Prioritization of Groundwater Quality Parameters for Drinking and Irrigation Purposes: A Perspective Analysis

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Abstract Water is probably the utmost prime natural asset after air. Though a large portion of the earth's surface consists of water, just a few portions of it are usable. Apart from drinking purposes, water resources have a crucial role in several segments of the economy. Day-by-day, surface and groundwater quality has deteriorated due to rapid industrialization and urbanization. Considering the environmental and economic aspects, the quality and quantity of water are very important. Since water is used for various purposes, its compatibility must be tested before use. Moreover, sources of water must be monitored on a regular basis and checked whether they are in good condition or not. Water quality assessment is very essential to overcome the adverse condition resulting from the deterioration of water quality. Standard protocol-based guidelines are now set after many years of research on water quality assessment. In this paper, several parameters with standard guidelines provided by different agencies have been discussed with comparison to measure the groundwater class for the use of drinking and irrigation. Groundwater sampling, water quality index, and Piper trilinear diagram are also associated. Finally, a rating analysis of water quality parameters has been done on a priority basis of the perspective assessment of groundwater characteristics for the use of drinking and irrigation.

Keywords Groundwater sampling · WQI · Piper trilinear diagram · Rating analysis

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1 Introduction

In many areas of a country, the available sources of water get exhausted and also contaminated due to rapid industrialization and urbanization [1]. Salinization, resulting from seawater intrusion, chemicals used in agricultural, geogenic activities, and irrigation, is the major issue for contamination of groundwater [2]. Water with some chemical hazards is unsuitable for specific use. A severe health problem can occur due to the utilization of unsafe water for drinking and cooking. For drinking purposes, water quality assessment involves the appraisal of chemical composition and identification of probable sources for the contamination of groundwater and also provides the curative measure for fixing the quality of water.

A sufficient amount of water is necessary for the growth of the plant. On the other hand, the quality of irrigation water should be within the permissible limit to avoid adverse effects on the growth of the plant. Characteristics of irrigation water are influenced by the quantity of suspended silt and chemical ingredients present in the water. In addition to surface water bodies and rainwater, another source of water supply is essential to attain continual crop production. Groundwater is considered an alternative source for irrigation farming [3].

In a region, the variation of groundwater quality depends on physical and chemical properties which are highly affected by geological features and humans' interference [4–6]. Groundwater contamination has been issued in many areas caused by normal climatic activities and human interruption in the geo-systems. To realize the method of controlling the hydro-chemical characteristics of groundwater in a particular region, it is necessary to culture the geologic formation of rocks, natural and human activity, melting of rocks and minerals, and weather conditions which affect the hydrochemistry of the region [7]. The water facies with respect to the most influential ions is classified by the Piper trilinear plot [8]. Water quality assessment is the major tool for reliable evolution and also gives conclusive details to manage water resources [2]. Water class evaluation is a method of finding the correct nature of water by calculating the presence of parameters and their range through several experiments. Considering the facts, groundwater quality assessment is necessary to find whether requisite water quality is in accordance with specified standards or not. Evaluating the class of water for proper groundwater sampling is very important for water quality analysis [9]. This paper aims to review the parameters with standards for ascertaining the compatibility of groundwater for drinking and irrigation purposes. Every parameter is important in water quality testing for different uses. But the presence of some of the parameters above the permissible limit has a significant impact on water quality as well as human growth and plant growth. Some parameters such as pH, chloride, calcium, magnesium, and sulfate have a major impact on human health. Parameters such as fluoride and arsenic have a profound effect on human health [10]. For irrigation water, parameters like total dissolved salts, electrical conductivity, and sodium absorption ratio have a significant impact on plant growth [1, 11]. Therefore, before using water for different purposes, parameters should be considered as per their importance in analyzing water quality. A rating analysis on a priority basis has been done to judge the groundwater class as well.

2 Groundwater Quality Assessment Parameters for Drinking Purpose

Limitations of drinking water quality have been proposed by many organizations such as APHA [12], WHO [10], and Indian standard [13] drinking water specifications. The acceptable limit (AL) and the permissible limit (PL) of water for drinking are given in Table 1 as per Indian standard drinking water specifications.

