

**EFFECT OF MONSOONS ON FECAL COLIFORM AND
Escherichia coli (E.coli) DISTRIBUTION IN WATER AND
SEDIMENTS OF SETIU LAGOON, TERENGGANU**

NURUL SYAZANA BT YAHAYA

**FACULTY OF MARITIME STUDIES AND MARINE SCIENCE
UNIVERSITI MALAYSIA TERENGGANU
2008**

**EFFECT OF MONSOONS ON FECAL COLIFORM AND *E.coli* DISTRIBUTION
IN WATER AND SEDIMENTS OF SETIU LAGOON, TERENGGANU.**

**By
NURUL SYAZANA BT YAHAYA**

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

**Department of Marine Science
Faculty of Maritime Studies and Marine Science
UNIVERSITI MALAYSIA TERENGGANU
2008**

This project report should be cited as:

Nurul Syazana , Y. 2008. Effect of Monsoons on Fecal Coliform and E.coli Distribution in Water and Sediments of Setiu Lagoon, Terengganu. Undergraduate thesis, Bachelor of Science (Marine Biology), Faculty of Maritime Studies and Marine Science, University Malaysia Terengganu, Terengganu.

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

1100061861



**JABATAN SAINS MARIN
FAKULTI PENGAJIAN MARITIM DAN SAINS MARIN
UNIVERSITI MALAYSIA TERENGGANU**

**PENGAKUAN DAN PENGESAHAN LAPORAN
PROJEK PENYELIDIKAN I DAN II**

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk:

Effect of Monsoons on Fecal Coliform and *Escherichia coli* (*E.coli*) distribution in water and sediments of Setiu Lagoon oleh Nurul Syazana bt Yahaya, No.Matrik UK12261 telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Marin sebagai memenuhi sebahagian daripada keperluan memperolehi Ijazah Sarjana Muda Sains (Biologi Marin), Fakulti Pengajian Maritim dan Sains Marin, Universiti Malaysia Terengganu.

Disahkan oleh:

Penyelia Utama **PROF. MADYA DR. MOHAMED KAMIL ABDUL RASHID**
Nama: **Timbalan Dekan (Siswazah & Penyelidikan)**
Fakulti Pengajian Maritim dan Sains Marin
Cop Rasmi: **Universiti Malaysia Terengganu**
(UMT)

Tarikh: **2.5.2008**

Penyelia Kedua

Nama: **YONG JAW CHUEN**
Pensyarah
Jabatan Sains Marin
Cop Rasmi: **Fakulti Pengajian Maritim dan Sains Marin**
Universiti Malaysia Terengganu (UMT)
21030 Kuala Terengganu.

Tarikh: **2/5/2008**

Ketua Jabatan Sains Marin

Nama: **DR. RAZAK ZAKARIYA**
Ketua Jabatan Sains Marin
Cop Rasmi: **Fakulti Pengajian Maritim dan Sains Marin**
Universiti Malaysia Terengganu
(UMT)

Tarikh: **8/5/08**

ACKNOWLEDGEMENTS

First and foremost, I would like to take this advantage to thank my supervisor, Assc Prof. Dr Mohammed Kamil Bin Abdul Rashid and also to my former supervisor, Prof. Dr. Law Ah Theem for their guidance and support in my final year project. Their guidance and advice are essential in helping me to complete my thesis successfully. I also would like to thank my second supervisor, Mr Yong Jaw Chuen for his encouragement and helpful comments during my thesis writing.

I am also thankful to all my friends especially my team group for their helps and supports during my sampling, laboratory analysis and thesis writing. Without them, I definitely cannot complete my project.

I am thankful to all the laboratory assistant in MOSEA and BioD laboratory for their kindness to borrowed me all the glassware and reagents that I needed during laboratory analysis. They also have joined our group during third sampling and give so much support and guidance to make our sampling goes smoothly.

Finally, this thesis I dedicated to my dearest family, especially to my dad for their help and support for all these years. Thank you so much.

