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Impact of SIDR-2007 on the status of chemical constituents of water

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Abstract: The chemical constituents of water were analyzed after SIDR-2007 in the affected regions of Bangladesh. Thirteen water samples were collected from different rivers, ponds and paddy fields of Bagerhat and Patuakhali districts within 7 days after SIDR and in the following year considered at normal condition. The waters were analyzed for pH, EC, HCO_3, TDS, Ca, Mg, K, Na, Cl, S, P, B, Zn, Fe, Mn, Cu, Cd and Pb. The levels of pH, EC, HCO_3, TDS, Cl, Ca, Mg, K, Fe and Cd were increased and the concentrations of P, S, B, Na, Zn, Cu, Mn and Pb were decreased at SIDR point. During SIDR condition pH, EC, HCO_3, Ca, K, P, Zn and Mn were marginally higher, TDS was thrice, Cl and Mg were twice and Fe and Cd around eight times higher than normal condition. Boron and Na were detected about double, S was around seven times, Cu was ten times and Pb was about twenty six times higher at normal condition as compared to SIDR. Remarkable variations were found in some of the ionic constituents indicated pollution in water. The TDS, Mg, Cl, K, Zn and Mn were detected at toxic level for aquaculture, Fe was toxic for drinking, aquaculture and livestock usage and Cd was toxic for drinking during SIDR time. Significant synergistic relationship was found among Ca-Mg, Ca-Zn, Ca-Cl, Mg-K, Pb-S and Fe-B ions but Zn-S and Cu-Cl ions reflected antagonistic relation at SIDR condition. During normal condition it was found among Ca-Mg, Ca-K, Ca-Na, Ca-S, Mg-K, Mg-Na, Mg-Cl, Mg-P, Mg-S, K-Na, K-Pb, K-Cl, K-P, K-S, Na-Cd, Na-Pb, Na-Cl, Na-S, Cd-Pb, Cd-S, Pb-Cl, Pb-S and Cl-S but Mg-Mn and K-Mn ions reflected antagonistic relation.
Key words: SIDR water, drinking, aquaculture and livestock consumption.

Introduction

The geographical condition of the coastal belt of Bangladesh is almost 'V' shaped against the Bay of Bengal. It invites flood, cyclone, SIDR, AILA, NARGIS followed by tidal water up charge. Flash flooding of the coastal region is not new experience in Bangladesh. Miseries due to disasters and flood water intrusion are enormous. Casualties due to flood water get high priority in both electronic and print media. However, need of conducting research to investigate the intensity of surface water pollution due to dissolved ionic constituents in flood water was not reported. In the crucial moment of flood condition the only life saving aid is drinking water but the water gets polluted and becomes a threat to living bodies. Flood water enters village after village, plenty of water is available everywhere but not a single glass of water is suitable for drinking, livestock consumption, poultry, aquaculture and other purposes. Water quality assessment was not reported during disaster point. Keeping these views in mind, the present piece of study was conducted.

Materials and Methods

The water samples for the study were collected from different locations of Patuakhali and Bagerhat districts as outlined in Table 1.

Table 1. Sampling Locations in Patuakhali and Bagerhat

Sl.	Name of the rivers	Location
1	Lake at Chaltabunia high school	Golachipa, Patuakhali
2	Ramnabad river at Chaltebunia	Golachipa, Patuakhali
3	Kazal river at Rangabali	Golachipa, Patuakhali
4	Pond at Golkhali	Mirjagonj, Patuakhali
5	Paira river at Subidkhali	Mirjagonj, Patuakhali
6	Pond at Charkhali	Mirjagonj, Patuakhali
7	Bakultola canal,Rayenda	Bakultola,Bagerhat
8	Bhola river at Soronkhola	Soronkhola,Bagerhat
9	Pond at Rayenda	Rayenda, Bagerhat
10	Rayenda canal	Soronkhola, Bagerhat
11	Bolessor river	Soronkhola, Bagerhat
12	Golbunia canal at Khontakata	Soronkhola, Bagerhat
13	Paddy field at Saudkhali	Soronkhola, Bagerhat

