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# GROUND WATER INVESTIGATION OF INDUSTRIAL AREA IN HARIDWAR

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**Abstract— A study of groundwater investigation in Sidcul and its nearby area (Haridwar) is carried out with an objective to investigate the groundwater quality as well as to get an insight into hydro chemical evaluation of groundwater. The groundwater regime at SIDCUL area is highly responsive to the anthropogenic stress of recharge and discharge parameter concerning the distressing industrial activities.**
**Groundwater quality is evaluated by measuring the quantities of major and minor elements, pH, Total Dissolved solids (TDS), alkalinity, acidity, turbidity, colour, chlorine content, hardness and electrical conductivity (EC). Water Quality Index of the samples was calculated.**

**Keywords- Groundwater, SIDCUL, water quality, WQI**

## I. INTRODUCTION

Water, a prime natural resource and precious national asset, forms the chief constituent of ecosystem Water covers 71% of the Earth's surface. It is vital for all known forms of life. On Earth, 96.5% of the planet's crust water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor. Only 2.5% of this water is fresh water, and 98.8% of that water is in ice (excepting ice in clouds) and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products [1]. Sufficient water supply of appropriate quality is a key ingredient in the health and well being of human and ecosystem , and for social and economic development. Water quality is becoming a global of increasing significance as risk of degradation translates directly into social economic impact. The most common standard used to assess water quality related to health of ecosystems, safety of human contact and drinking water. Water quality objective recognize the environmental values and uses for different water ways that the community want to see protected. These include recreational use, healthy aquatic ecosystem and water for drinking and irrigation[2]. Water quality of any specific area or specific source can be assessed using physical, chemical and biological parameters. The values of these parameters are harmful for human health if they occurred more than defined limits. This paper examines the state of the water quality in the industrial area of Haridwar. The suitability of water sources for human consumption has been described in terms of Water quality index (WQI), which is one of the most effective ways to describe the quality of water. WQI utilizes the water quality data and helps in the modification of the policies, which are formulated by various environmental monitoring agencies. **The Water Quality Index** is well known method as well as one of the most effective tools to express water quality that offers a simple, stable, reproducible unit of measure and communicate information of water quality to the concerned citizens and policy makers. It thus becomes an important parameter for the assessment and management of surface water. Water Quality Index is defined as a technique of rating that provides the composite influence of individual water quality parameters on the overall quality of water for human consumption [3] WQI summarizes large amounts of water quality data into simple terms (e.g., excellent, good, bad, etc.) for reporting to management and the public in a consistent manner. Horton [4] first introduced and defined it as mathematical form of WQI by selecting, rating and integrating the significant physical, chemical and biological parameters of water in a simple, yet scientifically defensible manner. After that it was improved by Brown [5] respectively.

## II. MATERIAL AND METHODS

Groundwater samples were collected from 5 locations (Sidcul, roshnabad , shivalik nagar, jamalpur khurd, bahadrabad) during March-April 2016. Each of the groundwater samples was analyzed for 5 parameters such as pH, Dissolved Oxygen, Biological Oxygen Demand, and Turbidity using standard procedures recommended by APHA [6].

## III. SITE DESCRIPTION

A. SIDCUL State Industrial Development Corporation of Uttarakhand (SIDCUL). SIDCUL, spread over a land of 2034 acres, developed by State Industrial Development Corporation of Uttarakhand (SIDCUL), a state government body. SIDCUL has now established one new ‘industrial development zone’ in the district, adjacent to Shivalik Nagar near Haridwar, to encourage industrialization. The Latitude of SIDCUL Haridwar is 29.9704.

The Longitude of SIDCUL Haridwar is 78.0602. The water sample was collected near the metro hospital with the depth of ground water approximately 280 feet.

Figure1: Map of SIDCUL

B. Roshnabad lies near the industrial area SIDCUL. It is famous for kutchery, government offices, prison, etc. The water sample was collected at the depth of approximately 200 feet.

Fig 2: Map of Roshnabad

C. Shivalik Nagar is a city in the Haridwar district of Uttarakhand, India, at the edge of Bharat Heavy Electrical Limited, Ranipur township and the SIDCUL industrial estate of state government, and 10 km away from the Hindu pilgrimage city of Haridwar. Shivalik Nagar One of the newest and biggest residential areas of Haridwar. It is divided into various clusters. It was originally developed as a residential colony for BHEL employees, but with the advent of SIDCUL, population and financial activity has grown rapidly in the area due to its proximity. It overlooks the Shivalik Hills Range of the lower Himalayas, after which it is named, and is partly encircled from east to west, by Ranipur Rao, a seasonal stream, that starts from Shivalik hills at the edge of Rajaji National Park, and now merges with Ganges Canal, ahead of Bahadrabad. The Latitude of Shivalik Nagar is 29.934°N. The Longitude of Shivalik Nagar is 78.072°E. .It is located at an elevation of 249.7m above sea level. The sample was collected from P cluster, with the ground water depth 180 feet.

