J. Myanmar Acad. Arts Sci. 2020 **Vol. XVIII.No.1**C

STUDY ON *IN SITU* REMEDIATION OF CONTAMINATED SEDIMENT FROM FLOODED AREA OF MINBYA TOWNSHIP, RAKHINE STATE

Khin Myint[1], Shwe Sin[2] and Aye Aye Lwin[3]

Abstract

This research is concerned with the remediation of contaminated sediments from the flooded areas, Middle Lake and Small Lake of Minbya Township in Rakhine State.The two sediment samples were collected in September, 2018. The investigative analyses were done in terms of distribution of some heavy metals in the sediment samples and microbiological properties of sediments. Relative abundances of elements in the sediment samples were determined by EDXRF. The quantitative elemental analysis of the sediment samples were determined by AAS. Cadmium concentrations of the both sampling sites were not detected and those of arsenic , iron and lead were (0. 14 , 0.15) ppm, (24.17 , 24.57) ppm and (0.09, 0.23) ppm, respectively. Microbiological properties of sediments were examined by using 3M Petri Films. Total Coliform could be observed as (3000) and (9000) cfu g^{-1} in these study areas. However, *E.coli* could not be detected in both sites. Overall values of study areas indicated that the iron was in high level in the contaminated samples. The in-Situ treatment system for contaminated sediment was treated by using lime amendment and sand-cap. The cost effective in-situ treatment system has shown the significant removal percent of iron (50.29 %) to (50 %) compared with control (without amendment) system. This remediation technique code inferred the very beneficial for rural area as in cost effective and locally available technique.

Keywords : sediment, flooded areas, microbiological properties , in-situ treatment system

Introduction

Widespread accumulations of flood sediments were left behind in Minbya Township after the flood. The main purpose of this paper is to provide a review on the in-situ remediation technology of heavy metal in sediment (Peng *et al* ., 2009). The contamination of aquatic sediments with metals is a widespread environmental and human health problem (Akcil *et al*., 2015).

Heavy metals from various sources can enter a natural aquatic system after flood waters. Heavy metal contamination has become a worldwide problem through disturbing the normal functions of river and lakes). Heavy metals usually possess significant toxicity to aquatic organisms and then effect human health from food chain (Peng *et al* ., 2009).

Sediment, as the largest storage and resources of heavy metal, plays a rather important role in metal transformations . Heavy metals cannot fix in sediment forever. With the variation of the physical-chemical characteristics of water conditions, part of these fixed metals will re-enter the overlying water (Loser *et al*.,2007) .

Conventional remediation strategies include in-place sediment remediation strategies such as In Situ- capping and relocation actions are still widely applied (Renholds,2015). Normally, decreasing the direct contact area between water and the contaminated sediment

---

[1] Dr, Lecturer, Department of Chemistry, Sittway University

[2] Dr, Associate Professor, Department of Chemistry, Mandalay University

[3] Dr, Associate Professor, Department of Chemistry, Maubin University

is a good choice for lowering the release content of heavy metal . Therefore , capping the contaminated sediment with sandy materials becomes an effective remediation technique. This remediation technique can only reduce the transfer rate of metal in sediment, while their immobilization effect for heavy metal is small. Therefore, for enhancing their immobilization capacity , some amendments such as apatite or zeolite can also be added into the sand cap.

Materials and Methods

Collection for Flooded Sediment Samples

The study area is located at Minbya Township in Rakhine State. Its geographical coordination is 20°21' 45.78" North Latitude and 93°16' 02.87" East Longitude. This study was conducted in September, 2018. The main annual rainfall is about nearly 150 mm while the average temperature ranged between 21°C to 34°C in the prescribed zone.

The sediment samples were collected from two sampling sites, Middle Lake and Small Lake, at Minbya Township in Rakhine State as shown in Figures 1 and 2.Both Lakes are located about North Latitude 20°21' and about East Longitude 93°16'. These sediment samples were taken from the depth of 15 cm of sediment surface in a zigzag manner by using GPS (Global Positioning System). Then the sediment sample from each site was mixed thoroughly to homogenize and put it into the plastic bottle . Sediment samples were carried to the laboratory and kept in cold and dark place.

Figure 1 Photograph of Middle Lake

Figure 2 Photograph of Small Lake

Determination of Trace Elements in Sediment Samples by Atomic Absorption Spectrometry

0.1 g of air-dried sediment sample was placed in an Erlenmeyer flask. 20 mL of extracting solution (0.05 M HCl + 0.0125 M H_2SO_4) was added in the flask and shaken for 15 min. Then the solution was filtered into a 50 mL volumetric flask through filter paper and diluted to 50 mL with extracting solution.

The standard solution having the varying strength was sprayed into the gas flame of Atomic Absorption Spectrometer.

