ASSESSMENT ON THE WATER QUALITY AT THE MOUTH OF PATHEIN RIVER, AYEYARWADY REGION, MYANMAR

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Abstract

The aim of this paper is to assess the water quality of Patheinriver around the river mouth and to evaluate the pollution loading and water quality criteria of Pathein river. In this paper, a total of 9 river water samples were collected near Payala Village in hot, rainy and cold seasons of the year 2014. Sampling sites were recorded with GPS detector. Some physicochemical properties (pH, DO, TSS, turbidity, chlorinity, salinity, total alkalinity, total hardness, BOD and COD)and nutrient levels (orthophosphate, organic phosphate, total phosphate, total nitrogen and chlorophyll *a*) were determined. Trace metals (As, Cd, Pb, Hg, Fe, Zn, Cr, Mn and Cu) concentrations of the river water samples were determined. (Based on DO (7.16-7.39 ppm),orthophosphate (0.15-0.24ppm) and total nitrogen(1.12-1.56 ppm) values, the river water near Payala village could be identified as low and medium nutrient enrichment, i.e., oligotrophic in hot season and mesotrophic in rainy and cold seasons.)

Keywords: Pathein river, water quality, orthophosphate, DO, total alkalinity, chlorophyll *a*

Introduction

Water is the most vital resource for all kinds of life on this planet. Water is one of the nature's most important gifts to mankind. It is essential and most precious commodity for life. Rivers are vital and vulnerable freshwater systems, and are essential for the sustenance of all life. Rivers supply valuable drinking water to humans, irrigation water to farmlands and provide habitat to many aquatic plants and living organisms. The study of rivers is important sources of natural water apart from serving as a source of drinking water, irrigation and fishing; they are generally of immense importance in geology, biology, history and culture (Anhwange *et al.,* 2012). Rivers can be classified according to the type of flow regime and magnitude of discharge (Chapman, 1996). Myanmar's main rivers run from north to

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south. About three-fifths of Myanmar's surface is drained by the Ayeyarwady and its tributaries. Flowing entirely through Myanmar, it is navigable for nearly 1, 000 miles (1, 600 km). At the apex of its delta, the Ayeyarwady breaks up into a vast network of streams and empties into the Andaman Sea through multiple mouths. The Ayeyarwady river is one vital artery waterway of Myanmar (Kyaw Naing, 2011).The Ayeyarwady Delta comprises the main arms of Pathein River. The purpose of the study was to investigate the water quality of Pathein river around the river mouth and to evaluate the pollution loading and water quality criteria of Pathein river and to find out seasonal and spatial variation and development of the region the important river flowing water chemistry.

Materials and Methods

In this research, totally 9 river water samples were collected in the year 2014 from Pathein river mouth, vicinity of Payala Village. Figure 1 shows the sampling sites of river water samplesby the GPS detector. All samples are surface river water (2 m depth). Some physicochemical properties (pH, DO, TSS, turbidity, chlorinity, salinity, total alkalinity, total hardness, BOD and COD) and nutrient levels (orthophosphate, organic phosphate, total phosphate, total nitrogen and chlorophyll *a*) were determined. The pH of river water samples were measured in the field by using digital pH meter. The temperature and dissolved oxygen of river water samples was measured in the field by using a DO meter-Temperature sensor probe HANNA Instrument. Chlorinity of the river water samples were determined by titrimetric method. Total alkalinity concentrations of river water samples were determined by titrimetric analysis. Biological oxygen demand of river water samples were determined by incubation method. Chemical oxygen demand of river water samples were determined by permanganate titrimetric analysis. Orthophosphate, organic phosphate and total phosphate were determined by UV-visible spectrophotometric method. Total nitrogenof river water samples were determined by Azo Dye method. Chlorophyll *a* contents of river water samples were measured by UV-Visible spectrophotometer. Trace metals (As, Cd, Pb, Hg, Fe, Zn, Cr, Mn and Cu) concentrations of the river water samples were measured by atomic absorption spectrophotometer (AAS).

Figure 1: Collection areas of river water samples (Site A 94° 27.239′ E, 16° 6.927′ N,Site B 94° 27.187′ E, 16° 6.842′ N , Site C 94° 27.205′ E, 16° 6.702′ N)

Results and Discussion

In this study, some physicochemical properties, nutrient levels and sometrace metals concentrations of the river water samples from Pathein River Mouth, vicinity of Payala village area were determined.

Physicochemical Properties of River Water Samples

pH in river samples

The pH of a water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity. In this present work, the pH values of the river water samples were recorded 7.78-7.87 in hot season, 7.71-7.73 in rainy season and 7.75-7.80 in cold season (Table 1).

