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Study of Water Quality Index with the help of Remote Sensing and GIS for Ground Water Sources between Ganga and Yamuna River Siwalik region in Doon Valley in Outer Himalaya

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Abstract

Ground water is a natural resource shared by both individual and industry. In the Uttarakhand state, much of residential rural water use comes from domestic ground-water wells, streams and small rivers. The chemical nature of natural water may serve as a useful tracer for several geohydrological processes. The total dissolved solids; hardness Eh pH etc in water often indicates frequent local fluctuations in the water-table. 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 for the sources between Ganga and Yamuna River of Siwalik region in Doon Valley in Outer Himalaya.The objective of the present study to evaluatewater quality index (WQI) with the help of Remote Sensing and GIS. To carry out the investigation, water samples from different locations were collected and analyzed. The water quality index (WQI) for the water was computed which based testes conducted for their pH, calcium, magnesium, chloride, nitrate, sulphate, iron, manganese, total dissolved solids (TDS) and total hardness content. The WQI values for the tested samples from the study area ranged between 50 to450. The WQI value of >100 was found for Chandrabani, SukhRao, Mohand, Thanda Sort, Mothorowala, Kaliyanpur and Donkwala areas. Higher content of iron, nitrate, TDS, hardness, flourides, bicarbonates and manganese in the water from these areas is responsible for the higher WQI. To prevent the detrimental effect of the contaminated water it is advised that the water from the above mentioned areas should be treated before consumption.

Keywords: Groundwater, Doon Valley, water quality index, remote sensing and GIS.

Introduction

In newly formed state Uttarakhand groundwater resources is subjected to under stress due to excessive extraction and use to overcome the problem of groundwater with respect to its use for various purpose is essential. Although Doon Valley is prosperous in groundwater wealth, its true prosperity depends on its use, which is controlled by its quality. 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. Based on several parameters, WQI provides a numeral value to designate the overall water quality at a certain location[1]. In the past, GIS and remote sensing have been extensively used all over the world to investigate the quality of water. Remote sensing, GIS and spatial interpolation has helped to integrate the laboratory data with the geographical data to robustly and accurately model the spatial distribution of the water quality parameters and their geological and anthropogenic influences. The present research work has been construct and examines the water quality index map for the ground water sources between Ganga and Yamuna rivers in the Siwalik region, Doon Valley in the outer Himalayas. The WQI has been tested to assess its suitability for human consumption.

Study Area: Present research work is lying in Doon Valley between the Yamuna and Ganga River district DehraDun. Geographically the area is located between the latitudes 77°30' to 78°28' and longitudes 30°05' to 30°30' and covers an area of about 2700 sqkm in Dehra Dun district. The area is easily approachable by metallic roads from Dehra Dun, Herbetpur, and Doiwala. Many good bridle paths and footpaths provide easy access to most parts of the area.

Material and Methods

Samples are collected from different sources of ground water viz. dugwells, hand pumps and springs located in different parts of the study area. Surface samples are collected from various streams draining the area. Before collecting sample initially the hand pump was run for some time so that the stagnant water in contact with metallic casing could be removed and fresh water sample could be acquired from that particular aquifer. One litre capacity pre-cleaned polyethylene bottles were used for collecting of ground water samples from different sources. The sample bottles washed and rinsed with distilled water and then with the sample water. The sample bottles were filled to the capacity of the bottle, tightly sealed and appropriately. All the major ground water quality parameters were analysed using standard procedures recommended by APHA[2].

