Assessment of Water Quality of Duya-Inn, Hinthada Township from the Aspect of Chemistry

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Abstract

This research work is about environmental studies on Duya-Inn in Hinthada Township, Ayeyarwady Region. The job of the villagers around the Inn depends on the environments of the Inn. A study on the aquatic organisms in water environment is one of the important subcomponents. Contaminated water can cause danger to the aquatic organisms. Proper Inn preparation is also essential for the survival of aquatic organism and water quality management. In this research, the water samples were collected from two layers, (1 foot depth and 9 feet depth from water surface in Duya-Inn). The position of the water collected from the sampling site was about 30 yards far from the shore of Duya-Inn behind the Duya market and these samples were collected by using sampling apparatus in May, August and December during 2017 and 2018. The physicochemical properties (pH, conductivity, temperature, DO, turbidity, total alkalinity, total hardness, nitrate nitrogen, total phosphate, COD and BOD) and elemental contents (Pb, As and Fe) were determined by using conventional methods and AAS method. These results were found not to exceed the harmful limits compared with EPA guideline values. But the arsenic content (0.02 to 2.42 ppb) was observed in this water sample. It can be polluted in this water. Moreover, the total coliform and fecal coliform contained within 3 to 20 CFU/100 mL counts by using 3M Petrifilm method. So water from Duya-Inn should be used for domestic and drinking purposes after being given any treatment. Nevertheless, fish and other aquatic life can survive in Duya-Inn and the villagers around the Inn should maintain the environmental system. It may support the commercial developments for the villagers around the Duya-Inn.

Keywords**:** Duya-Inn, physicochemical properties, conventional methods, modern technique, aquatic life, pollution, coliform and fecal coliform

INTRODUCTION

Water

Water is very essential for life and an invaluable resource to man and living things, essential for the sustenance of life on earth as exemplified by its diversified uses (drinking, cooking, washing, irrigation, farming, etc.). The quality of drinking water is a powerful and environmental determinant for health (WHO, 2010). Adequate supply of safe drinking water is universally recognized as a basic human need and one of the most essential factors of civilization. Due to the increasing numbers of population at the countryside, water is becoming inadequate and unsafe.

There are three main sources of water: surface water, ground water and rainwater. Surface water is found in lakes, rivers, and reservoirs. Ground water lies under the surface of the land, where it travels through and fills openings in the rocks. The rocks that store and transmit ground water are called aquifers. Rainwater is a relatively clean water source and with necessary causing it can be even used for portable consumptions. Importantly it is a free source

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and can be collected in a considerable quantity from roof catchments and other pavement areas which can be used for various purposes. Besides nonpoint sources are one of the important sources of water pollutions. It is known as diffuse or runoff pollution.

Water Pollution

Water pollution is a large of adverse effects upon water bodies (lakes, rivers, ocean, ground water) caused by human activities. Although natural phenomena such as volcanoes, storms, earthquakes etc. also cause major changes in water quality and the ecological status of water, these are not characteristics. Increases in nutrient loading may lead to eutrophication. Organic wastes such as sewage and farm waste impose high oxygen demands on the receiving water leading to oxygen depletion with potentially severe impacts on the whole ecosystem. Silt-bearing runoff from many activities including construction sites, forestry and farms can inhibit the penetration of sunlight through the water column restricting photosynthesis and causing blanketing of the lake or river bed which in turns damages the ecology (Ndang, 2013).

Eutrophication

Eutrophication is a process that results from accumulation of nutrients in water bodies of Inn. Furthermore, eutrophication is also a natural process, but it can be greatly accelerated by human activities that increase the rate at which nutrients enter the water. So, eutrophication is an increase in nutrients that can lead to overgrowth of algae. The overgrowth does not allow the plants to photosynthesize. If the plants do not photosynthesize, the levels of oxygen decrease possibly causing oxygen sensitive organisms to die. Water with extreme nutrient concentration is called "hypereutrophic". "Oligotrophic waters" are characterized by extremely low nutrient concentrations, resulting in moderate plant productivity (Fisher, 2006).

Water Quality Assessment

Water quality is determined by assessing three types of examinations: physical examinations, (temperature, pH, electrical conductivity) chemical examination (alkalinity, turbidity, total hardness, nitrate nitrogen, total phosphate, Dissolved oxygen (DO), biological oxygen demand (BOD), and microorganism examinations (coliform and fecal coliform). Physicochemical properties are important quality assessment of water (UNEP, 2004).

Coliform and Fecal Coliform

Microbiological water analysis is mainly based on the concept of fecal indicator bacteria. The main bacteria are present in human and animal feces and the most important fecal indicator bacteria are presented. Important sources of bacteria were to become fecal pollution of environmental water. Bacteria play an important role in the decomposition and cycling of a variety of compounds in freshwater aquatic environments, particularly nutrient-rich eutrophic water. Water pollution caused by fecal contamination is a serious problem due to the potential for contracting diseases from pathogens (disease causing organisms). Coliforms come from the same sources as pathogenic organisms. Coliforms are bacteria that are always present in the digestive tracts of animals, including humans, and are found in their wastes. They are also found in plant and soil material (Wilson, 2005).

