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Evaluation of Groundwater Quality Index with the help of Remote Sensing and GIS Techniques for Doiwala block of Doon valley

Devendra Singh, Anju Panwar, and Sapana

Uttarakhand Space Application Centre, Dehradun

Abstract- Groundwater is not only an important component of the hydrological cycle but also the most important source of water for drinking, domestic, industrial and agricultural uses. The present work is aimed at assessing the water quality index (WQI) for the groundwater of Doiwala block of Doon valley. This has been determined by collecting legacy data from concerned organization.For calculating the WQI, the following 11 parametershave been considered: pH, total hardness, calcium, magnesium, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides.The WQI for these samples ranges from 30 to 330. The high value ofWQI has been found to be mainly from the higher values of iron, nitrate, totaldissolved solids, hardness, fluorides, bicarbonate and manganese in the groundwater. The results of analyses have been used to suggest models for predicting water quality.

Index Terms- Groundwater, Water quality standards, Water quality index, Doon valley.

I. Introduction

Groundwater is not only an important component of the hydrological cycle but also the most important source of water for drinking, domestic, industrial and agricultural uses. The rapid pace of development and increased urbanization in Uttarakhand state has created potential conflicts for the most beneficial use of resources. Currently, there is a need for technical methods and protocols to achieve sustainable development. In the Uttarakhand state, much of residential rural water use comes from domestic ground-water wells, streams and small rivers. The present study carried out in Block Doiwala District Dehradun, Uttarakhand. This has been determined by collecting legacy pre-monsoon 2012 data from concerned organization. The quality of water generally is defined in terms of its physical, chemical and biological parameters (KetataMouna, et al., 2011) and measured as Water Quality Index (WQI) to assess whether water is potable or not. WQI provides a single number that expresses overall water quality at certain location, based on several water quality parameters (Yogendra and Puttaiah, 2008).GIS and remote sensing has been used extensively to assess the water quality all over the world (Shomar et al., 2010; Advancement of Geographical Information System (GIS) and Spatial Analysis help to integrate the laboratory analysis data with the geographic data and to model the spatial distributions of water quality parameters, most robustly and accurately. The objective of the study is to evaluate the water quality index map of Doiwala block of Distt Dehradun. For this purpose, Inverse Distance Weighed (IDW) spatial interpolation technique has been used to estimate the spatial distribution of the water quality parameters and WQI.WQI is calculated from the point of view of the suitability of groundwater for human consumption.

II. Study Area

The study area lies between 29058' and 310 2' 30" North latitudes and 770 34' 45" and 780 18' 30" East longitudes. Total area of the district is 3088 sqkms. Altitude is 640 mts. (2100 ft) above sea level.

