Application of Microtremor HVSR Method for Preliminary Assesment of Seismic Site Effect in Ngipik Landfill, Gresik

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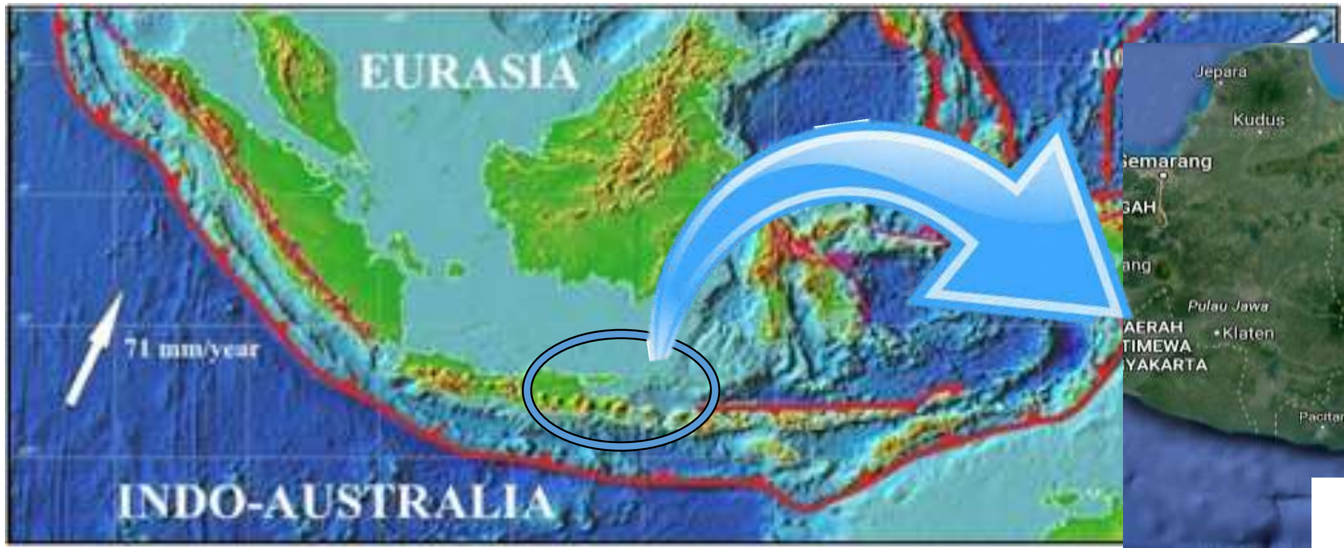
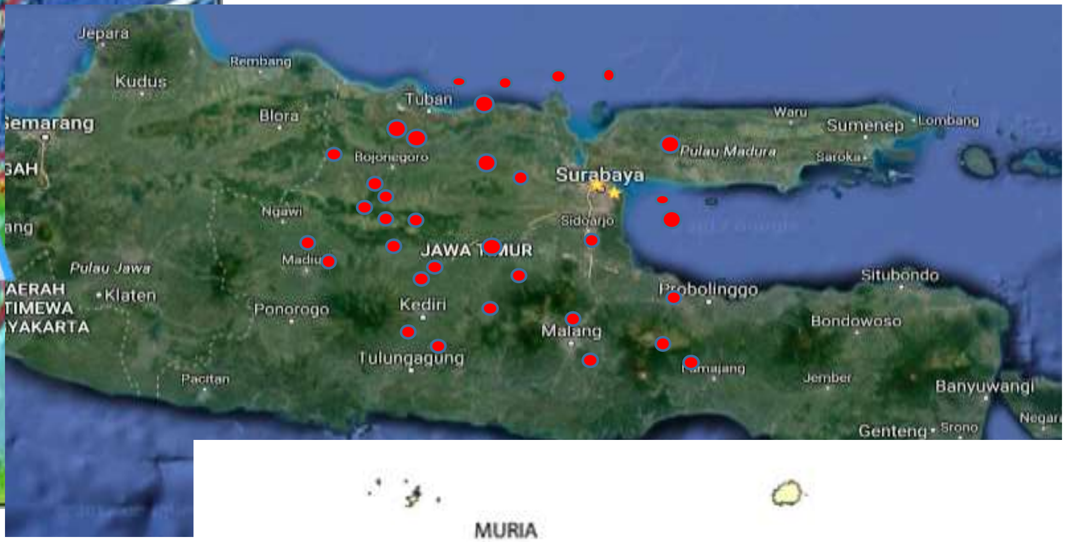
INTRODUCTION





