

ENVIRONMENTAL MANAGEMENT OF NORTHERN LAKES USING REMOTE SENSING DATA FUSION TECHNIQUE

Submitted By

Heba Abd El-Moteleb Ahmed Abd El-Fatah

B.Sc. of survey Engineering, Faculty of Engineering Shobra, Banha University, 2001

Master in survey Engineering, Faculty of Engineering Shobra, Banha University, 2006

**A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Sciences
Department of Environmental Engineering Sciences
Institute of Environmental Studies and Research
Ain Shams University**

2019



AIN SHAMS UNIVERSITY



Institute of Environmental Studies and Research

Environmental Engineering Department

**Environmental Management of Northern Lakes Using
Remote Sensing Data Fusion Technique**

By

Eng. Heba Abd el Moteleb Ahmed

A Dissertation presented to The Institute of Environmental
Studies and Research

In Partial Fulfillment of the Requirements for the degree of
Doctor of Philosophy in Environmental Engineering

Under the Supervision of

Dr. Noha Samir Donia

Director of Institute of Environmental Studies and Researches

Ain Shams University, Cairo, Egypt.

Dr. Sameh B. El Kafrawy

Head of Marine Sciences Department, National Authority for Remote Sensing and Space
Sciences (NARSS)

2019

APPROVAL SHEET
**ENVIRONMENTAL MANAGEMENT OF NORTHERN LAKES USING
REMOTE SENSING DATA FUSION TECHNIQUE**

Submitted By

Heba Abd El-Moteleb Ahmed Abd El-Fatah

B.Sc. of survey Engineering, Faculty of Engineering Shobra, Banha University, 2001

Master in survey Engineering, Faculty of Engineering Shobra, Banha University, 2006

A Thesis Submitted in Partial Fulfillment

Of

The Requirement for the Doctor of Philosophy Degree

In

Environmental Sciences

Department of Environmental Engineering Sciences

This thesis Towards a Doctor of Philosophy Degree in

Environmental Sciences Has been Approved by:

Name

Signature

1-Prof. Dr. Aly Nabih El Bahrawy

Prof. of Hydraulics

Faculty of Engineering

Ain Shams University

2-Prof. Dr. El Sayed Abass Zaghloul

Prof. of Remote Sensing

Authority for Remote Sensing & Space Science

3-Prof. Dr. Noha Samir Donia

Prof. & Head of Department of Environmental Engineering Sciences

Institute of Environmental Studies & Research

Ain Shams University

4-Prof. Dr. Sameh Bakr El Sayed El Kafrawy

Head of Marine Sciences Department & Coastal Zone Management

National Authority for Remote Sensing & Space Sciences

2019

وَمَا تَوْفِيقِي
إِلَّا بِاللَّهِ
عَلَيْهِ تَوَكَّلْتُ
وَإِلَيْهِ أُنِيبُ

سورة هود
الآية 88

Acknowledgment

First, I give thanks to **ALLAH** for protection and ability to do work.

I would like to thank my supervisor, **Prof. Noha Samir Donia**, Head of Environmental Engineering Sciences Institute of Environmental Studies and Researches, for her insightful comments and encouragement, but also for the hard question which incited me to widen my research from various perspectives. Especially I would like to express my sincere gratitude to my advisor **Prof. Sameh B. El Kafrawy**, Head of Marine Sciences Department NARSS for the continuous support of my Ph.D study and related research, for his patience, motivation, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my Ph.D study. Without their precious support it would not be possible to conduct this research. He spent with me a sleepless night to help me in the water quality assessment part of my research. It was a real privilege and an honor for me to share his scientific knowledge but also of his extraordinary human qualities.

Last but not the least, I also thank my family who encouraged me and prayed for me throughout the time of my research. This thesis is heartily dedicated to my mother who took the lead to heaven before the completion of this work.

May the Almighty **ALLAH** richly bless all of you.

CONTENTS

Contents

List of Figures

List of Tables

Abbreviation

CHAPTER ONE

1. Introduction

2. The objectives of this study.....32

3. Tools of study.....32

CHAPTER TWO

Literature Review

2.1. Previous Studies

CHAPTER THREE

Northern Lakes of EGYPT

3.1 Northern Lakes of Egypt.....	42
3.2 The importance of the Egyptian Lakes	44
3.2.1 Lake Manzala.....	45
3.2.2 Lake Brullus.....	46
3.2.3 Lake Edku	47
3.2.4 Lake Mariout.....	48
3.2.5 Lake Bardawil.....	49
3.3 Challenges facing the development of Northern Lakes.....	50
3.3.1 Drying And infringement	50
3.3.2 Pollution of the Water Body	51
3.3.3 Blockage Bogaz and estuaries Banks.....	51
3.3.4 Spread the plants water and drowsiness the lakeside.....	52