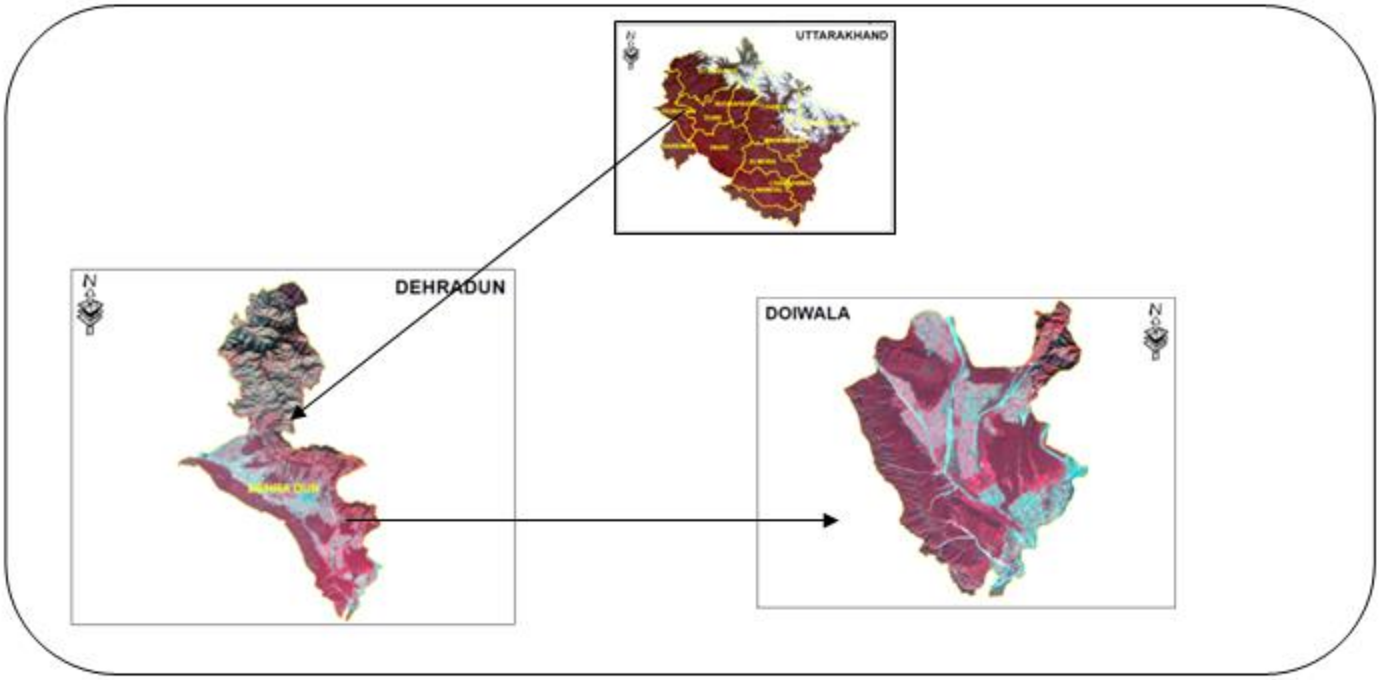

Figure 1: Location Map of Study Area

III. METHODOLOGY

Groundwater legacy data was collected for Doiwala block of Doon valley during pre-monsoon 2012 from the concerned organization .Each of the groundwater samples was consist of11parameters such as pH, TDS, total hardness, chloride, sulphate, nitrate, fluoride, calcium, magnesium, iron and manganese using standard procedures recommended by APHA6.

