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# Assessment of Groundwater Quality for Domestic Consumption and Irrigation in Kannur Taluk, Kannur, Kerala

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## Abstract

*The water quality means the physical, chemical, and biological properties of water according to usage requirements. The availability of water is greatly influenced by its quality, which also frequently dictates the available possibilities. This study assesses the Groundwater quality for domestic consumption and irrigation of the Kannur Taluk. The calculation for the study was done based on the BI Standard using thirteen parameters. The methods used for the study were the Relative Weight method and quality rating using WRIS data. The data was interpolated in ArcGIS to find the intensity of the chosen parameters.*

**Keywords:** Water Quality; Ground Water; Water Quality Index

## 1 Introduction

Water quality refers to the physical, chemical and biological properties of water, which are assessed based on specific usage requirements. It is a key indicator of ecosystem health, human safety, pollution levels and drinking water standards often achieved through treatment processes[9] . Water quality directly impacts its availability and potential uses, as defined by the Bureau of Indian Standards (BIS), which includes both treated and untreated water supplied for human consumption and cooking[5]. Water is crucial not only for life but also for economic development and ecosystem protection, analyzed from ecological, social, economic and political perspectives[4]. Ecologically, water sustains all forms of life and ecosystems, enabling biochemical reactions and cellular metabolism[7]. It cycles through various hydrological processes, appearing in rivers, lakes, groundwater and glaciers while aquatic ecosystems like rivers and wetlands contribute to biodiversity and purify water.

Terrestrial ecosystems, such as forests rely on specific water conditions and human activities or natural events that disrupt these systems can lead to the loss of biodiversity and reduced climate resilience[15]. Economically, water is essential for agriculture, which uses 70% of global water resources and industries that rely on water for cooking, cleaning and production. Hydropower contributes to sustainable energy, providing 16% of global electricity[18]. Water is also vital for tourism, transport and urbanization, driving industrial growth and trade.

Socially, access to clean water is a fundamental human right, yet millions still lack it, leading to waterborne diseases like cholera [6] . Water management is crucial for public health, disease prevention and achieving Sustainable Development Goal 6 on water and sanitation [3] . Lastly, water resources are central to environmental and climate resilience, aiding in disaster risk reduction and climate adaptation.

### 1.1 Groundwater Resources

Groundwater, stored in aquifers, originates from precipitation infiltrating the soil. It moves slowly with rates dependent on aquifer properties. Recharge occurs during rainy or winter seasons, replenishing groundwater. It supports agriculture and industry in arid regions but is vulnerable to over-extraction and pollution from fracking, chemicals and landfills. Despite its abundance, groundwater reservoirs require sustainable development to prevent depletion and contamination. Groundwater's stability during droughts makes it a reliable resource, though chemical pollution poses significant challenges. With an estimated 5.97 quintillion gallons globally, groundwater remains a critical, underutilized resource for sustaining life and development.

### 1.2 Study Area

Kannur taluk is an administrative division of Kannur district of Kerala, India. Kannur district is divided into five taluks, Thalassery, Kannur, Payyanur, Iritty and Taliparamba. Thalassery has 35 villages, Kannur has 28, Payyanur has 22, Taliparamba has 28 villages and Iritty has 20 villages. According to census 2011, Kannur taluk has a population of 7,84,984 of which 3,60,086 are male and 4,24,898 are female.

## 2 Methodology

This study was mainly done based on secondary data from WRIS. Using WRIS data several calculations have been done for this study. The formulas used for the study are:

$$Quality\ Rating = \frac{Parameters}{BIS * 100}$$

Relative weight

$$Wi = \frac{wi}{\sum n\ i = 1\ wi}$$

The study mainly determines the ground water quality of Kannur Taluk using thirteen parameters which leads to the quality of drinking water. Using thirteen parameters Water Quality Index is identified.

