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Analysis of drinking water quality in Bideha and Sahidnagar municipalities of Dhanusha District

Randhir Kumar Jha[1], Priyanka Kumari Sah[2], Vijay Kumar Jha[3], Yog Prakash Yadav[4], Ram Darash Pandey[5], Ramhit Yadav[6], Chandradip Kumar Yadav[7*], Fathan Bahfie[8] and Ajaya Bhattarai[9]

1 Trichandra Multiple Campus, Tribhuvan University, Nepal.
drrandhirjha123@gmail.com https://orcid.org/0009-0002-6696-4374
2 Trichandra Multiple Campus, Tribhuvan University, Nepal.
priyankashah1301@gmail.com https://orcid.org/0009-0009-7540-6455
3 Amrit Campus, Tribhuvan University, Thamel, Kathmandu, Nepal.
jhav234@gmail.com https://orcid.org/0000-0002-9003-6239
4 Amrit Campus, Tribhuvan University, Thamel, Kathmandu, Nepal
yogprakash121@gmail.com https://orcid.org/0009-0003-9110-5026
5 Amrit Campus, Tribhuvan University, Thamel, Kathmandu, Nepal.
chemrdp@gmail.com https://orcid.org/0009-0001-8738-8196
6 Surynarayan Sataynarayan Morbaita Yadav Multiple Campus, Siraha, Nepal.
yramhit44@gmail.com https://orcid.org/0000-0002-9535-456X
7 Department of Chemistry, Amrit Campus, Tribhuvan University, Nepal.
*Corresponding Author chandradip2y@gmail.com https://orcid.org/0009-0001-6462-5080
8 Research Center of Mineral Technology, National Research and Innovation Agency of Indonesia, Indonesia.
fath007@brin.go.id https://orcid.org/0000-0003-3460-469X
9 Department of Chemistry, Mahendra Morang Adarsh Multiple Campus, Tribhuvan University, Nepal.
bkajaya@yahoo.com https://orcid.org/0000-0002-2648-4686

ABSTRACT

This study evaluated the drinking water quality of hand pumps in Bideha and Sahidnagar Municipalities, Nepal, in relation to the Nepal Drinking Water Quality Standards (NDWQS), 2022. In a cross-sectional design, 14 groundwater samples were analyzed using standard methods for physicochemical parameters: pH, turbidity, electrical conductivity (EC), ammonia, chloride, and alkalinity. The findings indicated that all tested parameters conformed to NDWQS limits. The recorded ranges were: pH (6.59–7.19), turbidity (0.1–3.1 NTU), EC (236–570 µS/cm), ammonia (0.21–1.45 mg/L), chloride (15.88–24.84 mg/L), and alkalinity (16–32 mg/L). These values are under NDWQS limits, however ammonia concentration in Ekarahi and Navtoli are approaching the borderline. The study highlights the crucial need for ongoing monitoring, improved sanitation, and community education to ensure the safety of drinking water in these areas.

Keywords: Contamination, Acidity, Basicity, Drinking water quality, NDWQS

1.0 Introduction

Access to safe drinking water is fundamental to human health and survival, as it is a critical barrier against waterborne diseases (World Health Organization, 2017a, 2017b). In low-income nations like Nepal, particularly the Terai region, groundwater serves as the principal source of drinking water. However, its quality is often compromised by natural geochemical cycles, agricultural activities, and poor sanitation infrastructure (Todd & Mays, 2005).

Despite the prevalence of tube wells and hand pumps in Nepal, studies indicate their vulnerability to pollution. For instance, heavy metals, including Cd, Cr, Fe, and Pb in the dug -

well water of the Kathmandu Valley have been identified (Kandel et al., 2025; Pant, 2011). Concurrently, a separate hydrogeochemical investigation revealed elevated levels of turbidity, acidity, and basicity, as well as total coliforms, exceeding the NDWQS (Egbueri, 2019). A 2025 assessment of the Mahakali River also reported iron and ammonium concentrations surpassing safe drinking limits (Pant et al., 2025). Furthermore, while most wells in Rautahat met national standards, Alam et al. (2024) found that 29% exceeded the WHO arsenic guideline.