Fig 3: Map of Shivalik Nagar

D. Jamalpur khurd is a village panchayat located in the Haridwar district of Uttarakhand. The sample was collected from handpump with the depth of ground water approximately 40 feet.

Figure 4: Map of Jamalpur khurd

E. Bahadrabad is a village panchayat located in the Haridwar district of Uttarakhand state,India. The latitude 29.917894 and longitude 78.039279 are the geocoordinate of the Bahadrabad.It is located at an elevation of 269 m above sea level. According to 2011 census total population is 10232. Dehradun is the state capital for Bahadrabad village. It is located around 30.3 kilometer away from Bahadrabad. Bahadrabad is situated at a distance of 11 km from Haridwar, between the towns of Haridwar and Roorkee highway 58, between Delhi and Manna Pass. Integrated Industrial Estate (IIE) of SIDCUL (State Industrial Development Corporation of Uttarankhand) is situated close to Bahadrabad. Apart from that, Bahadrabad has a small but old industrial setup known as "BAHDRABAD INDUSTRIAL AREA", which has Indane Gas Plant and Modern Bread Factory. The sample was collected, with the ground water depth 50 feet.

## VI. WQI DETERMINATION

The standard formula to calculate water quality index is:

WQI = ΣWXQX = WBOD QBOD + WDOQDO + WpH QpH +WPHOSPHATEQPHOSPHATE + WNITRATEQNITRATE +WFCQFC+WTDSQTDS + WTEMPQTEMP + WTURBIDITYQTURBIDITY

In the case when concentrations of some parameters are not available,

- First we can calculate the Q values of those parameters, the concentration of which is available
- Now those Q values are multiplied with their respective weighting factors.
- Now the summation of these values are taken and then divided by the summation of weighting factors of available parameters.

## V. RESULT AND DISCUSSION

The status of water corresponding to different WQI values is presented in Table 1. If the index goes down, then it indicates that some of the water quality parameters are being affected due to some particular reason and suitable measures are needed to further improve the quality of water. Thus this index may be used as a guiding rule in management of quality of water resources.

| WQI Scale | |
|---|---|
| 91-100 | Excellent water quality |
| 71-90 | Good water quality |
| 51-70 | Medium or average water quality |
| 26-50 | Fair water quality |
| 0-25 | Poor water quality |

Table 1. WQI and corresponding class and status of water quality, Singh [7]

| S. no | Sites | WQI value | Class | Status of water |
|---|---|---|---|---|
| 1 | SIDCUL | 66.9 | Medium or Average | Some treatment or purification required |
| 2 | Roshnabad | 72.81 | Good | Acceptable Quality |
| 3 | Shivalik Nagar | 52.40 | Medium or average | Some treatment or purification required |
| 4 | Jamalpur Khurd | 44.40 | Fair | Needs more Treatment (Filtration & Disinfection |
| 5 | Bahadrabad | 69.159 | Medium or Average | Some treatment or purification required |

Table 2 Comparison of WQI of different regions

The average value of physico-chemical parameters and WQI of 5 samples are given in Tables 2,3,4,5,6 &7 respectively. The results observed that the maximum and minimum value of WQI has been found to be **72.81** and 44.40 delineated as per the Table 7 'good' and 'Fair' category, respectively. In the present study it is observed that majority of groundwater samples i.e., 60% are qualify in the 'Medium' category and are required some treatment particularly in the SIDCUL, Shiwalik Nagar and Bahadrabad region it can be used for domestic purpose. 20% samples qualify in 'good' category and 20% samples collected from Jamalpur Khurd qualify in the 'Fair' category which needs 'Filtration and disinfection' treatment. It may also be reflected that Jamalpur Kurd is highly populated area and have no proper drainage system this region also show a serious water logging problem so it may be a one cause of fair quality of water. Two parameters particularly chloride and hardness are found to be higher compared to permissible level resulting TDS value at higher order owing to anthropogenic contribution which might take place in the vicinity of industrial area in the Haridwar district [8]

| **Parameter** | **Standard value** | **Actual value** | **Weight ($w_i$)** | **Relative Weight ($W_i$)** | **Qualiy Rating ( $q_i$ )** | **$W_iq_i$** |
|---|---|---|---|---|---|---|
| DO | 5 mg/L | 14 | 5 | 0.26315 | 6.25 | 1.644 |
| pH | 6.5-8.5 | 7.56 | 4 | 0.21052 | 112 | 23.57 |
| Turbidity | 5 NTU | 9.9 | 4 | 0.21052 | 198 | 41.68 |
| BOD | 5 mg/L | 0.01 | 3 | 0.15789 | 0.1666 | 0.0263 |
| COD | 10 mg/L | 0.05 | 3 | 0.15789 | 0.1111 | 0.01754 |

