



**Faculty of Women for
Arts, Science and Education**

Integrated Field Studies and Remote Sensing Approach for Mapping Seagrasses and Mangrove Habitats, Red Sea, Egypt.

A THESIS

*Submitted in partial fulfillment for the degree of
Doctor of Philosophy of In Science (Plant ecology)*

By

Basma Shabaan Essa Ismaiel

Master. 2011

Supervisors

Dr. Soad Abd Elgaliel Sheteawi

Prof. of Plant Physiology,
Botany Department,
Faculty of Women for Art, Science and
Education,
Ain Shams University.

Dr. Ahmed Ahmed Khalafallah

Assistant Prof. of Plant Ecology,
Botany Department,
Faculty of Women for Art, Science and
Education,
Ain Shams University

Dr. Mahmoud Abd El Rady Dar

Prof. of Marine Environment
National Institute of Oceanography and
Fisheries, Hurghada

Dr. Sameh Bakr El Kafrawy

Researcher of Marine Environment
National Authority for Remote Sensing and
Space Sciences

**Botany Department
Faculty of Women for
Arts, Science and Education
Ain Shams University
2016**

Approval sheet

Name : Basma Shabaan Essa Ismaiel

Title : Integrated Field Studies and Remote Sensing Approach for Mapping Seagrasses and Mangrove Habitats, Red Sea, Egypt.

Subervised by

Approved

Dr. Soad Abd Elgaliele Sheteawi

Prof. of Plant Physiology,
Botany Department,
Faculty of Women for Art, Science and Education,
Ain Shams University

.....

Dr. Ahmed Ahmed Khalafallah

Assistant Prof. of Plant Ecology,
Botany Department,
Faculty of Women for Art, Science and Education,
Ain Shams University

.....

Dr. Mahmoud Abd El Rady Dar

Prof. of Marine Environment
National Institute of Oceanography and Fisheries,
Hurghada

.....

Dr. Sameh Bakr El Kafrawy

Researcher of Marine Environment
National Authority for Remote Sensing and Space
Sciences

.....

2016

Name : Basma Shabaan Essa Ismaiel

Title : Integrated Field Studies and Remote Sensing Approach for Mapping Seagrasses and Mangrove Habitats, Red Sea, Egypt.

Dr. Soad Abd Elgaliel Sheteawi

Prof. of Plant Physiology, Botany Department,
Faculty of Women for Art, Science and Education,
Ain Shams University

.....

Dr. Mohamed Adel Yahia

Prof. of Geology – Faculty of Science
Ain Shams University
The previous president of National Authority for
Remote Sensing and Space Sciences

.....

Dr. Nahed Mohsen Hassan

Prof. of Plant Ecology,
Botany and Microbiology Department,
Faculty of Science, Helwan University

.....

Dr. Mahmoud Abd El Rady Dar

Prof. of Marine Environment
National Institute of Oceanography and Fisheries,
Hurghada

.....

Dr. Ahmed Ahmed Khalafallah

Assistant Prof. of Plant Ecology,
Botany Department,
Faculty of Women for Art, Science and Education,
Ain Shams University

.....

2016

Dedication

To my father,

To my mother,

Specially, to my husband.

*To my sweat heart, my sons Logien and Yahia who
filled my life with happiness,*

To my brothers and my sister and my whole family.

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿إِنْ أُرِيدُ إِلَّا الْإِصْلَاحَ مَا اسْتَطَعْتُ وَمَا تَوْفِيقِي
إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ﴾

صدق الله العظيم

سورة هود (٨٨)

ACKNOWLEDGEMENT

(At first unlimited thanks to ALLAH)

I'd like to express my sincere appreciation and gratitude to **Dr. Soad A. Sheteawi**, Professor of Plant Physiology, Botany Department, Faculty of Women for Art, Science and Education, Ain Shams University, for her unlimited and devoted efforts, her valuable suggestions and her supervision during the course of this study.

Special unlimited and grateful acknowledgement, thanks and appreciation are expressed to **Dr. Ahmed A. M. Khalafallah**, Assistant Professor of Plant Ecology, Faculty of women for Art, Science and Education,, Ain Shams University, **Dr. Mahmoud A. Dar**, Professor of Marine Environment, National Institute of Oceanography and Fisheries, Hurghada, and **Dr. Sameh B. El Kafrawy**, Researcher of Marine Environment, National Authority for Remote Sensing and Space Sciences for their helpful suggestions, proposing and supervising this study, kind advises and guidance during the field and laboratory work, data processing, statistical analysis, preparation of the manuscript, revision of the whole thesis and continuous help, encouragement and support following up throughout the whole work.

Deep thanks to **Prof. Dr. Abeer Rushdy**, Head of Botany Department, College of Women for Arts, Science and Education, Ain Shams University.

I would like to thank all my colleagues (**Doaa, Asmaa, Amir, and Mannar**) at National Authority for Remote Sensing and Space Sciences, for their helpful during this study.

I would like to thank all my colleagues at National Institute of Oceanography and Fisheries in Hurghada and Suez, for their helpful during this study.

My gratitude to all the staff members and colleagues of Botany Department, Faculty of Women for Arts, Science and Education

Integrated Field Studies and Remote Sensing Approach for Mapping Seagrasses and Mangrove habitats, Red Sea, Egypt.

