Assessment of Drinking Water Quality and Its Effect on Health Sector in Satkhira Region, Bangladesh

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ABSTRACT

This study evaluates drinking water quality and its health impacts in Shyamnagar Upazila, Satkhira, a disaster-prone rural area in Bangladesh. Residents face significant health issues like hypertension and kidney disease, primarily due to salinity intrusion from rising sea levels and groundwater contact. This problem is worsened by limited freshwater access and the unreliability of pond and rainwater harvesting during dry seasons, which also heightens the risk of waterborne diseases such as diarrhea and cholera. Additionally, arsenic contamination (0-25 ppb) from shallow tube wells poses long-term health threats like skin lesions, with groundwater over-extraction making traditional wells unsustainable.

The research used a mixed-methods approach, collecting water samples from 14 deep and shallow tube wells across various Satkhira locations. On-site measurements included Dissolved Oxygen, Electrical Conductivity (EC), and temperature. Lab analysis determined salinity via EC and arsenic levels. Data was analyzed using SPSS, STATA, and Python for descriptive analysis, linear regression, and correlation.

Preliminary findings reveal considerable variations in water parameters. The average EC (5504.18 µS/cm) meets drinking water standards, but individual sites showed extreme ranges (e.g., Burigoalini at 9754 µS/cm, Atulia at 842 µS/cm). Temperatures reached up to 36°C in Shyamnagar S. TDS values varied from 434 ppm to 5607 ppm. Interestingly, direct arsenic contamination was not widely detected in the tested samples.

The study aims to foster community resilience for safe drinking and agricultural water. It acknowledges the vital roles of NGOs (BRAC, Uttaran) and government initiatives (pipelines, Aquifer Storage and Recharge, desalination plants) in improving water access. The findings emphasize the urgent need for continuous monitoring and intervention to ad- dress complex water quality challenges in this vulnerable deltaic region.

Keywords: Water quality, Arsenic contamination, Salinity Hazard, Health Hazard, Groundwater, Satkhira,

INTRODUCTION

In terms of health issues, the region Shyamnagar Upazilla faces significant challenges due to drinking water quality. Salinity intrusion can occur from sea levels rising, tidal surges, in contact with groundwater or inadequate freshwater sources causing health impact to local people. Hypertension, kidney disease, and gastrointestinal issues are some of the common health issues due to salinity. Moreover, the lack of easy access to safe water can increase the frequency of waterborne diseases, like diarrhea and cholera. At the time of dry seasons, the dependency on pond and rainwater harvesting systems becomes more unsustainable which also exacerbates health crises.

Shyamnagar is basically a rural region, has a lower population density in comparison to other districts due to the proximity of Sundarbans, and relies on small-scale farming. The people of this area experience extreme weather events such as cyclones and tidal surges compound the environmental challenges and significant climate variability, with an average annual rainfall of 1,374 mm with high humidity levels. The major effect of salinity is on agricultural land and freshwater sources. So, the community has adopted measures such as harvesting with rainwater, constructing embankments etc. The NGO's like BRAC and Uttaran have introduced water management

practices and alternative farming techniques.

Arsenic problem in Drinking water also has a notable impact on health issues. It mainly spreads through shallow tube wells which are commonly used for water extraction, and are at risk of contamination. The prolonged exposure to arsenic can lead to skin lesions, cancer, and other chronic health issues. Testing Arsenic and Awareness, promoting arsenic-safe wells and alternative sources such as deep tube wells can reduce the contamination. To reduce reliance on high-risk sources, community education is necessary.

Due to over-extraction and intrusion of saline water, making traditional tube wells unreliable. Over-extraction causes depletion of groundwater level, so alternative sources of water are necessary. Rainwater harvesting is a frequently used and reasonably priced technique, however it is constrained by storage issues during extended dry spells. Ponds and surface water are widely used for agriculture and drinking, but they need regular desalination and upkeep to stay healthy. In certain places, solar-powered systems have been used as an environmentally friendly way to turn salty water into potable water. In this way desalinization can occur.

NGO and Community-Based Projects are ensuring year-round water availability, like pond sand filters and upgraded rainwater collection systems are being progressively put into place.

Drinking water, commonly referred to as potable water, is water that is acceptable to drink or use for food preparation without posing a health concern. 91 percent of the world's population has access to safe drinking water. Almost 4.2 billion people had access to piped water, while another 2.4 billion relied on wells or public taps. Still, 1.8 billion people consume hazardous water that might be poisoned for a variety of causes [1]. The fresh water reservoirs are not suitable at moderate depths, and the groundwater is excessively salty and murky [2]. Rainwater collection might be a viable alternative supply of drinking water in similar water-stressed locations [3]. My working area Satkhira is a district in Khulna Division in southern Bangladesh. It has a border with India's West Bengal state. It is located on the Arpangachhia River's 4th bank. Industrialization, agriculture, and many household activities can pollute this surface water. The subterranean water in several places of Bangladesh has already been contaminated by arsenic. Due to its geographical position, extensive farming, and industrialization, the fresh water in Satkhira region may be polluted (based on personal communication). As a result, testing the water quality parameters is important. The majority of inhabitants in this region rely on subterranean water, including tube wells or tap water, for drinking (based on personal communication). Incomparable water-stressed areas, rainwater collecting might be a feasible alternative source of drinking water. However, rainwater harvesting and rainfed pond water is more difficult to maintain clean drinking water since they are more prone to pollution [4]. Groundwater quality and other sources of water quality are critical needs in this community. Both the governmental and non-governmental groups have lately undertaken initiatives to seek alternate drinking water sources for the coastal population in rural areas that has been found through the direct visit in the study area. Some main (Fe, Ca, Mg) and minor (As, Cd, Pb) elements dissolved in diverse sources of drinking water have yet to be fully identified. Coastal agriculture is primarily influenced by chemical elements and salinity. As a result, a research plan has been done in the coastal region of Satkhira, Khulna, Bangladesh, to locate numerous water sources for potable and agricultural reasons.

The specific objectives are-

a) To assess the drinking water quality from different sources.

b) To determine the effect of water quality on health in the study area.

Climate change and its effects on the resilience community for safe drinking water and health have also been carried out here in the Khulna region [5]. According to [6], the harvested rainwater from the area showed microbial contamination in the drinking water. Although the contamination at the consumption point reduced after treatment, that did not meet WHO standard in most cases. Therefore, proper hygiene practices are essential to reduce the deterioration of harvested rainwater quality. Higher concentrations of Pb are also found in stored rainwater tanks in some localities in the study area. The As concentration was not found so much though very limited work has been carried out regarding the study of groundwater quality and the assessment of the trace elements effects on health [3].

Government and some non govt organization have given more attention to ensure to provide the safe drinking water in the community level through the Pipeline, Aquifer Storage and Recharge (ASR), and small-scale desalination plants in this region [3]. However, those water supply options are mostly intended to provide potable water to the households [3].

A number of government and non-government organizations giving emphasis on the social context of flood resiliency is the burning research especially for the northern flood prone communities in Bangladesh.

