Using Remote Sensing Techniques and Geographic Information Systems to maximize the economic return of Manzala lake, Egypt

$\mathcal{B}y$

Hagar Mahmoud Mohamed Mohamed Amer

B.Sc of Science (Chemistry \ Zoology), Cairo University
2004

A Thesis submitted for partial fulfillment of requirement for the Master Degree in Zoology (Aquatic Ecology)

Department of Zoology Faculty of Science Ain Shams University



Ain Shams University Faculty of Sciences Zoology Department

Using Remote Sensing Techniques and Geographic Information Systems to maximize the economic return of Manzala lake, Egypt

Hagar Mahmoud Mohamed Mohamed Amer

B.Sc. of Science (Zoology)
Faculty of Science, Cairo University
2004

A Thesis submitted for partial fulfillment of requirement for the Master Degree in Zoology (Aquatic Ecology)

Department Zoology Faculty of Science Ain Shams University

Under supervision of

Prof. Dr. Mahmoud Hussien Ahmed

Prof. of Marine Environment
The National Authority for Remote Sensing and
Space Science, NARSS

Prof.Dr. Magdy Tawfik Khalil

Prof. of Aquatic Ecology,
ZoologyDepartment,
Faculty of Sciences, Ain Shams University

Dr. Sameh Bakr El Sayd El Kafrawy

Researcher, Marine Sciences Department
The National Authority for Remote Sensing and Space Science, NARSS



ACKNOWLEDGEMENTS

Firstly and lastly thanks to Allah

I am deeply grateful to **Prof. Magdy Tawfik Khalil** for his kind supervision, patience, encouragement and his great help.

I like to express my warmest gratitude and appreciation to **Prof.**Mahmoud Hussein, for his continuous encouragement and valuable advice during this work.

Special thanks to **Dr. Sameh El-Kafrawy**, for his valuable supervision at the field and lab work and facilities provided throughout the different stages of the work.

Finally, I wish to express my sincere gratitude to all staff members of Marine Science Department, for their help during the thesies stages and the Field Trips.

Finally my deep thanks and all respect to my parent for continuous encouragement and supporting during this work.

LIST OF CONTENTS

List of contents

Subject	Page
Abstract	1
Chapter (1) Introduction	3
Chapter (2) Review of Literature	7
Chapter (3) Materials and Materials	21
The Study area	21
1 Data acquisitions	21
1.2 Field observation	21
1.2.1 Data during 2003-2004	23
1.2.2 Data from EEAA 2011	26
1.2.3 Field trip winter 2012.	28
1.3 Remote sensing data	37
1.3.1 Image processing	39
1.3.1.1 Data fusion techniques	39
1.3.1.2 Scenes selection	39
1.3.1.3 Layer stacking	41
1.3.1.4 Image enhancement.	41
1.3.1.5 Image Classification	44
1.3.2 The Satellite images used	46
1.3.3 Application Techniques	48

1.3.3.1 NDWI Techniques.	48
1.3.3.2 Change detection	49
1.4 NOAA	51
1.4.1 NDVI	51
1.4.2 SST	55
1.5 Computer Software used	58
Chapter (4) Results and Discussion	59
1. Introduction	59
2. Physiochemical characteristics	60
3. Water quality of the lake results	60
3.1 Water quality (2003 NARSS)	60
3.2 Water quality (2011 EEAA)	86
4. NDWI Results	107
5. Change detection using digitizing	109
6. Meteorological Results	110
6.1 Sea Surface Temperature	111
6.2 Normalized vegetation index 2003	118
7. Integration between biological data and remote sensing data	126
8. Comparison between results 2003 & 2011	129
9. Conclusion	148

10. Recommendations	148
English summary	150
References	154
Arabic summary	1

LIST OF FIGURES

List of Figures

Figure No.	Subject	Page
1	Study area; Lake Manzala, Egypt	20
2	Location map for the study area	22
3	Location map 2003	25
4	Stations points 2011	27
5	Location map Manzala, 2012	30
6	GPS for spatial display and data recording purposes	31
7	The Echo-sounder	33
8	The Manta 2 TM Water Quality Multiprob	35
9	Manzala Lake after principle component	40
10	Enhanced image for water color interpretation (Bands Image 1,2,3) Image source landsat 2000.	42
11	Enhanced image for water color interpretation (Bands 2, 4 and 3) Image source landsat 2000.	43
12	Classification of Lake Manzala.	45
13	Raw data of NDVI of the study area	52
14	Typical spectral reflectance of vegetation and band location of AVHRR.	54
15	Row data of SST of the study area	57