Analytical methods: The pH and EC were determined by glass electrode pH meter and a conductivity meter (Ghosh *et al.*1983). Total dissolved solids (TDS) were measured by evaporating water samples to dryness after Chopra and Kanwar (1980). Chloride was determined by argentometric titration (APHA, 2005). Bicarbonate (HCO_3) was determined titrimetrically (Tandon,1995). Azomethine-H was used for the analysis of boron (Sparks, 1996) and phosphorus was determined colorimetrically using $SnCl_2$ as a reducing agent (Tandon, 1995). Potassium and sodium were determined flame photometrically (Ghosh *et al.*, 1983). Sulphur was analyzed turbidimetrically (Tandon, 1995). Ca, Mg**,** Zn, Cu, Mn, Fe, Pb and Cd were determined by atomic absorption spectrophotometer (APHA, 2005).

Results and Discussion

pH, EC and TDS status at SIDR condition: The pH of all the waters ranged from 7.1 to 7.9. The highest pH was detected in Ramnabad river at Chaltabunia and the lowest was in paddy field at Soronkhola. Electrical conductivity (EC) were found at normal range 0.21 to 1.10 dSm^{-1} (Imamul Huq, 1995). The highest EC was measured from Kazal river at Rangabali and the lowest was in Paira river at Subidkhali. The TDS varied from 200.00 to 3600.00 mgL^{-1} (Table 2). The highest TDS was present in water of paddy field at Southkhali and the lowest was in Ramnabad river at Chaltabunia, Bokultola canal and Rayenda canal (Table 2).

All the waters were catagorised as low saline level (below 10,000 mgL^{-1} TDS) in quality (Freeze and Cherry, 1979). But TDS were toxic for aquaculture in most of the rivers viz. Ramnabad river at Chaltabunia, Kazal river, Pond at Charkhali, Bhola river, Pond water at Rayenda, Paddy field of Southkhali, Soronkhola (acceptable range of TDS is <400.0 mgL^{-1}) (Meade, 1989). pH and EC were increased marginally but TDS was raised about three times at SIDR condition. TDS levels were toxic for livestock consumption in some of the rivers (ESB, 1972).

At normal condition: The pH, EC and TDS varied from 5.14-7.39, 0.020-0.969 dSm^{-1} and 12.7-520.0 mgL^{-1}. The highest pH was found at Paddy field water of Saudkhali. The maximum EC and TDS both were detected in Bolessor river. The respective lowest levels of pH, EC

and TDS were detected in water at Bakultola canal (Table 3).

Cl and HCO_3 status at SIDR condition: Chloride and HCO_3 contents ranged from 0.01 to15.51 $meClL^{-1}$ and 1.5 to 3.5 $meHCO_3L^{-1}$ (Table 2). The highest level of Cl was recorded in Kazal river and the lowest was in Paira river. All the detected Cl levels were toxic for aquaculture. Chloride in water was found harmful (acceptable range<0.003 $mgClL^{-1}$) for fishes and other aquatic species (Meade, 1989). The highest level of HCO_3 was observed in Ramnabad river at Chaltabunia and the lowest was found in four waters viz. pond at Charkhali, Rayenda canal at Bokultola, Rayenda canal at Soronkhola and Golbunia canal. The detected amounts of HCO_3 in all the waters were within the limit and safe for aquaculture, drinking and livestock usage. Rao *et al*. (1982) reported that in general, HCO_3^- and Cl^- ions were dominant among the anions in water.

