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A Quick Reference on the Water Quality at Adventist University of the Philippines

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Abstract The study was conducted to determine the water quality for domestic purposes at the Adventist University of the Philippines (AUP) dormitories. Specifically, itidentified the level of heavy metals such as lead(Pb), copper(Cu),chromium(Cr),total dissolved solids (TDS) and pH. The results of water quality analyses were compared with the standards set by the Philippine National Quality Standards for Drinking Water (PNSDW); (0.01 mg/L for Pb, 1.0mg/L for Cu; 0.05 mg/L for Cr;500.0 mg/L for TDS and 0-14 for pH).Water quality analyses were done using atomic absorption spectrophotometry (AAS) for Pb and Cu, respectively, photometric for Cr, gravimetric SMEWW 2540C for TDS and laboratory in situ for pH. The results of the analyses revealed that all water samples collected from the dormitories were far below the water quality than standards with reference to the parameters considered. Therefore, the water being used for domestic purposes such as for drinking, preparing food, bathing, washing clothes and dishes and brushing teeth is potable and safe.

Keywords: *ground water, heavy metals, water quality, potable*

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1. Introduction

Water is considered as one of the basic necessities of man. The groundwater resource is one of the common sources of water for agricultural and industrial purposes. Domestic water is water used for indoor and outdoor household purposes such as drinking, preparing food, bathing, and washing clothes and dishes, brushing teeth, watering the yard and garden. It is continuously recharged by runoff from precipitation and seepage from rivers and estuaries which go down the ground passing through the soil profile and eventually to the groundwater resource. Contamination of the resource is caused by natural and human induced activities. Once polluted, it is an extremely costly operation to remove the contaminant.

According to Tangahu et al., (2011),heavy metals are among the contaminants in the environment, including the groundwater system. Beside their natural occurrence, human induced activities have a potential contribution to produce side effects. Migration of these contaminants into non- contaminated areas as dust or leachates through the soil and spreading of heavy metals containing sewage sludge are a few examples of events contributing towards contamination of the ecosystems High concentration of heavy metals beyond the standards can cause biochemical effects such as inhibition of enzymes, genetic damage and hypertension (Fazil, et al., 2012). Likewise, biotoxic effects of heavy metals refer to the harmful effects to the body when consumed above the recommended limits. Although individual metals exhibit specific signs of their toxicity, the following have been reported as general signs associated with cadmium, lead, arsenic, mercury, zinc, copper and aluminium poisoning: gastrointestinal (GI) disorders, diarrheastomatitis, tremor, hemoglobinuria causing a rust–red colour to stool, ataxia, paralysis, vomiting and convulsion, depression, and pneumonia when volatile vapours and fumes are inhaled (McCluggage, 1991 and the findings was cited by (Verma1 and Dwived, 2013). A study conducted in Nigeria shows that the groundwater sources within 2 km radius of the Olusosun landfill in Ojota area are contaminated by heavy metals. This very large extent is associated with the dispersion of chemical constituents from leachates produced at the landfill (Oyeku and Eludoyin, 2010).Another completed study on hazards of heavy metal contamination on the groundwater around a municipal dump site in Lagos, Southwestern Nigeria showed that the influx of leachates through the water flow is gradually affecting the groundwater particularly that of lead, iron and cadmium that is extremely high. Inter-elemental analysis of the metals showed a strong and positive correlation with all the metals are from the same source which may be coming from the dumpsite and thus makes it of anthropogenic in origin (Laniyan, et al, 2011). In Cebu City, Philippines the results of the study conducted by Galarpea and Parillaa(2012)revealed that heavy metals in groundwater were found to be relatively lower compared to leachate (G<L) with higher concentrations of total Pb, Cd, and Cu.

Pb in groundwater originates from its dissolution from the soil and earth crust. Its particulate from the combustion of leaded gasoline, fossil and ore smelting can contaminate local surface water by surface runoff. Wide distribution of Pb from sedimentary rock and soils are reported at an average content of 10.0 ppm in soil usually found in upper ground soil, likewise from 7 to 12.5 ppm in sedimentary rock (Kinder, 2014).

Cu is a reddish metal with a face-centered cubic crystalline structure. It is a very common substance that occurs naturally in the environment and spreads through the environment through natural phenomena. Its use is mostly for electrical equipment (60%); construction, such as roofing and plumbing (20%); industrial machinery, such as heat exchangers (15%) and alloys (5% which could be potential sources of Cu in leachate and in adjacent groundwater when these materials are dumped in landfills. Its concentrations in drinking-water vary widely as a result of variations in water characteristics, such as pH, hardness and copper availability in the distribution system (NRC, 2000).

