

Comune di Viadanica (BG)

Via G. Scotti, 1
24060 Viadanica (BG)

PIANO DI GOVERNO DEL TERRITORIO

AGGIORNAMENTO DELLA COMPONENTE GEOLOGICA, IDROGEOLOGICA E SISMICA DEL PIANO DI GOVERNO DEL TERRITORIO

D.G.R. n. IX/2616 del 30/11/2011 D.G.R. n. X/6738 del 19/06/2017 D.G.R. n. XI/6702 del 18/07/2022

INDAGINI GEOFISICHE



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Referente	Dott. Geol. Marco Carraro
Data emissione	11/2023 rev. 01 05/2025
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1. INDAGINI SISMICHE HVSR

1.1. INDAGINE HVSR_1

winMASW & HoliSurface - Surface Waves & Beyond

file:///I:/Geotecnica/Prov_BG/VIADANICA/2022/via%20castello%...

winMASW & HoliSurface: Horizontal-to-Vertical Spectral Ratio

=====

Dataset: 2022-07-12_15-56HVSR20viadanica.seg2

DATA ACQUISITION

Date and time:

DATA PROCESSING

Date: 13 7 2022

Time: 10 5

Sampling frequency (Hz): 64

Window length (sec): 20

HVSR computation: quadratic mean

Minimum frequency soundly determined [10 cycles]: 0.5Hz

Length of analysed dataset (min): 20.0

Tapering (%): 5

Smoothing (%): 15

SESAME criteria

In the following the results considering the data in the 1.7-20.0Hz frequency range

Peak frequency (Hz): 3.4 (±0.5)

Peak HVSR value: 5.3 (±0.4)

=== Criteria for a reliable H/V curve ===

#1. $[f_0 > 10/Lw]$: $3.377 > 0.5$ (OK)#2. $[nc > 200]$: $7226 > 200$ (OK)#3. $[f_0 > 0.5\text{Hz}; \sigma_A(f) < 2 \text{ for } 0.5f_0 < f < 2f_0]$ (OK)

=== Criteria for a clear H/V peak (at least 5 should be fulfilled) ===

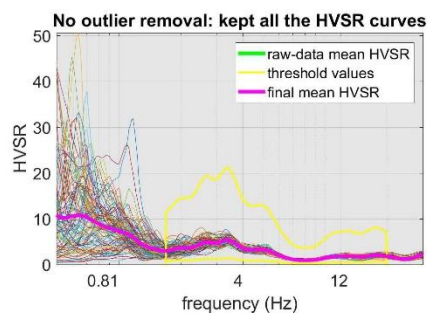
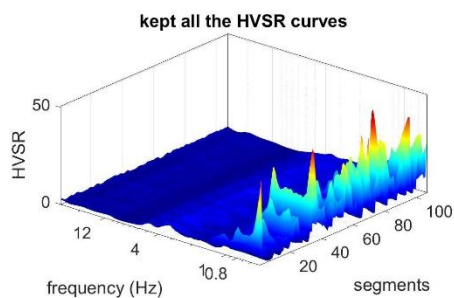
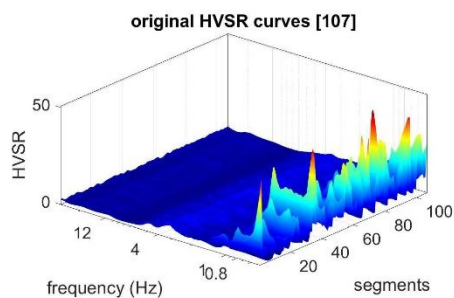
#1. [exists f- in the range $[f_0/4, f_0]$ | $AH/V(f_-) < A_0/2$]: yes (considering standard deviations), at frequency 1.2Hz (OK)#2. [exists f+ in the range $[f_0, 4f_0]$ | $AH/V(f_+) < A_0/2$]: yes, at frequency 5.6Hz (OK)#3. $[A_0 > 2]$: $5.3 > 2$ (OK)#4. $[f_{\text{peak}}[Ah/v(f)] \pm \sigma_A(f) = f_0 \pm 5\%]$: (OK)#5. $[\sigma_{\text{maf}} < \epsilon(f_0)]$: $0.491 > 0.169$ (NO)#6. $[\sigma_A(f_0) < \theta(f_0)]$: $0.996 < 1.58$ (OK)

Please, be aware of possible industrial/man-induced peaks or spurious peaks due to meaningless numerical instabilities.

