



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكرو فيلم

بسم الله الرحمن الرحيم



HANAA ALY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



HANAA ALY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغييرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



HANAA ALY

INTEGRATED SUSTAINABLE SYSTEM FOR IMPROVING GROUNDWATER QUALITY IN EL-WAHAT EL-BAHARIYA

Submitted By

Mohamed Ahmed Mohamed Fahmy El-Barad

B.Sc. of Civil Engineering (Public Works Sector), Faculty of Engineering,
Ain Shams University, 2010

Master in Civil Engineering (Public Works Sector), Faculty of Engineering,
Ain Shams University, 2015

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

2021

INTEGRATED SUSTAINABLE SYSTEM FOR IMPROVING GROUNDWATER QUALITY IN EL-WAHAT EL-BAHARIYA

Submitted By

Mohamed Ahmed Mohamed Fahmy El-Barad

B.Sc. of Civil Engineering (Public Works Sector), Faculty of Engineering,
Ain Shams University, 2010

Master in Civil Engineering (Public Works Sector), Faculty of Engineering,
Ain Shams University, 2015

A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Sciences
Department of Environmental Engineering Sciences

Under The Supervision of:

1-Prof. Dr. Ahmed Ali Ali Hassan

Prof. of Environmental Hydraulics, Department of Irrigation & Hydraulics
Faculty of Engineering
Ain Shams University

2-Dr. Heba Ahmed Elsayed Mosalam

Lecturer of Energy
Faculty of Engineering
Heliopolis for Sustainable Development University

3-Dr. Peter Hany Riad

Lecturer, Department of Irrigation & Hydraulics
Faculty of Engineering
Ain Shams University

2021

APPROVAL SHEET

INTEGRATED SUSTAINABLE SYSTEM FOR IMPROVING GROUNDWATER QUALITY IN EL-WAHAT EL-BAHARIYA

Submitted By

Mohamed Ahmed Mohamed Fahmy El-Barad

B.Sc. of Civil Engineering (Public Works Sector), Faculty of Engineering,
Ain Shams University, 2010

Master in Civil Engineering (Public Works Sector), Faculty of Engineering,
Ain Shams University, 2015

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 was discussed and approved by:

Name

Signature

1-Prof. Dr. Noha Samir Donia

Prof. of Environmental Hydraulics, Department of Environmental
Engineering Sciences

Dean, Institute of Environmental Studies & Research

Ain Shams University

2-Prof. Dr. Fatma Mohamed Hassan Shaltout

Prof. of Water Resources Management

Faculty of Engineering, Helwan University

Head of Construction Engineering Department

Egyptian Russian University

3-Prof. Dr. Ahmed Ali Ali Hassan

Prof. of Environmental Hydraulics, Department of Irrigation & Hydraulics

Faculty of Engineering

Ain Shams University

4-Dr. Peter Hany Riad

Associate Prof., Department of Irrigation & Hydraulics

Faculty of Engineering

Ain Shams University

2021

ACKNOWLEDGMENT

Gratitude is due to merciful generous God that guided me throughout this study.

Thanks are due to **Prof. Ahmed Ali** (Professor of Environmental Hydrology at the Faculty of Engineering, Ain Shams University), for his constant assistance and valuable advice throughout this study.

Gratitude is to be extended to the **Dr. Noha Samir** (Professor of Environmental Hydrology - Engineering Department Science, The Institution of Environmental Research and Studies, Ain Shams University and Dean of the Institution of Environmental Research and Studies).

My deepest thanks and appreciation went to **Dr. Fatma Shaltout** (Professor of Water Resources Management, Faculty of Engineering, Helwan University and Head of Construction Engineering Department, Egyptian Russian University).

Gratitude is also extended to **Dr. Peter Riad** (Associate Prof. at Irrigation and Hydraulics Department, Faculty of Engineering, Ain Shams University), for his valuable supervision, continuous encouragement, useful suggestions and active help during this investigation.

My sincere appreciation and gratitude are due to **Dr. Heba Mosalam** (Lecturer at Energy Program, Faculty of Engineering, Heliopolis University for Sustainable Development).

I might likewise want to show my appreciation to staff members of Institute of Environmental Studies and Research IESR and colleagues who assisted me to accomplish my thesis.

My sincere appreciation and gratitude are due to my family for their help and patience during the preparation of this study. Without their assistance, this investigation would have never ended.