The maximum value of pH 7.87 was observed in hot season for sampling site (A). The maximum value of pH observed in hot season might be due to biological activity and photosynthetic activities. The pH values are within the permissible level of 6.5-8.5 EPA standard (2009). Most fish can be

observed pH values of about 5-9. So, the observed pH value is suitable for fish and other aquatic life.

Temperature in river water samples

Temperature is a thermodynamic property of a fluid, and is due to the activity of molecules and atoms in the fluid. From the viewpoint of seasonal sample collection, the temperature values of river water were observed in the range of 32.2-32.8°C in hot season, 31.5-32.1°C in rainy season and 31.8-32.5°C in cold season (Table 1).The highest value of temperature 32.8 °C was observed in hot season for sampling site (B). The variation in the water temperature may be due to different timings of collection, influence of season and solar radiation.

Total suspended solids in river water samples

Total suspended solids are particles of sand, silt, clay and organic material moving with the water. In this study, the values of total suspended solids (TSS) in river water samples ranged from 45.42-60.72 ppm in hot season, 58.12-65.41 ppm in rainy season and 47.14-62.48 ppm in cold season (Table 1). The highest value of total suspended solids was observed as 65.41 ppm in rainy season for sampling site (B). The highest value of total suspended solids was recorded during rainy season, which indicates the river run off, industrial effluents and municipal sewage.

Turbidity in river water sample

Turbidity is a measure of the amount of particulate matter and dissolved color that is suspended in water. In this present work, the values of turbidity in river water were observed in the range of 42.53-58.25 FTU (hot), 55.43-69.12 FTU (rainy) 35.35-54.53 FTU (cold) for seasonal sample collection (Table 1). From the studied area results, the highest amount of turbidity was found in rainy season. In this case, a higher turbidity may be because of the soil erosion, river flow, presence of sources of organic pollution and run off factors. According to the results obtained, the values of turbidity were under the permissible level of EPA standard (< 700 FTU).

Chlorinity in river water samples

Chlorinity is one of the important indicators of pollution. Chlorinity are present in sewage, effluents and farm drainage. It is responsible for the brackish taste in water and is an indicator of sewage pollution because of the chlorinity content in urine. Seasonally, the values of chlorinity in river water samples ranged from 2.51-2.56 ppt in hot season, 2.37-2.41ppt in rainy season and 2.42-2.47 ppt in cold season (Table 1).The highest value of chlorinity was found 2.56 ppt in hot season for sampling site A. All chlorinity values were within the permissible level of 250 ppm EPA standard (2009).

Salinity in river water samples

Salinity is a measure of the amount of dissolved salts in the water. In this present work, the salinity values of the river water samples were found 4.53-4.62 ppt in hot season, 4.28-4.35ppt in rainy season and 4.37-4.46 ppt in cold (Table 1). The maximum content of salinity 4.62 ppt was recorded in hot season for sampling site (A). The seasonal variation salinity lowers in rainy season, due to the river run off in this period and high dilution in the estuary.

Total alkalinity in river water samples

Alkalinity is a total measure of the substances in water that have acid neutralizing ability. In this present work, the alkalinity of river water samples in the studied area were in the range of 100-150 ppm in hot season, 70-130 ppm in rainy season and 90-130 ppm in cold season (Table 1). The highest content of total alkalinity 150 ppm was found in the hot season for sampling site (B).The total alkalinity of all river water samples in the studied area were found to be within the permissible level of 30-150 ppm EPA standard (2009).

Total hardness in river water samples

Total hardness is the sum of calcium and magnesium concentration. It is used to measure the capacity of water to precipitate soap. In this research work, the values of total hardness in river water samples were found to

be4965-5213 ppm in hot season, 4981-5192 ppm in rainy season and 4772-4943 ppm in cold season (Table 1). The highest value of total hardness was 5213 ppm in hot season for sampling site (B). Higher value was observed in hot season may be due to increase of salt in water.

Dissolved oxygen (DO) in river water samples

Dissolved oxygen is an important limnological parameter indicating level of water quality and organic pollution in the water body. The dissolved oxygen (DO) values of river water samples were observed in the range of 7.16-7.28 ppm in hot season, 7.26-7.39 ppm in rainy season and 7.17-7.35 ppm in cold season (Table 1). Seasonally, the highest values of DO were found in rainy season and lowest values in hot season and intermediate values were recorded in cold season. The highest value of dissolved oxygen 7.39 ppm was observed in rainy season for sampling site (C). The maximum values of DO in rainy season might be due to the fact that the solubility of DO increases with the decrease in water temperature.