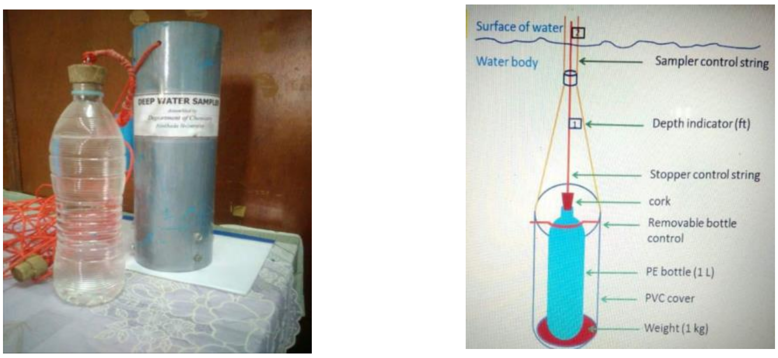
Toxic metals

Many trace elements are soluble to some extent in water. The excessive amounts of any metals may present health hazards because those metals are toxic at very low level. Many heavy metals occur naturally in the ecosystem, and some heavy metal (arsenic, cadmium, chromium, cobalt, gold iron, mercury, nickel, lead, etc.,) are important for the ecosystem. Heavy metals can enter a water supply by industrial, wastewaters by human activities, natural deposits, microbes and other several factors (Sengupta, 2002). Many metals at higher concentrations they can lead to poisoning however the other metals at very low concentrations can suffer serious effects. Among these metals, lead, arsenic and mercury are very important for aquatic life. So, these three metals were determined by the Atomic Absorption Spectroscopic technique (Mackay and Toose, 2004). Arsenic is the most important metal not only for drinking water but also for aquatic life. High levels of arsenic tend to be found more in ground water sources than in surface water sources (i.e., lakes and river) of drinking water. Many parts of the body may also be damaged by arsenic, including the skin, gut, lungs, heart blood vessels, immune system, urinary system, reproductive organs and the nervous system. Lead is also highly toxic to freshwater organisms and to humans if the water is used as drinking water. Lead reaches water bodies either through urban run-off or discharges such as sewage treatment plants and industrial plants.

MATERIALS AND METHODS

Sampling and Sample Site

The water samples were collected from Duya-Inn, Hinthada Township, Ayeyarwady Region. Duya-Inn is a natural lake and it is one of the oxbow lakes of Ayeyarwady River. The water samples for the determination of water qualities parameters were collected from 1 foot depth and 9 feet depth of surface water from Duya-Inn by using sampling apparatus. This site is located behind the Duya market. Physical, chemical and microorganism examinations for collected water samples were performed by using conventional methods, modern technique and 3M Petrifilm methods.



(a) (b)

Figure (1) Photograph of sampling apparatus (a) deep water sampler (b) deep water sampler and its specifications

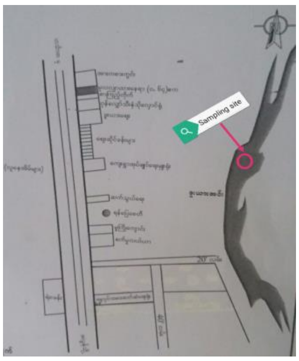


Figure (2) Local map for sample collecting site of water sample from two layers of Duya-Inn

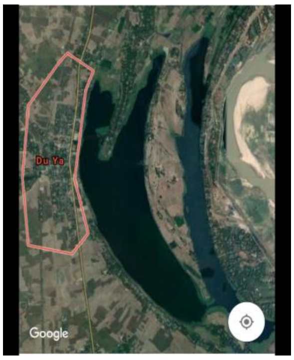


Figure (3) Google map of Duya-Inn and villages of Duya
The area shown in pink cycle is villages of Duya

Figure (4) Photographs of water collection in Duya - Inn

Methods

The water qualities parameters; pH, temperature, conductivity and DO were measured in the field by using digital oxygen meter (model YSI 50, Portable type, YSI Co., Japan) after adjusting with pH 4.0, 7.0 and 9.0 buffer solution. Nephelometric turbidity meter was used for the measurement of water turbidity. Total alkalinity, total hardness and COD were determined by using titrimetric method. The Nitrate nitrogen and total phosphate were measured by using Shimadzu UV-240 UV-visible spectrophotometer (Japan) at wavelength 640 nm. The BOD content was determined by the difference between the initial DO content and DO after 5 days incubation of the water samples that were filled into glass bottles without bubbling. Elemental contents (Pb, As and Fe) in water samples were determined by using Atomic Absorption Spectrophotometer (Perkin Elmer AA analyst 800). The microorganism examination (coliform and fecal coliform) was performed by using 3M Petrifilm method.

