QUALITY ASSESSMENT AND TREATMENT OF DOKHTAWADDY (MYITNGE) RIVER WATER NEAR MANDALAY ENVIRONS

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Abstract

Myanmar has a favorable situation of fresh water resources and adverse environmental effects degrade the strength of river water quality when utilizing natural resources. Measurements of aquatic biota in terms of water quality parameters have been essential for the assessment of river health. Some anthropogenic activities have a potentially negative cumulative impact on rivers and wetlands water quantity and quality, hence negatively impacting river-dependent people. This research will be emphasized on the evaluation of quality of Dokhtawaddy (Myitnge) river water near Mandalay Region. For this purpose, Dokhtawaddy river water samples were selected from four different points [the upstream (near Ta-Lin-Gyi village and near Shwesaryan Pagoda) and downstream (near Myitnge Bridge) places of Mandalay Industrial Sewage Ditch] in the middle of Dokhtawaddy (Myitnge) river near Mandalay environs. River water samples were collected seasonally (January, April, July and November during 2019 -2020). To evaluate the river water quality, its physico-chemical characteristics such as pH, color, conductivity, turbidity, total alkalinity, total hardness, calcium hardness, chemical oxygen demand (COD), biochemical oxygen demand (BOD) and traces of minerals like chloride, iron, manganese, sulfate, arsenic, copper, cyanide and lead were determined. In addition, its biological characteristics in terms of probable coliform count and *Escherichia coli* count (*E.coli*) were also examined. To reduce the contaminants, conventional water treatment methods such as plain sedimentation, filtration through the medium consisting of sand, gravel, broken bricks, rice straw, cotton fiber, rice husk char and charcoal. It was then again filtered with secondary filtration using sand column and rice husk char column. Effort of these stepwise treatment processes clearly shows that traces of contaminated ions, BOD and COD values were reduced within the desirable values. Benefits of this research would be helpful for the knowledge of simple water treatment technology in rural communities along the river bank of Dokhtawaddy (Myitnge) near Mandalay environs.

Keywords: Dokhtawaddy river**,** water quality, treatment technology, contaminant ions, filtration

Introduction

Some of the anthropogenic activities, the developments of industry, agricultural production and ever intensive urbanization have led to the pollution of natural flow regime of water bodies. The discharging of degradable wastewater in natural water bodies result to deteriorate the river water quality generally and difficult to meet satisfactory situation becomes growing.

Myitnge river, one of the surface water resources in Upper Myanmar, plays an important role in transportation, agriculture, domestic and industrial purposes. It is one of the largest tributaries on left bank of Ayeyarwady river and it originates from Mount Loi Swang at an elevation of 1460 m on the northern Shan Plateau and joins the Ayeyarwady river about 15 km southwest of Mandalay. River basin area is 34800 km^2 and it covers from Mandalay division near the confluence of the Ayeyarwady river to the north-west part of the Shan state. The river flows in a generated direction of north-east to south-west. It longs about 530 km and its tributaries are Zawgyi, Panlaung and Nantalan rivers. The Mytinge river basin covers the northwest part of the Shan state and its location is approximately between the latitude 20 51' to 23 48' N and the longitude 96 23' to 98 22' E (Su Su Hlaing *et al*, 2019).

On the other hand, water quality assessment is the process of overall evaluation of the physical, chemical and biological nature of the water. The quality of surface water is affected by the hydrochemical changes that are indicative of the climate and environment changes such as

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increased precipitation, evaporation, domestic and industrial activities, agriculture and breeding, human and animal consumption (Zhang *et al*., 2019).

However, an altered flow regime related to hydropower production along the Myitnge river could be threatening critical processes downstream in the Myitnge river and the receiving Ayeyarwady river. Hydropower projects can disrupt the natural flows and freshwater ecosystem. The magnitude, frequency, duration, and timing of flow regime and their sediments can be changed due to dam operation (Su Su Hlaing *et al*, 2019).

Recently, pollution has become a serious concern for human life due to the industrial burst in the world and the rivers are the main choices to hold and bear the responsibility of pollutants, especially in the developing countries (Ebrahimi *et al*.,2015). To supply the enough clean water for the demand of upper tropical regions in Myanmar, the pollutants from the river water must be reduced to the acceptable quality. The aim of this study is to evaluate Dokhtawaddy (Myitnge) river water quality to meet the supply of enough clean and safe water for the demand of domestic and irrigation water uses of upper tropical regions.

- To analyze the quality of Myitnge river water (i.e., physicochemical and biological characteristics).
- To remove the undesirable contaminants from river water for clean and safe purpose
- To find the effective surface water treatments for contributing the rural community in Mandalay environs.

