SOME METAL CONTENTS IN SEA WATER AND SEDIMENT SAMPLE AROUND CHAUNG THA AREA IN AYEYARWADY REGION, MYANMAR

Jue Jue Khin[1], Aye Aye Lwin[2], Myat Kyaw Thu[3], Kyaw Naing[4]

Abstract

Pollution of heavy metals in aquatic environment is a growing problem worldwide and currently it has reached an alarming rate. There are various sources of heavy metals; most of them originate from anthropogenic activities like draining of sewerage and recreational activities. As heavy metals cannot be degraded, they are continuously being deposited and incorporated in water and sediment, thus causing heavy metal pollution in water bodies. In this research sea water and sediment samples were collected seasonally and annually in (2012-2014). Heavy metal (Cr, Mn, Fe, Cu, Zn, As, Pb, Cd and Hg) contents were determined to identify pollution hot spots in the studied area. Sampling sites were recorded by using GPS detector. The concentrations of metals were determined by atomic absorption spectrometry (AAS) technique and compared with acceptable levels of ASEAN, EPA and CBSQGs standards.

Keywords: sea water, sediment, Chaung Tha, Ayeyarwady Region, ASEAN, EPA standards

Introduction

Marine pollution is a global environmental problem; human activities in the coastal area and marine water contribute to the discharge of various kinds of pollutants such as heavy metals into the marine ecosystems. Heavy metals can be added to an aquatic system either by natural or anthropogenic sources (Kyaw Naing, 2011). Other possible sources of pollution include; domestic effluents, urban storm water runoff, landfill leachate, atmospheric sources and boating activities.

Heavy metals released to aquatic systems are generally bound to particulate matter, which are eventually incorporated into sediments. Thus sediments are an efficient mean of accumulation and downstream transport of

[1]. Dr, Demonstrator, Department of Chemistry, Maubin University
[2]. Dr, Associate Professor, Department of Chemistry, Yenanchaung Degree College
[3]. Dr, Professor, Department of Chemistry, Mandalay University
[4]. Dr, Deputy Director General, Department of Higher Education (Yangon Office)

inorganic contaminants, like heavy metals. It is a proven fact that heavy metals induce toxic effects on living organisms, therefore they can pose a high risk when found in high concentrations in sediments (Censi *et al.,* 2006).

Materials and Methods

The sea water and sediment samples were collected from Chaung Tha area in Ayeyarwady region. The concentrations of metals have been determined by Atomic Absorption Spectrometry (AAS) techniques. The analytical data were tabulated and compared with ASEAN, EPA and CBSQGs Standards.

Study Area

The studied area ChaungTha is the most beautiful beach in Myanmar. It is located on the western coast of Rakhine state near Pathein where the waves of the Bay of Bengal (BOB) and the Indian ocean lap the shores. It is situated between North latitude 160º 179' North and South latitude940º 072' East (Wikipedia, 2013).