Water Quality Index (Permissible Limit)

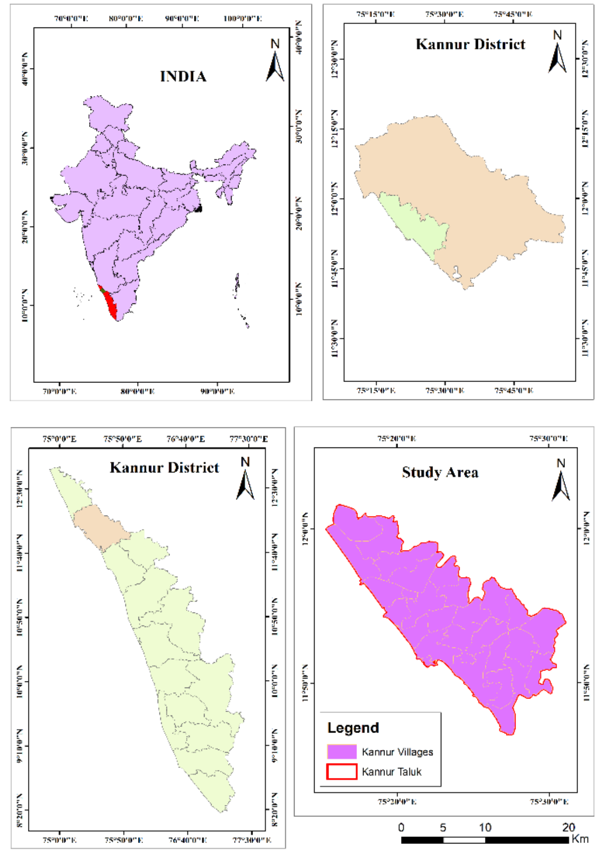


**Fig. 1. Location map of study area**

## 3 Results and Discussion

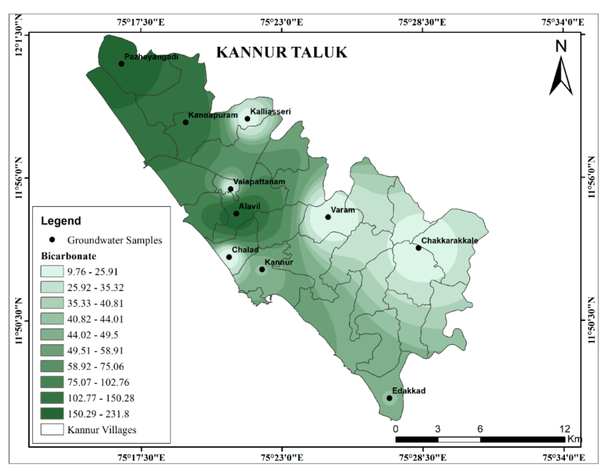


**Fig. 2. Spatial distribution of bicarbonate**

This map depicts the spatial distribution of bicarbonate concentrations in groundwater across Kannur Taluk, Kerala, India, ranging from 9.76 mg/L to 231.80 mg/L. Variations are represented by colors from light green (low concentrations) to dark green (high concentrations). Geographically, Kannur Taluk lies between 11°48'N–12°06'N latitude and 75°16'E–75°36'E longitude. Key elements such as village names, administrative boundaries, a north arrow, and a scale bar (approx. 12 km horizontally) enhance orientation.

The southern and eastern areas, including villages like Kanjhiram and Ancharkandy, exhibit lower bicarbonate concentrations, shown in light green. Central regions such as Pallikkunnu and Chirakkal display moderately high levels, while the northern and western parts, including Cherukunnu and Mattool, have the highest concentrations in dark green. This high bicarbonate concentration may result from carbonate-rich rocks or limestone, contributing to water hardness. Geological variations, soil composition and agricultural activities could further influence these patterns.

This map provides valuable insights into the hydrogeological environment of Kannur Taluk. It highlights the relationship between regional geology and bicarbonate levels, aiding in groundwater quality assessment, water resource management and environmental monitoring. Understanding these variations is crucial for addressing water quality issues and planning sustainable resource usage.