- Gresik has several active seismic activities and active faults.
- Geological conditions in Gresik consist of alluvial sedimentary, basin, limestone grumusol, red mediteran and sandstone with sediment in the form of limestone and clay

M 4.0 - Java, Indonesia

Time	1996-04-04 14:36:30 (UTC)
Location	7.067°S 112.436°E
Depth	100.0 km

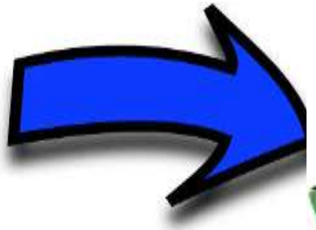
23km from Ngipik

M 4.0 - Java, Indonesia

Time	2003-03-09 02:23:33 (UTC)
Location	7.011°S 112.304°E
Depth	238.5 km

40km from Ngipik

INTRODUCTION



- The area of Ngipik Landfill is 6 hectares but the disposal zone area is around 4 hectares, and the height of the waste is about 10 and 12 m
- It still use open dumping method for disposing the waste.
- Leachate is a liquid that passes through refuse which has been extracted and suspended from the waste reaction and will contaminate the ground water

Topograpic

Geological

Local site effect

Ground Motion amplification during earthquake

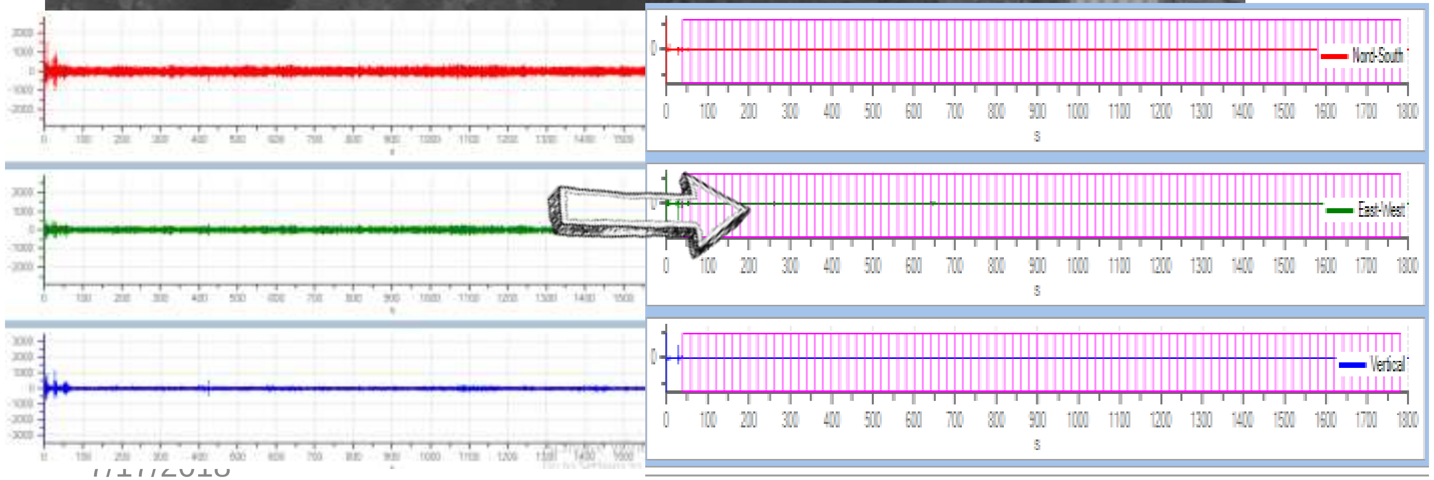
Geology subsurface's assessment with geophysical surveying as though borehole method

Microtremor Measurements analysis (HVSR Method)

MATERIAL AND METHOD

Geotechnical Investigation and Microtremor measurment

- The soil characteristic was taken from 3 (three) boreholes (red dots)
- The microtremor investigation was conducted on August 2017, on 25 x 25 m grid (white sign) and measured for 30 minutes of ambient noise were recorded