LITERATURE REVIEW

Global Overview of Drinking Water Quality

Access to safe and clean drinking water is recognized as a fundamental human right by the United Nations (UN) and is integral to Sustainable Development Goal (SDG) 6, which seeks to "ensure availability and sustainable management of water and sanitation for all" [18]. Despite global advancements in water infrastructure, approximately 2.2 billion people still lack access to safely managed drinking water services, with disparities most pronounced in low-income and rural regions [12].

Drinking water quality is assessed based on physical, chemical, and microbiological parameters: Physical characteristics (e.g., turbidity, color, odor) affect water acceptability [12]. Chemical contaminants, including heavy metals like arsenic, lead, and mercury, originate from natural and industrial sources and are linked to chronic diseases such as cancer and neurological disorders [17]. Microbiological contaminants, such as Escherichia coli (E. coli), viruses, and protozoa, often result from fecal contamination and cause waterborne diseases like cholera and typhoid [13]. Salinity and nitrates, stemming from agricultural runoff and seawater intrusion, pose additional health risks, particularly for individuals with hypertension [14]. Challenges in water quality management are exacerbated by climate change, urbanization, and weak governance, especially in sub-Saharan Africa, South Asia, and small island nations [12]. Addressing these issues requires enhanced monitoring, infrastructure investment, and policy enforcement [17].

Drinking Water Challenges in Coastal Bangladesh

Coastal Bangladesh, particularly Satkhira, Khulna, and Bagerhat, faces severe water quality issues due to salinity intrusion, cyclones, and shrimp farming [14]. Groundwater salinity frequently exceeds WHO and Bangladesh's Department of Public Health Engineering (DPHE) limits, rendering water unsafe for consumption and damaging infrastructure [7].

Brackish water shrimp farming, expanded since the 1980s, has worsened salinity by flooding agricultural lands with saline water [9]. Additionally, microbial contamination from poor sanitation and flooding introduces pathogens like coliform bacteria into water sources [10].

Health Impacts Of Contaminated Drinking Water

Contaminated water in Bangladesh contributes to diarrheal diseases, arsenic poisoning, and child mortality [11]. Chronic arsenic exposure is linked to skin lesions, cancer, and cardiovascular diseases, while microbial contamination increases gastrointestinal infections [15]. Children under five are particularly vulnerable, facing malnutrition, stunted growth, and cognitive impairments due to waterborne illnesses [11].

Drinking Water Quality And Public Health In Satkhira

Satkhira's vulnerability to cyclones (e.g., Aila, Sidr) and tidal flooding intensifies water contamination [8]. Studies indicate that over 60% of water sources in Satkhira fail national quality standards, with high levels of arsenic, iron, and salinity [11]. Despite health risks, limited public awareness and inadequate treatment methods persist, leading to seasonal spikes in waterborne diseases [7].

Method

The Satkhira district, located near the Bay of Bengal, faces numerous environmental challenges including salinity intrusion, arsenic contamination, and inadequate sanitation infrastructure, all of which contribute to the deterioration of water quality [8]; [9]. Frequent cyclones, tidal surges, and seawater encroachment have led to increased salinity in both surface and groundwater sources, thereby limiting the availability of potable water for the local population [14]. These conditions are further aggravated by climate change, which exacerbates flooding and sea-level rise, putting additional strain on already fragile water systems (Haque & Nicholls, 2006).

Water quality in Satkhira is also compromised by the presence of naturally occurring arsenic, iron, and microbial contaminants. Studies have shown that many tube wells in the region exceed the national standards for arsenic concentration, exposing residents to chronic health risks such as skin lesions, cancer, cardiovascular disease, and developmental disorders (Chowdhury et al., 2016; [11]). The lack of robust water treatment and purification mechanisms further compounds these challenges, especially in rural areas where awareness and infrastructure are limited.

Poor water quality has a direct impact on public health in Satkhira, contributing to a high incidence of waterborne illnesses such as diarrhea, dysentery, cholera, and hepatitis A and E. These health issues are particularly severe among children and pregnant women, leading to increased morbidity and mortality rates [10]. Additionally, long-term exposure to contaminated water has been linked to non-communicable diseases (NCDs) including kidney failure and arsenicosis, putting a significant burden on the local healthcare system [7].
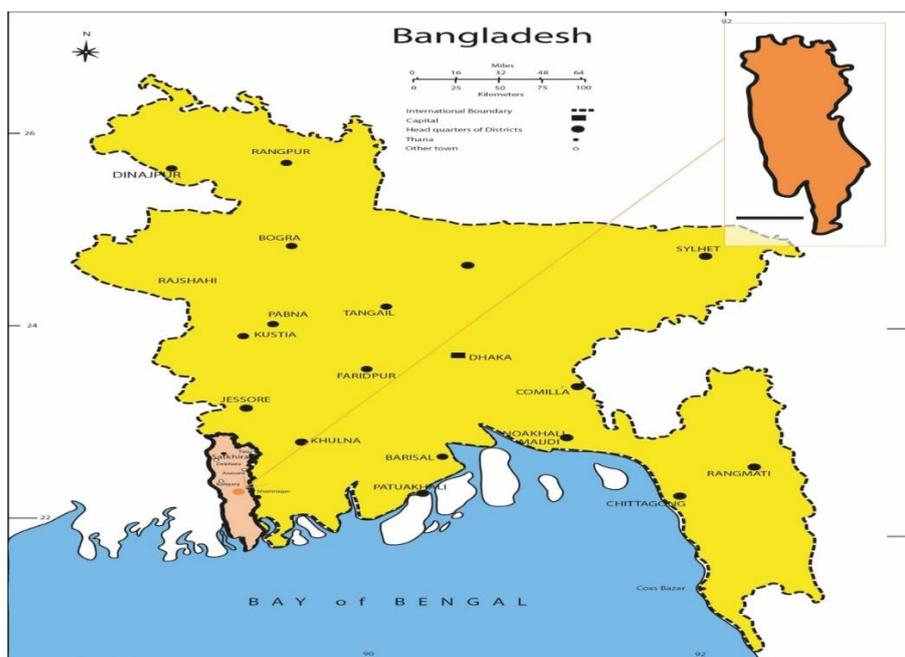

Figure 1 : Study Area Map

Those water samples were collected through random sampling methods from drinking water sources from different places of the study area Satkhira. Water samples were collected through sterilized plastic bottles from drinking water sources. DO has been measured on spot through DO meter and EC (Electrical Conductivity of water) also measured on spot through conductivity meter and took those readings of drinking water sources.

Laboratory Analysis

All the water samples are analyzed in the laboratory to examine the salinity efficiency through Electric Conductance in the unit µs/cm.

Water samples were collected by random sampling in the field. It was decided to collect water samples from deep tube-wells and International Journal of Advanced Geosciences 83 shallow tube wells. These were collected from all over the districts. Total 14 wells were selected for collecting water samples. Water samples were

collected in sterilized plastic bottles from a well only after it has been pumped for some time (Minimum 15 minutes). The bottles were cleaned two times with pumping water before collecting the samples and tightly sealed after collection. For field measurement of pH, a portable pH meter (HANNA pocket pH meter) was used. Salinity and temperature of water samples were measured by EC meter and thermometer respectively. Ionic TDS was simply determined by multiplying the measured EC values (in μ S/cm) by 0.64 as there exists an approximate relation between EC and TDS for most natural water in the range of 100 to 5000 μ S/cm leading to the equivalencies 1 meq/l of cations = 100 μ S/cm and 1 meq/l = 1.56 μ S/cm [6]. For determination of Arsenic concentration HANNA Portable arsenic Tool Box is used during the fieldwork for several days.

