

PHYSICO-CHEMICAL ASSESSMENT BY USING WATER QUALITY INDEX OF THE GROUNDWATER - JAMMU CITY

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Abstract—Assessment of water quality has been carried out for the Jammu City to determine the sources of dissolved ions in the groundwater and analyzing the different physico-chemical quality parameters, to be fit for agricultural and domestic purposes. The present study was proposed to calculate water quality index to establish the quality of water for public utilization, recreation and other purposes. Among various of the methods, Water quality index (WQI) is valuable and unique rating method to depict the overall water quality status in a single term that is helpful for the assortment of appropriate treatment technique to meet the concerned issues and is very useful representation of the overall quality of groundwater for public or for any intended use as well as in pollution abatement programs and in water quality management. A total 34 water samples from the dug wells, boreholes and hand pumps were collected from the study area and their physico-chemical and bacteriological analyses like pH, EC, Turb., F, NO₃⁻, SO₄²⁻, Sodium, potassium, carbonates, bicarbonates, Total dissolved solids, Total Hardness, Total alkalinity, Chlorides, fecal coliform using the procedures set according to Indian Standard methods. Weighted Arithmetic index method has been adopted in the study as recommended by WHO, BIS and ICMR. Almost all the water samples are fit for irrigation and drinking purposes.

Introduction

Water, a prime natural resource and precious national asset, forms the chief constituent of ecosystem. Water occurs on the earth's surface in two major spheres or zones:

I. Surface water

II. Sub-surface water (Ground water)

Ground water includes all the sub surface water, beyond a particular depth where the entire pore spaces, openings, rocks and other soil cavities are completely filled with water. This layer that is completely saturated with water is called an Aquifer. Though earth's surface contains 71% water but it contains only 3% as fresh water resource.

Approximately 30% of fresh water exists as Groundwater and much of it occurs very deep in the earth. The groundwater quality is the physical, chemical and biological characteristics

of water in relationship to a set of standards. Temperature, turbidity, color, taste, and odor make up the list of physical water quality parameters. Since most ground water is colorless, odorless, and without specific taste, we are typically most concerned with its chemical and biological qualities. Due to population growth and diverse human activities, the availability of water is becoming scare by each increasing day. In order to meet the requirement put forth by the different sectors of society, groundwater is hugely exploited due to the deficiency of other sources of fresh water. In response to the anthropogenic parameters and variation to local geologic setup, there is necessity to evaluate the quality of groundwater. Naturally, ground water contains mineral ions. These ions slowly dissolve from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer. They are referred to as dissolved solids.

The foremost viable way of solidifying all the parameters of water tests are quality indices. This makes a difference to know the quality of water with the assistance of a single list rather than comparing all the parameters and their guidelines. Water quality in numerical instrument to coordinated all parameters into a numerical score. WQI summarizes all parameters in to a single value. The objective of the paper includes

1. The assessment of the deep aquifer of study area by determining the physical, chemical and bacteriological characteristics.
2. To analyze the data and compare them for drinking and irrigation purposes/uses.
3. To evaluate the Water Quality Index for drinking.

1. STUDY AREA

The study area forms a part of Jammu city also called as "City of Temples". The Tawi River drains from the centre of Jammu

city dividing it into Left and Right Banks. The old Jammu City lies on the right bank of Tawi River. The study area is about 59.06 Sq. km. lying on the left bank, which includes about 13 sq. km. of residential use and rest of industrial and other uses area. As per 2011 census, the state has a population with density of population 56 person per sq km. The Jammu town lies between 32°33'07" & 33°07'30" North latitudes and 74°27'00" & 77°21'00" East longitudes & the district is bounded by district of Rajouri in the west, Udhampur is north and northwest and Kathua in the east and south east. The major sources of irritation are small water channels in the district and an area of 139.52 sq km is brought under irrigation by various sources like canals, tanks, wells and other sources. Whole of the state falls in the Indus River Basin.

