

**DISTRIBUTION OF HEAVY METALS IN SEDIMENTS OF
SETIU WETLAND, TERENGGANU DURING MONSOON AND
NON MONSOON SEASONS**

By

Fatthima Binti R. M Mohamad Hussain

**Research Report submitted in partial fulfillment of
The requirements for the degree of
Bachelor of Science (Marine Science)**

**Department of Marine Science
Faculty of Maritime Studies and Marine Science
UNIVERSITI MALAYSIA TERENGGANU
2007**

1100054332

This project should be cited as:

FATTHIMA, H., 2007. Distribution of Heavy Metals in Sediments of Setiu Wetland, Terengganu during Monsoon and Non Monsoon Seasons Final Year Project Report, Bachelor of Science (Marine Science), Department of Marine Science, Faculty of Maritime Studies and Marine Science, Universiti Malaysia Terengganu. 123p

No part of this project may be produced by any mechanical, photographic, or electronic process, or in a form photographic, recording nor may be stored in a retrieval system, transmitted, or otherwise copied for public or private use, without written permission from the author and the supervisor of the project.



**DEPARTMENT OF MARINE SCIENCE
FACULTY OF MARITIME STUDIES AND MARINE
SCIENCE
UNIVERSITI MALAYSIA TERENGGANU
Mengabang Telipot, 21030 Kuala Terengganu**

**APPROVAL AND CERTIFICATION FORM
RESEARCH PROJECT I AND II (SKL 4999A&B)**

I certify that the research report entitled: Distribution of Heavy Metals in Sediments of Setiu Wetland, Terengganu during Monsoon and Non Monsoon Seasons by Fathima Binti R.M Mohamad Hussain, Matric No. UK 10334 has been read and all corrections recommended by the examiners have been done. This research project is submitted to the Department of Marine Science in partial fulfillment of the requirements for the degree of Bachelor of Science in Marine Science, Faculty of Maritime Study and Marine Science Universiti Malaysia Terengganu.

Approved by:

Supervisor

Name: 
DR. NOR ANTONINA ABDULLAH

Stamp **Pensyarah
Jabatan Sains Marin
Fakulti Pengajian Maritim dan Sains Marin
Universiti Malaysia Terengganu
(UMT)**

Date: 30/04/07

Head of Department

Name:

Stamp


DR. RAZAK ZAKARIYA
Ketua Jabatan Sains Marin
Fakulti Pengajian Maritim dan Sains Marin
Universiti Malaysia Terengganu
(UMT)

Date:

6/5/07

ACKNOWLEDGEMENT

Alhamdulillah thanks to Allah S.W.T., The Almighty and full of graciousness. Great thanks also dedicated to my supervisor Dr. Nor Antonina bt Abdullah with all the support, guidance and or helping me for a solution for a problem, thank you very much for spending your time and your beautiful advice. Not forgetting, to my ex-second supervisor Assoc. Prof. Dr. Kamaruzzaman B. Haji Yunus and also Prof. Dr. Noor Azhar B. Mohd Shazili for lending me the microwave oven for heavy metal digestion during my analysis and also their attention and consideration by giving advice and guidance in completing my project. Besides that, many thanks to the laboratory assistants in Oceanography Laboratory, Mr Kamari in helping me for twice in sampling, Mr. Sulaiman, Mr. Raja, and Mr Kamarun for their help during my laboratory analysis. Thanks a lot to Mr Kamari who help me during sampling especially in the monsoon season with the hardness on the rainy season. To master student Kak Nad in guiding me to operate the AAS and all her advice and support, not forgotten to Benny in helping me during the laboratory analysis, thanks in never give up being disturb in helping me. Most importantly to my loving family, thanks to my mother, brothers and sister Khairun and not forgotten to my late father who is my inspiration, thanks for continuous encouragement, unconditional love and support with advices in furthering my studies here. Thanks for your love!! Thank you very much.