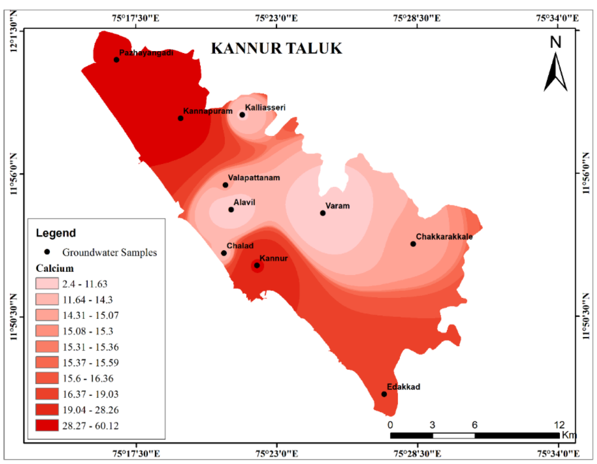


**Fig. 3. Spatial distribution of calcium**

This map illustrates the spatial distribution of calcium concentrations in various villages of Kannur Taluk, Kerala, India, using a color gradient for visual clarity. Calcium concentrations range from 2.40 mg/L to 60.12 mg/L, classified into ten levels. Lighter hues indicate lower concentrations, while darker hues represent higher levels. Northern villages like Kannapuram, Cherukunnu and Mattool show the highest calcium concentrations, peaking at 60.12 mg/L. Conversely, southern and central villages such as Kannur, Kadachira and Mavillayi exhibit lower concentrations, ranging from 2.40 mg/L to 15.22 mg/L. Central regions like Pappinisseri, Narath and Varam have moderate levels. The map covers coordinates from 75°16'0" E to 75°36'0" E (longitude) and 11°48'0" N to 12°00'0" N (latitude), with a scale bar indicating distances up to 12 km.

The map highlights significant hydrogeological and agricultural implications. High calcium levels may result from calcium-rich minerals or aquifers, potentially causing hard water issues in northern areas impacting plumbing and water quality. Variations in calcium concentrations influence soil fertility and crop choices as calcium is vital for plant growth. Additionally, areas with low calcium might affect dietary intake from groundwater. This map serves as a valuable tool for environmental, agricultural and public health planning in Kannur Taluk.

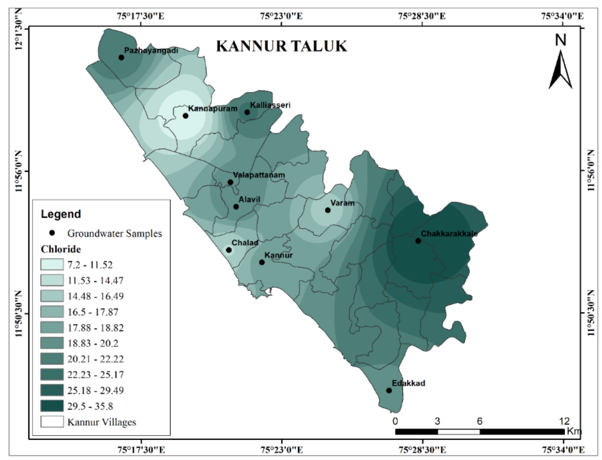


**Fig. 4. Spatial distribution of chloride**

The map showcases the distribution of chloride concentrations in villages across Kannur Taluk, Kerala, India, using a color gradient for visual representation. Chloride concentrations are categorized into ten ranges from 7.20 mg/L to 35.80 mg/L, with lighter shades indicating lower levels and darker shades signifying higher concentrations. Northwestern villages like Mattool, Kannapuram and Kalliasseri exhibit the lowest chloride levels ranging from 7.20 mg/L to 16.73 mg/L. In contrast, southeastern regions, including Iritty, Kanhirode and Peralasseri, show the highest concentrations, reaching up to 35.80 mg/L. The map spans coordinates 75°16'0" E to 75°36'0" E (longitude) and 11°48'0" N to 12°00'0" N (latitude) with a scale covering distances of up to 8 km.

This map highlights key environmental and hydrological conditions influencing agriculture, water resources and public health. Elevated chloride levels in southeastern areas may stem from coastal proximity groundwater flow and human activities such as farming and waste disposal. High chloride concentrations can cause soil salinization, reducing agricultural productivity and pose health risks like hypertension from contaminated drinking water. The insights provided are vital for environmental monitoring, agricultural management and public health planning in Kannur Taluk.

