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Groundwater Quality Evaluation through Heavy Metal Pollution Indices and Corrosion Study in Tangail Sadar Upzilla, Dhaka, Bangladesh

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Summary

This study emphasized on the groundwater quality of Tangail Sadar Upzilla, Dhaka by evaluating the heavy metal pollution indices and the corrosivity of the water. A total of ten (10) groundwater samples were collected at various depths (60-180 ft) from different places of Tangail Sadar Upzilla and the concentration of Ca, Mg, Fe, Mn, Cu, Zn, Ni, Cd, Cr, Pb and As were assessed. The heavy metal pollution indices like HPI, HEI, C_d, mC_d, PI, PLI, PERI etc. was evaluated and the average for HPI, HEI, C_d and PI was 4509.20, 44.51 25.68 and 5.148 individually and all these parameters indicate very severe heavy metal pollution. Although PERI, mC_d and PLI showed moderate pollution status independently. Additionally, according to corrosion study like Langelier Saturation Index (LSI), Ryzner Stabiltiy Index (RI), Agreesive Index (AI) and Pukorious Scaling Index (PI) all the samples showed moderate to high corrosivity but the Corrosivity Ratio (CR) was found less than 1, so, the water can be transported in any kind of pipes.

Introduction

Water resource has played a critical and vital role throughout the history in the growth and development of human civilization. Due to rapid industrialization and increasing human population, the stress on natural resources is increasing and their conservation is one of the major challenges for mankind.[1] The concentration of chemical constituents which is greatly influenced by geological formations and anthropogenic activities determine the groundwater quality. Increased agricultural activities in Bangladesh are likely to have an impact on the groundwater quality.[2]

Study Area

Tangail Sadar Upazilla is located in between 24'10' and 24'22' north latitudes and in between 88'46' and 89'59' east longitudes. The upazilla is situated on the bank of Jamuna River. Sampling has done on April 2017.

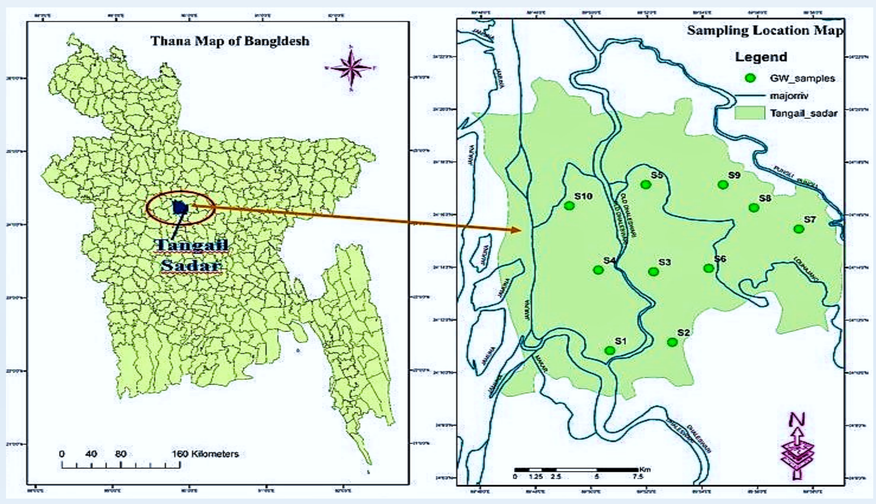


Fig 1: Study Area of Tangail Sadar Upzilla

Materials and Methods

- Ten (10) samples were taken from 60-180 feet.
- pH, EC and DO were measured on site.
- Heavy metals i.e., Ca, Mg, Fe, Mn, Cu, Zn, Ni, Cd, Cr, Pb and As were measured by AAS after successive acid digestion.[3]
- Anions like SO_4^{2-}, NO_3^-, Cl^- and HCO_3^- were measured by UV-Visible Spectrophotometer and Conventional Titration method respectively.[3]

