EVALUATION OF WATER QUALITIES FOR WATER SAMPLES COLLECTED FROM FLOODED AND NON-FLOODED AREAS IN BAGO CITY DURING 2014-2016

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Abstract

Bago City is situated on the Bago River. Some parts of this cityis frequently being flooded in rainy season. The comparative studies on the quality of water body sites in the flooded and non-flooded areas of Bago City, during the time frame (2014-2016) have been studied. Flooding causes changes of water quality. The physicochemical properties (pH, temperature, DO, COD, BOD, total alkalinity, total hardness, total dissolved solid, nitrate nitrogen, phosphate, chlorinity, salinity and turbidity were determined on a quarterly basis throughout each year. Microbiological properties (total coliform and *E. coli*) of the water samples were also determined. Atomic absorption spectrophotometric method was used to determine the toxic elements (As, Pb, Hg, and Cd). The qualities of water resources from flooded and non-flooded areas in Bago City and its vicinity have been assessed.

Keywords: Bago City, flooded site, flooded and non-flooded areas, water quality, toxic elements

Introduction

Bago city is the administrative site of the Bago region. It is only about 80 km north west of Yangon, Myanmar. It is situated as stride the Bago river which flows down from the Bago mountain ranges. Normally, during the monsoon period some sites of the Bago city were prone to be flooded while other sites were not.

Usually, during the flooding time period the downtown area of Bago city because of its high embankment remain non-flooded while the lowline municipal areas were often impacted by flooding.

In Bago city, domestic water was either supplied from a reservoir Kandawgyi lake or some communities have to depend on tube well water.

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As mentioned above, due to continual flooding within the city limit of Bago city, the underground water as well as the reservoir can be affected by the accumulation of toxic elements, such as arsenic, mercury, lead and cadmium. The water quality assessment of dams situated in the Bago region has been assessed by Myanmar researchers (Win Aung, 1996); (Khin Maw MawSoe, 2009); (Yin Thu, 2009) and (Nwe Ni Win, 2014).

This paper is comparative assessment of the water quality of the flooded and non-flooded sites in Bago region within the time-frame of period 2014 to 2016.

Materials and Methods

Sample Collection

Water samples were collected separately from the flooded and non-flooded areas of BagoCity. These samples have been quarterly collected since 2014.

The sites in non-flooded areas are:-**Site 1** (Laik Pyar Kan) [N17º 20.078' ; E 96º 29.164']; **Site 2** (Basic Education High School (BEHS) 1-tube well:390ft depth) [N17º 20.078'; E 96º 29.164']; and **Site 3** (Kandawgyi-the main fresh water source for the city)[N17º 22 36.03' ; E 96º 25 50.71']; **Site 8** (Mingalar Zayyon Monastery)[N17º 19.542' ; E 96º 28.414']; and **Site 9** (Dakkhina Monastery) [N17º 19.284' ; E 96º 28.245']. Similarly, the sites in the flooded areas are:-**Site 4** (Kyauk Kyisu) [N17º 20.581' ; E 96º 28.854']; **Site 5** (Basic Education High School (BEHS) 4/sub lake) [N17º 20.106' ; E 96º 28.575']; **Site 6** (Basic Education High School (BEHS) 4/sub TW) [N17º 20.137' ; E 96º 28.532'];and **Site 7** (Basic Education High School (BEHS) 5) [N17º 19.995' ; E 96º 28.415'].

Determination of Physicochemical and Microbiological Properties of Water Samples

The pH values of water samples were measured directly by using portable pH meter in the field.

The contents of dissolved oxygen in water samples and their temperatures were measured by using HANNA oxygen meter incorporated

with temperature probe in the field. These changes in values of dissolved oxygen and temperatures for the year 2015 were not significant (American Public Health Association, 1992).