These findings highlight an urgent need for consistent monitoring of both physicochemical and microbiological parameters as per the Nepal Drinking Water Quality Standards (Alighadri, 2011). In response to this necessity, the present study evaluates and compares drinking water quality in the Bideha and Sahidnagar Municipalities of Dhanusha District, Nepal. The location of the studies is shown in Figs. 1 and 2. Moreover, Table 1 shows the sample codes and locations.

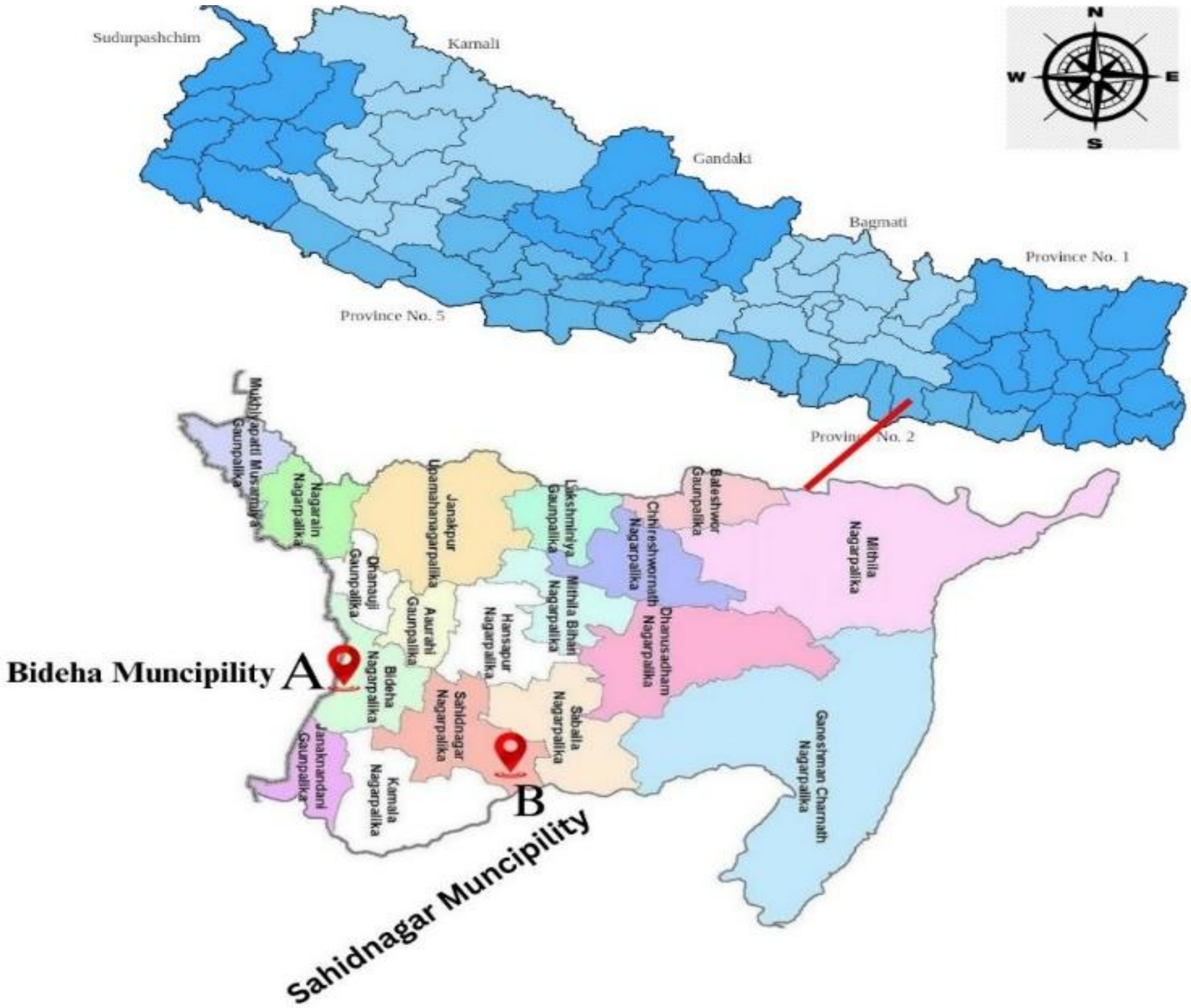

Figure 1: Map of Nepal showing Bideha and Sahidnagar municipalities

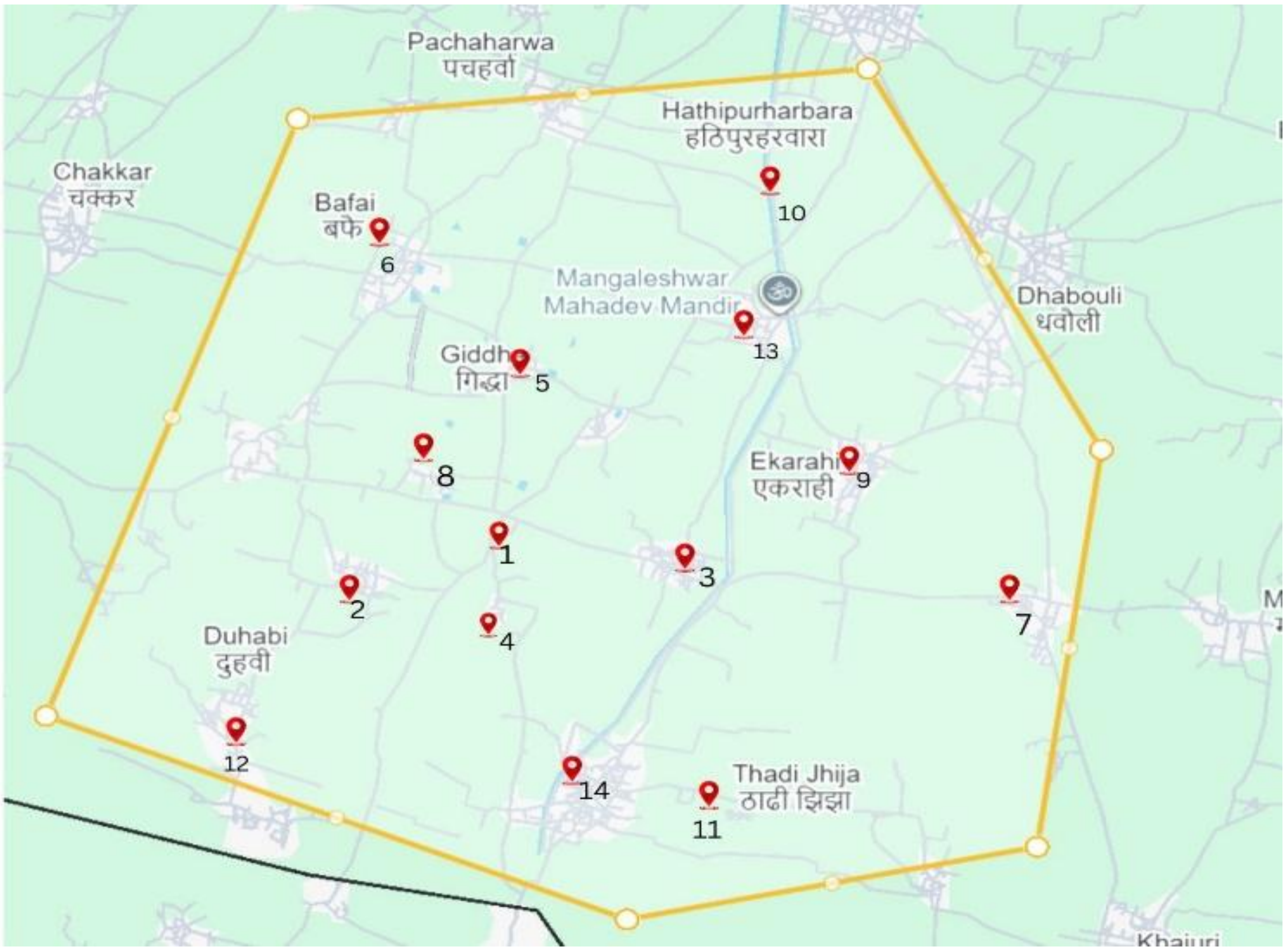

Figure 2: Location from where samples were collected

Table 1: Sample Codes and Location

S.No.	Sampling Names	Samples Code	Location		Ground Elevation(m)
			Latitude	Longitude	
1	Thadi	S1	26°39′57″	86°04′36″	100.52
2	Dhabouli	S2	26°42′02″	86°06′12″	99.93
3	Duhabi	S3	26°40′19″	86°02′47″	99.57
4	Sarabe	S4	26°40′46″	86°06′26″	96.67
5	Hathipur	S5	26°42′53″	86°05′13″	95.56
6	Ekarahi	S6	26°41′22″	86°05′33″	98.11
7	Tinkauriya Bazar	S7	26°41′14″	86°04′04″	96.57
8	Yogiyada	S8	26°41′33″	86°02′54″	95.47
9	Giddha	S9	26°41′51″	86°04′06″	97.59
