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Land Movement Studies using Continuous GPS Technique at Phrachunlachomklao Fort

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Abstract: From land movement studies using Continuous GPS Technique at tide gauge station in Phrachunlachomklao Fort results that this station clearly subsides 2 -3 mm./yr which is higher than CGPS Permanent station at Chulalongkorn University. The preliminary horizontal land motion in north, east direction and vertical movement results are -0.28 $\pm$ 3.63, 27.87 $\pm$ 4.35 and -27.89 $\pm$ 5.59 mm./yr, respectively.

Keywords: land movement, continuous global positioning system

1. Introduction

Subsidence of Bangkok metropolis and surrounding area has been known for a long time. This subsidence has been surveyed using leveling network conducted by Royal Thai survey department, but only hundred control points compared to thousands of square meter of Bangkok metropolis and surrounding area. So, we have to estimate subsidence rate for the area of our interest from very spared control points and could not get the real value. Furthermore, there is a subsidence from ground water pumping and weight of building or construction that has effected on soil and sand layer which is called local effect. Plate motion within seismic cycle also make subsidence rate differ from area to area. In order to study subsidence in specific area, we have to use high precision technique. For this study, we have installed continuous Global Positioning System (CGPS) which is an absolute and continuous positioning specialized for geophysical work. These GPS data will be processed by special scientific software in order to get high precision vertical position. The change of vertical position with time can be used to calculated for vertical motion or land subsidence rate in the area of our interest.

2. Materials and Methods

2.1 Continuous Global Positioning System (CGPS) Installation at Phrachunla-chomklao Fort

CGPS Installation can be divided into 2 parts : Antenna Installation and Receiver Installation

Installation of CGPS Antenna has to complied with three things

1.Antenna position should be as closed as possible to tide station in order to make sure that measured vertical motion of antenna is the same as vertical motion of tide gauge.

2.Antenna position should be clear from any objects which can be blocked GPS signal and also antenna should not put near buildings, trees that will be caused multipath error.

3.Antenna position should be fixed mount on stable platform, can tolerate any corrosion i.e. Stainless steel

After antenna and receiver Installation have finished, we can set up CGPS to save continuous data for every 30 seconds. These data can be downloaded for processing every two weeks.

CGPS equipment used in this study is Leica GR10 GNSS Reference Station which has been supported from Faculty of Aerospace Engineering, Delft University of Technology

We also installed antenna and receiver, together with solar panel, converter and battery on 28 November 2011 and do some maintenance on 13 March 2012. This station have a code named is "SPKN".

2.2 GPS data processing and Vertical motion rate

GPS data will be processed using GPS-Inferred Positioning System (GIPSY) Software from Jet Propulsion Laboratory (JPL). This software has also provided by Faculty of Aerospace Engineering, Delft University of Technology, Netherlands.

2.3 Land subsidence analysis

This study is a new way to calculate absolute land motion by using Precise Point Positioning technique (PPP) from continuous osition data received from GPS which named as "Continuous GPS (CGPS) technique"

Daily averaged vertical position analyzed from GPS data will be checked for the Outlier Elimination. After this elimination process, we will calculate for monthly averaged vertical position (Vigny et al., 2005 and Simons et al., 2007).

3. Results and Discussion

We plotted weekly SPKN station position both horizontal and vertical direction in ITRF-2008 Reference frame from 28 November 2011 to 30 September 2012. We have a short period of data and also 8.6 Mw Sumatra Island Earthquake occurred on 11 April 2012 which caused vertical motion especially in Bangkok area. From GIPSY software has analyzed vertical motion (Jump) which will be influenced for calculated tide gauge vertical motion's trend. We would like to present the result into two cases.

1. vertical motion at SPKN caused by Sumatra Island Earthquake (Figure 1)
2. No vertical motion at SPKN caused by Sumatra Island Earthquake (Figure 2)

We compared our station result with CGPS Permanent station at Chulalongkorn University which will be named later as "CUSV" (Figure 3 and 4)

Sumatra Island Earthquake on 11 April 2012 has caused horizontal movement in north and east direction about 5 – 10 mm. From preliminary analyzed data, SPKN station clearly subsided 2 -3 mm./yr (Figure 1 and Table 1) which is higher than CGPS Permanent station at Chulalongkorn University (CUSV) (Figure 3,4 and Table 1) The preliminary horizontal motion for SPKN station are -0.28 + 3.63 in north direction and 27.87 + 4.35 mm./yr in east direction (Figure 1 and Table 1). Vertical movement (not included vertical motion from Sumatra earthquake) is -27.89 + 5.59 mm./yr (Figure 2 and Table 1).