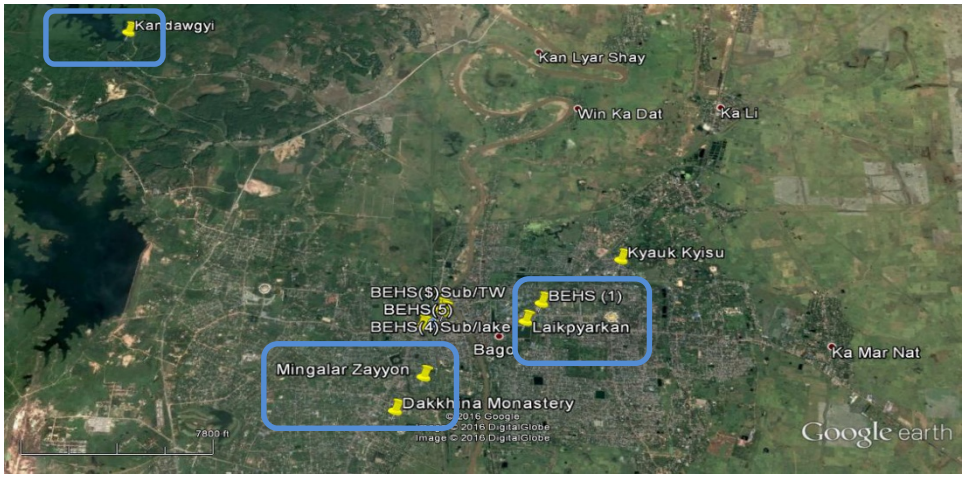


Figure 1: Google map of sample collecting sites (site 1 – site 9) in Bago city and its vicinity(The places in rectangle are non-flood areas)

The BOD_5 was carried out promptly after collecting the samples according to the water examination standard procedures. COD values of the collected water samples were measured by permanganate titrimetric method.

The dissolved solid contents in the samples were determined by using adissolved oxygen meter. Chlorinity of the water samples were determined by Mohr titrimetric method. By using Knudsen equation, the salinity of water was calculated. Total hardness was determined by EDTA titrimetric method. Total alkalinity of water samples was measured by titrimetric method. These laboratory works were carried out in the Analytical Research Laboratory (ACRL), Department of Chemistry, University of Yangon (Holden and Churchill, 1970).

The concentrations of nitrate and total phosphate were determined by spectroscopic methods at the Quality Control Laboratory, Fisheries' Enterprise, Ministry of Fisheries and Livestock (Crocodile Breeding Pond), Tharkayta Township. Moreover, the toxic metals (As, Hg, and Pb) were determined by Atomic Absorption Spectrophotometer at ISO 17025

Certificate Quality Control Laboratory, Fisheries' Enterprise, Tharkayta Township, Yangon.

The enumeration of *E.coli* and coliform counts were carried out at Analytical Research Laboratory (ACRL), Department of Chemistry, University of Yangon (Kumar and Kakrani, 2000).

Results and Discussion

In this research, the physicochemical and microbiological properties of water samples collected from the selected flooded and non-flooded areas of Bago city and its vicinity were measured by conventional standard methods at Analytical Research Laboratory, Department of Chemistry, University of Yangon.

The pH, temperature and dissolved oxygen (DO) were taken in the field by using portable pH meter, DO meter incorporated with thermometer probe. The data were compared with UNEP (United Nations Environmental Protection-2012) standards, this recent data are in the acceptable range of domestic water. The pH values of the water samples collected from the respective sampling sites quarterly during 2014-2016 did not significantly change.

The dissolved solid contained in the samples were determined by dissolved oxygen meter. It is noted that TDS values were not changed by flooding suddenly due to the slow perforation rate into the underground aquifers (Tables 11,13,15, and 17).

Although the impact areas were flooded for a few days in 2015, the parameter such asBOD and COD were also found to be low (Stone, 2012).

The conductivity of Laik Pyar Kan and Kandawgyi were abruptly changed by the flow of rain water into these lakes. Similarly, the salinity and chlorinity values of these two lakes were also significantly changed,(Tables 1 and 5).

The total hardness values of Laik Pyar Kan and Kandawgyi were suddenly dropped by the dilution effect of rain water. The tube well are

sources of water, so the changes in these parameters were not significant (Tables 1 and 5).

The total alkalinity values of water collected in August were abruptly increased. Explanation is given by comparing the data obtained for successive years, i.e., there have been remaining works in 2017 (Tables 1,3,11, and 15).

The values concerned with microorganisms were contributed to the people resided these respective areas. There were some impacts on water samples collected from BEHS (1) and BEHS (4) (Table 19).

The nitrate contents in most of the sampling sites were not noticeably changed. But the phosphate contents changed due to the effect of runoff from agricultural farms.