Generally, **pH** has an indefinite impression on users, but it is the utmost significant parameter to judge the class of water [10, 14, 15]. For drinking purposes, the pH value should be 6.50–8.50 [13].

Chlorine is the most common element that exists in terms of chloride ions in water. The sources of chloride in groundwater are possibly seawater intrusion, weathering, seepage of soil, household effluents, and industrial sewage [2]. Excess chloride imparts salted flavor to water and liquid refreshment. Chloride levels over 250-ppm can create perceptible flavor in water [10]. The high concentration of chloride causes a salty flavor to water and a purgative effect in unaccustomed consumers.

Fluorine is a general component that is broadly spread on the earth's layer and is present in terms of fluorides. The highest allowable range of fluoride in drinkable water is 1.50 ppm. Dental fluorosis is owing to the existence of fluoride in water over the allowable limit and skeletal fluorosis is caused by a much higher level of fluoride present in water [10].

It has been observed that people consuming **arsenic**-contaminated water suffer chronic diseases like skin lesions, skin cancer, bladder and lung cancers, peripheral neuropathy, and peripheral vascular disease. The most commonly viewed symptom is dermal lesions which occur due to at least exposure times of around five years.

Table 1 AL and PL of water for drinking [13]

Parameters	AL	PL
pH	6.50–8.50	No relaxation
Chloride (as Cl) (ppm)	250	1000
Fluoride (as F) (ppm)	1.0	1.5
Arsenic (as As) (ppm)	0.01	0.05
Total dissolved solids (TDS) (ppm)	500	2000
Nitrate (as NO_3) (ppm)	45	No relaxation
Calcium (as Ca) (ppm)	75	200
Magnesium (as Mg) (ppm)	30	100
Total hardness (as $CaCO_3$) (ppm)	200	600
Sulfate (SO_4) (ppm)	200	400

Melanosis, diffuse keratosis, and leuco-melanosis are the major dermatological signs. It has a substantial impact on the circulatory system of kiddies who are ingesting arsenic-contaminated water with a mean concentration of 0.60 ppm for a mean of seven years [10].

TDS indicates mineral ingredients exist in the water in dissolved forms. It is a special significant parameter to evaluate water class in drinkable water [4, 7, 16]. The high level of TDS in groundwater is mostly caused by the existence of calcium, chlorides, sulfates, carbonates, and bicarbonates [2]. Water is considered palatable if the TDS is under 600-ppm and the TDS level (ppm) > 1000 is not good for drinking [10]. Considering TDS concentration, groundwater quality is categorized as fresh (TDS $\leq$ 1000), brackish (1000 $\leq$ TDS $\leq$ 10,000), saline (10,000 $\leq$ TDS $\leq$ 1,000,000), and brine (TDS > 1,000,000) [14]. In potable water, water class with respect to TDS (ppm): below 300 $\rightarrow$ excellent water; 300–600 $\rightarrow$ good; 600–900 $\rightarrow$ fair; 900–1200 $\rightarrow$ poor; over 1200 $\rightarrow$ not acceptable [11].

The possible roots of **nitrate** are found in groundwater due to seepage of nitrogenous fertilizer and manures, disposal of wastewater, septic waste, human and animal excreta, etc. Rarely, nitrate possibly exists in groundwater as a consequence of leaching through normal plants. Changes in nitrate concentration in surface water occurred quickly due to runoff of manure, uptake by algae, and removal of nitrates by bacteria, but on the other hand nitrate concentration in groundwater changes relatively slowly. The allowable limitation of nitrate in drinkable water is 50-ppm [10]. The most common cause of thyroid disease, diabetes, gastric cancer, and methemoglobinemia (blue baby syndrome) is water with high nitrate concentration.

