PHYSICOCHEMICAL ANALYSES OF SELECTED TAP WATER SAMPLES FROM ADJACENT UNIVERSITY COMMUNITY, CAGAYAN DE ORO, PHILIPPINES

Joseph L. Bansilay[1], Ma. Judith B. Felisilda[1], Mohammad-Nor B. Ibrahim[1], Keir Joshua F. Maraviles [1], Richiel Lou A. Villanueva [1], and Van Ryan Kristopher R. Galarpe[2,*]

[1]BS Environmental Science & Technology, Department of Environmental Science & Technology, University of Science and Technology of Southern Philippines C.M. Recto Avenue, Cagayan de Oro, 9000 Philippines

[2]Department of Physics, University of Science and Technology of Southern Philippines C.M. Recto Avenue, Cagayan de Oro, 9000 Philippines

[*]For correspondence, E-mail: vanryangalarpe@gmail.com

ABSTRACT: *Drinking water quality has become an alarming concern to potentially pose health risks. This study was conducted to extrapolate the present tap water quality in adjacent communities in a university in Cagayan de Oro, Philippines. Two communities were identified, namely, Lapasan with two stations and Macabalan with three stations. Each station is composed of five sub-stations totaling of twenty five sampling stations. Sampling was carried on December, 2016 to February, 2017 with pH, temperature, dissolved oxygen (TDS), turbidity, salinity, conductivity, total dissolved solids (TDS) as studied parameters in triplicates. Overall the analyzed tap water samples passed the physicochemical parameters studied except for TDS and conductivity with variations found to be site specific (p value<0.05). The TDS, conductivity, and salinity were found to have positive associations (r = 0.94-0.99) with site specific variations. Extrapolating from this, it can be inferred that conductivity showed higher risk quotient (RQ) although may not conclusively suggest contamination. This study is preliminary in nature and further monitoring with other parameters may be considered.*

Keywords: *physicochemical parameters, tap water, risk quotient*

1. INTRODUCTION

Water quality elsewhere had become a concern owing to potential contamination. Studies in the Philippines showed contamination of the following water bodies:

1. Ground water with metals owing to landfills [1,2,3];
2. River, owing to anthropogenic activities yielding high metal concentrations [4,5] and coliform counts [6,7];
3. Coastal water [8];
4. Tap water and spring resources [9,10,11,12].

Associated risk factors may include disposal of untreated domestic wastewater to adjacent water bodies [13] and other anthropogenic activities. Consequently, a need to monitor drinking tap water is essential to secure public health.

Tap water resources are often monitored and treated by government water servicing units. However, leakage in the pipelines, corrosion, and failure to monitor may likely result to contamination. A study conducted by [14] suggested that during negative to low-pressure events, microorganisms may enter the treated drinking water through pipeline leaks. Given the potential concern, it is with this purpose this study was conducted.

The objectives of the study were the following:

1. To determine the physicochemical parameters of drinking water/tap water in five stations in Lapasan and Macabalan, Cagayan de Oro, Philippines;
2. To determine whether the studied parameters passed the water quality guidelines [15,16];
3. To determine if there is a significant difference among studied sites and sampling dates;
4. To determine if there is an association between studying physicochemical parameters; and lastly
5. To determine the risk quotient brought by the studied physicochemical parameters. Generally, these sites were adjacent to a nearby university.

2. MATERIALS AND METHODS

2.1 Sampling techniques

Sampling was carried on December Dec 16, 2016, Jan 11, 2017, Jan 14, 2017, Jan 30, 2017, and Feb 4, 2017 daytime to minimize weather factors. All samples were contained in pre-cleaned polyethylene (PET) bottles with distilled water. Upon sampling the bottles itself were prewashed by the samples prior to collecting water as final sample for analysis. All samples were analyzed in triplicates.

2.2 Physicochemical analyses

Each physicochemical parameter was analyzed using probe meters. The DO determination was carried using DO 6+ Oakton Eutech (manufactured in Singapore). The TDS, conductivity, salinity, and pH were all determined using Oyster series Extech instram (manufactured in Taiwan). Turbidity on the other hand was analyzed using Lamotte model 2020we (manufactured in USA).

2.3 Data analysis

All results were expressed descriptively as mean with standard deviation. The difference between stations and sampling dates were determined using Two Way-ANOVA at 0.05 level of significance. To determine the association between studying parameters the Pearson correlation was employed. The risk quotient (RQ) was also determined adopted from [2]. The RQ was calculated as the ratio between the determined concentration and the available standard [17]. The calculated RQ of >1 can gauge the parameter to likely pose environmental risks. To determine the RQ both PNSDW and WHO drinking water guidelines were used as a standard reference.