Materials and Methods

Sample Collection

Dokhtawaddy (Myitnge) river water has been used by the local people who live in villages near the river bank for domestic purposes. In this research, Dokhtawaddy (Myitnge) river water sample was collected from selected four different sampling points from the upstream (points A and B) and downstream (points C and D) places of Mandalay Industrial Sewage Ditch for evaluating water quality. The selected sampling sites are marked as Point A (near Ta-Lin-Gyi village, 22º 00' 09“ N and 96º 04' 02" E), Point B (near Shwesaryan Pagoda, 21º 50' 17" N and 96º 12' 50" E), Point C (upstream of Myitnge Bridge, 21º 50' 33" N and 96º 04' 03" E) and Point D (downstream of Myitnge Bridge, 21º 50' 40" and 96º 04' 09" E) located in Myitnge Township, Mandalay Region. The water quality parameters were determined by quarterly in a year from January, 2019 to October, 2020 and water samples were collected by 2 feet deep and 20 feet apart from the river bank. The clear sampling plastic bottles of (1) liter capacity each were rinsed three times with river water, filled and screwed tightly with caps. The samples were onsite tested at the river bank around sampling sites.

The physicochemical characteristics of collected water samples from the above sources were evaluated and the results are shown in Tables (1) to (4). The location of four sampling sites is shown in Figure (1).

Analysis of Collected Water Samples

The collected water sample from the selected points of Points A, B, C and D were analyzed quarterly in a year (January, April, July and October) by their physical, chemical and biological parameters. Those properties of water quality parameters such as pH was measured by pen-type pH meter (pH-2016), turbidity by Lovibond Turbicheck Water Testing Turbidimeter (Model SN13/45043), GMBH, Germany, color by using Lovibond Tintometer, conductivity by Milwaukee Portable Conductivity and TDS meter (Model SM 301 EC meter). The amount of total alkalinity, total hardness, calcium hardness, magnesium hardness, some minerals ions such as chloride, iron, manganese, sulphate, arsenic, copper, cyanide and lead present in collected water sample were determined by exact Micro 20 + Spectrophotometer with blue tooth SMART only, 525 nm + 638 nm wavelength (S/N: M 20 BTA 00009 HACH test kit).

Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were determined by HACH Sension 378 HANNA HI 839800 COD Reactor. Microbiological characteristics of collected river water before and after treatment such as total coliforms and *E.coli* were determined by agar plate method.

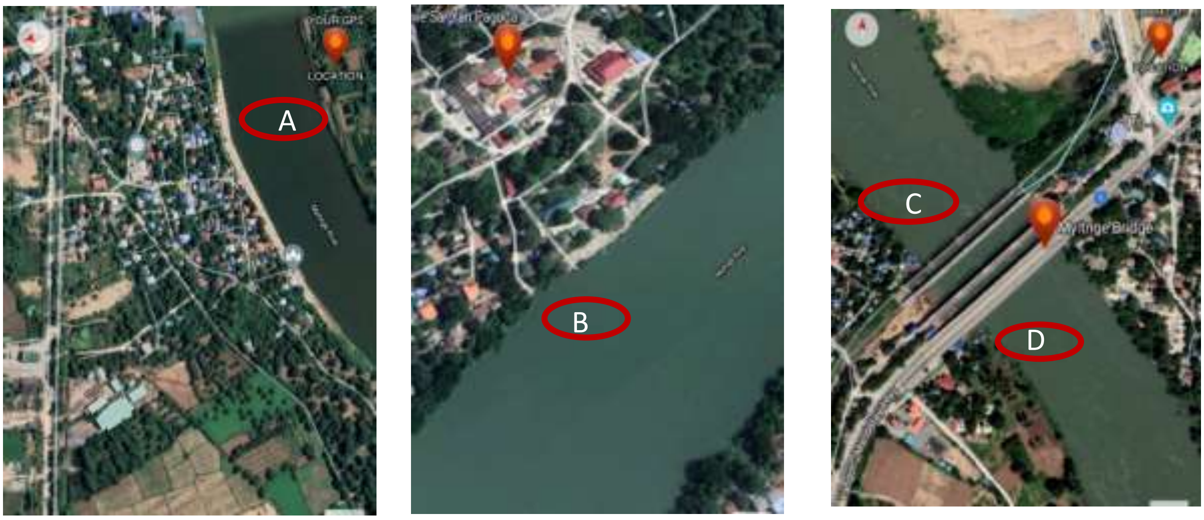

Figure (1) Sampling Sites of Dokhtawaddy (Myitnge) River at Point (A) near Ta-Lin-Gyi Village, Point (B) near Shwesaryan Pagoda and Points (C and D) near Myitnge Bridge

