ABSTRACT

Taught by the lesson from the 2011 Tōhoku earthquake and tsunami, we aim to probe into the potential large-scale trench-typed tsunami threats to Taiwan by means of the deterministic method. In this paper, 18 trench-typed tsunami sources and the 4 fault-typed tsunami sources will be constructed. The detailed construction, including the rupture length and width, the scale of seismic moment, the slip as well as the dip angle, will be elaborated. The tsunami numerical model, COMCOT, will be applied to simulate tsunami propagation, run-up and inundation; multi-nested grids will be used for a complete simulation of the process of a tsunami from the beginning to the inundation. The simulation result shows that tsunami source from the northern segment of the Manila Trench will pose a serious threat to the safety of Taiwan's southwest coast. The tsunami energy from the Yap Trench can be substantially projected onto Taiwan, and threatens the coasts of northern, eastern, southern as well as south-western Taiwan. The tsunami source from off the coast of Hualien will have a greater influence on the east coast of Taiwan.

KEY WORDS: 2011 Tohoku Earthquake and Tsunami, Potential Tsunami Threat in Taiwan, Tsunami Inundation, Trench-typed Tsunami Source, Manila Trench, Risk assessment

INTRODUCTION

On March 11, 2011, a magnitude 9.0 undersea megathrust earthquake occurred offshore Fukushima Prefecture, Japan. It triggered a large tsunami with wave height up to 10-20 m on the coast and 40 m for the runup height. The tsunami attacked the coastal areas of Aomori, Iwate, Miyagi, Fukushima, and Ibaraki Prefectures, and resulted in over 20,000 people dead and missing. In addition, this destructive tsunami also caused the explosion of the nuclear power plant in Fukushima with radioactive contamination. This incident revealed that the sea walls in those damaged regions failed to function against the tsunami hit. One of the issues is that, based on the earthquake data recorded by the modern seismic instrument, the Earth science community underestimated the largest earthquake and tsunami, which resulted in a series of destruction and disasters. On the other hand, due to the high similarities between Japan and Taiwan in geography, culture, and nuclear power plants, the National Science Council in Taiwan wishes the author to study the potential largest tsunami threat in Taiwan. The study shall be scientific sound, learn the lesson from this event, and also emphasis on the trench-type tsunami sources. The results shall include the thoroughly understanding on each tsunami sources including the propagation characteristics, inundation areas, the potential hazards brought upon the Taiwan coastal area, as well as the impact toward the four nuclear power plants. And this is the motivation of this paper.

APPROACH

The current tsunami hazard analysis has been based on deterministic methods. Compared to the probabilistic methods (Rikitake and Aida, 1988), the deterministic approach requires only a designed tsunami scenario, and follows up with the hazard simulation. The reason that this approach is popular is because the highly uncertainty of the tsunami cycle and recurrence. It is relatively difficult on applying the probabilistic method on the tsunami hazard analysis. In this paper, we will adopt the deterministic tsunami hazard analysis.

The potential tsunami sources invading Taiwan will be constructed and a numerical model will be employed to simulate tsunami propagation. In the case of drawing up the potential tsunami sources, the 2011 Tōhoku earthquake and tsunami will be referred to investigate the potential large-scale trench-typed earthquakes and tsunamis around Taiwan and to conduct two-dimensional numerical simulation of tsunami in high resolution. The simulation results will include tsunami generation, propagation, run-up, and inundation. For tsunami inundation, the numerical model will provide the inundation area, wave height and speed of flood. This information can be used for making tsunami hazard mitigation strategies.

CONSTRUCTION OF TSUNAMI SOURCES

Taiwan is located on the boundary of the western Pacific Ring of Fire, and suffers from not only by earthquakes on the island itself, but also by tsunamis generated from the neighboring trenches. Based on the analysis of seismic and geological records as well as a panel discussion in this field held by the National Science Council, the potential tsunami sources invading Taiwan are categorized in to the distance trench-typed

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