2.4 Sampling site

This research was conducted in the adjacent community to the University of Science and Technology of Southern Philippines (USTP). The site covered with Lapasan (two sub stations; refer to Figure 1) and Macablan (3 sub stations; refer

to Figure 3) in Cagayan de Oro, Philippines. Each sub-station was consisted of five sampling points. A total of 25 sampling points were covered in this study from December, 2016-February, 2017.

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Figure (1). Map of stations 1 and 3 located in Lapasan, Cagayan de Oro

Figure (2). Map of stations 2, 4, and 5 located in Macabalan, Cagayan de Oro

3. RESULTS AND DISCUSSION

3.1 Summary of physicochemical parameters

The determined physicochemical parameters showed a pH range of 7.24-7.55 (Table 1-5). Notable the highest pH was recorded from the water samples obtained in Sto Nino, Lapasan Cagayan de Oro while the lowest result was from Highway Macabalan, Cagayan de Oro (pH = 7.22). The result also showed higher values on January, 2017 sampling in all studied sites for pH (p value = 0.034486) indicating a sampling date specific variation. Overall, all studied stations had alkaline pH typical in communal drinking water sources [18]. Considerably all the determined pH was acceptable to the set standards (Figure 3). The overall temperature of water samples were in the range 20.52-26.91 ^{o}C (refer to Table 1-5). The highest temperature recorded was in Punta Macabalan, Cagayan de Oro while the lowest temp was recorded in Parola, Macabalan (p value = 0.008488; refer to Table 6). The temperature findings can be associated to the determined normal range of DO (see Table 1-5) in all studied sites. Overall, the determined temperatures were relatively within the standard set. The turbidity in water samples ranged 0.398 – 2.462 ntu in all studied sites. The lowest value was recorded from the water samples collected from Kolambog, Lapasan, Cagayan de Oro while the highest was from Highway, Macabalan, Cagayan de Oro. While the mean result for turbidity was within the set standard (Figure 4) some sample for the first week sampling (refer to Table 5) was relatively higher. Potential sources can be associated to either sample contamination or exposure to particulate matter to the water pipes. Overall present finding is comparable to reference [19,20].

On the other hand, the conductivity result was within the range 131-855 uS/cm. The large variation on the conductivity result was site specific (p value = 0.000797), notably the highest was the samples in Punta, Macabalan (Table 4) and the lowest was in Parola, Macabalan (Table 2). Some of the conductivity results exceeded the WHO drinking water quality standard (Figure 5). Overall, these results may indicate potential levels of ions [2,13,21] The TDS result was in agreement with the conductivity result which was site specific in terms of variation (p value = 0.010381; refer to Table 6), exceeding PNSDW drinking water standard (refer to Figure 6) [1]. The TDS can be associated to high levels of carbonates in water samples [22]. The highest TDS was 568 mg/L from the water samples in Punta Macabalan, the same site where conductivity and salinity (423 ppm) was high. The lowest in salinity were the water samples from Highway, Macabalan (94.628 ppm) and Parola, Macabalan (141.058 ppm). The salinity result similarly indicated site specific condition (p value= 0.010733; Table 6).

3.2 Correlation analysis

Overall, a strong association between conductivity- salinity (r =0.941), salinity-TDS (0.992), and conductivity-TDS(r =0.992) were determined (refer to Table 7). This strong association can be linked to the increase of these parameters at site specific condition. Data shown on Table 1-5 indicated high levels of TDS, salinity, and conductivity in two study sites in Lapasan (e.g. Sto Nino and Kolambog) and Punta, Macabalan. The present findings is comparable to other literature citing associations between TDS-conductivity [23]

3.2 Risk Quotient

Overall, the pH, TDS, and turbidity showed no risk with RQ values <1 (Table 8). However, the determined RQ (2) for conductivity showed risk in reference to WHO guideline of 250 uS/cm. While present result may indicate risk it is however better to consider specific metal ion analysis to extrapolate a conclusive findings.