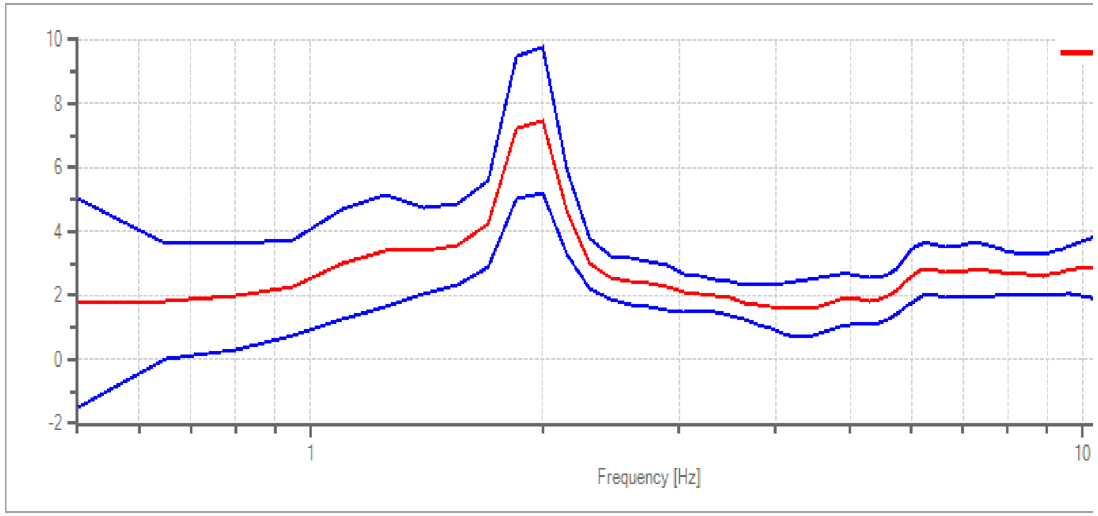


1. filtered frekuensi about 0.2 and 25 Hz with 4 poles Butterworth filter

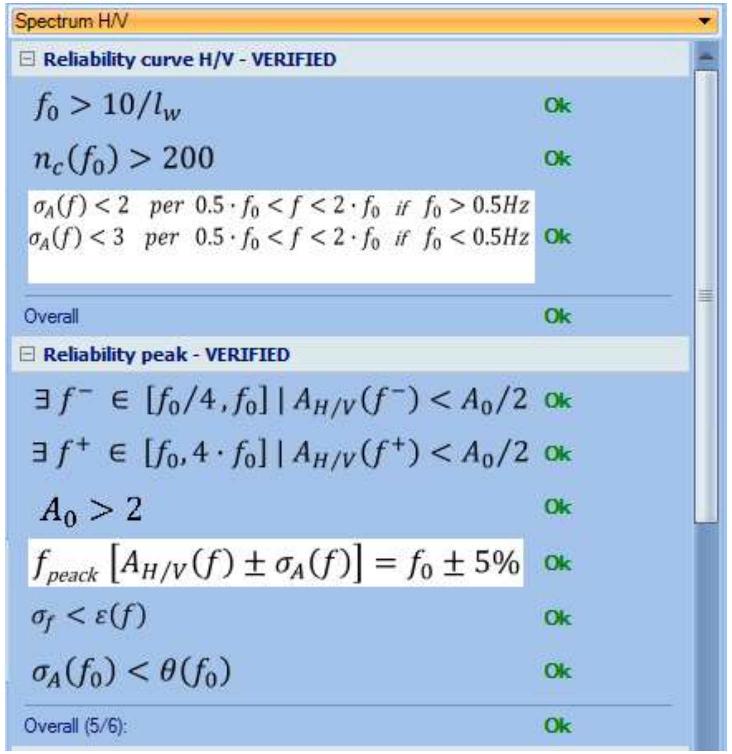
2. Time owned by each signal obtained 20 second length with cosine taper 5%

3. The FFT data has processed and smoothed by the Konno and Ohmachi (1998) method with (b=40) in each window.

4. HVSR Curve



HVSR analyses from microtremor measurements has to satisfy the criteria defined by SESAME project



