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Effect of Tsunamis generated in the Manila Trench on the Gulf of Thailand

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ABSTRACT

Tsunamis generated in the Manila Trench can be a threat to Thailand. Besides runup of tsunamis along the eastern coast, infrastructures in the Gulf of Thailand, for example, gas pipelines and platforms can be affected by tsunamis. In this study, the simulation of tsunamis in the Gulf of Thailand is conducted. Six cases of fault ruptures in the Manila trench are considered for earthquakes with magnitudes of 8.0, 8.5, and 9.0. The linear shallow water wave theory in spherical coordinate system is used for tsunami simulation in the large area covering Southeast Asia while the nonlinear shallow water wave theory in Cartesian coordinate system is used for tsunami simulation in the Gulf of Thailand. It is found that tsunamis reach the southern part of Thailand in 13 h after an earthquake and reach Bangkok in 19 h. The tsunami amplitude is largest in the direction towards the Philippines and Vietnam. The southern part of China is also severely affected. The Gulf of Thailand is affected by the diffraction of tsunamis around the southern part of Vietnam and Cambodia. The tsunami amplitude at the southernmost coastline is about 0.65 m for the M_w 9.0 earthquake. The current velocity in the Gulf of Thailand due to the M_w 9.0 earthquake is generally less than 0.2 m/s.

1. Introduction

The 26 December 2004 Indian Ocean tsunami was generated by the M_w 9.0 + earthquake off the shore of northwestern Sumatra. The first wave of the tsunami struck the western coast of Thailand in the Andaman Sea about 2 h after the earthquake. The tsunami caused human loss and devastating damage to civil engineering structures along the west coast of southern Thailand (TCLEE, 2005; Lukkunaprasit and Ruangrassamee, 2008). The event has drawn alerts in the engineering community to re-evaluate the tsunami hazard in Thailand. Studies on seismic activities in South East Asia have shown that the Philippines are seismically active with subduction earthquakes along the Manila trench (Zhu et al., 2000; Michel et al., 2000; Kreemer et al., 2000; Bautista et al., 2001; Torregosa et al., 2001). Tsunamis generated in the Manila trench can be a threat to Thailand. Besides runup of tsunamis along the eastern coast, infrastructures in the Gulf of Thailand, for example, gas pipelines and platforms can be affected by tsunamis.

Tsunami modeling has been developed as a tool to capture generation, propagation, and inundation of tsunamis (Shuto et al., 1986; Imamura, 1992). In this study, the simulation of tsunamis generated in the Manila trench is conducted to investigate the arrival time, tsunami amplitude, and current velocity with an emphasis on the Gulf of Thailand. The findings give an insight in the effects on Thailand and neighboring areas.

2. Scenario earthquakes for numerical modeling

Bautista et al. (2001) studied the geometry of subducting slabs in the Philippines. The focal mechanism data of earthquakes in the subduction zone were analyzed. A number of historical major events are associated with the Manila trench in the western part of the Philippines. Hypocenters are mainly located at the depth less than 100 km along the subducting slab of the Eurasian plate beneath the Manila trench. Based on collected information and analysis, they proposed a new model of the subducting slab in the Manila trench.

In this study, events of earthquakes generated around the Manila trench and the Philippines are collected from Advanced National Seismic System (ANSS) from 1963 to 2006 (ANSS, 2006). Fig. 1 shows the seismicity map of collected events. In selecting magnitudes of scenario earthquakes for further tsunami modeling, it is important to estimate return periods of the earthquakes. Based on the Gutenberg–Richter recurrence law, the annual rate of exceedance and magnitude relation is analyzed as presented in Fig. 2 (Gutenberg and Richter, 1954). The return period which is related to the annual rate of exceedance is summarized in Table 1. Since a return period of about 500 years is typically considered in seismic design of structures, magnitudes of 8.0, 8.5, and 9.0 are used in this study (AASHTO, 2004).

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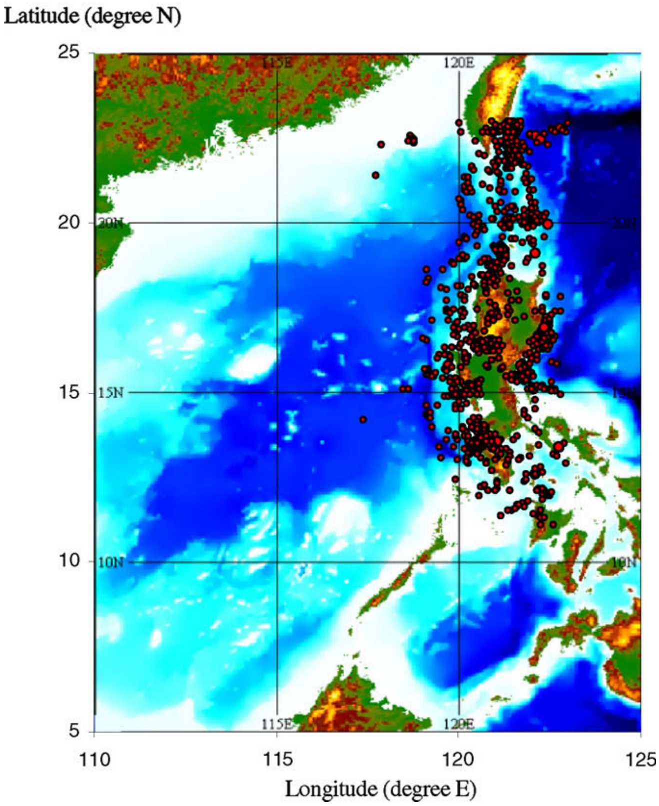

Fig. 1. Seismicity in the Philippines from the ANSS database.