Treatment of River Water Sample

Preparation of Filter Media for Water Treatment

Sand, gravel and broken bricks used as filter media in a filter column were purchased from 'Tharaphu' Construction Shop, (73) Street, near Mandalay University Campus, Mahar-Aung Myae Township. Before using, sand was washed eight times with water to remove adhering dust and impurities. It was dried under sunlight in a clean dry place and then 3000 g were weighed. Uniform sizes of about 0.2 inches diameter of gravels were washed five times with water, dried under sunlight and then 1500 g were weighed. Bricks were crushed into uniform size of about 0.3 inches diameter, washed five times with water to remove coloring impurities, dried and then 1500 g were weighed. Charcoal and rice husk char were purchased from Phayar Gyi Market, Chan-Aye-Thar-Zan Township. Charcoal was crushed into uniform size of about 0.2 inches diameter, washed five times with water, sun dried and then 1000g were weighed. Rice Husk Char was washed five times with water, drained, dried under sunlight at clean place, and then 1000 g were weighed.

Straw was obtained from Pathein-Gyi Township, Mandalay. It was thoroughly washed with water to remove soil residue and boiled in water at 100 ºC for three hours and then drained, sun dried in a clean place. About 100 g of this dried straw was weighed.

Cotton fabric used for the separation of each filter media was boiled with water at 100˚C for 2 hours and then washed with water. After washing, the cotton fabric was dried under sunlight. The Figures of prepared filtered media were shown in Figure (2).

Experimental Procedure for Water Treatment Process

The experimental water treatment includes plain sedimentation and a follow up aeration, primary filtration and secondary filtration. These sequences of treatment were conducted from water sample of Point (D) during October, 2020. The sequences of groundwater treatment processes were carried out and described below.

Aeration

Water sample after 24 hours plain sedimentation was aerated by air diffuser [model RS-9800 (Aquarium3 in 1) from Zhongshan Electrical Product, China] under sunlight for about 12 hours. The contact time of air and water support the effective removal of unwanted gases.

Primary Filtration Column

River water sample after plain sedimentation was passed through a filter column. A glass column of 6 inches square and 25 inches in height was used as filter column. Each of 4-inches thick layers of rice straw, broken bricks, gravel, sand and charcoal [Figure (2)] were used as filter media and this media were separated by cotton fiber [Figure (3)]. The column was connected by inlet and outlet pipes and the influent was allowed to flow down by gravity. The physicochemical characteristics of filtrate were analyzed and the results are recorded in Table (5).

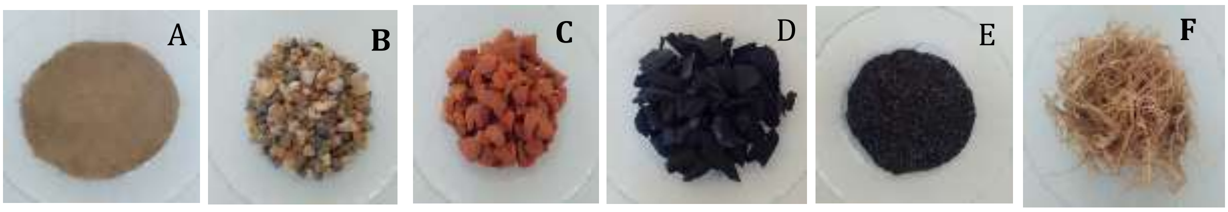

Figure (2) Filter Media (A) Sand (B) Gravel (C) Broken Bricks (D) Charcoal (E) Rice Husk Char and (F) Straw

Secondary Filtration

After treatment with the biofilter column, the filtrate was passed through secondary filter columns. Some colloidal matter was removed by filtration through the cylindrical-shaped sand filter column filled with 12 cm height sand medium [Figure (4)]. It was then passed through rice husk char column to again filtered. After filtering the water through the two columns, the filtered water was collected in sterilized plastic bottle, screw capped, placed in an ice box and taken to the laboratory within 3 hrs for analyzing the quality of treated water.

Figure (3) Primary Filtration Column

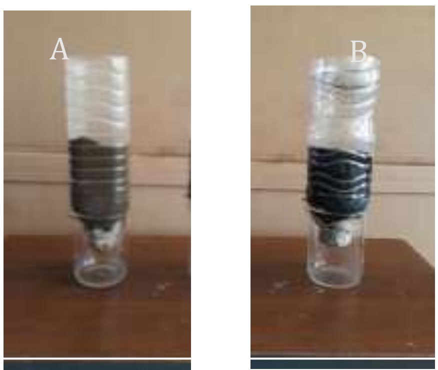

Figure (4) Secondary Filtration (A) Sand Filter (B) Rice Husk Char Filter Columns

Results and Discussion

Myanmar has an abundance of natural water resources, which are distributed unevenly spatially and temporally. Myitnge river rises on the Ayeyrawaddy-Salween watershed, flows westwards through northern Shan Plateau and eventually enters into the Ayeyarwady near

Mandalay (https://en.wikipedia.org/wiki/myitnge_River). **In most of the parts of Upper Myanmar,** groundwater as well as surface water quality varies seasonally according to the result of climate change and global warming. Due to the northern margins of dry zone, most of the dwellers in poor peri-urban area of Mandalay experienced water crisis problems during warm season.

