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Microzonation Study in the Hanoi, Vietnam

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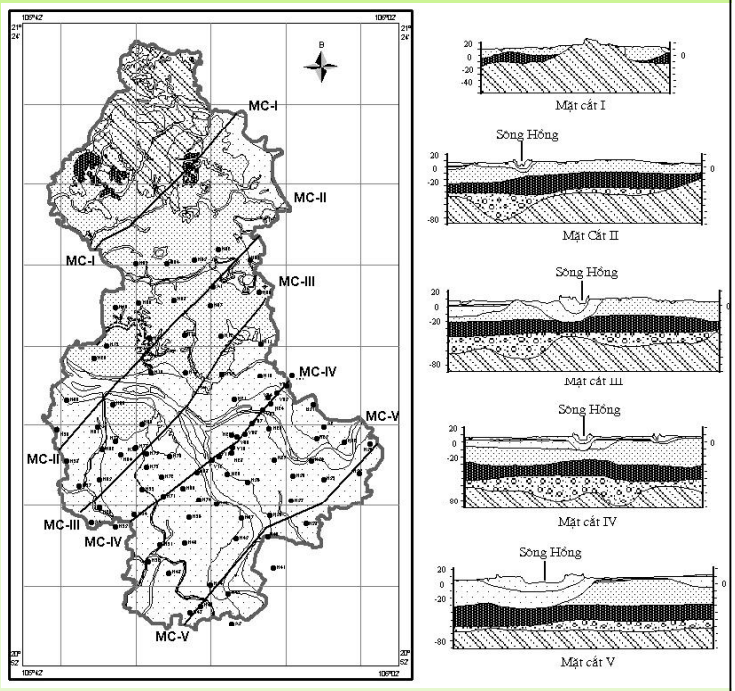
VIETNAM ACADEMY OF SCIENCE AND TECHNOLOGY

Hanoi

- Capital of Vietnam
- Center of the Red River triangular basin
- Area 920.97 km^2
- Population over 3 million

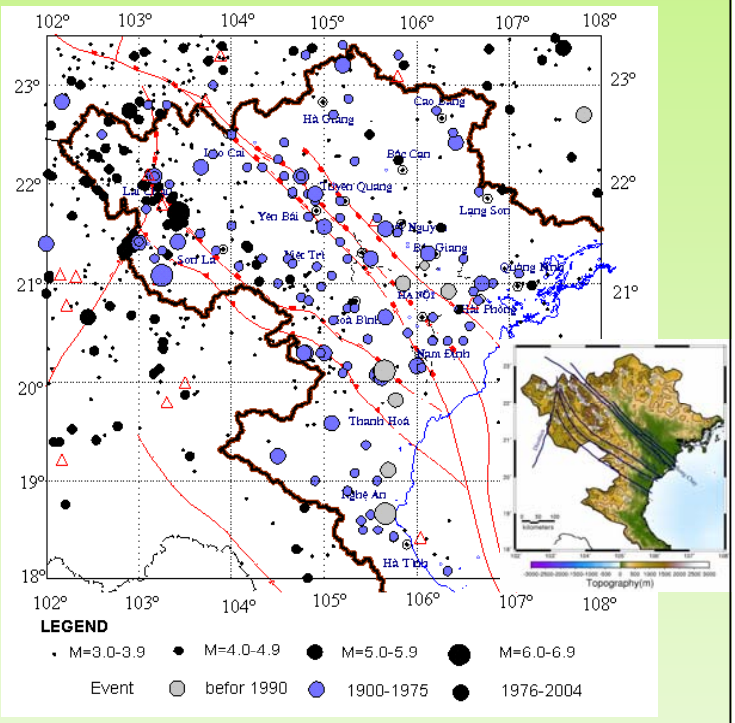
Geology

- Surface geology is mostly sand and clay sedimentary of Holocene or Pleistocene
- The bottom of Holocene deposits is at the depth of 10 ~ 45 m
- The bottom of Pleistocene deposits that overly the Neogene deposits is at the depth of 45 (north) ~ 110 (south) m



Seismicity

- Red-River fault zone is the main tectonic activity of South East Asia region. The slip of the fault zone is right lateral with normal fault component. It caused the major tectonic features in northern Vietnam.



Works in this study

1st Phase (2008~2009):

- 75 single-station microtremor measurements

⇒ Site response of H/V spectral ratios

- 4 microtremor arrays

⇒ Near-surface shear-velocity model

- Simulations of H/V spectral ratios

⇒ Detail subsurface shear-velocity structure

2nd Phase (2012~2013):