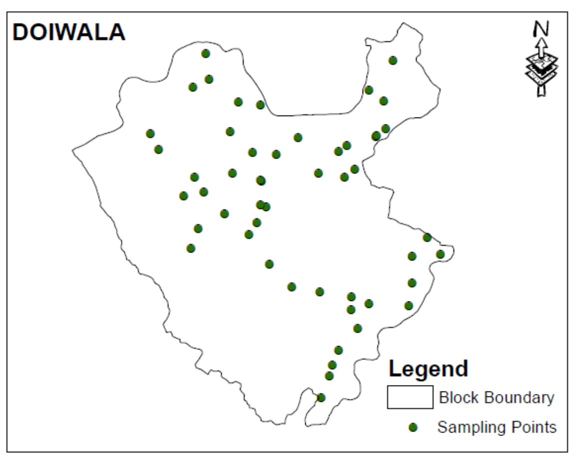

Figure 2: Location map of Sampling Points

IV. GEOLOGICAL AND GEOMORPHOLOGICAL MAP OF THE AREA

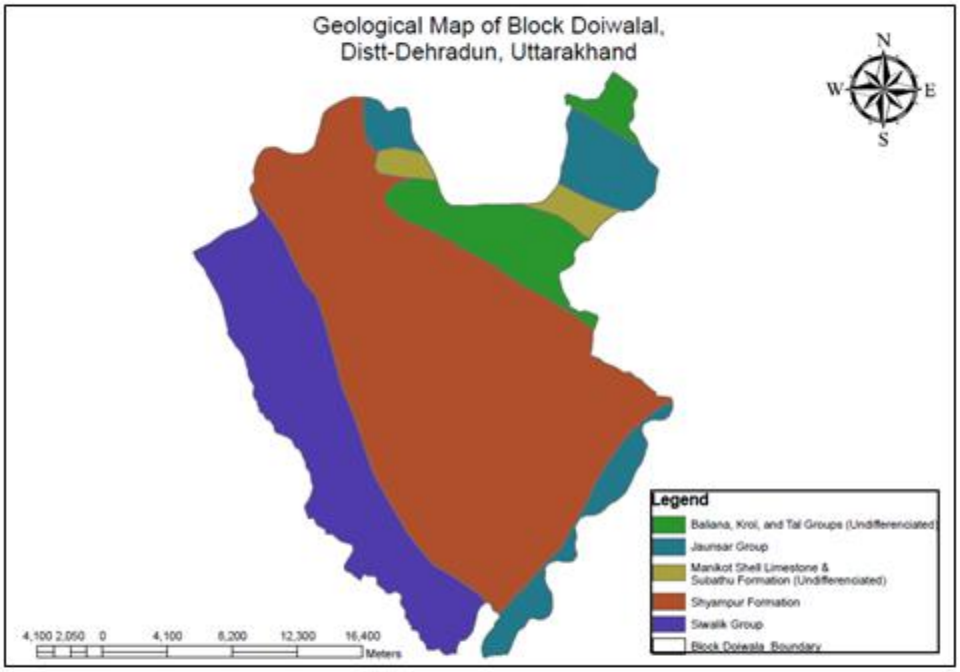

Figure 3-Geological Map of Block Doiwala

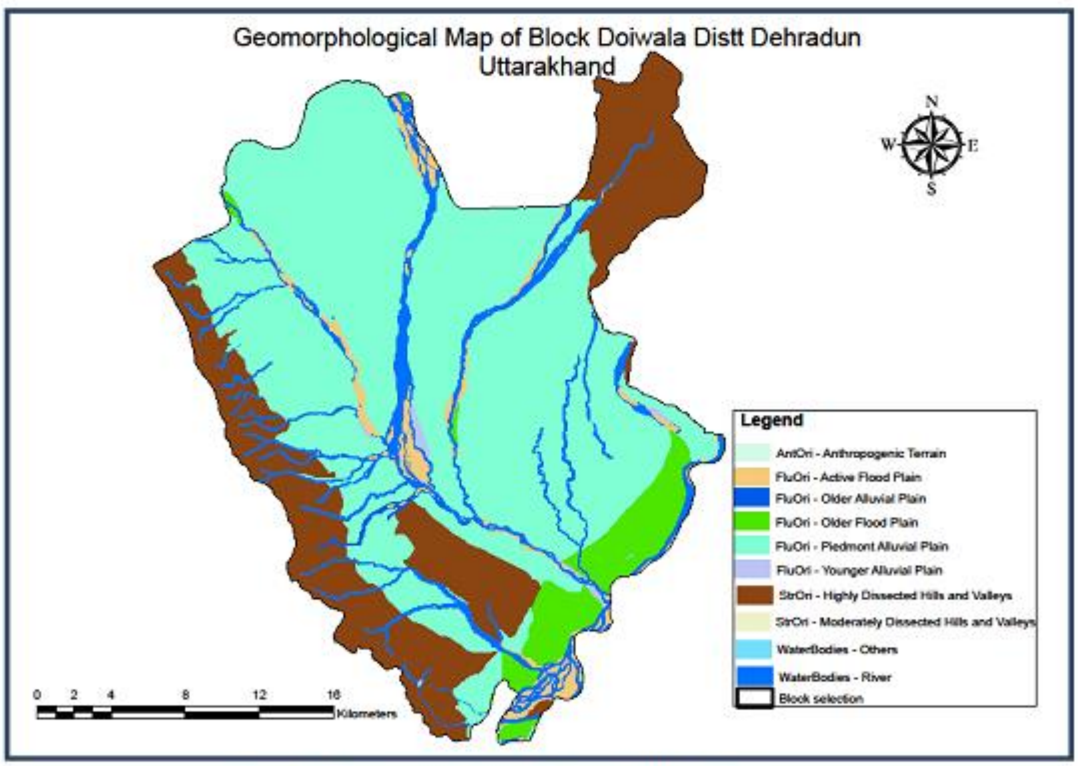

Figure 4-Geomorphological Map of Block Doiwala

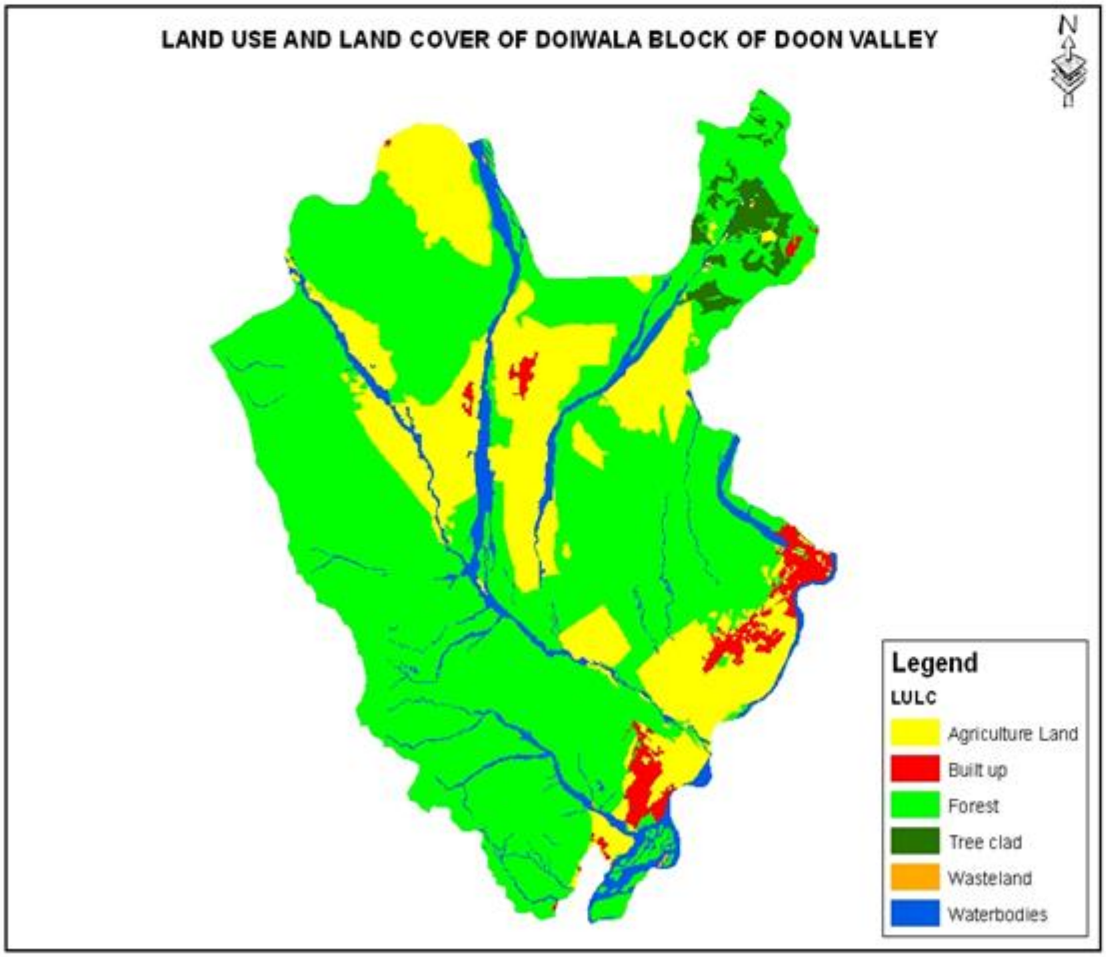

Figure 5: Land Use / Land Cover Map of BlockDoiwala

V. Spatial Modelling and Surface Interpolation through IDW

GIS can be a powerful tool for developing solutions for water resources problems for assessing water quality, determining water availability, preventing flooding, and understanding the natural environment, and managingwater resources on a local or regional scale. Though there are a number of spatial modeling techniques available with respect to application in GIS, spatial interpolation technique through Inverse Distance Weighted (IDW) approach has been used in the present study to delineate the location distribution of water pollutants orconstituents. This method uses a defined or selected set of sample points for estimating the output grid cell value. Itdetermines the cell values using a linearly weighted combination of a set of sample points and controls thesignificance of known points upon the interpolated values based upon their distance from the output point therebygenerating a surface grid as well as thematic isoclines. Thus, GIS Enables us to look into the cause and effect relationship with visual presentation.