Calcium and Magnesium (**Ca-Mg**) are commonly utilized to identify the compatibility of water. The hardness of water is directly connected to these ions. Ca-Mg ions are the utmost numerous substances in the surface and groundwater and are present in the form of bicarbonates, sulfate, and chloride. A high level of calcium ions in water may create abdominal disease and is unacceptable for households as it is the source of encrustation and scaling. Magnesium is a vital component for human health, as it is essential for the usual bone formation in the body. Hard water is not acceptable for domestic purposes as it carries excessive levels of magnesium or calcium. Ca-Mg is the utmost conventional mineral responsible for the **hardness** of the water. The presence of bicarbonate of Ca-Mg creates the temporary hardness of water and the existence of sulfates, chlorides, and nitrates of Ca-Mg indicates the permanent hardness of the water. This hardness of water indicates the soap destroying the property of water. Public acceptability criteria may differ from one society to another. Excess hardness in water can cause scaling in the distribution system, treatment system, pipes, and water reservoirs in residences. For drinking purposes, water class concerning total hardness as $CaCO_3$ (ppm): below 75 $\rightarrow$ soft; 75–150 $\rightarrow$ moderate; 150–300 $\rightarrow$ hard; and over 300 $\rightarrow$ extremely hard [17, 18].

The existence of **sulfate** in drinking water can make the perceptible flavor, and excessive concentration can cause a purgative effect in unwonted consumers [10]. The sulfate concentration over 400-ppm can probably react with the parts of the human body and creates a purgative effect on the human body with too much magnesium in groundwater.

3 Groundwater Quality Assessment Parameters for Irrigation Purpose

The main benefit of **pH** is a fast appraisal of the expectation of water being standard or not. The range of pH for irrigation water is 6.50–8.40. A pH above 8.20 in irrigation water can increase the potentiality of sodium problems. The high level of pH within groundwater is caused by the concentration of calcium, sodium, bicarbonate, carbonate, and magnesium [2].

All irrigation water carries **dissolved salts** such as NaCl, $CaSO_4$, $MgSO_4$, and $NaHCO_3$, but the levels and constituents of such salts differ concerning the origin of the irrigation water. The standard of water for irrigation is influenced by the number of soluble salts existing within the water. Due to the accumulation of salt at the root zone, crops are unable to withdraw enough water from the salty soil solution and that affects the plant growth as well as yield. Water with total dissolved salts below 450-ppm is regarded as excellent and above 2000-ppm is considered unsuited for irrigation [1]. Irrigation water class concerning the risky effects of total salt in terms of EC (μmhos/cm): below 1500 → low risk; 1500–3000 → moderate risk; 3000–6000 → high risk; and over 6000 → extremely high risk [19].

The entire level of the ionized components in natural water is indicated by **EC**. It is nearly connected to the amount of the cations (or anions) ascertained by the chemical test, and it corresponds well with the amount of soluble salts [20]. For irrigation water, salinity hazard is determined by electrical conductivity [21]. EC depends on the temperature, type, and concentration of various ions [4]. It is extremely meaningful as it raises the temperature and total dissolved salts in water [7]. Plants are unable to absorb enough water for growth from the soil solution (physiological drought) because of the existence of more EC in water. With the increase of EC, utilizable plant water in the soil reduces. EC (μmhos/cm) value in water below 250 is considered excellent and above 750 is regarded as unsuited to irrigation [1, 22–24]. The salinity class of irrigation water by EC (μmhos/cm) is represented as follows: below 250 → low salinity; 251–750 → moderate salinity; 751–2250 → high salinity; and extremely high → 2250–5000 [21].

Sodium percentage is a significant criterion to study sodium hazards. It is the prime factor to decide the class of water for the utilization of agricultural activities [1]. It is effective to distinguish the water, as a low amount is a sign of hard water and a high amount implies soft water. Sodium percentage indicates the sodium hazard, but it is not an efficient criterion as sodium adsorption ratio [2, 21]. Plant growth is reduced due to the application of water with a high percentage of sodium. The addition of gypsum to soil can decrease the outcome of a high level of sodium in irrigation water [1]. Equation 1 is used to compute the sodium percentage [17, 21] with reference to comparative ratios of cations that exist in water. The class of irrigation water regarding Na percentage:

$$\mathrm{Na}\% = \frac{\mathrm{K}^{+} + \mathrm{Na}^{+}}{\mathrm{Mg}^{2+} + \mathrm{Ca}^{2+} + \mathrm{K}^{+} + \mathrm{Na}^{+}} \times 100 \tag{1}$$

where Ca^{2+}, Na^{+}, Mg^{2+}, and K^{+} are the ion concentrations of calcium, sodium, magnesium, and potassium expressed in millie-quivalents per litre (m-eq/l). Irrigation water quality based on sodium percentage: below 20 → excellent; 20–40 → good; 40–60 → permissible; 60–80 → doubtful; and over 80 → not suitable [3].