ABSTRACT

ABSTRACT

In terms of the importance of constructing mega integrated sustainable projects in Egypt, this research was initiated with the impartial of investigating an integrated sustainable system for improving groundwater quality in El-Bahariya Oases. A methodology with 5 investigations was designed. During the ***“Theoretical Investigation”***, literature was reviewed about sustainable communities. Throughout the ***“Field Investigation”***, site visits were carried out and site data was assembled. All through the ***“Modeling Investigation”***, a water sub-system model (treatment by oxidation), an Energy sub-system model (solar Energy) and a food-sub-system model (aquaponic) were established in Bahariya Oases and Heliopolis University (HU). In the ***“Analytical Investigation”***, the samples were analyzed and a geostatistical analysis was done to determine iron concentration in Bahariya . Moreover, ANN was tooled to transfer the model from HU in Cairo to Bahariya Oases, where the proposed location was determined by GIS analysis. Likewise, a platform concept for Water, Energy and food Nexus was developed to determine future projects budget. During the ***“Inferential Investigation”***, conclusions were deduced and recommendations were suggested for future research so as the Engineering Practice. The results ***flagged out*** that the whole system needs 101 polycrystalline solar panels and an inverter 14-kilowatt. In addition, the results ***highlighted*** the importance of the availability of 288 volts to the system. The results ***proposed*** 2 sites for aquaponic system in the northwestern region. The results provided the iron concentration in the

ABSTRACT

groundwater, which is beneficial to integrated system planning in Bahariya Oases. In addition, the results indicated that the real model will improve the groundwater quality by eliminating iron concentration. Moreover, the results provided a design to the sustainable model to provide the required energy to the system. Likewise, the results reflected the importance of implementing aquaponics, as a food supply source. Similarly, results designated that Sustainable Development Goals and Egyptian vision 2030 will be met. Besides, a new application for WEF management was developed. *Innovative about this research*, is designing a mobile app for WEF management to estimate sustainable projects budget.

KEY WORDS:

Water Treatment – Sustainable Development – Geographic Information System – Underground water

TABLE OF CONTENTS

Table of Contents

ACKNOWLEDGMENT	IV
ABSTRACT.....	I
TABLE OF CONTENTS	III
LIST OF FIGURES	IX
LIST OF TABLES	XIV
LIST OF EQUATIONS.....	XVI
GLOSSARY OF ABBREVIATIONS	XVII
CHAPTER (1) INTRODUCTION	2
1.1 OVERVIEW TO THE WATER RESOURCES IN EGYPT.....	3
1.2 RESEARCH OBJECTIVES	7
1.3 RESEARCH METHODOLOGY.....	7
1.4 THESIS LAYOUT.....	8
CHAPTER (2) LITERATURE REVIEW	14
2.1 WATER RESOURCES	14
2.1.1 WATER QUALITY STANDARD.....	16
2.1.2 IRON IN GROUNDWATER	16
2.1.3 WATER TREATMENT	17
2.1.4 OXIDATION FOR IRON REMOVABLE.....	18
2.2 SUSTAINABLE ENERGY	21

TABLE OF CONTENTS

2.3 FOOD PRODUCTION	23
2.3.1 HYDROPONICS	25
2.3.2 AQUACULTURE.....	26
2.3.3 AQUAPONIC	27
2.4 WATER QUALITY INDEX GEO SPATIAL ANALYSIS.....	30
2.5 ARTIFICIAL NEURAL NETWORK ANN	32
2.6 NEXUS AND SUSTAINABLE DEVELOPMENT.....	35
2.6.1 VELOPMESUSTAINABLE DENT GOALS	35
2.6.2 APPLIED NEXUS APPROACH TO COVER SDGS	37
2.6.3 WEF IN THE ARAB AREA AND EGYPT.....	44
2.6.3.1 WEF NEXUS IN THE ARAB AREA.....	44
1. WATER	44
2. ENERGY	48
3. FOOD.....	49
2.6.3.2 WEF NEXUS IN EGYPT.....	50
1. WATER	51
2. ENERGY	53
3. FOOD.....	54
2.6.3.3 WATER, ENERGY, FOOD SECURITY NEXUS	55
1. WATER SECURITY	56
2. FOOD SECURITY	57