Table 3. WQI of SIDCUL area

| **Parameter** | **Standard value** | **Actual value** | **Weight ($w_i$)** | **Relative weight ($W_i$)** | **Quality Rating ( $q_i$ )** | **$W_iq_i$** |
|---|---|---|---|---|---|---|
| DO | 5 mg/L | 12 | 5 | 0.26315 | 27.083 | 7.126 |
| pH | 6.5-8.5 | 7.17 | 4 | 0.21052 | 34 | 7.1576 |
| Turbidity | 5 NTU | 13.9 | 4 | 0.21052 | 278 | 58.52 |
| BOD | 5 mg/L | 0.0 | 3 | 0.15789 | 0 | 0 |
| COD | 10 mg/L | 0.0 | 3 | 0.15789 | 0 | 0 |

Table4. WQI of **Roshnabad area**

| **Parameter** | **Standard value** | **Actual value** | **Weight ($w_i$)** | **Relative Weight ($W_i$)** | **Quality rating( $q_i$ )** | **$W_iq_i$** |
|---|---|---|---|---|---|---|
| DO | 5 mg/L | 7 | 5 | 0.26315 | 79.18 | 20.83 |
| pH | 6.5-8.5 | 6.76 | 4 | 0.21052 | 48 | 10.1049 |
| BOD | 5 mg/L | 0 | 3 | 0.15789 | 0 | 0 |
| Turbidity | 5 NTU | 9.9 | 4 | 0.21052 | 198 | 41.68 |
| COD | 10 mg/L | 0.05 | 3 | 0.15789 | 0 | 0 |

Table 5. WQI of Shivalik Nagar area

| **Parameter** | **Standard value** | **Actual value** | **Weight ($w_i$)** | **Relative weight ($W_i$)** | **Quality rating( $q_i$ )** | **$W_iq_i$** |
|---|---|---|---|---|---|---|
| DO | 5 mg/L | 8 | 5 | 0.26315 | 79.16 | 20.839 |
| pH | 6.5-8.5 | 7.42 | 4 | 0.21052 | 84 | 17.683 |
| Turbidity | 5 NTU | 1.4 | 4 | 0.21052 | 28 | 5.894 |
| BOD | 5 mg/L | 0 | 3 | 0.15789 | 0 | 0 |
| COD | 10 mg/L | 0 | 3 | 0.15789 | 0 | 0 |

Table 6. WQI of Jamalpur Khurd area

| Parameter | Standard value | Actual value | Weight ($w_i$) | Relative weight ($W_i$) | Qualiy Rating ( $q_i$ ) | $W_iq_i$ |
|---|---|---|---|---|---|---|
| DO | 5 mg/L | 9 | 5 | 0.26315 | 58.34 | 15.35 |
| pH | 6.5-8.5 | 7.51 | 4 | 0.21052 | 102 | 21.47 |
| Turbidity | 5 NTU | 10.2 | 4 | 0.21052 | 204 | 32.20 |
| BOD | 5 mg/L | 0.02 | 3 | 0.15789 | 0.4 | 0.08 |
| COD | 10 mg/L | 0.06 | 3 | 0.15789 | 0.2 | 0.03 |

Table 7. WQI of Bahadrabad area

## VI. CONCLUSIONS

WQI has been computed based on five different quality parameters to assess the suitability of groundwater for drinking purposes in industrialized area of Haridwar district, Uttarakhand. The results show that most of the groundwater samples qualified in the category of medium that required some treatment only one area was found as a good quality index. Rest 20% groundwater samples require advanced treatment. Effluents from various industries are dumped in to open pits or unlined channels without any treatment which pollute ground water sources [11]. The industrial waste water, sewage, sludge and solid waste are also discharged into the drains. These materials enter aquifers and make drinking water polluted[12, 13]. The continuous monitoring of groundwater is required in Industrial area of Haridwar district, Uttarakhand from any possible contamination in future due to growing industrialization and agricultural activities in the district.

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