Some of anthropogenic pressures such as river infrastructure and significant issues of water contamination as a result of urbanization, population expansion, the creation of special economic zones, extension of industrial sectors, agriculture and power generation are currently challenging the health of surface water bodies. The surface water quality in a particular region has varies from one season to another according to the result of rainfall, the source and the conditions of flow regimes, ecosystem and environment from which it is drawn (Bheemappa, 2015).

The water resource availability is strongly influence by climate change and the need to implement the demand of enough water is vital to the rural communities of Upper tropical region. One of the surface water resources like Myitnge river water near Mandalay city was necessary to analyzed for the purpose of potable as well as domestic uses of dwellers. For this purpose, physicochemical and biological characteristics of Myitnge river water were analyzed quarterly during the years of 2019 and 2020. According to the results shown in Tables (1) to (4), it is obvious that pH values were around 7 from the four sampling points during the sampling times. The turbidity value of river water at points A and B are within the desirable value of 5 NTU (**WHO, 2013**) except in July 2019 and 2020 because the rough flow of lower water level in river, mixed with a large proportional amount of erosive soil during the rainy season. Points C and D was above the desirable values all sampling times due to residue of some contaminants from the downstream of sewage Ditch [Figure (5)].

The reported values of one of the important chemical characteristics of thermal conductivity from all sampling locations were significantly higher than desirable values of 50 μS/cm ((https://en.wikipedia.org/wiki/Conductivity_(electrolytic)). The values of thermal conductivity not only related to the concentration of dissolved ions in water but the ions electrically remain neutral in water. **The conductivity value is more significant in rainy season of July 2019 and 2020.** Another characteristic likes total alkalinity value of river water in points A and B were lower than the maximum allowable values but points C and D were slightly higher than the desirable values in all investigating time as shown in Tables (1) to (4).

The total alkalinity of water is usually caused by the presence of carbonates, bicarbonates, hydroxides and less frequency by borates, silicates, and phosphates ions. Because of all the dissolved ions in the flow of river water were not only basic, but also some are acidic due to the pesticide residues from the growing areas and effluents near the sewage Ditch from northern part of Mandalay region. The wastes from other urban sewage materials can enter into streams and affect the alkalinity of natural water bodies.

The other important characteristic such as total hardness and calcium hardness were significantly higher than the desirable values in all locations but magnesium hardness was considerably lower than the desirable values**.** Weathering of limestone, erosion of sediment and calcium bearing minerals, percolation of domestic wastes and high rate of evaporation may enhance the total hardness value in the source of river water. Other factors such as geological formation, depth of water table, soil texture and filtration rate may be contributed to the high amount of hardness in this water sample.

Although the resultant values of some ions, namely chloride, iron, manganese, sulphate, copper were lower than the desirable values and some heavy metal ions such as arsenic, lead and cyanide concentrations in river water were not detected in all sampling points during the sampling periods.

For evaluation of biological characteristics, standard plate count, Probable Coliform count and *Esherichia coli* count were detected by agar plat method and it was observed that these values were unsatisfactory for drinking purposes throughout the sampling time during 2019 and 2020 [Tables (1) to (4)]. Therefore, some contaminated dissolving substances in river water must be removed by using appropriate treatment methods to access clean and safe water quality.

The technology for the removal of contaminated from river water has directed attention to the use of simple filtration in a carried out in a specially designed glass column using with readily available low-cost biomass owing to its great opportunity for the removal efficiency.

After analyzing the physicochemical and biological characteristics of Dokhtawaddy river water, the sequence of available water treatments such as plain sedimentation, aeration under sunlight and filtration were carried out to reduce the contaminants level in river water. Due to the comparison of contaminants level in selected four sampling points as reported in Tables (1) to (4), the river water sample from point D collected in October, 2020 was chosen to treat by the above series of treatments. Primary filtration was operated in glass column constructed with filter media of rice straw, sand, gravel, charcoal and broken brick. Each filtering media were separated by cotton fiber. Then, the secondary filtration was performed in a filter column consisting of 6 inches sand and rice husk char columns for the purpose of reducing the contaminants level in river water.

From the results reported in Table (5), the turbidity level was reduced to desirable limit (i.e., 2.2 NTU) and that of conductivity was also reduced. The total alkalinity value of treated water was decreased significantly in the sequence of treatments and found to reduce the removal efficiency of 52.5%. The values of total hardness, calcium hardness and magnesium hardness of treated water were significantly reduced and fall within the limit of desirable range. The amount of some contaminated ions like chloride, iron and manganese were more pronouncedly decreased after the series of treatment steps and the removal efficiency of above 80% was found to observed in treated water. The values of biochemical oxygen demand (BOD) decreased below the allowable values and that of chemical oxygen demand (COD) decreased slightly and the removal efficiency of above 50% was found to obtained after secondary filtration [Table (5)].

