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Review on Physicochemical Characteristics of Ground Water and Their Health Effects

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Abstract

Ground water is well described through some physical and chemical characteristics viz temperature, pH, turbidity, electric conductivity, total dissolved solid, total hardness, total alkalinity, nitrates, chlorides, fluorides and metal ions like calcium, magnesium, iron etc. Ground water is commonly used as drinking water for human worldwide, because it is quite economic, easy to use and less vulnerable to contamination than surface water. Nowadays, industrialization, urbanization, fast growth of civilization and increase in population have led to deterioration of the groundwater quality rapidly. Domestic and industrial discharge, landfills, improper drainage system, seepage through sewer lines, agricultural practices such as intense use of pesticides and fertilizers, uneven rainfall and mismanagement are some of major causes for its pollution. Therefore, it is necessary that the quality of ground water should be checked regularly for some physical and chemical parameters as their presence in water above the permissible limit has a serious effect on human health. Hence assessment of physicochemical characteristics of ground water is very important for human health studies and therefore an important research topic in recent years. In the present work, physicochemical characteristics associated with ground water are reviewed along with their health effects.

Keywords

physicochemical characteristics, contamination, industrialization, human health

1. Introduction

During past decades rapidly increasing population has led to the ground water polluted. Industrialization and urbanization seem to be main cause of ground water contamination. It is most important that water which people drink and use for other purpose is clean water.

The groundwater is a dynamic system; hence the chemistry of groundwater is greatly influenced by the geology and the ecosystem of the area where it flows. The quality of ground water depends upon the origin, atmosphere, the movement of water and reaction with soil and rock. The quality of ground water is affected by climatic factors, ground water extraction and anthropogenic activities such as domestic and agricultural practices.

Ground water is generally defined by various physicochemical characteristics viz. temperature, color, order, turbidity, pH, electrical conductivity, total hardness, total dissolved solid, fluoride, chloride, sulphate, nitrate, calcium and other heavy metal ions. Hence these parameters need to be monitored continuously in order to make it fit to domestic use.

2. Physicochemical Characteristics of Ground Water

Physicochemical characteristics of ground water determine its quality and suitability for human consumption. All these characteristics have certain limit value established by IS 10500 (2012) [1].

Temperature: Temperature of the water governs all other parameters in determining the quality status of the groundwater.

pH: pH is another important parameter of groundwater that decides its fitness for many households uses like drinking, cooking, washing, cleaning etc. the values of pH commonly range from 0 to 14. The value of pH determines the acidic, basic and neutral behavior of water. pH value less than 7 indicates the acidic water, while more than 7 indicates the water is basic. The exact 7 pH shows that water is neutral. The desirable limit of pH is 6.5-8.5 as per IS:10500-2012.

Turbidity: Suspension of particles in water which interfere with the way of light is called turbidity. Turbidity in water is caused by the presence of suspended particles of different kinds. It is measured by turbidity meter [2]. The acceptable limit is 1 NTU and permissible limit is 5 NTU as per IS:10500-2012.

Total Dissolved Solid (TDS): Different types of minerals present in water are represented by TDS. The quality of water is directly related to TDS. It is evaluated by TDS meter [3]. As per IS:10500-2012 the acceptable and permissible limit is 500 and 2000 mg/l respectively.

Figure 1. Testing the TDS of ground water

Total Hardness: Total hardness equals the sum of calcium and magnesium hardness in water [4]. Hardness in underground water resources may be due to the natural salt accumulation or direct entry of polluted water. The acceptable and permissible limit for total hardness as per IS:10500-2012 lies between 200-600 mg/l respectively.

Total Alkalinity: The sum of total components in the water which results in increasing the pH level to make the water alkaline is called the total alkalinity. The elevation of alkalinity in water is due to the presence of carbonates, bicarbonates, phosphates and hydroxide [5]. As per IS:10500-2012, the desirable limit for total alkalinity is 200 mg/l and 600 mg/l in permissible

limit.

Nitrates: In water resources, nitrate is found in the form of nitrogen compound. The occurrence of nitrate in water is due to domestic and industrial effluent, animal matters, rotten vegetables, fertilizers producing factories and agriculture runoff [6]. As per IS:10500-2012, the acceptable limit for nitrate is 45 mg/l and no relaxation in permissible limit.

Chloride: Chloride is naturally present in water from chloride stone, agriculture and industries. its acceptable limit and permissible limit are 250 mg/l and 1000 mg/l respectively.

