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A PREDICTION STUDY OF WAVE PROPAGATION BEFORE AND AFTER TSUNAMI IN ULEE LHEUE COASTAL WATERS, ACEH, INDONESIA

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Abstract
The prediction of wave propagation was done using wave numerical model for Ulee Lheue coastal waters, Banda Aceh. The purpose of the present research is to predict the wave propagation in Ulee Lheue coastal waters. The wind velocity and direction data for 2001 to 2006 were used to predict wave propagation before and after Tsunami. It is showed the maximum height of wave is 0.33 m during wet season and 0.25 m in dry season. Meanwhile, the maximum height after Tsunami is 1.50 m and 0.66 m during wet and dry season.

Key words: Wave refraction, maximum height of wave before and after tsunami in Ulee Lheue coastal waters

Introduction
Ulee Lheue coastal waters is situated in the northwest of Banda Aceh. It is a main sea trade route from Ulee Lheue port to Balohan Sabang port. Erosion and Sedimentation are major recent problems in this region, mostly caused by the wave striking upon the coast. Thereby, a forecast research of wave propagation which in advance results in wave height distribution is essential to carry out.

Material and Methods
The simulation of wave propagation was done by means of wave numerical model (Figure 1). Such incident wave data as height, angle and period were predicted using formulas taken from US Army Corps of Engineers, 2006. In addition, such initial data of wind as velocity and direction are taken from Agency of Meteorology and Geophysics (BMG) for 2001 - November 2004 and 2005-2006 for both pre-Tsunami and post-Tsunami data, respectively. In the meantime, the equation taken from US Army Corps of Engineers, 1984 was used to calculate wind Fetch. Pre-Tsunami bathymetry data are acquired from Agency of Hydro-Oceanography (Dishidros), 2001 (Figure 2). Meanwhile, Post-Tsunami bathymetry data are acquired from Departemen Pekerjaan Umum Dinas Sumber Daya Perairan Provinsi NAD for 2005 (Figure 3). Both data were used as the initial input in the model. The numerical solutions are derived from wave equation taken from van Rijn, 1990 and Koutitas, 1984. On the other hand, equation $H = H_o K s K r$ was then used to calculate wave height (Dean, 1984).
Model is run based on the following flowchart shown below:

![Flowchart](image)

**Fig. 1: Flowchart**
Fig. 2: The digitized pre-Tsunami Bathymetri data (m) according to Agency of Hydro-Oceanography (Dishidros), 2001. 1). Ulee Lheue port 2). Main road to Banda Aceh. 3). Main road to Lho’nga.

Fig. 3: The digitized pre-Tsunami Bathymetri data (m) according to Departemen Pekerjaan Umum Dinas Sumber Daya Perairan Provinsi NAD. 1). Ulee Lheue port 2). Main road to Banda Aceh. 3). Main road to Lho’nga.

Results and Discussion

The simulation of wave propagation

Figure 4 showed the propagation of wave for wet and dry season before and after Tsunami. The propagation eventually brings about the divergence and convergence zone. The latter occurred in cape where energy is greater than in bay (divergence zone). Erosion-Sedimentation are depicted by wave energy representing the formation of sedimentation in divergence zone where orthogonal wave spread in this area whereas erosion occurred in the convergence zone on the contrary.
Fig. 4: Wave propagation in Ulee Lheue waters for a). wet season before Tsunami, b). dry season before Tsunami, c). wet season after Tsunami, and d). dry season after Tsunami. 1). Convergence zone 2). Divergence zone.

Wave Height Distribution
Wave height distributions in the research before and after Tsunami are 0.33 m and 0.25 for wet and dry season. Meanwhile, after Tsunami they reach 1.5 m and 0.66 for wet and dry season. In addition, wave height breaks and decreases when it comes unto the coastal zone.
Fig. 5: The wave height distributions for a). scenario for wet season before Tsunami (m) 
b). scenario for dry season before Tsunami (m), c). scenario for wet season after 
Tsunami (m) and d). scenario for dry season after Tsunami (m).

Conclusions
From the results above, it can be concluded that:
1. The maximum height of wave propagation before Tsunami for wet and dry season are 
   0.33 and 0.25 m.
2. The maximum height of wave propagation after Tsunami for wet and dry season are 
   1.5 and 0.66 m.
3. The simulation of wave propagation is helpful in locating sedimentation and erosion 
   zone.

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