NUMERICAL MODELLING OF COASTAL WATER MOVEMENTS

1986

Lihat sebelah

NUMERICAL MODELLING OF COASTAL WATER MOVEMENTS

by

MOHD. NASIR SAADON

Thesis submitted to the University of Wales

for the Degree of Philosophiae Doctor

Department of Oceanography

University College of Swansea

November 1986

To Fatimah and Rashid.

CERTIFICATE OF ORIGINALITY

This is to certify that the work described in this thesis was carried out in the Department of Oceanography of the University College of Swansea and is the original and independent work of the author, except where specifically acknowledged in the text.

.....

Candidate

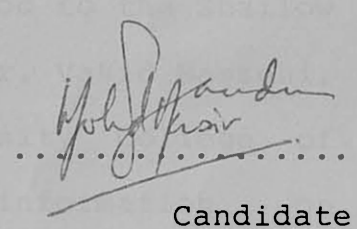
.....

Director of Studies

Date: 28/11/86.....

DECLARATION

No part of this thesis has been submitted for any Degree in the University of Wales, nor is it being submitted to any other university.



.....

Candidate

Date: 28/4/86.....

ACKNOWLEDGEMENTS

I wish to express my gratitude to my director of studies, Dr. A.E. James, for his encouragement and invaluable discussions throughout the course of this work.

I am also grateful to all my friends in the Department of Civil Engineering, University College of Swansea, especially Chow, Marque and Jose for their useful discussion about the application of finite element method to the Shallow Water Wave Equations. I also wish to thank Dr. Vahid Nassehi, Department of Chemical Engineering, University College of Swansea, for providing me with useful information on one-dimensional models. I am also indebted to Dr. Pattiaratchi of the Dept. of Oceanography, University College of Swansea, for providing me information on remote sensing and fluid dynamics. Sincere thanks are also due to my friends Rosman and Aini for their kind help and generosity during the completion of my work. I am also thankful to Mrs. E. Phillips for typing the manuscript.

I also wish to acknowledge my employer, Universiti Pertanian Malaysia and Jabatan Perkhidmatan Awam Malaysia, for jointly sponsoring my study.

Finally, I would like to convey my appreciation to my

wife, Cora, for her help and cooperation, to my son, Rashid, for inspiring me with his cries and laughters to strive harder in my work, and to my parents for their spiritual support.

MOHD. NASIR SAADON
DEPARTMENT OF OCEANOGRAPHY
UNIVERSITY COLLEGE OF SWANSEA

ABSTRACT

The shallow water equations have been solved numerically using the Galerkin finite element method. Flow problems which can be classified as one-dimensional and two-dimensional are investigated.

Two differing types of integration procedure (Gaussian Quadrature scheme and a mixed quadrature scheme involving both Gaussian Quadrature and Simpson's Rule) are examined to determine the most efficient way of obtaining the finite element solutions. The mixed quadrature scheme is shown to be a faster but less accurate process than the Gaussian scheme.

The numerical results from the one-dimensional models are initially tested by comparison with the known analytic solutions for a straight channel and a wedge-shaped channel. Solutions from numerical models show good agreement with the analytic solutions. The one-dimensional models are also used to simulate the M2 tide in the Bristol Channel. The results are in good agreement with observed field data. The two-dimensional models are tested against analytic solutions for a straight canal and an open coastal embayment with a variety of bottom topographies. The numerical results are in good agreement with the analytic solutions.

Finite element solutions are found for real situations, in particular the area around Lundy Island within the Bristol

Channel and in the Bristol Channel itself. The numerical solutions are compared with the observed field data. The two-dimensional numerical models produce solutions which are in good agreement with observed field data. An analysis of the eddy formation around Lundy Island shows that these features, which were first observed in satellite imagery, are predicted by the two-dimensional numerical models. Coriolis force is shown to be important in the formation of the island wake.

The one-dimensional numerical models are less successful in predicting the observed field data than the two-dimensional numerical models but the former are very efficient in terms of computer time and also provide a good prediction of water levels and elevation phase lags.