At least three known concentration of each standard metal solution were selected. These should be one concentration greatest and one less than that expected ppm range in the sample. Each standard solution was aspirated in turn into the gas flame and recorded the absorbance from the display. By using the calibration curve of the three standards, the concentrations of sample were read out. The results are presented in Table 2.

Determination of Total Coliform and *E.coli* in Sediment Sample Using 3M Petri Film

Petri Film *E.coli* count plate was placed on a flat surface. The top film was lifted and dispensed 1 mL of sample, treated with potassium dihydrogen phosphate buffer solution, onto the center of the bottom film. The top film was slowly rowed down onto the sample to prevent the entrapment of air. The sample was distributed evenly within the circular well using gentle downward pressure on the center of the plastic spreader (flat side down). The spreader was not slide across the film. The spreader was removed and left plate undisturbed for 1 min to permit solidification of the gel. The plate were left in a horizontal position with the clear side up in stacks not exceeding 20 plates. The plate were incubated for 24 ± 2h and examined for coliform and *E.coli* growth. Some *E.coli* colonies require additional time to form blue precipitate. The plates were re-incubated for an additional 24 ± 2h to detect any additional *E.coli* growth. According to AOAC method (991.14), Petri Film plates were incubated at 35 ± 1 ˚C.

Experimental Design for In-situ Remediation

In order to determine the removal efficiency of amendment, eight beakers were prepared. The experiments were completely arranged in 8 different series (I, II, III, IV, V, VI, VII, and VIII) and three replications for each treatment. Each vessel was filled by sediment sample (50 g) at the bottom. The collected water sample from respective sampling site was added into all vessels. Lime powder (10 g) each was added to the four vessels (I, II, III, IV) and marked as tested sample. The other four vessels (V, VI, VII and VIII) were not added with lime and designated as control sample. All the samples were kept in cold and dark place for one week.

The sand sample, lower the release content of heavy metal, was collected from Sittway Beach near Sittway Hotel in Rakhine State. The collected sand was washed with distilled water (three times), 1 % sulphuric acid, and dried under the sunlight. The obtained dry sand (10 g) was filled to cover the tested sample (I, II, III , IV) and control sample (V, VI, VII, VIII). All the samples were caped in similar manner that was described above for one week.

After two weeks, the sediment sample was collected to determine the removal percentage of Fe metal using AAS .

Results and Discussion

Qualitative Elemental Analysis of Sediment Samples by EDXRF

Relative abundances of elements in sediment samples were determined by EDXRF spectrometer. The EDXRF spectra of sediment samples are shown in Figures 3 and 4. The results are recorded in Table 1. It can be observed that the sediment samples of Middle Lake contained Si (47.633 %), Fe (36.596 %), K(8.290 %), Ca (3.492 %) and Ti (3.022 %), respectively. 45.072 %, 41.929 %, 7.073 %, 2.739 % and 2.371 % of Si, Fe, K, Ca and Ti, respectively, were present in the Small Lake. A small amount of other elements such as, Zr , Sr , Cr, Zn, Cu, As, Mn, and Y were found in the Middle Lake and Zr, Mn, Cu, Zn, Sr, Cr and Y were found in the Small Lake.

Table 1 Relative Abundance of Elements in Sediment Samples by EDXRF

No.	Element	Relative Abundance (%)	
		Middle Lake	Small Lake
1	Si	47.633	45.072
2	Fe	36.596	41.929
3	K	8.290	7.073
4	Ca	3.492	2.739
5	Ti	3.022	2.371
6	Zr	0.341	0.236
7	Sr	0.130	0.096
8	Cr	0.112	0.090
9	Zn	0.100	0.098
10	Cu	0.082	0.107
11	As	0.072	ND
12	Mn	0.067	0.137
13	Y	0.061	0.052