Remember that SESAME criteria should be considered in a flexible perspective and that if you modify the processing parameters the results may change.

winMASW & HoliSurface - Surface Waves & Beyond

file:///J:/Geotecnica/Prov_BG/VIADANICA/2022/via%20castello%...



show current data reset

step1 (optional) - decimate

step2 - HV computation

economic events on: Raw & T clean axes

20 window length (s) 5 tapering (%) Min. freq.: 0.5 Hz

15 amplitude threshold 400 HVSR threshold test removal

15% spectra smoothing (displays window) 8 delivering user HOLLAND 2 Hz

☒ full output ☐ exclude noise, all HVSRs, time-lapse videos ☐ close windows ☐ show videos ☐ quadratic mean compute

continuity show 3D motion

directivity analysis

ing. analysis: right left 3 3 3 3 3 compute

save - optional: save HVSR as it is

save HV rate 0.3 to 20 Hz

save HV curve (as it is)

picking HV or amplitude spectra

HVSr pick date

save picked HV compute

quick analysis (F=V44H)

average to end 200 (from surface to bedrock)

20 slope of the bedrock on 1200 slope of the bedrock

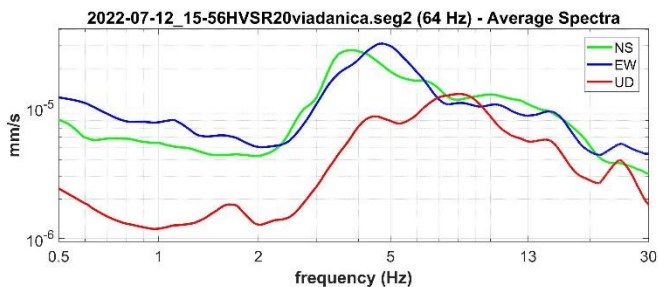
start compute

highlight a frequency

downhighlight 10 Hz upload HVSR curve

directivity over time

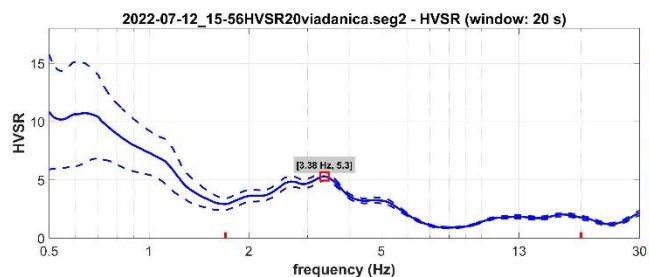
directivity on time time 50 s



open working folder
show location
field notes

your comments

default axes



Criteria for a reliable HV curve

R1 OK
R2 OK
R3 OK

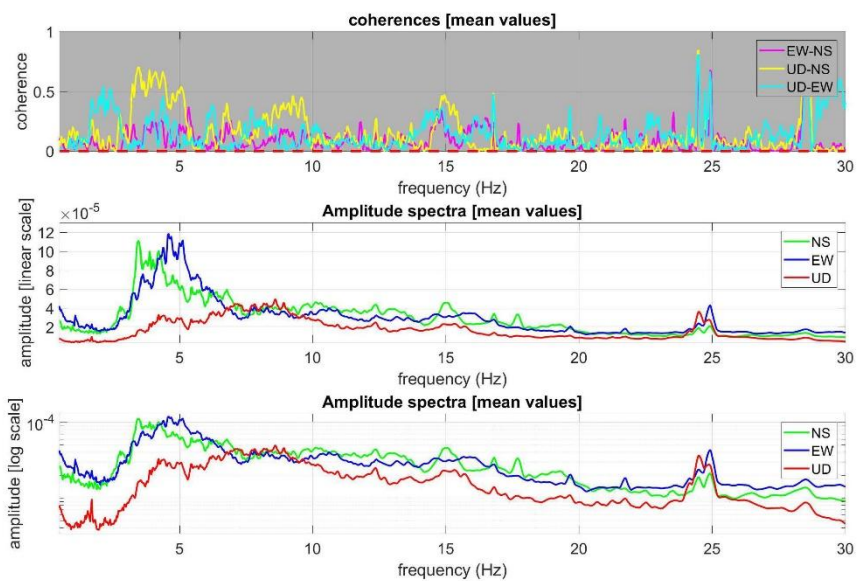
Criteria for a clear HV peak [3.38 Hz]