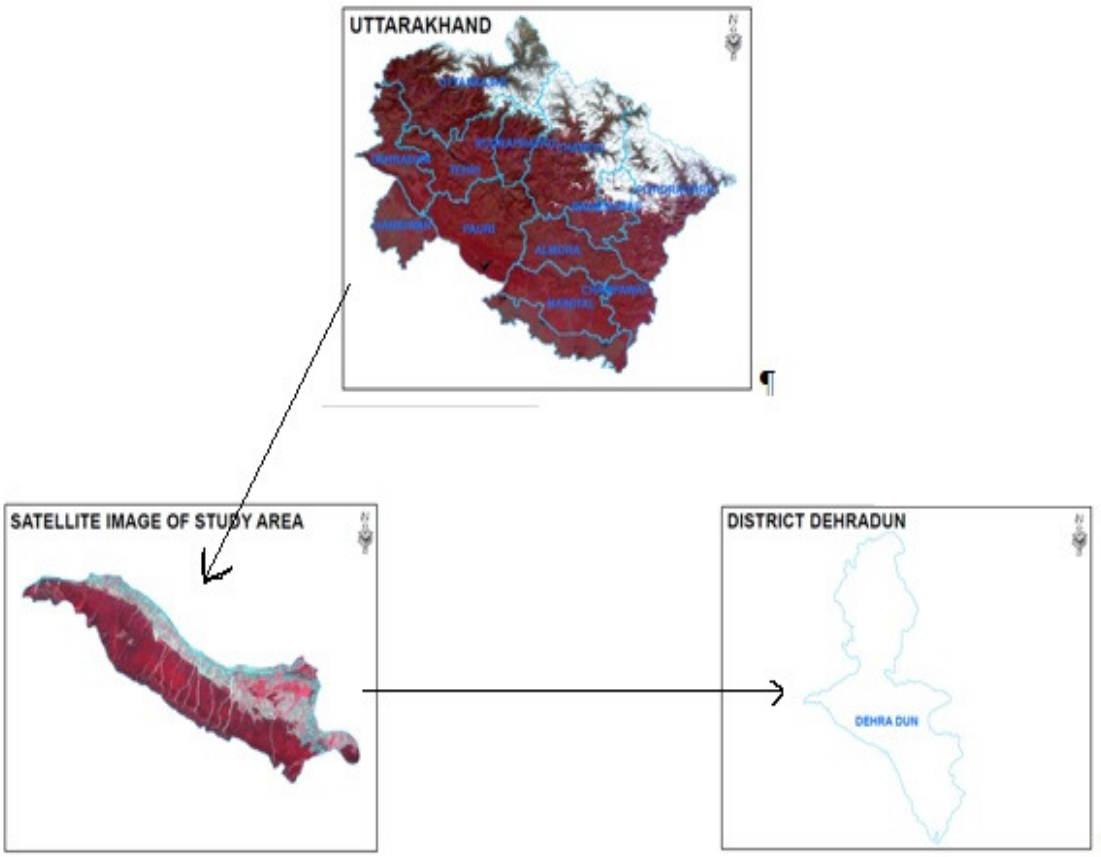

Figure-1
Location Map of Study Area

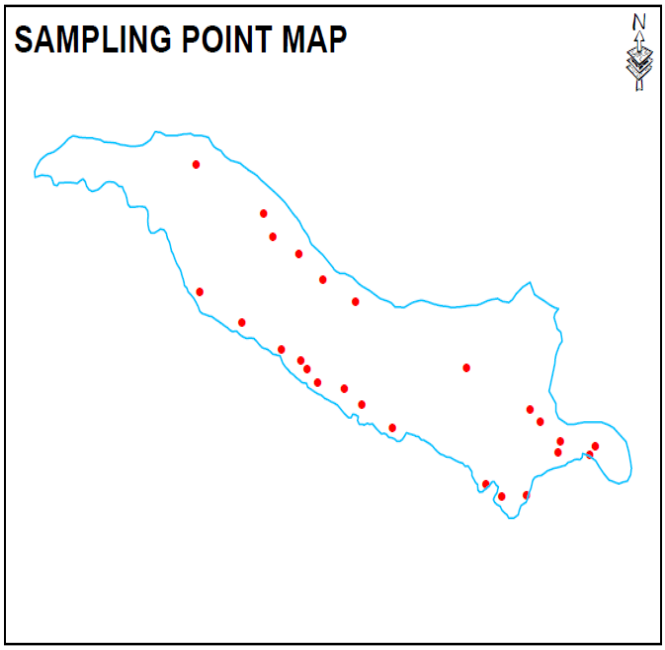

Figure-2
Location map of Sampling Points Geological and Geomorphological map of the area