Criteria for a reliable H/V curve

i) $f_0 > 10 / l_w$

and

ii) $n_c(f_0) > 200$

and

iii) $\sigma_A(f)<2$ for $0.5f_0<f<2f_0$ if $f0>0.5Hz$

or $\sigma_A(f)<3$ for $0.5f_0<f<2f_0$ if $f0<0.5Hz$

Criteria for a clear H/V peak

(at least 5 out of 6 criteria fulfilled)

i) $\exists f^- \in [f_0/4, f_0] \mid A_{H/V}(f^-) < A_0/2$

ii) $\exists f^+ \in [f_0, 4f_0] \mid A_{H/V}(f^+) < A_0/2$

iii) $A_0 > 2$

iv) $f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$

v) $\sigma_f < \varepsilon(f_0)$

vi) $\sigma_A(f_0) < \theta(f_0)$

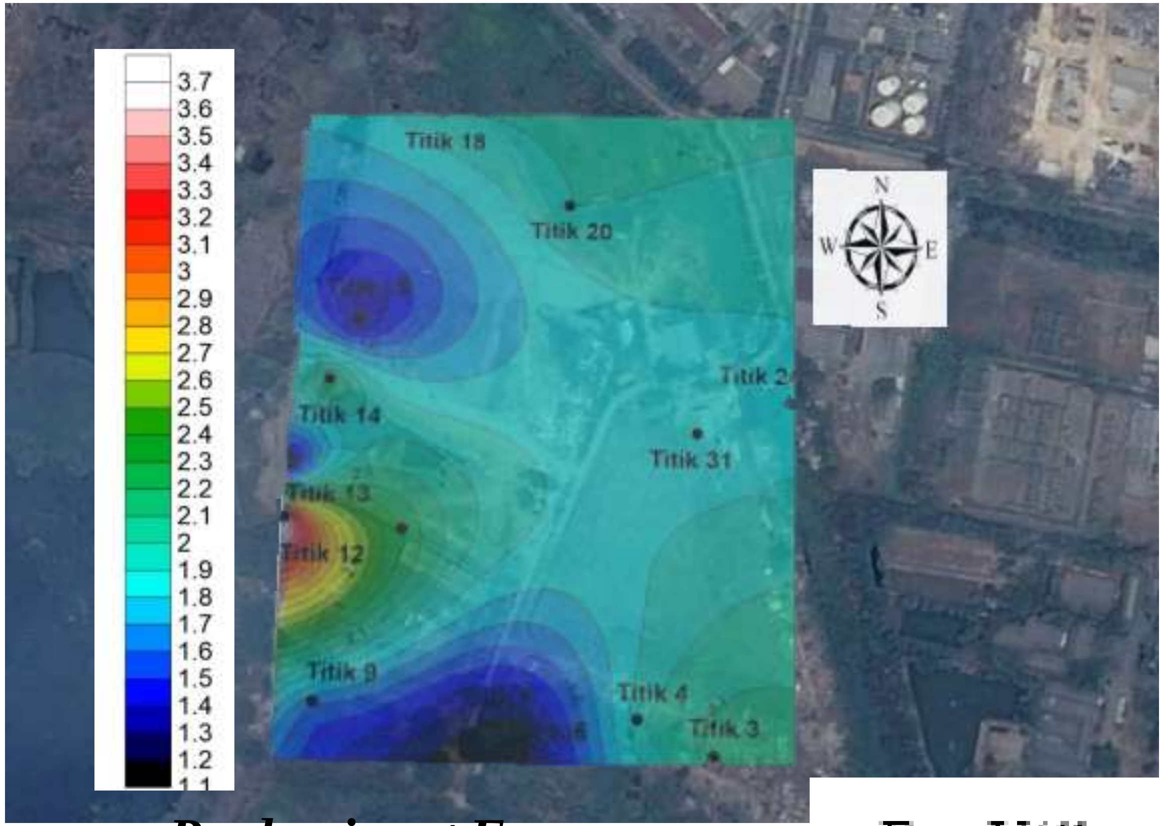
- l_w = window length
- n_w = number of windows selected for the average H/V curve
- $n_c = l_w \cdot n_w \cdot f_0$ = number of significant cycles
- f = current frequency
- f_{sensor} = sensor cut-off frequency
- f_0 = H/V peak frequency
- σ_f = standard deviation of H/V peak frequency ($f_0 \pm \sigma_f$)
- $\varepsilon(f_0)$ = threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
- A_0 = H/V peak amplitude at frequency f_0
- $A_{H/V}(f)$ = H/V curve amplitude at frequency f
- f^- = frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
- f^+ = frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
- $\sigma_A(f)$ = "standard deviation" of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
- $\sigma_{logH/V}(f)$ = standard deviation of the $logA_{H/V}(f)$ curve, $\sigma_{logH/V}(f)$ is an absolute value which should be added to or subtracted from the mean $logA_{H/V}(f)$ curve
- $\theta(f_0)$ = threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$
- $V_{s,av}$ = average S-wave velocity of the total deposits
- $V_{s,surf}$ = S-wave velocity of the surface layer
- h = depth to bedrock
- h_{min} = lower-bound estimate of h

