# Perception-Based Assessment of the Water Supply System in Bhimdatta Municipality, Sudurpashchim Province, Nepal

Tark Raj Joshi[1], Mahesh Prasad Awasthi[1*], Janardan Joshi[2], Ramesh Raj Pant[3], Harish Singh Bist[1], and Ganesh Singh Thagunna[4]

[1]Faculty of Science and Technology, Far Western University, Mahendranagar, Kanchanpur, Nepal
[2]School of Engineering, Far Western University, Mahendranagar, Kanchanpur, Nepal
[3]Central Department of Environmental Science, Tribhuvan University, Kirtipur, Kathmandu, Nepal
[4]Nepal National Social Welfare association (NNSWA), Kanchanpur, Nepal
*Corresponding E-mail: mahesh.awasthi@fwu.edu.np

## Abstract

Safe and adequate water supply is one of the serious and significant challenges for local governments in Nepal. The main objective of this study is to explore the community perception on existing water supply systems, its quality, and quantity alongside with associated problems in the Bhimdatta Municipality. The study adopted qualitative and quantitative methods with Systematic random sampling and purposive sampling techniques for data collection in 2024. A total of 379 households were selected across the 19 wards of municipality. The findings reveals that 44.9% of households use groundwater as their primary drinking water source, 31.9% rely on public supply, and the rest use both sources. The majority of respondents rated the water quality as good with 56.2%, while 26.4% rated as excellent, 10.8% as fair, 6.1% as poor, and 0.5% as very poor. Most of the respondents reported a lower incidence of diseases stemming from drinking water source, they noted problems such as taste, odor, turbidity, and color. Over the past decade, groundwater levels have declined, making access more difficult across all wards. This study provides vital insights for policymakers and stakeholders to address these challenges and improve water quality and accessibility.

***Keywords:*** *Water quality, Groundwater level, Water supply system, Urbanization, SDGs*

## Introduction

With over 70% of the Earth surface covered by water and being a primary constituent of all living organisms, only 2% of the total volume of water is fresh water available for consumption and agriculture, leaving approximately 11% of the global population without access to a safe drinking water source (Atauzzaman et al., 2020). The global demand for safe drinking water is on the rise due to population growth. As per the United Nations, approximately one-third of the world's population lives in water shortage areas, of which about 1.1 billion people live without access to safe drinking water (Abedin, 2014). Each year, around 1.8 million people in developing countries die from diarrhea and cholera, with the majority being children under the age of five, mainly due to unsafe water, inadequate sanitation, and poor hygiene, which account for 88% of diarrheal cases (Mussa et al., 2019).

The need for clean and reliable drinking water is essential for human health. However, factors such as climate change, rapid population growth, urbanization, and rising industrialization have intensified the overuse of our already scarce water resources (Gevera et al., 2022). Additionally, the impact of anthropogenic activities on groundwater quality and quantity has been studied extensively and emphasized the need for adopting remedial measures to address groundwater problems caused by human activities (Khan et al., 2020). Landuse and landcover types also affect infiltration rates subsequently affecting the availability of groundwater (Joshi, 2023). In the context of groundwater quantity trends, Dillon et al. (2019) quantified water quantities derived from different sources, including municipal wastewater, and observed increases in groundwater levels. The quantity and quality of groundwater are interconnected, affecting both aquifers and surface water bodies. This connection highlighted the challenges and prospects of advancing groundwater research, emphasizing the influence of surface water-groundwater interactions on water quantity and quality in aquifers (Mengistu et al., 2021).

Assessment of drinking water quality and groundwater quantity trends is crucial for ensuring the availability of safe and sustainable water resources. Various studies have highlighted the significance of groundwater quality assessments emphasized the importance of assessing groundwater quality to

determine its feasibility for drinking water and identify potential pollutant sources (Prihantono et al., 2021). Moreover, research focusing on individual perceptions of drinking water quality has highlighted the behavioral responses and actions taken to address perceived risks (Crampton & Ragusa, 2016). With the rise in water pollution, the need for proper remedial measures to improve groundwater quality has become crucial (Anis et al., 2019). In developing countries, particularly in Nepal, significant challenges remain regarding the quality and accessibility of drinking water, which poses serious health risks due to contamination from sewage, agriculture, and industry. This contamination leads to widespread endemic diseases such as typhoid, dysentery, and cholera every summer (Warner et al., 2008). Nepal National Census 2011 revealed that 20% of households lacked on-site water sources, while two-thirds of urban households faced insufficient water supply (Shrestha et al., 2019). Furthermore, unlike many other developing nations, access to improved water sources in urban areas of Nepal has also decreased from 97% in 1990 to 91% in 2015 (Guragai et al., 2017). NDHS (2022) reported that 88% of the household population had sufficient quantities of drinking water. By province, this ranges from 74% of the household population in Karnali Province to 94% in Madhesh Province. The main sources of drinking water in Nepal are water piped into the household's dwelling/yard/plot and tube wells or boreholes, followed by bottled water. Numerous governmental and non-governmental organizations, including international entities, are collaborating in Nepal to expand access to safe water and sanitation services for marginalized communities in impoverished and distant regions (Bhandari et al., 2017). Various factors, such as shifts in the societal perception of science, increased complexity and uncertainty, have led to the general public becoming a significant participant in water management (Franc, 2010). In rural areas and municipalities of Nepal, water supply systems face challenges such as limited coverage, inadequate quantities, and substandard quality (Tiwari et al., 2023). Understanding perceptions of water quality is intricate, influenced by various factors such as taste, risk perception, socio-economic status, location, gender, environmental consciousness, control over water access, past experiences, consumption patterns, trust in providers, and media influence (Alameddine, 2016).

Bhimdatta, a rapidly growing city in Nepal, has experienced rapid population growth, with an annual rate of around 1.3% from 2011 to 2021. Situated 5 kilometers east of the Indian border, Bhimdatta serves as a vital hub for industries operating between India and Nepal, indicating significant cross-border movement. Also, the city experiences a significant inflow of people, particularly from the hill and mountain districts of Sudurpaschim Province, drawn by its status as a center for higher education and business opportunities. This high level of migration underscores the critical need for a reliable and adequate water supply to support the growing population and its associated demands. However, this rapid and unplanned urbanization has placed immense pressure on the city's infrastructure, particularly its water supply system. The projected population increase without corresponding improvements in water supply infrastructure will exacerbate existing water supply challenges, making the provision of safe drinking water to residents a critical issue. The present study is carried out in Bhimdatta Municipality to address the persistent issues related to water supply that have emerged due to the city's rapid growth. Despite the significance of these challenges, there is a notable shortage of perception-based studies on water supply in Nepal. This study aims to fill that gap by thoroughly investigating the existing water supply system, its quality and quantity, and identifying specific problems associated with water provision and suggesting measures to ensure sustainable water resource management and adequate water availability in Bhimdatta Municipality, Kanchanpur District, Sudurpaschim Province, Nepal.

## Methodology

### *Study area*

This study was conducted in Bhimdatta Municipality, situated between 28°52' to 29°08' N and 80°06' to 80°15.5' E, with elevation ranging from 222.5 m to 1192 m above sea level (Figure 2), covering a total area of 171.34 $km^2$. Situated in Kanchanpur district within Sudurpashchim Province, it serves as the district headquarters. The municipality is bordered by Bedkot Municipality to the east, Dadeldhura district to the north, Shuklaphanta National Park to the south, and Uttarakhand, India to the west. This area, formerly known as Mahendranagar, holds significance as a commercial hub in

far western Nepal. The municipality is 700 kilometers away from the capital city of Nepal, Kathmandu, and serves as the termination point of the East West Highway facilitating access to remote western areas. Bhimdatta municipality is divided into 19 wards (Figure 1) and had a population of 114,404 (NSO, 2021). The area is inhabited by a blend of rural and semi-urban communities with diverse socio-economic backgrounds, livelihoods, and cultural practices show a diverse landscape, encompassing both plains and hills in the Terai region. This municipality experiences a tropical and subtropical climate due to its location in the Terai region. The highest recorded temperature in the municipality ranges from 43°C in summer to 6.96°C in winter. The average annual rainfall is about 1575 mm. Most of the land area of this municipality is flat, with the northern boundary reaching an elevation of around 1192 m above sea level, resulting in most of the land area sloping from north to south and experiencing water flow. Most of the land area was occupied by cropland, followed by forest area and others (Figure 3). Due to its geographical location and topography, this region encounters various climate-related challenges such as floods, and droughts.