R1 OK
R2 OK
R3 OK
R4 OK
R5 OK

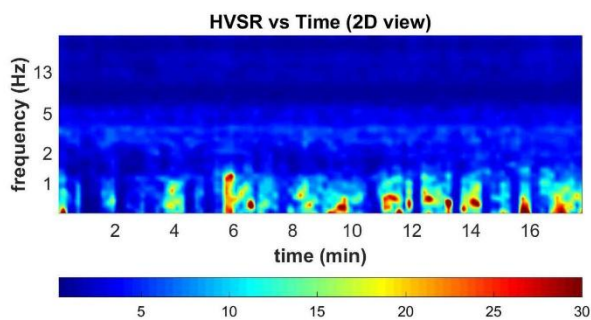
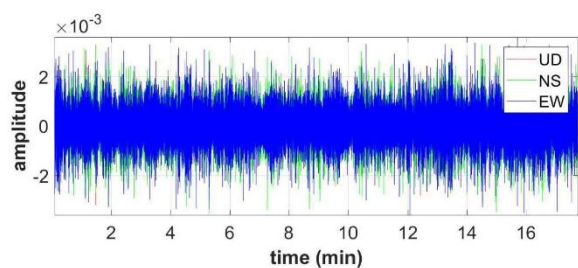
To model the HVSR (also jointly with MASW or ReMi/ESAC data), go to the "Velocity Spectra/Modeling & Picking" panels and upload the saved HV curve

winMASW & HoliSurface - Surface Waves & Beyond

file:///J:/Geotecnica/Prov_BG/VIADANICA/2022/via%20castello%...

