecation, Conventional Customs.*

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I. Introduction

Water is indispensable for the survival and well-being of all living organisms on Earth, including animals. Several critical reasons highlight the significance of water for the animal kingdom.(*1-5*) Animals depend on water for their survival and engage in various physiological processes like digestion, circulation, temperature regulation, and waste removal. Proper hydration is essential for maintaining the balance of bodily fluids, ensuring optimal organ function. Animals, like humans, rely on water to regulate body temperature, particularly in hot environments or during physical activities. Water also plays a crucial role in digesting and absorbing nutrients from food, breaking down particles, facilitating nutrient transport across cell membranes, and aiding in waste removal.(*6-8*)

Water bodies such as rivers, lakes, ponds, and oceans serve as habitats for numerous animal species, fostering diversity and providing essential elements like food, shelter, breeding grounds, and protection. Gathering points like waterholes and rivers are crucial for animals, especially in arid regions, as they offer opportunities for drinking, bathing, and social interactions. In certain cases, animal species undertake long-distance migrations in search of water resources for breeding, feeding, and survival. Water supports a wide array of species, contributing significantly to the overall biodiversity of the planet.(*7, 9, 10*)

Animals, both aquatic and terrestrial, play pivotal roles in maintaining ecosystem balance by contributing to nutrient cycling, seed dispersal, pollination, and predation. Specific adaptations in certain animal species allow them to thrive in aquatic environments, showcasing the efficiency of utilizing water resources. In summary, water is essential for the survival, hydration, nutrient absorption, and overall well-being of animals, shaping habitats, supporting ecosystems, and playing a fundamental role in maintaining the ecological balance of the animal planet.(*4, 11, 12*)

Water quality management encompasses processes and strategies aimed at monitoring, controlling, and improving water resource quality. This involves protecting and preserving the integrity of water bodies, such as lakes, rivers, streams, and groundwater. Regular monitoring helps identify changes or contaminants, with activities like sample collection, laboratory tests, and data analysis assessing overall water resource condition. Treatment processes like filtration, disinfection, sedimentation, and coagulation aim to remove or reduce contaminants, making water safe for various uses.(*13-19*)

Preventing pollution at its source is crucial, involving measures to minimize pollutant release into water bodies through waste management, industrial regulations, and agricultural best practices. Watershed management considers the entire ecosystem, incorporating land-use planning, erosion control, and riparian zone preservation. Governments and regulatory bodies enforce environmental regulations, setting standards for water quality, pollutant discharge limits, and penalties for non-compliance.(*19-22*)

Creating awareness among the public about water quality importance is crucial, with educational programs, campaigns, and community engagement promoting responsible water use, pollution prevention, and conservation. Ongoing research and technological advancements play a key role in improving water quality management, addressing emerging contaminants and finding sustainable solutions.(*18-24*)

To provide context, a renewable water supply of at least 2,000 cubic meters per person per year is necessary for a reasonable standard of living, with 1,000 to 2,000 cubic meters indicating water stress and less than 500 cubic meters as water scarcity. Current technology allows seawater desalination but is often impractical for widespread use due to cost considerations. The global distribution of freshwater poses challenges, with water-rich regions consuming without concern while others face inadequate supplies. Water management becomes critical to secure humanity's future, considering the limited and valuable nature of remaining water resources.(*10, 25-27*)

In Nalanda District, Bihar, groundwater from wells and tube wells serves as the primary water source. As an agricultural region, groundwater is crucial for irrigation, supplemented by water from major rivers like the Ganga and its tributaries. Government initiatives, including hand pump construction and piped water supply systems, aim to enhance access to safe drinking water. However, water availability and quality may vary across the district, presenting challenges such as water scarcity or contamination in certain areas. Refer to the table for a comparative overview of water availability in different parts of the district.

II. Material And Methods

Various methods are employed for sample analysis in this context. Grab samples, taken at a specific spot within a site over a brief period (typically seconds or minutes), offer a momentary snapshot of the sampling area in both space and time. Discrete grab samples are collected at a chosen location, depth, and time. Depth-integrated grab samples cover a predetermined section or the entire depth of a water column at a selected location and time in a given body of water.(*25, 28*)

Composite samples aim to provide a more representative sampling of diverse matrices where the concentrations of the analytes of interest may fluctuate rapidly over short time periods or spatially. These samples can be generated by combining portions of multiple grab samples or by utilizing specially designed automatic sampling devices. Sequential (time) composite samples are gathered through continuous, constant sample pumping or by mixing equal water volumes collected at regular time intervals. Flow-proportional composites are collected through continuous pumping at a rate proportional to the flow or by mixing equal volumes of water collected at time intervals inversely proportional to the flow or collected during regular time intervals.(*19, 25, 29*)

The advantages of composite samples include cost reduction in analyzing a large number of samples, obtaining more representative samples from heterogeneous matrices, and obtaining larger sample sizes when the available test samples are limited.

III. Result And Discussion

pH serves as a universal parameter for expressing the acidity or alkalinity of a solution. Water, being a weak electrolyte, ionizes to produce H+ and OH- ions. The ionic product of water, denoted as [H+] [OH-], remains constant at 10^-14 mol/liter at 25°C, applicable to solutions of varying acidity or alkalinity. In a neutral solution or pure water, the concentration of H+ ions is equal to that of OH- ions, both being 10^-7 mol/liter. If the concentration of H+ ions exceed 10^-7 mol/liter, the solution exhibits an acidic character, while an alkaline nature is observed when the concentration of OH- ions surpasses 10^-7 mol/liter in a 10^-7 mol/liter solution.(*6, 11, 24, 30, 31*)

pH serves as a crucial physicochemical parameter, offering insights into the fate of chemical constituents in water. The U.S. Public Health Service has established acceptable pH limits for potable water at 7.0-8.5. For inland surface waters used as raw water, public water supply, bathing ghats, and fish culture, the pH tolerance ranges from 6.0 to 9.0. In irrigation, the acceptable pH limits for inland surface water are set between 5.5 and 9.0.