- Dense microtremor survey

⇒ Total 700 single-station microtremor points

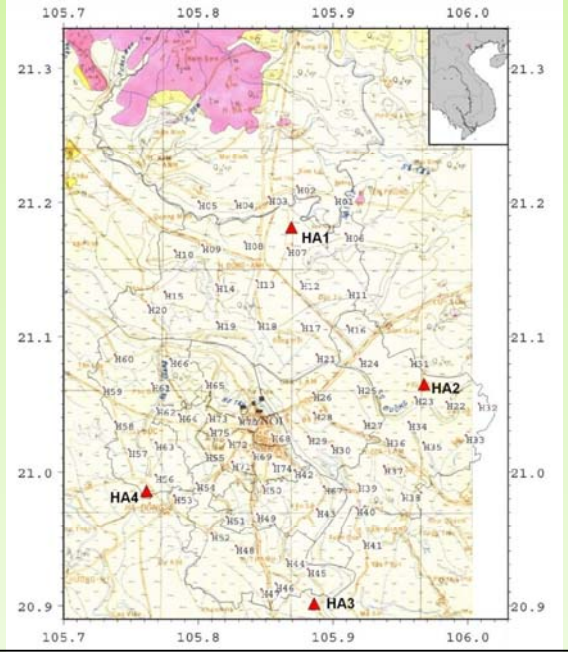
⇒ 4 more microtremor arrays

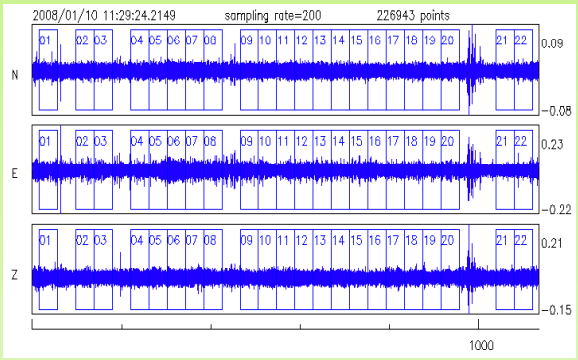
- Microzonation

⇒ Vs30 distribution

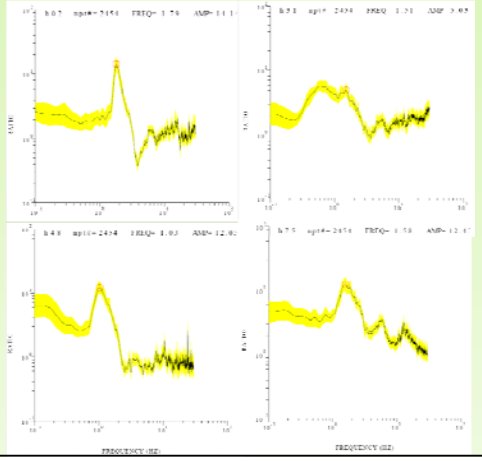
⇒ Seismic microzonation

Microtremor H/V Spectral Ratio (75 points of 1st phase)

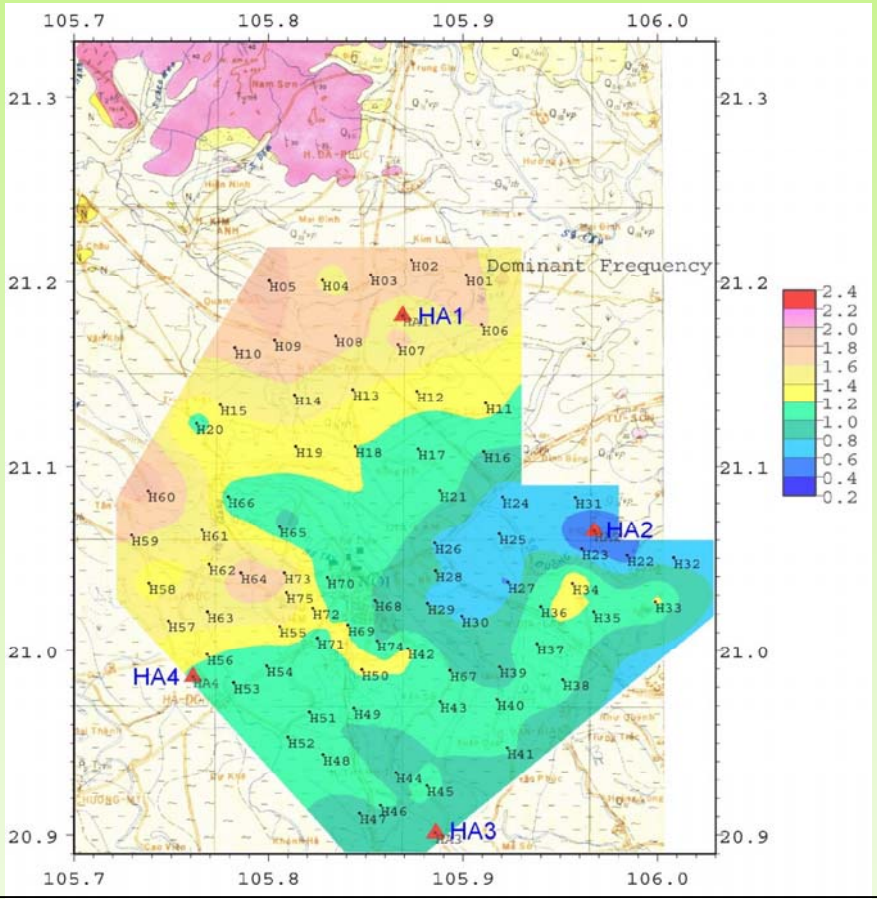




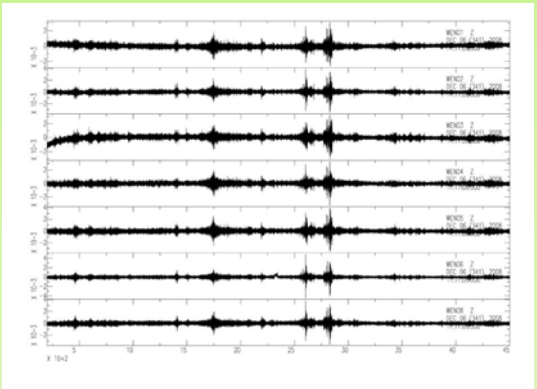
Apparent dominant frequency of seismic site effect

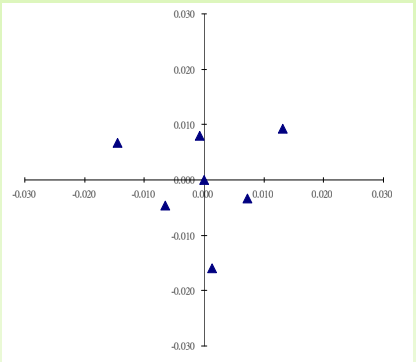


Dominant Frequency of H/V ratios (0.8 ~ 2.0 Hz)



Microtremor Array (4 arrays of 1st phase)