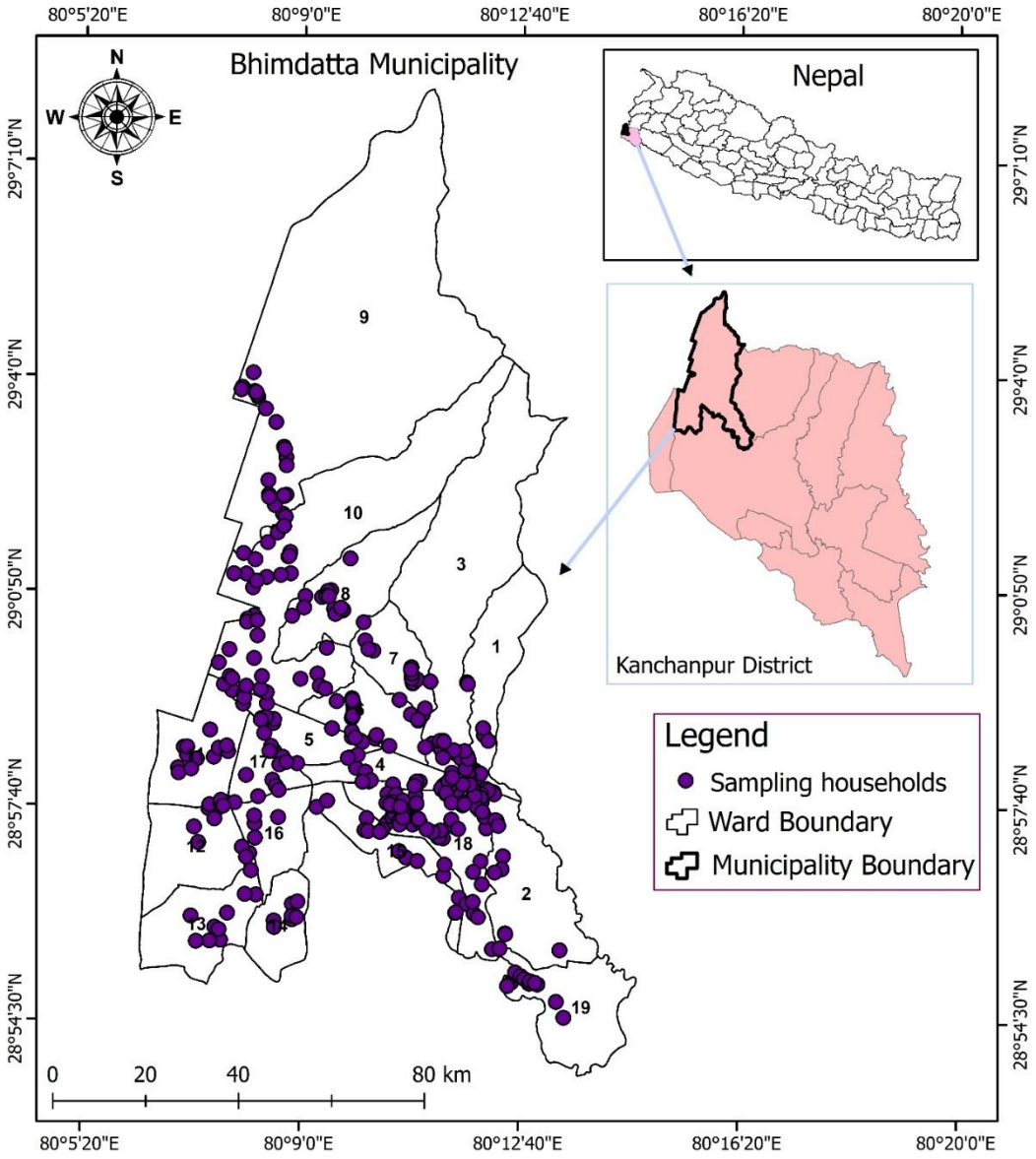


*Figure 1: Map indicating study area location and sampled households in Bhimdatta Municipality*

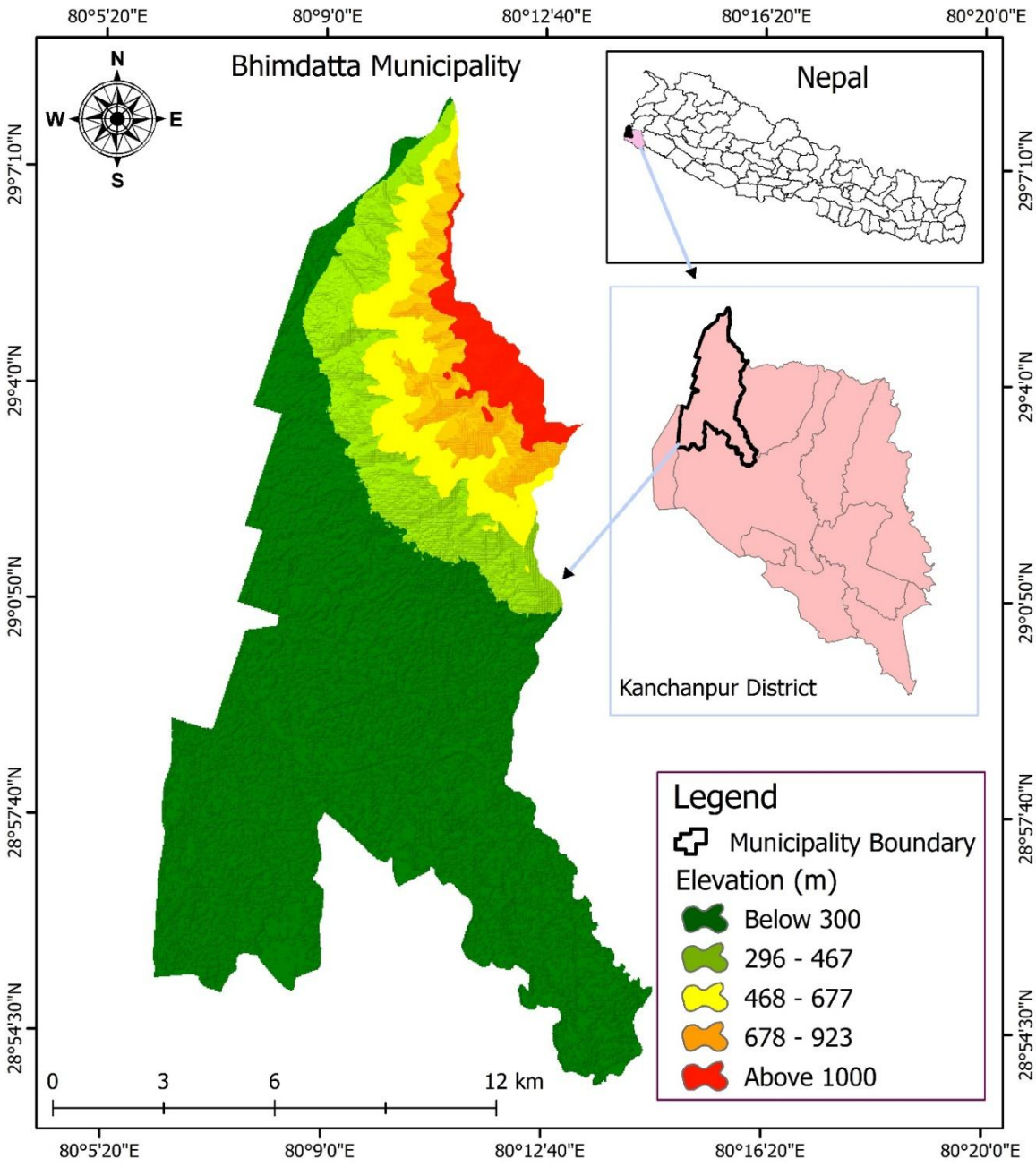


*Figure 2 Map displaying an elevation range of Bhimdatta Municipality*

### *Data Collection*

The current study relies on primary data gathered through various methods, including the utilization of questionnaires, interviews with key informants, and focused group discussions (FGD). Structured interview schedules were employed for the quantitative data collection, involving face-to-face interviews with respondents. Meanwhile, qualitative data was obtained from FGDs and key informant interviews.

### Key Informant Interview

In order to systematically investigate the existing water supply situation within the wards, a Key Informant Survey was conducted. The key informants were selected using purposive sampling technique. This entailed interviewing individuals with profound knowledge of the ward and its evolving conditions. The selected key informants, such as the Ward President, were chosen for their

deep understanding of the ward's context, providing valuable insights into how the ward is managing and responding to the existing water supply impacts observed within its area.