Table 2. pH, EC, TDS and concentration of the ionic constituents of water in Patuakhali and Bagerhat districts after 7 days of SIDR

Location	pH	EC $dS\ m^{-1}$	HCO_3 meL^{-1}	TDS	Cl	P	S	B	Ca	Mg	K	Na	Zn	Fe	Mn	Cu	Cd	Pb
				---------- mg L^{-1} ----------														
1	7.1	0.64	3.5	1000.0	300.33	0.13	3.65	0.19	24.09	15.02	11.0	26.95	0.007	0.27	0.016	0.005	0.004	0.005
2	7.9	0.25	2.0	200.0	100.11	0.06	3.31	0.22	17.41	6.00	4.0	31.38	0.005	1.05	0.021	0.006	0.007	0.002
3	7.5	1.10	2.0	1600.0	550.61	0.04	14.24	0.31	21.15	17.00	9.0	30.75	0.001	0.39	0.014	0.004	0.004	0.006
4	7.7	0.25	2.5	600.0	150.17	0.10	2.47	0.15	23.11	6.5	7.0	23.78	0.012	0.20	0.010	0.006	0.003	0.001
5	7.8	0.21	2.5	400.0	52.54	0.04	3.04	0.22	20.38	5.3	4.0	25.05	0.010	0.35	0.006	0.008	0.007	0.001
6	7.6	0.22	1.5	400.0	100.11	0.04	2.72	0.10	19.61	5.8	6.0	14.91	0.008	0.01	0.025	0.008	0.010	0.003
7	7.4	0.30	1.5	200.0	200.22	0.04	4.69	0.09	18.77	9.8	8.0	30.75	0.007	0.01	0.021	0.008	0.019	0.003
8	7.7	0.41	2.0	800.0	200.22	0.02	4.00	0.14	23.55	10.07	7.0	16.17	0.006	0.10	0.005	0.006	0.009	0.004
9	7.5	0.24	2.0	600.0	300.33	0.53	1.00	0.24	16.44	10.48	12.0	25.68	0.006	1.64	0.008	0.009	0.009	0.002
10	7.5	0.41	1.5	200.0	350.39	0.07	4.98	0.13	17.07	10.57	8.0	30.12	0.010	0.01	0.001	0.010	0.008	0.002
11	7.6	0.36	3.0	400.0	200.22	0.43	3.36	0.10	21.24	8.10	5.0	15.54	0.005	0.20	0.020	0.0002	0.008	0.003
12	7.4	0.26	1.5	200.0	200.22	0.40	2.05	0.16	17.62	7.70	9.0	30.12	0.008	0.34	0.017	0.004	0.011	0.005
13	7.1	0.79	3.0	3600.0	450.50	0.28	0.93	0.22	28.63	18.26	14.0	36.45	0.024	0.87	0.017	0.002	0.011	0.002
Mean	7.52	0.42	2.19	784.62	242.77	0.17	3.88	0.17	20.70	10.05	8.0	25.98	0.008	0.42	0.013	0.0058	0.0084	0.003
SD	0.24	0.20	0.54	936.17	144.00	0.15	1.91	0.05	3.48	4.28	3.03	6.79	0.005	0.49	0.007	0.0028	0.004	0.0016
CV (%)		47.62	24.66	119.32	59.32	88.24	49.23	29.41	16.81	42.59	37.88	26.14	68.75	116.6	53.85	48.28	47.62	53.33

1= Lake at Chaltabunia high school, Golachipa, Patuakhali; 2 = Ramnabad river at Chaltebunia, Golachipa, Patuakhali; 3 = Kazal river at Rangabali, Golachipa, Patuakhali; 4 = Pond at Golkhali, Mirjagonj, Patuakhali; 5 = Paira river at Subidkhali, Mirjagonj, Patuakhali; 6 = Pond at Charkhali, Mirjagonj, Patuakhali; 7. Bakultola canal,Rayenda, Bakultola,Bagerhat; 8. Bhola river at Soronkhola, Soronkhola,Bagerhat; 9= Pond at Rayenda, Rayenda, Bagerhat; 10= Rayenda canal, Soronkhola, Bagerhat; 11 = Bolessor river, Soronkhola, Bagerhat; 12 = Golbunia canal at Khontakata, Soronkhola, Bagerhat; 13= Paddy field at Saudkhali, Soronkhola, Bagerhat

