Crustal Displacement after the September 12, 2007 Earthquake at Phuket, Thailand

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Abstract

The earthquake of September 12, 2007 from southwest of Bengkulu, Sumatra, Indonesia had the magnitude 8.4 and 7.9. It was due to thrust faulting on the boundary between the Australia and Sunda plates. This study analyzes GPS data by GIPSY-OASIS II software in two experiments. The first experiment covering a period of seven days before and after earthquake occurrence shows 4.59 mm.horizontal displacement to SE, and 4.2 mm. downward displacement vertically.. The second experiment covering a period of three months, from August 1st to October 31st 2007, shows 4.96 mm. Horizontal displacement to SE, and 16 mm downward displacement vertically. Therefore, Phuket may not receive direct effect in horizontal displacement after September 12th earthquake because the horizontal displacement is 4-6 mm. which is the range of displacement typically observed in this area.

Keywords: Crustal displacement; GPS; Day of year (DOY)

1. Introduction

Four earthquakes with magnitudes higher than 7.9 in the Richter scale have occurred in this past decade near Sumatra, Indonesia (Fig.1). The first was on June 4, 2000 with 7.9 magnitude. December 26, 2004great earthquake or Sumatra-Andaman earthquake with magnitude 9.1 occurred which induced tsunami in Indian Ocean. According to GPS data, Phuket Island moved around 27 cm. in south-west direction. The third earthquake is Nias earthquake on March 28, 2005 with a magnitude of 8.6. Phuket Island move around 16 mm. in south-west direction (Laoniyomthai, 2006). The fourth earthquake occurred at 6:10 PM local time of Thailand, on September 12, 2007 with a magnitude of 8.4 ,due to thrust faulting on the boundary between the Australia and Sunda platesand was located 130 km (80 miles) to the southwest of Bengkulu, Sumatra, Indonesia and 1,408 km. from Phuket Island (Fig. 2).

Figure 1: Map shows epicenters of four important earthquakes. (Modified from: http://ww2.lafayette.edu/ ~stifeld/pics/Thailand _map_large. jpg)

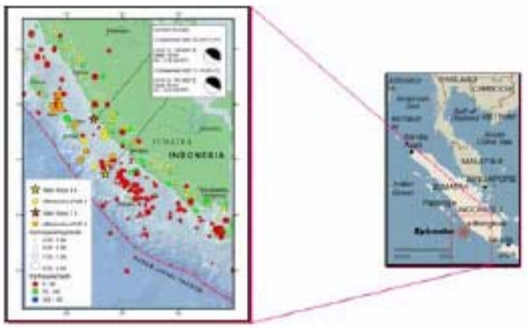

Figure 2: Relative plate motion,:the broad red vector represents the motion of the Australia Plate relative to the Sunda Plate in the region. The Australia Plate is moving generally 50 - 60 mm/yr north and slightly eastward with respect to the Sunda Plate. (Modified from: USGS and http://graphics8.nytimes.com/images/2007/09/12/world/0912-for-subwebearthquakema.gif)

Global Positioning System (GPS) meant for navigation by the Ministry of Defense, USA, can also be applied for geophysical research such as crustal displacement, height of oceanic wave, ion in the stratosphere, atmospheric water vapor and so on. GPS uses time difference between GPS satellite and receiver to determine unknown position on land, sea, in air or space.

2. Experimental Results and Discussion

This study has been carried out in two parts. The first experiment covers a seven day period before and after the earthquake occurrence, and analyzes the effective crustal displacement due to the earth quake. The second experiment covers a period between 42 daysbefore and 49 days after the earthquake occurred-i.e. covering a three month period, from August 1 to October 31, 2007.The study analyzed crustal displacement and finding the direction of movement of Phuket in the future. GPS data was retrieved from one GPS permanent station at Phuket (8.40°N: 98.30° E). The position of permanent GPS station was noted every week and the average calculated.. The displacement/movement of Phuket is shown in horizontal, vertical and by date (Fig. 3- 5). The data was analyzed covering a period of seven days before and after the earthquake occurred, during which the area was not disturbed by any other factor other than the earthquake.

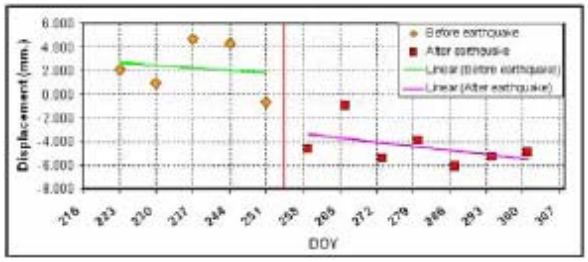

Figure 3: Effect from earthquake: Displacement was3.5 mm.to South and direction of movement is South. For a three month period, displacement was 5 mm. to South.

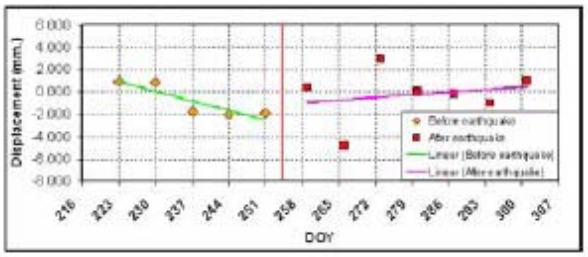

Figure 4: Effect from earthquake, displacement was 2.5 mm. to South. For three month period, the displacement was 1 mm. to East.

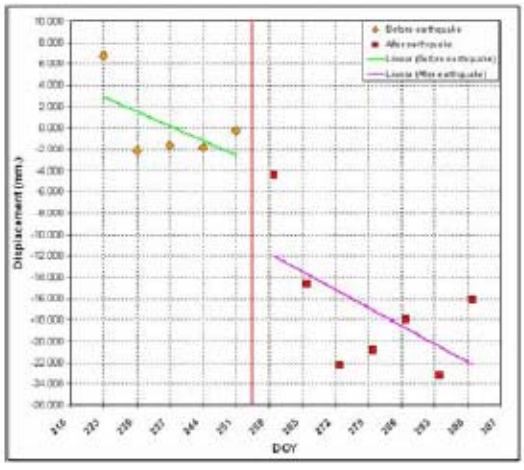

Figure 5: Effect from earthquake; displacement was 4.5 mm. in the downward direction.. For three month period the displacement was 16 mm. vertically down.

3. Conclusion

First experiment indicates that in the period of seven days before and after earthquake occurrence the horizontal, displacement is 4.59 mm. to the SE, and the downward vertical displacement is 4.2 mm. The second experiment covering the period 42 days before and 49 days after earthquake occurrence indicates 4.96 mm. Horizontal displacement to the SE, and a 16.06 mm.vertical downward displacement. Therefore, Phuket may not be affected its horizontal displacement after September 12, earthquake because the horizontal displacement is in the range of typically displacement of this area, 4-6 mm. only.

	Horizontal Direction	Horizontal displacement (mm.)	SD (Horizontal)	Vertical Direction	Vertical displacement (mm.)	SD (Vertical)
1.) Effect from earthquake	SE	4.59	6.49	down	-4.2	2.19
2.) 3 months	SE	4.96	3.65	down	-16.06	2.08

Figure 6: Summary of the horizontal/vertical displacements noted in the experiments.

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