ASSESSMENT OF SEISMIC SITE EFFECTS IN CHIANG MAI BASIN FROM MICROTREMOR OBSERVATION AND 1D SITE RESPONSE ANALYSIS

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1. INTRODUCTION

Chiang Mai, the largest city in northern Thailand and the second largest in the country after Bangkok. The city is located on a flood plain composed of unconsolidated sediments. The city is occasionally threatened by tremors originating from nearby faults in Thailand and neighboring countries. Although ground motion amplifications have been observed, limited research studies have been conducted to comprehensively understand the seismic mitigation measures required for the area, particularly regarding site effects.

This study aims to investigate seismic site effects in Chiang Mai basin and analyze site response using a 1-dimensional (1D) soil model. Approximately 50 sites distributed across the basin in Muang Chiang Mai area, covering an area of approximately 100 sq.km, were investigated by microtremor observations and site response analysis.

2. METHODOLOGY

Array microtremor with Centerless Circular Array (CCA) [1] was applied to this study to estimate phase velocity dispersion curve based on spectral ration representations. The spectral ratio which contains information of phase velocities is an integration of all information on the field of vertical component of microtremors. The technique of inversion analysis [2] was employed to determine shear wave velocity profile from surface to basement rock level. The dispersion relation of phase velocity and frequency from field observations are compared with those derived theoretically from a horizontally layered earth model by iteration procedure to provide the best-fit shear wave velocity–depth profile.

Site response analysis using 1D soil models was involved to examine site amplification. Ground motions obtained from Probabilistic Seismic Hazard Assessment were input as rock outcrop acceleration, and their propagation through the 1D soil models was analyzed using an equivalent linear analysis. From the strong motion database, motions with the same mechanism of occurrence were selected and scaled to match response spectra with the conditional mean spectrum (CMS) at periods of 0.2, 0.5, 1.0, 2.0, and 3.0 seconds, corresponding to a return period of 2475 years. The average spectral accelerations were then used to evaluate the Maximum Credible Earthquake (MCE) design spectrum for each site.

3. RESULTS

The results show that most sites exhibit VS30 from 200 to 500 m/s. The map of the distribution of VS30 in the study area is presented in Figure 1. It can be observed that the areas near Ping River show lower VS30 while some sites near the western boundary of the study area show relatively higher VS30.

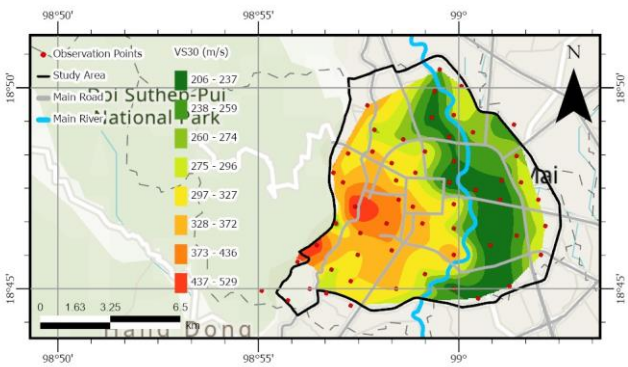

Figure 1. Map of VS30

From shear wave velocity profile along depth at a site, the estimated depth of basement rock could be inferred from the level having clear contrasts of shear wave velocity. The velocity at this level changes abruptly to about 2000 m/s or more. The estimated depth of basement rock found in this study varies mainly from 40 m to 750 m.

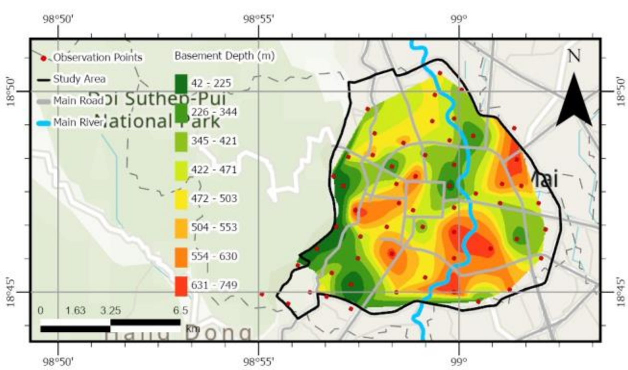

Figure 2. Map of basement

The results from site response analysis using 1D soil model with equivalent linear analysis method from 5 CMS periods are show in Figure 3 to Figure 8. Figure 3 and Figure 4 show the results of spectral acceleration (SA) and site amplification at 0.2 second which is the representative of low-rise buildings period in study area. The results revealed that SA higher than 1.40 g is in the area near the western boundary of the study area with the site amplification about 1.80 to 3.73 while the SA and site amplification in central and eastern parts of the study area are less than 1.0 g and less than 1.50 respectively.