Table 1: Comparison of Water Quality Parameters for Laik Pyar Kan (Non-Flooded Area) (2014-2016)

	pH	**DO (ppm)**	**BOD (ppm)**	**COD (ppm)**	**Alkalinity (ppm)**	**Hardness (ppm)**	**Turbidity (NTU)**	**TDS (ppm)**	**Conductivity (μS/cm)**
	7.3	6.2	2.1	4.90	45.0	20	15.0	28.0	56
2015 Feb	6.8	4.5	0.6	0.37	4.0	104	9.0	56.2	83
2015 May	6.8	5.0	0.5	1.84	5.6	260	18.7	45.7	118
2015 Aug	6.7	5.0	4.5	4.78	20.0	16	11.8	43.8	48
2015 Nov	6.9	5.5	3.7	3.44	15.2	88	10.3	50.9	78
2016 Feb	6.7	5.0	1.5	0.84	28.0	34	82.0	20.0	75
2016 May	6.5	5.0	2.0	1.11	40.0	40	120.0	20.5	114
2016 Aug	6.5	5.5	2.0	1.62	24.0	48	58.0	160.0	47
2016 Nov	6.8	4.0	2.0	1.75	100.0	60	85.0	20.5	50
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

Table 2: Comparison of Water Quality Parameters and Toxic Metal Contents for Laik Pyar Kan (Non-Flooded Area) (2014-2016)

	Chlorinity (‰)	**Salinity (‰)**	**Phosphate (ppm)**	**Nitrate (ppm)**	**Lead (ppm)**	**Cadmium (ppm)**	**Mercury (ppm)**	**Arsenic (ppm)**
2014 Nov	0.27	0.52	ND	ND	ND	ND	ND	ND
2015 Feb	0.02	0.06	0.30	ND	0.101	ND	ND	ND
2015 May	0.07	0.16	1.20	ND	0.192	ND	ND	ND
2015 Aug	0.06	0.13	0.40	0.01	0.189	0.0009	0.0009	0.002
2015 Nov	0.04	0.11	0.80	ND	0.174	ND	ND	0.001
2016 Feb	Nil	Nil	0.02	0.02	ND	0.0123	0.0004	0.006
2016 May	Nil	Nil	0.03	0.02	1.018	0.0510	0.0005	0.009
2016 Aug	Nil	Nil	0.10	0.01	1.205	0.0600	0.0005	0.015
2016 Nov	Nil	Nil	0.02	0.30	ND	0.0220	0.0004	0.002
UNEP (2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

2015, there was an impact of flood on ground water with respect to the perforation of toxic elements such as arsenic, mercury, lead, and cadmium. These toxic elements entered the water body due to the increase in level of aquifer or underground water table.

The rainfall in August was the highest and also the river water level was also high but the river water level did not exceed the critical level of Bago (910 cm) (Figure 2). It may be summarized that the impact of flooding was not significant according to the viewpoints of physicochemical properties. However, a little effect of short term flooding, the population of microorganism (Table 19) (Edberg, *et al.,* 2000) (Dubey, *et al.,* 2002) and contents of toxic elements were noticeable(Tables 12, 14, 16, and 18).

Table 3: Comparison of Water Quality Parameters for BEHS (1) (Non-Flooded Area) (2014-2016)

	pH	DO (ppm)	BOD (ppm)	COD (ppm)	Alkalinity (ppm)	Hardness (ppm)	Turbidity (NTU)	TDS (ppm)	Conductivity (μS/cm)
2014 Nov	6.9	6.7	1.9	4.00	61.0	36	11.0	156.0	312
2015 Feb	7.2	4.5	0.5	0.37	15.4	104	2.4	207.0	314
2015 May	6.8	5.5	3.5	1.47	19.8	325	1.2	198.6	337
2015 Aug	6.7	5.9	4.0	1.10	100.0	32	1.9	188.1	298
2015 Nov	7.0	5.9	3.0	0.99	28.1	94	1.6	200.6	301
2016 Feb	6.8	5.0	1.5	1.82	130.0	30	7.0	15.0	294
2016 May	6.9	5.0	1.5	2.21	100.0	60	7.0	10.0	326
2016 Aug	7.2	2.0	1.0	0.42	132.0	64	12.0	189.0	296
2016 Nov	7.2	3.5	2.0	0.32	140.0	70	25.0	210.0	302
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

Table 4: Comparison of Water Quality Parameters and Toxic Metal Contents for BEHS(1) (Non-Flooded Area) (2014-2016)

