VOLUME 9 ISSUE 1 2023

ISSN 2454 – 3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 9, No. 1, 1028-1032 (2023)

International Journal of Zoological Investigations
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

Physicochemical Analysis of the Traditional Water Sources of Lohaghat Region in Kumaon Himalayas, District Champawat, Uttarakhand, India

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Received: 8th April, 2023; **Accepted:** 28th May, 2023; **Published online:** 30th June, 2023

https://doi.org/10.33745/ijzi.2023.v09i01.115

Abstract: This study deals with the physicochemical characteristic of the traditional water body (Naula) in the Lohaghat region. Naulas are natural Aquifers that are considered sacred traditional sources of drinking water in the Kumaun region. In the present study, samples were taken from 5 Naulas of Lohaghat and a total of 7 parameters were tested between April to September 2022. It was observed that the pH of these samples ranged from 7.2 to 7.4, the temperature was recorded between 16.6 to 18.8 °C, EC was recorded between 485 µs/cm- 622 µs/cm, hardness was found between 141-147 mg/l, calcium and magnesium were found between 22-30 mg/l and 18-20 mg/l, respectively and the TDS was recorded between 110-132.6 mg/l. This study concluded that all these samples are suitable for potable uses, and all the tested parameters were found within the permissible limit of Bureau of Indian Standards.

Keywords: Naula, Physicochemical, Potable, Aquifers, Bureau of Indian Standards

Citation: Kharkwal Lata and Kumar Dharmendra: Physicochemical analysis of the traditional water sources of Lohaghat region in Kumaon Himalayas, District Champawat, Uttarakhand, India. Intern. J. Zool. Invest. 9(1): 1028-1032, 2023.

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Introduction

Water is the most widely distributed and abundant substance found in nature, but only 3% of water is available for human consumption. 97% of water is present in the sea which is unsuitable for drinking, of this 3% of fresh water, 2% is in the form of the polar ice cap and glaciers and 1% is available for potable uses (WHO, 2004). Water is an important natural substance for human health. Clean drinking water is a basic necessity for human beings. In this globe, there are still 2.2 billion people who do not have access to clean drinking water (UNICEF and WHO, 2019). Water is essential for human survival, in many places fresh water is not sufficient for consumption. 70% of the available fresh water is polluted in India, the main source of pollution is sewage which constitutes 84

Table 1: GPS location of sampling site

District	Area	Site No.	Sampling Sites	Longitude	Latitude
CHAMPAWAT	LOHAGHAT	Site 1	Katreshwer Naula	80.066473	29.413312
		Site 2	Taxi-stand Naula	80.089116	29.402927
		Site 3	Rukmani Naula	80.087683	29.39951
		Site 4	Shiv Mandir Naula	80.08935	29.395988
		Site 5	Chauri Naula	80.094708	29.391366

to 92% of wastewater (Joshi *et al*., 2009). 90% potable water of Uttarakhand comes from springs and rivers, and 60% of rural Kumaoni people depend on natural springs for their water needs (Chhimwal *et al*., 2022). Traditionally Kumauni people use Naula (a naturally occurring water aquifer, build with a house-like structure) for their water needs, this is considered a sacred water source in the Kumauni tradition. The majority of Naulas were thought to be constructed during Katyuri and Chand dynasties between the 7th and 8th centuries. The constructions were complicated and involved many religious rituals (Sinha *et al*., 2021). But nowadays these traditional sources are losing their fitness. Improper management of these resources, irregular rainfall pattern, loss of traditional knowledge, modernization, uncontrolled development, and increasing population are the major factors that directly impact the water quality of these sources.

The present study was carried out in Lohaghat which is located at 29.42˚N 80.10˚E having an elevation of 1754 m in the lower Himalayas of Kumaun region. Traditionally Naula (natural aquifer) is used for drinking purposes in this area, people worship these water bodies since ancient times because these are considered holy water sources, but due to modernization, these sources are lacking their popularity. The main aim of this study was to evaluate the status of water quality of these traditional water aquifers (Naula) so that the fitness of these sources can be analyzed.