Cris a metallic element found in rocks, soils, plants, and animals. It is used in steel making, metal plating, leather tanning, corrosion inhibitors, paints, dyes, and wood preservatives. The most common forms of chromium in the environment are trivalent, hexavalent and the metal form (American Water Works Association, 2013). It can exist in oxidation states of +2 to +6. Soils and rocks may contain small amounts of it, almost always in the trivalent state (WHO, 2006).

TDS is a term used to describe the inorganic salts and small amounts of organic matter present in water. The principal constituents were usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogencarbonate, chloride, sulfate, and nitrate anion. It originates from natural sources, sewage, urban and agricultural run-off, and industrial wastewater (Guidelines for Drinking Water Quality, 1996).

The pH level of drinking water reflects how acidic or alkaline it was. It is measured on a scale from 0-14. Seven was neutral, indicating there was no acid or alkalinity present. A measurement below 7 indicates that acid is present and a measurement above 7 indicates alkalinity. The normal range for pH in ground water lies between 6 and 8.5. The major importance of determining the pH was to determine the corrosiveness of water. In general, the lower the pH, the higher the level of corrosion. (Guidelines for Drinking Water Quality, 1996).

There have been past studies conducted on water quality at the university, however, a specific one with reference of its heavy metal content was not yet fully explored. The drinking water of the university community comes from the groundwater system. A tube well was constructed long time ago and water is pumped by a motor through a series of pipes connected to a cemented reservoir. A brass piping system from the main tank distributes water to the dormitories, faculty residential houses, colleges and service centers/offices within the campus. Furthermore, the university is within the industrial zones of Laguna wherein these could be possible sources of leachates. With these, there is a need to determine if there is an accumulation of heavy metals within the groundwater resource which may cause contamination to the water use for domestic purposes, hence this study.

Generally the study determined the quality status of the water quality for domestic purposes at university dormitories. Specifically, it identified the level of lead, chromium,copper, total dissolved solid (TDS), and pH of the water at the dormitories through water quality analyses and compared the results of the analyses with standards set by Philippine National Standards for drinking water.

2. Materials and Methods

2.1 Study Site

Six dormitories and the main tank (Dahilig) at AUP were selected as study areas. The dormitories are strategically located inside the campus. The main tank stores 1817.0 m^3 water lifted through a piping system powered by a motor from the groundwater via a constructed tube well.

2.2. Water Sample Collection

The water samples were collected from each of the faucet of the study sites from 7:00 – 8:30 in the morning of January17, 2014. Six liters of water were collected by the first-draw method in which first drop of water was collected with atotal of 42 samples.These were placed inside an ice chest to preserve water quality and were submitted for heavy metal analyses to the Department of Science and Technology(DOST), Cavite Water and Wastewater Testing Laboratory, Trece Martirez, Cavite, Philippines.

2.3. Heavy Metals, Total Dissolved Solid and pH Analyses

Water quality analyses were conducted using atomic absorption spectrophotometer (AAS) for Pb and Cu, respectively, photometric for Cr, gravimetric SMEWW 2540C for TDS and laboratory in situ for pH. For pH analysis, water samples were collected 10:24 –11:36 in the morning of February 27, 2014. A 350ml bottle of water was collected from each site, placed inside an ice chest and transported to the AUP Chemistry Department laboratory for analysis. The procedure was conducted using vortex shaker for 30 seconds and Denver tap bench pH meter. Each sample was replicated 3 times and data were recorded.

2.4. Dissemination of Results

The results of the study were presented to the students, staff, and faculty members of the Biology Department during the Biology Major’s Forum. Dormitory residents were also informed by personally presenting the water quality analyses results in their respective dormitories through the dean. Likewise, the information was presented to the administrators and policy makers of the university.

3. Results and Discussion

3.1. Study Sites

The study was conducted in seven locations inside the university (Figure 1). The first was from the main water source which supplies all the water to the campus. The other samples were gathered from the six student dormitories, namely: Mahogany, Gumamela, Molave, Cadena, Sampaguita and Ilang-ilang.Theuniversity started operations in 1979 along with the construction of a water system. Atube well (m) with a cemented reservoir 14^0 12' 38.13" N 121^0 02' 08.51" E at 231 m elevation distributes ground water through brass pipelines to the dormitories, faculty houses, colleges and service centers of the university. The dispensed water is mainly used for domestic purposes such as drinking, cooking, bathing and laboratory procedures at the colleges.