TABLE OF CONTENTS

	Pages
ACKNOWLEDGEMENTS	ii
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF ABBREVIATIONS	xi
LIST OF APPENDICES	xiii
ABSTRACT	xv
ABSTRAK	xvi
CHAPTER 1.0: INTRODUCTION	1
1.1 Introduction	1
1.2 Importance of Study	2
1.3 Objectives	4
CHAPTER 2.0: LITERATURE REVIEW	5
2.1 South China Sea	5
2.1.1 Setiu Lagoon	5
2.2 Wastewater Microbiology	6
2.3 Bacteria	7
2.3.1 Coliform Bacteria	8
2.3.2 The Properties of Ideal Fecal Indicator	9

2.3.3	<i>Escherichia coli</i> (<i>E. coli</i>)	10
2.3.4	<i>Escherichia coli</i> (<i>E. coli</i>) as an Indicator of Fecal Pollution	11
2.4	Water Quality Standard for Malaysia	12
2.4.1	Interim National Water Quality Standards for Malaysia (INWQS)	13
2.5	Multiple – Tube Fermentation Technique	17
2.5.1	The Membrane Filter Technique	18
2.6	Sewage Pollution in Setiu Lagoon	18
2.7	Effect of sewage pollution	20
2.7.1	Health risks	20
CHAPTER 3.0: MATERIALS AND METHODS		22
3.1	Field sampling	22
3.1.1	Collection of water sample	23
3.1.2	Collection of sediment sample	23
3.1.3	Glassware	24
3.2	Sampling Map	25
3.3	Medium and Reagent Preparation	26
3.3.1	Lactose and Lauryl Tryptose Broth Preparation	26
3.3.2	EC Broth Preparation	27
3.3.3	Glutamate Decarboxylase (GAD) Reagent Preparation	27
3.3.4	Phosphate Buffer Solution Preparation	28
3.4	Analytical Technique	28
3.4.1	The Presumptive Test of Fecal Coliform Bacteria	29
3.4.2	The Confirmative Test	29

3.4.3	The Completed Test: Rapid Glutamic Acid Decarboxylase (GAD)	30
3.5	Recovery Test	30
CHAPTER 4.0: RESULTS		34
4.1	The Distribution of Total Coliform, Fecal Coliform and <i>Escherichia coli</i> in water of Setiu Lagoon.	34
4.1.1	Total coliform counts in the water of Setiu Lagoon.	34
4.1.2	Fecal Coliform count in the waters of Setiu Lagoon	35
4.1.3	<i>Escherichia coli</i> count in waters of Setiu Lagoon.	37
4.2	The Distribution of Total coliform, Fecal coliform and <i>Escherichia coli</i> in sediments of Setiu Lagoon.	39
4.2.1	Total Coliform count in the sediments of Setiu Lagoon.	39
4.2.2	Fecal Coliform count in sediments of Setiu Lagoon	40
4.2.3	<i>Escherichia coli</i> in the sediments of Setiu Lagoon.	42
4.3	Regression analysis between fecal coliform (MPN.100mL ⁻¹) and salinity in the waters of Setiu Lagoon.	44
4.4	Regression analysis between DO (mgL ⁻¹) and Temperature (°C) in Setiu lagoon.	46
4.5	Regression analysis between Fecal Coliform (MPN.100mL ⁻¹) and DO (mg/L) in waters of Setiu lagoon.	48
4.6	Regression analysis between Fecal Coliform (MPN.100mL ⁻¹) and Temperature (°C) in waters of Setiu Lagoon.	50

CHAPTER 5.0: DISCUSSION	52
CHAPTER 6.0: CONCLUSION	66
LITERATURE CITED	68
APPENDICES	70
CURRICULUM VITAE	96

LIST OF TABLES

		Pages
2.1	The Microbiology Water Quality for Malaysia (DOE, 2002-2003)	12
2.2	DOE Interim National Water Quality Standards (INWQS) for Malaysia.	13
2.3	The classification of drinking water according to bacteriological test.	15
2.4	The comparison of mean value of total coliform, fecal coliform, and <i>E.coli</i> counts in water and sediment at Setiu Lagoon.	20
3.1	Chemical composition of lauryl tyrtptose broth per liter of deionized Water.	26
3.2	Chemical composition of EC broth per liter of deionized water.	27
5.1	Comparison of Total Coliform, Fecal Coliform and <i>Escherichia coli</i> counts with previous studies in Setiu Lagoon.	62
5.2	R ² values of regression analysis between various parameters in the waters of Setiu lagoon water.	64

LIST OF FIGURES

		Pages
2.1	Routes of transmission of waterborne diseases	16
3.1	Sampling stations at Setiu Lagoon	25
3.2	Flow Chart of Analytical Technique (Presumptive Test)	31
3.3	Flow Chart of Analytical Technique (Confirmative Test)	32
3.4	Flow Chart of Analytical Technique (Completed Test)	33
4.1.1	Total coliform count in the waters of Setiu Lagoon	35
4.1.2	Fecal coliform count in waters of Setiu Lagoon.	37
4.1.3	<i>Escherichia coli</i> count in the waters of Setiu Lagoon	38
4.2.1	Total coliform counts in sediments of Setiu Lagoon.	40
4.2.2	Fecal coliform counts in sediments of Setiu Lagoon.	41
4.2.3	<i>Escherichia coli</i> count in the sediments of Setiu Lagoon.	43
4.3 (a)	Regression analysis between fecal coliform (MPN.100mL ⁻¹) and salinity (ppt) in the water of Setiu lagoon on 8 th September 2007 (first sampling)	44
4.3 (b)	Regression analysis between fecal coliform (MPN.100mL ⁻¹) and salinity (ppt) in the water of Setiu lagoon on 21 st October 2007(second sampling)	45