Table 3. pH, EC, TDS and ionic constituents of waters of Patuakhali and Bagerhat districts at normal condition

Location	pH	EC $dS\ m^{-1}$	HCO_3 meL^{-1}	TDS	Cl	P	S	B	Ca	Mg	K	Na	Zn	Fe	Mn	Cu	Cd	Pb
				---------- mg L^{-1} ----------														
1	6.81	0.226	2.1	155.0	29.99	0.18	11.10	0.35	18.60	7.80	5.00	39.94	0.006	0.05	0.023	0.051	0.005	0.05
2	7.03	0.125	2.0	96.6	19.99	0.17	11.20	0.49	18.38	7.78	4.00	20.61	0.004	0.180	0.033	0.066	0.006	0.06
3	6.41	0.168	2.0	125.0	39.98	0.02	8.40	0.26	12.00	5.03	4.00	42.52	0.002	0.002	0.031	0.146	0.006	0.08
4	6.39	0.122	1.1	84.5	19.99	0.003	7.90	0.17	12.24	6.03	5.00	25.77	0.307	0.04	0.038	0.042	0.006	0.07
5	6.45	0.118	1.6	85.0	19.99	0.02	13.85	0.13	17.74	4.03	4.00	18.04	0.218	0.12	0.036	0.072	0.006	0.06
6	6.63	0.128	1.3	93.5	19.99	0.05	29.85	0.46	13.82	5.00	5.00	27.06	0.006	0.050	0.035	0.008	0.007	0.08
7	5.14	0.020	0.2	12.7	10.00	0.01	1.20	0.36	2.38	2.02	1.00	12.88	0.005	0.01	0.032	0.071	0.008	0.08
8	6.79	0.405	1.6	295.0	199.94	0.18	45.45	0.43	19.78	8.00	7.00	83.76	0.004	0.05	0.035	0.071	0.007	0.08
9	6.86	0.964	1.8	414.0	199.94	0.14	35.15	0.09	20.06	9.00	8.00	114.69	0.015	0.06	0.036	0.035	0.007	0.09
10	7.15	0.665	2.3	474.0	249.92	0.12	53.05	0.24	22.54	9.50	8.00	118.55	0.011	0.01	0.039	0.038	0.008	0.09
11	7.00	0.969	2.4	520.0	299.91	0.11	51.70	0.50	22.72	7.00	9.00	127.57	0.003	0.04	0.002	0.092	0.009	0.10
12	7.20	0.554	2.4	492.0	199.94	0.14	48.35	0.33	22.51	6.50	9.00	121.13	0.006	0.07	0.001	0.059	0.008	0.08
13	7.39	0.683	4.1	494.0	149.95	1.15	42.30	0.26	22.25	11.04	13.00	121.1	0.021	0.04	0.005	0.068	0.008	0.09
Mean	6.71	0.40	1.92	257.02	112.27	0.18	27.65	0.31	17.31	6.83	6.31	67.20	0.05	0.05	0.027	0.063	0.007	0.078
SD		0.34	0.90	194.31	106.13	0.30	19.23	0.14	5.87	2.43	3.09	47.30	0.10	0.05	0.014	0.033	0.001	0.012
CV (%)		85.00	46.87	75.60	94.53	166.66	69.54	45.16	33.91	35.58	48.97	70.39	200.0	100.0	51.85	52.38	14.29	15.38

At normal condition: At usual condition the ranges of Cl and HCO_3 varied from 10.00-299.91 mgL^{-1} and 0.2-4.1 meL^{-1}. The highest levels of Cl and HCO_3 were detected in the Bolessor river and paddy field of Saudkhali. The lowest levels of Cl and HCO_3 both were detected in water at Bakultola canal (Table 3).

It was observed that Cl content was raised at about double and HCO_3 was raised marginally at SIDR point.