TABLE OF CONTENTS

ACKNOWLEDGEMENT	ii
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF APPENDICES	xi
LIST OF ABBREVIATIONS	xiii
ABSTRACT	xiv
ABSTRAK	xv
Chapter 1 INTRODUCTION	1
1.1 Objectives of the study	4
Chapter 2 LITERATURE REVIEW	
2.1 Setiu Wetland	5
2.2 Heavy metal	6
2.3 Individual characteristics of heavy metal	
2.3.1 Aluminium (Al)	8
2.3.2 Copper (Cu)	9
2.3.3 Manganese (Mn)	9
2.3.4 Lead (Pb)	10
2.3.5 Zinc (Zn)	10

2.3.6 Cadmium (Cd)	10
2.4 Pollution and sources of heavy metal	11
2.5 Sedimentation and geological process	13
2.6 Particle size and its correlation with heavy metal	15
2.7 Organic Carbon and its correlation with heavy metal	16
2.8 Monsoon	18

Chapter 3 MATERIALS AND METHODS

3.1 Research location	20
3.2 Sampling	21
3.3 Hydrological Parameters Measurement	22
3.4 Laboratory analysis	22
3.4.1 Particle Size Analysis	23
3.4.1.1 Sample preparation	23
3.4.2 Sediment analysis using Laser Diffraction method	24
3.4.3 Dry sieving method	24
3.5 Calculation of sedimentological parameters	25
3.5.1 Mean(Φ)	26
3.5.2 Standard deviation (Φ)	26
3.5.3 Skewness (Φ)	26
3.5.4 Kurtosis (Φ)	26
3.6 Determination of Heavy Metals	27
3.6.1 Apparatus Preparation	27
3.6.2 Sample preparation	28

3.6.3	Microwave digestion	28
3.6.4	Heavy metal detection of AAS	31
3.6.5	Determination of enrichment factor	33
3.7	Organic Carbon Content	33
3.7.1	Titration technique	34
3.7.2	Blank Sample Preparation	35
3.7.3	Recovery Test	36
3.8	Geostatistical Analysis IDW mapping	37

Chapter 4 RESULTS

4.1	Sedimentological Characteristics	38
4.1.1	Mean Size	38
4.1.2	Sorting	40
4.1.3	Skewness	41
4.1.4	Kurtosis	42
4.2	Percentage of Organic Carbon	43
4.2.1	Recovery Test	43
4.3	Heavy Metal Analysis	45
4.3.1	Recovery Test	45
4.3.2	Copper (Cu)	46
4.3.3	Manganese (Mn)	46
4.3.4	Cadmium (Cd)	47
4.3.5	Lead (Pb)	48
4.3.6	Zinc (Zn)	48

4.3.7 Aluminium (Al)	49
4.4 Geostatistical Analysis IDW mapping	50
Chapter 5 DISCUSSION	
5.1 Sedimentological Characteristics	56
5.2 Percentage of Organic Carbon	59
5.2.1 Correlation between Particle Size and Organic Carbon	61
5.3 Heavy Metal and Sources	63
5.4 Enrichment Factor	68
5.5 Relation Graph	70
5.6 Relation of Heavy Metals with Percentage of Organic Carbon during monsoon and non monsoon	61 63
5.7 Relation of Heavy Metals with Mean particle size	78
5.8 Heavy Metals Content in Sediments	71
5.8.1 Aluminium (Al)	87
5.8.2 Copper (Cu)	87
5.8.3 Manganese (Mn)	88
5.8.4 Lead (Pb)	89
5.8.5 Zinc (Zn)	90
5.8.6 Cadmium (Cd)	91
Chapter 6 CONCLUSION	92
REFERENCES	94
APPENDICES	100
CURRICULUM VITAE	123