RESULTS AND DISCUSSION

Evaluation on Quality of Water in Duya-Inn Seasonally During 2017-2018

The evaluation of water quality parameters in Duya-Inn were done from May 2017 to December 2018. The sampling sites of water sample were divided into two parts, viz, a depth of 1 foot (upper layer) and a depth of 9 feet (lower layer) from the water surface. The positions of sampling sites were also recorded about 30-yard-distance from the shore of Duya-Inn behind the Duya market and the study periods were selected based on seasonally and annually.

In this work, the pH, temperature and dissolved oxygen (DO) were determined in field immediately after the collection of water samples from two layers.The observed pH values (7.7 to 8.3) for water samples from two layers were slightly basic during the study period (2017 and 2018). It was within the range of EPA standard guideline. So, the climate change did not affect that water.

According to the data, water samples from the two layers were found to be in the range from 100 to 123 μS/cm because of its low conductivity values for cold climate in December (*cf.*Table1 and 2). It was also possible that the value of conductivity varied with heavy rain falls and high water level of Inn in May during the study period.

The turbidity values did not exceed the EPA guideline value. So, the sunlight was able to penetrate the water surface and photosynthesis can occur.

The alkalinity values were higher in May during the study period. Higher alkalinity values can resist the changes of flood and season. Furthermore, the high alkalinity can also protect against pH changes for aquatic life.

The water hardness values were soft (*cf.* Table 1 and 2). But, the taste of soft water is salty and sometimes it is not suitable for drinking. So, water from Duya-Inn may contain only sodium ion. The DO values were within the acceptable guideline value (6.2 to 10 ppm). The measured value was around 5.0 ppm which indicates that the environment is not polluted.

The nitrate nitrogen contents for collected water samples in Duya-Inn agreed with the range of mesotrophic. In this range, the nutrients and sediment begin to accumulate that it is enable to increase the populations of aquatic life appearance. So, it may be good quality water for the survival of the fish and aquatic lives.

As an environmental impact for this Inn, the rainfall can cause varying amounts of phosphates and the rain waterways carry the agricultural waste and animal waste from the farm land into the nearby Duya-Inn. Nevertheless, the total phosphate was within the EPA guideline. So, it may also suitable for fish and aquatic life.

The COD results were higher than the WHO drinking water recommended values (23 ppm) but lower than the EPA standard values. It may be due to the flooding, which can cause the flowing of the chemical residues of pesticides and fertilizers into the inn from the paddy fields around the Duya-Inn. So, it can be assumed that it is not suitable for drinking.

The BOD contents were in the range of 10-12 ppm (*cf*. Table 1 and 2). In addition, a high BOD level (6-9 ppm) indicates polluted water. So, this water may be remarked somewhat polluted because these are usually organic matter present and bacteria are decomposing the waste.

Table (1) Physicochemical Parameters of Collected Water Samples from Duya-Inn in 2017

No.	Physicochemical parameters	May		August		December		*Standard EPA values
		upper	lower	upper	lower	upper	lower	
1	pH	7.7	7.9	8.1	8.1	8.3	8.3	6.5-8.5
2	Temperature (˚C)	25	25	25	25	22	20	-
3	DO (ppm)	6.6	6.4	6.8	6.2	7.2	7.4	0-18
4	Conductivity (μS/cm)	144	123	125	123	110	100	213-316
5	Turbidity (NTU)	22	32	38	30	20	28	<50
6	Total alkalinity(ppm)	64	62	52	54	59	60	40-150
7	Total hardness(ppm)	54	60	50	60	52	60	90-100
8	Nitrate nitrogen (ppm)	0.8	0.9	0.4	0.5	1.1	1.2	10
9	Total phosphate(ppm)	0.04	0.03	0.06	0.05	0.04	0.03	0.03-0.15
10	COD (ppm)	32	32	32	32	35	35	<40
11	BOD (ppm)	10	12	10	12	8.89	10.1	<15

* Standard EPA = Environmental Protection Agency values (2011)

DO = Dissolved Oxygen NTU = Nephelometric Turbidity Unit

COD = Chemical Oxygen Demand Upper = 1 foot depth from water surface of Duya-Inn

BOD = Biological Oxygen Demand Lower = 9 feet depth from water surface of Duya-Inn

Table (2) Physicochemical Parameters of Collected Water Samples from Duya-Inn in 2018