Fluoride: The presence of fluoride in groundwater is generally due to the minerals naturally found in the rocks. The acceptable and permissible limit for fluoride as per IS:10500-2012 lies between 1.0 to 1.5 mg/l respectively.

Calcium and Magnesium: The occurrence of calcium in ground water is mainly due to the minerals containing rocks found in the region such as CaCO3, CaSO4, CaMg(CO3)2 etc. The source of magnesium in ground water may be the same as that of calcium [7]. As per IS:10500-2012 the accepted limit for calcium is 75 mg/l and permissible limit is 200 mg/l.

As per IS:10500-2012 the accepted limit for magnesium is 30 mg/l and permissible limit is 100 mg/l.

Iron: Iron is a trace metal which in ground water mainly comes from weathering of rocks and minerals containing soil. Increasing human activities may also enhance the concentration of iron in ground water [8]. As per IS:10500-2012, the acceptable limit for nitrate is 0.3 mg/l and no relaxation in permissible limit.

Different parameters are shown in figure 2.

No.	Parameters
1	pH
2	Turbidity
3	Carbon-dioxide
4	Hardness as CaCO3
5	Iron Content
6	Manganese
7	Nitrate-Nitrogen
8	Total Alkalinity
9	Fluoride
10	Chloride
11	Arsenic
12	Temperature
13	Odour
14	Taste
15	Fluoride
16	Carbon dioxide

Figure 2. Water quality parameters

3. Review of Literature

I referred various technical research papers on physicochemical characteristics for ground water sources of different cities and countries which are summarized below: -

Jain et al. [9] assessed the ground water quality of Jaipur city, Rajasthan, India and concluded that excess concentration of chloride, EC and TDS including hardness make the ground water unfit for drinking. Pawari et al. [10] assessed the physico-

chemical characteristics such as pH, conductivity, alkalinity, TDS, hardness, Chloride, turbidity, temperature and concluded that hard water is unsuitable for domestic use. Choubisa [11] investigated fluoride distribution in drinking ground water in Rajasthan, India. In rural areas of all 33 districts in Rajasthan, drinking ground water sources have fluoride beyond the permissible limits of 1-1.5ppm. Consumption of such water is a threat to human health. Mathur et al. [12] studied 9 physico-chemical characteristics from different areas of Jaipur, Rajasthan, India such as pH Total hardness, Chloride, Fluoride, Total dissolved solids, Calcium, Magnesium, Nitrate, alkalinity and suggested treatment before consumption and protection from contamination.

Rao et al. [13] examined the Water Quality Index (WQI) ranging from 28 to 267 of ground water in Greater Vishakhapatnam city. The high value of WQI is found to be from the higher values of hardness, Ca, Mg, Chloride, Nitrate and TDS. Dohare et al. [14] analyzed the ground water parameters by assessing the WQI of ground water of different wards of Indore city and its industrial area. The study states that water quality is dependent on the type of pollutant added and the nature of mineral found. Ambiga et al. [15] carried out ground water quality assessment from 35 locations in Ranipet, Vellore district, Tamil Nadu. Different parameters were examined using regression model. The experimental work shows the increase in the pollution load due to the addition of domestic and industrial effluents into the ground water. Usman et al. [16] carried out examination of water quality of ground water in Terengganu, Malaysia using multivariate statistical techniques such as Cluster Analysis (CA), Discriminate Analysis (DA) and Principal Component Analysis (PCA). CA resulted in three clusters of sampling site. DA use only 3 parameters i.e., Ca+, NO2 and PH.

Deshpande et al. [17] carried out evaluation of ground water quality of 15 ground water sample collected from Vaijapur taluka of Aurangabad district Maharashtra, India Higher concentration of TDS (26.66%), TH (60%), EC (26.66), Chloride (33.33%) and Mg (86.66%) indicates deterioration as per WHO and BIS standards. Adekunle et al. [18] carried out assessment of some physical, chemical, biochemical and microbial water quality parameters in 12 hand- dug wells in typical rural areas of south-west Nigeria. The concentration of water quality parameters is influenced by the change of season from dry to wet period. The water samples from nearby pollution sources contained Pb, Cd and coliform levels above the WHO limits of drinking water. Arumugam et al. [19] carried out the work on ground water using geographical information system in Kannur district, Kerala, India.