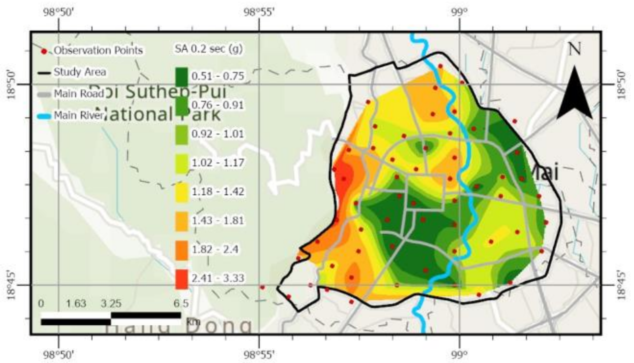

Figure 3. Map of spectral acceleration at 0.2 seconds

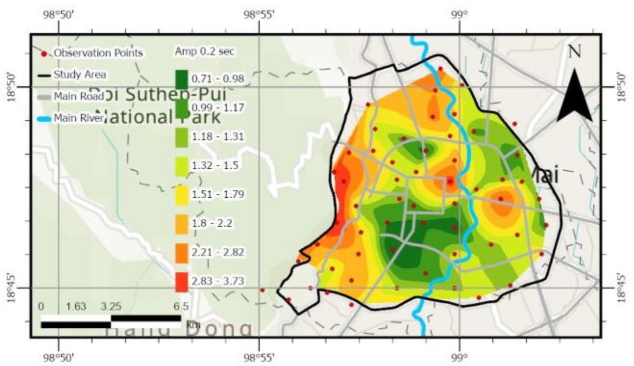

Figure 4. Map of amplification at 0.2 seconds

Figure 5 and Figure 6 show the results of spectral acceleration (SA) and site amplification at 0.5 second which is the representative of middle-rise buildings period in study area. The results show that SA higher than 1.00 g is in the area near the western part, northern part and some area near the Ping River of the study area with the site amplification in range of 2.50 to 3.70 in most sites in this area while the SA and site amplification in central and southern parts of the study area are less than 1.0 g and less than 2.20 respectively.

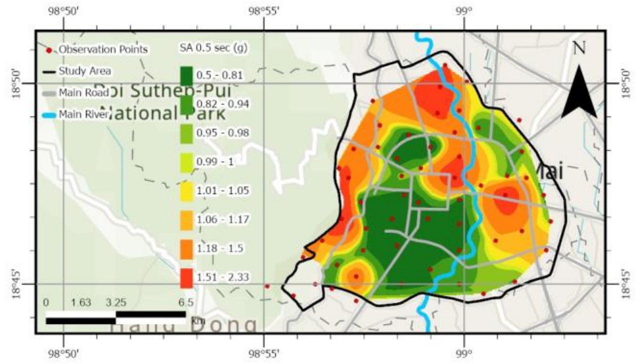

Figure 5. Map of spectral acceleration at 0.5 seconds

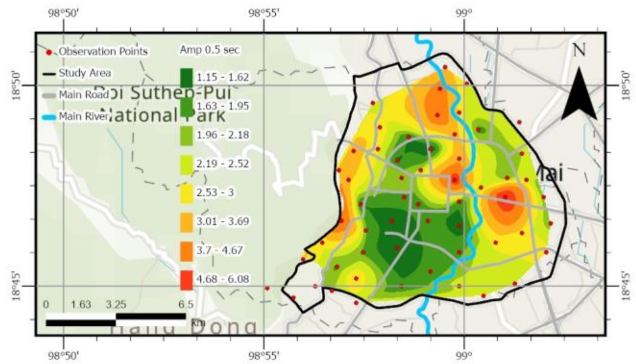

Figure 6. Map of amplification at 0.5 seconds

Figure 7 and Figure 8 show the results of spectral acceleration (SA) and site amplification at 1.0 second which is the representative of high-rise buildings period in study area. The results show that SA higher than 0.80 g is founded in the area along the Ping River from northern part to southern part of study area with the site amplification approximately about 2.80 to 4.23 while the SA in western and central parts of the study area are less than 0.50 g with the site amplification is less than 2.50.

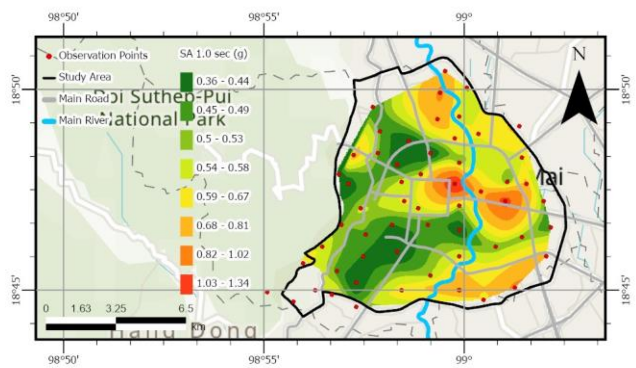

Figure 7. Map of spectral acceleration at 1.0 seconds

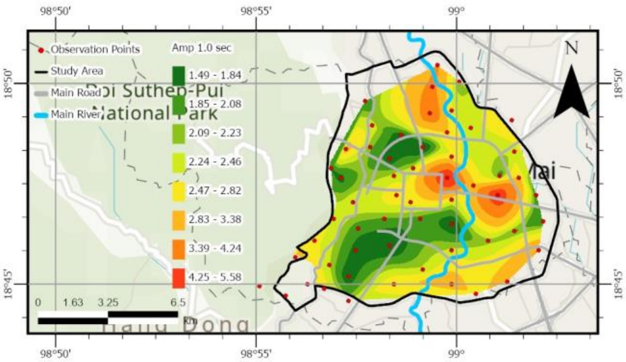

Figure 8. Map of amplification at 1.0 seconds

4. REFERENCE

[1] Cho, I., Tada, T. and Shinozaki, Y (2006). "Centerless circular array method: Inferring phase velocities of Rayleigh wave in broad wavelength range using microtremor records," Journal of Geophysical Research, 111, B09315.

[2] Wathelet, M (2008). "An improved neighborhood algorithm: parameter conditions and dynamic scaling," Geophysical Research Letters, 35, L09301, DOI 10.1029/2008GL033256.

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