	Chlorinity (‰)	Salinity (‰)	Phosphate (ppm)	Nitrate (ppm)	Lead (ppm)	Cadmium (ppm)	Mercury (ppm)	Arsenic (ppm)
2014 Nov	0.56	1.04	ND	ND	ND	ND	ND	ND
2015 Feb	0.02	0.06	0.80	ND	0.236	ND	ND	ND
2015 May	0.05	0.13	1.50	ND	0.541	ND	ND	ND
2015 Aug	0.48	0.90	1.20	ND	0.363	0.002	0.0007	0.025
2015 Nov	0.35	0.67	1.10	ND	0.404	ND	ND	0.011
2016 Feb	Nil	Nil	0.02	0.002	ND	0.013	0.0001	0.031
2016 May	Nil	Nil	0.01	0.020	1.029	0.058	0.0004	0.023
2016 Aug	Nil	Nil	0.05	0.020	1.221	0.067	0.0012	0.013
2016 Nov	Nil	Nil	0.07	0.050	ND	0.032	0.0003	0.009
UNEP (2012)	-	-	-	-	0.05	-	0.01	0.01

Table 5: Comparison of Water Quality Parameters for Kandawgyi(Non-Flooded Area) (2014-2016)

	pH	DO (ppm)	BOD (ppm)	COD (ppm)	Alkalinity (ppm)	Hardness (ppm)	Turbidity (NTU)	TDS (ppm)	Conductivity (μS/cm)
2014 Nov	7.1	5.8	1.80	0.70	12.0	7	6.00	11.0	23
2015 Feb	6.7	4.5	1.85	0.37	14.0	13	0.00	16.7	24
2015 May	6.9	4.3	1.50	1.84	14.0	31	0.42	10.5	27
2015 Aug	6.8	3.4	2.00	1.10	16.0	24	0.99	11.7	18
2015 Nov	7.0	5.8	2.20	0.59	14.5	19	0.09	14.8	21
2016 Feb	6.6	4.5	2.50	1.86	16.0	10	10.00	15.0	21
2016 May	6.5	4.5	2.50	2.87	12.0	20	8.00	10.5	27
2016 Aug	6.5	5.0	2.50	1.36	20.0	40	17.00	15.1	18
2016 Nov	6.7	4.0	2.50	1.32	20.0	25	6.00	20.5	18
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

Table 6: Comparison of Water Quality Parameters and Toxic Metal Contents for Kandawgyi (Non-Flooded Area) (2014-2016)

	Chlorinity (‰)	Salinity (‰)	Phosphate (ppm)	Nitrate (ppm)	Lead (ppm)	Cadmium (ppm)	Mercury (ppm)	Arsenic (ppm)
2014 Nov	0.04	0.11	ND	ND	ND	ND	ND	ND
2015 Feb	0.01	0.06	0.10	ND	0.011	ND	ND	ND
2015 May	0.04	0.11	1.50	ND	0.016	ND	ND	ND
2015 Aug	0.03	0.10	0.03	0.01	0.159	0.001	0.0006	0.003
2015 Nov	0.03	0.08	0.00	ND	0.034	ND	ND	ND
2016 Feb	Nil	Nil	0.01	0.03	ND	0.012	0.0005	0.001
2016 May	Nil	Nil	0.02	0.12	1.015	0.047	0.0003	0.003
2016 Aug	Nil	Nil	0.06	0.08	1.069	0.052	0.0006	0.011
2016 Nov	Nil	Nil	0.08	0.20	ND	0.029	0.0005	0.001
UNEP (2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

Table 7: Comparison of Water Quality Parameters for MingalarZayyon Monastery (Non-Flooded Area) (2014-2016)

	pH	DO (ppm)	BOD (ppm)	COD (ppm)	Alkalinity (ppm)	Hardness (ppm)	Turbidity (NTU)	TDS (ppm)	Conductivity (µS/cm)
2016 Feb	6.6	4.5	2.0	1.32	50	24	2	30	107
2016 May	6.8	5.5	1.5	2.78	36	36	3	25	109
2016 Aug	6.6	5.3	2.5	2.28	24	56	3	160	59
2016 Nov	6.9	5.0	2.0	2.87	65	32	5	102	73
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

Table 8: Comparison of Water Quality Parameters and Toxic Metal Contents for MingalarZayyon Monastery (Non-Flooded Area) (2014-2016)

	Chlorinity (‰)	Salinity (‰)	Phosphate (ppm)	Nitrate (ppm)	Lead (ppm)	Cadmium (ppm)	Mercury (ppm)	Arsenic (ppm)
2016 Feb	ND	ND	0.02	0.02	ND	0.012	0.0001	0.071
2016 May	ND	ND	0.01	0.28	1.017	0.059	0.0003	0.004
2016 Aug	ND	ND	0.04	0.04	1.175	0.060	0.0007	0.025
2016 Nov	ND	ND	0.02	0.01	ND	0.019	0.0002	0.005
UNEP(2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