Materials and Methods

Study Area:

Samples were taken from 5 different sites of the Lohaghat region. Lohaghat is situated at the bank of the Lohawati River in the district Champawat. Five Naulas (Natural Aquifers) from this region were selected for physicochemical analysis. These were Katreshwar Naula, Taxi Stand Naula, Rukmani Naula, Chauri Naula, and Shiv Mandir Naula. Detailed GPS locations of sampling sites are given in Table 1.

Sample Collection:

Samples were collected in 250 ml polypropylene sampling bottles between April to September 2022 and tested in the laboratory of S.V.G.P.G College, Lohaghat. All the samples were collected according to the guidelines of Bureau of Indian Standards (BIS).

Sample Analysis:

For the analysis of different physicochemical parameters following methods were used: pH was analyzed by electrometric method, Conductivity

Table 2: Mean values of physicochemical parameters

PARAMETERS	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	BIS Standards	
						Required Acceptable Limit	Permissible limit in the absence of Alternate source
pH	7.3	7.2	7.4	7.2	7.4	6.5-8.5	No relaxation
Temperature (°C)	17.2	18.9	18.5	16.6	18.3	-	-
CONDUCTIVITY (µs/c)	485	622	616.6	555.8	600.3	-	-
TOTAL HARDNESS (mg/l)	141	157	144.6	146	144.1	200	600
CALCIUM (mg/l)	26.3	30.3	23.1	22	27	75	200
MAGNESIUM (mg/l)	18	20	19	18	19	30	100
TDS (mg/l)	119.3	132.6	128.1	110	124.6	500	2000

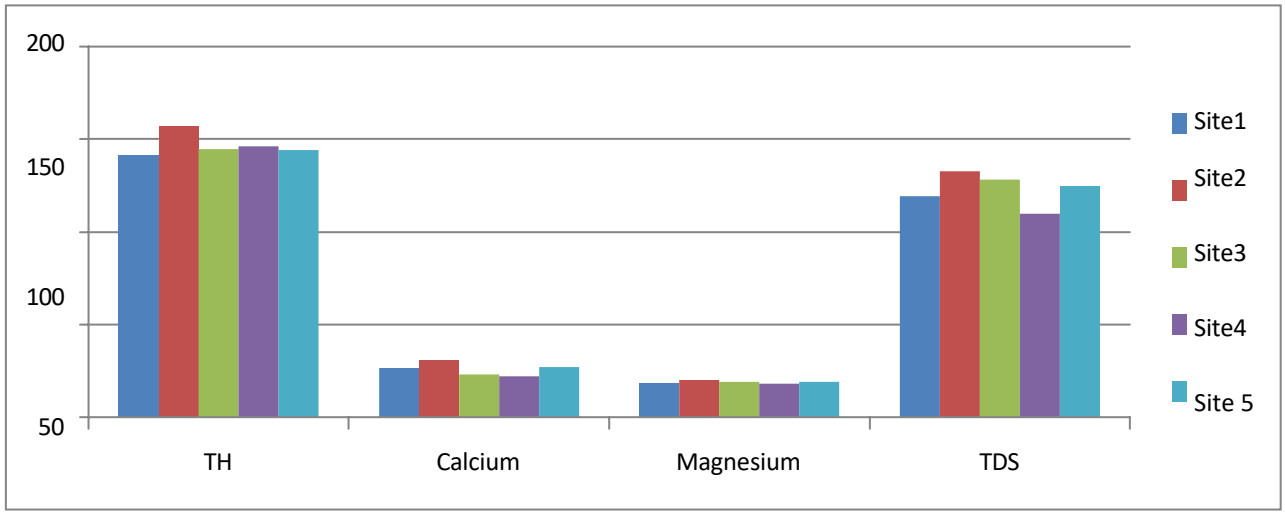

Fig. 1: Various physicochemical parameters of different sampling sites (all units are in mg/l).

and temperature were analyzed by Digital conductivity meter (HM digital AP-2 Aquapro), and Laboratory thermometer (Omsons), respectively. TDS was calculated by the gravimetric method. Total Hardness, Magnesium, and Calcium were analyzed by EDTA titration.