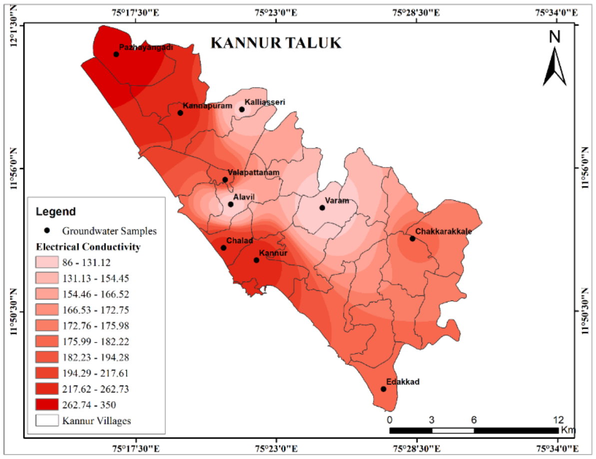


**Fig. 5. Spatial distribution of electrical conductivity**

The map illustrates the spatial distribution of electrical conductivity (EC) in villages across Kannur Taluk, Kerala, India. EC measures water's ability to conduct electricity, reflecting its salinity or mineral content. Values are classified into ten ranges, from 86.00 $\mu$S/cm to 349.99 $\mu$S/cm. Lighter shades represent lower EC values, primarily found in southern and northeastern areas such as Kannur, Kadachira and Iritty, ranging from 86.00 to 144.66 $\mu$S/cm. Darker shades denote higher EC levels concentrated in villages like Mattool, Kannapuram and Kalliasseri in the northwest, ranging from 291.33 to 349.99 $\mu$S/cm. The map spans geographic coordinates 75°16'0" E to 75°36'0" E (longitude) and 11°48'0" N to 12°00'0" N (latitude), with a scale extending up to 12 km.

This map is a valuable tool for understanding water quality in Kannur Taluk. High EC indicates elevated soluble salts and minerals, which may arise from natural sources or human activities like agricultural runoff and wastewater discharge. Such areas may face challenges in water usability for drinking and irrigation. Conversely, low EC areas signal better water quality suitable for consumption and agriculture. This data aids in water resource management and pollution control efforts.

The map provided the range of the fluoride concentration levels in the villages of Kannur Taluk, Kerala, India classified into different ranges. The presented color gradient stands for a gradient of the range in fluoride concentration from low concentrations in light blue to high concentrations represented by dark blue. Concentrations have been classified into 10 different ranges such that their range falls between 0.0 to 0.02, with the highest range situated between 0.21 and

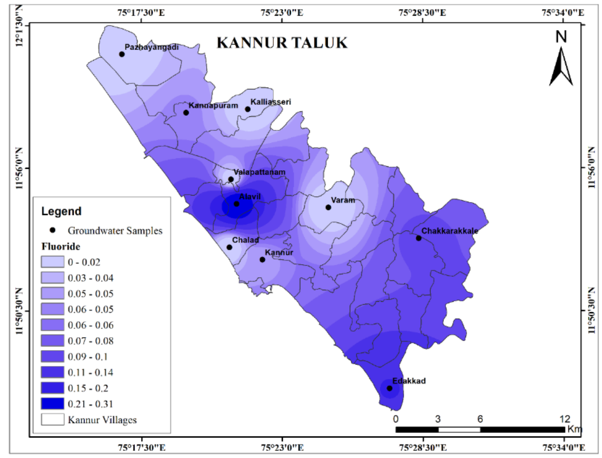


**Fig. 6. Spatial distribution of fluoride**

0.31. Darker blue indicates the lowest fluoride concentration and dark blue colored areas have the highest fluoride concentration in areas, particularly areas like Chikode South and adjacent areas.

The map concerning the environmental health and public planning of Kannur Taluk. While fluoride is beneficial in small amounts, it can have significant adverse effects in higher concentrations, like causing dental and skeletal fluorosis, when it occurs in drinking water. Thus, the map would show that this portion of the Taluk, around Chikode South in particular, poses a public health concern because of high fluoride levels in the water. Villages in this zone, where the concentration is more than 0.2 mg/L are at increased risk of health hazards. The north and east parts of the Taluk constitute safer zones as regards fluoride meaning that the people staying there are at reduced risk. This map can prove to be useful for the local agencies to initiate interventions or plan measures in risky areas like defluorination techniques alternative sources of drinking water or public sensitization campaigns.