10	Navtoli	S10	26°41′45″	86°03′10″	96.55
11	Bafai	S11	26°42′520″	86°03′34″	98.85
12	Belapatti	S12	26°41′23″	86°03′43″	96.67
13	Karmahi	S13	26°40′58″	86°03′26″	95.56
14	Chikna	S14	26°40′47″	86°03′59″	96.28

2.0 Materials and Methodology

Water samples were collected in clean, pre-labeled bottles. Standard laboratory glasswares, including volumetric flasks, beakers, pipettes, and filter paper, were used for the acidity and basicity related tests. The analysis utilized a range of chemical reagents. Common solutions included distilled water, sulfuric acid, silver nitrate, and EDTA. Specific indicators, such as methyl red was used to determine alkalinity. The targeted reagents like Nessler reagent was used for test for ammonia concentration, alongside appropriate buffering and oxidizing agents as needed. The laboratory equipment featured instruments for measuring various parameters, such as a pH meter for pH measurement, a digital conductivity meter for EC measurement, and a digital nephelometer to measure turbidity. Standard safety and documentation protocols were followed, with the use of laboratory coats, gloves, safety glasses, and notebooks.

2.1 Sampling Method

Fourteen groundwater samples were randomly selected from handpumps in Bideha Municipality and Sahidnagar Municipality, Dhanusha, for the physicochemical analysis. These handpumps serve as the primary source of drinking water for the residents. Each hand pump was pumped for roughly five minutes before collection to get rid of any standing water and to get a fresh sample. Samples were taken in clean plastic bottles that had been cleaned beforehand to avoid contamination. The bottles were securely packed and sent to E.G. Laboratory, Pulchowk, Kathmandu, for analysis.

3.0 Results and Discussion

The analysis of physicochemical parameters of water samples was done and compared with the Nepal Drinking Water Quality Standards (NDWQS, 2022). Due to growing urbanization, farming, and climate change, regular ground water monitoring is increasingly important to protect public health (Hem, 1959; Hem, 2005).

3.1 pH Value

The measured pH values are shown in Fig.1. The pH values ranged from 6.59 to 7.19, showing no considerable variations. All the pH values are well within NDWQS limit.