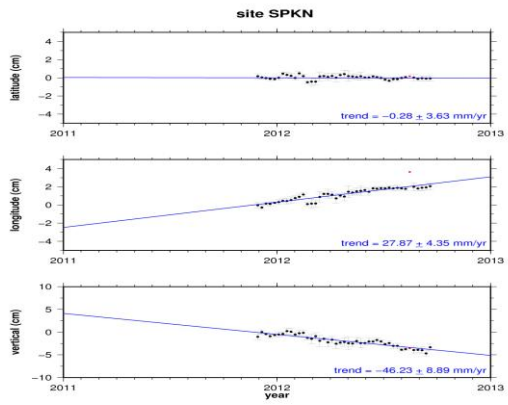

Fig. 1: Vertical motion at SPKN station caused by Sumatra Island Earthquake (JUMP)

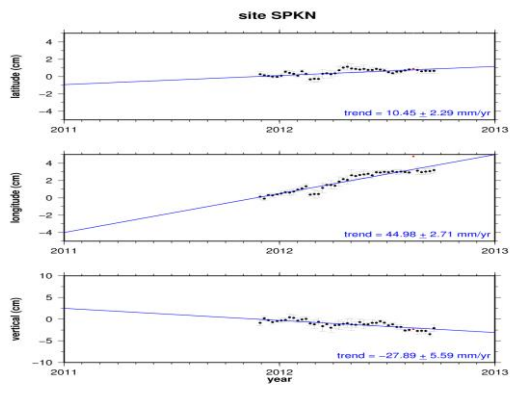

Fig. 2: No Vertical motion at SPKN station caused by Sumatra Island Earthquake (NO JUMP)

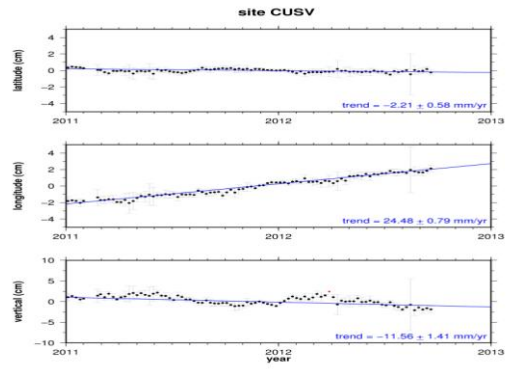

Fig. 3: Vertical motion at CUSV station caused by Sumatra Island Earthquake (JUMP)

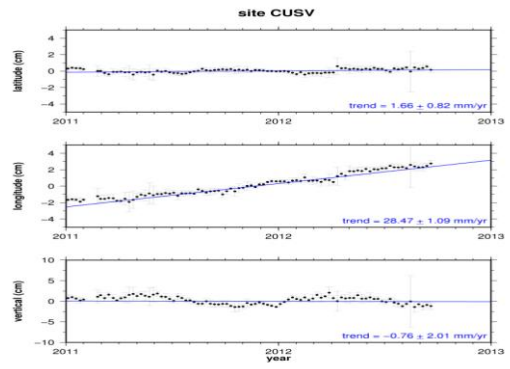

Fig. 4: No Vertical motion at CUSV station caused by Sumatra Island Earthquake (NO JUMP)

Table 1: Horizontal and Vertical movement at Phrachunlachomklao Fort (SPKN) and CGPS Permanent station at Chulalongkorn University (CUSV)

	SPKN station		CUSV station	
	JUMP (mm/yr)	NO JUMP (mm/yr)	JUMP (mm/yr)	NO JUMP (mm/yr)
Horizontal movement (Latitude direction)	**-0.28 ± 3.63**	10.45 ± 2.29	**-2.21 ± 0.58**	1.66 ± 0.82
Horizontal movement (Longitude direction)	**27.87 ± 4.35**	44.98 ± 2.91	**24.48 ± 0.79**	28.47 ± 1.09
Vertical movement	-46.23 ± 8.89	**-27.89 ± 5.59**	-11.56 ± 1.41	**-0.76 ± 2.01**

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4. Conclusions

From land movement studies using Continuous GPS Technique at tide gauge station in Phrachunlachomklao Fort results that this station clearly subsides 2 -3 mm./yr which is higher than CGPS Permanent station at Chulalongkorn University. The preliminary horizontal land motion in north, east direction are -0.28 + 3.63 and 27.87 + 4.35 mm/yr, respectively. Vertical movement (not included vertical motion from Sumatra earthquake) is -27.89 + 5.59 mm./yr which this movement can be used to calculate absolute sea level change rate for this station.

5. Acknowledgments

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