The map showcases the distribution of magnesium concentrations in groundwater across villages of Kannur Taluk, Kerala, using a gradient to depict variations. Magnesium levels range from 1.950 – 6.323 mg/L (light shade) to 36.935 – 41.309 mg/L (dark shade). Central areas, like Chikode South, show the highest concentrations, while northern and eastern regions exhibit lower levels.

Magnesium is crucial for bone health and metabolic functions, but excessive levels can cause laxative effects and health risks for individuals with renal issues. This map aids in identifying areas requiring water quality monitoring and health advisories.

The map depicts the spatial distribution of pH levels in groundwater across villages of Kannur Taluk, Kerala,

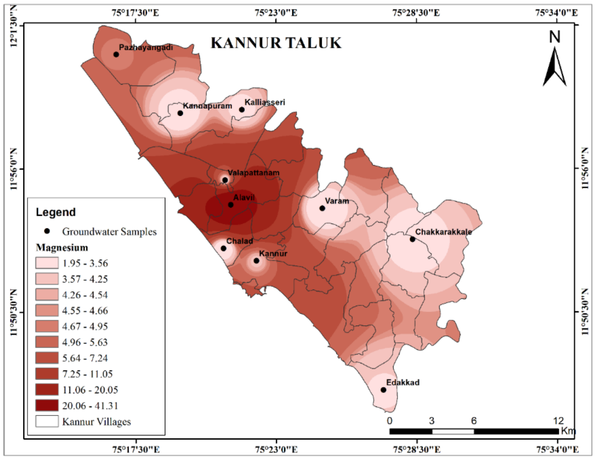


**Fig. 7. Spatial distribution of magnesium**

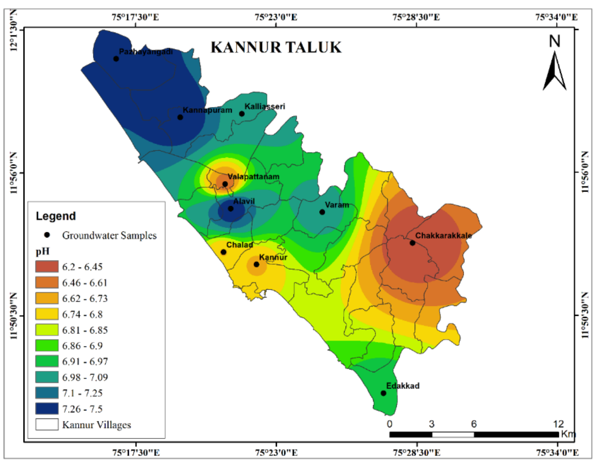


**Fig. 8. Spatial distribution of pH**

categorized into eight ranges from 6.2 to 7.5. Lower pH values, closer to neutral (green shades), dominate northeastern villages like Kanhirode and Ancharakandy. Higher pH values, leaning toward alkalinity (brown shades), are observed in western and southern villages such as Cherukunnu, Kalliasseri and Puzhathi.

Groundwater pH significantly affects water quality. The safe range for drinking water is 6.5–8.5. Acidic water (<6.5) can corrode pipes and leach harmful metals, while alkaline water (>8.5) may impair plumbing and disinfection. Monitoring and treatment strategies can ensure safe pH levels for sustainable water use.

The map illustrates the spatial distribution of potassium across Kannur Taluk, Kerala. Potassium concentrations range from 1.30 meq/L to 7.39 meq/L, with seven intervals. Lower concentrations are found in areas like Cherukunnu,