No.	Physicochemical parameters	May		August		December		*Standard EPA values
		upper	lower	upper	lower	upper	lower	
1	pH	7.8	7.9	8.1	8.1	8.0	8.3	6.5-8.5
2	Temperature (˚C)	25	25	25	25	23	21	-
3	DO (ppm)	6.5	6.4	7.2	6.2	7.9	8.1	0-18
4	Conductivity (µS/cm)	154	131	138	134	123	113	213-316
5	Turbidity (NTU)	23	25	40	25	22	28	<50
6	Total alkalinity (ppm)	64	60	50	54	60	62	40-150
7	Total hardness (ppm)	54	60	50	59	52	59	90-100
8	Nitrate nitrogen (ppm)	1.1	1.2	2.1	2.5	2.1	2.2	10
9	Total phosphate (ppm)	0.04	0.05	0.09	0.06	0.07	0.05	0.03-0.15
10	COD (ppm)	32	32	33	34	36	36	<40
11	BOD (ppm)	10	13	11	12	10	11	<50

* Standard EPA value = Environmental Protection Agency values (2011)

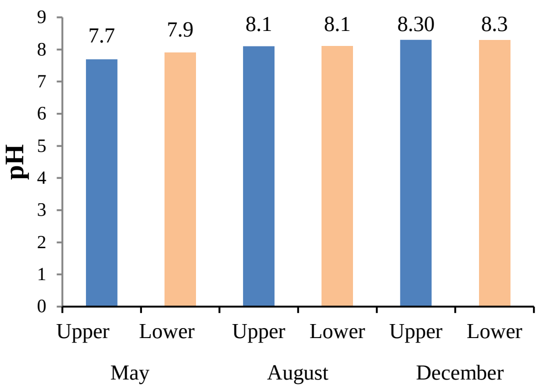


Figure (5) Histogram of pH values in water samples of Duya-Inn in 2017

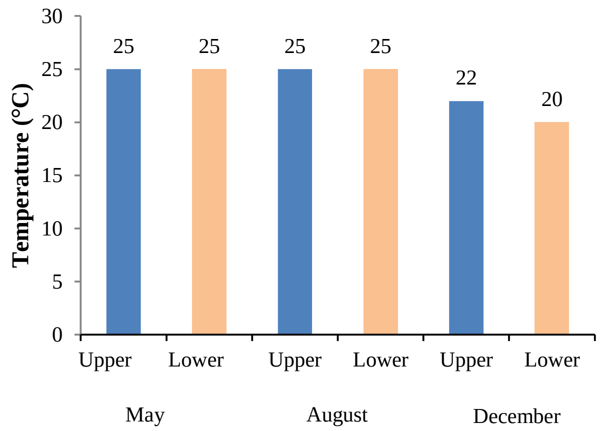


Figure (6) Histogram of temperature values in water samples of Duya-Inn in 2017

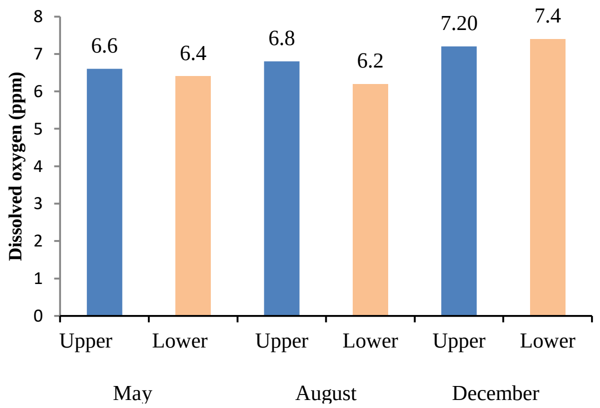


Figure (7) Histogram of dissolved oxygen values in water samples of Duya-Inn in 2017