Sodium-Absorption Ratio, **SAR**, is a vital factor to determine the compatibility of groundwater in irrigation works [2]. Soil properties are changed because the use of irrigation water with excess sodium and excess sodium in water also makes the soil impervious [1, 11]. High and extremely high sodium water is considered unsuited for irrigation purposes [2]. If groundwater with a high sodium proportion is used for irrigation purposes, it can demolish the soil structure [4, 11]. Equation 2 is used to compute the SAR [19, 21]:

$$\mathrm{SAR} = \frac{\mathrm{Na}^{+}}{\sqrt{\frac{\mathrm{Ca}^{2+}+\mathrm{Mg}^{2+}}{2}}} \tag{2}$$

where Ca^{2+}, Na^{+}, and Mg^{2+} are the ion concentrations of calcium, sodium, and magnesium expressed in milli-equivalents per litre (m-eq/l). Irrigation water class concerning risky effects of SAR (m-eq/l)1/2: under 10 → less; 10–18 → moderate; 18–26 → high; and over 26 → extremely high [19].

The compatibility of water for irrigation use relies on the concentration of **carbonate and bicarbonate** [1]. For agricultural purposes, the serious outcome of bicarbonate and carbonate on the class of water is checked by Residual-Sodium-Carbonate, **RSC** [2]. In irrigation water, the parameters like pH, EC, and SAR are seriously affected by RSC. The physical properties of soil are seriously influenced by the irrigation water with high RSC. The permeability of soil minimizes due to more RSC in irrigation water [4]. Water is considered safe if the water contains an RSC value below 1.25 m-eq/l, and an RSC value within 1.25–2.50 m-eq/l is regarded as low class. RSC value above 2.50 m-eq/l is unsuited for irrigation [21]. Equation 3 is used to calculate the RSC [19, 21]:

$$\mathrm{RSC} = \left(\mathrm{HCO}_3^{-} + \mathrm{CO}_3^{2-}\right) - \left(\mathrm{Ca}^{2+} + \mathrm{Mg}^{2+}\right) \tag{3}$$

where HCO_3^{-}, Ca^{2+}, CO_3^{2-}, and Mg^{2+} are ion concentrations of bicarbonate, calcium, carbonate, and magnesium expressed in m-eq/l. Irrigation water quality based on RSC (m-eq/l): under 1.5 → small; 1.5–3 → moderate; 3–6 → high; and over 6 → extremely high risk [19].

Though the existence of **boron** within irrigation water is a crucial micronutrient for the development of the plant, overdose can create toxicity symptoms in particular crops. Naturally, boron is present in groundwater because of the seepage through rocks and soils carrying borates and borosilicates. Contamination of water due to boron is probably caused by water-rock interaction, seawater interference, sewage effluents, and fertilizers [2]. Normally, plants do not show any sign of boron deficiency if irrigation is done with water containing boron of at least 0.10 ppm. But in the case of more sensitive crops, damage may exhibit if irrigation is done with

Table 2 Impact on crops concerning the concentration of chloride in irrigation water [25]

Chloride (ppm)	Impact on plants
≤70	Normally every plant is safe
71–140	Low to medium damage can occur in sensitive plants
141–350	Low to substantial damage can occur in moderately tolerant plants
≥351	May create acute problems

water containing boron of more than 1.00 ppm [21]. The rating of the quality of irrigation water concerning the harmful effects of boron (ppm): under 1 → less; 1–2 → moderate; 2–4 → high; and over 4 → extremely high toxicity [19].

The existence of **chloride** in irrigation water is generally in the form of chlorine. Normally, the lack of chloride has not ever been observed as it is spread extensively and can be responsible for salinity issues. In irrigation water, the utmost usual toxic ion is chloride [2, 25]. In natural waters, chloride level is relatively low excluding brackish or saline water. Though chlorides are essential for the growth of the plant, overdose can create toxicity to some kinds of plants [25]. The chloride (ppm) in groundwater below 70 is regarded as harmless and above 350 can cause acute problems for crops [2, 25]. Table 2 shows the effect on crops concerning the level of chloride in irrigation water.