2.2. Laboratory analysis All the groundwater samples were analyzed in the laboratory again to determine the Salinity range through the measurement of Electric Conductance in μs/cm.

2.3. Data presentation and interpretation the results of chemical analyses of ground water were presented by the program of SPSS 16.0 version in accordance with the objectives of the study.

Both empirical qualitative and quantitative methodologies will be used for the intended investigation. The majority of information will come from original sources. Water samples will be taken from a variety of locations, including deep tube wells, taps, ponds, rivers, and canals. Water samples will be will be taken with proper care, ensuring that no substantial changes occurred prior to the test. To keep the sample at room temperature, it will be kept in a black box.

Primary survey data will be compiled, analyzed, and visualized using SPSS and EXCEL software. To evaluate broad data such as demographic characteristics, socioeconomic position, and so on, descriptive statistical procedures such as frequency, proportion, mean, and standard error will be employed. The Chi-square analysis, Correlation and regression analysis, will all be used to assess the study's outcomes. The complete process of conducting this research work may be divided into the following categories:

3.1.1. Data collection: As, EC, Temperature, Odor, color, depth of tube well.

3.1.2. Field Sampling; For the Cation and Anion (Portable HANNA Arsenic test kit, EC Meter, Temperature Meter).

All the reading is imputed in an excel sheet and calculated and analyzed through STATA 17.2 and Python Programming.

RESULTS AND DISCUSSION

This bar diagram from Figure 2 shows the results of physio-chemical parameters of the drinking water samples of the study area of Satkhira district, Bangladesh. The maximum value is around 350 m depth in Burigoalini where second highest is at Munshiganj around 250 to 300. The lowest value is less than 50 in Shyamnagar S.
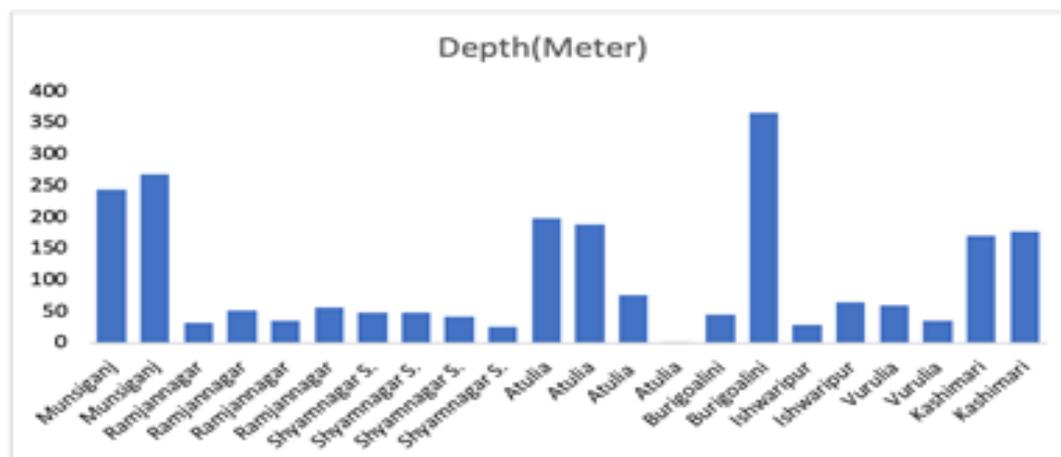

Figure 2 : Represents the results depth of the drinking water samples of the study area of Satkhira district
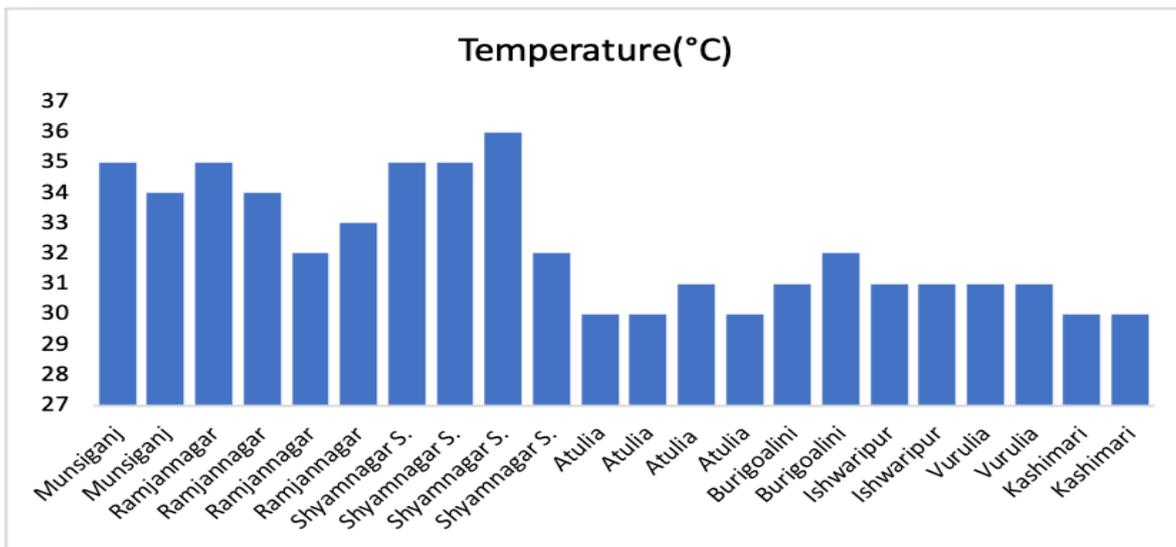
Figure 3 : The average temperature of drinking water samples of the study area was 27°C and in the range of 27 to 36 °

This bar diagram shows the temperature variance in different places. From this we got to know that Shyamnagar S. has the highest temperature in comparison to others. Shyamnagar S. has almost 36C in the range 27C-37C. Where the lowest temperature recorded is 30C.