By using the treatments of river water in series of steps, the clear water with desirable level of water quality was found to obtain for clean and safe utilization of local communities in rural area near the river bank.

Table (1) Comparison of Characteristics of Selective Points of Dokhtawaddy (Myitnge) River Water Samples for January and April, 2019 (Before Treatment)

Sr No.	Characteristics	Sample Collection Time (January, 2019)				Sample Collection Time (April, 2019)				*Literature Value (WHO Standard)	
		Point (A)	Point (B)	Point (C)	Point (D)	Point (A)	Point (B)	Point (C)	Point (D)	Desirable	Imperative
1	pH	7.1	7.1	7.1	7.1	7.1	7.1	7.2	7.2	7-8.5	6.5-9.2
2	Colour (Units)	5	5	5	5	5	5	5	5	5	50
3	Turbidity (N.T.U)	4.02	4.08	5.38	5.50	4.12	4.18	5.89	5.90	5	25
4	Conductivity (micromohs/cm)	362	366	355	355	346	341	342	345	50	500
5	Total Alkalinity (mg/L)	184	189	200	210	183	192	220	220	200	500
6	Total Hardness (mg/L)	200	211	224	228	210	210	253	260	100	500
7	Calcium Hardness(mg/L)	172	200	180	200	172	200	180	200	75	200
8	Magnesium Hardness (mg/L)	20	20	24	27	20	22	29	29	30	150
9	Chloride (mg/L)	5	8	10	10	6	8	12	18	200	600
10	Iron (mg/L)	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.03	0.1	1.0
11	Manganese (mg/L)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.5
12	Sulphate (mg/L)	<200	<200	<200	<200	<200	<200	<200	<200	<200	200
13	Arsenic (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
14	Copper (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	1.0	2.0
15	Cyanide (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.07
16	Lead (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
17	BOD (mg/L)	5.2	5.3	6.6	6.5	5.5	5.1	7.2	6.9	5.99	12
18	COD (mg/L)	11.9	14.1	18.9	22.3	12.4	13.1	21.2	23.4	6.99	30
19	Probable Coliform Counts	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	0	50
20	*Escherichia Coli Count*	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	0	0

***Source:** World Health Organization (2013), Standards of Potable Water Quality and Water-Borne Diseases, Geneva
World Health Organization (2015), Drinking Water Quality Standards, Geneva.

Table (2) Comparison of Characteristics of Selective Point of Dokhtawaddy (Myitnge) River Water Samples for July and October, 2019 (Before Treatment)

Sr No.	Characteristics	Sample Collection Time (July, 2019)				Sample Collection Time (October, 2019)				*Literature Value (WHO Standard)	
		Point (A)	Point (B)	Point (C)	Point (D)	Point (A)	Point (B)	Point (C)	Point (D)	Desirable	Imperative
1	pH	7.1	7.1	7.2	7.2	7.1	7.1	7.2	7.2	7-8.5	6.5-9.2
2	Colour (Units)	5	5	5	5	5	5	5	5	5	50
3	Turbidity (N.T.U)	5.02	5.08	6.50	6.88	4.10	4.18	4.81	5.30	5	25
4	Conductivity (micromohs/cm)	363	366	376	385	326	320	340	351	50	500
5	Total Alkalinity (mg/L)	185	192	218	210	183	198	220	235	200	500
6	Total Hardness (mg/L)	165	160	184	173	210	210	253	260	100	500
7	Calcium Hardness(mg/L)	132	140	150	155	172	174	195	210	75	200
8	Magnesium Hardness (mg/L)	17	17	19	19	22	22	25	29	30	150
9	Chloride (mg/L)	5	8	10	10	12	12	25	29	200	600
10	Iron (mg/L)	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.1	1.0
11	Manganese (mg/L)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.5
12	Sulphate (mg/L)	<200	<200	<200	<200	<200	<200	<200	<200	<200	200
13	Arsenic (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
14	Copper (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	1.0	2.0
15	Cyanide (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.07
16	Lead (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
17	BOD (mg/L)	5.3	6.2	6.2	7.3	6.2	6.3	6.8	7.6	5.99	12
18	COD (mg/L)	12.5	12.3	13.8	18.4	13.3	13.1	17.6	19.2	6.99	30
19	Probable Coliform Counts	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	0	50
20	*Escherichia Coli Count*	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	0	0

Source: World Health Organization (2013), Standards of Potable Water Quality and Water-Borne Diseases, Geneva
World Health Organization (2015), Drinking Water Quality Standards, Geneva.