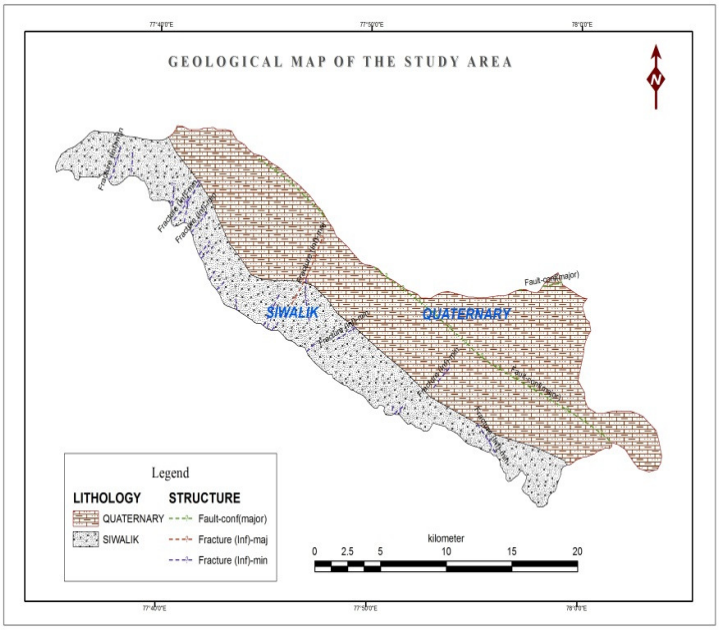

Figure-3
Geological Map of Study Area

Table-1
Lithostratigraphic succession of the rocks in and around Doon Valley

Formation		**Gross Lithology**	**Age**	**Thickness(m)**
Quaternary	Doon Gravel	Poorly sorted mixture of sub-angular to angular cobbles, pebbles, gravels and boulders in a sandy silty matrix. Characterised by presence of thick yellow to red coloured clay bands.	Holocene (0.05 Ma and younger)	600
Unconformity				
Deposit	Older Doon Gravel	Unassortedsubrounded (ellipsoidal) boulders and pebbles dominantly of Uppter Siwalik Formation embedded in a sand-clay matrix	Late Pleistocene	?
Unconformity				
Siwalik Group	Upper Siwalik Fm.	Thickly bedded massive conglomerate in Sandy matrix and interbedded sandstone.	Upper Plicene to Pleistocene	2000
	Middle Siwalik Fm.	Multistoried sandstone with pebbles and mudstone, siltstone. Grey micaceous sandstone with planar stratification.	Upper Miocene to Upper Pliocene	1800
	Lower Siwalik Fm.	Maroon coloured sandstone, and interbedded mudstone.	Middle Miocene	2000

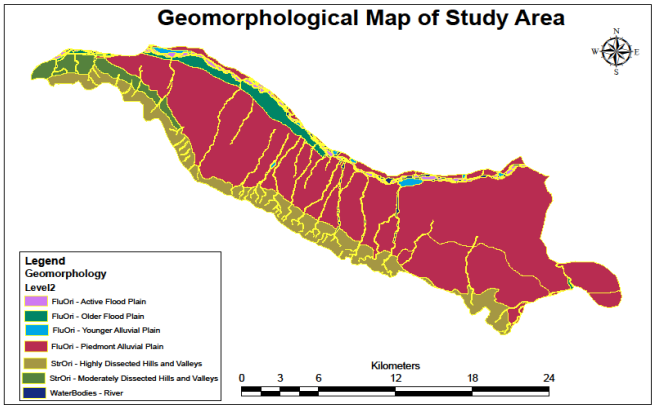

Figure-4
Geomorphological Map of Study Area

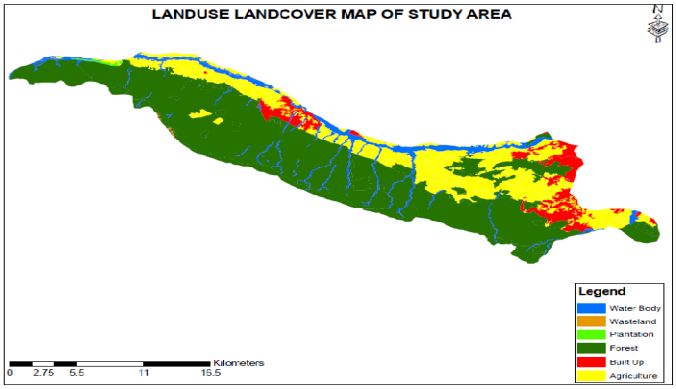

Figure-5
LU / LC Map of Research Work

Results and Discussion

Water Quality Index We used the fallowing formula to calculate the relative weight (Wi):

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

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 2.