Frequency-Wavenumber method (F-K) ：

Total time length: 70min

Window length: 1024, 2048, 4096 points

Moving window: 200 points

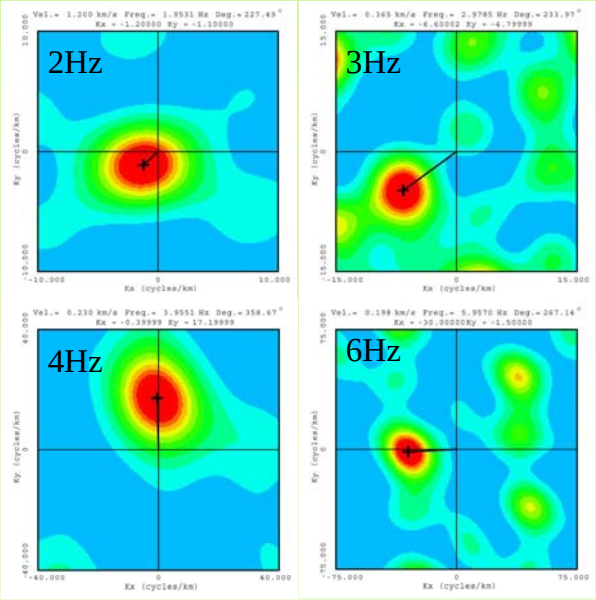
S array: 32m, 2.0~7.0 Hz

L array: 64m, 0.5~4.0 Hz

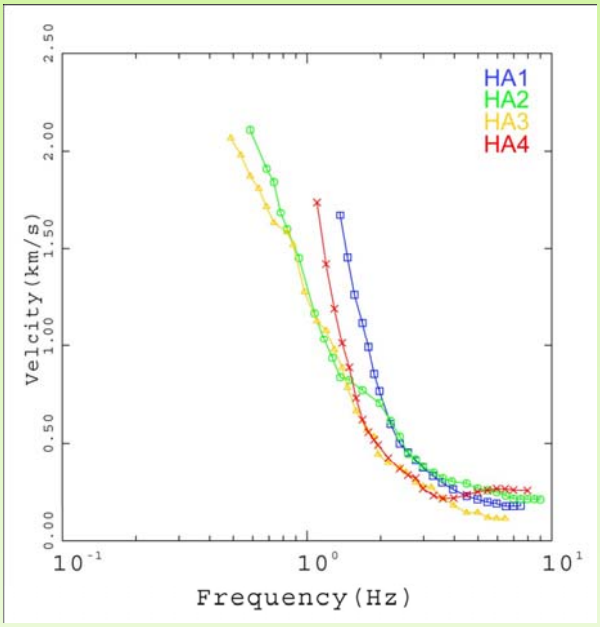
XL array: 96m, 0.5~2.0Hz (only for HA2)