16	Seasonal variations in surface water temperature measurements of Lake Manzala (NARSS 2003)	60
17	Seasonal variations in Hydrogen ion concentration measurements of Lake Manzala (NARSS 2003)	65
18	Seasonal variations in Salinity measurements of Lake Manzala (NARSS 2003)	68
19	Chart variation of salinity during 2003-2004	69
20	Seasonal distribution of DO measurements at water sample stations of Manzala Lake during (NARSS 2003).	71
21	Seasonal distribution of water Biological oxygen demand measurements at water sample stations of Manzala Lake during (NARSS 2003).	74
22	Seasonal distribution of water Total Phosphoures measurements at water sample stations of Manzala Lake during (NARSS 2003).	77
23	Seasonal distribution of water Total Nitrogen Measurements at water sample stations of Manzala Lake during NARSS (2003).	80
24	Seasonal distribution of water Chlorophyll-a Measurements at water sample stations of Manzala Lake during (NARSS 2003).	83
25	Chart showing the variation of chlorophyll concentration during (NARSS 2003)	84
26	Seasonal variations in surface water temperature measurements of Lake Manzala (EEAA 2011)	87
27	Seasonal variations in pH measurements of Lake Manzala (EEAA2011).	90
28	Seasonal variations in Salinity measurements of Lake Manzala (EEAA 2011)	92
29	Seasonal distribution of DO measurements at sample stations of Manzala Lake during (EEAA2011).	94
30	Seasonal distribution of BOD measurements at water sample stations of Manzala Lake during (EEAA2011).	97

31	Seasonal distribution of water Total Phosphorus Measurements at water sample stations of Manzala Lake during (EEAA2011).	99
32	Seasonal distribution of water Total Nitrogen measurements at water sample stations of Manzala during (EEAA2011).	102
33	Seasonal distribution of water Chlorophyll-a measurements at water sample stations of Manzala Lake during (EEAA2011).	105
34	NDWI for both 1987 and 2000 .	107
35	Diagram indicating the changes in area occurred in area Lake Manzala during the period between 1987 (blue line) and 2011 (Green line).	109
36	Sea surface Temperature from NOAA during Spring season 2003.	111
37	Sea surface Temperature from NOAA during Summer season 2003.	112
38	Sea surface Temperature from NOAA during autumn season 2003	113
39	Sea surface Temperater from NOAA during Winter season 2004.	114
40	Sea surface Temperature from NOAA during spring season 2004	115
41	Sea surface Temperature from NOAA during summer season 2004	116
42	Sea surface Temperature from NOAA during September season 2004	117
43	Normalized Vegetation Index from NOAA during Spring season 2003	118
44	Normalized Vegetation Index from NOAA during Summer season 2003	119
45	Normalized Vegetation Index from NOAA during autumn season 2003	120
46	Normalized Vegetation Index from NOAA during Winter season 2004.	121

47	Normalized Vegetation Index from NOAA during Spring season 2004.	122
48	Normalized Vegetation Index from NOAA during summer season 2004.	123
49	Normalized Vegetation Index from NOAA during September season 2004.	124
50	Chart variation of NDVI monthly during 2003-2004.	125
51	Chart variation of Mean SST & NDVI% monthly during 2003-2004.	127
52	Chart variation of Mean SST & NDVI% & Chlorophyll monthly during 2003-2004.	127
53	Chart variation of Salinity, Mean SST and Chlorophyll during 2003-2004.	128
54	Comparison of water Temperature measurements at water sample stations of Manzala Lake (2003) & (2011).	130
55	Comparison of water Hydrogen ion at water sample stations of Manzala Lake (2003) & (2011).	130
56	Comparison of water salinity measurements at water sample stations of Manzala Lake (2003) & (2011).	132
57	Comparison of water dissolved oxygen measurements at water sample stations of Manzala Lake (2003) & (2011).	134
58	Comparison of water Biological oxygen demand measurements at water sample stations of Manzala Lake (2003) & (2011).	138
59	Comparison of water Total phosphorus measurements at water sample stations of Manzala Lake (2003) & (2011).	140
60	Comparison of water Total nitrogen measurements at water sample stations of Manzala Lake (2003) & (2011).	144
62	Comparison of water Chlorophyll measurements at water sample stations of Manzala Lake (2003) & (2011).	146

LIST OF TABLES

List of Tables		
Table No.	Subject	Page
1	The co-ordinates of the selected 10 stations at Lake Manzala during 2003	24
2	The co-ordinates of the selected 11 stations at Lake Manzala during 2011	26
3	The co-ordinates of the selected 14 stations at Lake Manzala during 2012	29
4	Echo sounder depth measurements of lake Manzala during 2012	32
5	water quality in winter 2012 using The Manta 2 [™] Water Quality Multiprob	36
6	Available Landsat TM and Spot at NARSS	37
7	Spectral characteristics of Landsat TM system	46
8	Spectral characteristics of Spot images	47
9	Mean seasonal water temperature measurements in Lake Manzala during year 2003.	61
10	Mean seasonal hydrogen ion concentration (pH) measurements in Lake Manzala during (2003)	63
11	Mean seasonal Salinity measured in Lake Manzala during 2003.	66
12	Mean seasonal value of dissolved oxygen (DO) measured in Lake Manzala during 2003	70
13	Mean seasonal value of Biological Oxygen Demand (mg/l) measured in Lake Manzala during 2003	73
14	Mean seasonal value of Total Phosphorus (μM) measured in Lake Manzala during 2003	75
15	Mean seasonal value of Total Nitrogen (μM) measured in Lake Manzala during 2003	78