TABLE OF CONTENTS

3. ENERGY SECURITY	57
CHAPTER (3) FIELD INVESTIGATION	59
3.1 SITE DESCRIPTION	59
3.2 BAHARIYA VILLAGES.....	60
3.2.1 TOPOGRAPHY AND LITHOLOGY	61
3.2.1.1 MOUNTAINS, HILLS, AND DEPRESSIONS	61
3.2.1.2 LITHOLOGY AND DESERTS	64
3.3 CLIMATIC FEATURES	64
3.4 POPULATION, PEOPLE CULTURE, AND ACTIVITIES.....	65
3.5 WATER RESOURCES AND QUALITY	65
3.6 ENERGY RESOURCES	66
3.7 CULTIVATED CROPS.....	67
3.8 AREA PROBLEMS AND PROPOSED SOLUTION	67
CHAPTER (4) MODELING INVESTIGATION	70
4.1 WATER SUB-SYSTEM MODEL DEVELOPMENT.....	71
4.1.1 WATER PERSPECTIVE OVERVIEW	71
4.1.2 TREATMENT APPROACH IN BAHARIYA.....	73
4.1.3 WATER SUB-SYSTEM MODEL (TREATMENT)	74
4.2 ENERGY SUB-SYSTEM MODEL DEVELOPMENT.....	77
4.2.1 ENERGY PERSPECTIVE	77
4.2.2 ENERGY APPROACH IN BAHARIYA.....	77

TABLE OF CONTENTS

4.2.3 ENERGY SUB-SYSTEM MODEL (SOLAR)	78
4.3 FOOD SUB-SYSTEM MODEL DEVELOPMENT	82
4.3.1 FOOD PERSPECTIVE.....	82
4.3.2 FOOD PRODUCTION APPROACH IN BAHARIYA	83
4.3.3 FOOD SUB- MODEL (AQUAPONIC)	84
4.4 WEF NEXUS PERSPECTIVE OVERVIEW	86
4.4.1 WEF NEXUS APPROACH IN BAHARIYA	90
4.4.2 WEF NEXUS MODEL.....	91
4.4.3 APPLICATION IDEA AND WORKFLOW.....	93
CHAPTER (5) ANALYTICAL INVESTIGATION.....	100
5.1 WATER DATA ANALYSIS	101
5.1.1 GROUNDWATER DATA COLLECTION	101
5.1.2 GROUNDWATER STATISTICAL ANALYSIS	101
5.1.3 GROUNDWATER GEO STATISTICAL RESULTS	103
5.1.4 GROUNDWATER TREATMENT RESULTS.....	104
5.1.5 GROUNDWATER TREATMENT DISCUSSION	104
5.2 ENERGY DATA ANALYSIS	106
5.2.1 ENERGY DATA COLLECTION	106
5.2.1.1 ENERGY DATA CALCULATIONS IN BAHARIYA	106
5.2.1.2 ENERGY - DATA COLLECTION FROM CAIRO	108
5.2.2 ENERGY ANN ANALYSIS	111

TABLE OF CONTENTS

5.2.3 ENERGY ANN RESULTS	112
5.2.4 ENERGY SOLAR PV SYSTEM RESULTS	117
5.2.5 ENERGY SOLAR PV SYSTEM DISCUSSION.....	121
5.3 FOOD DATA ANALYSIS.....	121
5.3.1 FOOD ENHANCEMENT DATA COLLECTION	122
5.3.2 AQUAPONIC ENHANCEMENT SYSTEM DESIGN	123
5.3.3 AQUAPONIC ENHANCEMENT SYSTEM RESULTS	125
5.3.4 FOOD MULTI-CRITERIA ANALYSIS	127
5.3.5 RESULT OF AQUAPONIC SITE SELECTION.....	134
5.3.6 FOOD AQUAPONIC SYSTEM DISCUSSION.....	137
5.4 WEF DATA ANALYSIS, RESULTS AND DISCUSSION....	147
5.4.1 WEF APPLICATION RESULTS.....	148
5.4.2 WEF – APPLICATION DISCUSSION	152
5.4.2.1 WEF NEXUS OPPORTUNITY AND CHALLENGES	153
5.4.2.2 EGYPTIAN OPPORTUNITIES FOR A NEXUS.....	154
CHAPTER (6) INFERENTIAL INVESTIGATION.....	158
6.1 CONCLUSIONS.....	158
6.2 RECOMMENDATIONS	162
SUMMARY.....	165
LIST OF REFERENCES	165
APPENDIX I: PAPERS TO PUBLISH	189

TABLE OF CONTENTS

APPENDIX II: WATER ANALYSIS REPORTS	197
TENTATIVE INVESTIGATION FOR WATER SAMPLES.....	198
ON SITE DATA COLLECTION AND ANALYSIS	201
APPENDIX III: IMAGES.....	208
TREATMENT DATA SAMPLE BEFORE AND AFTER TREATMENT.....	215
HISTORICAL DATA.....	218
المستخلص	1
محتويات الرسالة.....	1