Results and Discussion

The mean value of physicochemical parameters are shown in Table 2. A total of seven parameters were tested for the analysis of the water quality of the aquifers (Naula) in Lohaghat. These parameters were pH, Temperature, Calcium, Magnesium, Total hardness (TH), EC, and TDS.

TDS is the value of total organic and inorganic salts found in water. In the tested samples the values of TDS vary between 110-132.6 mg/l. The required acceptable limit for the TDS is 500 mg/l and the permissible limit of TDS is 2000 mg/l. Figure 1 shows amount of TDS in all five sampling sites. Patni *et al*. (2018) worked on the springs of Pithoragarh and tested various physicochemical parameters, TDS in their water samples ranged from 315-727 mg/l, and maximum samples were found under the permissible limit except for two samples, because these two samples are located in the market area that is why their water has a high amount of TDS. Based on their observation it can

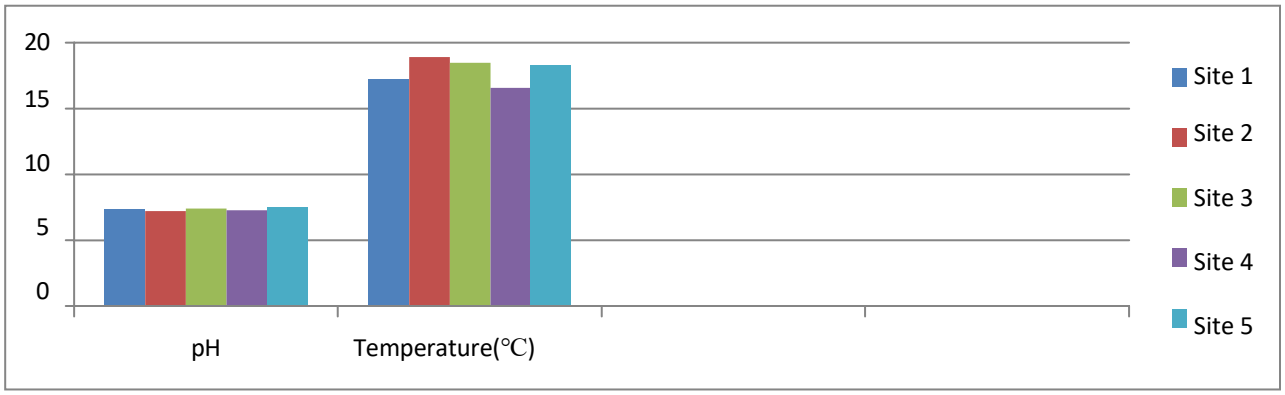

Fig. 2: pH and temperature of different sampling site.

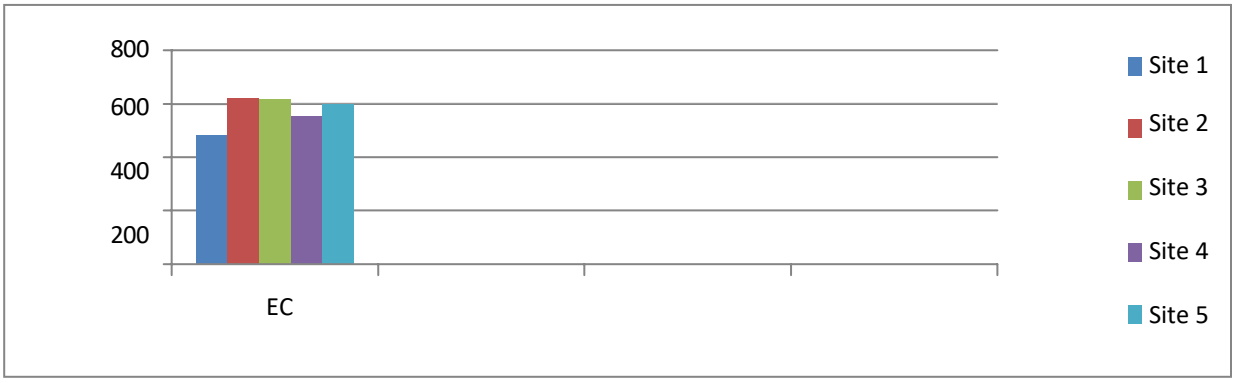

Fig. 3: Electrical conductivity of different sampling sites (µs/cm).