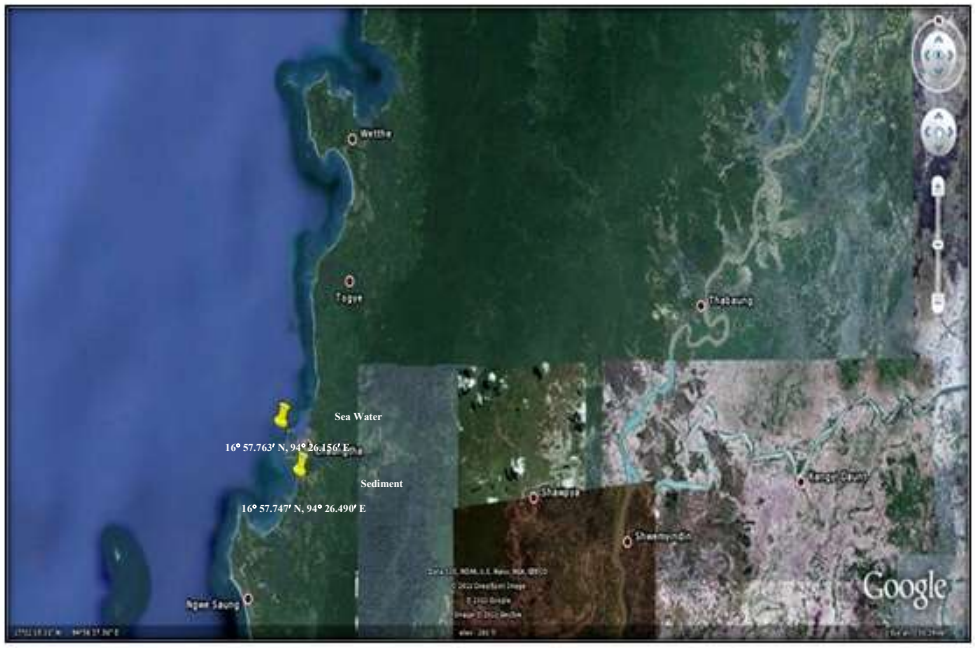

Figure 1: Satellite image of ChaungTha in Ayeyarwady Region Sampling Site for Sea Water - 16° 57.463' N, 94° 26.150' E Sampling Site for Sediment - 16° 57.747' N, 94° 26.490' E

Sample Collection

Sea water samples were taken 1 mile away from the Sea Shore and 2m depth from the surface water level. The water samples were collected by means of a water sampler. Sediment samples were collected about 5 to 10 cm thickness of the surface sediment with a stainless steel grab sampler during low tide.

Results and Discussion

Seasonal Variation of some Metals (Cr, Cu, Mn, Fe, Zn, Pb, Cd, Hg and As) Contents in Sea Water and Sediment Samples Chromium (Cr) content in sea water and sediment samples

In the present study, the chromium (Cr) content in sea water samples were found to be in the annual range of 0.010 - 0.020 ppm in 2012, 0.003 - 0.050 ppm in 2013 and 0.006 - 0.050 ppm in 2014, respectively. Of these three seasons, the highest Chromium (Cr) content(0.050 ppm)was found in cold season due to the decreasing rate of organic matter decomposition and low water temperature. The lowest value 0.003 ppm was found in rainy season. According to the data, all measured values were within the range of ASEAN standard0.05 ppm (Table 1 and Figure 2).

The concentration of chromium (Cr) in sediment samples were found to be in the annual range of 0.00-0.12 mg/kg in 2012, 0.22 - 0.23 mg/kg in 2013 and 0.24 - 0.26 mg/kg in 2014, respectively. The highest value 0.26 mg/kg was found in cold season and the lowest value 0.12 mg/kg was found in rainy season. Observed values were within the CBSQGs (TEC) (2010) value 43 mg/kg for aquatic life protection (Table 1 and Figure 3).

Copper (Cu) content in sea water and sediment samples

The concentration of copper (Cu) in sea water samples were found to be in the annual range of 0.003 - 0.036 ppm in 2012, 0.004 - 0.060 ppm in 2013 and 0.003 - 0.013 ppm in 2014. Of these three seasons, the highest value of 0.036 ppm was found in hot season and the lowest value of 0.003 ppm was found in rainy season. The resultants values exceeded the permissible level of ASEAN standard 0.008 ppm because of the sewage and industrial waste are

the major sources of copper contamination in aquatic environment (Table 2 and Figure 4).

The concentration of copper (Cu) in sediment samples were found in the annual range of 3.18- 3.85 mg/kg in 2012, 4.25- 4.85 mg/kg in 2013 and 6.20- 6.40 mg/kg in 2014, respectively. The highest copper (Cu) value of 6.40 mg/kg was found in hot season and the lowest value of 3.18 mg/kg was found in rainy season. Observed values were within the CBSQGs (TEC) (2010) value of 32 mg/kg for aquatic life protection (Table 2 and Figure 5).