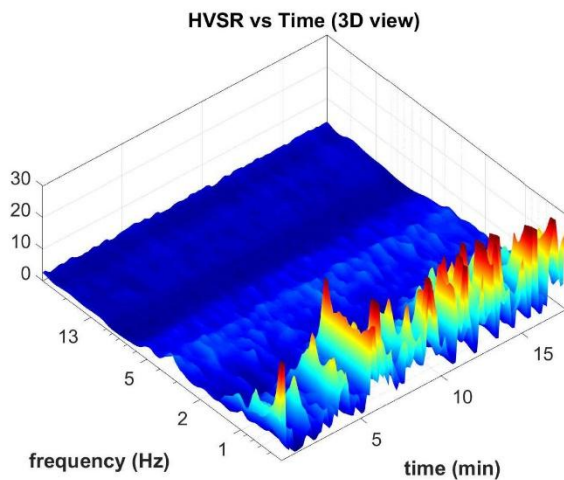


Continuity (Persistence) of the H/V Spectral Ratio

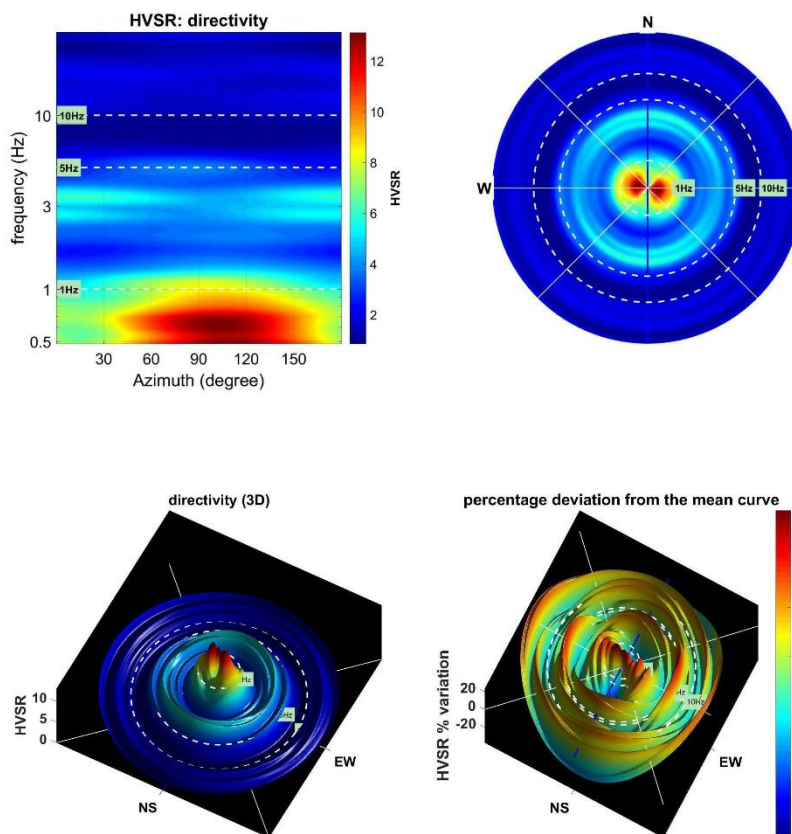


winMASW & HoliSurface - Surface Waves & Beyond

file:///J:/Geotecnica/Prov_BG/VIADANICA/2022/via%20castello%...



Directivity of the H/V Spectral Ratio



winMASW & HoliSurface - Surface Waves and Beyond

www.winmasw.com

1.2. INDAGINE HVSR_2

winMASW & HoliSurface: Horizontal-to-Vertical Spectral Ratio

Dataset: 2023-11-17_12-10HVSR10Viadanica.seg2

DATA ACQUISITION

Date and time:

DATA PROCESSING

Date: 20 11 2023

Time: 11 36

Sampling frequency (Hz): 64

Window length (sec): 20

HVSR computation: quadratic mean

Minimum frequency soundly determined [10 cycles]: 0.5Hz

Length of analysed dataset (min): 10.0

Tapering (%): 5

Smoothing (%): 15

SESAME criteria

In the following the results considering the data in the 3.0-13.0Hz frequency range

Peak frequency (Hz): 6.3 (± 0.9)

Peak HVSR value: 2.3 (± 0.4)

==== Criteria for a reliable H/V curve =====

#1. $[f_0 > 10/Lw]$: $6.331 > 0.5$ (OK)

#2. $[nc > 200]$: $6711 > 200$ (OK)

#3. $[f_0 > 0.5\text{Hz}; \sigma_A(f) < 2 \text{ for } 0.5f_0 < f < 2f_0]$ (OK)

==== Criteria for a clear H/V peak (at least 5 should be fulfilled) =====

#1. [exists f^- in the range $[f_0/4, f_0]$ | $AH/V(f^-) < A_0/2$]: yes, at frequency 2.8Hz (OK)

#2. [exists f^+ in the range $[f_0, 4f_0]$ | $AH/V(f^+) < A_0/2$]: yes, at frequency 3.4Hz (OK)

#3. $[A_0 > 2]$: $2.3 > 2$ (OK)