Ca and Mg concentration at SIDR condition: The ranges of Ca and Mg varied from 16.44-28.63 mgCaL^{-1}, and 5.3-18.26 mgMgL^{-1} at SIDR point. The highest levels of Ca and Mg both were measured from water at the Paddy field of Saudkhali, Soronkhola. The lowest amounts of Ca and Mg were obtained from pond water at Rayenda, Bagerhat and Paira river at Subidkhali, Patuakhali (Table 2).

It was observed that the amount of Ca was increased marginally and Mg content was raised at around 1.5 times at SIDR condition.

At normal condition: The ranges of Ca and Mg were 2.38-22.72 mgCaL^{-1} and 2.02-11.04 mgMgL^{-1}. The highest level of Ca was estimated in water at Bolessor river and Mg was at paddy field at Saudkhali. Lowest levels of Ca and Mg both were found in Bakultola canal water (Table 3).

K and Na concentration at SIDR condition: The ranges of K and Na in water varied from 4.0-14.0 mgKL^{-1}, and 14.91-36.45 mgNaL^{-1}. The highest levels of K and Na were estimated from paddy field of Saudkhali, Soronkhola. The lowest amount of K was found at both the Ramnabad river and Paira river and lowest amount of Na was present in pond water at Charkhali, Patuakhali (Table 2).

It was observed that the amount of K was raised at higher level and Na concentration was diluted twice at SIDR point.

At normal condition: The ranges of K and Na were 1.0-13.0 mgKL^{-1} and 12.88-127.57 mgNaL^{-1} respectively. The highest level of K was determined in the paddy field water at Saudkhali and highest Na was in Bolessor river. Lowest levels of both K and Na were found at Bakultola canal water (Table 3).

At normal condition, the concentrations of both K and Na were low at Bakultola canal in Bagerhat district.

P, S and B concentration at SIDR condition: The concentrations of P, S and B varied from 0.02 to 0.53, 0.93 to 14.24 and 0.09 to 0.31 mgL^{-1}, respectively (Table 2). The highest concentration of P was present in pond water at Rayenda and the lowest was detected in Bhola river. The highest level of S was found in Kazal river and the lowest was at paddy field water of Saudkhali. The highest level of B was recorded in Kazal river and the lowest was in Bokultola canal at Rayenda.

Phosphorus and S content of all the waters were found safe for aquaculture and livestock purposes. Gupta, 1983 reported that higher concentration of B (> 1.00 mgL^{-1}) in water affects rice growth. Sulphur content of all the river waters were found at toxic level except paddy field water at Saudkhali (acceptable range of S is <1.0 mgSL^{-1}) for aquaculture (Meade, 1989).

At normal condition: At usual condition the ranges of P, S and B varied from 0.003-1.15 mgPL^{-1}, 1.20-53.05 mgSL^{-1}, and 0.09-0.50 mgBL^{-1} respectively. The highest level of P was found in paddy field water at Saudkhali and the lowest was in pond water at Golkhali. The highest level of S was present in Rayenda canal and the lowest was in Bakultola canal. The highest level of B was detected in Bolessor river and the lowest was in pond water at Rayenda (Table 3).

It was observed that the concentration of S remain high at normal condition as compared to SIDR point. The limits of P and B were almost same at both the conditions.

Zn, Fe, Cu, Mn, Cd and Pb concentrations at SIDR condition: The concentrations of Zn, Fe, Cu, Mn, Cd and Pb in all river waters varied from 0.001 to 0.012, 0.01 to 1.64, 0.0002 to 0.01, 0.001 to 0.025, 0.004 to 0.019 and 0.001 to 0.006 mgL^{-1}, respectively. The highest level of Zn was found in pond at Charkhali and the lowest was in Kazal river. The highest level of Fe was recorded in pond water at Rayenda and the lowest was in three waters viz. pond at Charkhali, Bokultola canal and Rayenda canal. The highest level of Cu was found in Rayenda canal water and the lowest was in Bolessor river. The highest concentration of Mn was recorded in pond at Charkhali and the lowest was in pond water at Rayenda. The highest level of Cd was detected at Bokultola canal and the lowest was in pond water at Charkhali. The highest level of Pb was measured in Kazal river and the lowest was in Paira river (Table-2).