contents

3.4 The economic importance of the proper management of the Egyptian Northern Lakes	52
---	----

CHAPTER FOUR

Materials and Methods

4.1 Lake El Brullus	55
4.1.1 DATA during 1973-2018	57

4.2 Lake Edku	60
4.2.1 DATA during 1973-2018	62
4.3 Study Methodology.....	66
4.3.1 Data acquisition	67
4.3.2 Field observations	67
4.3.3 The used Materials.....	67
4.3.3.1 Satellite Data.....	67
4.5 Remote sensing data	69
4.5.1 Basic concepts in remote sensing	70
4.5.2 Image Processing techniques	70
4.5.2.1 Layer Stacking	70
4.5.2.2 Image Enhancement	71
4.5.2.3 Analysis of change in surface area / size / shape of lakes	71
4.5.2.4 Image Classification	72
4.5.2.5 Change detection	75
4.5.2.6 Change detection using digitizing	76
4.6 Data Fusion	77
4.6.1 Types of Data Fusion Techniques	78

Contents

4.7 Geographic Information System (GIS) :.....	79
3.7.1 Converting Raster data to Vector map	80
4.8 Interpolation	81
4.8.1 Topo to Raster Method	81
4.9 Normalized Difference of Vegetation NDVI.....	82
4.9.1 How do you calculate NDVI?.....	82
3.10 NDWI (Normalized Difference Water Index)	83

3.11 Digital Shoreline Analysis System (DSAS)	84
4.12 Work Steps for Solving :.....	85
4.12.1 pollution problem in Edku Lake	85
4.12.2 Sampling strategy	85
4.12.2.1 Sampling procedures and analyses	85
4.12.3 Lake Eutrophication	88
4.12.3.1 Nutritious salts	90
4.13 Computer Software Used.....	90

CHAPTER FIVE

Results and Discussion

5.1 The boundaries changes of El Brullus Lake:	92
5.2 The total area classification of El Brullus.....	103
5.2.1 The Lake Land Use.....	103
5.3 The Vegetation area changes of El Brullus Lake:	106
5.3.1 El Brullus Lake NDVI	106
5.3.2 The Bathometry of El Brullus Lake	115
5.4 The Water area changes of El Brullus Lake:	116
5.5.1 The Edku Lake area changes:	126

Contents

5.5.2 DSAS Results	138
5.6 The Vegetation area changes of Edku Lake:	145
5.6.1 Edku Lake NDVI	145
5.7 The Water area changes of Edku Lake:	157
5.8 Problems Solutions	163
1. Proposed Rehabilitation Plan for Infringements and Drying	163
Proposed solution for the Spreading of aquatic plants	170

5.8 The Edku Lake pollution	171
5.8.1 Water Analysis.....	172
5.8.1.3 Salinity	174
5.8.1.4 Hydrogen ion concentration (pH).....	176
5.8.1.5 Total suspended materials TSM	178
5.8.1.6 Phosphorus.....	180
5.8.2 Water Analysis of the study:	182
5.9 The Lake Eutrophication	183
5.9.1.2 Nitrate element (NO ₃ -N).....	185
5.9.2 Ammonia NH ₄ -N	187
5.9.3 Water Organic Mater	189
5.9.4 Heavy metals.....	191
5.9.4.1 An introduction:.....	191
5.9.4.2 Heavy Metals Analysis.....	192
The results of the present study indicate the following	201
5.9.5 Water cluster analysis	203
5.9.6 Water Pollution Index of the Lake Edku with Heavy Metals	205
5.9.6.1 Water Pollution Index Index (PI)	205
5.9.6.2 Water cluster analysis	205

Contents

5.10 Sediment Analysis.....	207
5.10.1 Total suspended materials TDS	209
5.10.2 Hydrogen ion concentration (pH) in Sediments	210
5.10.3 Phosphorus.....	212
5.10.5 Sediment Heavy Metals Analysis.....	216
5.10.5.1 Cadmium element.....	216
5.10.5.2 Chromium element	218

5.10.5.3 Iron element	220
5.10.5.4 Nickel element	222
5.10.6.1 Sediment cluster analysis.....	225
5.10.7 National Recommended Water Quality Criteria - Aquatic Life Criteria Table	228
5.10.7.1 The results compared to the National Recommended Water Quality Criteria as the following:	228
Proposed solution for the Pollution problem	230
CHAPTER SIX	
Conclusions and Recommendations	
Conclusion	
Main Study Conclusions	233
Recommendations	
Recommendations	234
ARABIC SUMMARY	

LIST OF FIGURES

LIST OF FIGURES

FIG. (1) LOCATIONS OF THE EGYPTIAN NORTHERN COASTAL LAKES 2017 (NARSS)	43
FIG. (2) THE EGYPTIAN NORTHERN LAKES 2018 (NARSS)	44
FIG (3) SENTINEL SATELLITE IMAGE OF MANZALA (NARSS 2017)	46
FIG.(4) LANDSAT SATELLITE IMAGE OF BRULLUS (NARSS 2017)	47
FIG. (5) LANDSAT SATELLITE IMAGE OF EDKU (USGS EARTH EXPLORER 2017).....	48
FIG (6) SENTINEL SATELLITE IMAGE OF MARIOUT (NARSS 2017).....	48