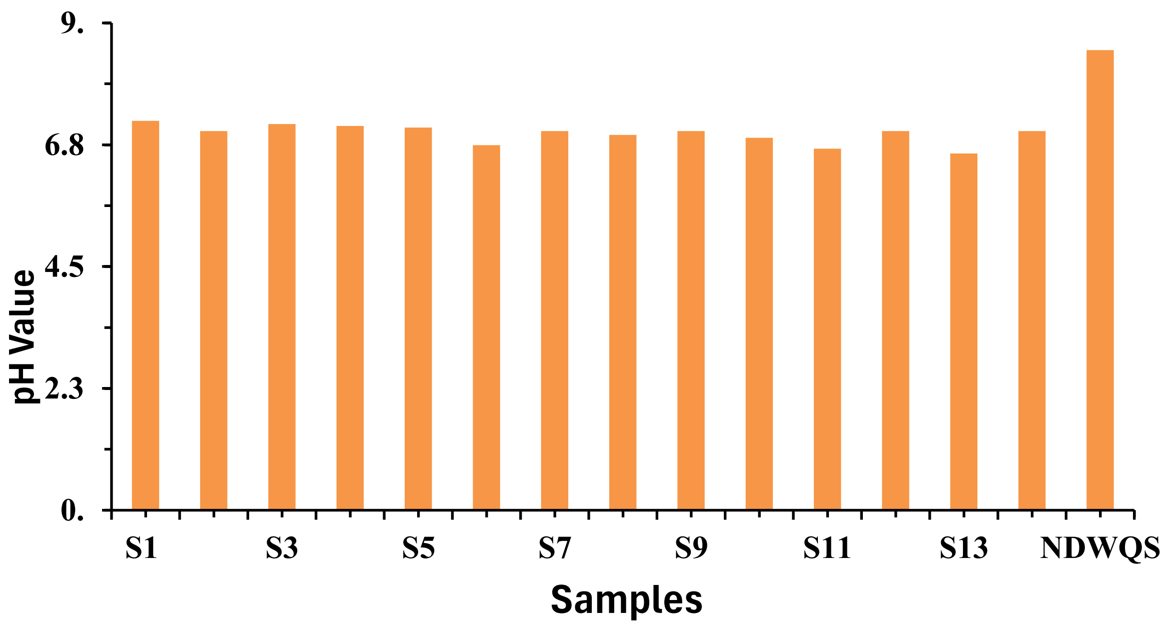

Figure 3: Variation of pH values in Water Samples

3.2 Turbidity

The turbidity affects water clarity and quality. The turbidity values for each study site and their variation across the locations are shown in Fig. 4. Turbidity levels in the 14 groundwater samples varied widely, ranging from 0.1 NTU (Samples 2, 5, and 9) to a maximum of 3.1 NTU (Sample 7). Most samples had turbidity below 1 NTU, indicating relatively clear water, but a few samples (7, 10, 11, and 13) showed higher turbidity values between 2.2 and 3.1 NTU, however all the vales are well below NDWQS limit.