Table 1 : WHO standards of water quality

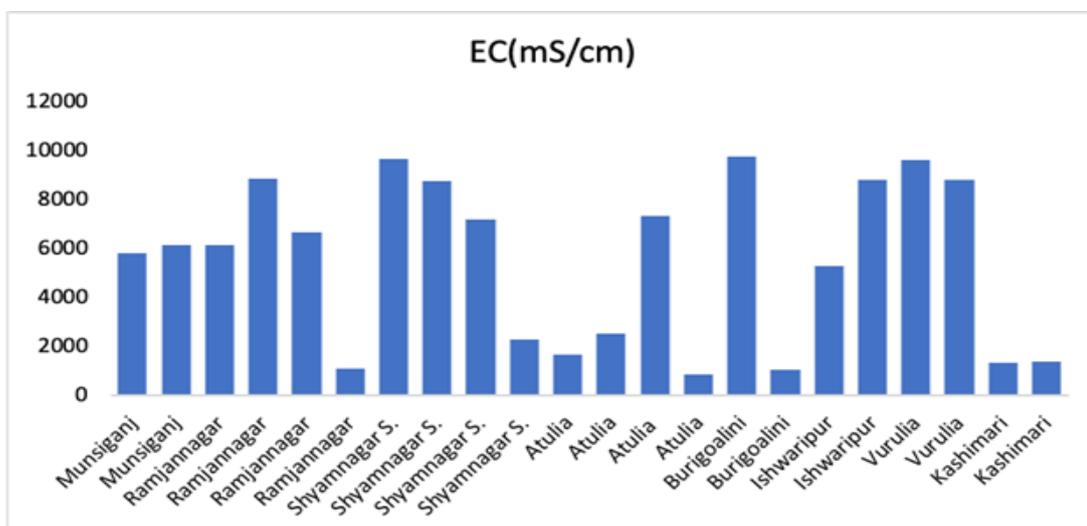| Water class	Specific conductance in (μ S/cm)	EC values in μ S/cm
Excellent	<250	
Good	250-750	
Permissible	750-2000	5504
Doubtful	2000-3000	
Unsuitable	>3000	

Figure 4 : Reveals that the EC values of drinking water samples of the study area ranging from 842 μ S/cm to 9754 μ S/cm

The EC value of drinking water of the study area ranges from 0 to 1000 µ S/cm with an average value of 5504.18 µ S/cm falls within the drinking water quality classification 'Standard'. The max value is in Burigoalini (9754) and the minimum value is in Atulia (842).
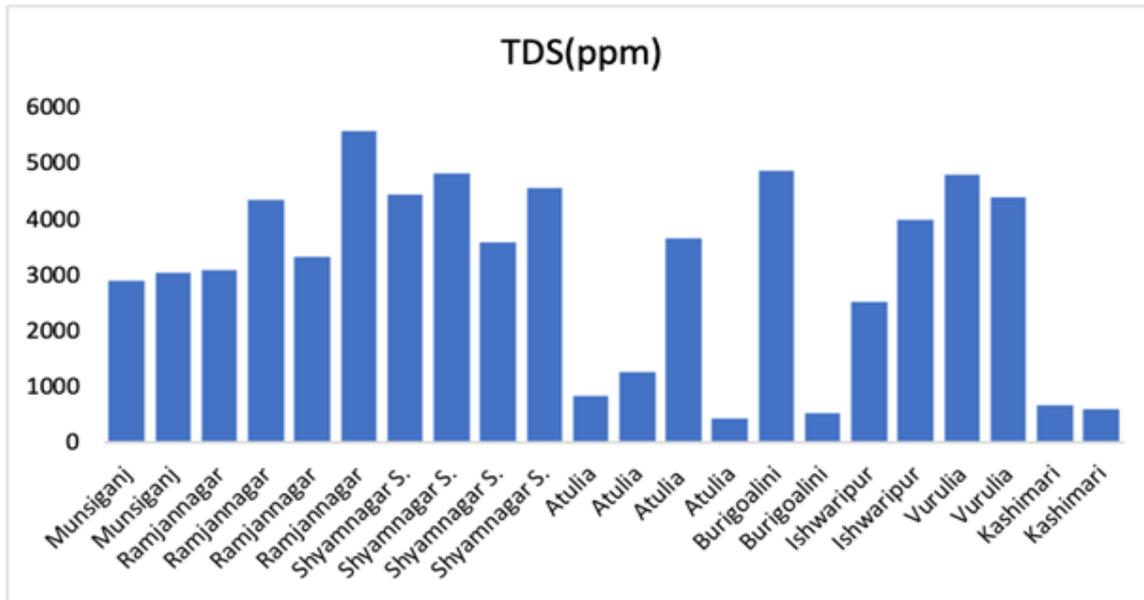

Figure 5 : Reveals that the TDS values of drinking water samples of the study area range from 434ppmto 5607 ppm.

The TDS values range from 434 ppm to 5607 ppm with an average value of 3105.33 ppm. The max value is in Ramjannagar (5607) and the minimum value is in Atulia (434).
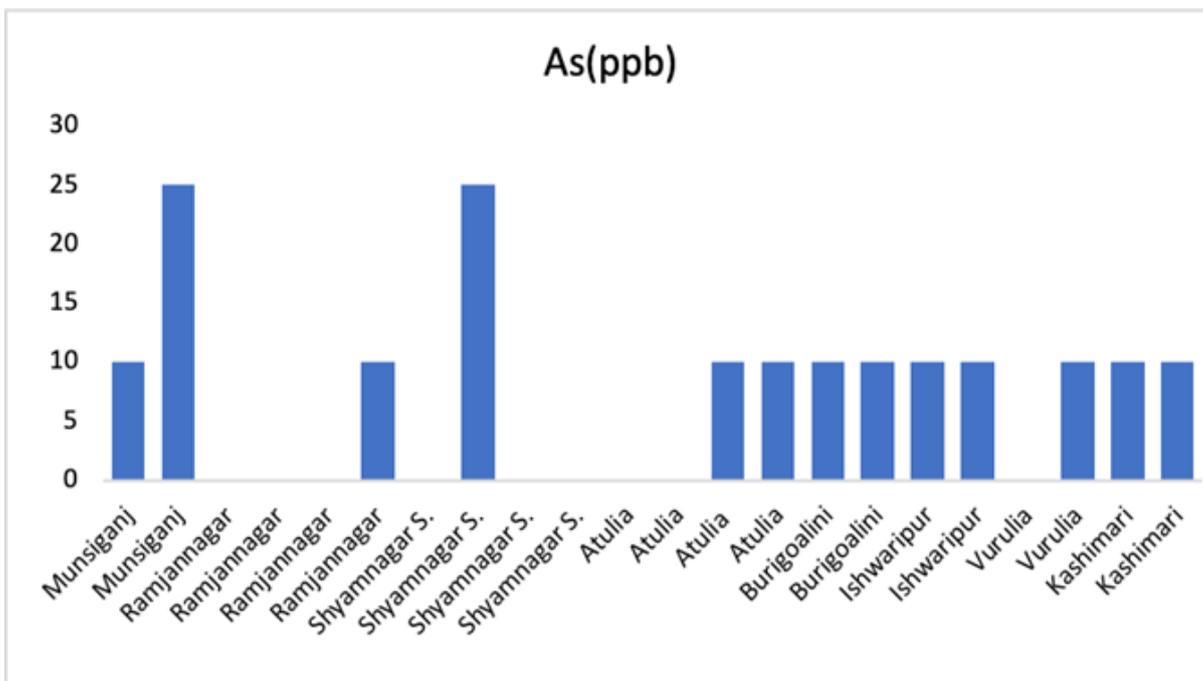

Figure 6 : Reveals the Arsenic contamination of drinking water samples of the study area.