Table (1). Summary of the physicochemical analyses of water samples in Sto Nino , Lapasan, Cagayan de Oro City

Sampling dates	pH	Temp (°C)	DO (ppm)	Turbidity (NTU)	Conductivity (uS/cm)	Salinity (ppm)	TDS (mg/L)
Dec 16, 2016	7.06	27.7	6.02	0.73	754.26	373.4	500.28
Jan 11, 2017	7.47	25.87	7.15	0.4	673	361.87	425
Jan 14, 2017	7.6	26.63	8.512	0.81	464.4	201.86	355.53
Jan 30, 2017	7.84	27.41	8.28	0.28	722.27	361.13	484
Feb 4, 2017	7.81	24.12	5.16	0.23	736.53	363.8	492.6
Mean ± SD	7.55± 0.32	26.35 ± 143	7.024 ± 1.44	0.49 ± 0.30	670.09 ± 118.9	332.41 ± 73.15	451.48 ± 61.31

Table (2). Summary of the physicochemical analyses of water samples in Parola, Macabalan, Cagayan de Oro City

Sampling dates	pH	Temp (°C)	DO (ppm)	Turbidity (NTU)	Conductivity (uS/cm)	Salinity (ppm)	TDS (mg/L)
Dec 16, 2016	7.13	25.4	5.3	1.94	495.08	314.6	420.9
Jan 11, 2017	7.39	23.3	6.42	0.99	75.84	42.66	55.08
Jan 14, 2017	7.98	23.5	6.38	0.76	66.84	333	445
Jan 30, 2017	7.38	7.38	7.38	7.38	7.38	7.38	7.38
Feb 4, 2017	7.39	23	5.68	0.60	13.5	7.65	5.68
Mean ± SD	7.45 ± 0.31	20.516 ± 7.40	6.232 ± 0.80	2.334 ± 2.87	131.728 ± 205.4	141.058 ± 167.6	186.808 ± 225.7

Table (3) Summary of the physicochemical analyses of water samples in Kolambog, Lapasan Cagayan de Oro City

Sampling dates	pH	Temp (°C)	DO (ppm)	Turbidity (NTU)	Conductivity (uS/cm)	Salinity (ppm)	TDS (mg/L)
Dec 16, 2016	7.25	23.0	6.12	0.36	595.4	355.2	407.8
Jan 11, 2017	7.2	23	4.63	0.19	731.4	365.6	489
Jan 14, 2017	7.6	23	5.78	0.65	727	361	531
Jan 30, 2017	7.64	23.5	7.21	0.43	667.6	335	448
Feb 4, 2017	7.24	23	6.94	0.36	595	355	408
Mean ± SD	7.39 ± 0.21	23.1 ± 0.22	6.136 ± 1.02	0.398 ± 0.17	663.28 ± 67.06	354.36 ± 11.69	456.76 ± 53.39

Table (4). Summary of the physicochemical analyses of water samples in Punta, Macabalan, Cagayan de Oro City

Sampling dates	pH	Temp (°C)	DO (ppm)	Turbidity (NTU)	Conductivity (uS/cm)	Salinity (ppm)	TDS (mg/L)
Dec 16, 2016	7.5	25	6.7	0.5	756	378	508
Jan 11, 2017	7.27	31.88	7.04	0.89	128.48	64.7	86.24
Jan 14, 2017	7.52	24.52	8.58	0.81	1075.6	538.72	721.52
Jan 30, 2017	7.50	27.5	7.73	0.62	1130	572.4	779.4
Feb 4, 2017	7.78	25.64	6.28	0.42	1188	562	745
Mean ± SD	7.51 ± 0.18	26.908 ± 3.00	7.266 ± 0.91	0.648 ± 0.20	855.616 ± 439.55	423.164 ± 215.31	568.032 ± 289.52

Table (5) Summary of the physicochemical analyses of water samples in Highway, Macabalan, Cagayan de Oro City

Sampling dates	pH	Temp (°C)	DO (ppm)	Turbidity (NTU)	Conductivity (uS/cm)	Salinity (ppm)	TDS (mg/L)
Dec 16, 2016	7.13	23.3	8.03	7.96	595	296	397
Jan 11, 2017	7.25	27.92	9.25	0.41	90	44.8	60
Jan 14, 2017	7.44	26.6	7.87	2.03	89.9	44.9	60.3
Jan 30, 2017	7.31	27.7	7.06	0.86	83.5	41.8	56
Feb 4, 2017	7.06	27.11	6.90	1.05	96.3	45.64	65.6
Mean ± SD	7.24 ± 0.15	26.526 ± 1.86	7.822 ± 0.94	2.462 ± 3.13	190.94 ± 225.92	94.628 ± 112.58	127.78 ± 150.54