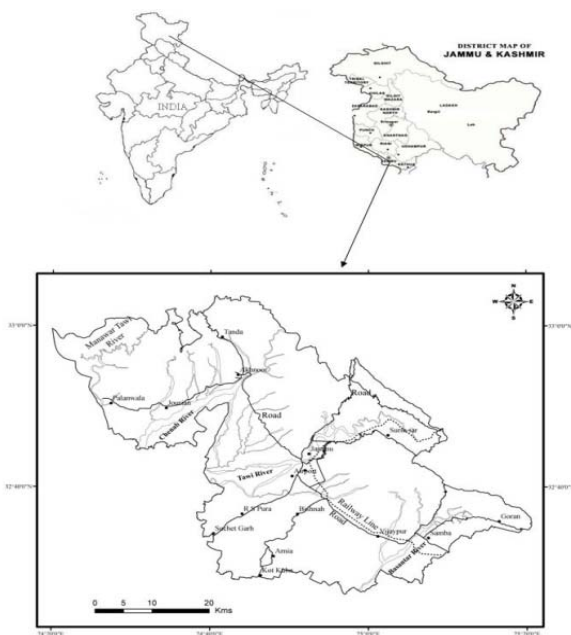


Figure 1: Layout of Study Area

2. METHODOLOGY:

Firstly there is selection of sampling sites. Thirty four samples each collected from different sites of Jammu City to check their assessment for pH, EC, TDS, calcium, total alkalinity, chloride, sulfate, nitrate, fluorides, magnesium, Carbonates bicarbonates, sodium, potassium, fecal coliform and total hardness. The tests were analyzed by utilizing Standard Strategies for the Examination of Water and Wastewater. Sampling was done at the period during Jan to April 2019. The sampling sites were named as Jhiri, Batera ,Kana Chak , Patta Khu , Muthi Marjholi, Nagbani ,Purkhoo, Gho-Manhasan, Sandhawan, Patyala Chak, Gajansoo, Marh, Lower Bernai, Sobka, Batera, Dharmkhu, Channi, Hazuribagh, Satwari, Kalu Chak, SohanJana, Greater Kailash, Sidhra, Sitli, Jagti , New Plot, Tophsherkhania, CPC medical, Gandhi nagar BlockA, Company Bagh, shastri nagar, Samba, and Miransahab. Grab

samples were collected as per standard methods for examination of water and waste water from tube wells and dug wells. Samples were collected from deep aquifers at the depth of 100-400ft.



Figure 2: Collection of samples

The analyses of these water samples were done at Water Testing Laboratory Sitli under PHE Jammu. All the samples tested were according to the standards set by APHA 2008.

Water Quality Index (WQI)

The WQI could be an administration device and is characterized as rating of diverse water quality parameters and their appropriateness for human utilization. The main highlight of this article is to assess water quality of the city. In the event that the WQI is high meaning a few parameters are over. It is vital to explore the source of contamination. The metropolitan strong waste dump locales are contributing for water contamination.

Different methods are available to calculate WQI. Initially according to their relative importance in overall water quality or their perceived effects on health, each one among 11 chosen chemical parameters were assigned a weight (wi) for drinking purposes. The weights were given from 1 to 5 ranges. The maximum weight of 5 was allotted to those parameters which have the key effects on water quality and their significance in quality like NO³⁻, TDS and a minimum of 2 was assigned to those parameters which were considered as unimportant and plays an irrelevant part in the assessment of water quality like Ca²⁺, Mg²⁺. Their relative weights have been calculated using eqn.

$$W_i = w_i / \sum w_i$$

Table 1 Water Quality Index parameters with their standards, weights & relative weights

S.NO.	PARAMETER S INVOLVED	DRINKI NG WATER STANDARDS	WEIGH TS(wi)	RELATIV E WEIGHTS (Wi)
1.	TDS(mg/l)	500	5	0.1190
2.	pH	7.5	4	0.0952
3.	CHLORIDES (mg/l)	250	5	0.1190

4.	SULPHATES (mg/l)	200	5	0.1190
5.	NITRATES (mg/l)	45	5	0.1190
6.	FLUORIDE (mg/l)	1.0	5	0.1190
7.	CALCIUM(mg/l)	75	3	0.0714
8.	MAGNESIUM (mg/l)	30	3	0.0714
9.	SODIUM(mg/l)	200	4	0.0952
10.	BICARBONATES(mg/l)	244	1	0.0238
11.	POTASSIUM (mg/l)	-	2	0.0476
			$\sum w_i = 42$	

Then the sub index Q_i is calculated by using the below formula.

$$Q_i = C_i/S_i \times 100$$

Where Q_i = sub-index.

