AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
IRRIGATION AND HYDRAULICS DEPARTMENT

"SUSTAINABLE DEVELOPMENT AND MANAGEMENT OF WATER RESOURCES IN ARID REGIONS CATCHMENTS"

BY

Eng. GAMAL IBRAHIM MOHAMED KOTB

A Thesis
Submitted in Fulfillment
of the Requirements for the
Degree of

Doctor of Philosophy

in Civil Engineering
(Irrigation & Hydraulics)

Supervised By

Prof. Dr. MOSTAFA M. SOLIMAN

Professor of Irrigation and Hydraulics, Faculty of Engineering, Ain Shams University, Cairo - Egypt

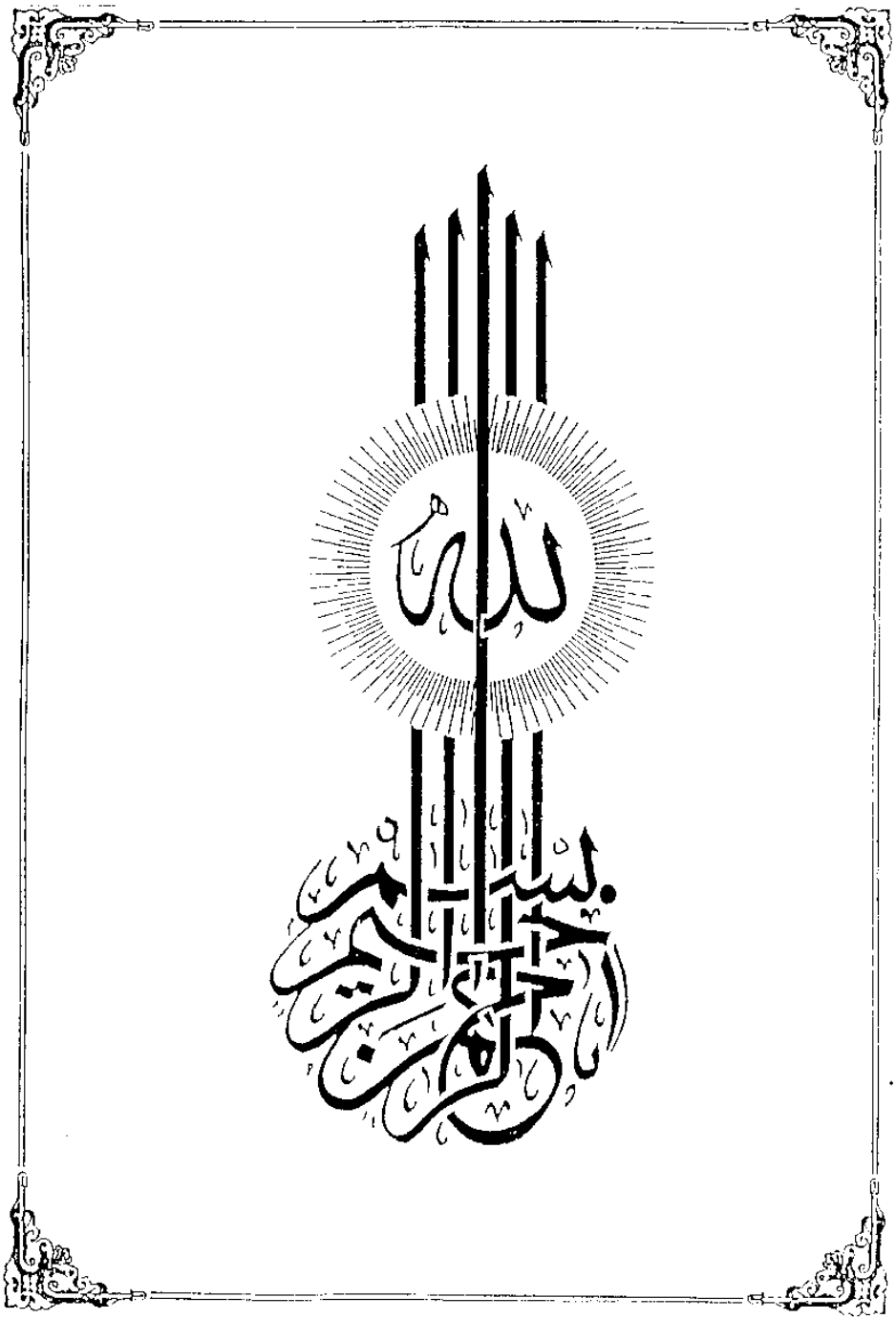
Prof. Dr. ABD EL MOHSEN EL MONGY

Prof. of Harbors, Inland Navigation and Shore Protection Engineering, Faculty of Engineering, Ain Shams University, Cairo-Egypt.

Prof. Dr. M. SAMIR M. FARID

Director of Water Resources Reshearch Institute (WRRI), National Water Research Center (NWRC), Ministry of Public Works and Water Resources, Egypt.

Cairo, Egypt
1998



Ph.D. Thesis
submitted by Gamal I.M. Kotb
in Civil Engineering (Irrigation and Hydraulics)

Examiners Committee

Prof. Dr. MOSTAFA M. SOLIMAN
rigation and Hydraulics Department,
aculty of Engineering, Ain Shams University,
airo -Egypt.

Prof. Dr. AHMED FAKHRY KHATTAB
:onsultant, National Water Research Center,
1inistry of Public Works and Water Resources,
'airo - Egypt.

Prof. Dr. ALI MOHAMED TALAAT
'rigation and Hydraulics Department,
aculty of Engineering, Ain Shams University,
'airo - Egypt.

STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy in Civil Engineering.

The work included in this thesis was carried out by the author in the Department of Irrigation & Hydraulics, Ain Shams University, from January, 1996 to June, 1998.

No part of this thesis has been submitted for a degree or a qualification at any other University or Institution.

Date : **June 20, 1998**

Signature : GAMAL H.o.TB.

Name: Gamal Ibrahim Mohamed Kotb

ACKNOWLEDGEMENTS

As a PH D. student, you can consider yourself very lucky when having an intelligent and stimulating adviser who demonstrates great competence in his field. I must consider my self extremely lucky in having three advisers who correspond to the previous description.