Biochemical oxygen demand in river water samples

Biochemical oxygen demand is a measure of the use dissolved oxygen by life forms, particularly during decomposition. BOD is the amount of oxygen required by bacteria to stabilize organic matter under aerobic conditions. The values of BOD were observed in the range of 2.43-2.76 ppm in hot season, 2.01-2.38 ppm in rainy season and 2.08-2.41 ppm in cold season (Table 1). The highest value of BOD was found to be 2.76 ppm in hot season for sampling site (A). The maximum value of BOD in hot season might be due to biological as well as natural oxidation process with increase in temperature. All BOD values of river water samples were below the permissible level of 5 ppm EPA standard (2009).

Chemical oxygen demand in river water samples

Chemical oxygen demand is defined as the amount of oxygen needed to oxidize the dissolved and particulate matter in water, is a practical indicator of the concentration of organic matter and of water quality (Kawabe and Kawabe, 1997). Seasonally, the concentrations of COD were observed in the

range of 9.18-11.21 ppm in hot season, 6.48-9.29 ppm in rainy season and 7.28-10.23 ppm in cold season, respectively (Table 1). The highest value of COD was observed 11.21 ppm in hot season for sampling site (A). COD high level indicates presence of all forms of organic matter, both biodegradable and non biodegradable and hence the degree of pollution in water. All COD values of river water samples were above the maximum permissible level of 10ppm EPA standard (2009).

Table 1: Some Physicochemical Properties of River Water Samples from Three Sampling Sites (2014)

Parameters	Sampling Sites	Season			Standard	
		Hot	Rainy	Cold	EPA (2009)	ASEAN (2010)
pH	A	7.87	7.73	7.79	6.5-8.5	6.0-8.0
	B	7.78	7.71	7.75		
	C	7.85	7.72	7.80		
Temperature	A	32.2	31.5	31.9	NC	-
	B	32.8	32.1	32.5		
	C	32.5	31.7	31.8		
Total suspended Solids (ppm)(Mean±SD)	A	45.42±0.38	62.23±0.61	61.51±0.61	NC	NC
	B	57.34±0.46	65.41±0.54	62.48±0.55		
	C	60.72±0.38	58.12±0.44	47.14±0.47		
Turbidity (FTU) (Mean±SD)	A	42.53	63.13	41.56	<700	15
	B	49.78	69.12	54.53		
	C	58.25	55.43	35.35		
Chlorinity (ppt) (Mean±SD)	A	2.56±0.06	2.38±0.03	2.42±0.03	250	<19
	B	2.51±0.04	2.37±0.02	2.47±0.08		
	C	2.55±0.05	2.41±0.04	2.44±0.09		
Salinity (ppt) (Mean±SD)	A	4.62±0.09	4.29±0.12	4.37±0.08	NC	NC
	B	4.53±0.13	4.28±0.11	4.46±0.11		
	C	4.60±0.17	4.35±0.09	4.40±0.12		
Total alkalinity (ppm) (Mean±SD)	A	100±4	70±1	90±2	30-150	120
	B	150±3	130±3	130±3		
	C	110±2	100±2	120±2		
Total hardness (ppm) (Mean±SD)	A	4965±72	4981±61	4772±64	NC	NC
	B	5213±65	5192±63	4931±73		
	C	5189±70	5123±59	4943±63		
Dissolved oxygen (ppm)	A	7.16	7.26	7.17	>4	>5
	B	7.28	7.38	7.35		
	C	7.22	7.39	7.31		
Biochemical oxygen demand(ppm)	A	2.76	2.38	2.41	5	>15
	B	2.61	2.28	2.08		
	C	2.43	2.01	2.35		
Chemical oxygen demand (ppm)(Mean±SD)	A	11.21±0.23	9.29±0.22	7.28±0.19	10	40
	B	11.13±0.21	6.48±0.25	10.23±0.21		
	C	9.18±0.19	8.31±0.27	9.24±0.18		

*EPA standards(2009) NC=Not of Concern

*ASEAN standards for aquatic life protection (2010)

Nutrient Levels of River Water Samples

Orthophosphate, organic phosphate, total phosphate, and chlorophyll *a* in river water samples