The study reveals slight variations in pH values near Punpun, particularly at different sites around Maner village. The pH values show minimal changes from May-June 2013 to May-June 2014. Around Dehri, four sites were studied, with the maximum pH observed at the Cremation ghat (site 5) due to downstream effluents from various industries. The pH values at other sites exhibits moderate changes.

Near Patna, the comparison of pH data from May & July 2013 and June & July 2014 shows slight increases in pH values in July 2013 and July 2014, possibly attributed to changes in water volume. Around Fatuahm, the pH values at different sites vary slightly, with the highest values near the township, likely influenced by drains carrying township and housing area wastes. The pH values at confluence sites and downstream show minor changes.

Overall, the study provides valuable information on pH variations in different water bodies, emphasizing the importance of pH in water quality assessment.

Table 01: Water condition in the peripheral regions of Nalanda district

Various Pollution Parameters of water of River Phalgue at Nalanda

No.	Parameters	Site-1.1	Site-1.2	Site-1.3	Site-1.4	Site-1.5
1.	pH	7.8	8.0	7.8	8.0	7.8
2.	Turbidity	24	25	36	48	50
3.	Dissolved oxygen	6.0	3.0	3.6	3.4	3.2
4.	Dissolved CO_2	2.8	3.0	3.6	3.4	3.2
5.	C.O.D.	18	28	36	27	64
6.	B.O.D.	7.0	11	16	6.5	31
7.	PAHS	0.1	1.2	0.2	0.1	0.3
8.	PH PCBs(μ g/l)	3	1	3	2	4
9.	Total Hardness	180	189	230	169	112
10.	Calcium	52	36	47	36	67
11.	Magnesium	62	68	86	67	79
12.	Total alkalinity	186	192	212	186	204
13.	Chloride	28	27	36	42	37
14.	Phosphate	0.21	0.28	0.27	0.3	0.35
15.	Nitrate	0.1	0.18	0.3	0.22	0.23
16.	Sulphate	47	52	72	96	48
17.	Iron	0.2	0.6	0.1	0.1	0.2

Ligand: All values are ppm except PH value, turbidity NTU, PCB, PAHS μg/l.

Silver nitrate reacts with chloride ions to form silver chloride, and the reaction is indicated by a red color produced when silver nitrate reacts with potassium chromate solution. Potable water typically contains substances that do not interfere with the reaction, except for bromide, iodide, and cyanide, which titrate as chloride. However, orthophosphate in excess of 25mg/L can interfere, and iron in excess of 10mg/L marks the endpoint. Additionally, sulphide, sulphite, and thiocyanate ions can interfere, but these interferences can be eliminated by the addition of hydrogen peroxide.

Reagents used for the analysis include chloride-free distilled water for preparation. Standard silver nitrate titrant (0.0282 N) is prepared by dissolving 4.791 gm of AgNO3 in distilled water and making it up to 1000 ml. It is standardized against 0.0282 N sodium chloride solution. Standard sodium chloride titrant (0.0282 N) is prepared by dissolving 1.648 gm NaCl in distilled water and making it up to 1000 ml. Potassium Chromate Indicator Solution is prepared by dissolving 25 gm of potassium chromate in 100 ml distilled water, and AgNO3 solution is added dropwise until a slight red precipitate is formed. Special reagents for removal of interferences include aluminum hydroxide suspensions, sodium hydroxide (1 N), sulphuric acid (1 N), and hydrogen peroxide (30%).

The assessment of water quality management involves a systematic qualitative analysis of water pollution, covering various parameters such as pH, temperature, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total suspended solids, nutrient levels, and the presence of heavy metals or pathogens. This analysis is conducted by selecting representative sampling sites, collecting water samples, and comparing the obtained data with established water quality standards.

The overall process includes identifying parameters, sampling, data collection, analysis, source identification, impact assessment, recommendations, and establishing a monitoring and evaluation system. The assessment considers local regulatory standards and guidelines, aiming to propose effective water quality management strategies and interventions tailored to the specific context.

Additionally, the monitoring and evaluation phase includes trend analysis during pre and post-monsoon seasons, assessing groundwater levels over a ten-year period, and preparing region-wise percentages of wells showing rise, fall, or no significant trend. This comprehensive approach ensures a thorough understanding of water quality dynamics and supports informed decision-making for sustainable water resource management.

IV. Conclusion

Nalanda District in Bihar primarily relies on groundwater, sourced from wells and tube wells, as its main water supply. Given its agricultural nature, groundwater plays a pivotal role in irrigation. Additionally, the district receives water from prominent rivers like the Ganga River and its tributaries, including the Punpun River. The local government has initiated various programs to enhance access to safe drinking water, involving the installation of hand pumps and piped water supply systems. However, variations in water availability and quality exist across different areas of the district, with some regions encountering challenges related to either water scarcity or contamination.

A qualitative analysis of water pollution in Nalanda district underscores the substantial contributions of agricultural activities and inadequate waste management to contamination. The overuse of fertilizers and pesticides in farming results in nutrient runoff, causing eutrophication in water bodies. Simultaneously, improper disposal of industrial waste exacerbates the pollution issue. Addressing these concerns requires the implementation of stringent regulations in agriculture, the promotion of organic farming practices, enhanced waste management strategies, and comprehensive public awareness initiatives. Effective collaboration among stakeholders and the establishment of regular monitoring programs are essential steps toward ensuring robust water quality management in the district, thereby safeguarding water resources for the well-being of both the human population and the local ecosystem.