VI. Result and Discussion

Spatial Distribution of Water quality parameters

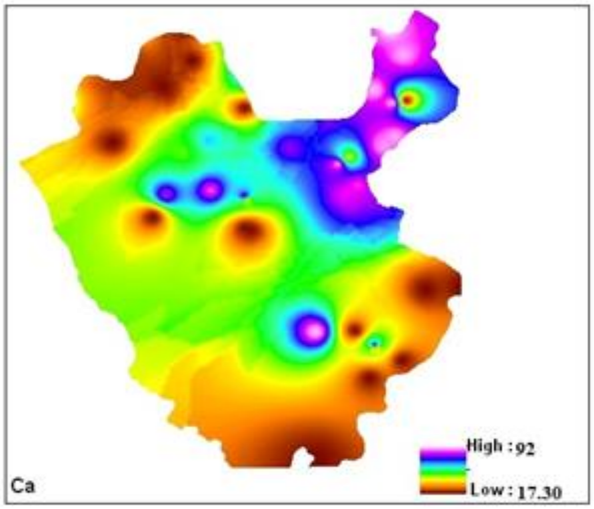

Figure 6: Spatial Distribution of Calcium

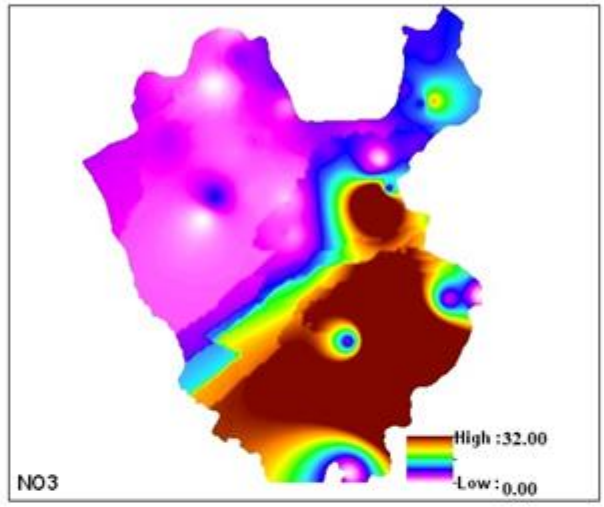

Figure 7: Spatial Distribution of Nitrate

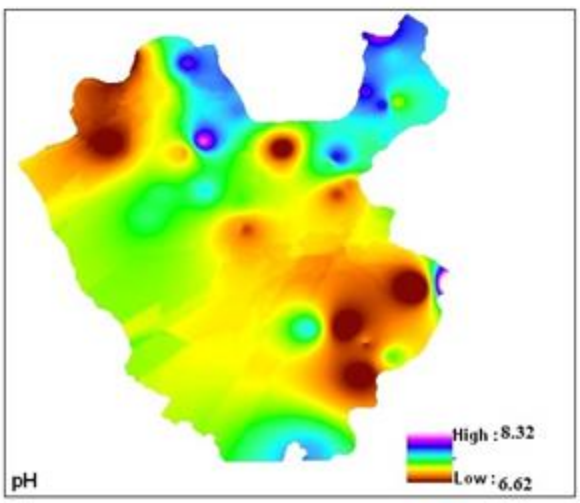

Figure 8: Spatial Distribution of pH

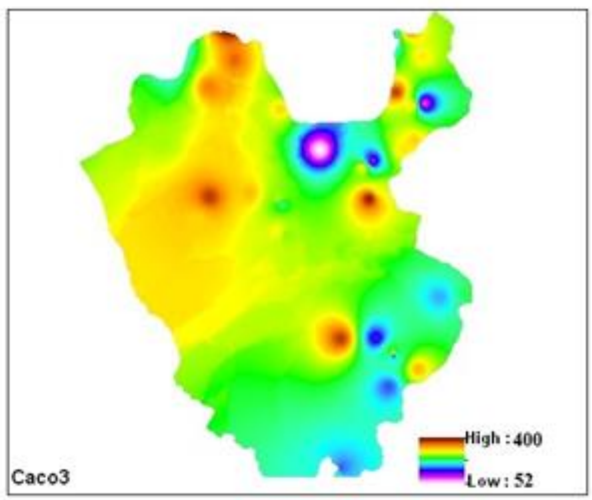

Figure 9: Spatial Distribution of Hardness

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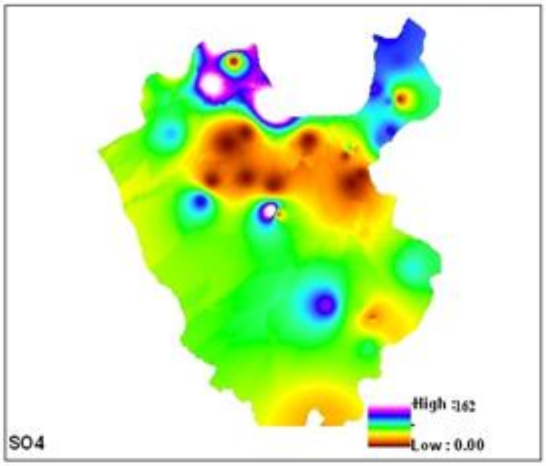


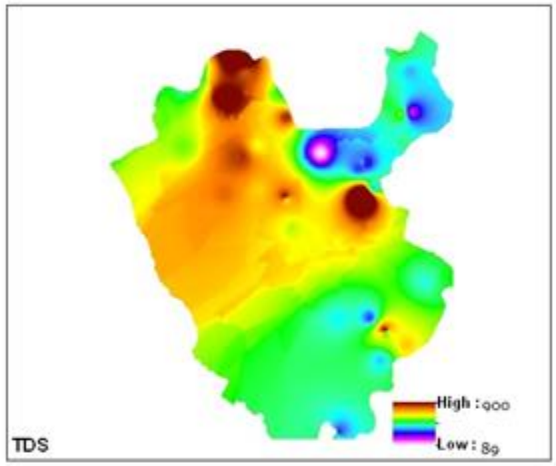
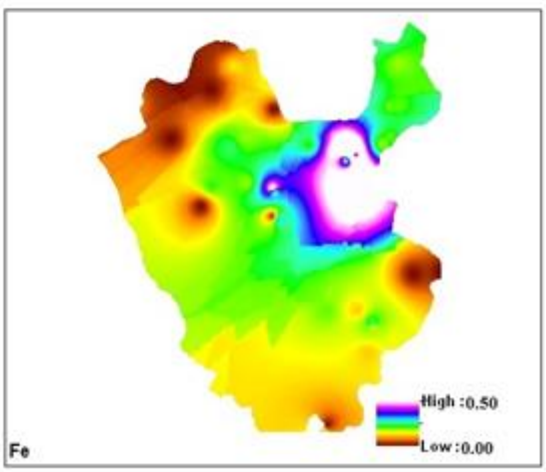