LIST OF TABLES

TABLE	PAGE
(3.1) Sampling location	21
(4.1) Sedimentological result for Non monsoon season	39
(4.2) Sedimentological result for monsoon season	39
(4.3) Result of Recovery test for organic carbon (%)	43
(4.4) Percentage of Organic Carbon (%) in sediment	44
(4.5) Result of Recovery test for heavy metals	45
(4.6) Heavy Metals Concentration during non monsoon	45
(4.7) Heavy Metals Concentration during monsoon	45
(5.1) Average of Enrichment factor	69
(5.2) Correlation matrix for the non monsoon season	86
(5.3) Correlation matrix for the during monsoon season	86

LIST OF FIGURES

FIGURE	PAGE
(3.1) Research location-Setiu Wetland	20
(4.1) Graph of the mean particle size	40
(4.2) Graph of the Sorting (ϕ)	41
(4.3) Graph of the skewness (ϕ)	42
(4.4) Graph of the kurtosis (ϕ)	43
(4.5) Graph of Percentage of Total Organic Carbon	44
(4.6) The Concentration of Cu ($\mu\text{g/g}$) in each station	46
(4.7) The Concentration of Mn ($\mu\text{g/g}$) in each station	47
(4.8) The Concentration of Cd ($\mu\text{g/g}$) in each station	47
(4.9) The Concentration of Pb ($\mu\text{g/g}$) in each station	48
(4.10) The Concentration of Zn ($\mu\text{g/g}$) in each station	49
(4.11) The Concentration of Al (%) in each station	49
(4.12) Cu ($\mu\text{g/g}$) distribution on non Monsoon Season	50
(4.13) Cu ($\mu\text{g/g}$) distribution on Monsoon Season	50
(4.14) Al (%) distribution on non Monsoon	51
(4.15) Al (%) distribution on Monsoon Season	51
(4.16) Mn ($\mu\text{g/g}$) distribution on non Monsoon Season	52
(4.17) Mn ($\mu\text{g/g}$) distribution on Monsoon Season	52
(4.18) Cd ($\mu\text{g/g}$) distribution on non Monsoon Season	53
(4.19) Cd ($\mu\text{g/g}$) distribution on Monsoon Season	53

(4.20) Zn ($\mu\text{g/g}$) distribution on non Monsoon Season	54
(4.21) Zn ($\mu\text{g/g}$) distribution on Monsoon Season	54
(4.22) Pb ($\mu\text{g/g}$) distribution on non Monsoon Season	55
(4.23) Pb ($\mu\text{g/g}$) distribution on Monsoon Season	55
(5.1) Percentage of OC% vs. mean during non-monsoon seasons	62
(5.2) Percentage of OC% vs. mean during monsoon seasons	63
(5.3) Cu ($\mu\text{g/g}$) concentration with OC% for Non Monsoon Season.	72
(5.4) Cu ($\mu\text{g/g}$) concentration with OC% for Monsoon Season	73
(5.5) Mn ($\mu\text{g/g}$) concentration with OC% for Non Monsoon Season.	73
(5.6) Mn ($\mu\text{g/g}$) concentration with OC% for Monsoon Season	74
(5.7) Cd ($\mu\text{g/g}$) concentration with OC% for Non Monsoon Season.	74
(5.8) Cd ($\mu\text{g/g}$) concentration with OC% for Monsoon Season	75
(5.9) Pb ($\mu\text{g/g}$) concentration with OC% for Non Monsoon Season.	75
(5.10) Pb ($\mu\text{g/g}$) concentration with OC% for Monsoon Season	76
(5.11) Zn ($\mu\text{g/g}$) concentration with OC% for Non Monsoon Season.	76
(5.12) Zn ($\mu\text{g/g}$) concentration with OC% for Monsoon Season	77
(5.13) Al (%) concentration with OC% for Non Monsoon Season.	77
(5.14) Al (%) concentration with OC% for Monsoon Season	78
(5.15) Cu ($\mu\text{g/g}$) concentration with mean size for Non Monsoon Season	80
(5.16) Cu ($\mu\text{g/g}$) concentration with mean size for Monsoon Season	81
(5.17) Mn ($\mu\text{g/g}$) concentration with mean size for Non Monsoon Season	81
(5.18) Mn ($\mu\text{g/g}$) concentration with mean size for Monsoon Season	82
(5.19) Cd ($\mu\text{g/g}$) concentration with mean size for Non Monsoon Season	82
(5.20) Cd ($\mu\text{g/g}$) concentration with mean size for Monsoon Season	83