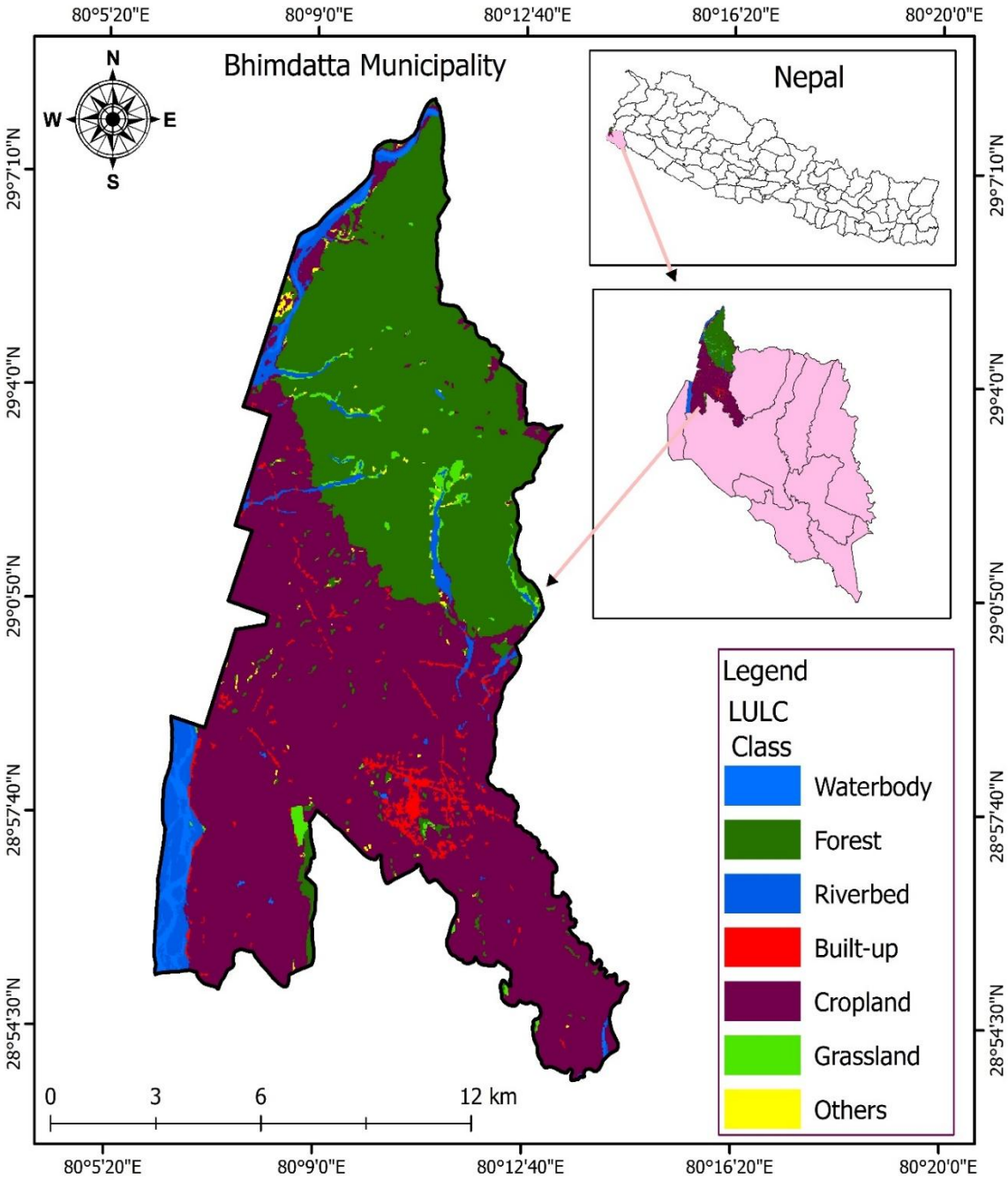


*Figure 3: Map illustrating the land use/land cover of Bhimdatta Municipality*

**Focus Group Discussion**

Focus group discussion was carried out to cross-check and validates the answers from respondents regarding water supply situation, its quality, quantity, associated issues and socio-economic conditions. These discussions involved active participation from ward members and representatives of social institutions across all 19 wards within the municipality.

***Sampling Design, Sample Size Determination and Household Survey***

The study encompassed all permanent residents of Bhimdatta Municipality aged 18 years and above. A representative sample was derived through a multistage simple random sampling strategy. A

systematic approach was utilized to survey 379 households in each ward of Municipality, selected through systematic random sampling. This process aimed to acquire representative data concerning Water supply issues. Both quantitative and qualitative data were collected from the community through interviews conducted with the assistance of a semi-structured questionnaire. Subsequently, one member from each selected household was approached to respond to the questionnaire, resulting in a total of 379 respondents. The determination of the household sample size employed the formula developed by Arkin and Colton (1963). This method ensured a comprehensive, statistically sound collection of information from the targeted community.

Sample size, $n = \frac{NZ^2P(1-P)}{Nd^2+Z^2P(1-P)}$

Where,

n= sample size

N= total number of households

Z=confidence level (at 95% level Z=1.96)

p= estimated population proportion (0.5, this maximizes the sample size),

d=error level of 8%

*Table 1: Sampled households in 19 wards of Bhimdatta Municipality*

| Ward No. | Total Household | Proportion of HH out of Total | Sampled HH |
|---|---|---|---|
| 1 | 955 | 3 | 13 |
| 2 | 1778 | 6 | 24 |
| 3 | 1820 | 7 | 25 |
| 4 | 1501 | 5 | 21 |
| 5 | 1255 | 5 | 17 |
| 6 | 2238 | 8 | 31 |
| 7 | 1255 | 5 | 17 |
| 8 | 1116 | 4 | 15 |
| 9 | 1738 | 6 | 24 |
| 10 | 2550 | 9 | 35 |
| 11 | 845 | 3 | 12 |
| 12 | 765 | 3 | 11 |
| 13 | 1177 | 4 | 16 |
| 14 | 678 | 2 | 9 |
| 15 | 1010 | 4 | 14 |
| 16 | 735 | 3 | 10 |
| 17 | 462 | 2 | 6 |
| 18 | 4624 | 17 | 64 |
| 19 | 1088 | 4 | 15 |
| Total | 27590 | 100 | 379 |

***Statistical Analysis***

The gathered datasets were systematically organized using Microsoft Excel and Word. The quantitative and qualitative data were meticulously organized into thematic categories, summarized, and subsequently interpreted to draw meaningful insights. ArcGIS 10.8 version was employed for mapping and Origin Pro 2023b software for quantitative data analysis and graphical representations.

## Results and Discussion

This study assessed the water supply systems in Bhimdatta Municipality, including its quality, quantity, and related issues. The collected primary data were analyzed to understand the current state of water resources in the municipality.

### *Demographic Characteristics of Respondents*

Demographic characteristics such as gender, age, education, occupation affect how they perceive the effect of drinking water quality on their life and livelihood. Majority of the respondents among surveyed households from different wards are male (240 and 63.32%) and 36.68% (139) female respondents (Figure 4). The percentages and number of respondents indicate a detailed perspective on the gender composition within each ward, showing clear variations in male and female representation (Figure 4 and Figure 5). The age categories-young adults (18-29), middle-aged (30-49), and older aged (50 and above) illustrate generational distribution among respondents. Middle-aged respondents were dominant comprising 54.35% of surveyed households, followed by old-aged (31.4%) and young adults (14.25%) (Figure 6; Table 2). These variations are important to understand the community dynamics and perceptions. The highest percentage of education level is 55.15% from school level, followed by high school with 23.75%, undergraduate level with 15.83% and remaining levels are dominated by graduate level (Figure 7; Table 2).