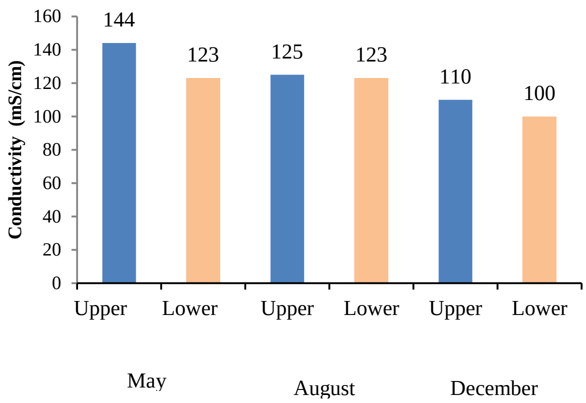


Figure (8) Histogram of conductivity values in water sample sof Duya-Inn in 2017

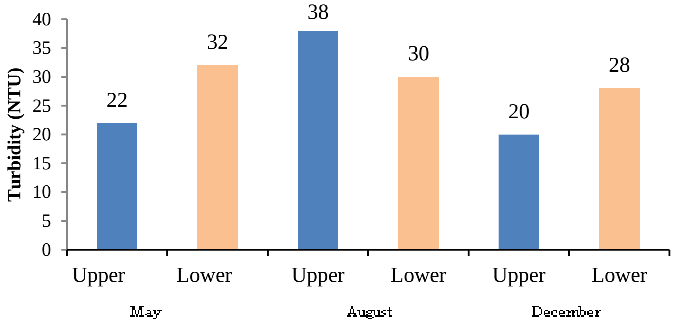


Figure (9) Histogram of turbidity values in water samples of Duya-Inn in 2017

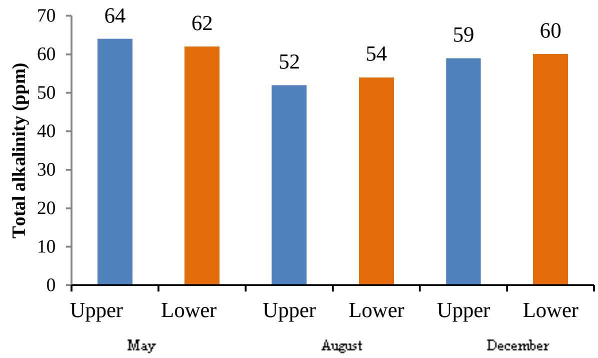


Figure (10) Histogram of total alkalinity values in water samples of Duya-Inn in 2017

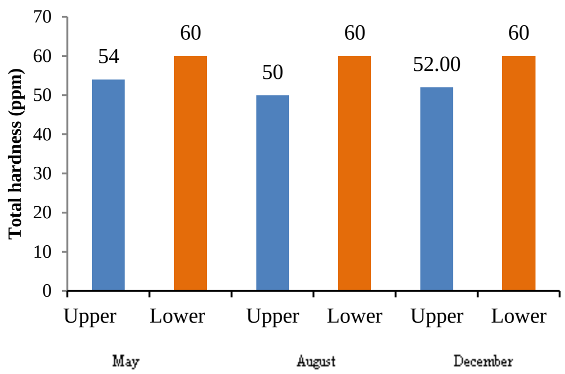


Figure (11) Histogram of total hardness values in water samples of Duya-Inn in 2017

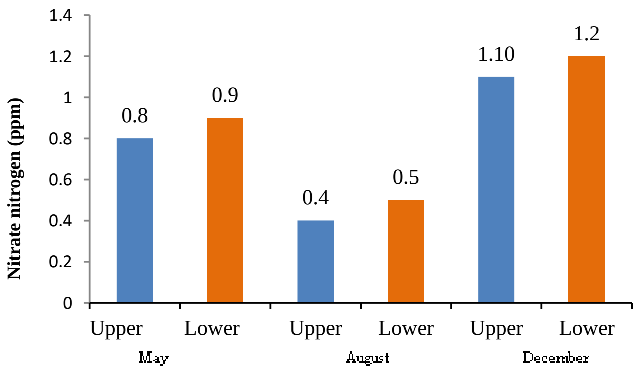


Figure (12) Histogram of nitrate nitrogen values in water samples of Duya-Innin 2017

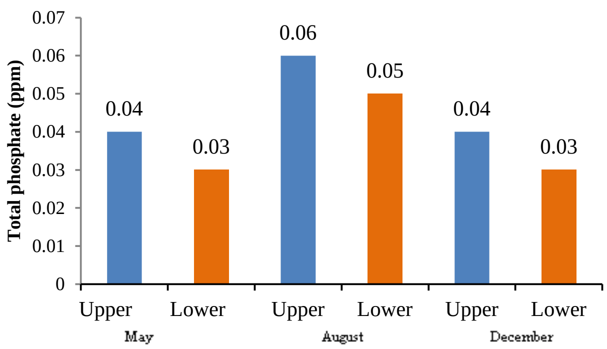


Figure (13) Histogram of total phosphate values in water samples of Duya-Inn in 2017

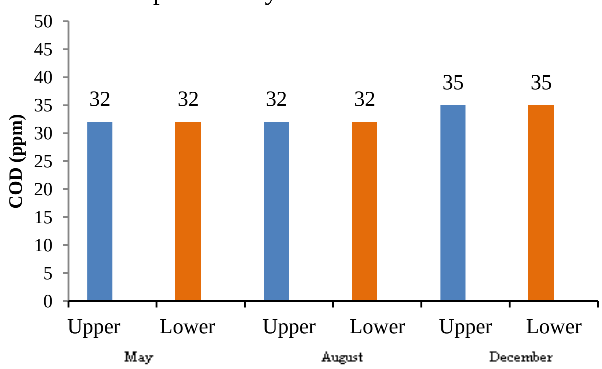


Figure (14) Histogram of chemical oxygen demand (COD) values in water samples of Duya-Inn in 2017