Manganese (Mn) content in sea water and sediment samples

Manganese (Mn) is the naturally occurring metal usually present in many types of rocks. In sea water Mn tends to form particles in the water or settle into the sediment. The manganese (Mn) content in sea water samples were observed in the annual range of 0.003-0.012 ppm in 2012, 0.008-0.026 ppm in 2013 and 0.010- 0.026 ppm in 2014, respectively. The highest value of0.026 ppm was observed in cold season. These values exceeded the EPA standard 0.05 ppm because of the environmental pollution by the waste products of visiting people and villagers (such as, batteries, materials made by iron). The lowest value of 0.003ppm was observed in hot season (Table 3 and Figure 6).

The concentration of manganese (Mn) in sediment samples were in the annual range of 150.5- 152.2 mg/kg in 2012, 156.3-160.2 mg/kg in 2013 and 160.4 - 164.3 mg/kg in 2014, respectively. The highest content of 164.3 mg/kg was observed in cold season and the lowest value of150.5 mg/kg was found in hot season. The resultant data were within the CBSQGs (TEC) (2010) value 460 mg/kg for aquatic life protection (Table 3 and Figure 7).

Iron (Fe) content in sea water and sediment samples

The iron (Fe) concentration in water may be present in varying quantities depending upon the geological area and other chemical component of the water way (Chapman.,1996). The iron (Fe) contents was found to be in the annual range of 0.140-0.143 ppm in 2012, 0.160-0.190 ppm in 2013 and 0.169- 0.210 ppm in 2014, respectively. Fe content is not of concern (NC) in the ASEAN Standard. The highest iron (Fe) content of 0.210 ppm was found

in hot season due to the geological nature of the sewage and some industrial waste and the lowest value0.140 ppm was found in rainy season (Table 4 and Figure 8).

The iron (Fe) content in sediment samples were found to be in the annual range of 1200- 1260 mg/kg in 2012, 1300-1500 mg/kg in 2013 and 1400-1700 mg/kg in 2014, respectively. The maximum value1700 mg/kg was found in hot season and the minimum value 1200 mg/kg was found in rainy season. These values were lower than the CBSQGs (TEC) (2010) value of 20000 mg/kg for aquatic life protection (Table 4 and Figure 9).

Zinc (Zn) content in sea water and sediment samples

The zinc (Zn) concentration in sea water samples were observed in the annual range of 0.060 - 0.130 ppm in 2012, 0.079 - 0.139 ppm in 2013 and 0.088 - 0.130 ppm in 2014, respectively. The maximum Zn value 0.139 ppm was observed in hot season due to the evaporation of water and temperature effect. The minimum Zn value 0.060 ppm was observed in rainy season(Table 5 and Figure 10). Zn value is not of concern (NC) in the ASEAN standard.

The concentration of Zinc (Zn) in sediment samples may be present in the annual range of 50.70- 57.55 mg/kg in 2012, 56.50–58.70 mg/kg in 2013 and 60.20 - 60.80 mg/kg in 2014, respectively. The maximum content of (Zn)60.80 mg/kgwas observed in hot season and the minimum value of (Zn)50.70mg/kg was found in rainy season. The resultant data were within the CBSQGs (TEC) (2010) value of 120 mg/kg for aquatic life protection (Table 5 and Figure 11).

Lead (Pb) content in sea water and sediment samples

The Lead (Pb) concentration in sea water samples were observed in the annual range of 0.001 - 0.003 ppm in 2012, 0.002 - 0.007 ppm in 2013 and 0.003 - 0.008 ppm in 2014, respectively. The highest Pb value 0.008 ppm was observed in hot season. The lowest Pb value 0.001 ppm was observed in cold season (Table 6 and Figure 12). These values were lower than the ASEAN standard 0.009 ppm.