Table (3) Comparison of Characteristics of Selective Point of Dokhtawaddy (Myitnge) River Water Samples for January and April, 2020

Sr No.	Characteristics	Sample Collection Time (January, 2020)				Sample Collection Time (April, 2020)				*Literature Value (WHO Standard)	
		Point (A)	Point (B)	Point (C)	Point (D)	Point (A)	Point (B)	Point (C)	Point (D)	Desirable	Imperative
1	pH	7.1	7.1	7.1	7.1	7.2	7.2	7.4	74	7-8.5	6.5-9.2
2	Colour (Units)	5	5	5	5	5	5	5	5	5	50
3	Turbidity (N.T.U)	4.07	4.12	5.10	5.10	4.12	4.18	5.90	6.15	5	25
4	Conductivity (micromohs/cm)	365	363	358	365	343	351	372	350	50	500
5	Total Alkalinity (mg/L)	180	185	220	220	190	195	225	238	200	500
6	Total Hardness (mg/L)	200	211	224	228	210	210	253	260	100	500
7	Calcium Hardness(mg/L)	35	32	38	38	32	30	45	52	75	200
8	Magnesium Hardness (mg/L)	18	13	25	27	18	18	25	31	30	150
9	Chloride (mg/L)	5	5	10	10	8	8	16	18	200	600
10	Iron (mg/L)	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.03	0.1	1.0
11	Manganese (mg/L)	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.05	0.5
12	Sulphate (mg/L)	<200	<200	<200	<200	<200	<200	<200	<200	<200	200
13	Arsenic (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
14	Copper (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	1.0	2.0
15	Cyanide (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.07
16	Lead (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
17	BOD (mg/L)	4.3	4.6	5.9	6.2	5.2	5.9	6.7	7.2	5.99	12
18	COD (mg/L)	13.6	12.5	14.3	21.3	12.5	12.3	15.5	18.3	6.99	30
19	Probable Coliform Counts	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	0	50
20	*Escherichia Coli Count*	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	0	0

Source: World Health Organization (2013), Standards of Potable Water Quality and Water-Borne Diseases, Geneva
World Health Organization (2015), Drinking Water Quality Standards, Geneva.

Table (4) Comparison of Characteristics of Selective Point of Dokhtawaddy (Myitnge) River Water Samples for July and October, 2020 (Before Treatment)

Sr No.	Characteristics	Sample Collection Time (July, 2020)				Sample Collection Time (October, 2020)				*Literature Value (WHO Standard)	
		Point (A)	Point (B)	Point (C)	Point (D)	Point (A)	Point (B)	Point (C)	Point (D)	Desirable	Imperative
1	pH	7.1	7.1	7.2	7.2	7.2	7.2	7.5	7.5	7-8.5	6.5-9.2
2	Colour (Units)	5	5	5	5	5	5	5	5	5	50
3	Turbidity (N.T.U)	5.02	5.08	6.50	6.88	4.13	4.28	5.71	7.20	5	25
4	Conductivity (micromohs/cm)	372	372	384	389	343	340	350	372	50	500
5	Total Alkalinity (mg/L)	179	175	195	200	185	185	225	246	200	500
6	Total Hardness (mg/L)	165	160	184	173	210	210	253	260	100	500
7	Calcium Hardness(mg/L)	32	32	40	45	32	42	75	89	75	200
8	Magnesium Hardness (mg/L)	17	17	19	19	22	22	25	31	30	150
9	Chloride (mg/L)	5	5	12	12	10	10	25	28	200	600
10	Iron (mg/L)	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.1	1.0
11	Manganese (mg/L)	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.05	0.05	0.5
12	Sulphate (mg/L)	<200	<200	<200	<200	<200	<200	<200	<200	<200	200
13	Arsenic (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
14	Copper (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	1.0	2.0
15	Cyanide (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.07
16	Lead (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	-	0.01
17	BOD ((mg/L)	5.4	5.7	6.2	6.9	5.4	5.8	7.1	7.4	5.99	12
18	COD (mg/L)	12.3	13.5	18.9	24.5	13.4	15.6	18.9	27.8	6.99	30
19	Probable Coliform Counts	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5	0	50
20	*Escherichia Coli Count*	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	Isolated	0	0

***Source:** World Health Organization (2013), Standards of Potable Water Quality and Water-Borne Diseases, Geneva
World Health Organization (2015), Drinking Water Quality Standards, Geneva.