Figure 6 presents the levels of arsenic contamination across the various drinking water samples collected in the Satkhira region. The results show that arsenic concentrations remain generally low across all locations, with values mostly between 0 and 1 ppb. These levels are well below the World Health Organization's safety threshold of 10 ppb for drinking water, suggesting that arsenic contamination is not a major health threat in the sampled areas. However, given the history of arsenic issues in shallow tube wells in Bangladesh, continuous monitoring remains crucial.
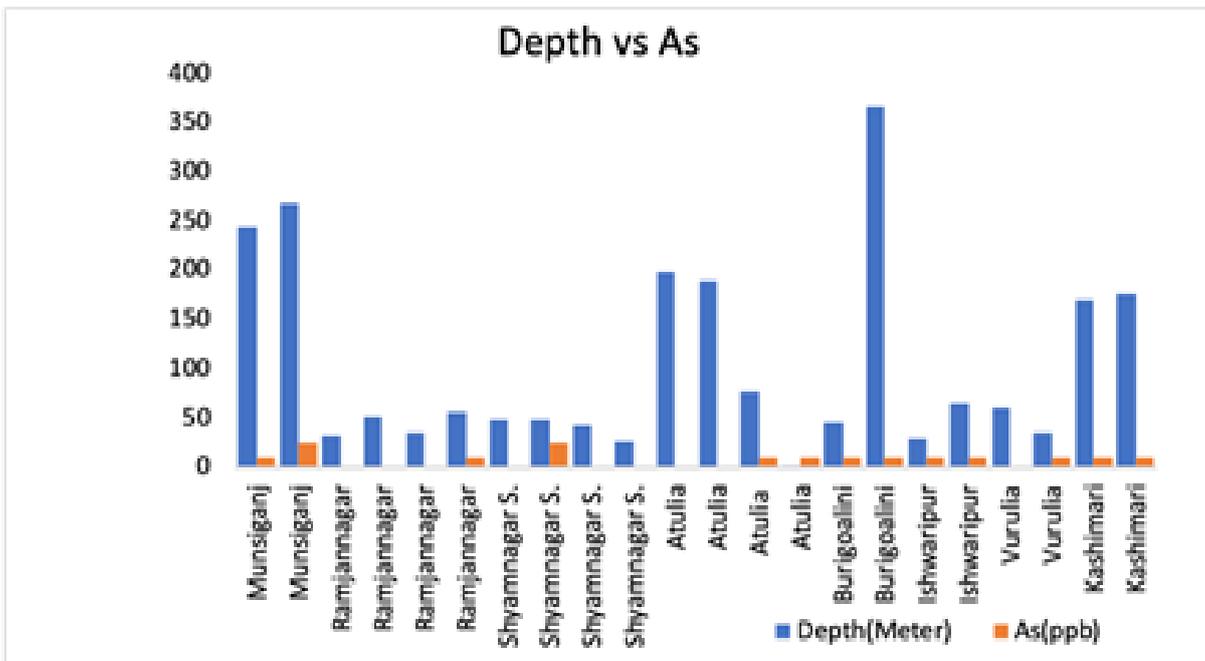
Figure 7 : Relation between depth and Arsenic contamination of drinking water samples of the study area.

Figure 7 explores the relationship between the depth of the tube wells and the level of arsenic contamination. The plot does not demonstrate any significant trend or correlation between these two variables. Arsenic appears sporadically across both shallow and deep wells, which implies that depth alone is not a reliable predictor of arsenic presence in the study area. This finding may be influenced by complex subsurface geology and hydrological dynamics that govern arsenic mobility.
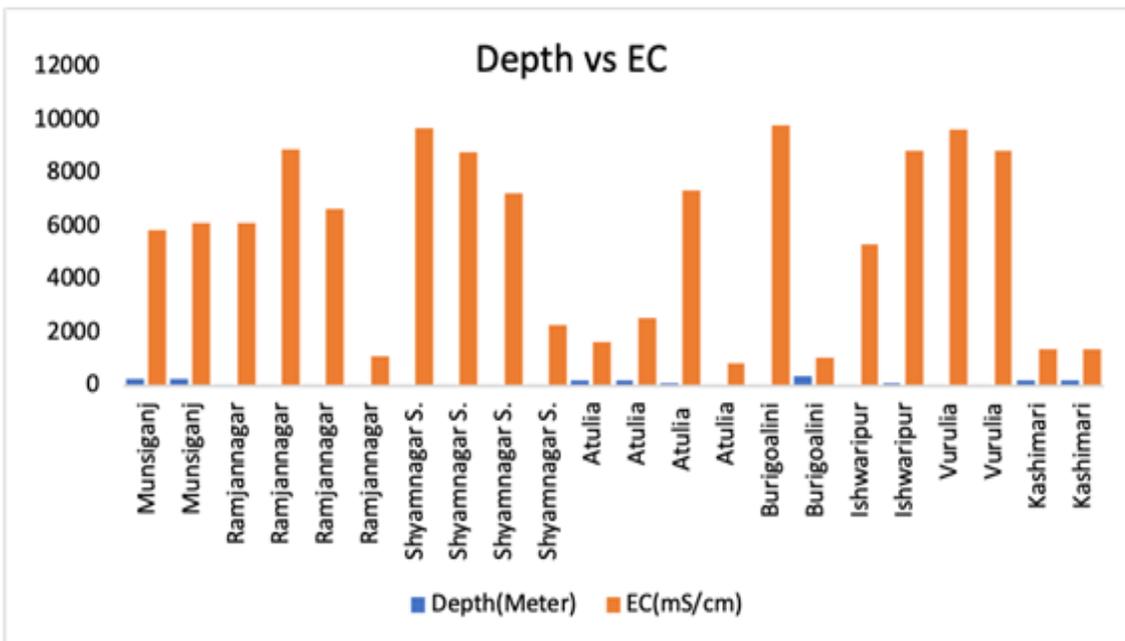

Figure 8 : Difference between the depth and Electrical Conductivity of drinking water samples taken from the study area.

Figure 8 compares the depth of water sources with their Electrical Conductivity (EC), a key indicator of salinity. The data shows inconsistent patterns, with both high and low EC values recorded across varying depths. This indicates that deeper wells are not necessarily less saline, and salinity levels fluctuate independently of depth. Such variation suggests the influence of saline intrusion and heterogeneous aquifer characteristics that affect water quality unpredictably.
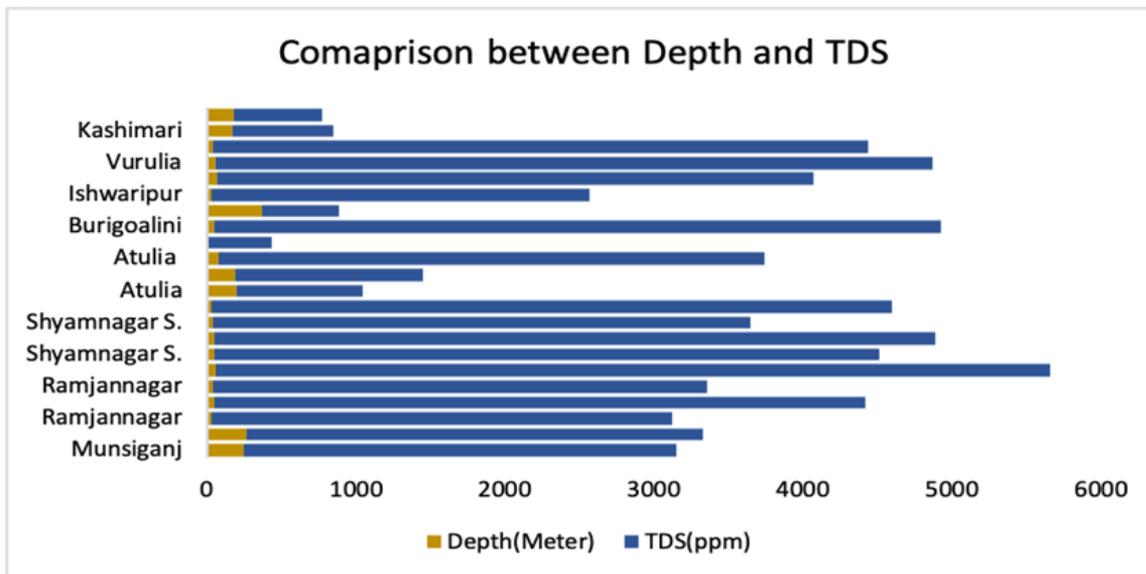
Figure 9 : Comparison between the depth and TDS of drinking water samples taken from the study area.