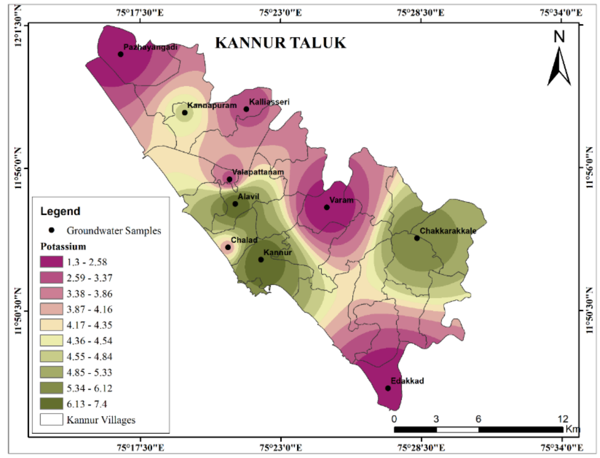


**Fig. 9. Spatial distribution of potassium**

Kannapuram, and Varam, while higher concentrations are observed in regions like Peralasseri, Iritty and Thottada.

This map is significant for agricultural planning, as potassium is essential for plant growth. Areas with low potassium may require fertilizer, while high concentrations could lead to soil imbalances. It informs land management and agricultural practices in Kannur Taluk.

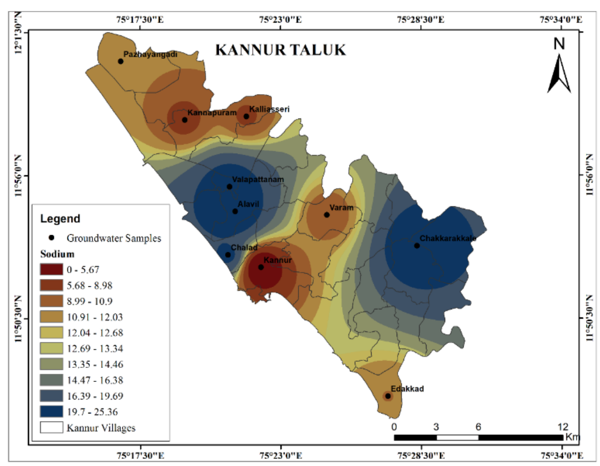


**Fig. 10. Spatial distribution of sodium**

The map shows sodium concentrations across Kannur Taluk, Kerala, ranging from 0.00 to 25.35 milligram-equivalents per litre (meq/L). Areas like Cherukunnu, Kannapuram, and Varam have low sodium, while Iritty, Kanhirode and Peralasseri have higher sodium levels. The map suggests sodium variability is influenced by local geology, irrigation practices and soil types.

This map is vital for soil salinity management, as high sodium can degrade soil structure and plant growth. It informs land-use policies and sustainable farming practices to protect soil fertility and agricultural productivity.

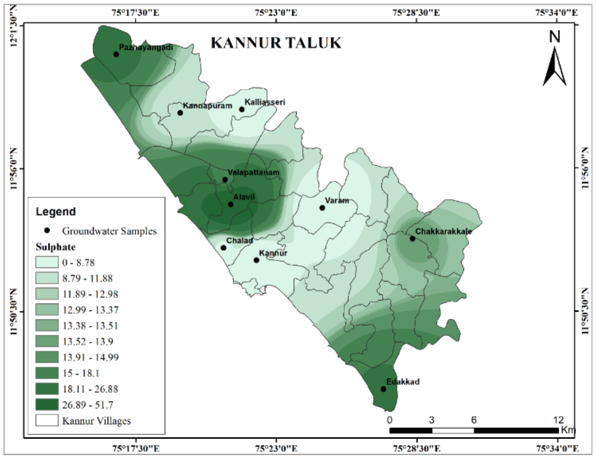


**Fig. 11. Spatial distribution Sulphate**

The map shows the distribution of sulphate concentrations in Kannur Taluk, Kerala, with values ranging from 0.00 to 51.69 milligram equivalents per liter (meq/L). Lighter green shades indicate low sulphate concentrations, while darker green represent higher levels. Areas like Cherukunnu, Kannapuram and Pappinisseri have low sulphate, while regions like Azheekode South and Chirakkal exhibit higher concentrations. The central part, near Valapattanam and Azheekode South, has the highest sulphate levels.

Sulphate is vital for plant growth, but excess levels can cause soil acidity, negatively impacting crops. High sulphate areas may need interventions like lime application, while low sulphate regions might require fertilizers. This map aids agricultural and environmental planning for sustainable farming in the region.