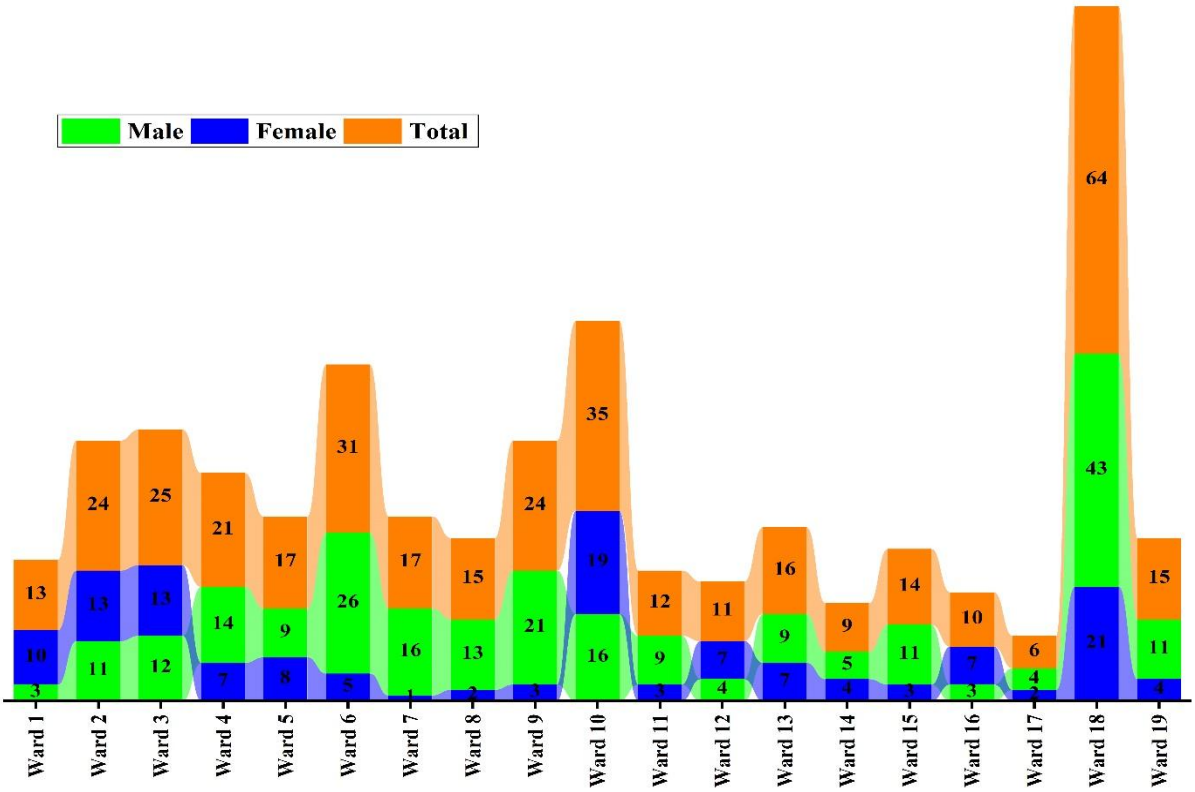


*Figure 4: Gender-wise distribution of respondents*

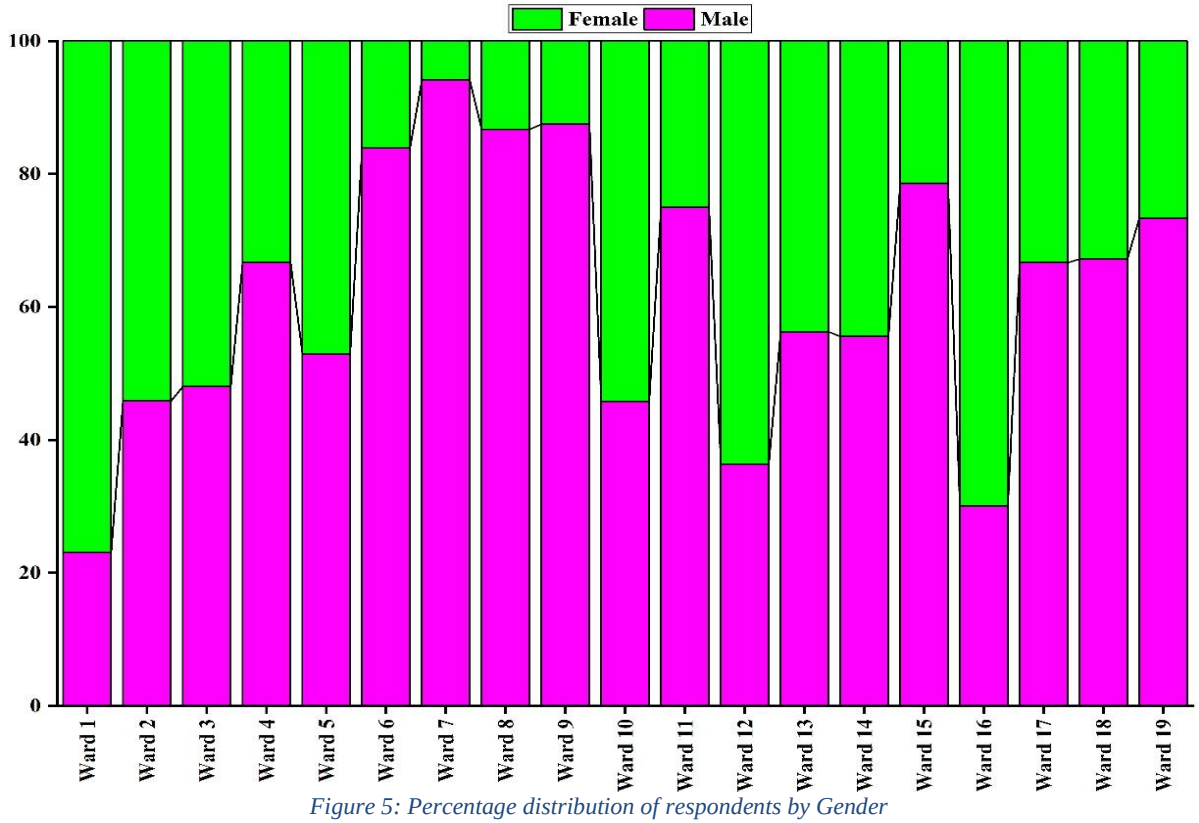


*Figure 5: Percentage distribution of respondents by Gender*

*Table 2: Distribution of respondents by age group and educational level (Source: Field Survey, 2024)*

| | Age Range | | | | Education Level/Qualification | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Wards** | **18-29** | **30-49** | **>=50** | **Total** | **Below SEE** | **High School** | **Bachelor** | **Master** | **Total** |
| Ward 1 | 4 | 8 | 1 | 13 | 6 | 3 | 3 | 1 | 13 |
| Ward 2 | 3 | 18 | 3 | 24 | 11 | 4 | 8 | 1 | 24 |
| Ward 3 | 1 | 15 | 9 | 25 | 11 | 5 | 8 | 1 | 25 |
| Ward 4 | 7 | 9 | 5 | 21 | 7 | 7 | 7 | 0 | 21 |
| Ward 5 | 4 | 8 | 5 | 17 | 10 | 6 | 1 | 0 | 17 |
| Ward 6 | 5 | 12 | 14 | 31 | 21 | 6 | 3 | 1 | 31 |
| Ward 7 | 1 | 7 | 9 | 17 | 10 | 5 | 1 | 1 | 17 |
| Ward 8 | 2 | 9 | 4 | 15 | 12 | 2 | 0 | 1 | 15 |
| Ward 9 | 2 | 14 | 8 | 24 | 15 | 5 | 3 | 1 | 24 |
| Ward 10 | 4 | 20 | 11 | 35 | 24 | 6 | 4 | 1 | 35 |
| Ward 11 | 1 | 3 | 8 | 12 | 9 | 1 | 1 | 1 | 12 |
| Ward 12 | 1 | 9 | 1 | 11 | 4 | 5 | 2 | 0 | 11 |
| Ward 13 | 2 | 8 | 6 | 16 | 8 | 4 | 2 | 2 | 16 |
| Ward 14 | 2 | 4 | 3 | 9 | 4 | 4 | 1 | 0 | 9 |
| Ward 15 | 0 | 8 | 6 | 14 | 6 | 6 | 1 | 1 | 14 |
| Ward 16 | 0 | 8 | 2 | 10 | 6 | 1 | 2 | 1 | 10 |
| Ward 17 | 2 | 3 | 1 | 6 | 1 | 2 | 3 | 0 | 6 |
| Ward 18 | 13 | 33 | 18 | 64 | 33 | 15 | 10 | 6 | 64 |
| Ward 19 | 0 | 10 | 5 | 15 | 11 | 3 | 0 | 1 | 15 |
| Total | 54 | 206 | 119 | 379 | 209 | 90 | 60 | 20 | 379 |

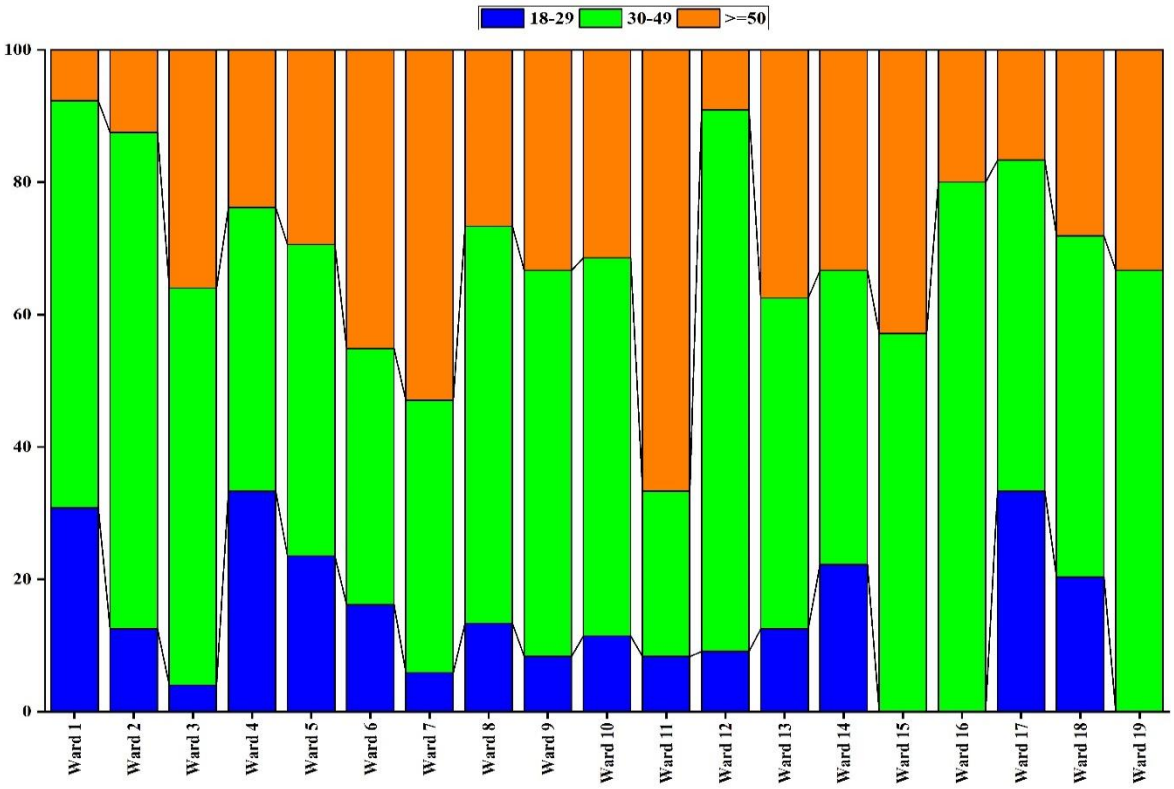


*Figure 6: Percentage distribution of respondents by Age group*

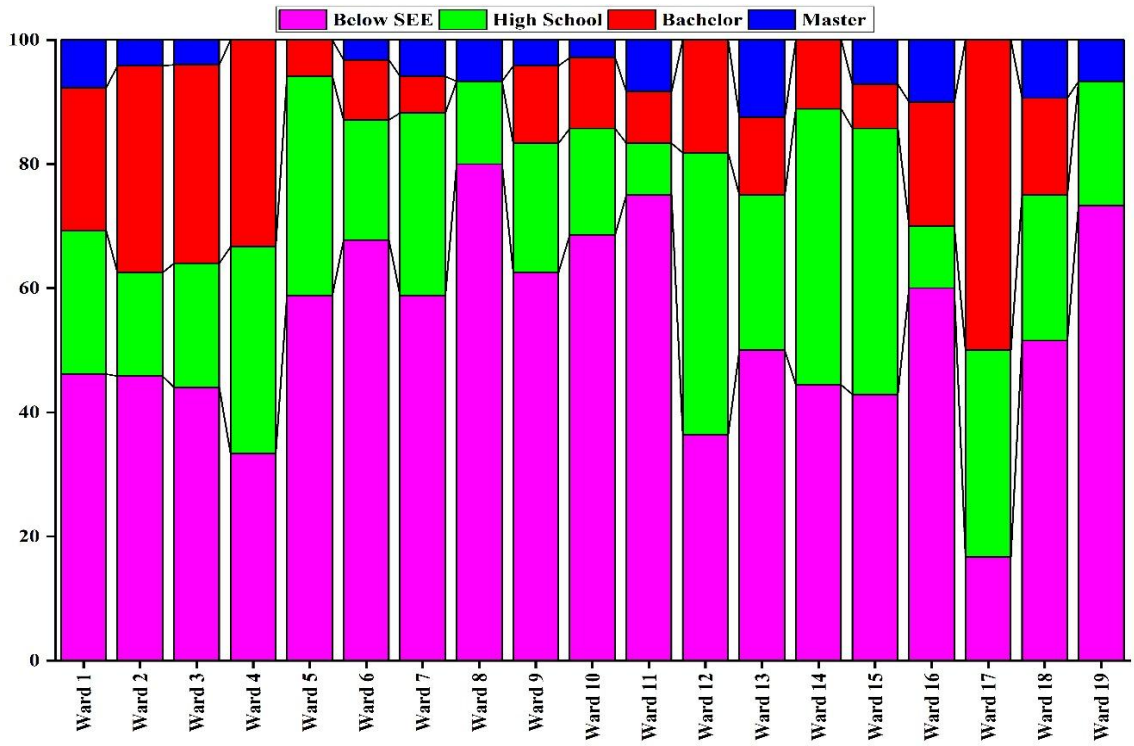


*Figure 7: Percentage distribution of respondents by educational level*

### *Existing Drinking Water Supply Situations in Bhimdatta Municipality*

Decentralized tap water systems are an important drinking water source worldwide. A good quality, high-pressure continuous water supply (CWS) is always the target of any urban settlement. The findings reveals that 44.9% of households use groundwater as their primary drinking water source, 31.9% rely on public supply, and the rest use both sources. Ward 1 shows (46.15%) of preference for

