MATHEMATICAL MODELLING OF WIND EFFECTS ON CLOSED LAKES

by

ROBERT JOHN ARNOLD, B.Sc.(Hons) (Adelaide)

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University of Adelaide,

Department of Applied Mathematics.

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SUMMARY

This thesis investigates general methods with which the circulation induced by a wind blowing over the surface of a closed basin may be calculated. Firstly, the linear, depth integrated equations describing such motions are used to model the motions induced by an oscillating wind blowing over a system of connected lakes each of constant depth. The techniques used to model this problem are the Collocation and Galerkin methods, which assume the basins are of rectangular shape, and a Boundary Integral Technique, which models basins of arbitrary contour. The performance of each of these methods is analysed.

By way of developing the above methods, the effect of the Coriolis force on the motion in rectangular lakes of various dimensions is also discussed. Results from the Boundary Integral Technique are also compared with analytic solutions available for simple geometries.

Various numerical methods of solving the depth integrated equations are also developed. Some of these methods can be used to calculate the effect of a wind blowing over a basin of arbitrary depth and contour. As part of this section of the thesis, finite difference approximations are developed which enable derivatives at a point near a curved boundary, along which a Neumann boundary condition applies, to be modelled with second order accuracy. Results from all the numerical models are compared with each other as well as with analytic solutions of problems with simple boundaries.

Finally, the depth variation of horizontal velocity in such flows is considered. Several analytic solutions, applicable to channel flow, are developed. These are compared with experimental observations. A turbulent energy closure scheme is also used to examine the vertical profile of velocity and comparisons are made between the results from this model and the analytic solutions as well as some experimental observations.