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A Review on Significance of Ground Water Quality Assessment

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Abstract - Many people throughout the world rely on groundwater water stored below the surface of the Earth for their daily water needs. The ecological stability of our world depends on it, and its quality has an effect on human health. Natural processes, human activities, pollution dangers, and monitoring methods are all relevant to this discussion. The continued availability of groundwater and the safety of the people who rely on it depend on our capacity to accurately assess and characterize its quality. In this investigation, we will dig into the many facets of groundwater quality, illuminating the problems, potential solutions, and criticality of protecting this unseen resource.

Keywords - Groundwater, WHO, pollution, contamination, Ecological stability.

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INTRODUCTION

The groundwater in urban and industrial regions is particularly vulnerable to contamination. Both human activities and natural processes contribute to the contamination of groundwater. The reaction of solid waste and discharged effluents from industrial facilities, which infiltrate via precipitation, contaminate the groundwater. This groundwater is tainted because percolating water takes up several heavy metals on its way to the aquifer system. It has been estimated that eighty percent of human ailments in underdeveloped nations are caused by polluted groundwater. [1]

According to the World Health Organization, drinking water pollution is responsible for roughly 5 million annual fatalities worldwide. Water pollution prevention has risen to the forefront of environmental protection agendas in both industrialized and a growing number of developing nations. Successful policies for preventing, controlling, and reducing inputs of hazardous substances, nutrients, and other water pollutants from point source into aquatic environment have incorporated the prevention of pollution at the source, the precautionary principle, and the prior licensing of waste water discharges by competent authorities.[2]

Only 2.5% of the entire stock in the hydrosphere is freshwater, with a total of 35 million km3. The ice and permafrost of the Arctic and Antarctic areas hold vast quantities of freshwater. Vapor and cloud water in the atmosphere have a volume of around 12,900 km3, or 0.04 percent of all available freshwater. In 2020, when the global population is expected to reach roughly 7.5 billion, there will be enough freshwater on Earth to provide each person with about 12,000 liters.

However, natural and anthropogenic causes have led to a worldwide shortage of fresh water and widespread water contamination. Water is deemed polluted when it contains enough contaminants to render it unsafe for consumption or other purposes. Increased population, better standards of life, and expanding economies have all contributed to a surge in the need for high-quality water.[3]

Water use has increased six fold during the last century. Human activities have resulted in the loss of between 64 and 71 percent of the world's natural wetland habitat since 1900. Sixty percent of the world's population, or roughly 4 billion people, lives in areas with almost permanent water stress. Three billion people worldwide do not have access to safe, clean water at home.

By 2025, half of the world's population may face water scarcity. By 2030, global water demand is expected to exceed availability by 40 percent, and by 2050, as many as 6 billion people may confront water scarcity.

One billion people still practice open defecation in 2016, and over 600 million do not have access to even minimal levels of drinking water, according to UNICEF's report Strategy for Water, Sanitation, and Hygiene 2016-2030. The first discovery, related to water contamination, is of grave concern, as is the second finding, related to public health.

As surface water resources dwindle and pollution rises in many regions of the globe, there has been a frantic hunt for new, clean water sources, and this has forced people to turn to groundwater.

Groundwater

The term "groundwater" is used to describe the aqueous substance that fills all subterranean voids and flows only because of gravity. It's the water that collects in the cracks and crevices of rocks and soil due to infiltration of rainwater or the water that flows into these areas from rivers, lakes, and other bodies of water. [4]

Aquifers are underground water reserves that may be found in either rock formations or unconsolidated deposits. The water table is the depth at which water completely fills all of the spaces in the ground, including soil pores, rock cracks, and rock voids. The chemical make-up of groundwater is "a result of where the water has been and what sort of substance it has washed over or through" (www.env.gov.html).

The groundwater regime is an intricate ecosystem in which water is always on the move thanks to the processes of recharge (water entry) and discharge (water exit), both of which may happen naturally or be influenced by human activity. Water may be extracted from impermeable rocks like granite that contain an abundance of sand or gravel when the regular sources of groundwater supplies are depleted. Recharge of a basin's aquifers is influenced by a number of factors, including precipitation, solar radiation, groundwater usage, ground qualities, and the depth to which aquifers are buried under the surface.