public water usage, 23.08% use groundwater, and 30.77% use both. Ward 2 shows 29.17% relying on public water, 29.17% on groundwater, and 41.67% on both. Ward 3 has a majority of using public water (60%), with 40% using both. In Ward 4, (85.71%) use public water, while only 4.76% use groundwater. Ward 5 stands out with 94.12% relying on groundwater. Ward 6 has 51.61% using groundwater, 16.13% using public water, and 32.26% using both. Ward 7 primarily uses groundwater, with a significant portion relying on public water and the remainder using both sources. Ward 8, in study area, is predominantly reliant on public water. Ward 9 favors public water but uses both sources to some extent. Ward 10 mainly uses groundwater. Wards 11 through 17 rely exclusively on groundwater. Ward 18 has a balanced use of both sources, and Ward 19 exclusively uses groundwater. This variation in water supply depicts the insufficient development of municipal tap water supply system across the municipality. The lack of water supply infrastructure exacerbates socio-economic challenges in municipalities by stalling new construction and hindering development. Addressing this issue requires regional or national financial and managerial support, coupled with proactive efforts from local municipalities. Despite ample water resources, water insecurity remains widespread in Nepal (Maskey et al., 2023). The Department of Water Supply and Sewerage Management (DWSSM) reported that only 51.69% of the population has piped water, while 48.31% depend on non-piped systems like private tube wells (DWSSM, 2019). The WHO/UNICEF Joint Monitoring Program (JMP) for Water Supply, Sanitation, and Hygiene indicates that safely managed improved water sources decreased from 24% to 18% between 2000 and 2020, while non-piped coverage rose from 36% in 2000 to 44% in 2017 (Maskey et al., 2023). Meanwhile, water demand is also rapidly increasing in urban areas (Maskey et al., 2023).

.

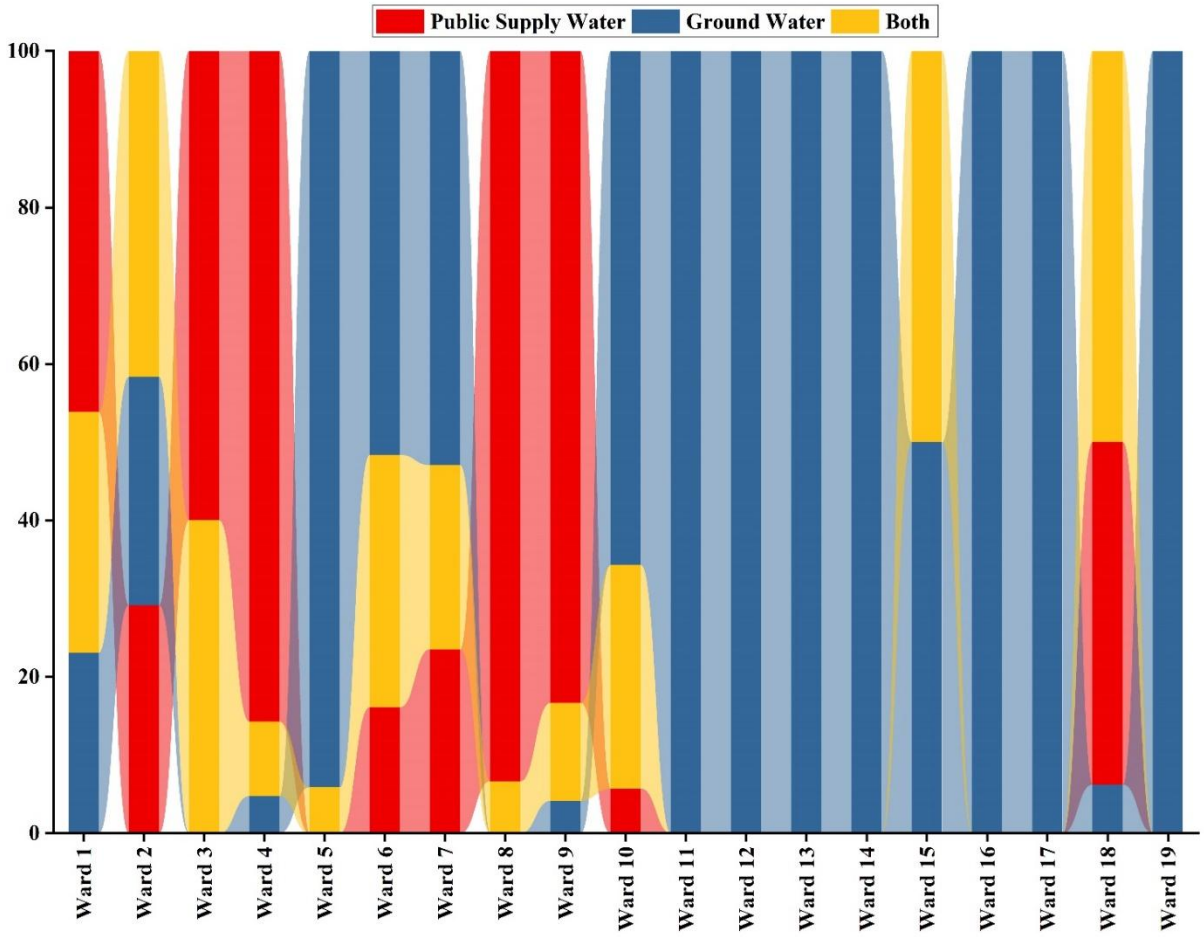


*Figure 8: Percentage distribution of primary drinking water source in Bhimdatta Municipality*

*Table 3: Distribution of primary drinking water source in Bhimdatta Municipality (Source: Field Survey, 2024)*

| Primary Source of Drinking Water | | | | |
|---|---|---|---|---|
| **Wards** | **Public Water Supply** | **Ground Water** | **Both** | **Total** |
| Ward 1 | 6 | 3 | 4 | 13 |
| Ward 2 | 7 | 7 | 10 | 24 |
| Ward 3 | 15 | 0 | 10 | 25 |
| Ward 4 | 18 | 1 | 2 | 21 |
| Ward 5 | 0 | 16 | 1 | 17 |
| Ward 6 | 5 | 16 | 10 | 31 |
| Ward 7 | 4 | 9 | 4 | 17 |
| Ward 8 | 14 | 0 | 1 | 15 |
| Ward 9 | 20 | 1 | 3 | 24 |
| Ward 10 | 2 | 23 | 10 | 35 |
| Ward 11 | 0 | 12 | 0 | 12 |
| Ward 12 | 0 | 11 | 0 | 11 |
| Ward 13 | 0 | 16 | 0 | 16 |
| Ward 14 | 0 | 9 | 0 | 9 |
| Ward 15 | 0 | 7 | 7 | 14 |
| Ward 16 | 0 | 10 | 0 | 10 |
| Ward 17 | 0 | 6 | 0 | 6 |
| Ward 18 | 28 | 4 | 32 | 64 |
| Ward 19 | 0 | 15 | 0 | 15 |
| Total | 119 | 166 | 94 | 379 |

***Rating of drinking water quality***

Communities are at the forefront in responding to water quality issues, their perception is vital. This section outlines the respondents' perception on drinking water situation including its availability and quality. In analyzing the respondents' ratings of drinking water quality, distinct patterns emerge across the 19 wards. The rate scale was fixed as: Excellent, Good, fair, poor and very poor. Analysis of respondents' ratings of drinking water quality reveals distinct trends across the 19 wards. The majority of the respondents from different wards (n=213) perceived their water quality as good followed by excellent (n=100).Of the respondents, 41 perceived their drinking water quality as (fair) , 23 of them were selected as (poor) and remaining 2 were rated (very Poor). Figure 9 and Table 4 depicts the perception of ward wise rating of the existing water quality.