Threshold Values for σ_f and $\sigma_A(f_0)$

Frequency range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.20 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

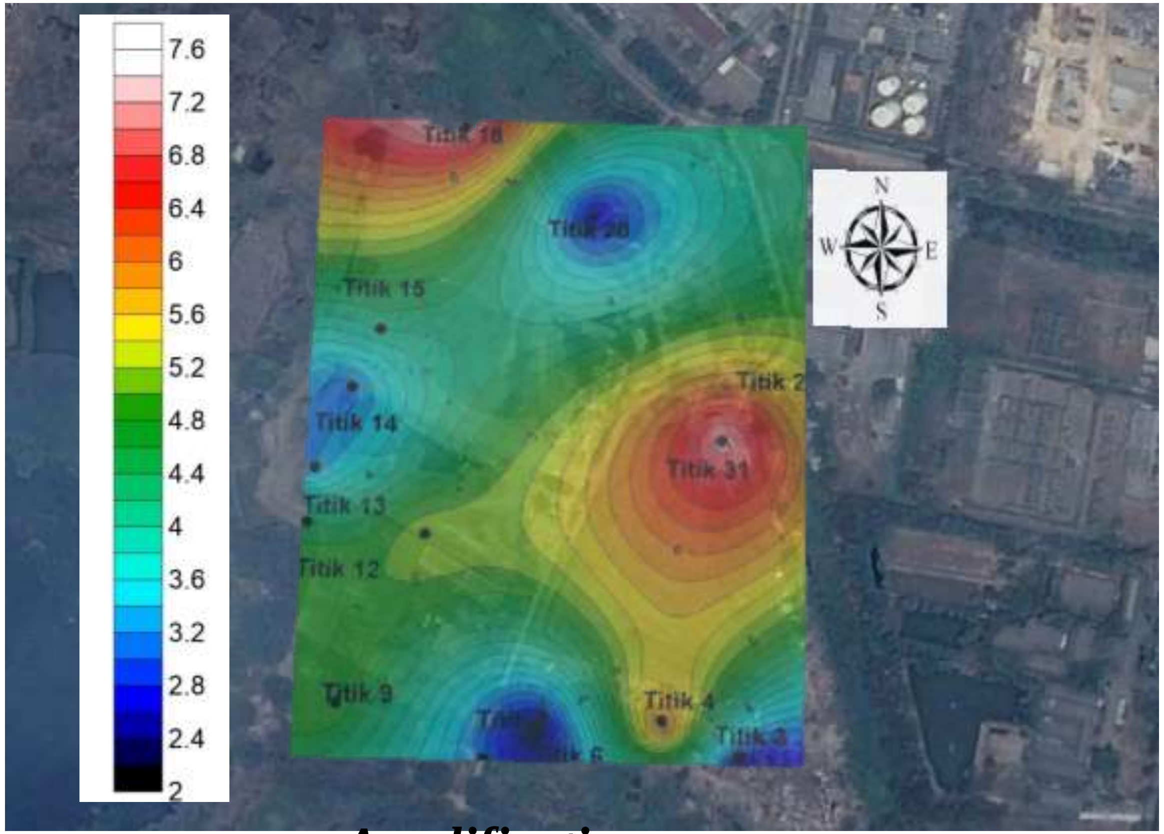
Result and interpretation

Distribution of predominant frequency (f_0) and Amplification factor (A_m)



Predominant Frequency

$$F_0 = V/4h$$



Amplification

- ***The f_o value represent the pattern of topographic area. The greater of depth of bedrock represent the smaller f_o. The landfill's height in northwest is the heighest, But he factors that may affect the factor f_o is not the only one of topographic effect factor.***
- ***No correlation of Amplification and natural frequency. The soil depth not strongly controlled by variation of Am value. it can be concluded that the dominant factor controlled the Am variation is geological factors.***