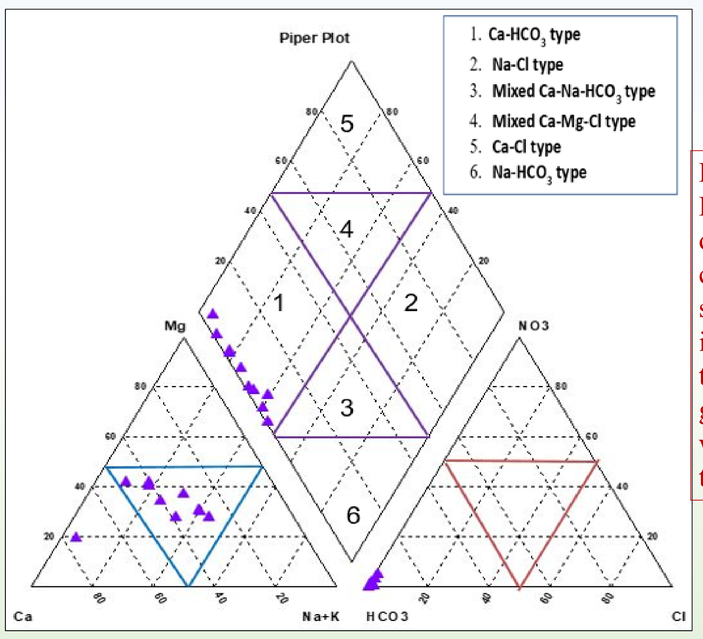


Fig 2: Piper Plot of the collected samples indicating the ground water type

Results and Discussions

Table 1: Descriptive statistics of heavy metals in collected samples

Parameters	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Mn (mg/L)	Zn (mg/L)	Ni (mg/L)	Cr (mg/L)	Cd (mg/L)	Pb (mg/L)	As (mg/L)
Maximum	60.40	26.00	**7.390**	**0.910**	1.520	**0.152**	**0.077**	**0.034**	**0.107**	**0.170**
Minimum	10.70	6.84	0.440	0.020	0.220	0.014	0.020	BDL*	0.009	0.040
Mean	31.04	15.62	3.572	0.415	1.091	0.075	0.039	0.014	0.040	0.119
SD	1.972	1.126	0.572	0.096	0.120	0.016	0.005	0.003	0.011	0.012
WHO Std (2017)	**75**	**50**	**0.3**	**0.4**	**3.0**	**0.07**	**0.05**	**0.003**	**0.01**	**0.01**
BD Std (2009)	**75**	**35**	**1.0**	**0.1**	**5.0**	**0.10**	**0.05**	**0.005**	**0.05**	**0.05**

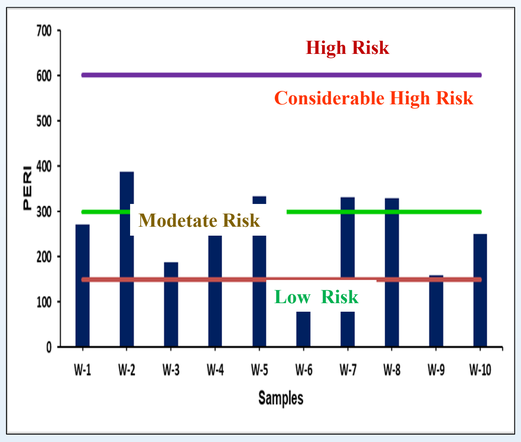


Fig 3: Graphical Distribution of PERI

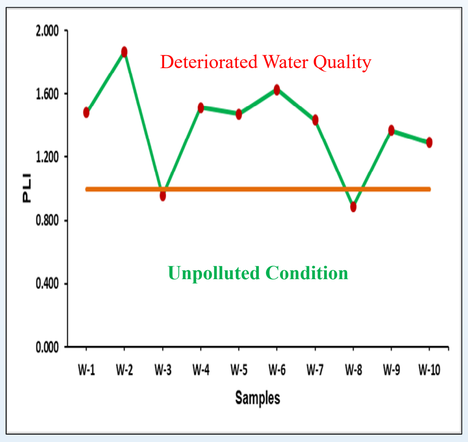
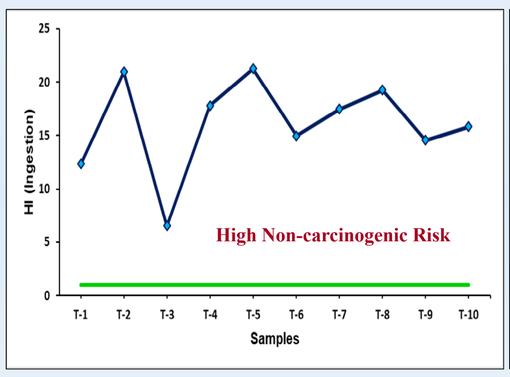