The map shows the spatial distribution of Total Dissolved Solids (TDS) in groundwater across Kannur Taluk, Kerala. TDS levels are represented using a color gradient, ranging from light shade (low TDS concentrations of 172–239 mg/L) to darker shade (high concentrations up to 728 mg/L). Lower TDS levels, seen in areas like Varam and parts of Chelora and Narath indicate better water quality, while higher concentrations in the northwest (Cherukunnu, Matool, and Kannapuram) may be caused by saltwater intrusion or industrial activities. High TDS levels can affect water quality, making it unsuitable for drinking and irrigation.

The map illustrates the spatial variation of total alkalinity in the groundwater of Kannur Taluk, Kerala. Total alkalinity, indicating water's ability to neutralize acids, is crucial for water quality and its suitability for domestic, agricultural

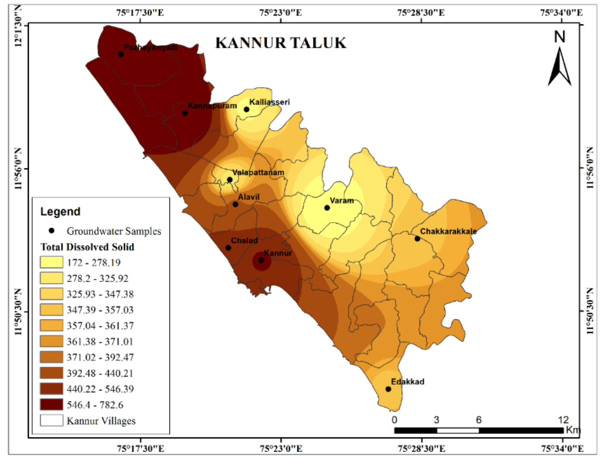


**Fig. 12. Spatial distribution of Total Dissolved Solids**

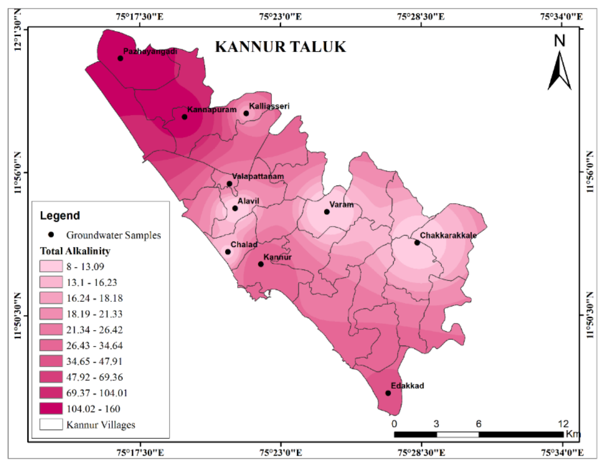


**Fig. 13. Spatial variation of total alkalinity**

and industrial use. The map's colour gradient ranges from light shade for low alkalinity (8–24 mg/L) to dark shade for higher levels, peaking at 159 mg/L. Higher alkalinity levels are found in the northwest (Cherukunnu, Kannapuram and Matool), while lower levels are in the central and southern parts. Excessive alkalinity can cause scaling in pipes, but it benefits agricultural practices by preventing soil acidification.

The map displays the distribution of total hardness in groundwater across Kannur Taluk, Kerala, using a color-coded legend. Groundwater hardness, caused by dissolved calcium and magnesium compounds, ranges from very soft to very hard water. Values range from 14.00 mg/L to 234.99 mg/L. The northern regions, like Cherukunnu and Kannapuram, exhibit the hardest water (185.88 to 234.99 mg/L), which can affect household use, irrigation and health. The central areas, including Azheekode South and Chirakkal,