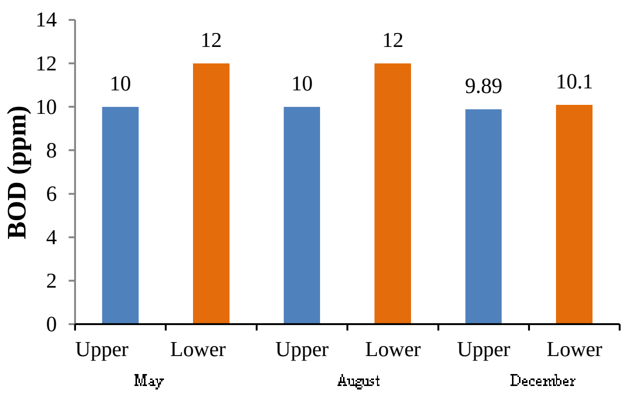


Figure (15) Histogram of biological oxygen demand (BOD) values in water samples of Duya-Inn in 2017

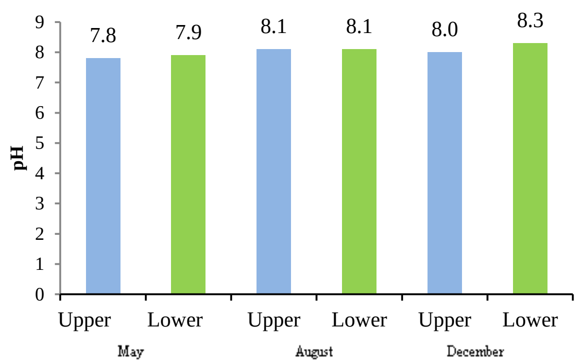


Figure (16) Histogram of pH values in water samples of Duya-Inn

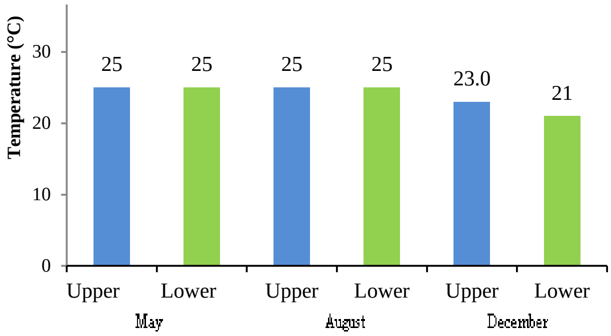


Figure (17) Histogram of temperature values in water samples of Duya-Inn in 2018

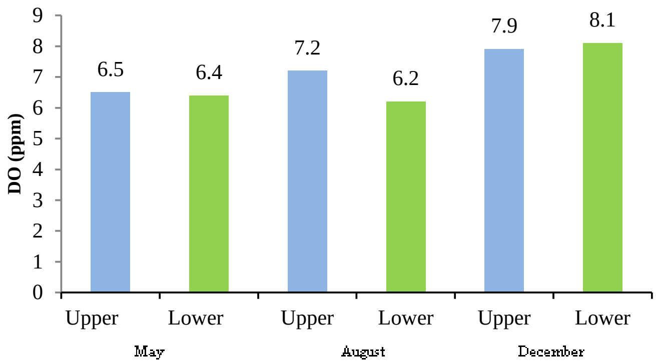


Figure (18) Histogram of dissolved oxygen (DO) values in water samples of Duya-Inn

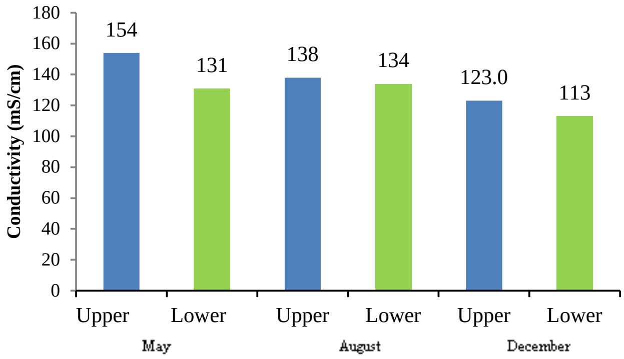


Figure (19) Histogram of conductivity values in water samples of Duya-Inn in 2018