Maximum Likelihood Method of Frequency-Wavenumber (F-K) Analyses

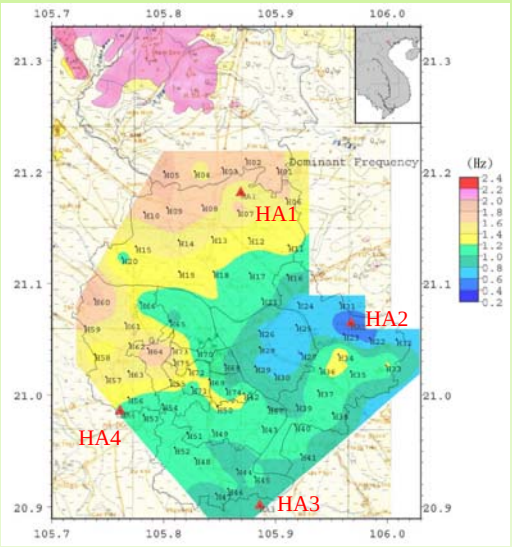
F-K Spectra

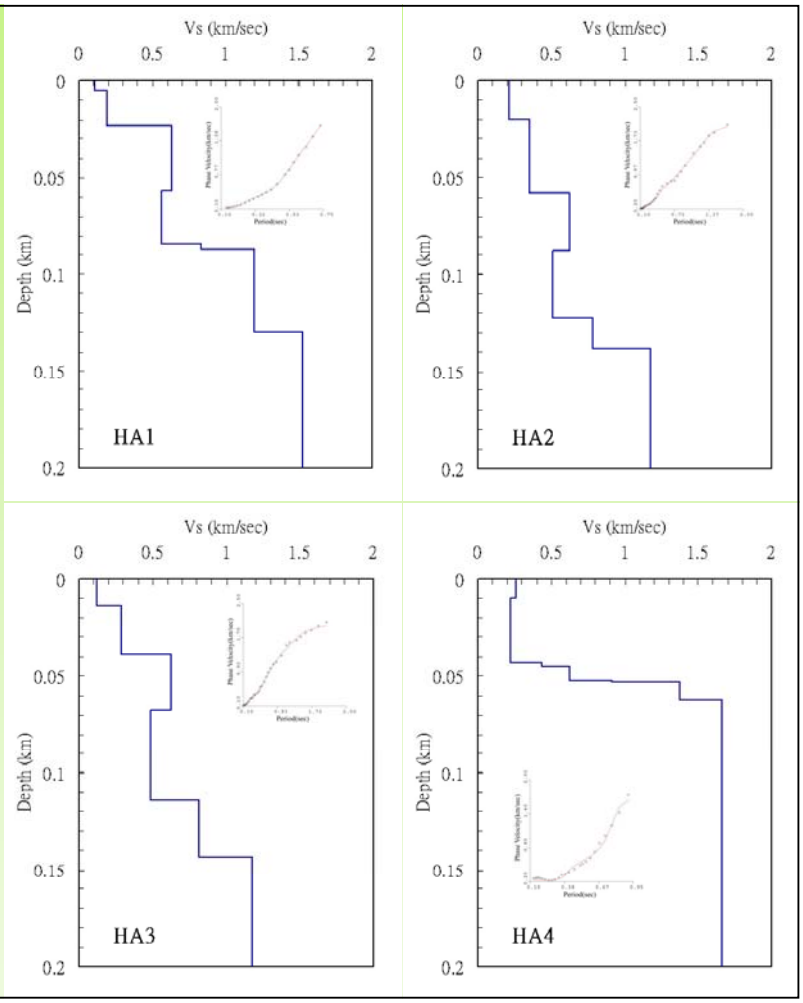


Dispersion Curves



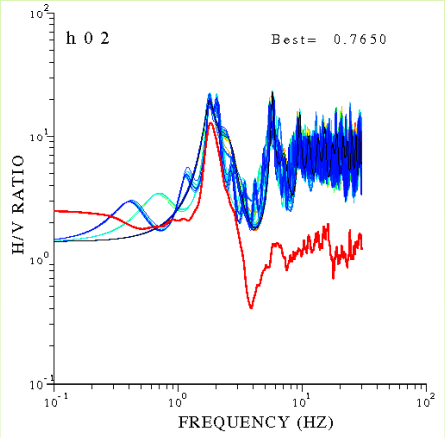
Inversed Near-Surface Vs Models

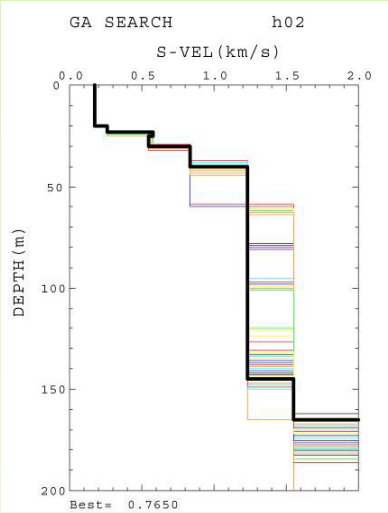




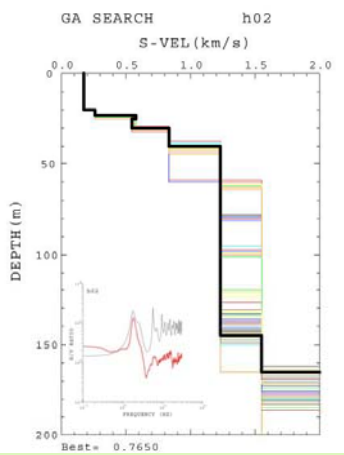
Simulations of H/V Spectral Ratios

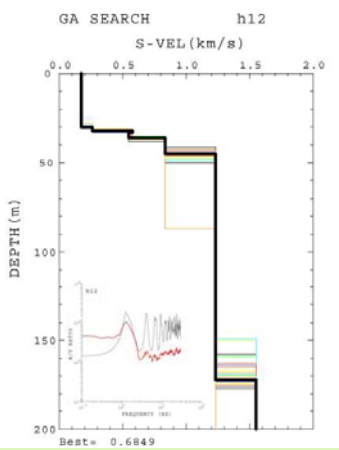
- Simulating the microtremor H/V spectra ratios to estimate the Vs model of the 75 points based on the theoretic SH-wave transfer function (Haskell, 1960)
- The initial 8-layer model was decided by the inversed models of the arrays in Hanoi. And the averaged Vs were used as the fixed Vs to estimated the thickness of each stratum