Figure 9 attempts to identify a correlation between the depth of tube wells and Total Dissolved Solids (TDS) levels in drinking water. Similar to the findings in Figure 7, there is no evident or consistent relationship between these parameters. TDS levels vary widely across both shallow and deep wells, indicating that factors other than depth, such as soil type, recharge sources, and surface contamination, likely control the dissolve solids content in groundwater.
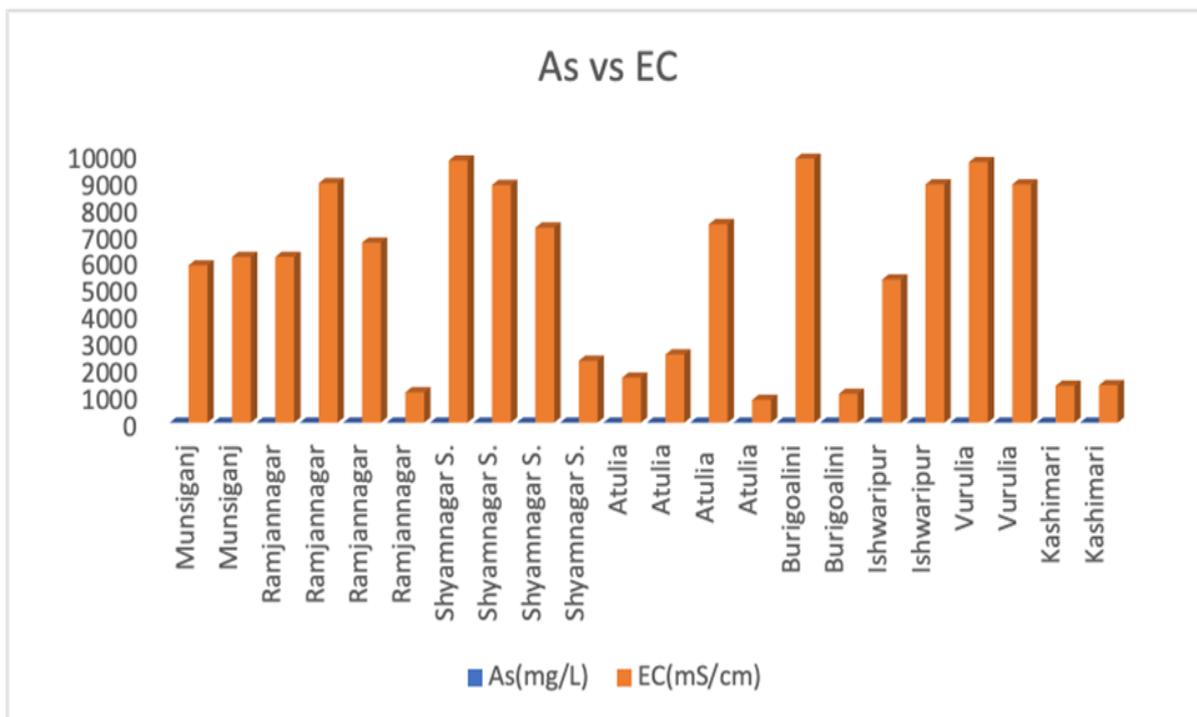

Figure 10 : Difference between the Arsenic contamination and Electrical Conductivity of drinking water samples taken from the study area.

Figure 10 investigates whether there is any connection between arsenic contamination and Electrical Conductivity in the water samples. The results show no correlation between the two, confirming that arsenic concentration and salinity levels are independent of each other in this study area. This reinforces the conclusion that separate sources and mechanisms influence arsenic leaching and saltwater intrusion in the groundwater system.
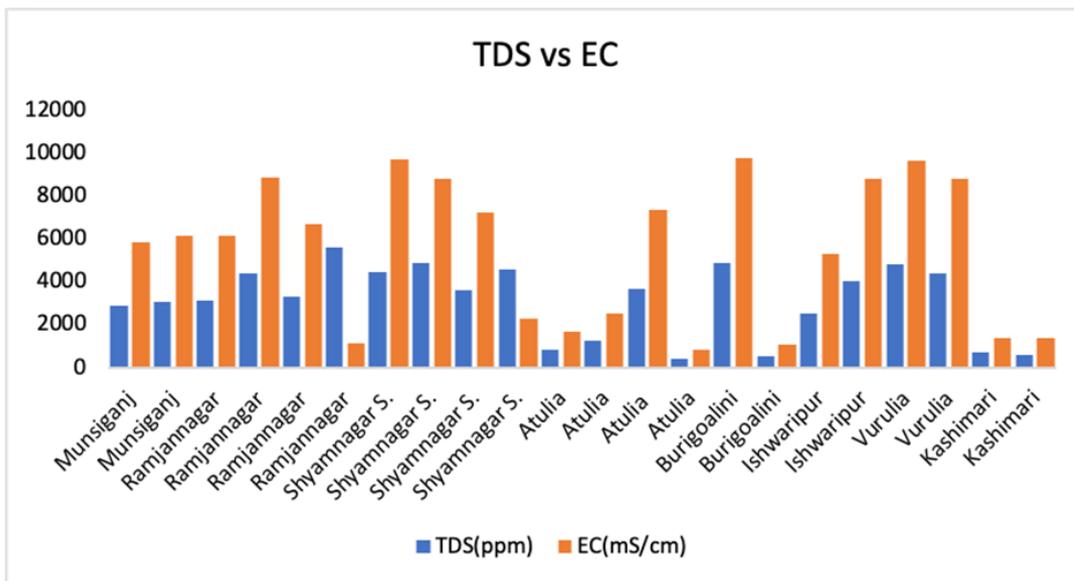
Figure 11: Difference between the TDS and Electrical Conductivity of drinking water samples taken from the study area

Figure 11 analyzes the relationship between Total Dissolved Solids (TDS) and Electrical Conductivity (EC), revealing a clear positive linear correlation. As EC increases, TDS also increases proportionally, which is consistent with the chemical nature of both metrics as they both reflect the ionic concentration in water. This strong correlation validates the field measurements and confirms that EC can reliably serve as a proxy for estimating TDS in water quality assessments.