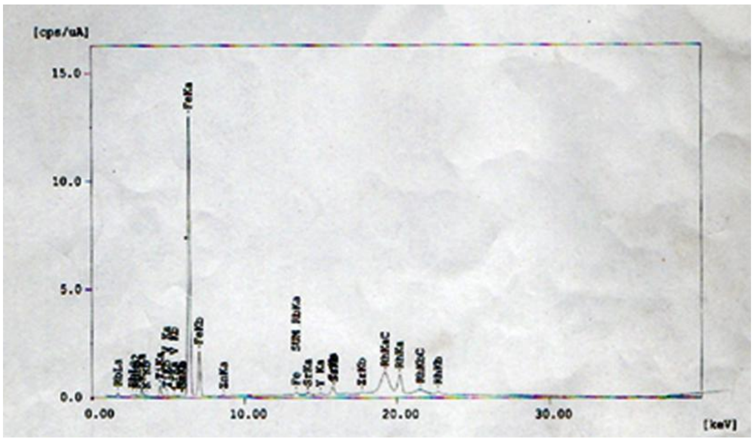

Figure 3 EDXRF spectrum of sediment sample from Middle Lake

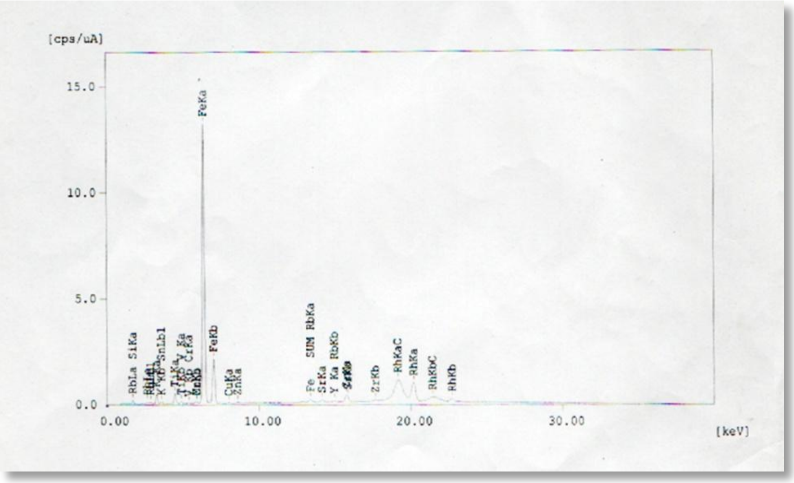

Figure 4 EDXRF spectrum of sediment sample from Small Lake

Determination of Heavy Metals in the Sediment Samples by Atomic Absorption Spectrophotometry

In this research, atomic absorption spectrophotometer (Perkin-Elmer) was employed for the determination of heavy metals in the collected sediment samples.

The contents of heavy metals in the collected sediment samples are shown in Table 2 and Figure 5. Iron concentrations of the two sampling sites were 24.17 and 24.57 ppm, arsenic concentrations were 0.14 and 0.15 ppm and lead concentrations were 0.09 and 0.23 ppm, respectively. Cadmium concentration of those samples were not detected in both sites. The level of Iron in these study areas were above the permissible limit set by the World Health Organization (1-3) ppm .

Table 2 Some Heavy Metal Contents of the Collected Sediment Samples by AAS

No.	Heavy Metals	Concentration (ppm)	
		Middle Lake	Small Lake
1	Fe	24.17	24.57
2	As	0.14	0.15
3	Pb	0.09	0.23
4	Cd	ND	ND

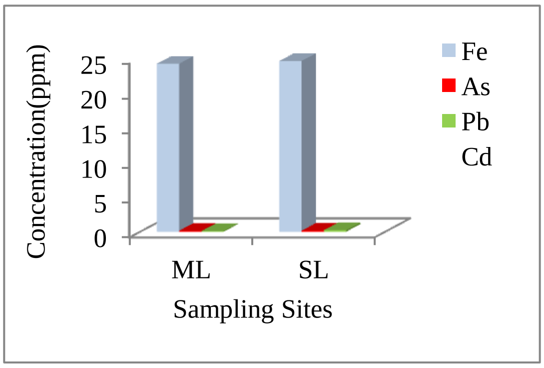

Figure 5 Heavy metal concentration of collected sediment samples

Total Coliform and *E.coli* in the Sediment Samples

In this research, 3 M Petri Film was used for the microbiological test of the collected sediment samples.

Total Coliform and *E.coli* contents of the collected sediment samples are shown in Table 3 and Figures 6 (a) and (b). Total Coliforms of Middle Lake and Small Lake were 3000 and 9000 cfu g^{-1}, respectively. Total Coliforms of these two Lakes were below the permissible limit of AOAC standard . However, *E.coli* was not detected in both sites.

Table 3 Coliforms and *E.coli* Contents of the Collected Sediment Samples

No.	Sediment Sample	Coliform (cfu/g)	*E.coli* (cfu/g)
1	Middle Lake	3000	ND
2	Small Lake	9000	ND

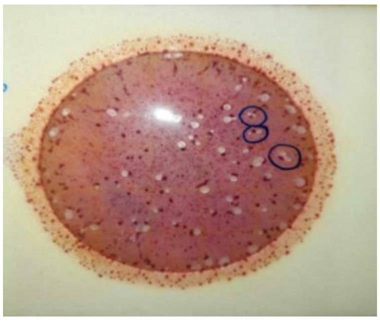

Figure 6 (a) Photograph of Coliform and *E.coli*

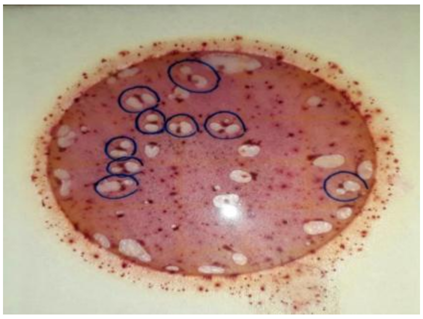

Figure 6 (b) Photograph of Coliform and *E.coli* colle in the Middle Lake in the Small Lake

Removal Percent of Iron from the Collected Sediment Samples by using In-situ Capping Method

In-situ capping method was used for the determination of removal percent of Iron in Middle Lake and Small Lake.