Table 9: Comparison of Water Quality Parameters for Dakkhina Monastery (Non-Flooded Area) (2014-2016)

	pH	DO (ppm)	BOD (ppm)	COD (ppm)	Alkalinity (ppm)	Hardness (ppm)	Turbidity (NTU)	TDS (ppm)	Conductivity (µS/cm)
2016 Feb	6.2	5.0	2.0	1.87	20	14	1	10.5	47
2016 May	6.0	4.0	2.0	5.57	20	20	2	20.0	42
2016 Aug	6.5	4.0	2.0	1.88	28	44	3	147.0	46
2016 Nov	6.8	4.0	2.0	2.36	80	42	2	85.0	49
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

Table 10: Comparison of Water Quality Parameters and Toxic Metal Contents for Dakkhina Monastery (Non-Flooded Area) (2014-2016)

	Chlorinity (‰)	**Salinity (‰)**	**Phosphate (ppm)**	**Nitrate (ppm)**	**Lead (ppm)**	**Cadmium (ppm)**	**Mercury (ppm)**	**Arsenic (ppm)**
2016 Feb	ND	ND	0.01	0.001	ND	0.012	0.0005	0.007
2016 May	ND	ND	0.01	0.110	1.019	0.059	0.0002	0.008
2016 Aug	ND	ND	0.07	0.050	1.178	0.061	0.0004	0.018
2016 Nov	ND	ND	0.03	0.010	ND	0.027	0.0004	0.006
UNEP (2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

Table 11: Comparison of Water Quality Parameters for Kyauk Kyisu (Flooded Area) (2014-2016)

	pH	**DO (ppm)**	**BOD (ppm)**	**COD (ppm)**	**Alkalinity (ppm)**	**Hardness (ppm)**	**Turbidity (NTU)**	**TDS (ppm)**	**Conductivity (μS/cm)**
2014 Nov	6.8	6.6	1.3	2.90	80.0	38	8.00	143.0	287
2015 Feb	6.8	4.0	0.5	0.37	13.8	52	0.17	188.0	287
2015 May	6.7	5.5	3.5	0.74	15.4	130	0.53	176.8	263
2015 Aug	7.2	5.3	1.5	1.10	92.0	28	2.02	166.9	250
2015 Nov	6.9	5.4	3.1	0.55	26.0	56	1.27	179.2	272
2016 Feb	6.5	4.0	2.5	1.87	118.0	30	16.00	125.0	273
2016 May	6.8	4.0	2.5	4.65	84.0	40	12.00	115.5	276
2016 Aug	6.5	5.3	2.5	3.82	28.0	56	13.00	179.0	264
2016 Nov	6.9	5.0	2.0	3.62	125.0	45	28.00	100.0	270
UNEP(2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

Table 12: Comparison of Water Quality Parameters and Toxic Metal Contents for Kyauk Kyisu (Flooded Area) (2014-2016)

	Chlorinity (‰)	Salinity (‰)	Phosphate (ppm)	Nitrate (ppm)	Lead (ppm)	Cadmium (ppm)	Mercury (ppm)	Arsenic (ppm)
2014 Nov	0.65	1.21	ND	ND	ND	ND	ND	ND
2015 Feb	0.03	0.09	0.20	ND	0.024	ND	ND	ND
2015 May	0.09	0.19	1.00	ND	0.158	ND	ND	ND
2015 Aug	0.08	0.17	0.50	ND	0.215	0.004	0.0001	0.008
2015 Nov	0.06	0.14	0.30	ND	0.116	ND	ND	0.004
2016 Feb	ND	ND	0.01	0.04	ND	0.013	0.0004	0.020
2016 May	ND	ND	0.01	0.22	1.026	0.053	0.0002	0.010
2016 Aug	ND	ND	0.20	0.06	1.220	0.065	0.0011	0.015
2016 Nov	ND	ND	0.03	0.06	ND	0.031	0.0005	0.002
UNEP (2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