Table 2: Normalized datasets of water sampling.

Sampling Location	Temperature(°C)	TDS (ppm)	Depth (Feet)	EC (mS/cm)	As(ppb)
Munsiganj	0.83	0.48	0.67	0.56	0.40
Munsiganj	0.67	0.51	0.73	0.59	1.00
Ramjannagar	0.83	0.51	0.09	0.59	0.00
Ramjannagar	0.67	0.76	0.14	0.90	0.00
Ramjannagar	0.33	0.56	0.09	0.65	0.00
Ramjannagar	0.50	1.00	0.15	0.03	0.40
Shyamnagar S.	0.83	0.78	0.13	0.99	0.00
Shyamnagar S.	0.83	0.85	0.13	0.89	1.00
Shyamnagar S.	1.00	0.61	0.12	0.71	0.00
Shyamnagar S.	0.33	0.80	0.07	0.16	0.00
Atulia	0.00	0.08	0.54	0.09	0.00
Atulia	0.00	0.16	0.52	0.19	0.00
Atulia	0.17	0.62	0.21	0.73	0.40
Atulia	0.00	0.00	0.00	0.00	0.40
Burigoalini	0.17	0.86	0.12	1.00	0.40
Burigoalini	0.33	0.02	1.00	0.03	0.40
Ishwaripur	0.17	0.41	0.08	0.50	0.40
Ishwaripur	0.17	0.69	0.18	0.89	0.40
Vurulia	0.17	0.85	0.16	0.99	0.00
Vurulia	0.17	0.77	0.09	0.89	0.40
Kashimari	0.00	0.05	0.47	0.06	0.40
Kashimari	0.00	0.03	0.48	0.06	0.40

Table 2 provides a normalized dataset of various water quality parameters—including temperature, TDS (Total Dissolved Solids), depth, electrical conductivity (EC), and arsenic concentration (As) collected from multiple

sampling sites across the Satkhira district. The values are scaled between 0 and 1 to allow for easier comparison across different parameters and locations. From the data, it is evident that Ramjannagar and Burigoalini stand out with some of the highest normalized values for TDS and EC, indicating elevated salinity and dissolved solid content in these areas. For example, Ramjannagar records TDS values of 1.00 and 0.76, and EC values of 0.90 and 0.59, making it a hotspot for potential salinity concerns. On the other hand, Atulia shows consistently low values for both TDS and EC, confirming it as one of the least saline sites with better overall water quality. Arsenic values remain mostly low across all sites, with slight elevations in Munsiganj, Burigoalini, and Ishwaripur (up to 1.00 or 0.40), but these still fall within acceptable safety limits. The depth variable is more varied but does not show a strong pattern when compared to other factors like EC or arsenic. Overall, Table 2 helps visualize how water quality issues particularly salinity is site-specific, reinforcing the need for localized water treatment and monitoring strategies.

The utmost expected outcome of the formulated research is building the resilience community for the safe supply of drinking water and for the use in agricultural purpose. The study will also produce a guideline for disaster managers as well as for the policy makers of the country to know the overall situation against any scarcity of demotic and agricultural use in Mongla city. Moreover, it will also help the future researchers, government organizations (GOs) and non-government organizations (NGO's) to make a good concern of ground water quality and the potential sources of water to mitigate the crisis during and after and hydrological disaster. Hence, groundwater arsenic and salinity hazard mapping in Mongla city can be produce. Local people affected by arsenic and salinity hazards will be aware and take necessary precautionary measure to protect the hazards.

Then we tried STATA to analyzed the correlation and regression of the available datasets. Firstly, we tried to normalized datasets to organized and easy to analyze. Then we tried the descriptive analysis to see the situation of mean standard deviation and minimum-maximum which is shown in a data chart:
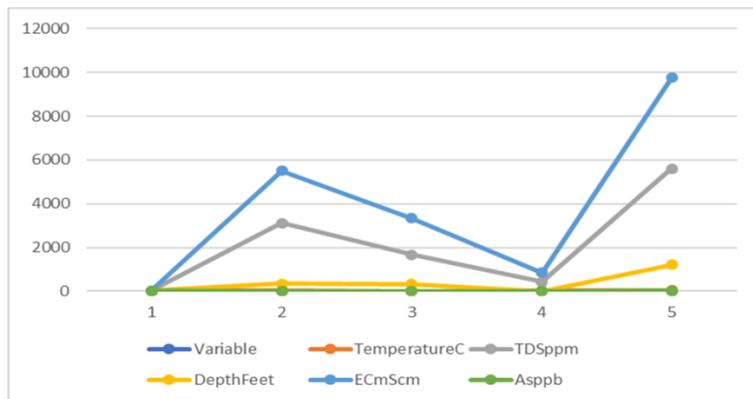

Figure 12: Visualization of normalized datasets for each sampling site with all the variables.

After that we did the linear Regression where Temperature is the dependent variable. The analyzed data is visualized through scatter plot which is developed in python.
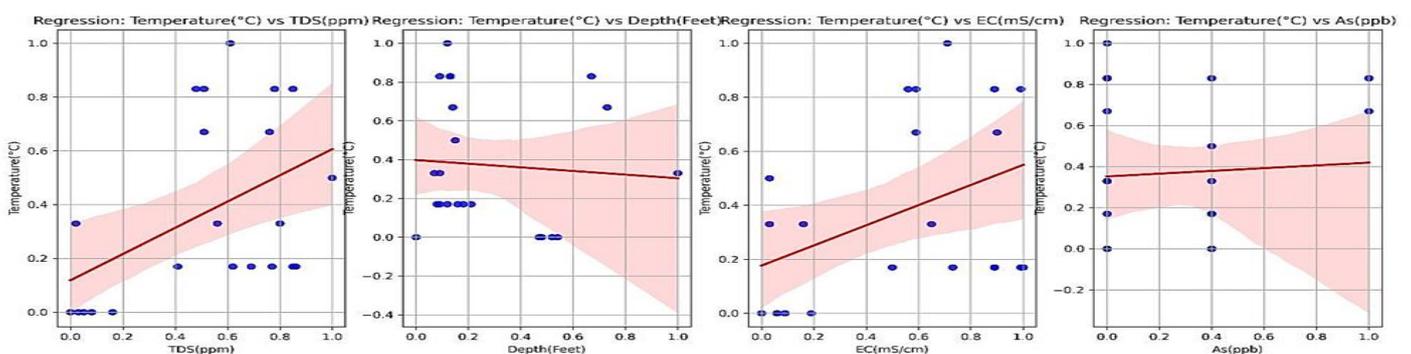