The concentration of Lead (Pb) in sediment samples were in the annual range of 0.016 – 0.019 mg/kg in 2012, 0.024 – 0.028 mg/kg in 2013 and 0.024 – 0.045 mg/kg in 2014, respectively. The highest content 0.045 mg/ kg was observed in hot season and the lowest value of 0.016 mg/kg was found in cold season. Both of sea water and sediment samples the highest values were found in hot season. It would be attributed to the industrial and agricultural discharge as well as from spill of lead petrol from fishing boats and dust (Table 6 and Figure 13).

Cadmium (Cd) content in sea water and sediment samples

Cadmium (Cd) is certainly a dangerous water pollutant, causing a major water quality problem. Source of cadmium is industrial discharge, mining waste, metal plating and water pipes (Strickland and Parsons, 1972). The concentration of cadmium (Cd) in sea water samples were found to be in the annual range of 0.003-0.004 ppm in 2012, 0.004- 0.007 ppm in 2013 and 0.006 - 0.008 ppm in 2014, respectively. Of these three season, the highest value 0.008 ppm was found in cold season due to the decreasing rate of organic matter decomposition and low water temperature. The lowest value of0.003 ppm was found in rainy season (Table 7 and Figure 14). These values were lower than the ASEAN standard of 0.010 ppm.

The concentration of cadmium (Cd) in sediment samples were found to be in the annual range of 0.011-0.021 mg/kg in 2012, 0.020-0.024 mg/kg in 2013 and 0.012-0.031 mg/kg in 2014, respectively. The highest cadmium (Cd) value 0.031 mg/kg was found in cold season and the lowest value 0.011mg/kg was found in rainy season. The high level of cadmium contamination may be due to the soil composition and environmental pollution in the study area (Table 7 and Figure 15).

Mercury (Hg) and Arsenic (As) contents in sea water and sediment samples

The mercury and arsenic contents were not detected in sea water and sediment sample (Tables 8 and 9).

Table 1. Seasonal Variation of Chromium (Cr) Content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Cr (ppm)	Cr (mg/kg)
2012	Hot	ND	ND
	Rainy	0.010	0.12
	Cold	0.020	ND
2013	Hot	0.020	ND
	Rainy	0.003	0.22
	Cold	0.050	0.23
2014	Hot	0.040	ND
	Rainy	0.006	0.24
	Cold	0.050	0.26
ASEAN (2010)		0.05	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	43

- ASEAN Standard for human health protection (2010) (for recreational activities)
- EPA standard for aquatic life protection (2010)
- CBSQGs, Consensus Based Sediment Quality Guide lines (2010)
- TEC- Threshold Effect Concentration
- ND- Not Detected

Table 2. Seasonal Variation of Copper (Cu) Content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Cu (ppm)	Cu (mg/kg)
2012	Hot	0.036	3.85
	Rainy	ND	3.18
	Cold	0.003	3.45
2013	Hot	0.060	4.85
	Rainy	0.004	4.60
	Cold	0.009	4.25
2014	Hot	0.013	6.40
	Rainy	0.003	6.30
	Cold	0.008	6.20
ASEAN (2010)		0.008	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	32

ND = Not Detected

Table 3. Seasonal Variation of Manganese (Mn) content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Mn (ppm)	Mn mg/kg)
2012	Hot	ND	152.2
	Rainy	0.003	150.5
	Cold	0.012	151.5
2013	Hot	ND	156.3
	Rainy	0.008	158.4
	Cold	0.026	160.2
2014	Hot	ND	160.4
	Rainy	0.010	162.5
	Cold	0.026	164.3
ASEAN (2010)		NC	-
EPA (2010)		0.05	-
CBSQGs (TEC) (2010)		-	460