First I want to acknowledge and thank my promotor, Prof. Dr. **Mohamed Samir M. F.**, director of Water Resources Research Institute (WRRI), National Water Resources Center (NWRC), who triggered in me the interest in my studying sustainable development and management of water resources and who has unceasingly encouraged me in my research. He offered me opportunities to work with detailed field data and to collaborate with the best people working in hydrology, without his help this work could never have been successful.

I wish to express my profound gratitude to Prof. Dr. **Moustafa M. Soliman** for his kind and consistent advice and guidance which contribute to success of this study. He was sharing his ideas on surface and subsurface water hydrology with me. And I was trying to absorb as much as possible the knowledge that was exchanged.

Special thanks goes to Prof. Dr. **Abd El Mohsen El Mongy** for his guidance, Constructive criticism and continued encouragement throughout this research. Any body who has had the opportunity to work closely with prof. El Mongy knows what a great mind he is and admires him for his modesty and kindness.

A special appreciation goes to Prof. Dr. **Hassen Ibrahim**, who has given me his support, and I would like to thank all the following persons for their help in the realization of this dissertation: Dr. **Ahmed H.F.**, Eng. **Abd El Aziz F.**, and Mr. **Ahmed S.**.

I would like to express my deep apprectiation to Dr. **Gamal Allam** for his keen advice and technical support throught this research.

During the preparation of this dissertation I have had the opportunity to work with many good friends, who contributed in one way or the other during the period of my research. I gratefully acknowledge their contribution to this dissertation.

Finally, I wish to express my deep appreciation to my parents who have encouraged me all the time. Special deep appreciation to my wife, my son Mohammed and my daughter Omnia, for their spiritual guidance. Their continuous love and supports was a safe beacon during this long and difficult work

ABSTRACT

Kotb Gamal Ibrahim Mohammed 'SUSTAINABLE DEVELOPMENT AND MANAGEMENT OF WATER RESOURCES IN ARID REGIONS CATCHMENTS' Unpublished Doctor of Philosophy dissertation, Ain Shams University, Faculty of Engineering, Cairo, Egypt.