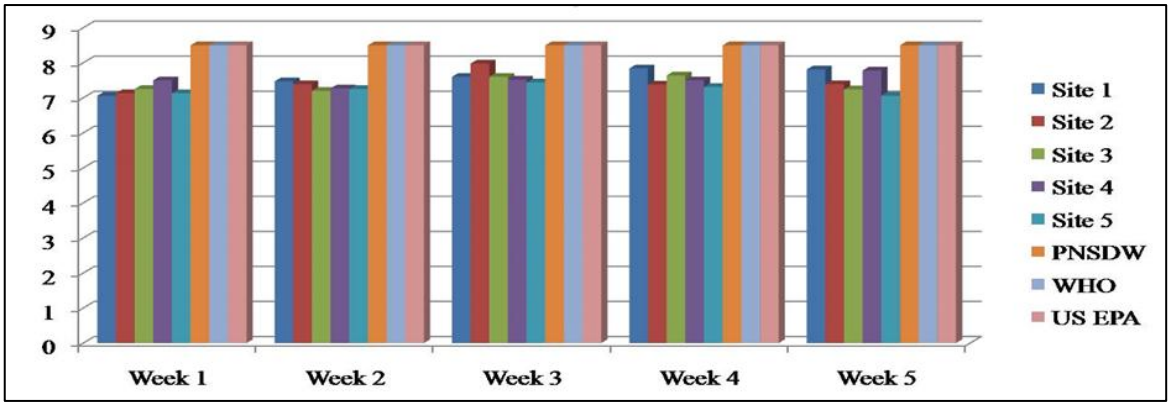

Figure (3). The pH of the water samples monitored weekly compared to standards

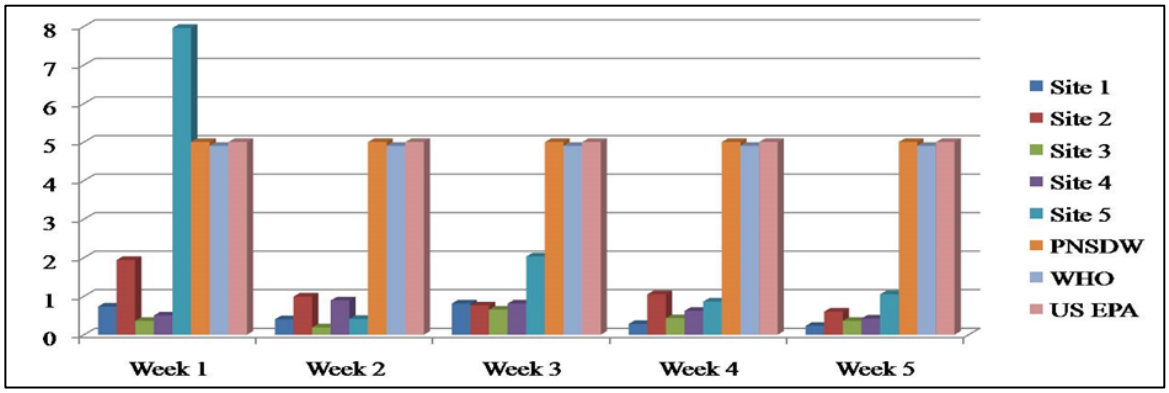

Figure (4). The turbidity of the water samples monitored weekly compared to standards