4 Groundwater Sampling

For appropriate evaluation of water quality parameters, accurate sampling is very essential. Even if leading skills with advanced tools are applied, the parameters may provide a false reflection of the original structure due to inaccurate sampling [9]. The samples are collected before and after monsoon periods in a year. Groundwater specimens are collected from bore/hand pumps that must be in active condition. Polyethene bottles of one-litre capacity are used for the collection of groundwater samples. A bottle should be washed properly with distilled water first and then deionized water and labeled before collecting the samples. Groundwater specimens are stored after driving out water for around 10 min to extract stagnant water present in the well. After that, the samples are moved to the laboratory and kept at 40 °C [8]. After that, the samples are examined with the help of a standard method as per guidelines provided by APHA [12].

For accurate sampling, the factors given below should be planned perfectly [9]: (a) method of sampling, (b) volume/size of the sampling, (c) sampling location number, (d) sample number, (e) sample type, and (f) intervals of time. At the time of sampling, the following factors must be considered [9]: (a) selection of an accurate sampling container, (b) contamination should be avoided, and (c) safety.

5 Water Quality Index (WQI)

WQI is one of the most productive and appropriate mechanisms to assess and report the quality of water of a particular water source [26]. It converts a huge amount of water quality data into an isolated digit and describes the class of water in a very simple way. It provides a common structure for comparing a large number of measured data with specified standard limits. Thus, it is easily acceptable to the administration and common people [9]. It was evolved to inspect the condition of groundwater class by including important parameters. There are a lot of water quality indices like the NSFWQI, CCMEWQI, OWQI, and WAWQI. Three steps are executed for determining WQI. At first, the weight (w_i) of every water class parameter is assigned as per its importance for drinkable water. Equation 4 is used to calculate the relative weight (W_i):

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \tag{4}$$

where n indicates the number of parameters. Then, a rating of quality (q_i) is measured for each parameter. Equation 5 is used to calculate the rating of quality (q_i):

$$q_i = \left(\frac{C_{ic}}{S_{id}}\right) \times 100 \tag{5}$$

where C_{ic} indicates the concentration level of chemical parameters of the sample of water in ppm, and S_{id} represents the standard limit of each parameter of drinkable water in ppm provided by WHO [10]. In the end, the WQI is calculated by Eq. 6:

$$\mathrm{WQI} = \sum_{i=1}^{n} W_i q_i \tag{6}$$

The class of water based on the WQI: under 50 → excellent; 50–100 → good; 100–200 → poor; 200–300 → very poor; and over 300 → not suitable [7] for drinking.

6 Piper Trilinear Diagram

Piper [27] trilinear diagram (Fig. 1) is an efficient graphical method for introducing water chemistry data that assist to understand the origins of the dissolved elements in the water. This model composes of three specified portions with pairs of triangular and a diamond. The positively charged and negatively charged ions are represented on the left and right triangles, respectively. The left triangle consists of major cations like Mg^{2+}, Ca^{2+}, and ($K^+ + Na^+$). The right triangle consists of major anions like $SO_4{}^{2-}$,

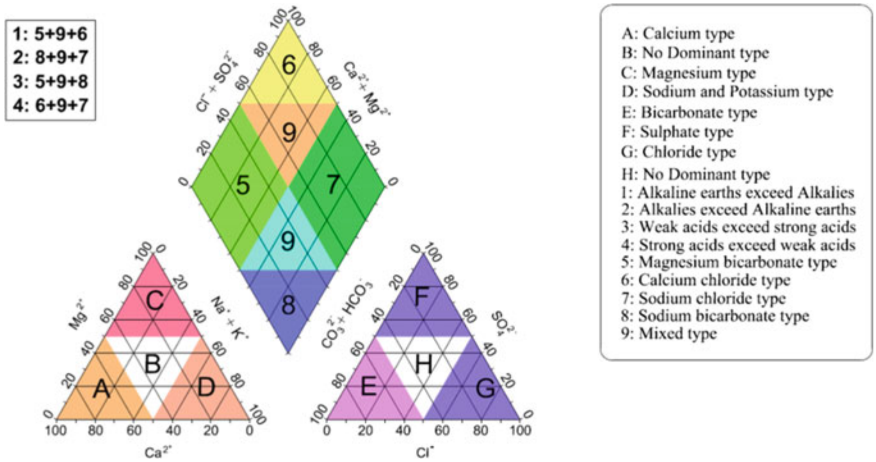

Fig. 1 Piper trilinear diagram describing the groundwater composition with respect to cation and anion

