NUMERICAL MODELING OF TSUNAMI WAVES

Book Written by**:**

Juan Horrillo, William Knight and Zygmunt Kowalik

REVIEW

by

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The monograph “Numerical Modeling of Tsunami Waves” by Juan Horrillo, (Texas A&M University), William Knight (National Tsunami Warning Center, retired, USA) and Zygmunt Kowalik (University of Alaska, Fairbanks, USA), focuses on reproducing and predicting tsunamis using numerical models. It not only helps us to understand various phenomena such as earthquake and landslide sources, but also covers practical applications for tsunami hazard mitigation that provides guidance to local emergency managers to help evacuation planning and public education/awareness -- thus saving lives from sudden tsunamis attacks.

Entering the 21st century, the 2004 Sumatra earthquake and the associated Indian Ocean tsunami, the 2011 Great East Japan Earthquake, and the 2018 Indonesian Palu earthquake and tsunamis have occurred one after another, resulting in the loss of many lives and great damage. There is a short time between the generation of the tsunami and its arrival at the coastal area and run-up on land. During that time, appropriate evacuation is possible by notification of the arrival of the tsunami as estimated by numerical models. The monograph covers in detail the controversial tsunami arrival time of first and most significant wave traveling different tsunami routes due to prominent bathymetric features as in the Kurile and Indian Ocean tsunamis. Furthermore, if the inundation area of the tsunami can be known in advance from numerical modeling, it will be possible to plan evacuation and land use, including the design of tide embankments and breakwaters that reduce damage. For that purpose, a highly reliable tsunami numerical model and analysis tools are required, and this monograph comprehensively introduces the basics and proceeds to the application. The monograph uses finite difference approaches to study the entire tsunami process from source to propagation and runup. With practical examples related to recent tsunamis, many aspects of numerical modeling are covered.

The monograph starts by discussing in great detail earthquake, landslide and volcano sources. Since there are various causes of tsunami generation, it devises tools and simplified physics when setting wave sources. Next, tsunami signal propagation from sources is considered by numerical modeling application to the great Indian Ocean tsunami (2004), the Kurile Island tsunami (2006) and the Japan Tohoku tsunami (2011). Several case tests are included for understanding model wave propagation which compare wave propagation with and without dispersion. There are various methods for numerical analysis discussed in the monograph, and the importance of stability and reliability in addition to improving accuracy of numerical schemes. The reader can carefully introduce such a process and learn how to use numerical codes and understand the needs and difficulties in developing numerical codes.

Finally, in coastal areas where runup occurs it is difficult to develop numerical models because they are more complicated than shallow water deformation and breaking waves. In addition, wave dispersion is important in the propagation process to the coast. Therefore, application of 3D Navier-Stokes equations and associated numerical models are discussed in the monograph. Greater attention is given by the authors in describing dispersion processes in simple terms in Chapter 6.

In summary, this monograph reviews numerical modeling applications to tsunami starting from simple physics and models progressing on to complex problems that arise in the study of recent tsunamis.