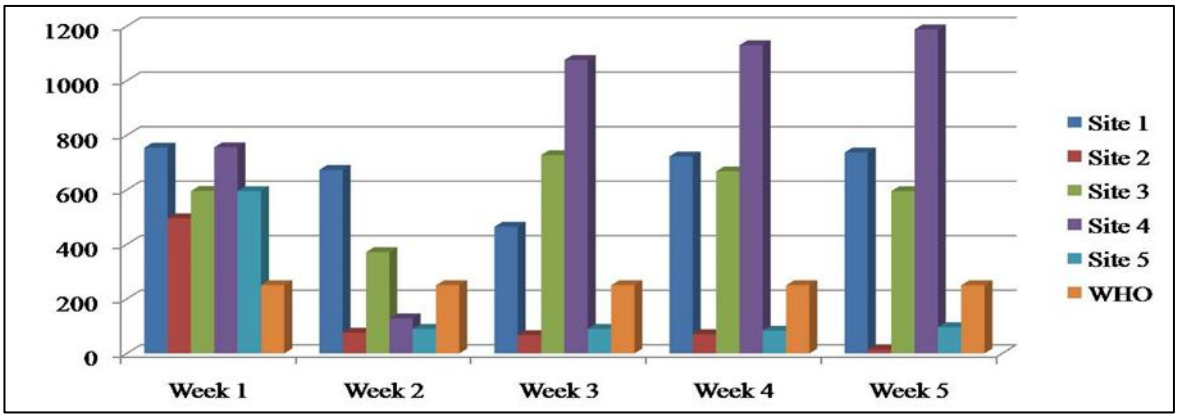

Figure (5). The conductivity of the water samples compared to standards

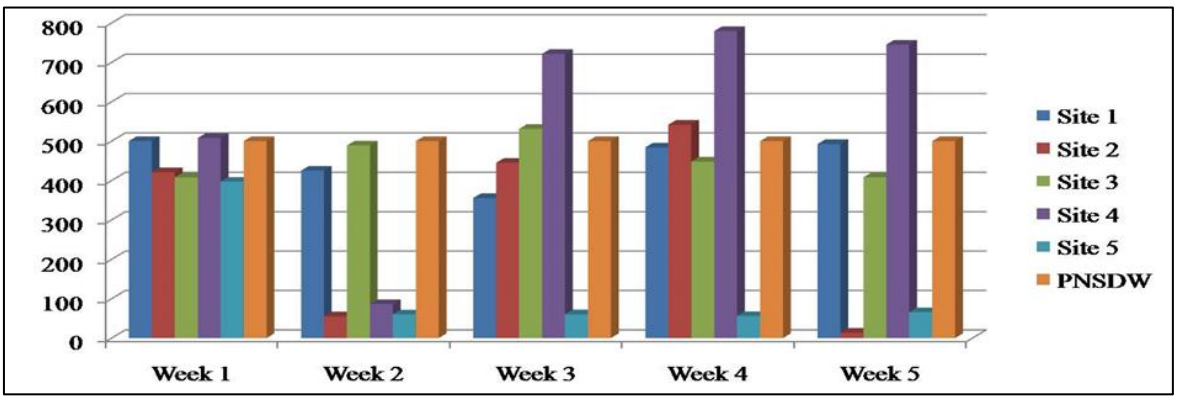

Figure (6). The TDS of the water samples compared to standards

Table (6). Two-way ANOVA for the studied sites

Parameter	F critical	P value	Description
pH			
Months	3.006917	0.034486	significant difference
Site	3.006917	0.164992	no significant difference
Temperature			
Months	3.006917	0.419452	No significant difference
Site	3.006917	0.008488	significant difference
DO			
Months	3.006917	0.393765	No significant difference
Site	3.006917	0.502764	No significant difference
Turbidity			
Months	3.006917	0.254129	No significant difference
Site	3.006917	0.152911	No significant difference
Conductivity			
Months	3.006917	0.452343	No significant difference
Site	3.006917	0.000797	significant difference
Salinity			
Months	3.006917	0.318074	No significant difference
Site	3.006917	0.010733	significant difference
TDS			
Months	3.006917	0.231716	No significant difference
Site	3.006917	0.010381	significant difference

Table (7) Correlation analysis of studied parameters

Para-meters	pH	Temp	DO	Turbid-ity	Conduc-tivity	Salin-ity	TDS
pH	1	-0.05	0.07	-0.27	0.25	0.36	0.38
Temp		1	0.14	-0.59	0.15	0.12	0.13
DO			1	0.22	-0.07	-0.13	-0.11
Turbid-ity				1	-0.24	-0.26	-0.26
Conduc-tivity					1	0.94	0.99
Salinity						1	0.99
TDS							1

Table (8). Risk Quotient (RQ) for the studied sites

Parameter	**PNSDW**	**WHO**	**Mean result**	**RQ**	**Decision**
Ph	6-8.5	6-8.5	7.43	1.24-0.87	no risk
Turbidity (ntu)	5	<4.9	1.27	0.25	no risk
conductivity (uS/cm)	N/A	250	502.33	2.00	risk
TDS (mg/L)	500	N/A	358.17	0.72	no risk

4. CONCLUSIONS

Overall the analyzed tap water samples passed the physicochemical parameters studied except for TDS and conductivity. However, the variations in these parameters were found to be site specific based on the Two-Way ANOVA. The TDS, conductivity, and salinity were found to have positive associations (r = 0.94-0.99) with site specific variations. Extrapolating from this, it can be inferred that conductivity showed higher RQ although may not conclusively suggest contamination.

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