Fig 4: Graphical Distribution of PLI



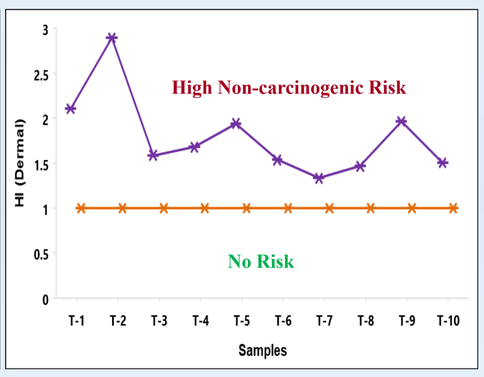


Fig 5: Non-Carcinogenic Risk for both Oral Ingestion and Dermal Exposure of Groundwater in Tangail Sadar Upzilla

Table 2: Corrosion Study of Study Area[5]

Indices	LSI	AI	RI	PI	CR
Maximum	-0.4174	11.4181	9.8072	9.6703	0.0510
Minimum	-1.3334	10.4452	8.0940	7.2054	0.0035
Remarks	**Corrosive tendency**	**Moderate corrosive tendency**	**Moderate to aggressive corrosive nature**	**Corrosive tendency**	**Recommended to transport in any kind of pipes**

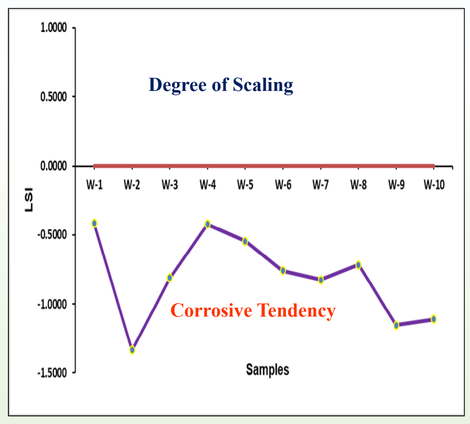


Fig 6: Graphical Distribution of LSI

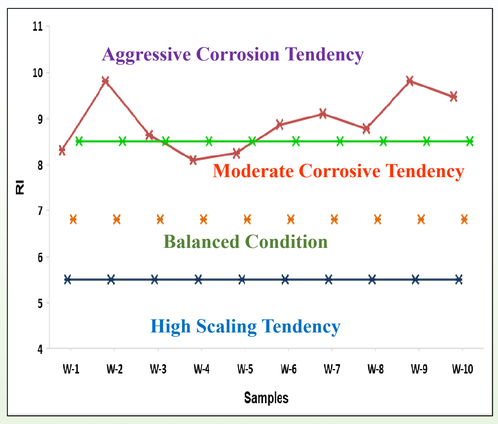


Fig 7: Graphical View of Ryzer Stability Index

Table 3: Heavy Metal Pollution Indices[5]

Indices	Classification	Samples (%)
Heavy Metal Evaluation Index (HEI)	HEI≤10: low metal concentration in drinking water 10<HEI<20: medium metal concentration in drinking water HEI>20: high metal concentration in drinking water	100%
Heavy Metal Pollution Index (HPI)	HPI<100: low heavy metal pollution, HPI>100: high heavy metal pollution (critical pollution index).	100%
The Degree of Contamination (C_d)	C_d<1: low level contamination 1<Cd<3: medium contamination C_d>3: high contamination	100%
Modified Degree of Contamination (mC_d)	mCd<1.5: Nil to very low degree of contamination 1.5≤mCd<2: Low degree of contamination 2≤mCd<4: Moderate degree of contamination 4≤mCd<8: High degree of contamination 8≤mCd<16: Very high degree of contamination	10% 20% 40% 30%
Pollution Load Index (PLI)	PLI<1: Unpolluted condition of the site PLI>1: Progressive deterioration of the water quality	20% 80%
Potential Ecological Risks (PERI)	PERI< 150: Low ecological risk 150<PERI<300: Moderate ecological risk 300<PERI<600: Considerable ecological risk PERI>600: Very high ecological risk	10% 50% 40%
Pollution Index (PI)	PI<0.7: No pollution 0.7<PI<1: indicates slightly polluted 1.0<PI<2.0: moderately polluted 2.0<P<3.0: Severely polluted condition PI>3.0: heavily polluted condition	11.11% 44.44% 11.11% 33.33%

Conclusion

❖ Heavy metal pollution index is an effective tool to characterize the groundwater pollution with respect to heavy metals. The groundwater of Tangail Sadar Upzilla was polluted with heavy metals and is not very suitable for daily as well as long term usage.

❖ Corrosion indices were also calculated of the collected samples. Although CR<1 indicating the water is suitable for transportation through pipes but it will corrode the pipe materials for long term running.

❖ So, water should be properly treated and purified before using for drinking and other household purposes.

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