(5.21) Pb ($\mu\text{g/g}$) concentration with mean size for Non Monsoon Season	83
(5.22) Pb ($\mu\text{g/g}$) concentration with mean size for Monsoon Season	84
(5.23) Zn ($\mu\text{g/g}$) concentration with mean size for Non Monsoon Season	84
(5.24) Zn ($\mu\text{g/g}$) concentration with mean size for Monsoon Season	85
(5.25) Al (%) concentration with mean size for Non Monsoon Season	85
(5.26) Al (%) concentration with mean size for Monsoon Season	86

LIST OF APPENDICES

APPENDIX		PAGE
1	Statistical analysis (T-test) for mean particle size	100
2	Statistical analysis (T-test) for sediment sorting	101
3	Statistical analysis (T-test) for sediment skewness	102
4	Statistical analysis (T-test) for sediment kurtosis	103
5	Statistical analysis (T-test) for sediment organic carbon percentage	104
6	Regression between mean size and the OC% on the non monsoon season.	105
7	Regression between mean size and the OC% on the monsoon season	106
8	Statistical analysis (T-test) for Cu	107
9	Statistical analysis (T-test) for Cd	108
10	Statistical analysis (T-test) for Mn	109
11	Statistical analysis (T-test) for Zn	110
12	Statistical analysis (T-test) for Pb	111
13	Statistical analysis (T-test) for Al	112
14	Concentration of heavy metals in the earth crust	113
15	Particle Size Analysis Laboratory work photo	114
16	Microwave Oven Digestion Method Laboratory work photo	115
17	Tide Table during Sampling Days	117
18	Hydrological data	118

19	Sedimentology classification	119
20	The enrichment value for all the stations	121
21	Non Monsoon PSA data for Station 5 (Non Monsoon)	122

LIST OF ABBREVIATIONS

° C	degree Celsius
Ø	Phi
µm	micrometer
g	gram
cm	centimeter
mL	milliliter
L	Liter
Mg/l	milligram per liter
µg/l	microgram per liter
ppm	part per million
ppb	part per billion
HF	Hydrofluoric acid
HNO ₃	Nitric acid
K ₂ Cr ₂ O ₇	Potassium dichromate
H ₂ SO ₄	Sulfuric acid
Al	Aluminium
Cu	Copper
Co	Cobalt
Mn	Mangan
Pb	Plumbum
Zn	Zinc
Cr	Chromium
Ni	Nickel
AAS	Atomic Absorption Spectrophotometry
EDTA	Ethylene Diamine Tetra Acetic Acid