Phosphate is one of the most important nutrients responsible for eutrophication of rivers which increases algae growth and ultimately reduces dissolved oxygen level in the water (Anhwange, 2012). In seasonal sampling, the orthophosphate values were found to be 0.18-0.24 ppm in rainy season and 0.15-0.19 ppm in cold season (Table 2).The values of orthophosphate were not detected in hot season. The maximum contents of orthophosphate 0.24 ppm were recorded in rainy season for sampling site (C). The amount of organic phosphate ranged from 5.21-5.85 ppm in hot season, 6.02-6.50 ppm in rainy season and 5.66-6.17 ppm in cold season. The contents of total phosphate were in the range of 5.21-5.85 ppm in hot season, 6.24-6.74 ppm in rainy season and 5.85-6.32 ppm in cold season (Table 2). In the present observation, the maximum value of total phosphate was recorded 6.74 ppm in rainy season for sampling site (C). The high phosphate level during the rainy season could be related to the high rate of decomposition of organic matter and from run-off, surface catchment and interaction between the water and sediments from dead plants and animals remains at the bottom of the river. Total nitrogen is an essential nutrient or plants and animals. An excess amount of nitrogen in a waterway may lead to low levels of dissolved oxygen and negatively alter various plant life and organisms. In this research work, total nitrogen values were observed to be 1.12-1.35ppm in hot season, 1.52-1.56 ppm in rainy season and 1.37-1.48 ppm in cold season (Table 2). The contents of chlorophyll *a* were observed in the range of 1.2833-1.4128 μg/ 10 mL in hot season, 2.3741-2.5312 μg/10 mL in rainy season and 1.7289-2.2374 μg/10mL in cold season (Table 2). The maximum value of chlorophyll *a* was found 2.5312 μg/10mL in rainy season for sampling site C. It was found that increasing concentration of chlorophyll *a* in river water is directly proportional to the value of increase DO levels and phytoplankton biomass.

Table 2: Nutrient Levels of River Water Samples from Three Sampling Sites (2014)

Parameters	Sampling sites	Season			Standard	
		Hot	Rainy	Cold	EPA (2009)	ASEAN (2010)
Orthophosphate (ppm) (Mean±SD)	A	ND	0.22±0.02	0.19±0.01	-	0.015
	B	ND	0.18±0.01	0.15±0.02		
	C	ND	0.24±0.03	0.17±0.01		
Organic phosphate (ppm) (Mean±SD)	A	5.48±0.06	6.02±0.09	5.66±0.11	-	NC
	B	5.85±0.04	6.44±0.12	6.17±0.08		
	C	5.21±0.06	6.50±0.09	6.11±0.12		
Total phosphate (ppm) (Mean±SD)	A	5.48±0.06	6.24±0.05	5.85±0.04	-	<0.05
	B	5.85±0.04	6.62±0.06	6.32±0.08		
	C	5.21±0.06	6.74±0.08	6.28±0.05		
Total Nitrogen (ppm) (Mean ± SD)	A	1.29±0.03	1.54±0.03	1.37±0.01	-	NC
	B	1.12±0.01	1.52±0.04	1.39±0.02		
	C	1.35±0.02	1.56±0.03	1.48±0.03		
Chlorophyll *a* (μg/10 mL) (Mean±SD)	A	1.2833±0.0018	2.4435±0.0023	2.2374±0.0031	NC	2
	B	1.4128±0.0017	2.3741±0.0018	1.8921±0.0032		
	C	1.3532±0.0019	2.5312±0.0016	1.7289±0.0028		

*EPA standards (2009) NC=Not of Concern

*ASEAN standards for aquatic life protection (2010)

Trace Elements in River Water Samples

Arsenic in river water sample

Arsenic is ubiquitous element that is comparatively rare, but widely distributed in the atmosphere, soils and rocks, natural water and organisms. From the study area, the concentrations of arsenic in river water samples ranged from 0.0163-0.0195 ppm in hot season and 0.0138-0.0185 ppm in cold season (Table 3). The arsenic content was not detected in rainy season. The highest values of arsenic was observed to be 0.0195 ppm in hot season for sampling site (B). Among these samples, the values of arsenic were found

under the permissible levels of 0.036 ppm of ASEAN standard (2010) and no toxicity of arsenic in the river waters is observed during the studied period.

Cadmium in river water samples

Cadmium is an element that occurs naturally earth's crust. Cadmium is toxic to humans, animals, microorganisms and plants, however only a small amount of cadmium intake is absorbed by the body and will be stored mainly in bones, liver and, in case of chronic exposure, in kidneys. In the present study, the contents of cadmium were observed 0.045-0.048 ppm in hot season, 0.031-0.039 ppm in rainy season and 0.037-0.043 ppm in cold season for seasonally collected samples (Table 3). The highest value of cadmium was observed 0.048 ppm in hot season for sampling site C. According to these data, all measured values were higher than the permissible level of 0.010ppm ASEAN standard (2010).The possible sources of contamination of cadmium might be due to the runoff from the agricultural soil. The entire studied area is covered by agricultural land where rock phosphate is used as phosphorous fertilizer.