Water strategy is a part of the political direction of a country. Water is the resource, product and source of influence to economic, social and ecological development of a country, and it is essential for preserving life. It is a strategic resource for any development because reserves are very limited.

IDENTIFICATION OF THE PROBLEM

Water problems in arid and semi-arid regions stem primarily from rapidly rising water demands. This regions are highly vulnerable to drought and their sensitivity to this phenomenon increases with increasing aridity and it begins to face serious water shortage and the limited of water resources could meet the needs of the population in these regions. The rapid growth of population and socio-economic development seems to be overwhelming the technological capability to supply it, and further the cost of supplying water to water-short areas is increasing. Under such conditions water resources management could alleviate existing and potential water supply problems.

As a result of high population growth rate and substantial improvement in the standard of living in most of the countries and extensive socio-economic development. Management of water resources should be comprehensive and flexible in order to accommodate social and economic changes, and to promote the allocation of water on a competitive basis.

An integrated management of surface and groundwater resources of wadi basins could reduce water intrusion and lead to a sustainable development. Besides in the arid regions the direct use of flood water for groundwater recharge is small compared to the amount of available surface runoff. Under the limited water resources, the optimum utilization of water resources is vital.

SCOPE AND OBJECTIVE OF THE THESIS

This Thesis describes the supply and demand characteristics of the water management system in W. Feiran area in order to provide an insight into the various problems that may occur.

1-Develop a generalized strategies for sustainable development of arid lands watershed through management of their water resources;

2-Evaluate various water resources, i.e. rainfall, snowfall, and groundwater for optimal and sustainable utilization and management techniques of available water;

3-Optimize use of rainfall and uncontrolled flow by increasing water conservation, provide flood protection and promote groundwater;

4-develop a software package in order to have the flexibility of incorporating both aspects and objectives involved in watershed management, and to advise the decision makers about the best solution.

In order to achieve the optimum use of water resources and the conservation of water, water resources master plan will be required to translate the overall water targets into programs, and enable their impacts on Socio-economic development goals to be examined and reviewed.

To achieve the main purpose of this thesis, it is necessary to describe the supply and demand characteristics of the water management system in the study area. Also the different watershed management aspects should be discussed in order to provide an insight into the various water management problems that may occur and to yield a solution for these problems. This management tool have two parts. The first is the assessment procedure, in which the various water resources are assessed. The second is a management strategy formulation, which enables practical management options to be identified and considered once the effects have been assessed.

Under local conditions enough water is not available in wadi Feiran area to meet the various demands. Since both supply and demand vary, problems do occur in certain dry periods. These problems may be related to the limited availability of surface water or groundwater, or to bad quality of available water.

W. Feiran area is characterized by low rainfall amounts and by the occurrence of flash floods, so there is need for a better control of flood water and it is important to capture and use a significant part of the flow before it becomes brackish and saline.

METHOD OF PRESENTATION

The **introduction** is followed by a review of the relevant watershed management and characteristics, national plans and strategies of water and decision support system literature in **CHAPTER 2. CHAPTER** 3 shows detailed description of the study area, including information about climatic, geomorphology and topography, soils and lands, geology, hydrogeology, hydrology, economic activities, infrastructures and social services. **CHAPTER** 4 reviews literature on previous geological, geophysical, hydrgeological studies and hydrological characteristics, and the hydrologic model used to develop potential runoff estimates for Feiran basin. Assessment of potential water resources and developed precipitation-runoff and recharge equations are provided in **CHAPTER** 5. Water plan and management is discussed in **CHAPTER** 6. Cost water analysis for groundwater and surface water is provided in **CHAPTER** 7. Develop new software model, evaluation of the decision supporting system and multicriteria decision making analysis are discussed in **CHAPTER** 8. Conclusions and recommendations are presented in **CHAPTER 9 and CHAPTER** 10, respectively.

TABLE OF CONTENTS