Abstract

Seagrasses and mangroves represent the main producers in the marine habitats and their importance extended to marine organisms and terrestrial ones and provides high values of goods and services to humanity. Hurghada and Safaga at the Red Sea Coast, have witnessed over the past few decades, a lot of anthropogenic activities which affected certainly on these habitats. Clearly, these habitats didn't found the appropriate attention from botanists. In addition to the field monitoring, Remote Sensing techniques was applied successfully for monitoring and mapping the terrestrial and aquatic egetation. Therefore, the current study aimed to integrate between field study and Remote Sensing Technique in monitoring and mapping seagrasses growing in Hurghada and Safaga and detect the periodical changes in these habitats as well as to assess using the seagrasses beds as biomonitoring agent for heavy metals pollution in coastal zone of Hurghada and Safaga was also investigated. Five seagrasses were identified in the 41 stands; *Halophila stipulacea* (Forssk.) Asch., *Halodule uninervis* (Forssk.) Boiss., *Halophila ovals* (R.Br.) Hook. f., *Thalassodendron ciliatum* (Forssk.) Hartog and *Syringodium isoetifolium* (Forssk.) Hartog. All recorded seagrasses are belonging to tropical indo-pacific bioregion. Application of TWINSpan and DECORANA, as classification and ordination techniques to the 41 stands resulted in five vegetation groups. Integration between field data and satellite images resulted in mapping seagrass and mangrove sites and the coverage area of each seagrass species and the total coverage area of seagrass beds and mangrove forests along the Red Sea coast. Results indicated that *H. uninervis* represents the dominant seagrasses in Hurghada and Safaga according to its spatial distribution and coverage area. Satellite images showed that seagrass beds coverage areas were reduced by 69.8% in Hurghada and 25.4% in Safaga. Mangrove coverage area shows drastic reduction by 98.65% in Um Dehais and 52.7% in Km-17 S. Safaga. The net mangrove coverage area in Abu Minqar (Hurghada) and Sharm El Bahari (Qusier) increased by 59.6 and 127.2% respectively. All sites in Hurghada, Safaga and Qusier showed reduction in their mangrove coverage areas in the period 1990-2002. Seawater contains low concentrations of heavy metals in the study sites dominated by Fe and followed the orders; Fe>Mn>Cu>Pb>Zn>Cd, or Fe>Cu>Mn>Pb>Zn>Cd.

Abstract

Fine sediment granules (Ø3, Ø4 and Ø5) had the highest percentage ranged from 62.91 to 92.20% than other granules in the study sites. Highest percentage of silicates and total organic matter were recorded in Safaga Fishing Port site (SFP) while that of carbonates were recorded in Wadi Quiah. Noticeably, high fluctuation in the concentrations of each heavy metal in the same site indicate variation in heavy metals resources. Iron is the main metal in the fine fractions of sediments. The dominant order of heavy metals in the fine granules of the sediments in the studied sites was $Fe > Zn > Mn > Cu > Pb > Cd$. These results showed that SFP sediment contains highest concentrations for the most heavy metals. In parallel to fluctuation of heavy metals in sediment high fluctuation of heavy metals concentrations were recorded in each seagrass part at the same site. Iron is the dominant heavy metal in the four seagrasses organs. Bioconcentration factor (BCF) calculation indicated that *H. uninervis* had the capability to bioconcentrate Cu and Cd in their leaves; *H. stipulacea* had high ability to bioconcentrate Cd in their roots, rhizomes and leaves; *H. ovalis* bioconcentrated Cu and Pb in leaves but Cd in rhizomes and *Th. ciliatum* bioconcentrated Cd with higher BCF value in rhizomes. On the other hand, the four seagrasses didn't show tendency to bioconcentrate Fe, Mn and Zn. So, the four seagrasses can be used as bioindicator for Cu, Pb and Cd pollution. The data showed that the highest density of *H. stipulacea* and *H. uninervis* were recorded in SFP but recorded the lowest biomass. While, *H. ovalis* recorded its highest density and biomass in SFP site. *H. stipulacea*, *H. uninervis* and *H. ovalis* contains their highest chl *a* content in Gasous sites and chl. *b* in Hurghada, in addition their highest carotenoids content in SFP. This result indicated that seagrasses were affected by bioconcentration of heavy metals in their tissues, but they have the ability to resist their risks by increasing carotenoids in their tissues. Integration between field monitoring and remote sensing technology provided entire vision of seagrasses species, spatial distribution cover area and healthy as well as mapping of these habitats. In addition, remote sensing provided maps on successive time intervals led to study the change in seagrass and mangrove habitats. The study confirmed the possibility of the use of seagrasses to monitor heavy metals pollution. So the study recommends using remote sensing alongside field monitoring for vegetation mapping of aquatic and terrestrial habitats.

Keywords: Seagrasses, Mangrove, Field monitoring, Remote Sensing Technique, Heavy Metals, Biocncentration factor (BCF), Translocation factor (TF)

CONTENTS

<i>Subject</i>	<i>Page</i>
Abstract	i
Contents	iii
List of tables	Vi
List of figures	viii
I-Introduction	1
II-Review of literature	5
III-Materials and methods	53
Study areas	53
Field Monitoring	55
<i>Floristic analysis</i>	55
<i>Vegetation analysis</i>	55
<i>Multivariate analysis</i>	55
<i>Diversity indices</i>	56
Remote Sensing Monitoring	56
<i>Data Availability and Instruments</i>	56
<i>Instruments and Software</i>	61
<i>Image acquisition and processing</i>	62
<i>Benthic habitat classification</i>	65
<i>Seagrass mapping</i>	67
<i>Composition and the seagrass cover mapping</i>	71
<i>Periodical changes in seagrasses</i>	72
<i>Mangrove mapping</i>	73
<i>Periodical changes in mangroves</i>	75
Biomonitoring	76
<i>Grain size analyses</i>	76
<i>Determination of heavy metals in seawater</i>	77
<i>Determination the mobile forms of heavy metals in sediments</i>	77
<i>Determination Carbonate contents, total organic matter (TOM) and total silicates in sediments</i>	78
<i>Determination of heavy metals in seagrass species</i>	79