Figure 13: Regression plots of the water samples

The regression analysis in the study focused on identifying potential predictive relationships between

temperature (used as the dependent variable) and other water quality parameters such as TDS, EC, depth, and arsenic concentration. Visualized through a scatter plot in Figure 13, the regression plots demonstrated no significant linear trend between temperature and the other variables. This indicates that temperature variations in the sampled water sources are not directly influenced by the chemical parameters measured. Instead, temperature is likely affected by external environmental conditions such as solar exposure, time of sampling, or surface interaction. The regression results confirm that chemical concentrations and salinity levels do not meaningfully impact water temperature in this dataset.
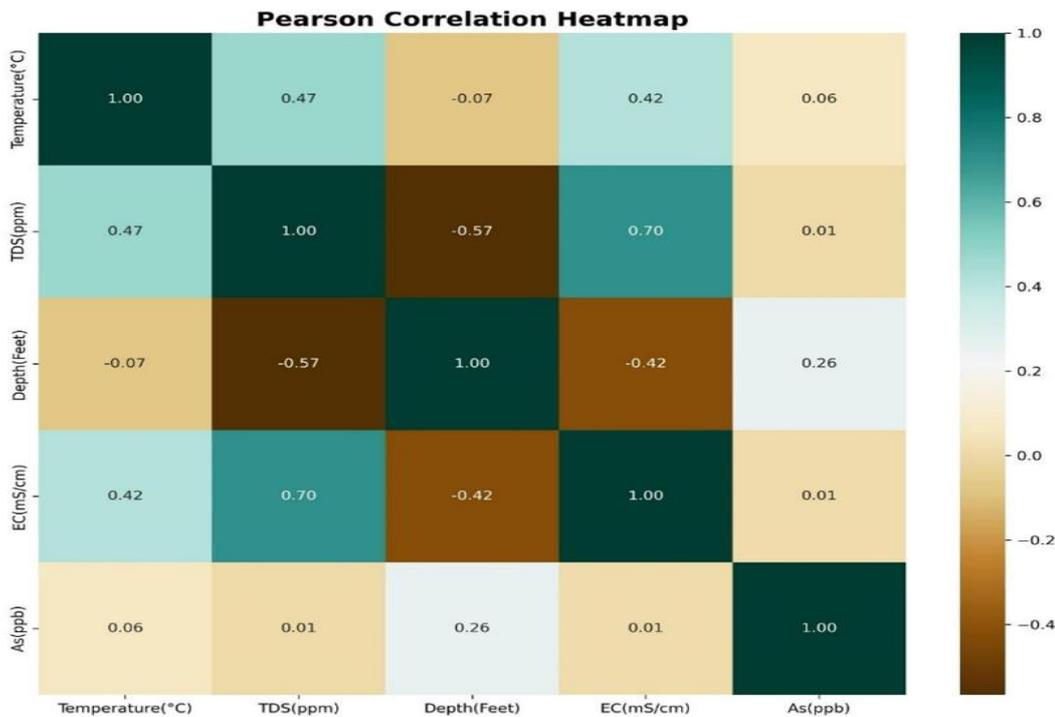

Figure 14: Pearson correlation for the heatmap of variables of the study area

Figure 14 displays a Pearson correlation heatmap, which visually represents the relationships between various water quality parameters measured in the Satkhira region. In this heatmap, darker or warmer colors (closer to red) indicate a strong positive correlation, while cooler or lighter colors (closer to blue) suggest a weaker or negative correlation. The most prominent observation from the heatmap is the strong positive correlation between Total Dissolved Solids (TDS) and Electrical Conductivity (EC), which is scientifically expected since both are measures of the number of dissolved ions in water. This validates the consistency of the field data and supports the use of EC as a proxy for TDS in rapid assessments.

On the other hand, temperature, depth, and arsenic concentration show weak or no significant correlation with other variables. For instance, temperature does not appear to strongly correlate with either TDS or EC, indicating that thermal conditions of the water sources are likely influenced by environmental or external factors rather than chemical composition. Similarly, arsenic does not correlate meaningfully with depth or salinity, suggesting that its distribution is more dependent on local geology rather than on water quality parameters like EC or TDS.

Overall, the heatmap offers a quick visual overview of how different parameters relate to each other and confirms that salinity-related indicators (TDS and EC) are closely linked, while arsenic, temperature, and depth behave independently, reflecting the complex and variable nature of groundwater quality in coastal Bangladesh.

After regression, we go for correlation where we again take Temperature as a dependent variable and this is also visualized through python (heatmap). The heatmap shows the intensity along with the correlation between variables. Correlation Heatmap (Python Visualization) indicates strong correlation between EC and TDS (r > 0.9). Moderate inverse relationship between depth and EC. Weak positive correlation between arsenic and depth.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The purpose of this study was to determine the drinking water quality and public health impacts in Shyamnagar Upazila of Satkhira district, a vulnerable coastal area of Bangladesh. The results unequivocally show that the region's water quality is severely degraded, primarily as a result of salinity intrusion, inadequate management of water sources, and a dearth of widely used water treatment technologies. In most places, but especially in Burigoalini, Ramjannagar, and Shyamnagar S., the two main physio-chemical indicators—Electrical Conductivity (EC) and Total Dissolved Solids (TDS)—surpassed WHO drinking water limits, indicating severe saline contamination. Even though the study period's arsenic levels were mostly within safe bounds, there is still a chance of long-term exposure, particularly from shallow tube wells.

Deteriorating water quality is directly linked to a higher prevalence of waterborne and chronic illnesses, such as skin disorders, kidney disease, diarrhea, and hypertension, according to field observations and secondary health data. Particularly at risk are vulnerable populations like children and the elderly.

Additionally, the analysis confirms salinity as the primary threat to water quality by demonstrating a positive correlation between EC and TDS. Additionally, there is a moderate correlation between EC and water temperature, which may be caused by heat exposure and shallow storage, both of which increase the risk of microbial contamination.

In short, the Satkhira region, particularly Shyamnagar Upazila, represents a critical zone for water-related health hazards, exacerbated by climate change, over-extraction, and infrastructural deficits.

Recommendations

Based on the results and stakeholder observations, several recommendations are proposed to enhance community resilience, policy interventions, and sustainable water management in Satkhira, Bangladesh. For short-term actions, community-driven water quality monitoring should be established using portable kits to assess Electrical Conductivity (EC), Total Dissolved Solids (TDS), and arsenic levels [12], alongside training community health workers to correlate contamination with disease patterns [13]. Additionally, safe water alternatives should be promoted by subsidizing deep tube wells to reduce dependence on contaminated shallow aquifers [14] and deploying solar-powered desalination units while improving rainwater harvesting [7]. Health outreach efforts should include awareness campaigns on waterborne diseases [15] and the distribution of water purification tablets and filters to vulnerable households.

For long-term solutions, infrastructure development should focus on implementing Aquifer Storage and Recovery (ASR) systems to mitigate salinity [9] and expanding pipeline networks with community-scale pond sand filters. Policy integration is crucial, requiring the mainstreaming of water safety into climate adaptation plans [16] and strengthening collaboration between NGOs (e.g., BRAC) and government agencies. The health sector should engage by introducing water-related health screenings in primary care [11] and developing a water-health database to track outbreaks. Finally, capacity building should involve training local technicians in water testing and maintenance [17] and researching emerging contaminants such as lead and cadmium. These measures aim to ensure sustainable water security and resilience in Satkhira.

Final Remarks

The water crisis in Satkhira demands integrated solutions combining science, policy, and community action [18]. Without intervention, climate change and salinity intrusion will worsen health and livelihoods. However, investments in resilient infrastructure (e.g., desalination, ASR) and governance reforms can mitigate risks.

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