Obtainable Water:

Only 2.4% of the total water in the world is found on land, and only a fraction of that is drinkable. According to estimates by Prakash et al. and Ganesh Hegde ef a/., fresh water supplies to humans make up just 0.3-0.50 a of the world's total water supply.23 There is a limiting amount of fresh water available. Water has been used for centuries, and as the population grows and the quality of life people enjoy thanks to technical advances rises, so does the risk of overexploitation (Todd and Raj Indra). Since water is a solvent, it may be used to break down almost all organic substances. To maintain good health, access to clean, portable water is crucial. In both urban and rural settings, groundwater is the best and most reliable supply of potable water. It is impossible to overstate the significance of ground water to the continued survival of human civilization. More than 90% of the people in certain Indian states rely on groundwater for their daily needs. In addition to its primary application in agriculture, groundwater is increasingly being put to use in the manufacturing and processing industries.[5]

The reservoirs are constantly swapping water back and forth. The water in rivers is typically refreshed every 16 days. Once every 8 days, all of the water vapour in the atmosphere is replenished. Large bodies of water including lakes, glaciers, oceans, and aquifers have a slower rate of replenishment. These reservoirs require hundreds of years to thousands of years to replenish. In the case of several of these resources (particularly groundwater), human consumption rates far surpass their natural regeneration rates.

About 329 m ha of land in India is drained by 24 large river basins and clusters of minor river basins. Few natural lakes exist at the country's surface. The rains and snowfall in northern India are essential to the country's yearly water cycle. Some of the glaciers in the upper portions of the Indus, Ganga, and a tiny portion of the Brahmaputra basin rely on snow from the higher Himalaya as a reservoir for their water supply. Overall, the country's water balance is unfavourable, with considerable run off during the monsoon, modest infiltration and low recharge, negligible river flow during dry periods, and limited ground water potential. Rainfall, various types of precipitation, snow, and dew are the main sources of water. It is estimated that just over 400 M ha m of precipitation falls annually across the entire country; of this total, about 70 M ha m is lost to evaporation; about 215 M ha m seeps into the soil; about 115 M ha m flow into the river system, lakes, and tanks; and the remaining about 50 M ha m percolates into the porous strata and contributes to the yearly enrichment of underground water. The relative contributions of run-off, percolation [6]

Hydrologic Status:

The word "water quality" refers to the chemical, visual, physical, and biological properties of water in relation to how well it serves a certain function. A healthy ecosystem is one in which a diverse array of organisms may thrive without endangering human health. The dramatic increase in population, urbanization, and industrialization has contributed to the current water crisis. Water quality issues are exacerbated in rural locations. The economic and recreational values of our water resources will decrease if the quality of our water is not maintained (ESCAP).

Pure Water:

Water, in its numerous forms in nature (including clouds, rain, snow, ice, and fog), is essential to all kinds of life. Chemically pure water, however, does not exist for any considerable amount of time in nature. Water still absorbs trace quantities of gases, ions, dust, and particle materials from the air even as it falls as rain. Then, it dissolves and takes with it some of practically everything it touches as it runs over or through the surface layers of the ground, including that which is put into it by man. The categories of biological, chemical (including inorganic and organic), physical, and radioactive contaminants are rather arbitrary. Solvents used in industry, metals and salts, sediments, pesticides, herbicides, plant nutrients, radioactive materials, road salts, decomposing animal and vegetable waste, and microorganisms including algae, bacteria, and viruses are all examples of pollutants. These contaminants may alter the water's flavour, colour, odour, or cloudiness (turbidity), as well as make it hard, caustic, stain, or foam. They might spread diseases and harm plants in the process of growth.[7]

Homeowners worry most about issues associated with drinking water and their families' health, as well as the expense of soaps, detergents, "softening," or other treatments needed to improve water quality. Farmers care about the overall mineral content, the amount of sodium, and the presence of ions "toxic" to plant development because of the impact irrigation water has on soil's chemical, physical, and osmotic qualities, which in turn affect crop productivity. Setting a standard for different pollutants is one way to establish and guarantee the purity and safety of water.