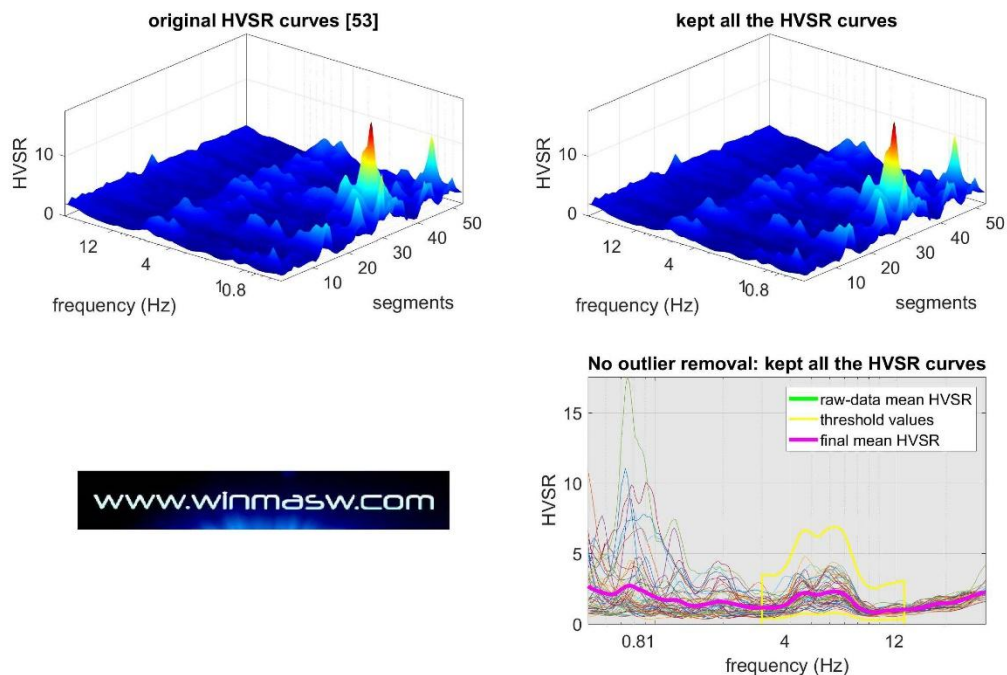
#4. $[f_{\text{peak}}[Ah/v(f) \pm \sigma_A(f)] = f_0 \pm 5\%]$: (OK)

#5. $[\sigma_A(f) < \epsilon(f_0)]$: $0.923 > 0.317$ (NO)

#6. $[\sigma_A(f_0) < \theta(f_0)]$: $0.427 < 1.58$ (OK)

Please, be aware of possible industrial/man-induced peaks or spurious peaks due to meaningless numerical instabilities.

Remember that SESAME criteria should be considered in a flexible perspective and that if you modify the processing parameters the results may change.



show current data

step1 (optional) - decimate

step2 - HV computation

remove events

Min. freq.: 0.5 Hz

amplitude threshold

test removal

continuity

show 3D motion

directivity analysis

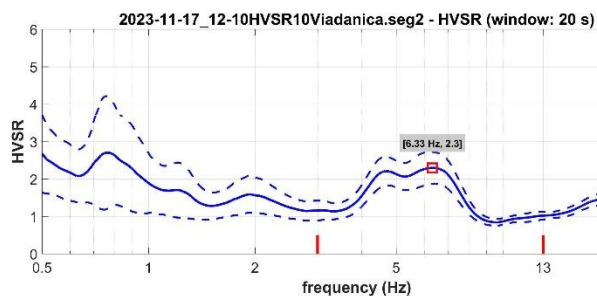
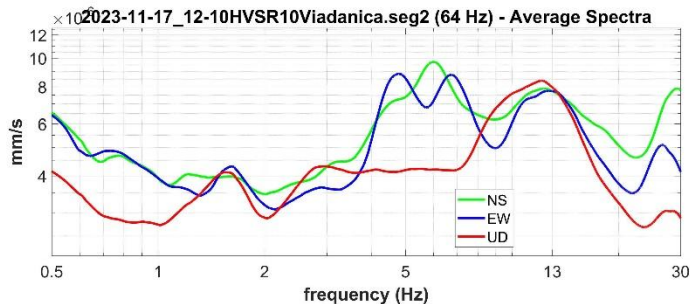
save-option1: save HVSR as it is