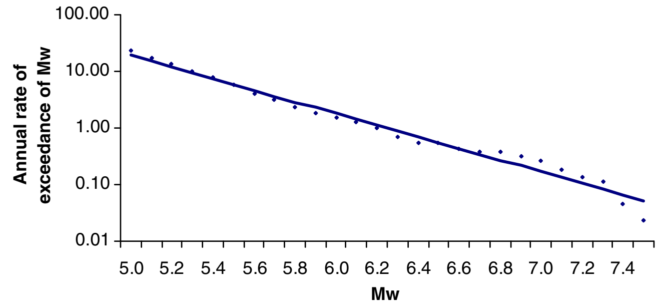

Fig. 2. Relation between the annual rate of exceedance and magnitude.

Table 1
Return period for each magnitude.

Magnitude (M_w)	Return Period (Years)
7.0	6
7.5	19
8.0	63
8.5	205
9.0	667

Table 2
Predicted dimension and displacement of faults.

Magnitude M_w	Length (km)	Width (km)	Dislocation (m)
8.0	162	71	2.2
8.5	305	102	4.5
9.0	575	145	9.5

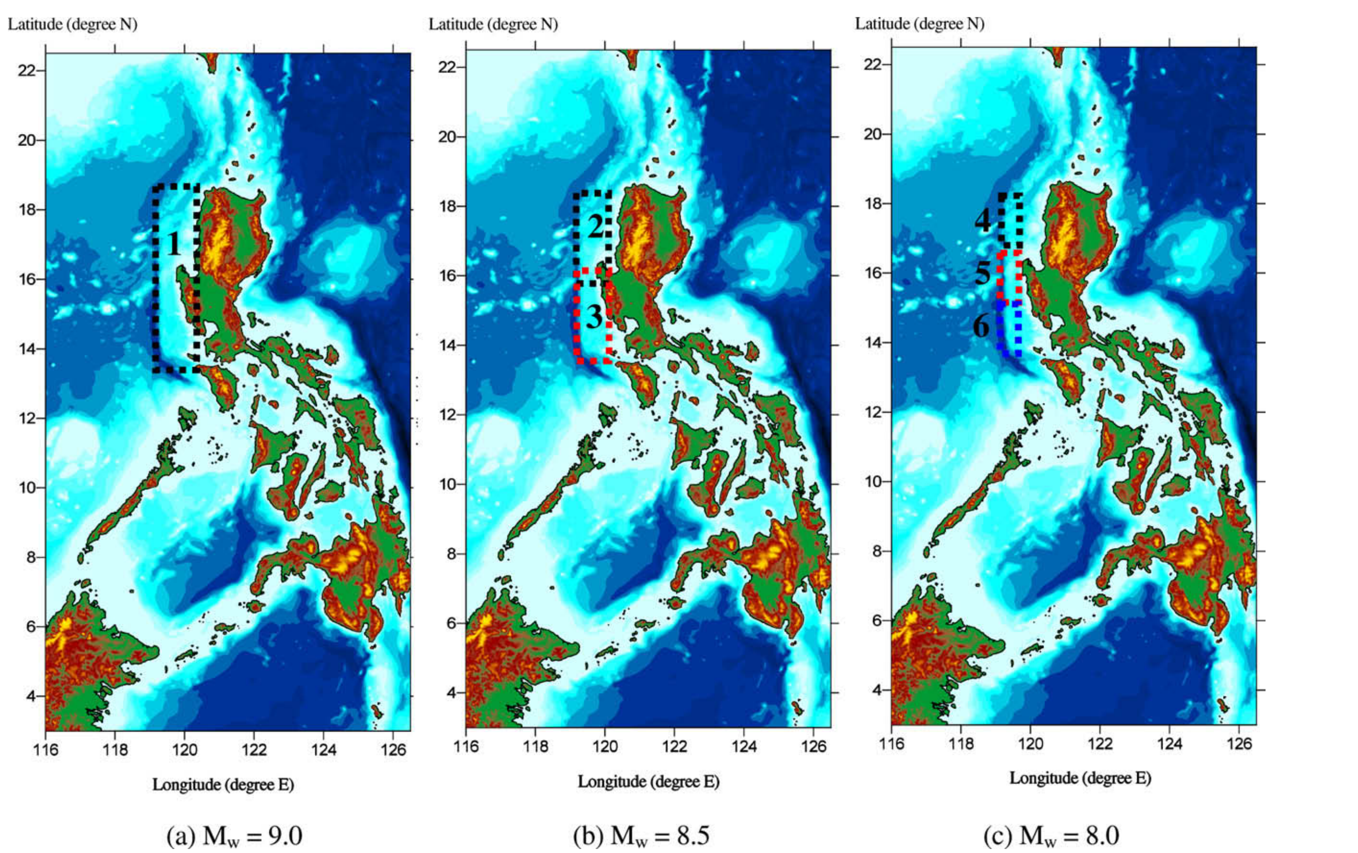

Fig. 3. Location of faults for six cases in analysis.