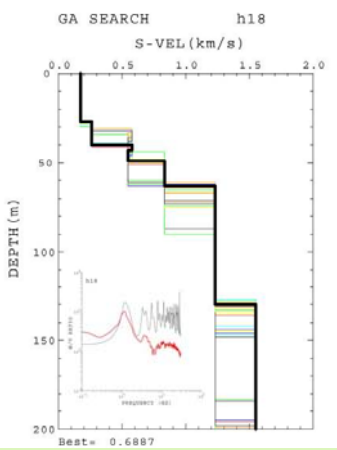


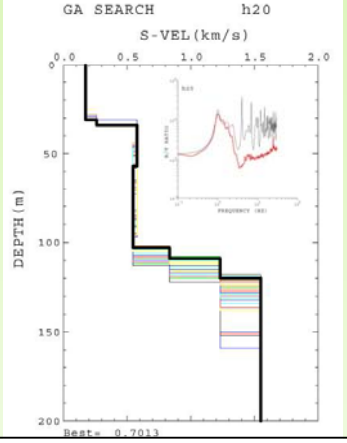


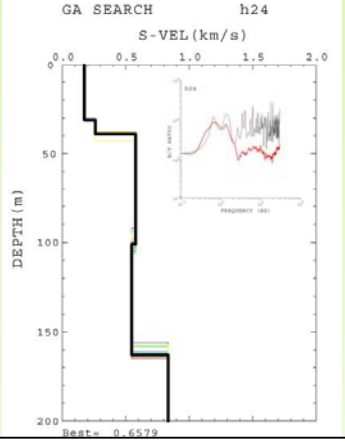
1D Vs Model for 75 sites

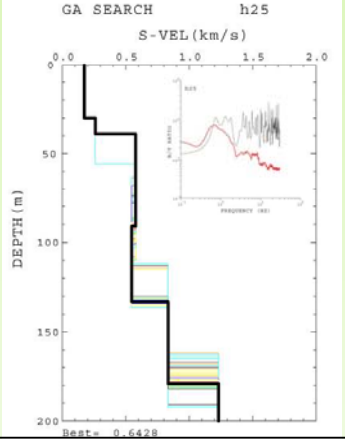






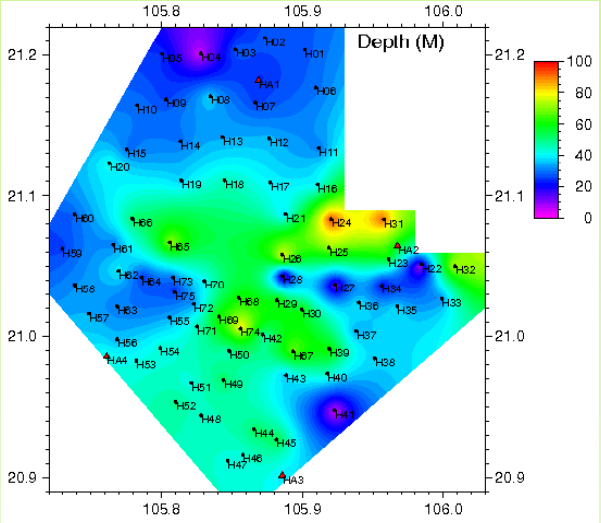






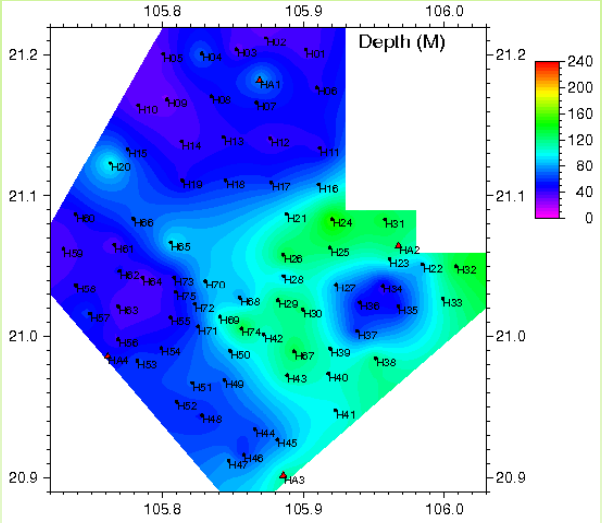
Main Interface of the Vs Structure

V_S > 0.5 km/sec



Comparable with the bottom of Holocene deposits which is at the depth of 10 (north) ~ 45 (south) m

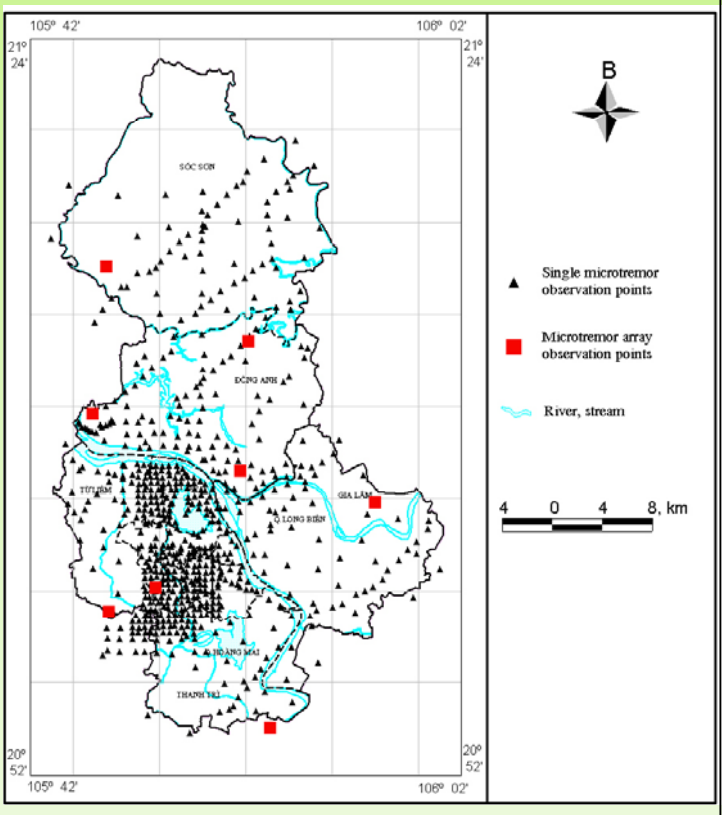
V_S > 0.8 km/sec



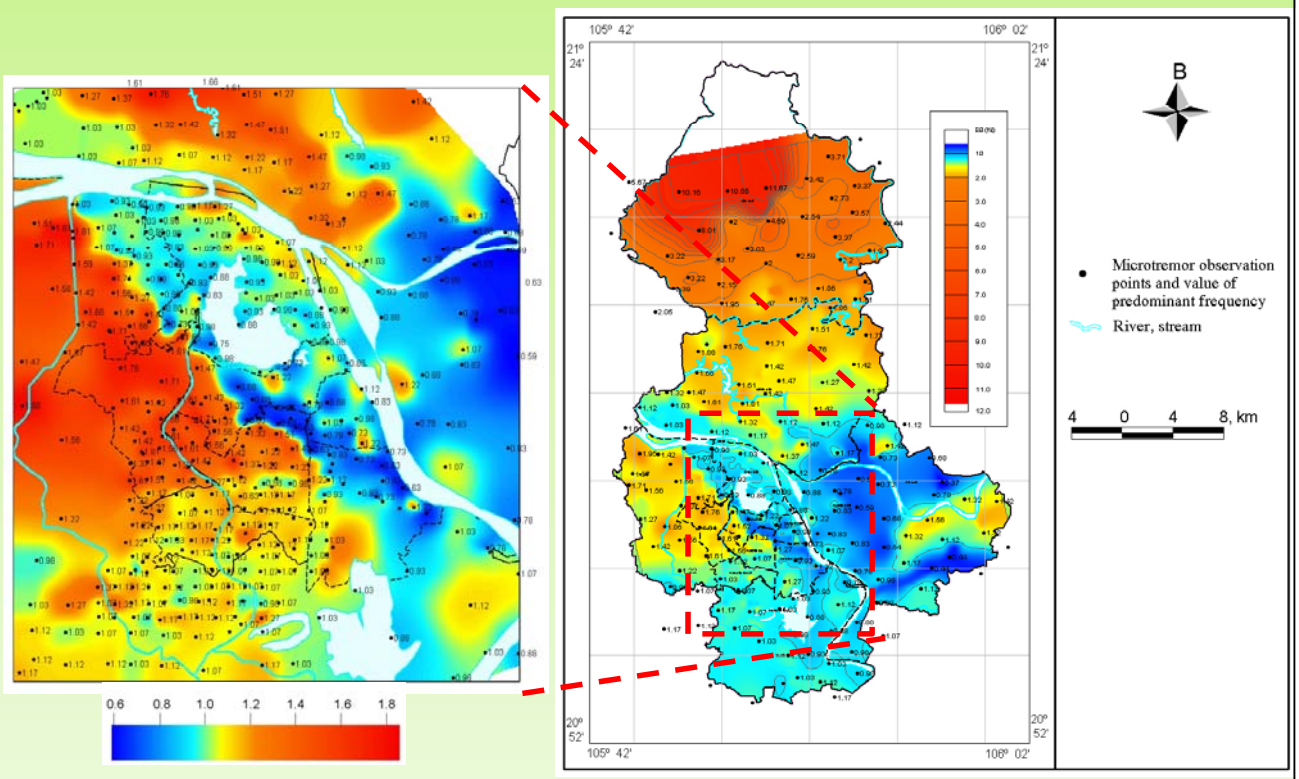
Comparable with the bottom of Pleistocene deposits which is at the depth of 45 (north) ~ 110 (south) m