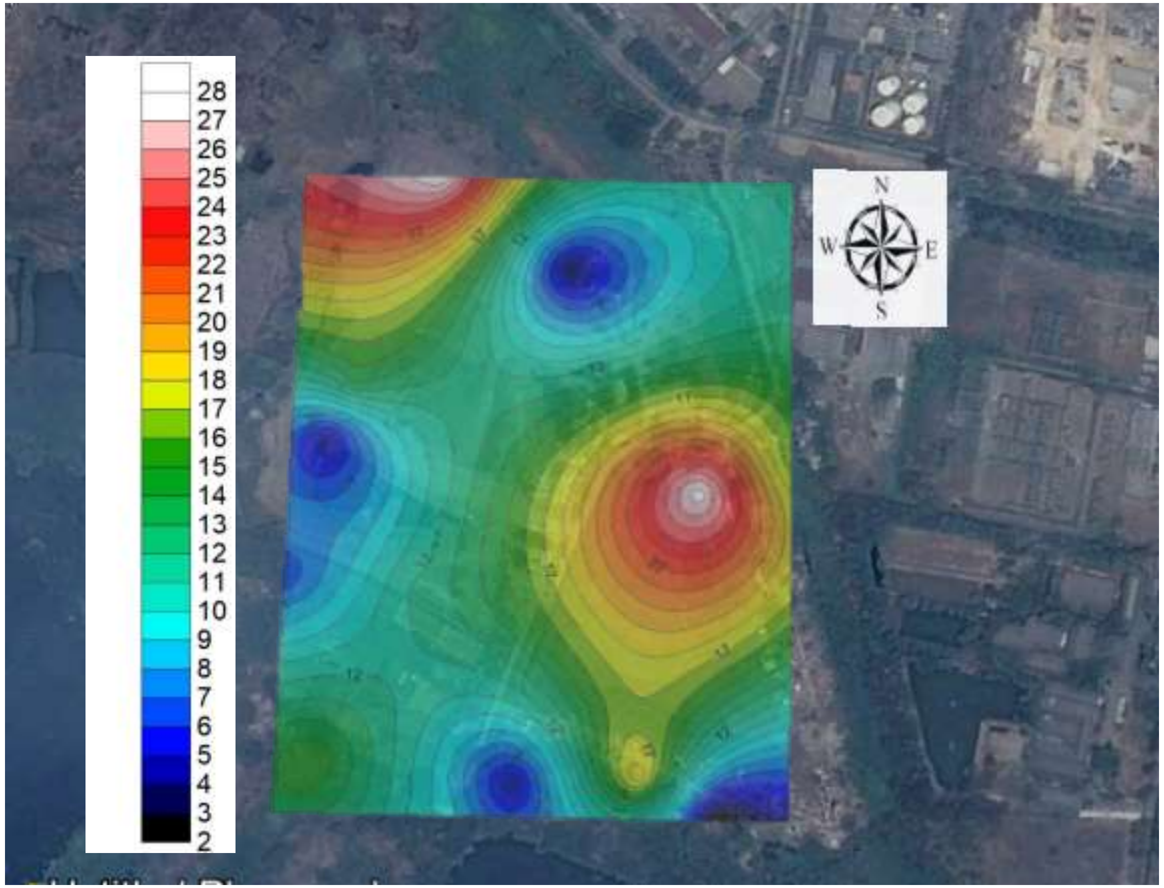
Result and interpretation

Distribution of Soil Vulnerability Index (kg)

$$Kg = A_m^2 / F_0$$

Where :
A_m = Amplification
F_0 = Natural frequency

This method can be identified areas where greater seismic hazards and damage. The high value represent an indicator which could be helpful in choosing weak point of this area. The weak zone during earthquake and indicated the leachate's spread due to ground motion of subsurface landfill.



Soil Vulnerability Index(Kg)

Conclusion

- Microtremor and geotechnical measurement are generally employed for preliminary assessing site effect. Variation of soil subsurface properties and bedrock depth was provided to give initial information. Concurrently, the microtremor's preparation and measurement are kept low due to no other active source is required. Hence, the microtremor HVSR method is very helpful to determined preliminary seismic microzonation in landfill.
- The value of predominant frequency (f_0) between 1.1 and 3.65 Hz and peak of HVSR (A_m) varies from 2.04 to 7.16 and effecting to Vulnerability index (Kg). Large values of Kg was found at Northwest; these zone were considered as weak zones and indicated the leachate spread. This result could be considered preliminary assessment the local site effects to rescirculation design of leachate.

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Questions
Answers
Are there any questions?