NC = Not of Concern

ND = Not Detected

Table 4: Seasonal Variation of Iron (Fe) content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Fe (ppm)	Fe (mg/kg)
2012	Hot	0.140	1260
	Rainy	0.142	1200
	Cold	0.143	1250
2013	Hot	0.190	1500
	Rainy	0.160	1400
	Cold	0.160	1300
2014	Hot	0.210	1700
	Rainy	0.169	1600
	Cold	0.172	1400
ASEAN (2010)		NC	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	20000

NC = Not of Concern

Table 5: Seasonal Variation of Zinc (Zn) Content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Zn (ppm)	Zn (mg/kg)
2012	Hot	0.130	57.55
	Rainy	0.060	50.70
	Cold	0.101	55.60
2013	Hot	0.139	58.70
	Rainy	0.079	57.60
	Cold	0.110	56.50
2014	Hot	0.120	60.80
	Rainy	0.088	60.40
	Cold	0.130	60.20
ASEAN (2010)		NC	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	120

NC = Not of Concern

Table 6: Seasonal Variation of Lead (Pb) Content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Pb (ppm)	Pb (mg/kg)
2012	Hot	0.003	0.018
	Rainy	0.001	0.019
	Cold	0.001	0.016
2013	Hot	0.007	0.028
	Rainy	0.002	0.024
	Cold	0.004	0.027
2014	Hot	0.008	0.045
	Rainy	0.003	0.024
	Cold	0.006	0.025
ASEAN (2010)		0.009	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	-

Table7: Seasonal Variation of Cadmium (Cd) content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Cd (ppm)	Cd (mg/kg)
2012	Hot	ND	ND
	Rainy	0.003	0.011
	Cold	0.004	0.021
2013	Hot	ND	0.020
	Rainy	0.007	0.024
	Cold	0.004	0.021
2014	Hot	ND	0.012
	Rainy	0.006	0.025
	Cold	0.008	0.031
ASEAN (2010)		0.010	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	-

ND = Not Detected

Table 8: Seasonal Variation of Arsenic (As) Content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		As (ppm)	As (mg/kg)
2012	Hot	ND	ND
	Rainy	ND	ND
	Cold	ND	ND
2013	Hot	ND	ND
	Rainy	ND	ND
	Cold	ND	ND
2014	Hot	ND	ND
	Rainy	ND	ND
	Cold	ND	ND
ASEAN (2010)		0.036	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	-

ND = Not Detected

Table 9: Seasonal Variation of Mercury (Hg) Content in Sea Water and Sediment Samples

Year	Season	Sea Water	Sediment
		Hg (ppm)	Hg (mg/kg)
2012	Hot	ND	ND
	Rainy	ND	ND
	Cold	ND	ND
2013	Hot	ND	ND
	Rainy	ND	ND
	Cold	ND	ND
2014	Hot	ND	ND
	Rainy	ND	ND
	Cold	ND	ND
ASEAN (2010)		0.16	-
EPA (2010)		-	-
CBSQGs (TEC) (2010)		-	-