Table 13: Comparison of Water Quality Parameters for BEHS(4) Sub/Lake (Flooded Area) (2014-2016)

	pH	DO (ppm)	BOD (ppm)	COD (ppm)	Alkalinity (ppm)	Hardness (ppm)	Turbidity (NTU)	TDS (ppm)	Conductivity (µS/cm)
2014 Nov	7.0	5.1	1.6	3.70	23.0	10	19	92.0	183
2015 Feb	6.8	4.0	0.5	0.37	20.0	13	ND	20.3	31
2015 May	6.7	3.3	0.5	1.47	23.4	35	ND	25.8	47
2015 Aug	6.8	5.0	1.5	1.10	16.0	28	ND	22.5	34
2015 Nov	6.8	5.3	2.3	0.66	15.2	22	2	21.1	30
2016 Feb	6.8	5.0	1.5	1.84	20.0	20	3	15.0	30
2016 May	6.8	5.5	2.0	1.47	20.0	36	8	20.0	52
2016 Aug	6.7	3.5	1.5	0.23	40.0	48	16	164.0	34
2016 Nov	6.8	3.5	2.5	0.57	45.0	48	4	180.0	31
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

ND = not detectable

Table 14: Comparison of Water Quality Parameters and Toxic Metal Contents for BEHS(4) Sub/Lake (Flooded Area)(2014-2016)

	Chlorinity (‰)	**Salinity (‰)**	**Phosphate (ppm)**	**Nitrate (ppm)**	**Lead (ppm)**	**Cadmium (ppm)**	**Mercury (ppm)**	**Arsenic (ppm)**
2014 Nov	0.12	0.24	ND	ND	ND	ND	ND	ND
2015 Feb	0.01	0.06	0.10	ND	0.042	ND	ND	ND
2015 May	0.04	0.12	1.20	ND	0.039	ND	ND	ND
2015 Aug	0.04	0.11	1.40	ND	0.336	0.001	0.0002	0.004
2015 Nov	0.03	0.09	0.10	ND	0.076	ND	ND	ND
2016 Feb	ND	ND	0.02	0.003	ND	0.012	0.0006	0.005
2016 May	ND	ND	0.02	0.020	1.102	0.050	0.0007	0.001
2016 Aug	ND	ND	0.03	0.050	1.169	0.058	0.0007	0.012
2016 Nov	ND	ND	0.06	0.040	ND	0.029	0.0006	0.004
UNEP (2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

Table 15: Comparison of Water Quality Parameters for BEHS(4) Sub/TW (Flooded Area)(2014-2016)

	pH	**DO (ppm)**	**BOD (ppm)**	**COD (ppm)**	**Alkalinity (ppm)**	**Hardness (ppm)**	**Turbidity (NTU)**	**TDS (ppm)**	**Conductivity (μS/cm)**
2014 Nov	6.8	5.2	1.1	2.50	44.0	36	4.00	127.0	255
2015 Feb	7.2	5.0	1.0	1.47	110.0	65	0.32	193.0	291
2015 May	7.5	4.0	1.0	0.37	13.8	273	11.14	179.4	273
2015 Aug	8.3	5.2	3.5	2.21	104.0	52	ND	181.5	292
2015 Nov	7.3	5.0	2.5	1.99	94.0	70	ND	188.2	286
2016 Feb	7.2	5.0	2.0	0.32	106.0	52	12.00	120.0	291
2016 May	7.3	4.8	2.0	0.74	100.0	76	5.00	130.0	370
2016 Aug	7.5	5.5	2.5	0.58	108.0	72	9.00	192.0	317
2016 Nov	7.6	5.0	3.0	0.53	118.0	78	30.00	198.0	319
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

ND = not detectable

Table 16: Comparison of Water Quality Parameters and Toxic Metal Contents for BEHS(4) Sub/TW (Flooded Area)(2014-2016)

	Chlorinity (‰)	**Salinity (‰)**	**Phosphate (ppm)**	**Nitrate (ppm)**	**Lead (ppm)**	**Cadmium (ppm)**	**Mercury (ppm)**	**Arsenic (ppm)**
2014 Nov	0.79	1.46	ND	ND	ND	ND	ND	ND
2015 Feb	0.02	0.06	0.20	ND	0.128	ND	ND	ND
2015 May	0.09	0.19	1.50	ND	0.157	ND	ND	ND
2015 Aug	0.07	0.16	0.20	ND	0.286	0.008	0.0004	0.082
2015 Nov	0.04	0.11	0.10	ND	0.223	ND	ND	0.002
2016 Feb	ND	ND	0.03	0.02	ND	0.122	0.0005	0.003
2016 May	ND	ND	0.01	0.01	1.021	0.052	0.0009	0.002
2016 Aug	ND	ND	0.10	0.01	1.135	0.061	0.0006	0.012
2016 Nov	ND	ND	0.05	0.12	ND	0.024	0.0006	0.007
UNEP (2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