Cl^-, and ($CO_3{}^{2-}$ + $HCO_3{}^-$). The pair of triangular plots are then projected onto a diamond. Here, diamond field is a formation of anions [(sulfates + chlorides)/(total anions)] and cations [(potassium + sodium)/(total cations)] [8, 27].

7 Rating Analysis

Considering the above groundwater quality parameters for drinking, some of the parameters with a concentration above the permissible limit have a great impact on the human body. Depending on the effect of water quality parameters on human fitness, a quantitative rating analysis has been done on a priority basis for the prospective evaluation of groundwater class for drinking. The maximum rating value of 3 is assigned. The parameter with rating value 1 indicates less priority, rating value 2 indicates medium priority, and rating value 3 indicates a high priority to judge the groundwater class for drinking purposes as shown in Table 3.

8 Rating of Groundwater Quality Parameters Concerning Crops Using Irrigation

Considering the above parameters for irrigation, some of the parameters with a concentration above the permissible limit have a great impact on crops. Concerning the impact of parameters on crops, a rating analysis has been done on a priority basis to judge the groundwater quality for irrigation works. The maximum rating value of

Table 3 Rating of groundwater drinking quality parameters

Parameters	Rating value out of 3	Explanation concerning the impact on human health
pH	1	No direct impact on health [10]. The concentration of pH increases due to the intrusion of seawater in coastal areas [28]
Chlorides	1	No guideline value is provided based on human health [10]. Chloride is one of the important parameters in coastal areas [28]
Fluoride	3	The concentration of fluoride is comparatively high in groundwater [10]. Water containing fluoride above permissible limit results in dental fluorosis and skeletal fluorosis [10]. In India, around 12 million tons of fluorides are found out of 850 lakh tons of overall fluoride available on the earth's crust [29]. So, it's alarming as the concentration of fluoride is widely spread over India
Arsenic	3	Arsenic possibly exists in potable water sources, especially in groundwater, at high concentrations [10]. Arsenic is regarded as a high-precedence element for screening in potable water sources [10]. Use of water with excessive levels of arsenic results in skin cancer, bladder, and lung cancers [10]
TDS	2	No guideline value is provided concerning human fitness but a high level of TDS in drinkable water may be rejected by consumers [10]. In the seaside area, the level of TDS is excessive in groundwater due to the intrusion of seawater into the aquifer [28]. The salinity of water enhances due to the surplus TDS in groundwater
Nitrate	2	The concentration of nitrate in groundwater is relatively low, but water with a high concentration of nitrate can cause thyroid disease, diabetes, gastric cancer, and methemoglobinemia [10]. In recent times, groundwater contaminated by nitrates has been found out extremely over the world [2]
Calcium and Magnesium	1	The concentration of Ca and Mg is high in hard water, but it has an insignificant effect on human fitness [10]
Hardness	1	No guideline value is provided based on human health. The degree of hardness can affect the admissibility criteria of the consumers [10]. In the seaside area, water becomes hard because of the interference of seawater in the aquifer [28]

(continued)

Table 3 (continued)

Parameters	Rating value out of 3	Explanation concerning the impact on human health
Sulfate	1	No guideline value is provided based on human health [10]

3 is assigned. The parameter with rating value 1 indicates less priority, rating value 2 indicates medium priority, and rating value 3 indicates a high priority to evaluate the groundwater class for irrigation purposes as represented in Table 4.