ABSTRACT

Surface sediment samples from 10 stations along the Setiu River were analyzed to investigate and analyzed the differences on the distribution and sources of heavy metals during monsoon and non monsoon seasons. Sediment particle size was studied and the value of the sediment mean size was found to be higher during the monsoon season. The mean size ranged between 0.70 ϕ to 5.29 ϕ and 0.50 ϕ to 2.38 ϕ during both the non monsoon and monsoon seasons respectively. The organic carbon content also was studied and was higher during the monsoon season and ranged between 1.73% to 4.89% during the non monsoon season and 2.75% to 4.94% during the monsoon season. Correlation between organic carbon and particle mean size was high on the non monsoon season and was moderate on the monsoon season. Heavy metal was found to be lower on the monsoon season. The ranged of the heavy metals concentrations for both non monsoon and monsoon season are 2.58 $\mu\text{g/g}$ -8.83 $\mu\text{g/g}$ and 1.09 $\mu\text{g/g}$ -2.51 $\mu\text{g/g}$ for Cu, 54.65 $\mu\text{g/g}$ - 272.90 $\mu\text{g/g}$ and 76.91 $\mu\text{g/g}$ -199.29 $\mu\text{g/g}$ for Mn, 0.04 $\mu\text{g/g}$ -0.25 $\mu\text{g/g}$ and 0.01 $\mu\text{g/g}$ -0.12 $\mu\text{g/g}$ for Cd, 9.23 $\mu\text{g/g}$ -17.31 $\mu\text{g/g}$ and 5.34 $\mu\text{g/g}$ -10.67 $\mu\text{g/g}$ for Pb, 10.14 $\mu\text{g/g}$ -58.74 $\mu\text{g/g}$ and 5.90 $\mu\text{g/g}$ -21.09 $\mu\text{g/g}$ for Zn, and 6.04%-13.18% and 2.41%-5.04% for Al. The selected heavy metals had a weak correlation with both particle size and organic carbon content. Enrichment Factor showed a non significant correlation relationship with Al ($p>0.05$), and the source of heavy metal was of natural origin except for Pb which indicates the pollution is at the initial stage.

ABSTRAK

Sampel sedimen tanah dari 10 stesen sepanjang Sungai Setiu dianalisa untuk mengkaji dan melihat perbezaan bagi tanuran dan sumber logam berat pada musim sebelum monsun dan ketika monsun, Partikel saiz sedimen telah dikaji dan nilai min size didapati lebih tinggi ketika musim monsun. Min saiz berjulat antara 0.70ϕ - 5.29ϕ dan 0.50ϕ - 2.38ϕ pada musim sebelum monsun dan juga selepas monsoon. Kandungan peratus karbon organik pula bertambah tinggi pada musim monsoon yang berjulat antara 1.73%- 4.89% pada musim sebelum monsoon dan 2.75%-4.94% pada musim monsun. Korelasi diantara peratus karbon organik dengan min partikel saiz adalah tinggi pada musim bukan monsoon, manakala korelasi sederhana didapati pada musim monsoon. Daripada kajian, didapati kandungan logam berat adalah lebih rendah pada musim monsun. Julat kepekatan logam berat bagi kedua-dua musim sebelum monsun dan ketika monsun adalah $2.58\mu\text{g/g}$ - $8.83\mu\text{g/g}$ dan $1.09\mu\text{g/g}$ - $2.51\mu\text{g/g}$ bagi Cu, $54.65\mu\text{g/g}$ - $272.90\mu\text{g/g}$ dan $76.91\mu\text{g/g}$ - $199.29\mu\text{g/g}$ bagi Mn, $0.04\mu\text{g/g}$ - $0.25\mu\text{g/g}$ dan $0.01\mu\text{g/g}$ - $0.12\mu\text{g/g}$ bagi Cd, $9.23\mu\text{g/g}$ - $17.31\mu\text{g/g}$ dan $5.34\mu\text{g/g}$ - $10.67\mu\text{g/g}$ bagi Pb, $10.14\mu\text{g/g}$ - $58.74\mu\text{g/g}$ dan $5.90\mu\text{g/g}$ - $21.09\mu\text{g/g}$ bagi Zn, dan 6.04%-13.18% dan 2.41%-5.04% bagi Al. Logam berat yang dipilih untuk dikaji menunjukkan korelasi yang lemah dengan peratus kandungan organik karbon dan min partikel saiz. Faktor pengkayaan dan hubungan korelasi yang tidak signifikan dengan Al ($P>0.05$), menunjukkan kesemua logam berat bukan berpunca dari aktiviti manusia kecuali bagi Pb yang menunjukkan tahap pencemaran baru bermula.