4.3 (c)	Regression analysis between fecal coliform (MPN.100mL ⁻¹) and salinity (ppt) in the water of Setiu lagoon on 29 th December 2007 (third sampling)	45
4.4 (a)	Regression analysis between DO and Temperature in the waters of Setiu lagoon on 8 th September 2007	46
4.4 (b)	Regression analysis between DO and Temperature in the waters of Setiu lagoon on 21 st October 2007	47
4.4 (c)	Regression analysis between DO and Temperature in the waters of Setiu lagoon on 29 th December 2007	47
4.5 (a)	Regression analysis between Fecal coliform and DO in the waters of Setiu lagoon on 8 th September 2007	48
4.5 (b)	Regression analysis between Fecal coliform and DO in the waters of Setiu lagoon on 21 st October 2007	49
4.5 (c)	Regression analysis between Fecal coliform and DO in the waters of Setiu lagoon on 29 th December 2007	49
4.6 (a)	Regression analysis between Fecal coliform and Temperature in the waters of Setiu lagoon on 8 th September 2007	50
4.6 (b)	Regression analysis between Fecal coliform and Temperature in the waters of Setiu lagoon on 21 st October 2007	51
4.6 (c)	Regression analysis between Fecal coliform and Temperature in the waters of Setiu lagoon on 29 December 2007.	51
5.1	Total coliform, fecal coliform and <i>E. coli</i> in Setiu Lagoon waters, 2007.	54
5.2	Total coliform, fecal coliform and <i>E. coli</i> in Setiu Lagoon sediments, 2007.	55

5.3	Comparison of mean total coliform counts in the waters of Setiu lagoon with the total coliform standards according to the microbiological water quality for Malaysia.	56
5.4	Comparison of mean fecal coliform count in the waters of Setiu Lagoon with the fecal coliform standards according to the microbiological water quality for Malaysia.	57
5.5	Tide level during sampling on 8 th September 2007	60
5.6	Tide level during sampling on 21 st October 2007	60
5.7	Tide level during sampling on 29 th December 2007	61
5.8	Monthly rainfall in Kuala Terengganu for the year 2007	61
5.9	Comparison data fecal coliform count and <i>E.coli</i> count in water of Setiu Lagoon with the year 2004, 2005, 2006, 2007 and 2008.	63

LIST OF ABBREVIATIONS

APHA	–	American Public Health Association
Apr	–	April
Aug	–	August
ASEAN	–	Association of South East Asia Nations
°C	–	degree centigrade
Dec	–	December
DO	–	dissolve oxygen
DOE	–	Department of Environment
<i>E. coli</i>	–	<i>Escherichia coli</i>
EU	–	European Union
FC	–	Fecal Coliform
FDA	–	Food and Drug Administration
g	–	gram
GAD	–	glutamic acid decarboxylase
INWQS	–	Interim National Water Quality Standards
kg	–	kilogram
M	–	molarity
mg	–	milligram
mL	–	millilitre
mm	–	millimetre
MF	–	Membrane Filter

MPN	–	Most Probable Number
MTF	–	Multiple-tube Fermentation Technique
NaCl	–	sodium chloride
NaOH	–	sodium hydroxide
Nov	–	November
Oct	–	October
pH	–	potential of hydrogen
ppt	–	parts per thousand
Sept	–	September
TC	–	total coliform
USEPA	–	United States Environmental Protection Agency
WHO	–	World Health Organisation