ND = Not Detected

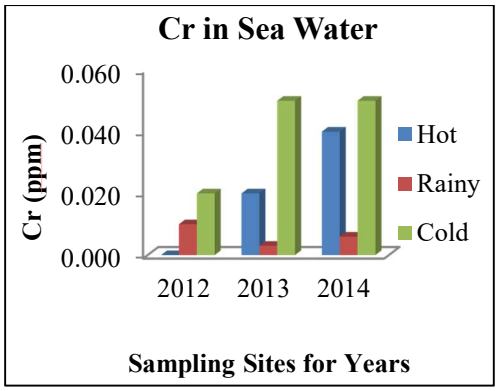

Figure 2: Histogram of Cr in sea water samples Vs study period

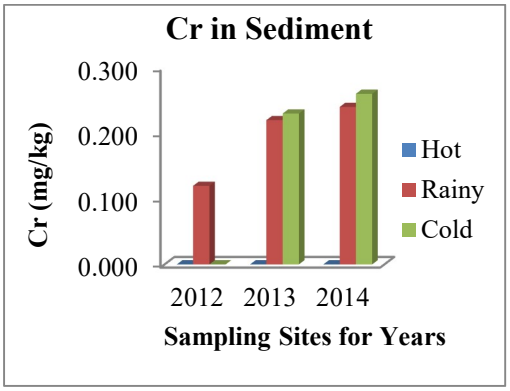

Figure 3: Histogram of Cr in sediment samples Vs study period

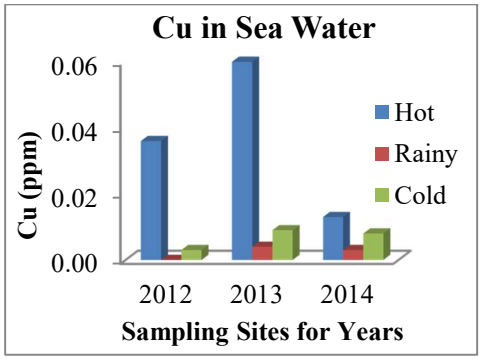

Figure 4: Histogram of Cu in sea water samples Vs study period

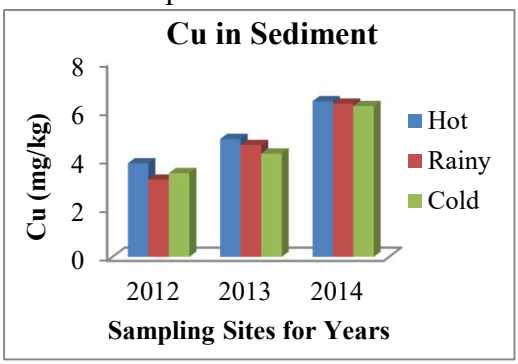

Figure 5: Histogram of Cu in sediment samples Vs study period

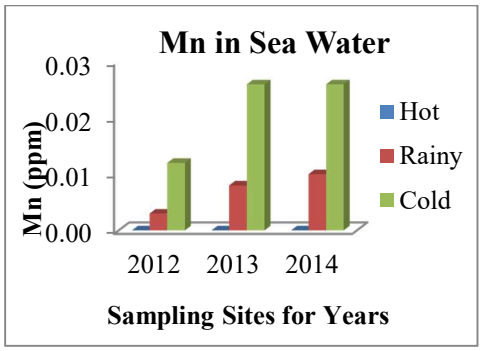

Figure 6: Histogram of Mn in sea water samples Vs study period

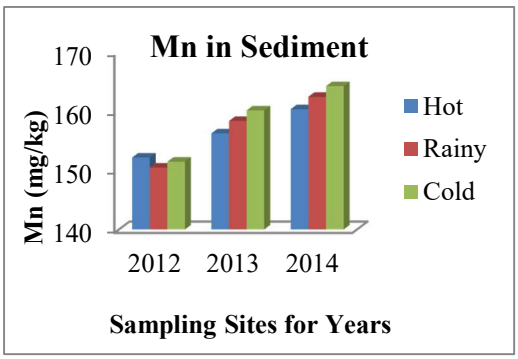

Figure 7: Histogram of Mn in sediment samples Vs study period

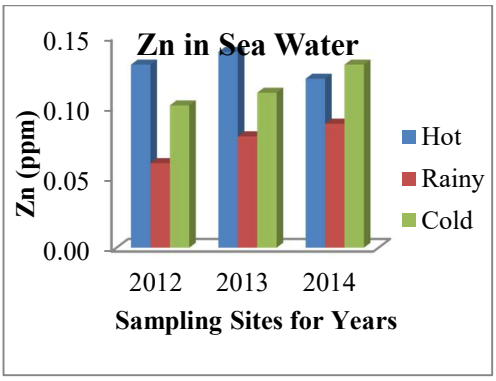

Figure 8: Histogram of Zn in sea water samples Vs study period

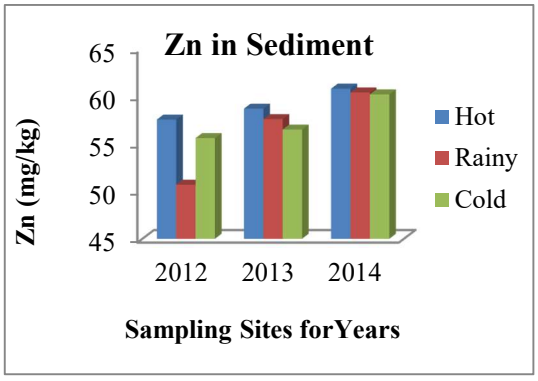

Figure 9: Histogram of Zn in sediment samples Vs study period

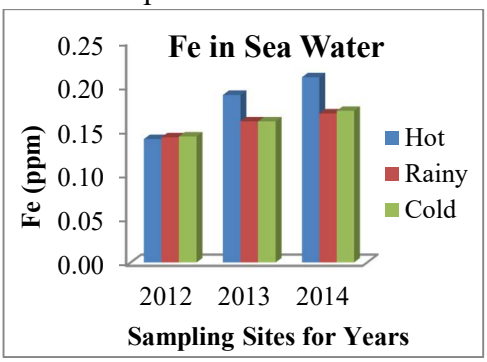

Figure 10: Histogram of Cu in sea water samples Vs study period

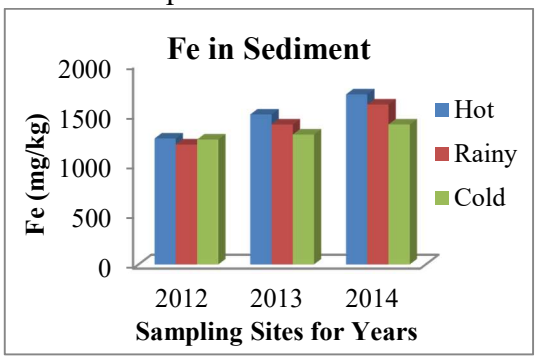

Figure 11: Histogram of Cu in sediment samples Vs study period

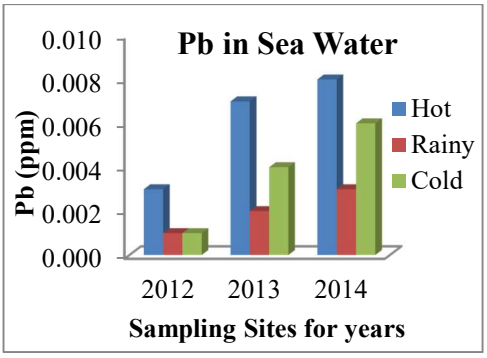

Figure 12: Histogram of Pb in sea water samples Vs study period

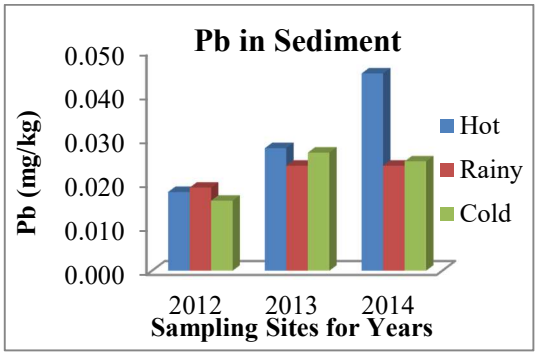

Figure 13: Histogram of Pb in sediment samples Vs study period

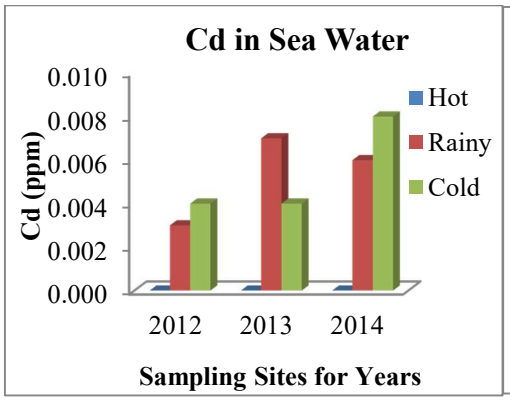