Lead in river water samples

Lead is the one of the most common of the some metals. In the present study, the contents of lead in river water samples collected seasonally were found to be 1.095-1.192 ppm in hot season, 0.019-0.045 ppm in rainy season and 0.017-0.038 ppm in cold season (Table 3). The maximum value of lead was found to be 1.192 ppm in hot season for sampling site (B). The excess of lead content may be due to the runoff from agricultural fields where phosphorous fertilizers are applied, in which lead is one of the impurities.

Mercury in the river water samples

Mercury is one of the most toxic metals, interfering seriously with the human central nervous system. In the environment, it can be found in its volatile elemental form, as slightly soluble inorganic salts, and as mono and di-methylated mercury (Lomniczi, 2004). In the present work, the mercury concentrations in river water samples ranged from0.0012 to 0.0025 ppb in cold season. Mercury was not detected in hot and rainy seasons. From the

data results, the values of mercury were below the permissible levels of 0.016 ppb (ASEAN standard, 2010). So, the river water in the studied area was not polluted from viewpoint of toxic element, Hg.

Iron in river water samples

The iron concentrations in river water, samples collected seasonally were observed as 0.034-0.081 ppm in rainy season (Table 3).Iron was not detected in hot and cold seasons. The highest value of iron was found as 0.081 ppm in rainy season for sampling site (A). The increase in iron content might be due to discharge into the river through industrial, agricultural, and other human activities in the area.

Zinc in river water samples

Zinc is an essential element for all living things; including man. Zinc is unusual in that it has low toxicity to man, but relatively high toxic to fish (Badr *et al.,* 2006). In this research work, the zinc concentrations were observed to be0.029-0.035 ppm in hot season, 0.018-0.035 ppm in rainy season and 0.024-0.032 ppm in cold season (Table 3). The maximum content (0.035 ppm) was observed in hot sample for site C.

Among the some metals measured, the rest of elements (Cr, Mn and Cu) were not detected in all river water sample for seasonally collected samples (Table 3).

Table 3: Trace Element Contents in River Water for Seasonally Sampling

Elements	Sampling sites	Seasons			Standard	
		Hot	Rainy	Cold	EPA (2009)	ASEAN (2010)
As (ppm)	A	0.0163	ND	0.0152	0.69	0.036
	B	0.0195	ND	0.0138		
	C	0.0192	ND	0.0185		
Cd (ppm)	A	0.045	0.039	0.043	0.4	0.01
	B	0.047	0.031	0.037		
	C	0.048	0.036	0.041		
Pb (ppm)	A	1.189	0.019	0.017	2.1	0.009
	B	1.192	0.045	0.038		
	C	1.095	0.033	0.032		
Hg (ppb)	A	ND	ND	0.0017	1.8	0.16
	B	ND	ND	0.0025		
	C	ND	ND	0.0012		
Fe (ppm)	A	ND	0.081	ND	-	NC
	B	ND	0.034	ND		
	C	ND	0.047	ND		
Zn (ppm)	A	0.031	0.018	0.028	-	NC
	B	0.029	0.022	0.024		
	C	0.035	0.035	0.032		
Cr (ppm)	A	ND	ND	ND	-	0.05
	B	ND	ND	ND		
	C	ND	ND	ND		
Mn(ppm)	A	ND	ND	ND	-	NC
	B	ND	ND	ND		
	C	ND	ND	ND		
Cu (ppm)	A	ND	ND	ND	4.8	8
	B	ND	ND	ND		
	C	ND	ND	ND		

*EPA standards (2009) NC=Not of Concern

*ASEAN standards for aquatic life protection (2010)

Conclusion

In this study, totally 9 river water samples from different sites were collected from the Pathein river mouth, vicinity of Payala village seasonally during 2014. The river water quality assessment helps to identify the significant parameters of getting better information about source of pollution. From the results that are recorded in the different sites are compared with acceptable levels of EPA and ASEAN standards. From study area data, all measured values (pH, TSS, turbidity, chlorinity, salinity, total alkalinity, total hardness, As, Hg, Fe, Zn, Cr, Mn, Cu, total nitrogen, DO and BOD) were within the permissible levels of EPA (2009) and ASEAN (2010) standards but except (Pb, Cd, orthophosphate, organic phosphate, total phosphate, COD and chlorophyll *a*). Therefore, the observed water quality suggests that the river water could not be used for drinking purpose. It could only be used for irrigation after suitable treatment.

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