Figure 10: Spatial Distribution of SulphateFigure 11: Spatial Distribution of TDS



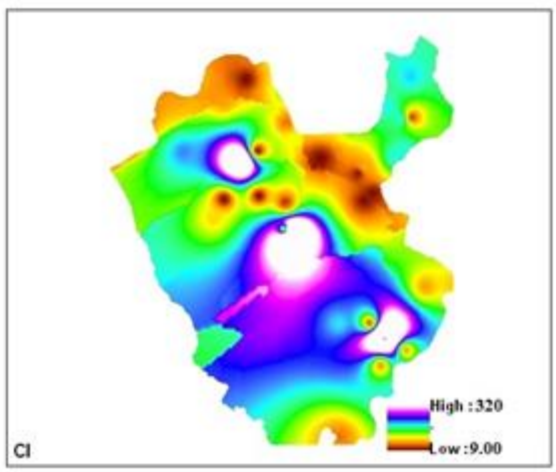


Figure 12: Spatial Distribution of Iron **Figure 13: Spatial Distribution of Chloride**

VII. Water Quality Index

Each of the 11parametershas been assigned a weight (wi) according to its relative importance in the overall quality ofwater for drinking purposes (Table-1). The maximum weight of 5 has been assigned to theparameter nitrate due to its major importance in water quality assessment. Magnesium whichis given the minimum weight of 1 as magnesium by itself may not be harmful.

