USING SIMULATION MATHEMATICAL MODELS TO STUDY THE ENVIRONMENTAL CHANGES DUE TO NAVIGATION DEVELOPMENT IN THE NILE RIVER

BY

Eng. Mohamed El-Sayed Mohamed Abdel Naby
Assistant Researcher-National Water Research Center, Nile Research Institute
Diploma, Environmental Science, Ain Shams University, ٢٠٠٢
M. Sc. Environmental Engineering, Ain Shams University, ٢٠٠٦

A thesis Submitted in Partial Fulfillment
of
The Requirements for the Doctor of philosophy
in
Environmental Science

Department of Engineering Science
Institute of Environmental Studies and Research
Ain Shams University

٢٠١٢

APPROVAL SHEET

USING SIMULATION MATHEMATICAL MODELS TO STUDY THE ENVIRONMENTAL CHANGES DUE TO NAVIGATION DEVELOPMENT IN THE NILE RIVER

BY

Eng. Mohamed El-Sayed Mohamed Abdel Naby
Assistant Researcher-National Water Research Center,(NRI)
Diploma, Environmental Science, Ain Shams University, ٢٠٠٢
M. Sc. Environmental Engineering, Ain Shams University, ٢٠٠٦

This Thesis Towards a Doctor of Philosophy in Environmental Science Has Been Approved by:

Name	Signature
١. **Prof. Dr : Aly Nabih El-Bahrawy** Prof. of Hydraulics, Irrigation and Hydraulic Dept., Faculty of Engineering, Ain Shams University, Cairo, Egypt.	……...
٢. **Prof. Dr.: Medhat Saad Aziz** Director of Nile Research Institute (NRI), National Water Research Center (NWRC), Cairo, Egypt	……...
٣. **Prof. Dr.: Mohamed Mohamed Nour El-Dien** Head of Irrigation and Hydraulic Dept., Faculty of Engineering, Ain Shams University, Cairo, Egypt.	……...
٤. **Prof. Dr. Karima Mahmoud Attia** Deputy Director, Nile Research Institute (NRI), National Water Research Center (NWRC), Cairo, Egypt.	……

USING SIMULATION MATHEMATICAL MODELS TO STUDY THE ENVIRONMENTAL CHANGES DUE TO NAVIGATION DEVELOPMENT IN THE NILE RIVER

BY

Eng. Mohamed El-Sayed Mohamed Abdel Naby
Assistant Researcher-National Water Research Center, Nile Research Institute
Diploma, Environmental Science, Ain Shams University, ٢٠٠٢
M. Sc. Environmental Engineering, Ain Shams University, ٢٠٠٦

A thesis Submitted in Partial Fulfillment
of
the Requirements for the Doctor of philosophy
in
Environmental Science

Under The Supervision of:

١- **Prof. Dr.: MOHAMED NOUR EL-DIEN**
Head of Hydraulics Department.,Faculty of Engineering,
Ain Shams University, Cairo, Egypt.

٢- **Prof. Dr.: KARIMA MAHMOUD ATTIA**
Deputy Director, Nile Research Institute (NRI),
National Water Research Center (NWRC), Cairo, Egypt.

٣- **Dr.: NOHA SAMIR DONIA**
Associate Prof., Environmental Engineering Department
Institute of Environmental Studies and Research
Ain Shams University, Cairo, Egypt

٤- **Dr.: HOSSAM MOHAMED EL-SERSAWY**
Associate Prof., Nile Research Institute (NRI),
National Water Research Center (NWRC), Cairo, Egypt.

٢٠١٢

ACKNOWLEDGEMENT

First of all, thanks to **ALLA** without whom anything could not be possible.

I would like to express my appreciation and gratitude to ***my advisor prof. Dr. Mohamed Nour Eldien,*** Head of Irrigation & Hydraulics Dept., Faculty of Engineering, Ain Shams University, for his support precious remarks, suggestion and expert advice that lead to the successful completion of this study.

The author wishes to express his sincere appreciation to ***prof. Dr., Karima M. Attia*** Vice director, Nile Research Institute (NRI), National Water Research Center, for her guidance, and advice.

Grateful thanks are due to ***Dr. Noha Samir Donia*** Associate Prof Environmental Engineering Department, Institute of Environmental Studies and Research, Ain Shams University, for her guidance and advice throughout the study.

Deepest gratitude and thanks to ***Dr. Hossam El Sersawy*** Associate Prof., Nile Research Institute (NRI)**,** National Water Research Center (NWRC) for his advice, support and his guidance that leads to complete this study.

Special thanks are due to ***Dr. Medhet Aziz***, Director, Nile Research Institute (NRI) for his continuous support and encouragement through this research.