Table 17: Comparison of Water Quality Parameters for BEHS(5) Sub/TW (Flooded Area) (2014-2016)

	pH	**DO (ppm)**	**BOD (ppm)**	**COD (ppm)**	**Alkalinity (ppm)**	**Hardness (ppm)**	**Turbidity (NTU)**	**TDS (ppm)**	**Conductivity (µS/cm)**
2014 Nov	7.1	6.4	0.8	2.10	67	26	5.00	76.0	152
2015 Feb	6.7	4.0	0.5	0.37	90	52	0.25	118.3	177
2015 May	6.8	5.5	3.0	1.47	48	247	0.34	124.6	219
2015 Aug	6.6	5.4	4.5	2.94	60	56	ND	129.8	137
2015 Nov	6.8	5.1	3.2	1.76	73	87	3.14	119.1	150
2016 Feb	6.5	4.5	2.0	1.82	94	40	18.00	25.0	172
2016 May	6.8	5.2	1.5	2.77	56	60	14.00	15.0	199
2016 Aug	6.8	5.0	2.0	1.12	68	72	7.00	191.0	147
2016 Nov	7.2	4.0	2.0	0.18	110	65	4.00	160.0	167
UNEP (2012)	6.0-8.0	-	10.0	5.0	-	-	-	-	-

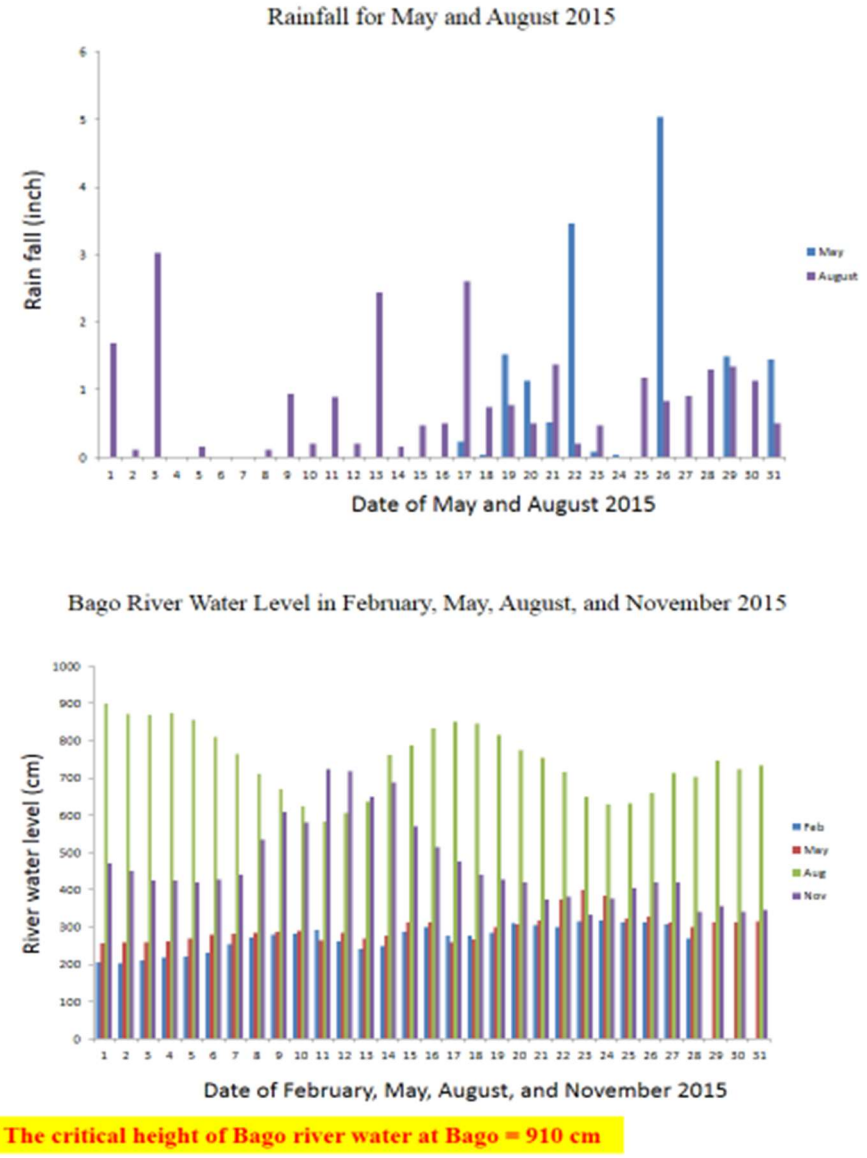
Table 18: Comparison of Water Quality Parameters and Toxic Metal Contents for BEHS(5) Sub/TW (Flooded Area)(2014-2016)