be concluded that anthropogenic activities impact the water quality of springs.

pH is the value of Hydrogen ion concentration of any solution, it ranged between 0-14 (Ben Chioma *et al*., 2015). In this study pH of samples was recorded between 7.2-7.4. These values are shown in Figure 2. The permissible limit of pH for potable water according to BIS is 6.5 to 8.5. Sinha *et al*. (2021) worked on the hydrochemistry of aquifers in the springs of Almora. They have studied 21 samples and found pH values of their samples varied from 6.85-7.82, which is under the acceptable limits of BIS.

Temperature is an important parameter to define the fitness of any water body (Rajesh and Rehana, 2022). Temperature is a quality parameter that defines the health of aquatic ecosystems. It also impacts other parameters like DO, an increase in water temperature often results in a decrease in the amount of DO. The temperature of all tested samples was found between 16.6-18.9 ℃. Figure 2 shows the temperature of different sampling sites, the maximum temperature was observed in sampling site 2 which is located in between the dense population of Lohaghat city.

Water conductivity explains the amount of dissolved substance and minerals in the water. The conductivity of all five samples was recorded between 485-622 µs/cm (Fig. 3). Singh *et al.* (2014) studied the physicochemical characters of springs around Srinagar Garhwal Valley and found fluctuation in the value of EC. They recorded value of EC between 509.68 µs/cm - 684.01 µs/cm, and observed that inorganic fertilizers, domestic sewage, presence of bicarbonate and calcium ions in the rocks of Garhwal Valley are responsible for the fluctuation in the values of EC.

One another important water quality parameter is hardness, which is the general measure of magnesium and calcium in the water. Generally, there are two kinds of Hardness-

Carbonate and Non-carbonate hardness. Carbonate hardness of any water sample can be removed by boiling that is why it is known as temporary hardness and non-carbonate hardness is called permanent hardness (Ramya *et al*., 2015). The acceptable limit for water hardness is 200 mg/l and the permissible limit for the hardness of water is 600 mg/l. The hardness of the tested samples was observed between 141-157 mg/l (Fig. 1). Two major ions which impact the hardness of water are calcium and magnesium. Calcium enters the water through gypsum, limestone, dolomite, and other calcium-bearing rocks. The amount of calcium was recorded between 22-30.3 mg/l and the amount of magnesium was recorded between 18-20 mg/l (Fig. 1). The acceptable limit for calcium is 75 mg/l and the accepted limit for magnesium is 30 mg/l. Patni *et al*. (2022) analyzed aquifers of Champawat and their study showed similar results. TH, calcium, and magnesium of their samples were also found under the permissible limits of BIS. They found their all samples are potable and safe for human consumption.

Conclusion

It can be concluded that anthropogenic activities are affecting the water quality of Naulas in the Lohaghat region. All the samples were found within the permissible range of the BIS. The main reason for the water crisis in Lohaghat is the increasing population and rapid urbanization. Safe and clean drinking water is a big challenge in this city especially in the summer season when surface water sources get dried or their amount of water gets reduced. At this time city faces a major water crisis, during crisis time these traditional sources which nowadays are losing their popularity can become a good alternative source of drinking water. But good management and awareness plans for the protection of these sources are very important, because physic-chemically most of the aquifers (Naulas) are still in good condition for drinking, but losing their fitness and water level in the absence of proper care and good maintenance.

Acknowledgements

The authors are thankful to the Principal, S.V.G.P.G College, Lohaghat for providing Laboratory facilities for experiments.

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