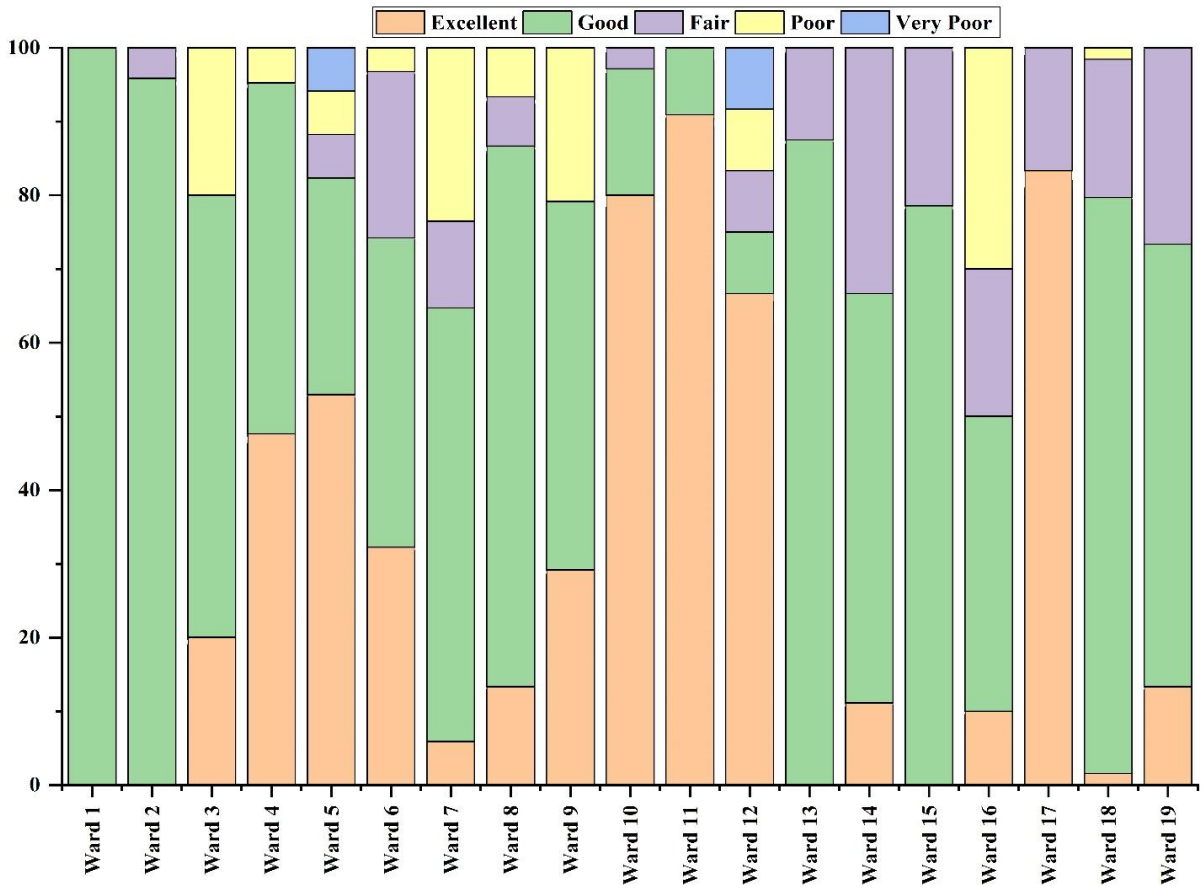


*Figure 9: Percentage of respondent's rating on quality drinking water in Bhimdatta Municipality*

These results highlight variations in perceptions of water quality, with some wards consistently rating water quality higher than others. This may be due to spatial variation in distribution of ground water hydrology and dissimilar soil and geology. Increased ground water pumping and reduced recharge can greatly influence the quality of water (Abdi et.al, 2019). Abdi et al (2019) also mentioned that the main factors influencing people's water quality perception are its color and appearance, which form a sort of quality standard used to evaluate the water quality, even of raw water. Coetzee et al (2016) revealed that most residents understood the quality of water to relate to aspects like the clarity and color (cleanliness and brightness), as well as smell and composition.

*Table 4: Respondent's rating on quality of drinking water in Bhimdatta Municipality (Source: Field Survey, 2024)*

| Wards | Excellent | Good | Fair | Poor | Very Poor | Total |
|---|---|---|---|---|---|---|
| Ward 1 | 0 | 13 | 0 | 0 | 0 | 13 |
| Ward 2 | 0 | 23 | 1 | 0 | 0 | 24 |
| Ward 3 | 5 | 15 | 0 | 5 | 0 | 25 |
| Ward 4 | 10 | 10 | 0 | 1 | 0 | 21 |
| Ward 5 | 9 | 5 | 1 | 1 | 1 | 17 |
| Ward 6 | 10 | 13 | 7 | 1 | 0 | 31 |
| Ward 7 | 1 | 10 | 2 | 4 | 0 | 17 |
| Ward 8 | 2 | 11 | 1 | 1 | 0 | 15 |
| Ward 9 | 7 | 12 | 0 | 5 | 0 | 24 |
| Ward 10 | 28 | 6 | 1 | 0 | 0 | 35 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ward 11 | 10 | 1 | 0 | 0 | 0 | 11 |
| Ward 12 | 8 | 1 | 1 | 1 | 1 | 12 |
| Ward 13 | 0 | 14 | 2 | 0 | 0 | 16 |
| Ward 14 | 1 | 5 | 3 | 0 | 0 | 9 |
| Ward 15 | 0 | 11 | 3 | 0 | 0 | 14 |
| Ward 16 | 1 | 4 | 2 | 3 | 0 | 10 |
| Ward 17 | 5 | 0 | 1 | 0 | 0 | 6 |
| Ward 18 | 1 | 50 | 12 | 1 | 0 | 64 |
| Ward 19 | 2 | 9 | 4 | 0 | 0 | 15 |
| Total | 100 | 213 | 41 | 23 | 2 | 379 |

***Public Health concern and Water Supply system***

Analyzing the data on reported cases regarding the waterborne diseases, across the 19 wards relative to the total number of respondents, the findings exhibit among 6 different wards (Ward no. 1, 4, 6, 10, 13, and 17) there is no instances of diseases attributed from drinking water while other remaining wards shows prevalence of water borne diseases. In response to public health concern, when basic water supply is poor, compromised drinking water quality can lead to various health risks. Climate change worsens these issues, contributing to waterborne diseases, vector-borne diseases, and climate-related damage to infrastructure. Direct effects of changing climate and its influence on the water sector may raise a key concern for public health. As a consequence, various skin and intestinal diseases, dysentery, fever, and diarrhea become a regular part of life for the people that rely on underground (Hand pumped) water supply system. Figure 10 depicts the perception of public health concern, related to drinking water supply at different wards.

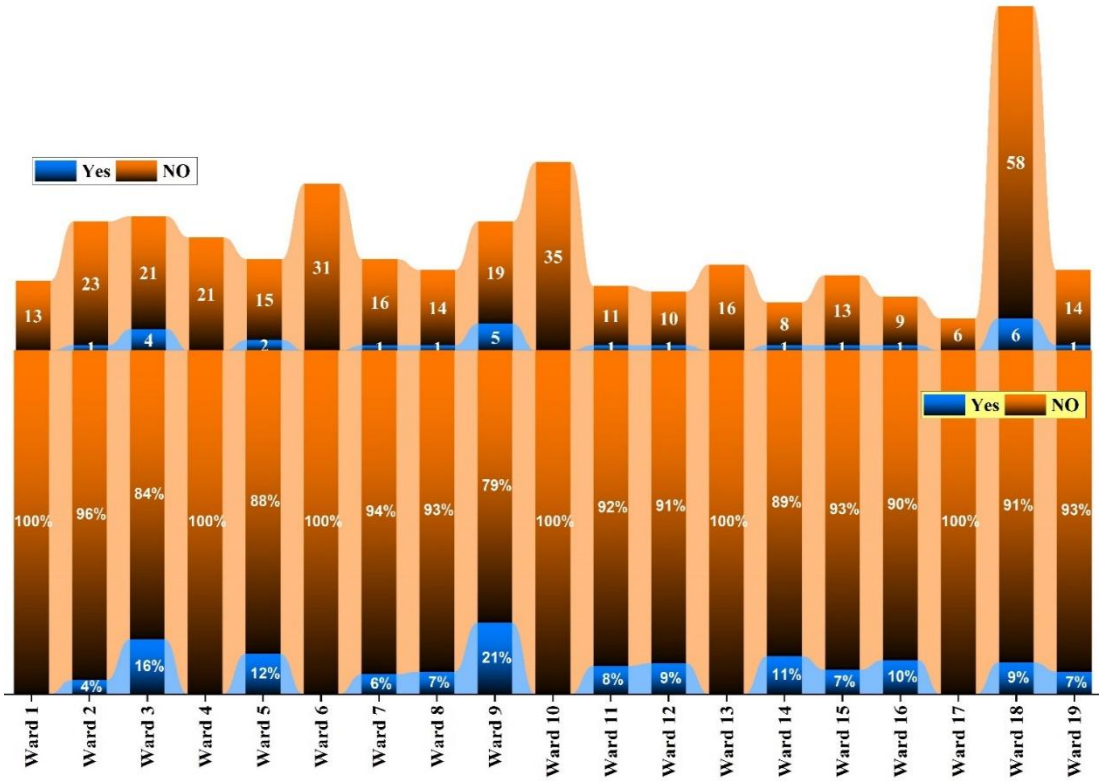


*Figure 10: Diseases observed in drinking water*

***Issues Perceived in Drinking Water***

Examining the feedback on drinking water issues across the 19 wards relative to the total number of respondents reveals a varied picture (Figure 11). These results depict a range of concerns regarding physical appearance of water which includes taste, odor, smell, turbidity, and color in drinking water across different wards. Study reveals that drinking water has normal color, and no odor or smell at all, since the source of mostly drinking water for local community was tap water. The rating of the quality of their drinking water was good. But other respondents using underground hand pumped water, showed significant issues. The overall water quality of local wells was good and adequate (normal), but the important issue about contamination of water was source pollution of water wells. The respondents answered the quality of water in local area is affected by toilet digged near wells. Aside from increased population growth and rapid urbanization, inefficient water management in the region further exacerbates the safe drinking water situation.