Table 4 Rating of irrigation groundwater quality parameters

Parameters	Rating value out of 3	Explanation based on the impact on crops
pH	1	It is an inadmissible standard of water class as the pH of water is absorbed by the soil. And maximum crops can bear a broad range of pH limits [25]
TDS	3	Excessive salt is present in irrigation water responsible for saline soil. The salinity problem is a major issue in crop production. It reduces plant growth and yield [1]. Groundwater salinity will increase because of rare rainfall in hot arid areas. The plants will wilt due to high salt concentration in irrigation water [25]. The salinity of soil enhances due to the surplus dissolved salts in groundwater. The natural characteristics and fruitiness of soil are influenced by the surplus dissolved salts in groundwater
EC	3	EC is the key factor in deciding the appropriateness of groundwater for cultivation works [8]. With the increase of total dissolved solids, EC will also increase. Excess concentration of electrical conductivity in groundwater occurs because of the interference of seawater in the seaside aquifers and sewage water input [28]. It reduces plant growth and yield
Na%	2	It is the key factor to decide the eligibility of groundwater for cultivation works [8]. It has a great impact on soil permeability and as a result, it is difficult to plow and unfit for seed maturation [8]. Sodium accumulation affects the soil structure, infiltration, and aeration, therefore, affects on plant growth [2]. It is not an efficient criterion as SAR for groundwater quality assessment [21]

(continued)

Table 4 (continued)

Parameters	Rating value out of 3	Explanation based on the impact on crops
SAR	3	For sensitive fruits, SAR in irrigation water shouldn't be above 4, and for common crops and herbages, a limit of 8–18 is generally considered appropriate [2]. More SAR concentration results in soil grinding, bad seedling emergence, and bad aeration. It also makes the soil impermeable and demolishes the soil structure [4, 25]. In irrigation water, surplus sodium can collapse the quality of soil and can harm sensitive crops [11]
RSC	2	High levels of calcium and magnesium in groundwater are indicated by a negative value of RSC. More RSC in water can reduce the yield of crops and cause the burning of plant leaves [30]. It makes the soil impervious and affects the parameters like pH, EC, and SAR
Boron content	1	Semi-sensitive, semi-tolerant, and tolerant crops can tolerate boron concentrations of more than 1.25, 2.50, and 3.75, respectively. It has serious effects on sensitive crops if the concentration of boron is above 1 ppm [17, 21]. A level of boron above 1 ppm is regarded as significant intimidation to the utilization of groundwater for cultivation purposes. It is an essential water quality parameter for irrigation, but boron toxicity is a minor issue in maximum fields [25]
Chloride	1	It is necessary for the growth of plants, but high concentration can cause acute problems for some particular plants [21, 25]. Leaf burn may be caused if irrigation is done with water containing high chloride concentrations [2]
pH	1	It is an inadmissible standard of water class as the pH of water is absorbed by the soil. And maximum crops can bear a broad range of pH limits [25]

pH: potential of hydrogen; TDS: total dissolved salts; EC: electrical conductivity; Na%: sodium percentage; SAR: sodium-absorption ratio; RSC: residual-sodium-carbonate

9 Conclusions

Evaluation and monitoring of groundwater standard parameters for drinking and irrigation uses are very essential, particularly in growing nations like India because of rapid industrialization and urbanization. As groundwater is a valuable resource, so, it is required to maintain and save this precious resource by following some measures to prevent contamination. It is mandatory to analyze the groundwater quality for checking the compatibility criteria for the designated use. Various water quality parameters are evaluated and differentiated with their standard values to decide the acceptability of water to be used. In this paper, several parameters with their standards are mentioned in brief in one place, and rating analysis on a priority basis has been done to judge the groundwater class for drinking and irrigation uses. The rating value

3 is assigned for the parameters like fluoride and arsenic, rating value 2 is assigned for the parameters like TDS and nitrate, and rating value 1 is assigned for the parameters like pH, calcium, chloride, hardness, magnesium, and sulfate for the evaluation of groundwater class for drinking. The rating value 3 is assigned for the parameters like total dissolved salts, EC, and SAR, rating value 2 is assigned for the parameters like Na% and RSC, and rating value 1 is assigned for the parameters like pH, chloride, and boron for the evaluation of groundwater class for irrigation. It may be useful for researchers and analysts to get a detailed outline to evaluate the groundwater class for drinking and irrigation purposes.

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