Dense Microtremor Survey (2nd phase)

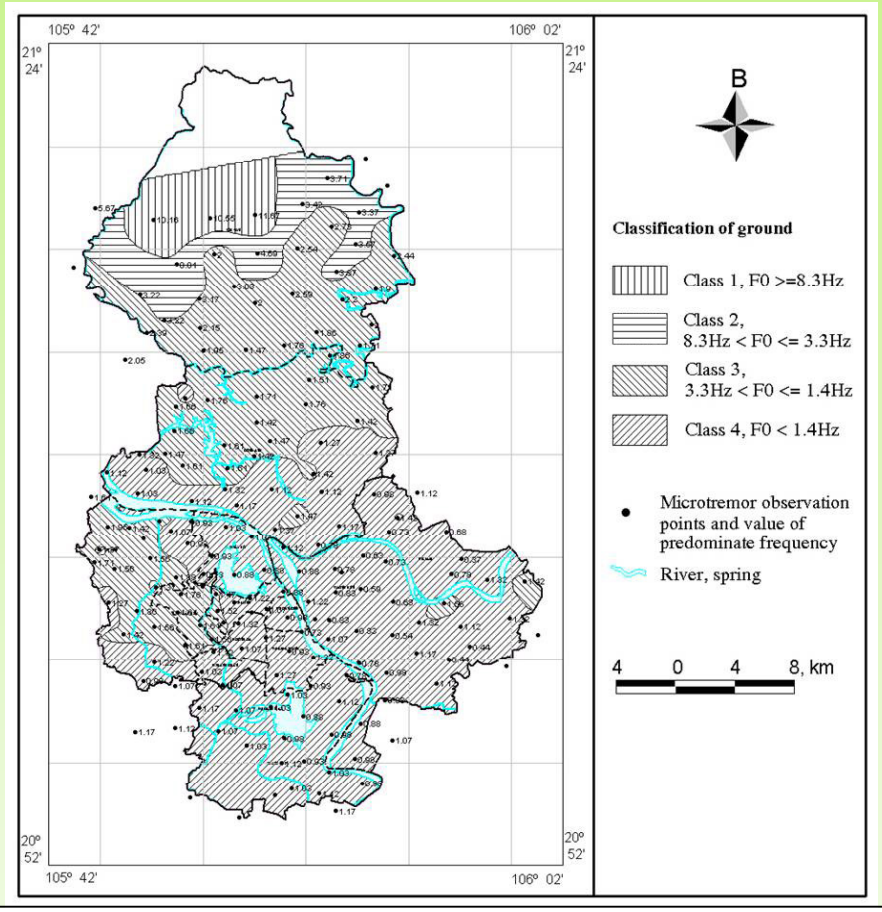
- Dense survey, especially at urban region, is necessary to provide detail site information for seismic microzonation and risk assessment
- Total 700 single-station microtremor points and 4 more arrays were completed