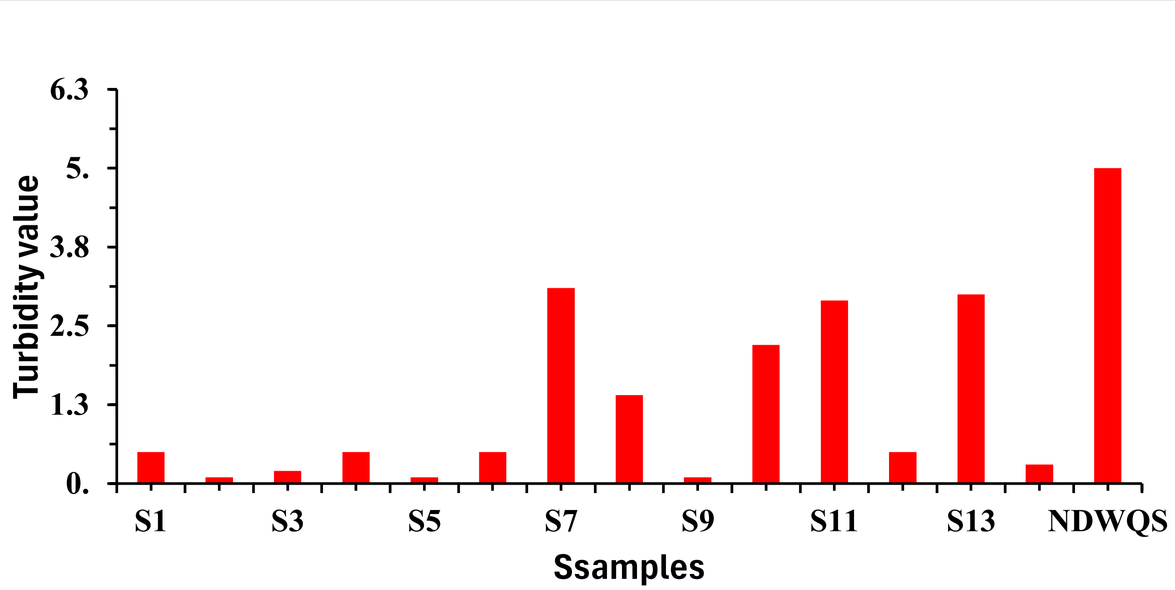

Figure 4: Sample-wise variation of turbidity level

3.3 Electrical Conductivity

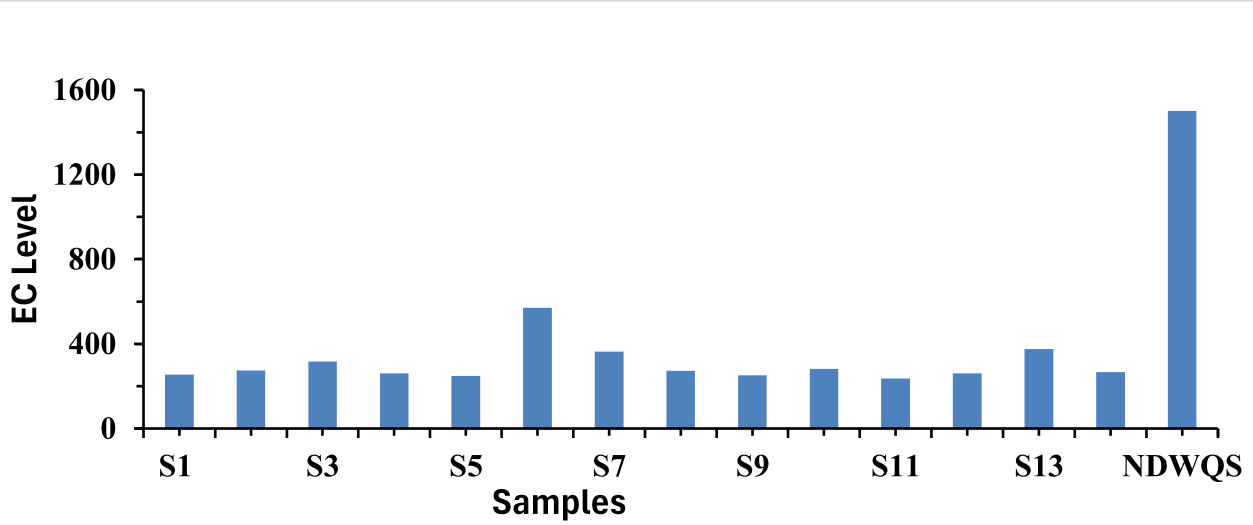

Figure 5: Electrical Conductivity of Water Samples

Electrical conductivity (EC) is the measure of the total dissolved ions in the water. The NDWQS value for EC is 1500 µS cm^{-1}. The EC Level for each study site, and its variation across the locations, is shown in Fig. 5. Values recorded ranged from 236 µS/cm to 570 µS/cm, with the least conductivity observed for Sample 11 (236 µS/cm) and the highest conductivity for Sample

6 (570 µS/cm). The average conductivity of the groundwater for the entire study area stands at 290.14 µS/cm.

3.4 Ammonia Concentration

The ammonia concentration for each study site and its variation across the locations are shown in Fig. 6. Ammonia concentration in the 14 groundwater samples ranged from 0.21 mg/L (Sample 8) to 1.45 mg/L (Sample 10). Sample 10 showed the highest ammonia level, while Sample 8 had the lowest. Most samples had ammonia values between 0.22 and 0.84 mg/L. The average ammonia concentration across all samples was approximately 0.70 mg/L, which is well within the permissible limit of 1.5 mg/L set by the NDWQS (2022). This indicates that the groundwater in the study area is generally safe with respect to ammonia content (Sarkar et al., 2022). The ammonia concentrations observed in Samples 6 (1.4 mg/L) and 10 (1.45 mg/L) are notably higher compared to other samples and are approaching the permissible limit of 1.5 mg/L set by the NDWQS. Although the measured values remain within the acceptable range, their proximity to the borderline level indicates a potential risk of future exceedance if contamination sources persist. Elevated ammonia levels may originate from organic matter decomposition, agricultural runoff, or sewage intrusion (Loan et al., 2013).