Table-2
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: For each parameter, a quality ranging scale (qi) has been assigned, which is evaluated as the percentage of the concentration of a component divided by its standard concentration, as per the BIS guidelines. qi= (Ci/Si) * 100 Where, Ci is the concentration of each chemical component in the tested water samples (mg/L) and Si (mg/L) is the standard concentration for the drinking water in India (BIS 10500, 1991)[3].

The SLi (sub index of the ith parameter) is first determined for each chemical parameter, which is then used to evaluate the WQI using the following equation:
SLi= Wi* qi, WQI= Sum (SLi)

WQI values are classified into five types, from "excellent" to water, "unsuitable for drinking".

Table-3
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 varies from 50 to 450 and therefore, can be classified into five types “excellent water” to “water unsuitable for drinking”.

Conclusion

The value of Water Quality Index ranges from 50 to 450for the study area. Forty percent of the samples have WQI value more than 100, the quality of these samples ranges from poor water to water unsuitable for drinking range. Sample taken from Chandrabani has the WQI value 450. That water is unsuitablefor drinking purpose. From all sources Sukh Rao, Biras Rao, Mohand Village, Thanda Sort, Mothorowala, Kaliyanpur, and Donkwala has WQI more than 100. Higher concentration of iron, nitrates, flourides, bicarbonates, chlorides, manganese, hardness and TDS is responsible for the higher values of WQI at these stations. At these locations, the quality of water may improve during the monsoons due to the inflow of fresh water. Mg and Cl concentration are significantly interrelated and imply the permanent nature of the hardness in water. The present research work indicates that quality of water from some of the locations from the study area is quite poor and unfit for drinking. In this area, hazardous ground water needs to be treated prior to be consumption.

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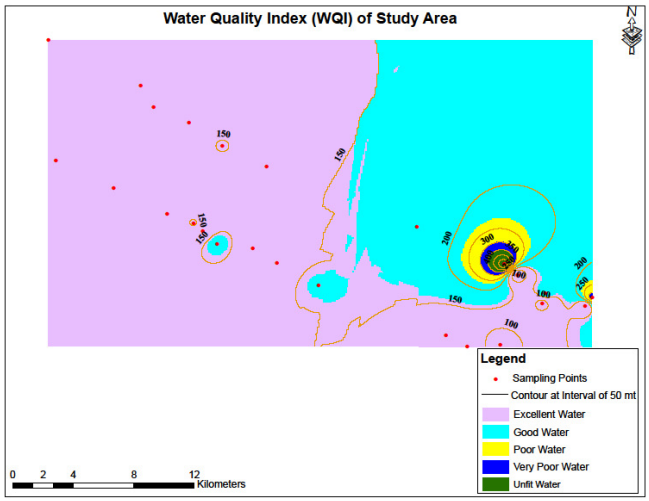

Figure-6
Water Quality Index Map of Doiwala Block

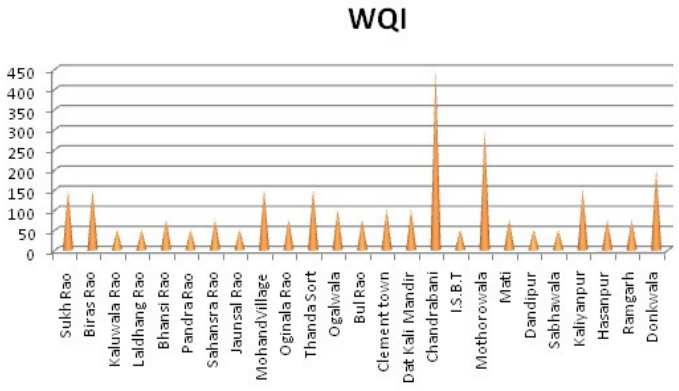

Figure 7
Variation in WQI of all sources

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