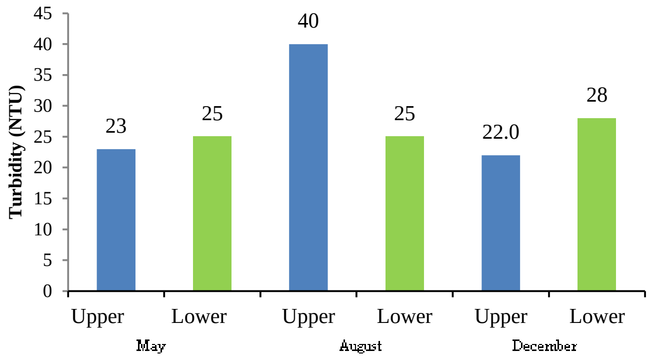


Figure (20) Histogram of turbidity values in water samples of Duya-Inn in 2018

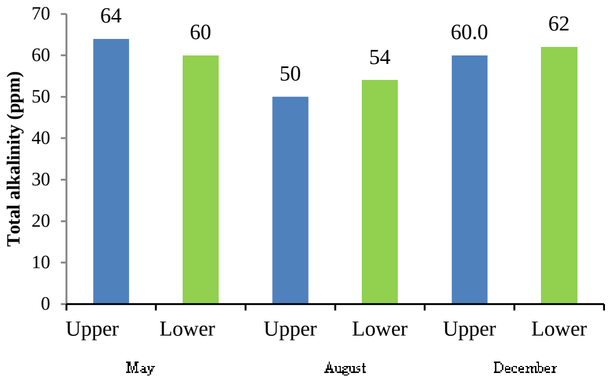


Figure (21) Histogram of total alkalinity values in water samples of Duya-Inn in 2018

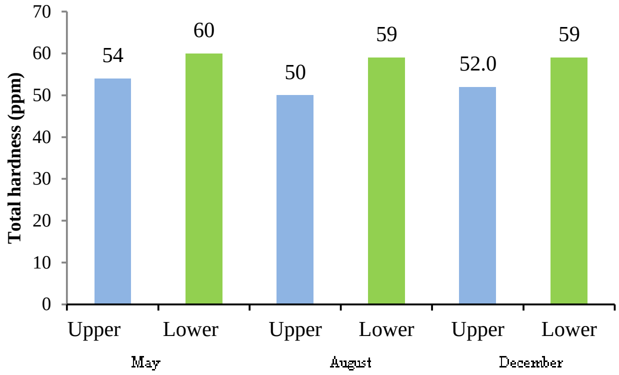


Figure (22) Histogram of total hardness values in water samplesof Duya-Inn in 2018

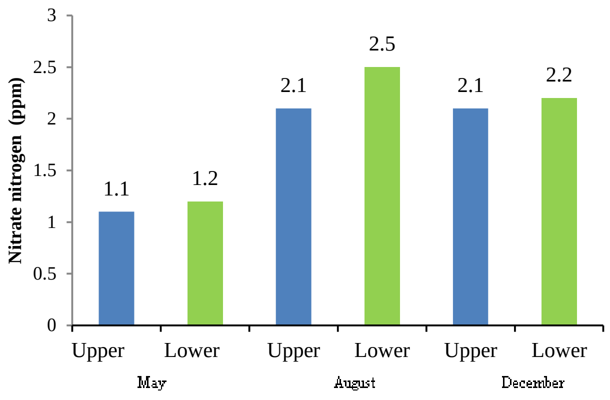


Figure (23) Histogram of nitrate nitrogen values in water samples of Duya-Inn in 2018

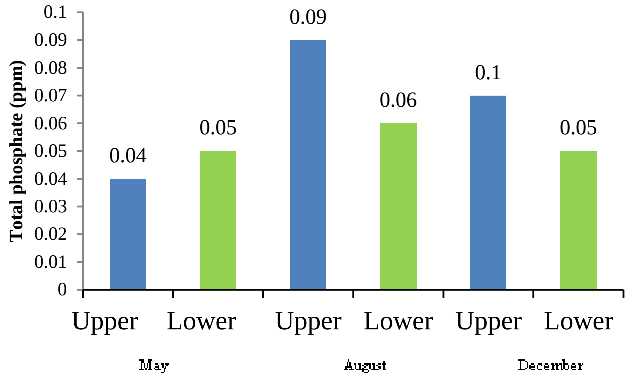


Figure (24) Histogram of total phosphate values in water samples of Duya-Inn in 2018

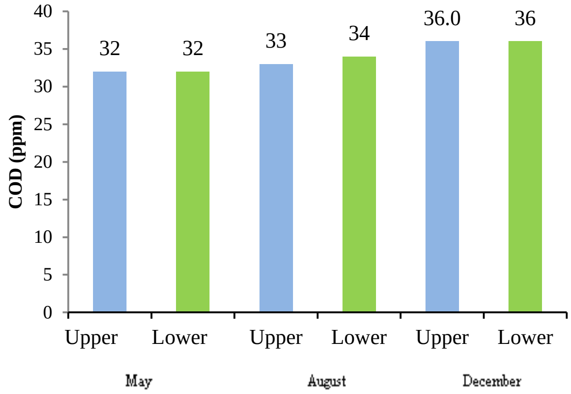


Figure (25) Histogram of chemical oxygen demand (COD) values in water samples of Duya-Inn in 2018