Figure 14: Histogram of Cd in sea water samples Vs study period

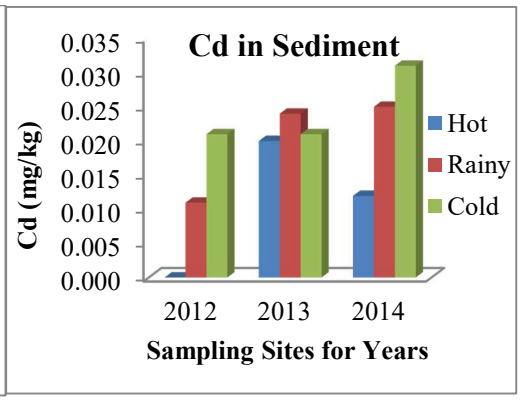

Figure 15: Histogram of Cd in sediment samples Vs study period

Conclusion

By evaluating the heavy metals accumulation content in sea water and sediments, it can be concluded that heavy metals are highly accumulated in sediments than sea water. Some metal (Cr, Mn, Fe, Zn, Pb and Cd) contents in sea water samples (except Cu) were found within the permissible level of ASEAN and EPA standards. In sediment samples (Cr, Cu, Mn, Zn, Fe, Pb and Cd) values were lower than the Consensus Based Sediment Quality Guide lines (TEC) standards for aquatic life protection showing not toxic on aquatic life especially benthic-dwelling organisms. The mercury and arsenic values were not detected during the study period in sea water and sediment sample. Thus the studied region in the period from 2012-2014, is free of heavy metals pollution and the marine ecosy ohm is still Sofe to for aquatic life and fisheries.

Acknowledgements

The authors would like to express their profound gratitude to the Department of Higher Education (Yangon Office), Ministry of Education, Yangon, Myanmar, for provision of opportunity to do this research and Myanmar Academy of Arts and Science for allowing to present this paper.

References