pick data

compute

highlight a frequency

upload HVSR curve



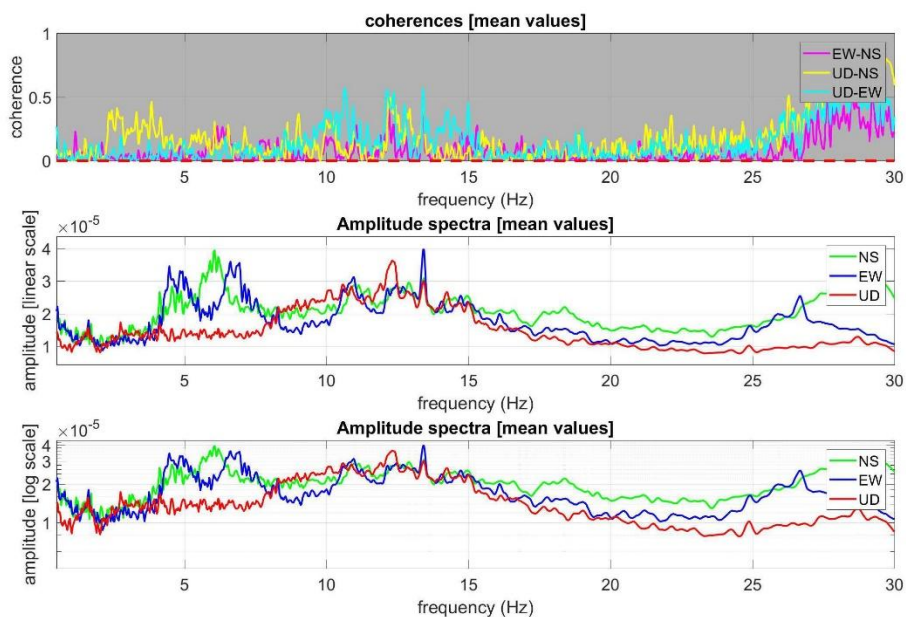
Criteria for a reliable HV curve

#1 OK
#2 OK
#3 OK

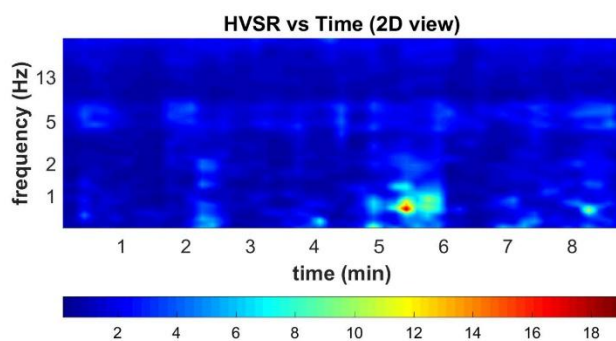
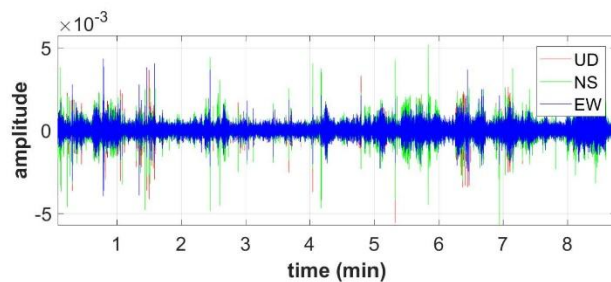
Criteria for a clear H/V peak [6.33 Hz]

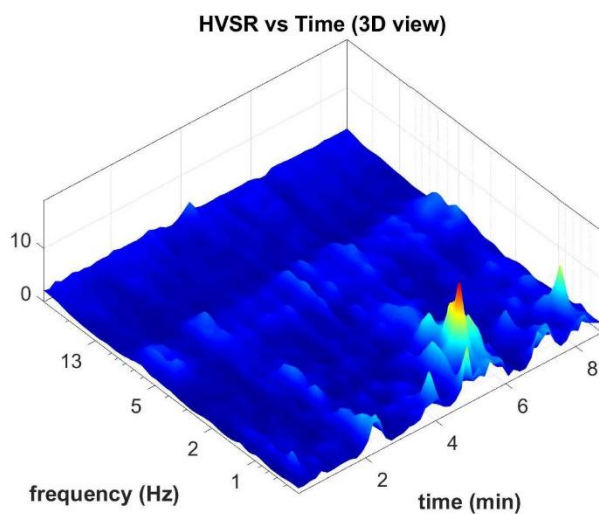
#1 OK
#2 OK
#3 OK
#4 OK
#5 OK
#6 OK

To model the HVSR (also jointly with MASW or ReMiESAC data), go to the "Velocity Spectrum/a, Modeling & Picking" panels and upload the saved HV curve