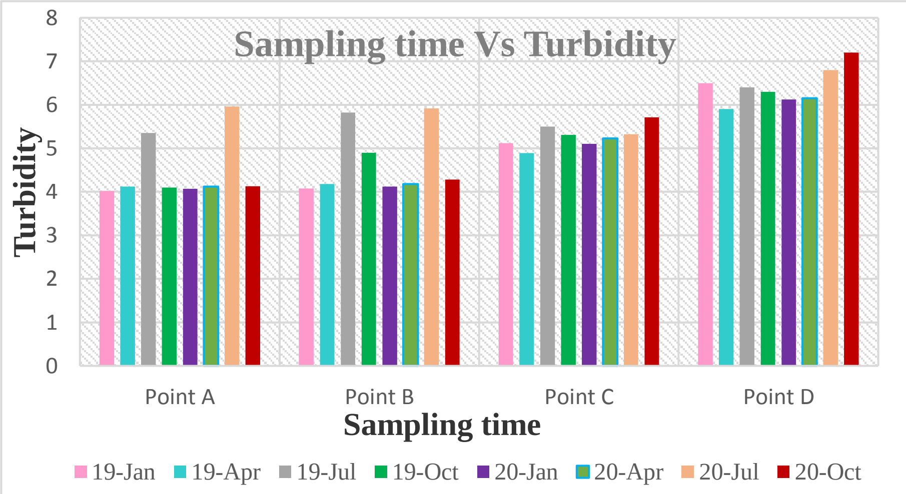

Figure (5) Comparison of Turbidity Values of Myitnge River Water Selected During 2019-2020

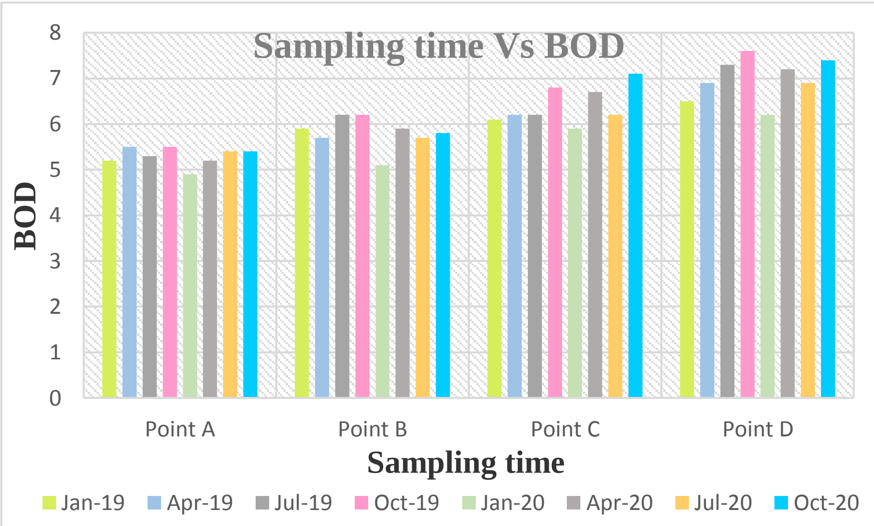

Figure (6) Comparison of BOD Values of Myitnga River Water During 2019-2020

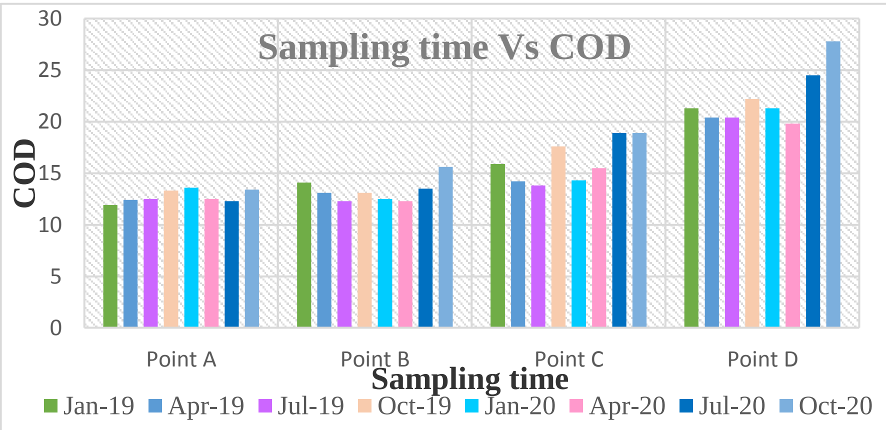

Figure (7) Comparison of COD Values of Myitnga River Water During 2019-2020

Table (5) Comparison of Characteristics of Dokhtawaddy (Myitnge) River Water Before and After Treatment from Selected Point (D) During October, 2020