ASEAN Marine Environmental Management.(2010). *Water Quality Criteria and Standards for Freshwater and Marine Aquaculture*. North Vancouver: EVS Environmental Consultants Ltd., 171-189

Censi, P., Spoto, S.E., Saiano, F., Sprovieri, M. and Mazzola, S. (2006). "Heavy Metals in Coastal Water System, A Case Study from the North Western Gulf of Thailand". *Chemosphere,*vol.64, pp.1167-1176

Chapman, D. (1996). *A Guide to the Use of Biota Sediments and Water in Environmental Monitoring in Water Quality Assessment*. London : 2nd Edn. , E & FNSPON, pp.8-91

Consensus-Based Sediment Quality Guidelines (CBSQGs). (2010). *Contaminated Sediment Standing team Recommendations for Use & Application.* Washington DC: Equal Opportunity Office, Department of Interior, pp.1-17

EPA.(2010). *Nutrient Water Quality Standards.* Washington, DC: Office of Water Research

Kyaw Naing. (2011). *National Report of Myanmar on the Coastal Pollution Loading and Water Quality Criteria (Land-based Sources of Marine Pollution).*Rome: Bay of Bengal Large Marine Ecosystem Project to the Food and Agriculture Organization of the United Nations, FAO, 1-53

Strickland, J. D. H. and Parsons, T. R. (1972). *A Practical Handbook of Sea Water Analysis*. Fisheries Research Board of Canada, 21-29

Wikipedia, the Free Encyclopedia. (2013). *Chaung Tha Beach.* http://en.wikipedia.org/wiki/ Chaung Tha. html (Accessed 30 May 2011)