The great Greek philosopher Pinder once observed, "Water is the best of all things." Water is a crucial component of the environment and may be found in abundance. Water is essential to the development and survival of every living thing on Earth. Seventy-one percent of Earth's surface is now covered with water, making it an essential resource for all kinds of life. Most of the water on Earth is located in the oceans and seas (96.5 percent), in groundwater (1.7 percent), in glaciers and ice caps (1.7 percent), in other large water bodies (less than 1 percent), and in the air (0.001 percent) as vapor, clouds (made of solid and liquid water particles suspended in air), and precipitation. Fresh water accounts for just 2.5% of the world's water supply, and almost all of it is frozen or underground. Less than 0.3% of the world's freshwater is found in rivers, lakes, and the air, and an even smaller quantity (0.003%) is hidden away in biological systems and man-made items. [8]

Most modern advancements still rely on ground water, which has historically been the most significant supply of potable and industrial water. Agricultural, industrial, transportational, aqua cultural, public water supply, etc. all have various applications for ground water. The use of ground water for both irrigation and human use is crucial. It's great for maintaining natural ecosystems, full with flora and wildlife of all kinds. It's also vital to our enjoyment of leisure time and the quality of life as a whole. Each watershed's quality and features are determined by a number of variables, including its size, the volume of water flowing through it, the ratio of undeveloped to developed land, and the direct influences of humans. Each kind of water resource requires its own unique approach to management and conservation. No one indicator of water quality exists. It's safe to assume that human activities have added to the already complex chemical makeup of ground waters. As a result, experts in the field have refined their methods for quantifying excellence.

Depending on the situation, a single water sample may be analyzed for a few of compounds or hundreds. The quantity of usable groundwater is diminishing due to human demands on the hydrosphere as a whole and climate change-induced droughts. Also, many areas' groundwater supplies are being polluted with dangerous substances like fertilizer and sewage. Understanding the effects of management activities on water quality is essential for managing water habitats. The goals of most water quality monitoring systems are to determine both the current state of the water supply (does it fulfill certain criteria?) and its trajectory (is it growing better or worse over time?). However, it has become very contaminated with a wide variety of dangerous toxins as a result of human population growth, industrialization, the use of fertilizers in agriculture, and other activities.[9]

Since many different water-borne illnesses may be acquired through drinking water that has been tainted, it is crucial that the quality of drinking water be monitored on a regular basis. Because the chemistry of water discloses so much about the metabolism of the ecosystem and explains the overall hydro - biological link, it is challenging to get a complete understanding of the biological phenomena. However, it cannot be denied that in the previous several decades, clean drinking water has been more widely available in practically every region of the globe. However, over 2.5 billion people still lack access to appropriate sanitation and over one billion people lack access to clean water. As a result, there is a direct link between the availability of clean water and the level of economic development. By 2025, more than half of the global population may be at risk due to their proximity to water, according to some estimates. Because of factors including population expansion, industrial development, pollution from a wide range of human, agricultural, and industrial wastes, and sudden changes in climate, both surface and groundwater resources are rapidly depleting.

Analysis revealed that physicochemical characteristics often surpassed WHO drinking water criterion. The World Health Organization (WHO) recommends that contaminants be classified in terms of their toxicity, environmental permanence, and mobility. The biggest possible effect on human health is generated by trace metals. Highly harmful metal contaminants include cadmium, mercury, lead, nickel, chromium, and aluminum.[10]

INORGANIC SALTS AND THEIR INFLUENCE ON GROUNDWATER

"Hard" water, brought on by inorganic salts, is unfit for domestic, commercial, or agricultural use. In Table 1.2, we see some of the issues that might arise from groundwater containing inorganic salts. Both calcium and magnesium are major contributors to hardness. According to BIS, the recommended limit for calcium (Ca^{2+}) in drinking water is 75 mg/l, while the acceptable limit is set at 200 mg/l. Manganese (Mn) in water is mostly derived through the weathering of manganese-containing minerals and rocks. Algae, particularly blue-green algae, have a metabolic slowdown with decreased concentrations of potassium from agricultural run-off.

