NUMERICAL STORM SURGE PREDICTION IN INDIA

THESIS

By

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... to my parents

CERTIFICATE

This is to certify that the thesis entitled 'NUMERICAL STORM SURGE PREDICTION IN INDIA' being submitted by AMBARUKHANA DEVENDRA RAO for the award of the degree of DOCTOR OF PHILOSOPHY, is a record of the original bonafide research work carried out by him. He has worked under our joint guidance and supervision and has fulfilled the requirements for the submission of this thesis. The results presented in this thesis have not been submitted in part or full to any other University or Institute for award of any degree/diploma.

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SUMMARY

The main objective of this thesis is to present the numerical models developed for the improved prediction of storm surges and coastal inundation along the Indian coasts, which may help in effective evacuation measures and thus minimize the damage caused by severe cyclonic storms.

In Chapter I, a brief review of the literature relevant to the studies made in the thesis has been presented. Recent developments made in the various methods used for the storm surge prediction in India and neighbourhood together with a brief description of the existing models has also been included in the chapter.

Starting from the basic set of hydrodynamic equations governing the motion of the sea, Chapter II briefly describes the theoretical formulation of the depth-averaged numerical storm surge prediction models, which have been used for performing a number of numerical experiments in order to see the effect of coastal geometry and different wind stress forcings on the location and intensity of peak surge along the east coast of India.

In Chapter III, a finite-difference method is used for the treatment of a continuously deforming lateral fluid boundary in computer simulations of systems involving the

shallow water equations. The technique is described in the context of a numerical storm surge model for the east coast of India. Using a forcing wind stress distribution representative of the 1977 Andhra cyclone, a comparison is made between simulations using models both with and without inland intrusion of water along the coast of Andhra Pradesh.

Chapter IV gives a description of a numerical model which has been developed for the prediction of storm surges along the west coast of India. Numerical experiments are performed with the help of this model in order to simulate the surge generated by the 1975 Porbandar cyclone. The results of these experiments show that the maximum surge predicted at Porbandar is in good agreement with the reported values in that region.

A three-dimensional numerical model for the simulation of storm surges generated by tropical cyclones off the east coast of India is described in Chapter V. Experiments are performed using wind-stress forcing data representative of the 1977 Andhra cyclone and the results are compared with earlier simulations using the depth-averaged model. The three-dimensional model incorporates a turbulence energy closure scheme and is fairly sophisticated in comparison with the depth-averaged approach. Even with the apparently more refined treatment of the frictional processes, there is no substancial difference between simulations performed with the two models.

In the last chapter, a numerical model is described for the simulation of storm surges which uses a non-uniform off-shore grid-spacing adjacent to coastal boundaries. This permits an increased resolution near the coast in the models described in Chapters II and III. Using data on the 1977 Andhra cyclone it is shown that the near-coastal bathymetry is critical in determining the coastal surge-induced sea-surface elevation. It is also shown that the coastal surge response is effectively independent of the depth of water in the deepest regions of the analysis area. Conclusions are drawn concerning the selection of an optimum resolution in the numerical scheme together with the proper representation of the bathymetry.

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