C_i =water quality analysis for the i th parameter.

The value is obtained from the Table-1

S_i is the maximum permissible standard value for the i th parameter.

Finally water quality index is calculated

$$WQI = \sum W_i \times Q_i$$

Table 2: Range of Water Quality Index

S.NO.	WQI RANGE	WATER QUALITY
1.	<50	Excellent water
2.	50-100	Good water
3.	100-200	Poor water
4.	200-300	Very poor water
5.	>300	Water unsuitable for drinking purpose

3. RESULTS AND DISCUSSIONS

The results are tabulated in Table 3 showing the parameters having maximum, minimum values with mean and standard deviation.

Table 3 Sites having different parameters Range, mean and standard deviation

PARAMETERS ANALYZED	MIN VALUE	MAX VALUE	MEAN	STD DEVIATION
pH	6.73	8.46	7.69	0.48
Electrical conductivity	220	1300	605.85	289.95
Total Hardness	144	620	284	117.49
Total dissolved solids(TDS)	89	676	314	165.12
Iron	0.0	7.27	0.63	1.43
Chlorides	4	71	23	18.16
Sulphates	0.1	304	48.71	60.21
Nitrates	0.0	139	43	29.07
Fluorides	0	1.09	0.28	0.368
Calcium	12	130	47	23.07
Magnesium	12	139	43	29.07
Bicarbonates	85.4	866	318.19	181.81
Carbonates	0	60	2.11	10.43
Sodium	3	225	43	53.99
Potassium	0.52	74.6	5.83	13.07
Alkalinity	70	710	263	148.17
Turbidity	1.09	5.40	2.03	1.29

- I. pH: The value of the pH has falling under permitted range and none of the site is crossing the desirable limit.
- II. Total Hardness: A total of 24 sites are above the desirable limit for hardness i.e. 500 mg/l and about 1 site is above permissible limit. More than 70% of sites were having hard water making it conclude that water of Jammu has hard type of water. It is due to the presence of divalent metallic cations, of which calcium and magnesium are the most abundant in groundwater.
- III. Alkalinity: About 50% sites were having alkaline water with only 3% sites were above permissible ranges. It is due to the presence of CO_3^{2-} and OH^- ions in water.
- IV. Turbidity: About 77% sites were having values more than the desirable range of the drinking water but are within permissible range except one site.
- V. TDS: almost all the samples are within the desirable range except 6 sites having values more than

acceptable range. TDS values should not be less 1000 g/l for the safe drinking of water.

- VI. Major Anions: all the major anions like chlorides, sulphates, fluorides, and nitrates are having sites within the permissible ranges.
- VII. Cations: cations present in the water are checked for calcium, magnesium, sodium and potassium are with limits, excepting magnesium have values above permissible ranges for 3 sites.
- VIII. Water Quality Index have been worked out for each of the sites and following tabulated results have been shown.

Table 4: Water Quality Index Ranges

S. No.	Water Quality Index Range	Water Category	Sites falling in category
1.	<50	Excellent water	W1, W2, W3, W4, W5, W6, W7, W8, W9, W10, W11, W12, W13, W14, W15, W16, W17, W23, W26, W29, W32
2.	50-100	Good water	W18, W19, W20, W21, W22, W24, W25, W27, W28, W30, W31
3.	>100	Poor water	-

4. CONCLUSIONS

None of the sites were having water quality as poor indicator inspite of having some chemical parameters having values above permissible levels. Almost all the sites were having water quality as excellent and good. The water quality of the Jammu city is absolutely fit for drinking. But there is need for the cleaning of the water as obtained from the groundwater. Proper methods have been employed for the purifying water for alkalinity.

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