Chaudhary et al. [20] carried out ground water quality status in arid areas of Rajasthan (India). The quality of ground water was assessed on their suitability for drinking and irrigation in the samples collected from 3 different canal catchment areas. High level of TDS and F- are major water quality issues in drinking purpose. Reza et al. [21] carried out work on quality of ground water by WQI method in Angul-Talcher region of Orissa (India). 24 ground water samples were collected from open tube well during summer and post monsoon season. The values of WQI were found in the range of 14-57 in summer season while 19-67 in post monsoon season. Thangavelu et al. [22] carried out work on physicochemical characteristics for mapping the ground water quality in Coimbatore city, India. This research work deals with mapping the quality of ground water using GIS software. Spatial distribution maps of water quality parameters such as pH, EC, TDS, Ca, Mg, TH, Alkalinity, Cl2, Na, SO42- and K of North Coimbatore were prepared using ArcGIS 9.3.

Jencipriya et al. [23] carried out work on analysis of ground water quality mapping using GIS around Singanallur Lake located in Coimbatore. 22 samples were collected and analyzed for both pre (2019) and post (2020) monsoon season. TDS, EC, TH, Mg exceeded the permissible limits. It results that the lake water was not suitable for drinking and irrigation uses because of discharge of domestic sewage into the lake. Razbe et al. [24] removed fluoride from drinking water through various options like alternate water sources, better nutrition and defluorination of water by adsorption, ion-exchange, membrane process and coagulation-precipitation. Sanghratna et al. [25] reviewed fluoride removal from water by various techniques like coagulation and precipitation method, ion-exchange process, electro-coagulation process, adsorption and membrane process by reverse osmosis, nano filtration membrane process, dialysis, and electro-dialysis. Woldu [26] reviewed fluoride

removal from drinking water by various methods like coagulation and flocculation, adsorption, membrane filtration, electro dialysis and adsorption by using diatomaceous earth. Raul et al. [27] studied removal of fluoride from water using Iron oxide-hydroxide nanoparticles. They investigate that the maximum sorption capacity of the Iron oxide-hydroxide is found to be 16.70mgg-1 for fluoride at room temperature and also influenced by pH of the medium.

4. Health Effects of different Physiochemical Characteristics of Ground Water

The presence of various physicochemical parameters in excess quantity in drinking groundwater adversely affects public health. Ground water having pH less than 6.5 is said to be unfit for drinking purposes, as it is considered too acidic and may be responsible for acidosis and other health hazards in humans [28]. The highly turbid water may lead to the elevation in the water temperature. Moreover, the suspended particle in water gives more space for adsorption of harmful chemicals too. This may cause undesirable taste and odor to drink water and rise in temperature may cause health related problems in humans [29,30]. The higher value of total hardness in drinking ground water may cause the risk of failure of reproductive system, retardation of physical growth, diseases related to cardiovascular system and other health issues [31,32]. The excess concentration of TDS gives a bitter taste to the water and causes stomach disorder. The higher concentration of carbonates and bicarbonates which are responsible for alkalinity in water shows that the water is unfit for human consumption [33]. The long-time consumption of alkaline water is not suitable for human health, so it can be utilized in drinking for some medical reasons, because it can lower the causes of cancer and ulcer [34]. The drinking ground water with higher concentration of nitrate is associated with hypertension, goiter, gastric cancer, methemoglobinemia, birth malformation and is dangerous to the pregnant women [35,36,37]. The consumption of ground water having higher amount of chloride may cause laxative effect in humans and also gives a salty taste [38]. It may cause high blood pressure and problems related to the heart [39]. The amount of fluoride above the permissible limit of 1.5 mg/l causes dental and skeletal fluorosis and non-skeletal fluorosis [40]. The insufficient quantity of calcium in drinking water may causes rickets while the excess amount may cause kidney stone or stone in bladder [41]. The magnesium in excessive amount is laxative. Its salts have cathartic and diuretic effects on human health [42]. Trace metals like Iron are needed in very small quantity for body but excessive iron content in drinking ground water led to the hazardous and lethal effect on health [43].

5. Conclusion

Ground water quality of particular region plays a vital role in determining the standards of human health [44]. Higher concentration of physicochemical characteristics in ground water may arise several medical and health problems in human beings. To meet all this health problems, timely observation of groundwater quality is essential, especially in the context of rural area, because in India, the majority of the population live in villages. The residents in rural areas are mainly dependent on groundwater for drinking and other household purposes. Therefore, the quality status of drinking groundwater should be checked regularly Thus, physico-chemical assessment of groundwater is necessary to evaluate the required parameters of water to see whether they are in limit as per the standards, following standard test methods.

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