Removal Iron percents of the two study areas are shown in Table 4 and Figure 7. Removal Iron percent of Middle Lake and Small Lake were 50.29 % and 50.00 % .

Table 4 Removal Iron Percent of the Collected Sediment Samples by using In-situ Capping Method

No.	**Sediment Sample**	**Removal Percent of Iron (%)**
1	Middle Lake	50.29
2	Small Lake	50.00

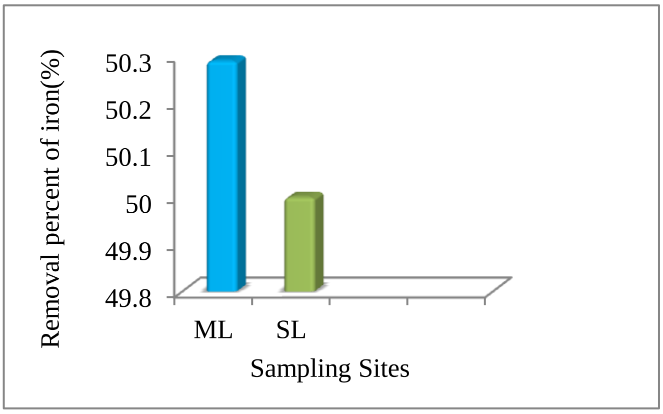

Figure 7 Removal percent of iron from the collected sediment samples

Conclusion

Nowadays, heavy metals pollution in river and lake sediments have gradually become a major concern worldwide. The remediation of contaminated sediment is necessary.

In this research, two lakes of flooded areas in Minbya Township were used as the sampling sites. EDXRF spectra indicated that the higher percents of Fe(36.596 %) in Middle Lake and Fe (41.929 %) in Small Lake . A small amount of other elements, Zr, Sr, Cr, Zn, Cu, As, Mn, and Y were found in the Middle Lake and Zr, Mn, Cu, Zn, Sr, Cr and Y were found in the Small Lake.

From the quantitative analysis of the sediment samples, it was found that iron concentrations of the two sampling sites were 24.17 and 24.57 ppm, arsenic concentrations were 0.14 and 0.15 ppm and lead concentrations were 0.09 and 0.23 ppm, respectively. Cadmium concentrations of those samples were not detected in both sites.

From the investigation of microbiological test using 3M Petri Film 3000 and 9000 cfu g^{-1} of total Coliforms were observed in Middle Lake and Small Lake, respectively. However, *E.coli* would not be detected in both sites.

According to the results of In Situ capping method to the contaminated sediments, the concentration of Irons (50.29 % and 50 % for Middle Lake and Small Lake) could be reduced significantly using lime amendment and sand-cap. This remediation technique code inferred the very beneficial for rural area due to their easy operation, low costs and fast remediation effect.

Acknowledgements

The authors would like to thank the Department of Higher Education, Ministry of Education for allowing to carry out this research program . The authors are also thankful to Professor Dr Mya Thu Zar , Head of the Department of Chemistry , University of Sittway, for providing the research facilities.

References

Akcil,A., Erust,C., Ozdemiroglu, S.,Fonti,V.,and Beolchini,F.(2015). "A Review of Techniques used in Aquatic Contaminated Sediments: Metal Removal and Stabilization by Chemical and Biotechnological Process". *Journal of Cleaner Production*, vol.86,pp.24-36

Renholds.(1998) . *In Situ Treatment of Contaminated Sediments .U.S.Environmental Protection Agency Office of Solid Waste and Emergency Response Technology Innovation Office Washington,D.C.*,PP.3-4

Loser,C ., Andreas, Z., Petra,H., and Seidel,H. (2007) . " Remediation of Heavy Metal Polluted Sediment by Suspension and Solid – bed Leaching : Estimate of Metal Removal Efficiency ." *Chemosphere* , vol. 66, pp.1699-1705

Peng, J.f., Song,Y.,Yuan,P.,Cui,X-yu ,and Qiu,G.lu. (2009). "The Remediation of Heavy Metals Contaminated Sediment". *Journal of Hazardous Materials* , vol.161, pp.633-640