Sr. No.	Characteristics	Before Treatment	After Treatment	Removal Efficiency (% w/v)	*Literature Value (WHO Standard)	
					Desirable	Imperative
1	pH	7.5	7.1	-	7-8.5	6.5-9.2
2	Colour (Units)	5	3	40	5	50
3	Turbidity (N.T.U)	7.20	2.2	69.4	5	25
4	Conductivity (ms/cm)	372	356	-	50	500
5	Total Alkalinity (mg/L)	240	122	52.5	200	500
6	Total Hardness (mg/L)	260	134	48.5	100	500
7	Calcium Hardness(mg/L)	89	35	60.6	75	200
8	Magnesium Hardness (mg/L)	31	21	32.3	30	150
9	Chloride (mg/L)	28	5	82.1	200	600
10	Iron (mg/L)	0.05	0.01	80	0.1	1.0
11	Manganese (mg/L)	0.05	0.01	80	0.05	0.5
12	Sulphate (mg/L)	<200	<200	-	<200	200
13	Arsenic (mg/L)	ND	ND	-	-	0.01
14	Copper (mg/L)	ND	ND	-	1.0	2.0
15	Cyanide (mg/L)	ND	ND	-	-	0.07
16	Lead (mg/L)	ND	ND	-	-	0.01
17	BOD(mg/L)	7.4	3.2	56.7	5.99	12
18	COD (mg/L)	27.8	12.5	55.0	6.99	30
19	Probable Coliform Counts	5/5	5/5	5/5	0	50
20	*Escherichia Coli Count*	Isolated	Isolated	Isolated	-	-

***Source:** World Health Organization (2013), Standards of Potable Water Quality and Water-Borne Diseases, Geneva

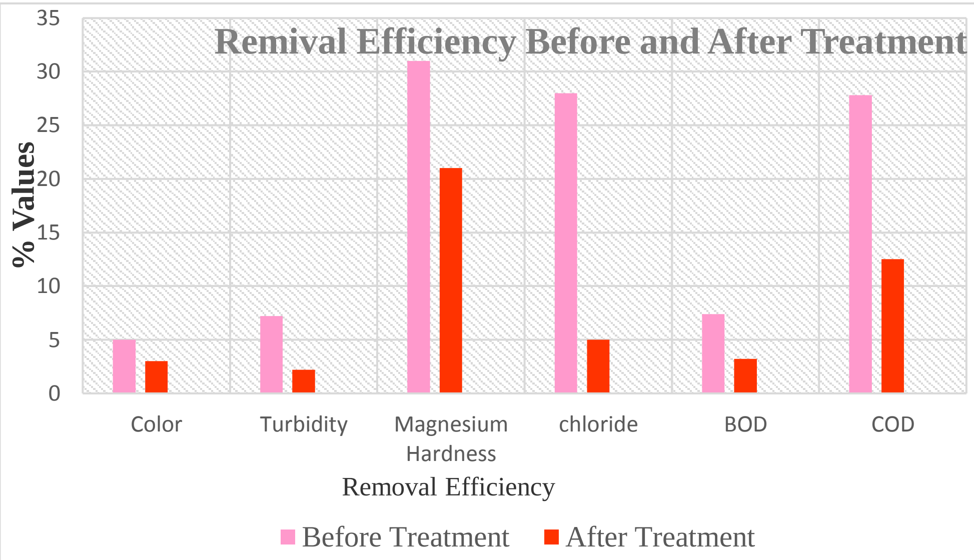

Figure (8) Comparison of Characteristics of Dokhtawaddy (Myitnge) River Water Before and After Treatment

Conclusion

Myanmar is heavily dependent on inland surface waterbodies for domestic use, agricultural irrigation and industrial production. Water quality monitoring data of Myitnge river revealed that water quality conditions in rivers are generally good, however need to treat for clean and safe uses.

In this research, the water samples were collected quarterly from upstream and downstream Mandalay Industrial Sewage Ditch of Dokhtawaddy River during 2019 and 2020. The characteristics of seasonally collected water samples are shown in Tables (1) to (4). Based on collected area as shown in tables, it must be concluded that the present investigation of site (C) and (D) is most polluted than others. The contamination degree of all collected water samples from the downstream side of Mandalay Industrial Sewage Ditch at points (C) and (D) were not suitable for potable purposes due to the presence of color, odor, suspended solids, several different minerals and bacteria for causing human intestinal diseases. And so, the water samples must be definitely treated by appropriate methods. Moreover, hydropower projects along Myitnge river can disrupt the natural flows river and freshwater ecosystem. These energy generation operations can destruct flow regime and influence the water quality parameters.

The effort of this research work contributes to the information of easier and inexpensive water treatments technology readily available for which rural people were early carried out. It is concluded that by contributing this low cost technology, the poor people could get the knowledge for the better clean water. From the results of this research work, this present study will be implemented the sustainable water resource development and support the downstream riverine ecosystem by controlling the impact risk on the flow regime. In addition, this work would confer a low cost approach to water treatment for poor peri-urban communities to get safe water and to maintain the native biodiversity and ecosystem integrity in the Dokhtawaddy river basin.

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