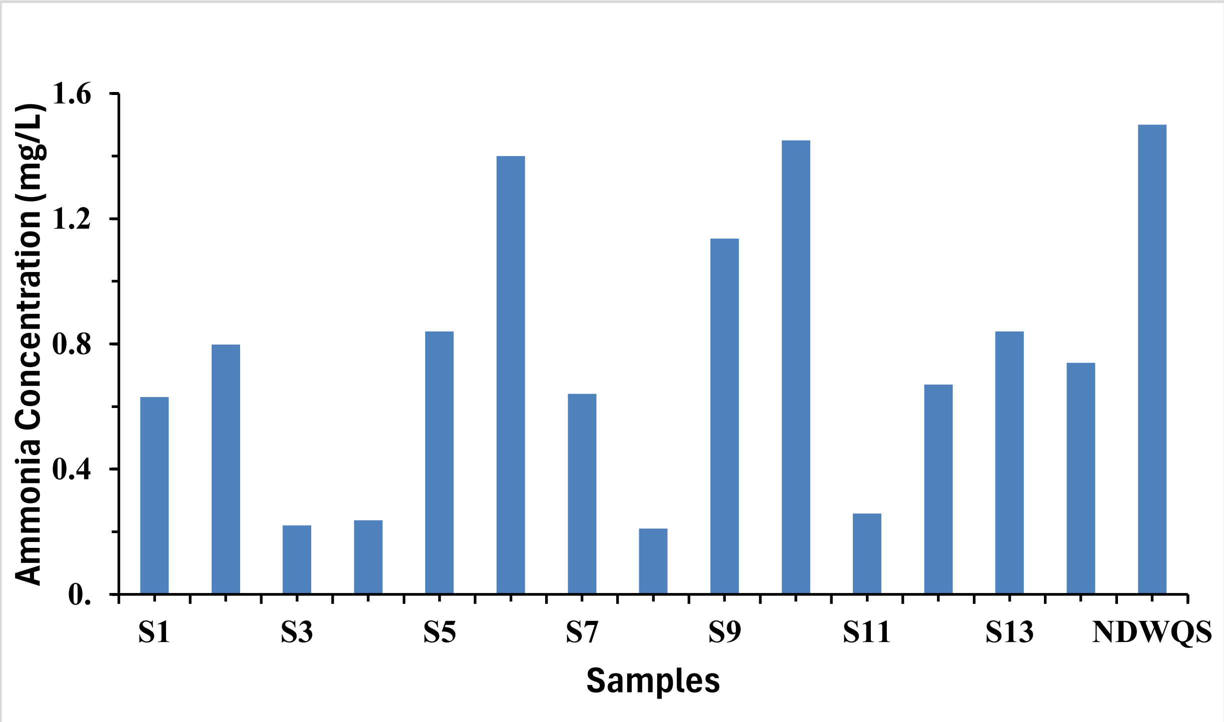

Figure 6: Sample-wise variation of ammonia concentration

3.5 Chloride concentration

Chloride is a salt that dissolves easily in water and can come from rocks or human activities like farming. In this study, chloride levels ranged from 15.88 mg/L to 24.84 mg/L, with the lowest in Sample 10 and the highest in Samples 7 and 8. All values are well below the safe limit of 250 mg/L set by NDWQS, showing that the groundwater is safe and not affected by salt contamination (Kartika et al., 2023; Asfaw et al., 2025). The chloride concentration for each study site and its variation across the locations are shown in Fig. 7.