Zinc contents of all the river waters were toxic for aquaculture except Kazal river, Ramnabad river at Chaltabunia and Bolessor river. The concentrations of Fe in most of the river water were detected as toxic for drinking, aquaculture and livestock usage. Manganese level of most of the waters were recorded at toxic level for aquaculture (acceptable range < 0.01mgMnL^{-1} for aquaculture) (Meade, 1989). Cadmium of most of the river waters was found toxic for drinking (acceptable limits of Cd for drinking is less than 0.005 mgCdL^{-1}) (Meade, 1989). The concentration of Pb was safe for drinking aquaculture and livestock usage. The contents of Zn, Cu, Mn and Pb were lower and Fe and Cd were raised at higher level in SIDR affected waters as compared to normal condition at the same period of the following year.

At normal condition: The ranges of Zn**,** Fe Cu, Mn Cd and Pb concentrations at normal condition ranged from 0.002-0.307 mgZnL^{-1}, 0.01-0.18 mgFeL^{-1}, 0.00-0.039 mgCuL^{-1}, 0.001-0.039 mgMnL^{-1}, 0.005-0.009 mgCdL^{-1} and 0.05-0.10 mgPbL^{-1} respectively. The highest content of Zn was present in pond water at Golkhali and the lowest was in Kazal river. The maximum concentration of Fe was present in Ramnabad river and the lowest was in Bakultola canal. The highest level of Mn was detected in Rayenda canal and the lowest was in Golbunia canal. The highest levels of Cu, Cd and Pb were detected in Bolessor river. Lowest limit of Cu was present in pond water at Charkhali. The lowest limits of Cd and Pb both were found in Chaltabunia high school lake, Patuakhali (Table 3).

Relationship between ionic constituents of water: Significant synergistic relationship was found among Ca-Mg, Ca-Zn, Ca-Cl, Mg-K, Pb-S and Fe-B ions but Zn-S and Cu-Cl ions reflected antagonistic relation at SIDR point (Table 4). During normal condition it was found among Ca-Mg, Ca-K, Ca-Na, Ca-S, Mg-K, Mg-Na, Mg-Cl, Mg-P, Mg-S, K-Na, K-Pb, K-Cl, K-P, K-S, Na-Cd, Na-Pb, Na-Cl, Na-S, Cd-Pb, Cd-S, Pb-Cl, Pb-S and Cl-S but Mg-Mn and K-Mn ions reflected antagonistic relation (Table 5). On the contrary at both the conditions some of the ions failed to show neither synergistic nor antagonistic relation. Few ionic

constituents missed the level of significance and this might be due to natural causes. Poor or no remarkable relation was found between some ions, but the reasons are difficult to explain.

Table 4. Correlation matrix of the ionic constituents of water at SIDR point

Ions	Mg	K	Na	Zn	Fe	Mn	Cu	Cd	Pb	Cl	P	S	B
Ca	0.553*	0.378NS	0.030 NS	0.580*	-0.134 NS	0.053 NS	-0.563 NS	-0.199 NS	0.059 NS	0.703**	-0.116 NS	-0.051 NS	0.104 NS
Mg	-	0.795**	0.495 NS	0.229 NS	0.164 NS	-0.049 NS	-0.344 NS	-0.068 NS	0.463 NS	0.374 NS	0.082 NS	0.392 NS	0.476 NS
K	-	-	0.491 NS	0.436 NS	0.385 NS	-0.075 NS	-0.125 NS	0.114 NS	0.244 NS	0.228 NS	0.423 NS	-0.087 NS	0.324 NS
Na	-	-	-	0.346 NS	0.353 NS	-0.025 NS	0.014 NS	0.143 NS	0.010 NS	-0.020 NS	0.012 NS	0.139 NS	0.501 NS
Zn	-	-	-	-	0.096 NS	-0.057 NS	-0.128 NS	0.176 NS	-0.503 NS	0.299 NS	0.115 NS	-0.569 *	-0.082 NS
Fe	-	-	-	-	-	-0.028 NS	0.003 NS	-0.090 NS	-0.235 NS	0.139 NS	0.554 NS	-0.266 NS	0.625 *
Mn	-	-	-	-	-	-	-0.424 NS	0.321 NS	0.245 NS	0.038 NS	0.077 NS	-0.050 NS	-0.206 NS
Cu	-	-	-	-	-	-	-	0.156 NS	-0.351 NS	-0.578 *	-0.371 NS	-0.074 NS	-0.090 NS
Cd	-	-	-	-	-	-	-	-	-0.051 NS	-0.465 NS	0.094 NS	-0.259 NS	-0.475 NS
Pb	-	-	-	-	-	-	-	-	-	-0.040 NS	-0.006 NS	0.581 *	0.177 NS
Cl	-	-	-	-	-	-	-	-	-	-	0.198 NS	-0.165 NS	0.218 NS
P	-	-	-	-	-	-	-	-	-	-	-	-0.429 NS	0.063 NS
S	-	-	-	-	-	-	-	-	-	-	-	-	0.411 NS