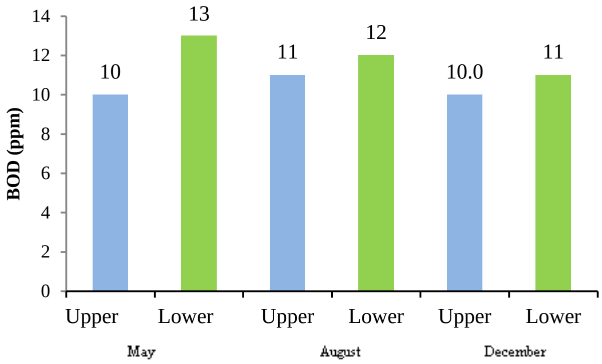


Figure (26) Histogram of biological oxygen demand (BOD) values in water samples of Duya-Inn in 2018

Toxic metals

The arsenic contaminations were free in both collected water samples in May and August, 2017 but it was observed in December, 2017. Furthermore, in 2018, the arsenic contents were also detected in August and December. So, the arsenic contaminations should be removed or reduced for drinking and domestic purposes.

Even though the lead did not contain, iron content was acceptable level in guideline value of EPA (*cf.* Table 3 and 4). It may be the geographical nature of the sampling site.

Table (3) Elemental Concentration in Collected Water Samples by AAS Method in 2017

No.	Element	May		August		December		*Standard EPA values
		upper	lower	upper	lower	upper	lower	
1	Pb (ppm)	ND	ND	ND	ND	ND	ND	0.01 ppm
2	As (ppb)	ND	ND	ND	ND	2.02	2.24	50 ppb
3	Fe (ppm)	0.55	0.59	0.38	0.35	0.53	0.56	0.30 ppm

* Standard EPA = Environmental Protection Agency values (2011)

ND = non-detection

Table (4) Elemental Concentration in Collected Water Samples byAAS Method in 2018

No.	Element	May		August		December		*Standard EPA values
		upper	lower	upper	lower	upper	lower	
1	Pb (ppm)	ND	ND	ND	ND	ND	ND	0.01 ppm
2	As (ppb)	ND	0.55	0.02	0.65	1.03	2.42	50 ppb
3	Fe (ppm)	0.86	1.57	0.58	0.62	0.92	2.67	0.30 ppm

* Standard EPA value = Environmental Protection Agency values (2011)

ND = non-detection

Total coliform and fecal coliform

The total coliform and fecal coliform counts were found to be 3-20 CFU/100mL during the study period because this Duya-Inn is situated about 100 ft away from toilets used in markets and villages. Therefore, this Inn may be also biologically polluted (*cf.*Table 5 and 6).

Table (5) Mean Values of Coliform and Fecal Coliform in Collected Water Samples in 2017

No.	Microbial property (CFU/ 100mL)	May		August		December		*Standard EPA values
		upper	lower	upper	lower	upper	lower	
1	Coliform count	10	12	20	18	9	10	ND
2	Fecal coliform count	3	4	10	8	2	3	ND

* Standard UNEP Value = United Nations Environmental Programme

CFU = Colony Forming Unit

ND = non-detection

Table (6) Mean Values of Coliform and Fecal Coliform in Collected Water Samples in 2018

No.	Microbial property (CFU/ 100mL)	May		August		December		*Standard EPA values
		upper	lower	upper	lower	upper	lower	
1	Coliform count	10	13	15	20	9	10	Not detected
2	Fecal coliform count	13	5	10	9	2	3	Not detected

* Standard UNEP Value = United Nations Environmental Programme

CFU = Colony Forming Unit

CONCLUSION

Physicochemical properties, elemental analysis and microorganism examination of Duya-Inn water were studied seasonally in 2017 and 2018. Temperature, pH, conductivity, turbidity, alkalinity and water hardness values were in agreement with EPA guideline values. DO, BOD and COD values were also further given credence to the quality of water and indicated the medium condition of organic residue presence. The nitrate nitrogen contents and total phosphate contents were within the guideline values of good water quality.

As the toxic metals for the water samples collected from two layers in Duya-Inn, it contains a little amount of arsenic contaminations that are not enable to cause the harmful effect. Containing the iron can cause a metallic taste and it is unpleasant to drink. When vegetables and other foods are cooked in such water, they blacken and absorb a bad taste.

Furthermore, the total coliform and fecal coliform counts of these water samples were found. So, Duya-Inn water should not be used without being given any treatment for domestic and drinking purposes. Although water in Duya-Inn is slightly polluted, the fish and other aquatic lives can survive in it.

Finally, it can be summarized that water in Duya-Inn is of good quality and agrees with guideline values during study period in 2017 and 2018. According to the quality parameters, the people surrounding the Duya-Inn should do the maintenance. So, the water in Duya-Inn surely becomes safe to drink and it can be used as the good quality water for the domestic and drinking purposes. Moreover, the fish and aquatic life become increased and may support the local consumers.

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