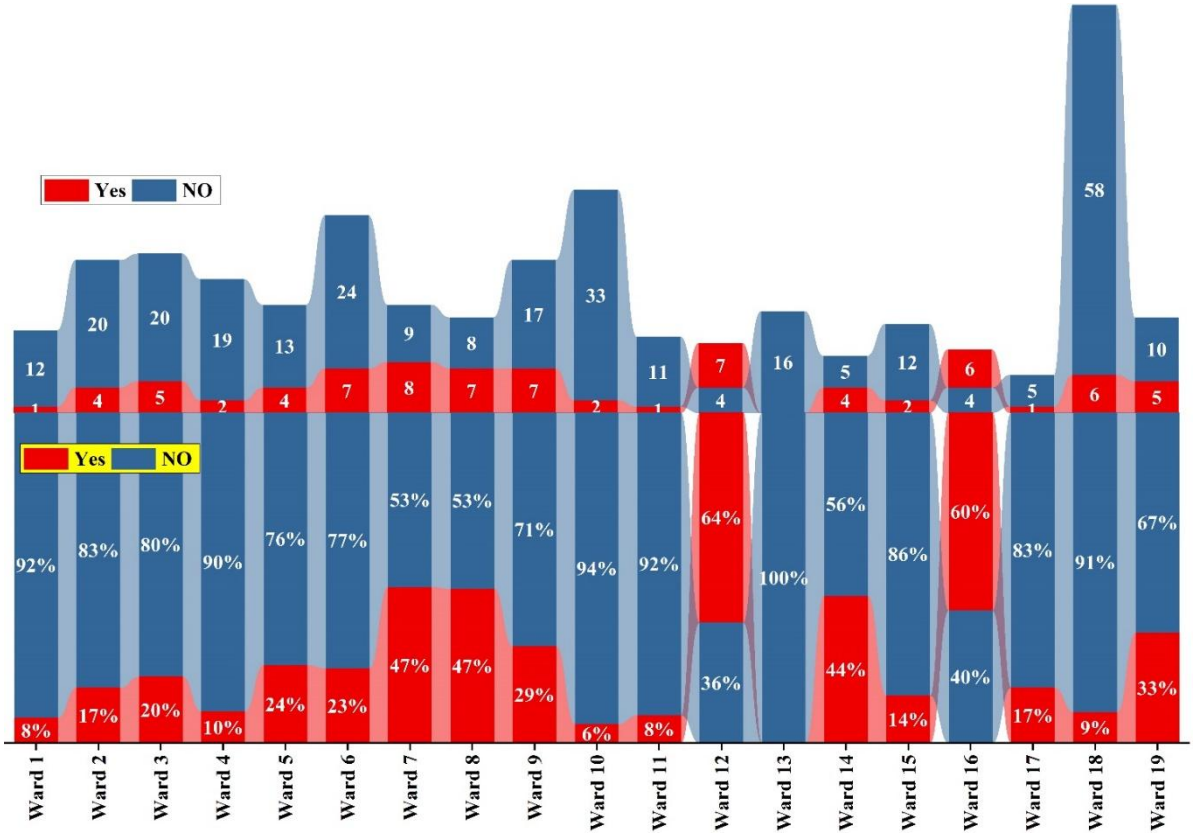


*Figure 11: Issues perceived in drinking water*

***Perception on quantity of Groundwater (Compared to last 10 years)***

Analyzing perceptions regarding changes in groundwater quantity over the past decade across the 19 wards shows declining water levels in wells or increased difficulty in accessing groundwater sources (Figure 12). Wards 3, 4, and 6, with 72% to 77.42% of respondents expressing concerns about declining groundwater levels, reflect a significant portion of the community witnessing such changes. This is due to the urbanization, population growth and anthropogenic pressures. In ward 3, out of 25 respondents, 18 (72%) perceived a decrease water levels, while in ward 4 (95%) of 21 respondents noticed a decline, and in ward 6, (77.42%) of 31 respondents shared similar concerns. Conversely, in wards 5, 12, and 15, where 7.14% to 14.29% of respondents observed improvements in groundwater level, which is smaller, but notable proportion of residents report positive changes.

In ward 5, out of 17 respondents, 1 (5.88%) noted an increase, while in ward 12, 1 (9.09%) out of 11 respondents perceived a rise in ground level. Reasons for this could include variations in individual experiences or differing sensitivities to groundwater issues within the community. Wards 13 and 18 expressing neutrality at 50% and 4.69% respectively highlight mixed perceptions among residents. In

ward 13, out of 16 respondents, 8 (50%) indicated a neutral stance, while in ward 18, 3 (4.69%) out of 64 respondents shared similar sentiments. Wards 10 and 15, at 14.29%, indicating no change suggest a substantial portion of residents perceiving stability in groundwater levels. In ward 10, out of 35 respondents, 5 (14.29%) observed no change. Possible reasons for this decline could include factors like rapid urbanization, intensified agricultural practices, and over-extraction for domestic or industrial purposes, leading to aquifer depletion (Lamichhane & Shakya, 2020). This analysis underscores the diversity of perspectives within each ward (Table 5; Figure 12). Overall, these household perceptions offer valuable qualitative data complementing quantitative assessments, highlighting local perspectives and priorities in groundwater management and conservation efforts

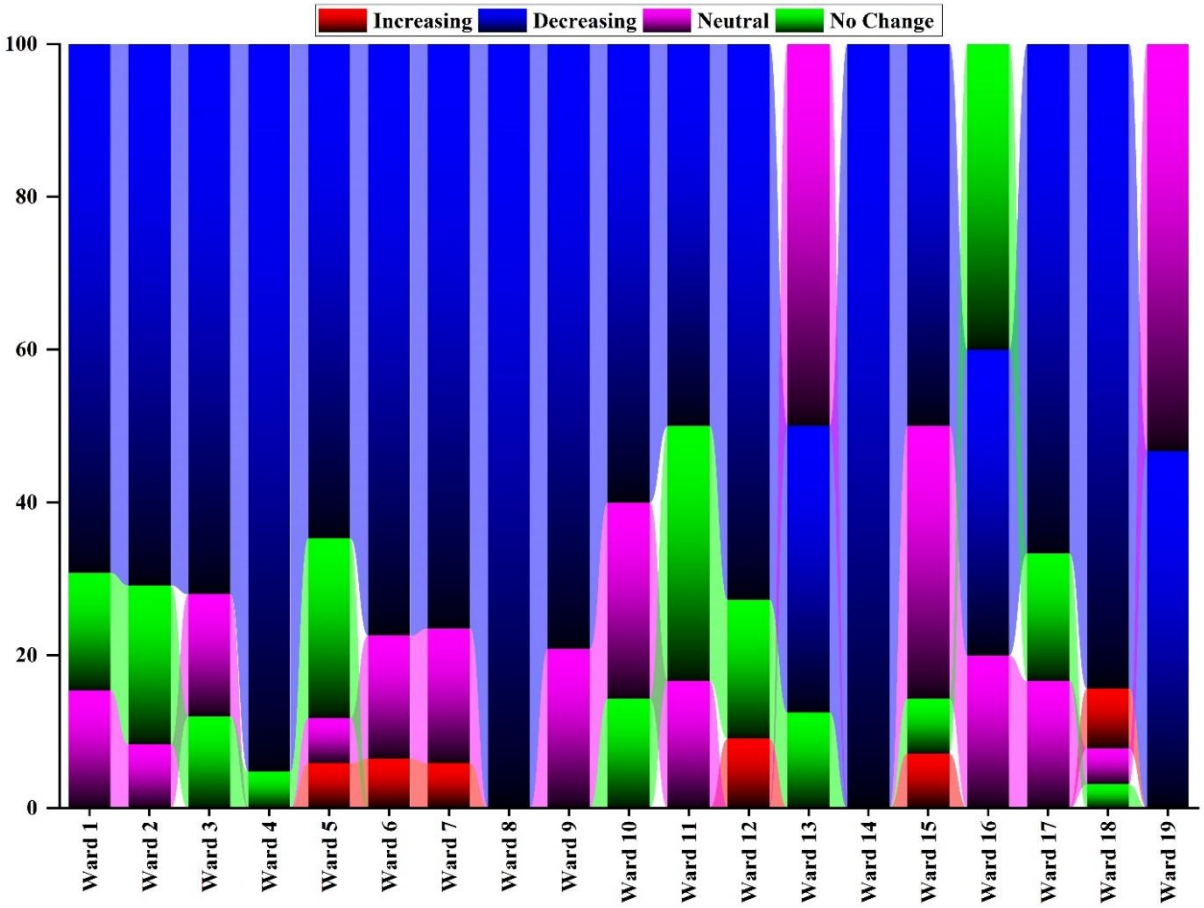


*Figure 12: Respondent's perception on quantity of groundwater over last decade*

*Table 5: Respondent's perception on quantity of groundwater over last decade (Source: Field Survey, 2024)*

| Wards | Increasing | Decreasing | Neutral | No Change | Total |
|---|---|---|---|---|---|
| Ward 1 | 0 | 9 | 2 | 2 | 13 |
| Ward 2 | 0 | 17 | 2 | 5 | 24 |
| Ward 3 | 0 | 18 | 4 | 3 | 25 |
| Ward 4 | 0 | 20 | 0 | 1 | 21 |
| Ward 5 | 1 | 11 | 1 | 4 | 17 |
| Ward 6 | 2 | 24 | 5 | 0 | 31 |
| Ward 7 | 1 | 13 | 3 | 0 | 17 |
| Ward 8 | 0 | 15 | 0 | 0 | 15 |
| Ward 9 | 0 | 19 | 5 | 0 | 24 |
| Ward 10 | 0 | 21 | 9 | 5 | 35 |
| Ward 11 | 0 | 6 | 2 | 4 | 12 |

| | | | | | |
|---|---|---|---|---|---|
| Ward 12 | 1 | 8 | 0 | 2 | 11 |
| Ward 13 | 0 | 6 | 8 | 2 | 16 |
| Ward 14 | 0 | 9 | 0 | 0 | 9 |
| Ward 15 | 1 | 7 | 5 | 1 | 14 |
| Ward 16 | 0 | 4 | 2 | 4 | 10 |
| Ward 17 | 0 | 4 | 1 | 1 | 6 |
| Ward 18 | 5 | 54 | 3 | 2 | 64 |
| Ward 19 | 0 | 7 | 8 | 0 | 15 |
| Total | 11 | 272 | 60 | 36 | 379 |

***Suggestive measures***

Despite the reliance on groundwater and public tap water, a majority of residents in study area express dissatisfaction with the current water supply system. To make better decisions and improve community well-being, it's important to conduct a comprehensive assessment of both groundwater and tap water quality using relevant parameters in future. These measures are essential for informed decision-making and the overall well-being of the community. Since majority of the residents rely on groundwater for drinking it's crucial to manage it sustainably. To tackle concerns raised by households regarding water quality and associated problems like waterborne diseases, odor, turbidity, and color, collaborative efforts are necessary. Public awareness campaigns and participation are vital to ensure proper water usage, alongside regular inspection of pipelines to prevent leaks. Implementing initiatives such as frequent water quality monitoring, community education on water purification techniques, and infrastructure enhancements can significantly reduce health risks. Furthermore, community engagement programs focusing on water conservation and eco-friendly sanitation facilities can ease pressure on groundwater resources and enhance overall water security. In the days ahead, it is crucial to prioritize significant efforts to address specific issues in each ward, like ensuring everyone has access to clean water and sanitation facilities, which can enhance resilience and elevate the quality of life for all residents. These measures, adjusted to fit local needs and supported by everyone involved, offer hope for sustainable water management practices and safeguarding public health in Bhimdatta Municipality. Although Nepal exceeded the Millennium Development Goals (MDG) for basic water supply access, the data reveal significant disparities in service coverage. The increase was in basic water supply only, with little focus on quality and resilience. Inadequate and poor-quality water supply poses health risks, particularly as climate change exacerbates issues with water and vector-borne diseases. Drinking water supply infrastructure issues are part of the National Sustainable Development Goals, in particular to Goal 6 (Clean Water and Sanitation) and Goal 9 (Industry, Innovation and Infrastructure). The results in accordance with this study confirm the need to support the quality of water supply as a precondition for development of a resilient economy and quality of life in connection with the adaptation to climate change in particular to SDG-13 (Climate Action).