Table 1: The Role of Inorganic Salts in Human Health

S.No	Inorganic salts	Effects
1	Magnesium sulphate	Cathartic effect
2	Metal chloride	Increases the conductance of electrical insulating paper
3	Iron salts	Lung and heart tissues
4	Metal carbonates	Nasal and respiratory
5	Metal nitrates and phosphates	Induce the growth of Algae

Sodium in water increases soil hardness and decreases soil permeability. Some bacterial decomposition of organic molecules causes iron to be present in water. Chloride in water is indicative of organic contamination from sources such as human waste, industrial runoff, and agricultural fertilizers. An excessive amount of sulfate in the water, which is produced during the leaching of gypsum, might irritate the digestive tract. Orthophosphate from farm runoff is a major source of fluoride and phosphate contamination in aquatic environments.[11]

Anthropogenic causes, such as the discharge of septic waste, sewage, industrial waste, and septic tanks, have been shown in several studies to cause groundwater to exceed the limits of health requirements. Water quality maintenance and the prevention of contamination in ground and river water are crucial. The natural system is impacted by water contamination. Therefore, it is crucial to regularly evaluate the water's physicochemical properties.

The groundwater supply is being depleted by human use, industrial use, and irrigation. When there is a pattern of consecutive days without rain, it may deplete the water table. Rapid urbanization and industrialization have increased the demand for and exploitation of groundwater, which has an impact on both the amount and quality of this resource. Groundwater's high standard is confirmed by its physicochemical analysis [12] .

Different ion chemistry of groundwater is maintained through ion exchange reaction, the dissolution of mineral salts of the rocks, and the topography. There is a body of study in India devoted to determining the quality of ground and river water via various geochemical investigations. Related research was conducted at the study site. This research, unlike its predecessors, is concerned with the hydro geochemical characterization of ground and river water as a whole.

Recent years have brought increasing anxiety, particularly to the coastal sections of the Kanyakumari district, due to alerts about rising water deficit and poisoning of the water sources. The collected water samples were tested for a wide range of physicochemical characteristics, including pH, temperature, alkalinity, chloride, fluoride, iron, sulphate, ammonia nitrogen, nitrite nitrogen, phosphate, dissolved oxygen, and trace metals like lead, cadmium, iron, silica, calcium, magnesium, sodium, potassium, copper, zinc, mercury, and aluminum. Farmers have also dug a number of bore wells for irrigation purposes in recent years, where as there is now a significant difference in water chemistry.

The Pazhayar river water is utilized for both agricultural and household uses, as is the groundwater and coastal aquifers of the region under investigation. The groundwater quality in this region has declined after the December 26, 2004 tsunami flooded coastal areas. Therefore, this research is now more important than ever.[13]

Water, a resource that is crucial to life on Earth, is the most precious commodity in the universe. The name "Elixir of life" fits the substance well. Because water is so valuable, disagreements and even wars may break out when various parts of the globe compete for the same supply. Because of how important it is, scientists are actively searching for other planets in the universe that could have water.

Conflicts over water are seen on all social scales. Conflicts over water resources have the potential to foster new rival factions inside a state and even sow discord across nations. Although water conflicts are widespread, those involving transnational rivers are especially complex and difficult to resolve. Internal instability and political turbulence might have erupted into violence, and it's possible that water scarcity had a role in all three. That water has been called the "oil of the twenty-first century" is not surprising.[14]

Water makes up around 57% of a human's total mass. In many ways, from drinking and eating to cooking and irrigating crops and raising animals to processing and manufacturing, water is essential to human life. It acts as a sink for toxins created by human activities and protects landscapes in a variety of climatic zones. India's National Water Policy from 2002 recognizes water as a precious commodity, basic human need, and precious natural resource.

Clean water is not only essential to supporting life on Earth but also to making any kind of long-term advancement feasible. Volcanoes spewing forth water vapor throughout the early Earth's history are solely responsible for the planet's water supply. Almost little change has been seen in the total volume of water that makes up the world's seas, glaciers, arctic ice, groundwater, rivers, and lakes. The total amount of the water reserves is about 1.386 million km3. The majority of these reservoirs are really salt water found in the world's seas.[15]

CONCLUSION

Groundwater quality is a major issue that has serious consequences for ecosystems and human health. The future of this priceless resource is clearly dependent on our capacity to solve the complex problems it confronts. As we traverse the complicated web of natural processes, human activities, and pollution hazards, it becomes evident that careful management and protection of groundwater are vital. This requires preventative surveillance, strict restrictions, and a shared dedication to safeguarding this buried wealth. Safe drinking water for future generations depends on maintaining groundwater quality, which is not merely an environmental need. Groundwater quality maintenance is essential to ensuring a sustainable and healthy future in the face of growing demands on our freshwater supplies.

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