Dominant Frequency of Dense Microtremor Survey

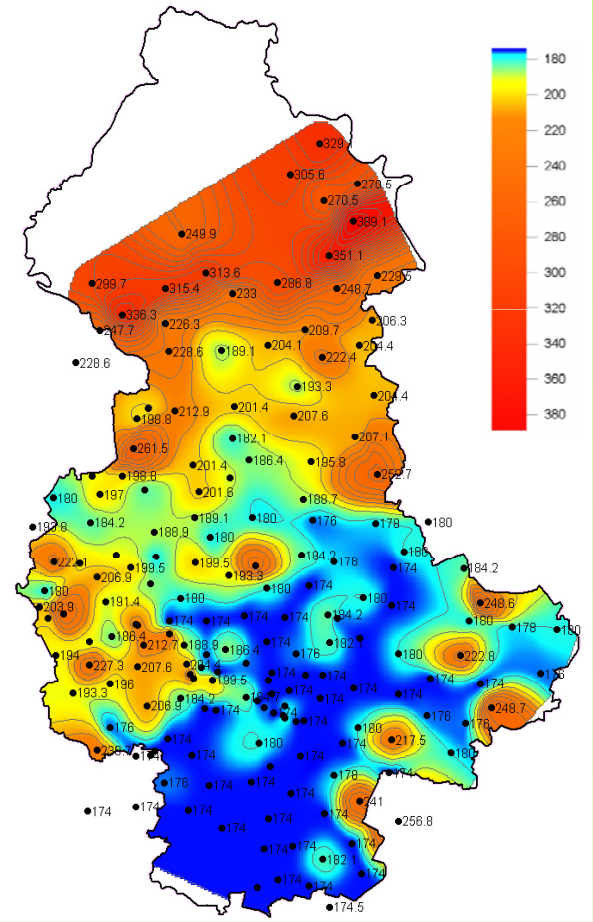


Seismic Microzonation of Hanoi



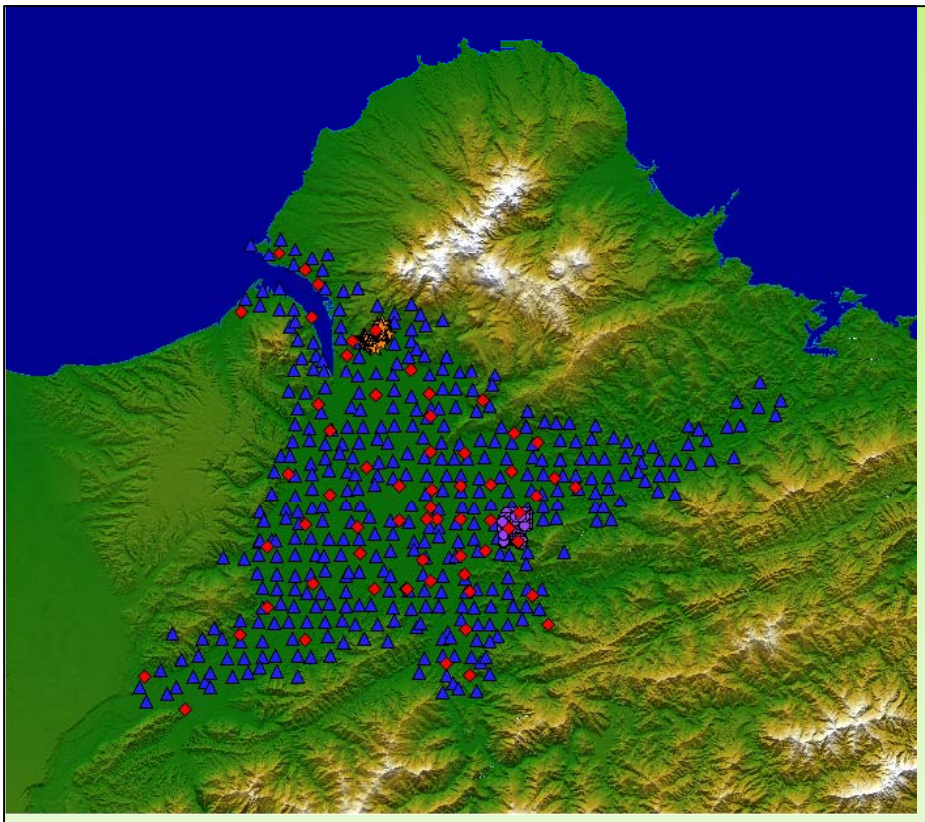
Vs30 Map of Hanoi

- All the H/V spectral ratios were simulated to estimate the Vs models and calculate the seismic site conditions (Vs30).
- Vs30 decreases from North to South in Hanoi
- The highest Vs30 is more than 300m/s in the northern part. The lowest Vs30 is less than 180 m/s in the southern part, including a part of the urban region.



Conclusions

- The dense microtremor surveys, including 700 single-station measurements and array measurements at 8 sites, have been conducted in Hanoi region.
- H/V spectral ratios in Hanoi region show an apparent dominant frequency between 0.8 and 2.0 Hz. It was proved that the apparent site amplification is dominated by the thicknesses of near-surface deposits.
- All the observed microtremor H/V spectral ratios were simulated to figure out the overall detail subsurface Vs structure in Hanoi region.
- According to the site characteristics and Vs structure, the seismic microzonation and Vs30 map of Hanoi were accomplished to provide the site information for the seismic risk assessment.

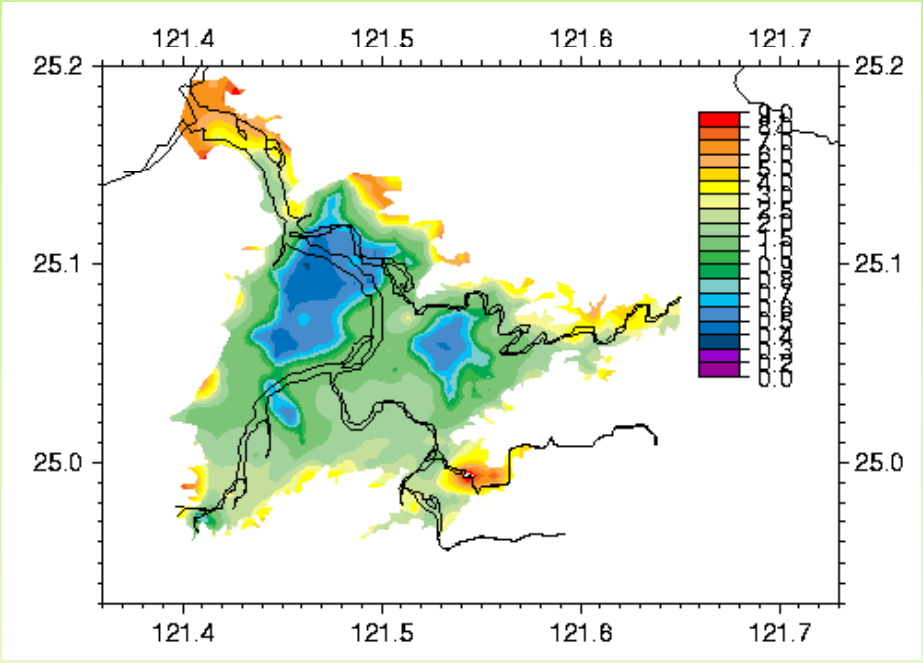


Strong motion station : 69

500 stations

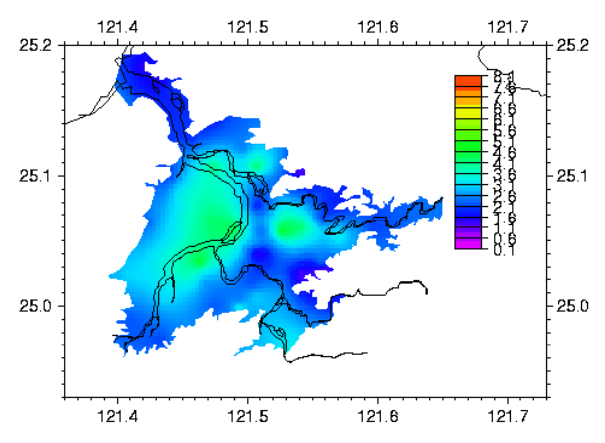
Interval ~ 1 km

Locations of the microtremor survey points in the Taipei area. Red symbols indicate the strong motion stations.