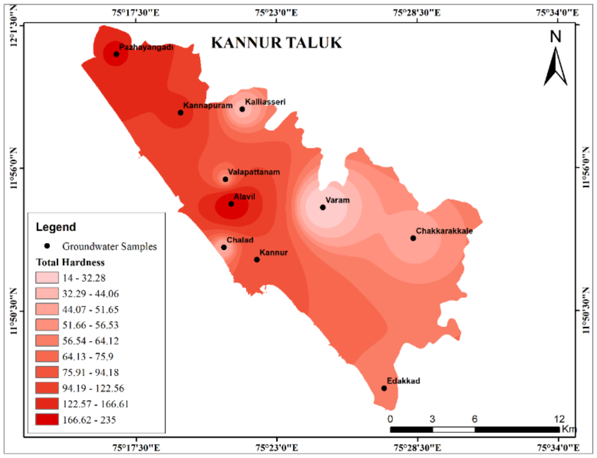


**Fig. 14. Distribution of total hardness**

show moderate hardness (87.66 to 112.22 mg/L), while the southern and eastern regions, like Peralasseri which have softer water (38.55 to 63.11 mg/L). This map aids in addressing water quality issues and guides targeted treatment strategies.

## 4 Results

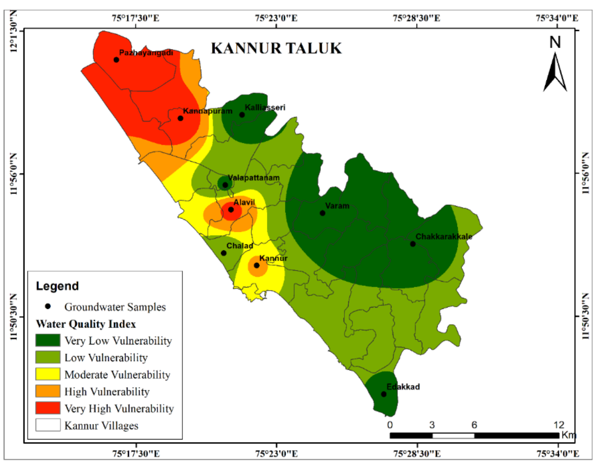


**Fig. 15. Water Quality Index**

The map provides a detailed representation of the distribution of total hardness in groundwater across the Kannur Taluk region in Kerala. Groundwater hardness is primarily caused by the presence of dissolved calcium and magnesium compounds, which contribute to the overall hardness of the water. The map categorizes the hardness levels from very soft to very hard water with values ranging from 14.00 mg/L to 234.99 mg/L.

The northern parts of the Taluk, such as Cherukunnu and Kannapuram, exhibit some of the hardest water, with hardness levels ranging between 185.88 to 234.99 mg/L. These high hardness levels can impact various aspects, including household water usage, agricultural irrigation and even human health, particularly if the water is consumed without proper treatment. In contrast, the central regions of Azheekode South, Chirakkal and surrounding areas show moderate hardness levels, typically ranging from 87.66 to 112.22 mg/L. The southern and eastern parts of the Taluk, including Peralasseri and Elayavoor, are characterized by softer water, with hardness levels between 38.55 to 63.11 mg/L.

This spatial distribution of water hardness is crucial for local water management, helping to identify areas where targeted water treatment or softening interventions may be needed to ensure the suitability of water for various uses, including domestic consumption, agriculture and industry.

## 5 Conclusion

The maps of groundwater characteristics across Kannur Taluk, Kerala, provide critical insights into the region's water quality and its implications for agriculture, public health and environmental management. Key parameters such as electrical conductivity (EC), pH, magnesium, sodium, sulphate, total dissolved solids (TDS), alkalinity and hardness were properly analyzed to highlight spatial variations and their potential impact on the community.

The data reveals significant geographical variation in these parameters. For instance, high electrical conductivity in the northwest suggests areas where water quality may be compromised, potentially due to industrial activities or saltwater intrusion. Similarly, sodium concentrations show variability that directly affects soil salinity, with higher levels in some regions potentially threatening agricultural productivity. Areas with elevated sulphate levels, such as Valapattanam, may require lime application to prevent soil acidification, while moderate hardness in the central Taluk poses a manageable challenge for water use.

The distribution of alkalinity and magnesium further underscores the need for region-specific interventions, with high alkalinity benefiting agricultural buffering but potentially causing scaling in pipes. Lower alkalinity areas, while suitable for household use may lack sufficient buffering against pH fluctuations.

In conclusion, these findings serve as valuable tools for local authorities and planners to design effective water management strategies to improve water quality and address agricultural and public health challenges, ensuring sustainable water use across Kannur Taluk.

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