	Chlorinity (‰)	**Salinity (‰)**	**Phosphate (ppm)**	**Nitrate (ppm)**	**Lead (ppm)**	**Cadmium (ppm)**	**Mercury (ppm)**	**Arsenic (ppm)**
2014 Nov	0.52	0.96	ND	ND	ND	ND	ND	ND
2015 Feb	0.01	0.05	0.10	ND	0.104	ND	ND	ND
2015 May	0.04	0.10	1.00	ND	0.223	ND	ND	ND
2015 Aug	0.04	0.70	0.80	ND	0.259	0.005	0.0008	0.008
2015 Nov	0.29	0.55	0.10	ND	0.179	ND	ND	0.001
2016 Feb	ND	ND	0.02	0.01	ND	0.012	0.0004	0.009
2016 May	ND	ND	0.03	0.01	1.022	0.055	0.0002	0.007
2016 Aug	ND	ND	0.03	0.06	1.130	0.062	0.0016	0.014
2016 Nov	ND	ND	0.02	0.01	ND	0.015	0.0007	0.008
UNEP(2012)	-	-	-	-	0.05	-	0.01	0.01

ND = not detectable

Table 19: Total Coliform and *E. coli* of Water Samples Collected from Flooded and Non-flooded Areas in Bago City

Site No.	Location	Total coliform and *E. coli* (cfu/mL)															
		2015 Feb		2015 May		2015 Aug		2015 Nov		2016 Feb		2016 May		2016 Aug		2016 Nov	
		Coli form	*E.coli*	Coli form	*E.coli*	Coli form	*E.coli*	Coli form	*E.coli*	Coli form	*E.coli*	Coli form	*E.coli*	Coli form	*E.coli*	Coli form	*E.coli*
1	LaikPyarKan	2	0	11	0	11	2	5	1	25	1	23	1	13	3	24	0
2	BEHS(1)TW	2	0	12	4	8	11	4	0	3	0	20	11	12	4	28	14
3	Kandawgyi	0	0	0	0	20	1	4	0	11	0	10	0	11	0	5	0
4	KyaukKyisu	0	0	0	0	5	0	3	0	4	2	8	2	30	0	16	2
5	BEHS (4/sublake)	3	0	16	0	3	1	5	0	0	0	7	0	12	0	10	2
6	BEHS (4/sub TW)	0	0	2	1	20	6	10	2	8	1	15	1	13	0	6	0
7	BEHS (5)	2	0	4	1	15	1	4	0	10	0	6	0	26	0	30	16
8	MingalarZayon	-	-	-	-	-	-	-	-	0	0	0	0	28	16	40	25
9	Dakkhina Monastery	-	-	-	-	-	-	-	-	5	0	3	0	8	5	11	2
UNEP standard (2012)		< 3 (*E. coli*)															



Figures 2: Histograms for rainfall in Bago and Bago river water level at Bago in 2015

Conclusion

In the three year study period (2014-2016), the assessment of water quality of those targeted sites which became flooded was found to show higher quantity of the toxic elements such as Ag, Hg, Pb and Cd. By comparingwith those targeted sites, the remaining non-flooded sites were found to show lower or resilient quantity of toxic element.

There are two probable aspects; firstly, it may be due to perforation or permeation of the toxic elements through the ground strata or ground water flow. Secondly, it may be due to the dissolved chemicals corresponding to excel respective trace toxic elements. It may be polluted by use of fertilizer, insecticides, pesticides and battery plants etc., carried during the water flood flow.

The intensity of the presence of toxic metals (As, Pb, Hg and Cd) was high at the target flooded sites, whereas the non-flooded sites remain resilient as it was. Higher intensity of toxic metals was perhaps due to the over accumulation of the dissolved metal complexes which occurred during the flooding time period. This occurred during the heavy monsoonrainy period. The high level dissolved toxic metals compounds was attributed to thesurface water body flow to & fro.

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