Figure 1. The 7 sampling sites of the study

3.2. Collection of Water Sample for Heavy Metal Analyses

Water samples were gathered from 7:00 – 8:30 in the morning of January 17, 2014ateach sampling site. Six liters of water were collected from each site, that was a total of 42 samples.The samples were placed inside an ice chest to preserve water quality and was transported and submitted for heavy metal analyses by the Department of Science and Technology(DOST), Cavite Water and Wastewater Testing Laboratory, Trece Martirez, Cavite.

3.3. Heavy Metal Analyses

Table 1, Figure 2 and Figure 3 show the levels of Pb, Cu, Cr and TDS gathered from the seven sampling sites. Numerically, Molave and Acacia registered the highest Pb and Culevels followed by the other dormitories; however, this level was far below the standards for the parameters set by the PNSDW. All other parameters considered to exhibit very safe levels for domestic purposes.

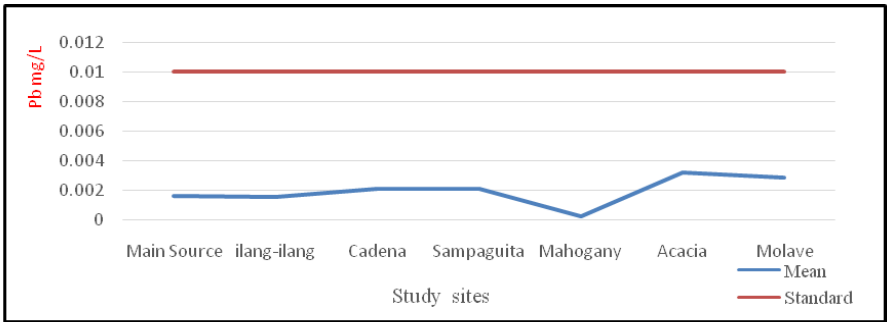

Figure 2. Lead concentration levels at the different study sites

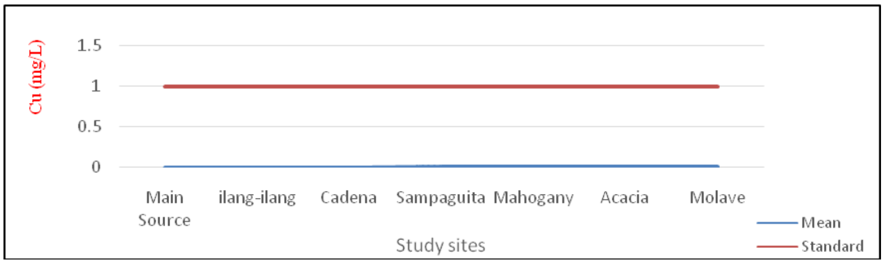

Figure 3. Copper concentration levels at the different study sites

Table 1. Water quality analyses result on lead, copper, chromium, and TDS of the 7 sampling sites

Sampling sites	Lead (mg/L)		Chromium (mg/L)		Copper (mg/L)		TDS (mg/L)	
	Mean	Standard	Mean	Standard	Mean	Standard	Mean	Standard
Main Source	0.002	**0.01**	<0.01	**0.05**	0.001	**1.00**	276.00	**500.00**
Ilang-ilang	0.002	**0.01**	<0.01	**0.05**	0.005	**1.00**	280.00	**500.00**
Cadena	0.002	**0.01**	<0.01	**0.05**	0.002	**1.00**	282.00	**500.00**
Sampaguita	0.002	**0.01**	<0.01	**0.05**	0.009	**1.00**	266.00	**500.00**
Mahogany	0.000	**0.01**	<0.01	**0.05**	0.010	**1.00**	268.00	**500.00**
Acacia	0.003	**0.01**	<0.01	**0.05**	0.008	**1.00**	264.00	**500.00**
Molave	0.003	**0.01**	<0.01	**0.05**	0.006	**1.00**	258.00	**500.00**

The excellent metal levels in the drinking water in the study areas indicated a safe groundwater system in the university. This may be attributed to the fact that the university maintains a balance ecological system, despite its proximity to the industrial zones of Laguna and Cavite where possible leachates or contaminants may originate.