The relative weight (Wi) is computed from the following equation:

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

Where, W_i is the relative weight, w_i is the weight of each parameter and n is the number of parameters. Calculated relative weight (W_i) values of each parameter are also given in Table 1.

Table-1 Relative weight of chemical parameters

Chemical parameter	Indian standards	Weight (wi)	Relative weight(Wi)
pH	6.5-8.5	4	0.10526
Total hardness (TH)	300-600	2	0.052631
Calcium	75-200	2	0.052631
Magnesium	30-100	2	0.052631
Chloride	250-1,000	3	0.078947
Total dissolved solids (TDS)	500-2,000	4	0.10526
Fluoride	1-1.5	4	0.10526
Manganese	0.1-0.3	4	0.10526
Nitrate	45-100	5	0.13157
Iron	0.3-1.0	4	0.10526
Sulphate	200-400	4	0.10526

Groundwater Quality Variation

A quality rating scale (q_i) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the BIS and the result multiplied by 100:

$$q_i = (C_i / S_i) \times 100$$

Where q_i is the quality rating, C_i is the concentration of each chemical parameter in each water sample in mg/L, and S_i is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of the BIS7 10500, 1991.

For computing the WQI, the SI is first determined for each chemical parameter, which is then used to determine the WQI as per the following equation:

$$SI_i = W_i \cdot q_i$$

$$WQI = \sum SI_i$$

SIi is the sub index of ith parameter; qi is the rating based on concentration of ith parameter and n is the number of parameters. The computed WQI values are classified into five types, "excellent water" to "water, unsuitable for drinking".

Table-2 Water quality classification based on WQI value

WQI value	Water quality
<50	excellent
50-100	good water
100-200	poor water
200-300	very poor water
>300	Water unsuitable for drinking

In this study, the computed WQI values ranges from 30 to 330 and therefore, canbe categorized into five types "excellent water" to "water unsuitable for drinking".

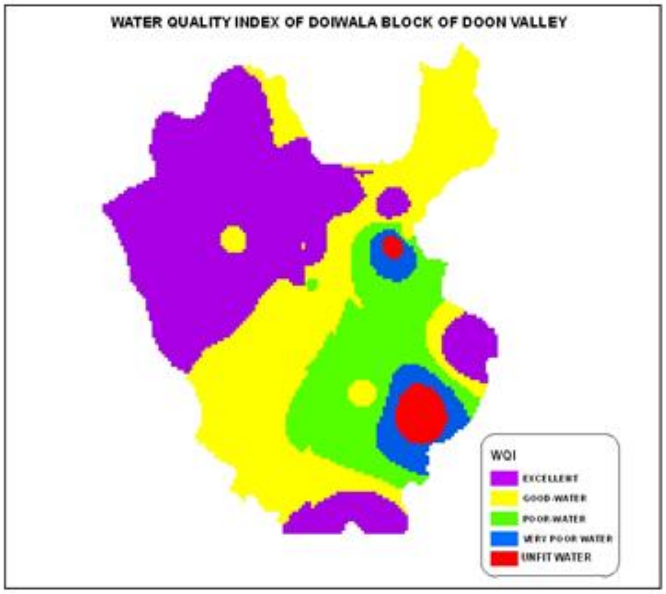


Figure 14: Water Quality Index Map of Doiwala Block

VIII. Conclusions

The value of WQI ranges from 30 to 330. The maximum value of WQI is 330 in Gumaniwala, Block Doiwala and minimum value of WQI is 30 in Haripur Kalan, Block Doiwala. Almost fifty percent of the samples exceeded 100, the upper limit for drinking water. The high value of WQI at these stations has been found due to dense residential area and due to intensive irrigation in that area. Higher values of iron, nitrate, total dissolved solids, hardness, fluorides, bicarbonate, chloride and manganese in the groundwater also increase the value of WQI in this area. The analysis reveals that the groundwater of the area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination.

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AUTHORS

First Author –Devendra Singh, Anju Panwar, and Sapana, Uttarakhand Space Application Centre, Dehradun, Email:devendra.singh505@gmail.com

Second Author –Anju Panwar, Uttarakhand Space Application Centre, Dehradun

Third Author – Sapana, Uttarakhand Space Application Centre, Dehradun