**Significant at 1% level of probability; *Significant at 5% level of probability; NS Not significant

Table 5. Correlation matrix of the ionic constituents of water at normal condition

Ions	Mg	K	Na	Zn	Fe	Mn	Cu	Cd	Pb	Cl	P	S	B
Ca	0.791**	0.800**	0.750**	-0.188 NS	0.263 NS	-0.445 NS	-0.128 NS	0.261 NS	0.219 NS	0.707**	0.399 NS	0.776**	0.099 NS
Mg	-	0.806**	0.693**	-0.255 NS	0.056 NS	-0.631 *	-0.203 NS	0.136 NS	0.264 NS	0.573*	0.657*	0.613*	-0.078 NS
K	-	-	0.886**	-0.207 NS	-0.121 NS	-0.579 *	-0.106 NS	0.513 NS	0.566*	0.741**	0.726**	0.821**	-0.079 NS
Na	-	-	-	-0.386 NS	-0.270 NS	-0.025 NS	-0.018 NS	0.674 *	0.728**	0.942**	0.440 NS	0.902**	-0.059 NS
Zn	-	-	-	-	0.153 NS	0.315 NS	-0.133 NS	-0.365 NS	-0.345 NS	-0.366 NS	-0.200 NS	-0.374 NS	-0.542 NS
Fe	-	-	-	-	-	0.060 NS	-0.146 NS	-0.348 NS	-0.528 NS	-0.247 NS	-0.022 NS	-0.166 NS	0.153 NS
Mn	-	-	-	-	-	-	-0.244 NS	-0.522 NS	-0.334 NS	-0.456 NS	-0.500 NS	-0.460 NS	-0.303 NS
Cu	-	-	-	-	-	-	-	-0.017 NS	0.076 NS	0.003 NS	0.003 NS	-0.198 NS	0.064 NS
Cd	-	-	-	-	-	-	-	-	0.862**	0.714**	0.257 NS	0.693**	0.234 NS
Pb	-	-	-	-	-	-	-	-	-	0.743**	0.241 NS	0.687**	0.030 NS
Cl	-	-	-	-	-	-	-	-	-	-	0.212 NS	0.917**	0.066 NS
P	-	-	-	-	-	-	-	-	-	-	-	0.332 NS	-0.036 NS
S	-	-	-	-	-	-	-	-	-	-	-	-	0.146 NS

**Significant at 1% level of probability; *Significant at 5% level of probability; NS Not significant

The information, regarding the status of chemical constituents of water are essential for judging its suitability for public health, irrigation, industry, livestock and environmental safety. Conservation of sustainable and integrated management of natural resources, proper land use, water use management, scientific management of on land water bodies in and around coastal areas may be the appropriate step in reducing the adverse effect of disaster. Age old water harvesting and reserving technology of Bangladesh is big ponds with high bank/pool is appropriate during disaster condition and even at the time of water scarcity.

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