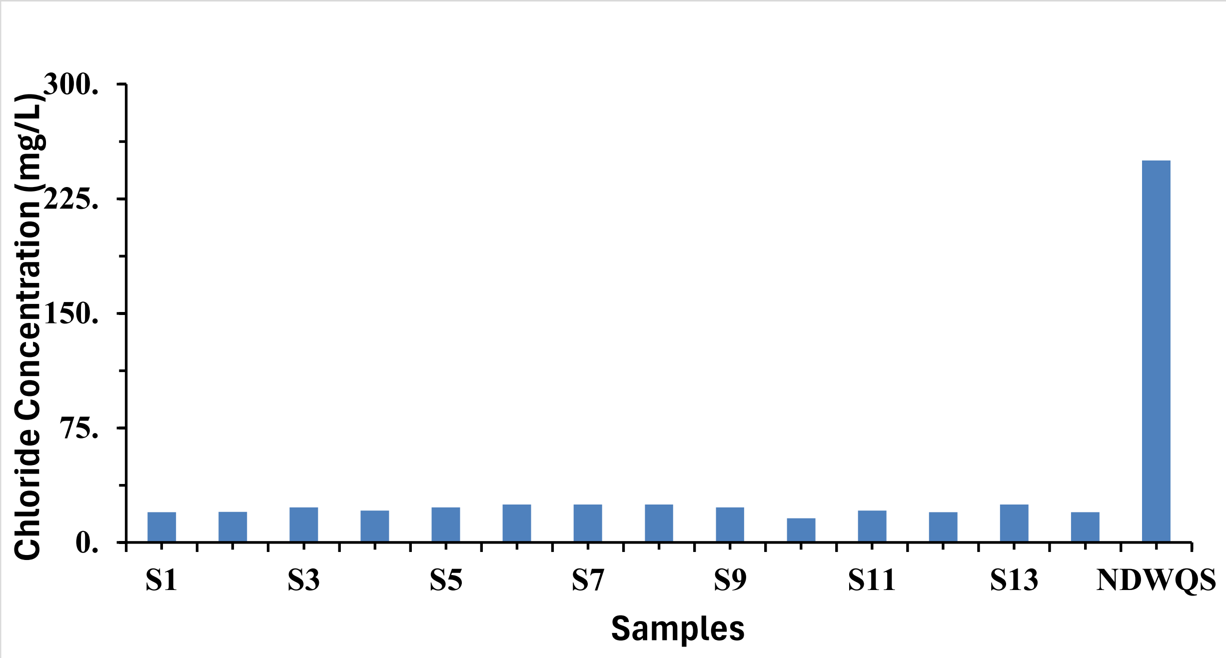

Figure 7: Sample-wise variation of chloride concentration

3.6 Alkalinity Level

Water's capacity to neutralize acids and maintain a steady pH is known as alkalinity. It mainly comes from dissolved minerals like bicarbonates. According to NDWQS, the safe limit is 200 mg/L. In our study, alkalinity ranged from 16 to 32 mg/L. The lowest values were found in Samples 5, 8, and 14 (16 mg/L), and the highest in Samples 6 and 13 (32 mg/L). All values are well within the safe range, showing that the water has a good buffering capacity (Dhoke, 2023). The Alkalinity Level for each study site and its variation across the locations are shown in Fig. 8.

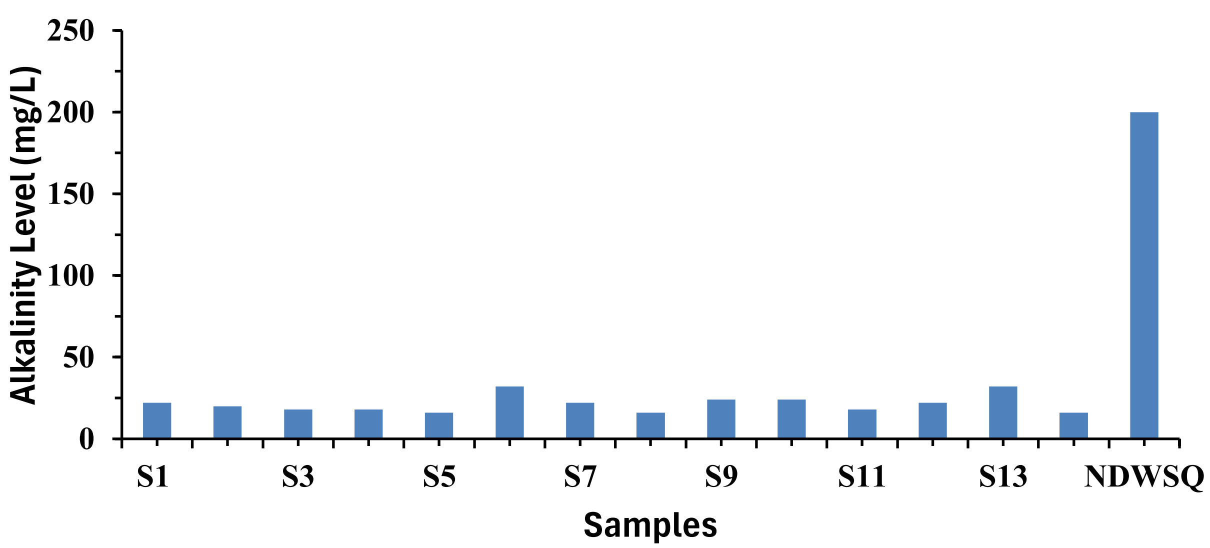

Figure 8: Sample-wise variation of Alakalinity Level

4.0 Conclusion

Based on the comprehensive evaluation against the Nepal Drinking Water Quality Standards (NDWQS, 2022), the study concluded that the groundwater in the study area is of a satisfactory physicochemical quality and is generally suitable for domestic use. Key parameters, including pH, turbidity, ammonia, chloride, and alkalinity, were found to be predominantly within the permissible limits. This indicates that the groundwater is largely unaffected by significant mineral contamination, excessive salinity, or pronounced impacts from domestic and agricultural runoff, rendering it safe from major health and cosmetic concerns. However, the findings highlight the cautious level of ammonia concentration in Ekarahi and Navtoli, thus the study recommends for continuous monitoring for the assessment of physicochemical parameters of drinking water in the study area.

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