# APPLICATIONS OF A 2DH POST-BOUSSINESQ MODEL: GENERATION AND PROPAGATION OF TSUNAMI AND SHIP-BORNE WAVES

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## INTRODUCTION

In this work, the 2DH post-Boussinesq model of Karambas and Memos (2009) is tested in the generation and propagation of tsunami and ship-borne waves. Model results compare well with analytical solutions and physical experiments presented by Hammack (1973), Mitsotakis (2009) and David et al. (2017), highlighting the model's accuracy and versatility.

## MODEL EQUATIONS AND NUMERICAL SCHEME

The proposed momentum equations are written:

$$\frac{\partial U}{\partial t}+U\frac{\partial U}{\partial x}+V\frac{\partial U}{\partial y}+g\frac{\partial \zeta}{\partial x}= \\ -\int_{\infty}^{\infty}\int_{-\infty}^{\infty}\left(\frac{\partial \zeta}{\partial x}(x-\xi_1,x-\xi_2,t)-\frac{\partial \zeta}{\partial x}\right)K(\xi_1,\xi_2)\,d\xi_1 d\xi_2 \qquad (1)$$

$$\frac{\partial V}{\partial t}+U\frac{\partial V}{\partial x}+V\frac{\partial V}{\partial y}+g\frac{\partial \zeta}{\partial y}= \\ -\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left(\frac{\partial \zeta}{\partial y}(x-\xi_1,x-\xi_2,t)-\frac{\partial \zeta}{\partial y}\right)K(\xi_1,\xi_2)\,d\xi_1 d\xi_2 \qquad (2)$$

in which the kernel *K(x,y)* is given by:

$$K(x,y)=\frac{g}{2\pi d^2}\left[\frac{1}{r/d}-\sum_{n=1}^{\infty}\frac{(-1)^{n-1}}{\sqrt{n^2+(r/d)^2/4}}\right] \quad \text{with}$$

$r^2=x^2+y^2$.

The above model is wavenumber free and as far as the linear dispersion relation is concerned, the approach is exact (i.e. the present Boussinesq-type model poses no restriction on the water depth).

The numerical solution is accomplished by a widely used simple and well documented explicit 2$^{nd}$ order finite difference scheme centered in space and forward in time on a staggered grid, conserving mass and energy for non-breaking waves in a satisfactory manner. The discrete continuity equation is centered in the level points and the momentum equations in the flux points.

## MODEL VERIFICATION

Regarding its capabilities in representing the generation and propagation of tsunami waves, the model was tested against the results of Hammack (1973), for 1D wave profiles generated by impulsive exponential bed deformations (both upthrusts and downthrows; see Figure 1), and the results of Mitsotakis (2009), for 2D waveforms generated by dynamic bed displacements due to dip-slip faulting.

Regarding ship-borne waves, the model was tested against the physical experiments and analytical solution presented by David et al. (2017), adopting their approach for wave generation by a moving local pressure disturbance by adding a respective pressure term in the model's governing equations.

## ACKNOWLEDGEMENT

A part of this work was undertaken within the framework of the project 'Consultancy on wave disturbance and wave conditions in Port of Alexandroupolis', funded by Port Authority of Alexandroupolis, Greece.

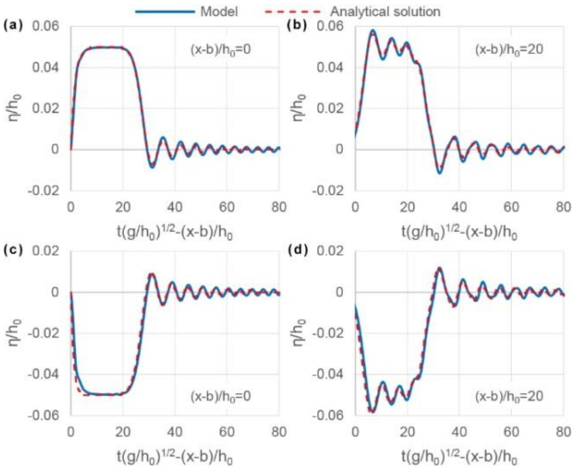


Figure 1 - Downstream wave profiles generated by impulsive exponential bed upthrusts (a,b) and downthrows (c,d).

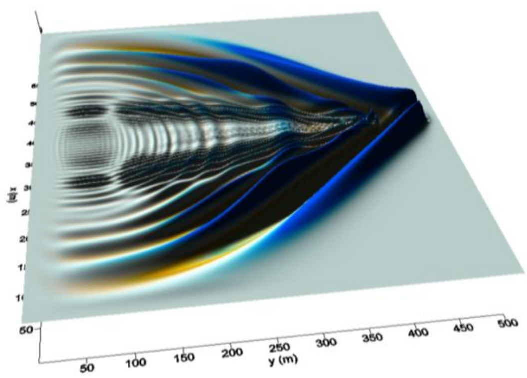


Figure 2 - Computed waves generated by a moving local pressure disturbance.

## REFERENCES

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