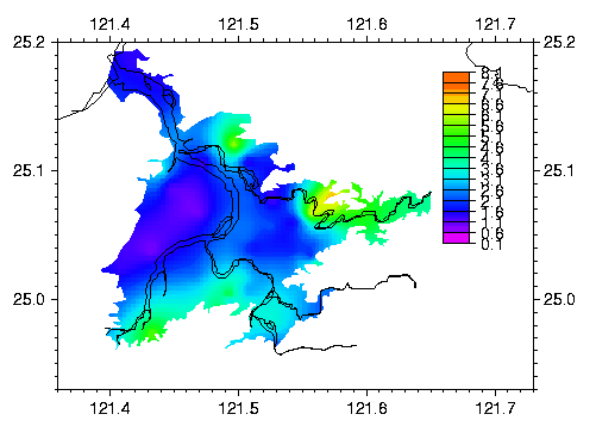


Dominant frequency contour in the Taipei basin area, result from the H/V ratio of dense microtremor survey

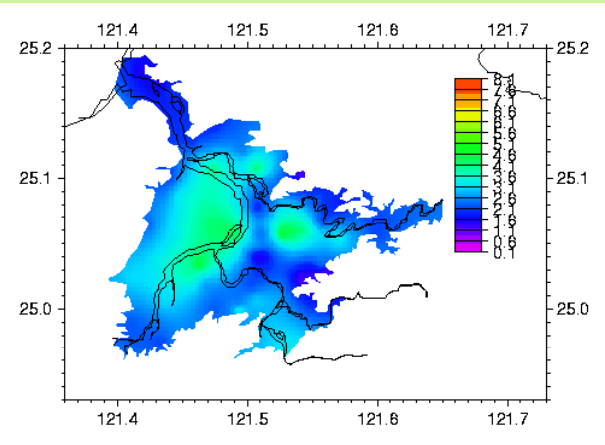
0.5 Hz



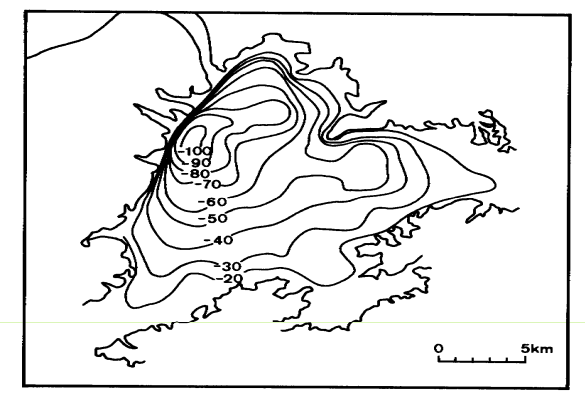
2.0 Hz



H/V spectral ratio contours at 0.5 and 2.0 Hz.

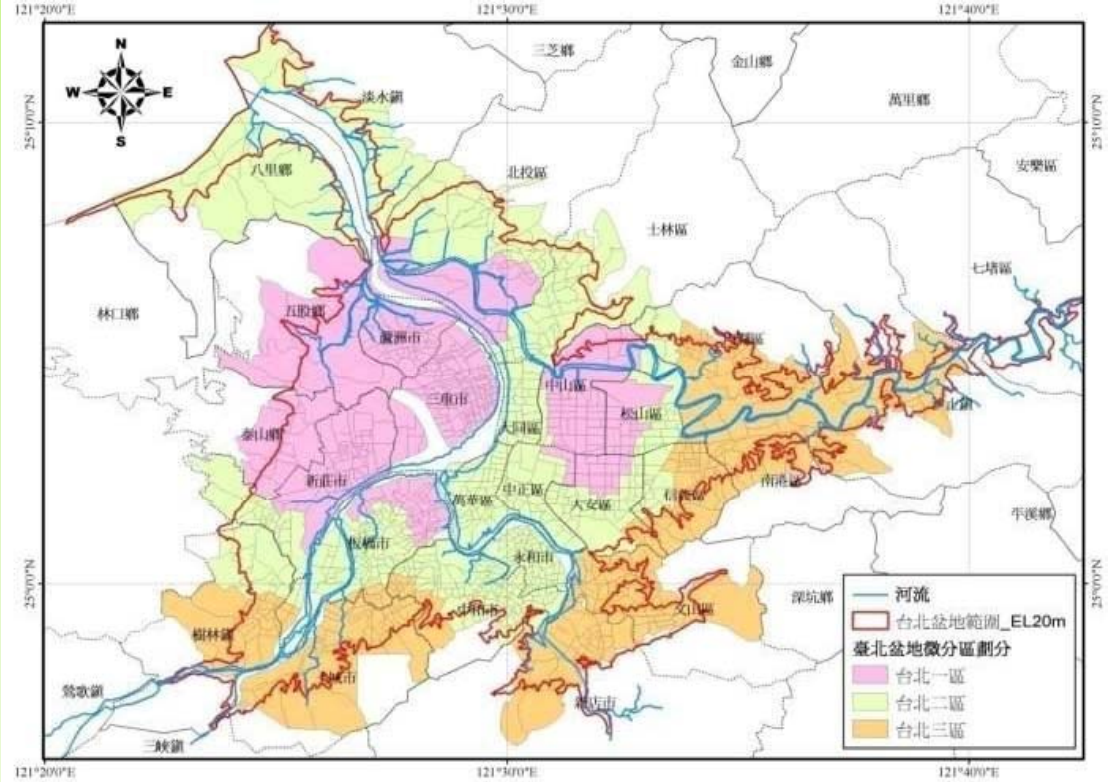


H/V spectral ratio contour at 0.5 Hz.



Sungshan Formation Bottom --- Taipei Basin

2011.1修訂後公告之臺北盆地設計地震微分區圖
Microzonation Map of Taipei Basin in the Building Code Modified on 2011.



Thanks for your attention!

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