## Conclusions

Bhimdatta is one of the developing cities of Kanchanpur District, Sudurpashchim Province, Nepal. In the municipality, majority of the households primarily rely on groundwater for drinking, followed by public tap water, with some using both sources. A significant 44.9% of households rely on groundwater as their primary source, 31.9% on public supply tap water, and the rest use both sources. In areas where both sources are available, tap water is typically used for drinking, while groundwater serves for cooking, washing, bathing, and other purposes. The majority of the respondents rated the water quality as good (56.2%; n=213), although concerns about taste, odor, turbidity, and color persist, particularly with groundwater. Additionally, some residents reported skin ailments and allergies linked to their water sources. There has also been a decline in groundwater levels over the past decade, making access more challenging. This study underscores the necessity of regular assessments and sustainable management of both supply tap water and groundwater sources. By highlighting the reliance on groundwater and public tap water, and identifying issues such as declining groundwater levels, quality, and dissatisfaction with the water supply system, this study

provides crucial insights for policymakers, local authorities, and community stakeholders. It underscores the need for sustainable water management practices, improved infrastructure, and public awareness initiatives, which are essential for ensuring safe and reliable water access. The study also highlights the importance of treatment technology before consumption to ensure a safe and healthy environment not only for the local levels but also for regional and national level. Furthermore, this study provides critical insights for developing sustainable water management strategies to improve water quality, accessibility, availability, and public health in Bhimdatta Municipality, suggesting actionable recommendations that can support the achievement of Sustainable Development Goals (SDGs) related to water security, public health, and climate resilience.

## Acknowledgements

The authors acknowledge the financial support provided by Nepal National Social Welfare Association (NNSWA) Kanchanpur, Nepal and DCA. We express deepest gratitude to the residents, officials, and local stakeholders of each ward in Bhimdatta Municipality for their cooperation throughout the study.

## References

Abdi-Soojeede, M. I., & Kullane, M. A. (2019). Study of Community Perception on Drinking Water Quality in Mogadishu, Somalia. *Open Journal of Applied Sciences*, *9*(5), 361-371. https://doi.org/10.4236/ojapps.2019.95030.

Abedin, M. A., Habiba, U., & Shaw, R. (2014). Community Perception and Adaptation to Safe Drinking Water Scarcity: Salinity, Arsenic, and Drought Risks in Coastal Bangladesh. *International Journal of Disaster Risk Science,* 5(2), 110–124. https://doi.org/10.1007/s13753-014-0021-6.

Alameddine, I. (2016). Social Perception of Public Water Supply Network and Groundwater Quality in an Urban Setting Facing Saltwater Intrusion and Water Shortages. *Environmental Management*, 0–1. https://doi.org/10.1007/s00267-016-0803-2

Anis, S. F., Hashaikeh, R., & Hilal, N. (2019). Functional materials in desalination: A review. *Desalination*, *468*, 114077. https://doi.org/10.1016/j.desal.2019.114077

Atauzzaman, M., Ali, M. Y., & Nesa, M. M. (2020). Water Supply System in Pabna Municipality of Bangladesh: A Case Study. *American Journal of Science, Engineering and Technology*, *5*(1), 20-24. https://doi.org/10.11648/j.ajset.20200501.12

Bhandari, B., & Grant, M. (2007). User satisfaction and sustainability of drinking water schemes in rural communities of Nepal. *Sustainability: Science, Practice and Policy*, *3*(1), 12-20. https://doi.org/10.1080/15487733.2007.11907988

Nepal. Kendrīya Tathyāṅka Vibhāga. (2012). *National Population and Housing Census 2011: National report* (Vol. 1). Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics.

Coetzee, H., Nell, W., & Bezuidenhout, C. (2016). An assessment of perceptions, sources and uses of water among six African communities in the North West Province of South Africa. *Water SA*, *42*(3), 432-441. https://doi.org/10.4314/wsa.v42i3.08.

Crampton, A., & Ragusa, A. T. (2016). Exploring perceptions and behaviors about drinking water in Australia and New Zealand: is it risky to drink water, when and why?. *Hydrology*, *3*(1), 8. https://doi.org/10.3390/hydrology3010008

Dillon, P., Stuyfzand, P., Grischek, T., Lluria, M., Pyne, R. D. G., Jain, R. C., ... & Sapiano, M. (2019). Sixty years of global progress in managed aquifer recharge. *Hydrogeology journal*, *27*(1), 1-30.

DWSSM (2019) Drinking Water and Sanitation Status – 2075 BS Government of Nepal, Kathmandu, Nepal.

de França Doria, M. (2010). Factors influencing public perception of drinking water quality. *Water policy*, *12*(1), 1-19. https://doi.org/10.2166/wp.2009.051

Gevera, P. K., Dowling, K., Gikuma-Njuru, P., & Mouri, H. (2022). Public knowledge and perception of drinking water quality and its health implications: an example from the Makueni County, South-Eastern Kenya. *International Journal of Environmental Research and Public Health*, *19*(8), 4530.

Guragai, B., Takizawa, S., Hashimoto, T., & Oguma, K. (2017). Effects of inequality of supply hours on consumers' coping strategies and perceptions of intermittent water supply in Kathmandu Valley, Nepal. *Science of the Total Environment*, *599*, 431-441.https://doi.org/10.1016/j.scitotenv.2017.04.182

Joshi, J. (2023). Effect of Surface Characteristics and Rainfall in Infiltration Rate: A Case Study of Kaligandaki River Basin. *Journal of Engineering Technology and Planning*, *4*(1), 96–111. https://doi.org/10.3126/joetp.v4i1.58445

Khan, R., Indhulekha, K., Mawale, Y. K., Dewangan, R., Shekhar, S., Dwivedi, C. S., ... & Jhariya, D. C. (2020, December). Impact of anthropogenic activities on groundwater quality and quantity in Raipur City, Chhattisgarh, India. In *IOP Conference Series: Earth and Environmental Science* (Vol. 597, No. 1, p. 012006). IOP Publishing.

Lamichhane, S., & Shakya, N. M. (2020). Shallow aquifer groundwater dynamics due to land use/cover change in highly urbanized basin: the case of Kathmandu Valley. *Journal of Hydrology: Regional Studies*, *30*, 100707. https://doi.org/10.1016/j.ejrh.2020.100707.

Maskey, G., Pandey, C. L., & Giri, M. (2023). Water scarcity and excess: water insecurity in cities of Nepal. *Water Supply*, *23*(4), 1544-1556.

Mengistu, T. D., Chung, I. M., Chang, S. W., Yifru, B. A., Kim, M. G., Lee, J., ... & Kim, I. H. (2021). Challenges and prospects of advancing groundwater research in Ethiopian aquifers: A review. *Sustainability*, *13*(20), 11500.

Mussa, K. R., Mjemah, I. C., & Walraevens, K. (2019). Quantification of groundwater exploitation and assessment of water quality risk perception in the Dar Es Salaam quaternary aquifer, Tanzania. *Water*, *11*(12), 2552. https://doi.org/10.3390/w11122552

NDHS (2022) Ministry of Health and Population, Kathmandu, Nepal

NSO. (2021). National Population and Housing Census 2021. In Government of Nepal, Office of the Prime Minister and Council of Ministers, National Statistics Office, 614.

Prihantono, J., Yulius, Y., Husrin, S., Ramdhan, M., & Gemilang, W. A. (2021). Assessment of underground water quality in Karimunjawa Island, Central Java–Indonesia. *Jurnal Segara*, *17*(1), 23-32.

Shrestha, K. B., Kamei, T., Shrestha, S., Aihara, Y., Bhattarai, A. P., Bista, N., ... & Shindo, J. (2019). Socioeconomic impacts of LCD-treated drinking water distribution in an urban community of the Kathmandu Valley, Nepal. *Water*, *11*(7), 1323. https://doi.org/10.3390/w11071323

Tiwari, S., Timalsina, B., Sitaula, S., Awasthi, M. P., Mahat, A., & Pant, R. R. (2023). Evaluating the Major Sources of Surface Water Quality in Pokhara Metropolitan City, Gandaki Province, Nepal. *Himalayan Biodiversity*, 29-38. https://doi.org/10.3126/hebids.v9i1.59584

Warner, N. R., Levy, J., Harpp, K., & Farruggia, F. (2008). Drinking water quality in Nepal's Kathmandu Valley: a survey and assessment of selected controlling site characteristics. *Hydrogeology Journal*, *16*, 321-334. https://doi.org/10.1007/s10040-007-0238-1.