FIG. (7) LANDSAT SATELLITE IMAGE OF BARDAWIL (NARSS 2016)	50
FIG.(8) REMOVING THE ENCROACHMENTS ON THE LAKE BRULLUS 2018 (GAFRD).....	50
FIG. (9) HUNDREDS OF FISH DEATH IN THE EDKU LAKE 2018 (GAFRD).....	51
FIG. (11) CONTAMINATION OF LAKE EDKU WATER AND DEATH OF FISH 2018 (GAFRD)	52
FIG. (12) LOCATIONS OF THE TWO STUDIED LAKES; EDKU AND BRULLUS (NARSS).	55
FIG.(8) EL BRULLUS LAKE	56
4.1.1 DATA DURING 1973-2018	57
FIG. (13) SATELLITE IMAGE OF EL BRULLUS LAKE 1973.....	57
FIG. (14) SATELLITE IMAGE OF EL BRULLUS LAKE 1985.....	58

LIST OF FIGURES

FIG. (15) SATELLITE IMAGE OF EL BRULLUS LAKE 1990.....	58
FIG. (16) SATELLITE IMAGE OF EL BRULLUS LAKE 2003.....	59
FIG. (17) SATELLITE IMAGE OF EL BRULLUS LAKE 2015	59
FIG (18) EL-BRULLUS BLANET LAB IMAGE OF THE YEAR 2018.....	60
FIG. (19) DETERMINED EDKU LAKE LOCATION MAP 2018	61
FIG. (20) SATELLITE IMAGE OF EDKU LAKE 1973.....	62

FIG. (21) SATELLITE IMAGE OF EDKU LAKE 1985.....	63
FIG. (22) SATELLITE IMAGE OF EDKU LAKE 1990.....	63
FIG. (23) SATELLITE IMAGE OF EDKU LAKE 2003.....	64
FIG. (24) SATELLITE IMAGE OF EDKU LAKE 2015.....	64
FIG. (25) SATELLITE IMAGE OF EDKU LAKE 2018.....	65
FIG. (26) THE MAIN FEATURES OF LAKE EDKU, AS REVEALED BY REMOTE SENSING MAPPING (A M. ABDEL HALIM ET. AL 2013).....	65
FIG.(27) THE METHODOLOGY OF THE STUDY WORK STEPS	66
4.3.3.1 SATELLITE DATA	67

LIST OF FIGURES

FIG. (28) REMOTE SENSING PROCESS	70
4.5.2.1 LAYER STACKING	70
FIG. (29) LAYER STACK BANDS PROCESS IN ERDAS IMAGINE PROGRAM	71
4.5.2.2 IMAGE ENHANCEMENT.....	71
4.5.2.3 ANALYSIS OF CHANGE IN SURFACE AREA / SIZE / SHAPE OF LAKES	71
4.5.2.4 IMAGE CLASSIFICATION	72

FIG. (30) STEPS OF THE UNSUPERVISED CLASSIFICATION METHOD.....	73
FIG. (31) SUPERVISED CLASSIFICATION OF EL BRULLUS BY ERDAS IMAGINE PROGRAM.....	73
FIG. (32) STEPS OF SUPERVISED CLASSIFICATION OF EL BRULLUS BY ERDAS IMAGINE SOFTWARE	74
FIG. (34) UNSUPERVISED CLASSIFICATION OF EL BRULLUS BY ERDAS IMAGINE PROGRAM	75
FIG. (35) UNSUPERVISED CLASSIFICATION STEPS BY ERDAS IMAGINE PROGRAM.....	75
4.5.2.5 CHANGE DETECTION	75
FIG.(36) ERDAS IMAGINE CHANGE DETECTION PROCESS	76
4.5.2.6 CHANGE DETECTION USING DIGITIZING	76

LIST OF FIGURES

FIG.(37) FLOWCHART OF IMAGE PROCESSING TECHNIQUES.....	77
FIG.(38) DATA FUSION METHODOLOGY	78
FIG (39) COMPONENTS OF GIS (PSE,2019)	80
FIG.(40) FORMING VECTOR MAP OF EL BRULLUS BOUNDARY USING THE SHAPE FILE METHOD ..	80
FIG. (41) MANIPULATION OF INTERPOLATION PROCESS USING ARC MAP 10.1	81
FIG. (42) TOPO TO RASTER INTERPOLATION PROCESS USING ARC MAP 10.1	82
FIG. (43) BUILDING NDVI USING ERDAS IMAGINE 2014 PROGRAM.....	83