Deepest gratitude and thanks to ***Dr. Mostafa El-Sammany***, ***Dr. Mohsen yousry ,*** and ***Dr. Talat Abdel Ghafar*** Nile Research Institute (NRI)**,** National Water Research Center (NWRC) for their analysis , advice, support and their guidance that leads to complete this study.

Finally I wish to express my deepest thanks and appreciation to ***my mother*** for her sacrifices, encouragement and for her support not only these days but since I was born. There is no words can express my deepest gratitude towards ***my wife Hanan***.

My warmest thanks are to ***my daughters, Aya, Doha and my son Yassien*** who supported and patient through the time of study.

Abstract

The Egyptian Government has paid a lot of attention to the preparation of the Nile River as a navigation channel. Such preparation includes surveying, dredging, and installation of aids to navigation. All such efforts aim to increase the safety of navigation in the Nile River. In this study another aspect of safety is being addressed, namely the environmental impact of channel dredging.

Recently, every country all over the world has recognized that, compared with other transportation modes, navigation causes less environmental impact and is a transport mode for sustainable development. Inland navigation is the transport mode with minimum energy consuming, transport cost saving, environmental impact decreased and traffic jam alleviated for the large quantity of freight transportation.

Studies must consider all positive and negative environmental effects of the alternative dredging plans considered. Some of the environmental effects may be changes in water levels, erosion and water velocities. The assessment will indicate whether a Statement of findings or an Environmental Impact Statement will be required, including a comprehensive mitigation plan for any adverse effects. In the development or improvement of deep-draft navigation projects, the effects of dredging on fish and wildlife resources must be considered. Another aspect of safety is being addressed, namely Environmental impacts of the disposal of dredged material, where is added to soil as sources of fertilizer and conditioner for the soil, the assessment of dredged material was conducted by comparing the average total heavy metals concentration with the permissible values of different sediment quality. The results were found within the permissible limits of standards. Two dimensional mathematical model has been used to simulate the changes in river at study reach. The model was calibrated and verified using field measurements and historical data (water levels and discharges). The calibration and verification process shows close agreement between actual and predicted parameters. Four different scenarios were applied to represent the situation before and after dredging in minimum and maximum water level.

It was concluded that Successful applications of this model to simulating large scale river channel flows proved to be reliable and could be applied to similar cases to assist decision makers. The dredging process dropped the water surface, decreased the velocity and almost improved water depths for navigation channel.

This study uses Geographical Information System to evaluate and simulate the occurred changes. Based on the actual and basic interaction between the hydraulics, morphological and environmental parameters, main tools can be utilized to illustrate and explain these relations.

Through this study Environmental Impacts Assessment (EIA) by using JICA tables for irrigation projects to represent the changes before and after the project according to the situation where can be predicted and therefore monitoring and mitigation can be applied. It was concluded that the increased turbidity might be detrimental to benthic species particularly sedentary species such as tube worms. Prolonged reduced water column clarity might also lead to a reduction in the photosynthetic productivity of the water column.

The study recommended that it's important to encourage the Nile navigation. Developing guidelines for EIA study to be conducted dredging projects which these guidelines can be used for all similar projects. Integration of new techniques modeling and GIS for impact assessment into the EIA study to help decision maker to select suitable actions and mitigation measures before the project implementation.

SUMMARY

Recently, every country all over the world has recognized that, compared with other transportation modes, navigation causes less environmental impact and is a transport mode for sustainable development. Inland navigation is the transport mode with minimum energy consuming, transport cost saving, environmental impact decreased and traffic jam alleviated for the large quantity of freight transportation.

Studies must consider all positive and negative environmental effects of the alternative dredging plans considered. Some of the environmental effects may be changes in water levels, erosion and water velocities. The assessment will indicate whether a Statement of findings or an Environmental Impact Statement will be required, including a comprehensive mitigation plan for any adverse effects.

Through this study Environmental Impacts Assessment (EIA) by using JICA tables for irrigation projects to represent the changes before and after the project according to the situation where can be predicted and therefore monitoring and mitigation can be applied. It was concluded that the increased turbidity might be detrimental to benthic species particularly sedentary species such as tube worms. Prolonged reduced water column clarity might also lead to a reduction in the photosynthetic productivity of the water column.

The study recommended that it's important to encourage the Nile navigation. Developing guidelines for EIA study to be conducted dredging projects which these guidelines can be used for all similar projects. Integration of new techniques modeling and GIS for impact assessment into the EIA study to help decision maker to select suitable actions and mitigation measures before the project implementation.

TABLE OF CONTENTS

CHAPTER 3 DATA COLLECTION AND METHODOLOGY

CHAPTER ٤ ENVRONMENTAL IMPACTS ANALYSIS

CHAPTER ٥ ANALYSIS OF RESULTS

CHAPTER ٦ CONCLUSIONS AND RECOMMENDATIONS

LIST OF FIGURES