UNSTRUCTURED FINITE ELEMENT TSUNAMI MODELING AND ITS APPLICATION IN/FOR INDONESIA (INDIAN OCEAN RIM COUNTRIES)

Widodo S. Pranowo[1,2,3,] Jörn Behrens[1]

[1] *Alfred Wegener Institute (AWI) for Polar and Marine Research, Bremerhaven, Germany.*
[2] *United Nations University – Institute for Environment and Human Security (UNU-EHS), Bonn, Germany.*
[3] *Ministry of Marine Affairs and Fisheries, Indonesia*

Indonesia is a tsunami prone area, having been hit by 6 events within the last 6 years: The Christmas tsunami 26 December 2004 in Aceh (earthquake Mw 9.2) as the biggest in this decade, Nias 28 March 2005 (earthquake Mw 8.7), South Java 17 July 2006 (earthquake Mw 7.7), Bengkulu 12 September 2007 (earthquake Mw 7.7 – 8.4), Toli-toli Northern Sulawesi 17 November 2008 (earthquake Mw 7.6) and Manokwari Papua 4 January 2009 (earthquake Mw 7.3 – 7.6). Many scientists (in Indonesia and from other countries) have been working on investigating, simulating and analysing those events using numerical tsunami modeling tools, which are available as open-source/free-ware or even commercial-ware. Many numerical methods have been applied and are represented in these codes (Finite Difference, Finite Element, and Finite Volume). Gridding methods such as structured and unstructured non-adaptive have been applied. Since 11 November 2008, Indonesia has a sophisticated tsunami early warning system (Ina-TEWS) based on pre-computed simulation results for the database. An unstructured finite element based code developed at Alfred Wegener Institute (TsunAWI) as the official (operational) GITEWS tsunami model and an extended version of TUNAMI (finite difference) model as the contribution by Institut Teknologi Bandung are employed for this purpose as well as for creating hazard maps. Even though both tsunami models have been well tested and validated, they are still having some efficiency problems. TsunAWI suffers from high computational costs, while TUNAMI cannot be easily refined arbitrarily.

To overcome those problems, we conduct further development in unstructured finite element tsunami modeling using adaptive mesh refinement. Similarly, to TsunAWI, the new TsunaFLASH code uses unstructured finite elements with conforming (P1) and non-conforming (P1nc) elements. The objective of developing TsunaFLASH is to improve computational efficiency by avoiding unnecessary calculations and saving computer memory. amatos (Adaptive Mesh generator for ATmosphere and Ocean Simulation) by Behrens et al. (2006) is employed for generating adaptive triangular meshes. In addition to the numerical development, the acquisition of detailed high-resolution bathymetry and topography is a pre-requisite for obtaining accurate and reliable modeling results. This presentation will show: A short introduction of the GITEWS achievements and its role in Ina-TEWS, unstructured finite element tsunami modeling and recent developments using adaptive methods, and some problems that arise during its applications in/for Indonesia and potentially other Indian Ocean rim countries.

Keywords: adaptive mesh refinement, finite element, tsunami modeling, GITEWS

Corresponding Author: widodo.pranowo@awi.de