LIST OF APPENDICES

	Pages
1	70
Hydrological Parameter of Waters of Setiu Lagoon during the first sampling (8 th September 2007), second sampling (21 st October 2007) and third sampling (29 th December 2007)	
2	73
Estimation of Total Coliform in Setiu Lagoon during first sampling (8 th September 2007), second sampling (21 st October 2007) and third sampling (29 th December 2007)	
3	75
Estimation of Fecal Coliform in Setiu Lagoon during first sampling (8 th September 2007), second sampling (21 st October 2007) and third sampling (29 th December 2007)	
4	77
Estimation of <i>Escherichia coli</i> in Setiu Lagoon during first sampling (8 th September 2007), second sampling (21 st October 2007) and third sampling (29 th December 2007)	
5	79
Two Way ANOVA analysis of Total Coliform in the waters of Setiu Lagoon	
6	81
Two Way ANOVA analysis of Fecal Coliform in the waters of Setiu Lagoon	
7	83
Two Way ANOVA analysis of <i>E.coli</i> in the waters of Setiu Lagoon	
8	85
Two Way ANOVA analysis of Total Coliform in the sediments of Setiu Lagoon	

9	Two Way ANOVA analysis of Fecal Coliform in the sediments of Setiu Lagoon	87
10	Two Way ANOVA analysis of <i>E. coli</i> in the sediments of Setiu Lagoon	89
11	Probability Plot of Total Coliform, Fecal Coliform and <i>E. coli</i> in waters and sediments of Setiu Lagoon.	91
12	The MPN Table	94
13	Recovery Test for GAD analysis using cultured bacteria <i>Bacillus sp.</i> and cultured pure <i>Escherichia coli</i> .	95

ABSTRACT

The study on fecal coliform and *E.coli* distribution in waters and sediments of Setiu lagoon is aimed to evaluate the level of fecal contamination caused by sewage pollution and other aquaculture activities in that area. Three sampling trips have been conducted, during 8th September 2007, 21st October 2007 and 29th December 2007. Fourteen sampling stations were established in this study. Total coliform, fecal coliform and *E. coli* counts in waters and sediments were estimated by using Multiple Test Fermentation Tube of Standard Method. GAD test was done for detection of *Escherichia coli* (*E. coli*) in water and sediment samples. Results of this study showed that the mean of total coliform, fecal coliform and *E. coli* counts in waters of Setiu lagoon in September, October and December were 344.023 MPN.100mL⁻¹, 204.333 MPN.100mL⁻¹ and 11.9037 MPN.100mL⁻¹ respectively. The mean of total coliform, fecal coliform and *E. coli* counts in sediments were 7.4953 MPN.g⁻¹, 8.2377 MPN.g⁻¹ and 1.1553 MPN.g⁻¹ for September, October and December respectively. Presence of coliform bacteria indicates that the waters in Setiu lagoon had been contaminated with domestic sewage pollution. Based on the standard set by DOE, the mean fecal coliform counts in September, October and December 2007 exceeded the water quality standard. Strict enforcement should therefore be taken in this area to prevent further deterioration..

ABSTRAK

Objektif kajian mengenai tahap pencemaran najis and *E. coli* di dalam air dan tanah mendapan lagun Setiu adalah untuk menilai taburan najis yang berpunca dari sisa kumbahan dan aktiviti akuakultur di kawasan tersebut. Persampelan telah dibuat sebanyak tiga kali iaitu pada 8 September 2007, 21 Oktober 2007 dan 29 Disember 2007. Sebanyak 14 stesen telah didirikan semasa persampelan dijalankan. Jumlah 'total coliform, fecal coliform dan *E. coli*' di dalam air dan tanah mendapan ditentukan dengan menggunakan 'Multiple Test Fermentation Tube of Standard Method'. Ujian GAD telah dijalankan untuk mengesan kehadiran bacteria *Escherichia coli* (*E. coli*) di dalam sampel air dan tanah mendapan. Min taburan 'total coliform, fecal coliform dan *E. coli*' di dalam air pada bulan September, Oktober dan Disember adalah 344.023 MPN.100mL⁻¹, 204.333 MPN.100mL⁻¹ dan 11.9037 MPN.100mL⁻¹ masing-masing. Manakala min taburan bagi 'total coliform, fecal coliform dan *E. coli*' di dalam tanah adalah 7.4953 MPN.g⁻¹, 8.2377 MPN.g⁻¹ dan 1.1553 MPN.g⁻¹ bagi bulan September, Oktober dan Disember masing-masing. Kehadiran bakteria 'coliform' menunjukkan bahawa kawasan lagun Setiu telah dicemari dengan sisa kumbahan serta najis. Berasaskan piawaian yang telah ditetapkan oleh Jabatan Alam Sekitar, min taburan bagi 'fecal coliform' semasa persampelan dijalankan (September, Oktober dan Disember), kesemuanya telah melebihi tahap kualiti air yang ditetapkan. Tindakan tegas perlu dilaksanakan bagi menjamin kualiti air di kawasan lagun Setiu tidak bertambah buruk dengan pencemaran najis.