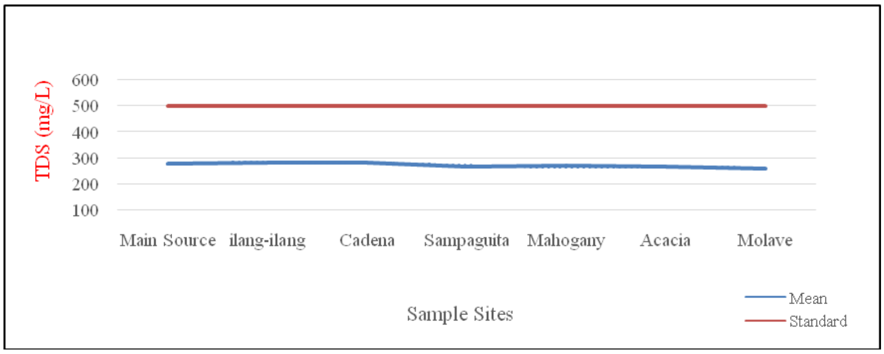

Figure 4. Total dissolved solid observed at the study sites

3.4. pH Levels

Table 2 and Figure 5 shows the pH levels of the collected water samples that were within the safe levels for drinking water. The average range for all samples is 6.9-7.0. Technically, water is naturally in neutral pH. Any water below 7 is considered acidic and above 7 is basic. A good pH for drinking water should be between 6.5 and 8.5 set by the Philippine National Standard for Drinking Water. Any pH level lower than 6.5 will be corrosive and higher than 8.5 alkali and will not only taste alkaline. pH levels above 12 like in bleach are dangerous if taken internally. All samples from study areas fall within safe level for drinking and for other domestic uses.

Table 2. pH levels of water samples gathered from the seven study sites

Sampling Site	Trial 1	Trial 2	Trial 3	Average	Standard
Main Tank	6.90	6.91	6.91	6.91	6.5-8.5
Ilang – Ilang	7.10	7.08	7.11	7.10	6.5-8.5
Cadena de Amor	7.05	7.10	7.12	7.09	6.5-8.5
Sampaguita	7.15	7.16	7.19	7.17	6.5-8.5
Molave	7.14	7.17	7.19	7.17	6.5-8.5
Acacia	6.93	7.02	7.11	7.06	6.5-8.5
Mahogany	6.97	7.08	7.23	7.09	6.5-8.5

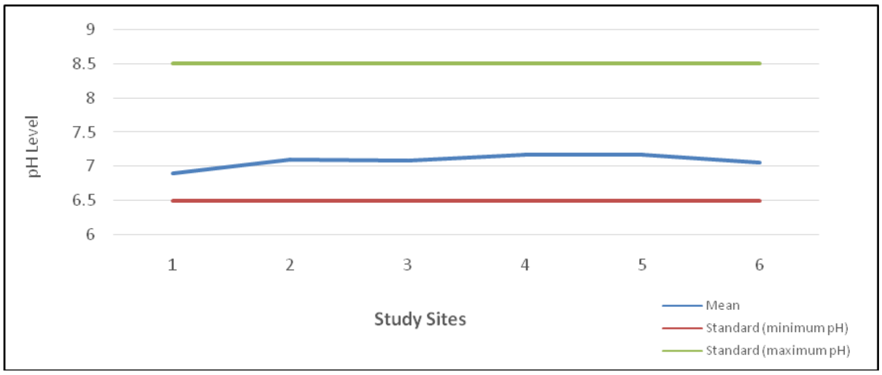

Figure 5. pH level of the different study sites

4. Conclusion

The results of the water analyses revealed that the drinking water supplied from ground water is far below the standards for water quality set by the Philippine Water Quality Standards. Further, the water is potable for human consumption with reference to the heavy metals investigated.

Specifically, all sampling sites are safe from the toxicity of lead, copper and chromium, TDS and pH.

Therefore, the groundwater system of the university is within the safe levels for drinking and for other domestic uses such as cooking, bathing and laboratory procedures that may need water.

5. Recommendations

Future research undertakings may focus on other types of heavy metals such as mercury, arsenic, and cadmium, likewise on other water quality indicators such as total organic compound (TOC), chemical oxygen demand (COD), and dissolved oxygen (DO). Bacteriological concentration analyses on *E. coli* and *S. aureus*, amoeba are also recommendatory for inclusion.

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