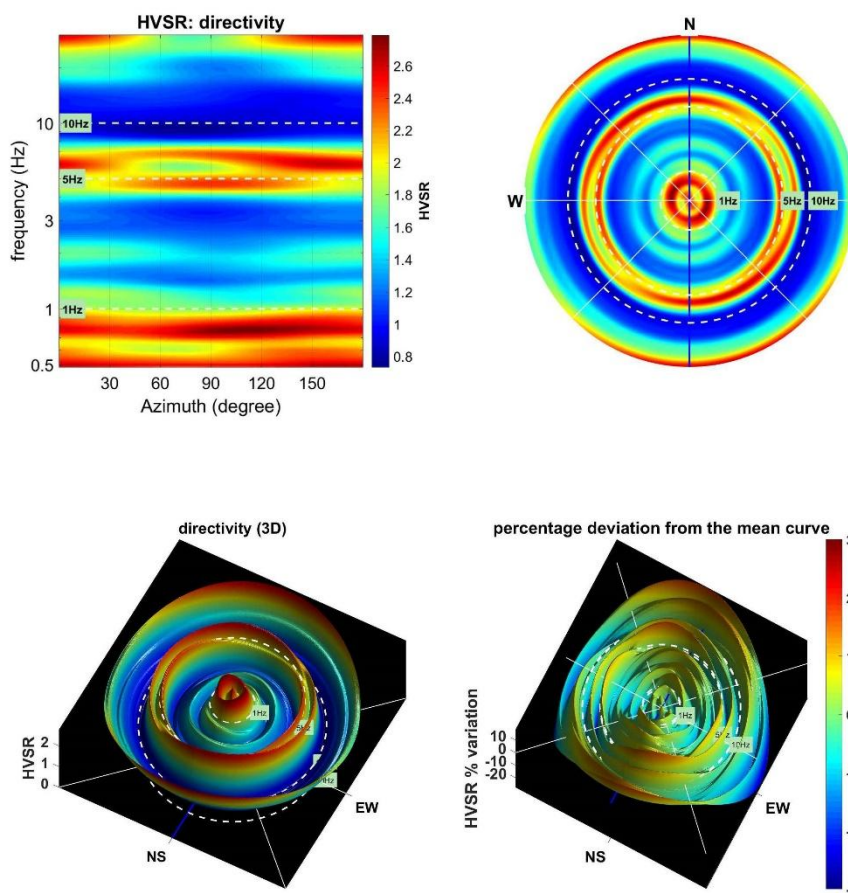


Continuity (Persistence) of the H/V Spectral Ratio





Directivity of the H/V Spectral Ratio



winMASW & HoliSurface - Surface Waves and Beyond

1.3. INDAGINE HVSR_3

winMASW & HoliSurface: Horizontal-to-Vertical Spectral Ratio

Dataset: 2023-11-17_14-04HVSR10_B_Viadanica.seg2

DATA ACQUISITION

Date and time:

DATA PROCESSING

Date: 22 11 2023

Time: 17 18

Sampling frequency (Hz): 64

Window length (sec): 20

HVSR computation: quadratic mean

Minimum frequency soundly determined [10 cycles]: 0.5Hz

Length of analysed dataset (min): 10.0

Tapering (%): 5

Smoothing (%): 15

SESAME criteria

In the following the results considering the data in the 2.0-13.0Hz frequency range

Peak frequency (Hz): 5.7 (±0.8)

Peak HVSR value: 8.7 (±1.1)

Criteria for a reliable H/V curve

#1. $[f_0 > 10/L_w]$: $5.706 > 0.5$ (OK)

#2. $[n_c > 200]$: $3309 > 200$ (OK)

#3. $[f_0 > 0.5\text{Hz}; \sigma_A(f) < 2 \text{ for } 0.5f_0 < f < 2f_0]$ (OK)

Criteria for a clear H/V peak (at least 5 should be fulfilled)

#1. $[\text{exists } f^- \text{ in the range } [f_0/4, f_0] \mid AH/V(f^-) < A_0/2]$: yes, at frequency 1.5Hz (OK)

#2. $[\text{exists } f^+ \text{ in the range } [f_0, 4f_0] \mid AH/V(f^+) < A_0/2]$: yes, at frequency 3.7Hz (OK)

#3. $[A_0 > 2]$: $8.7 > 2$ (OK)

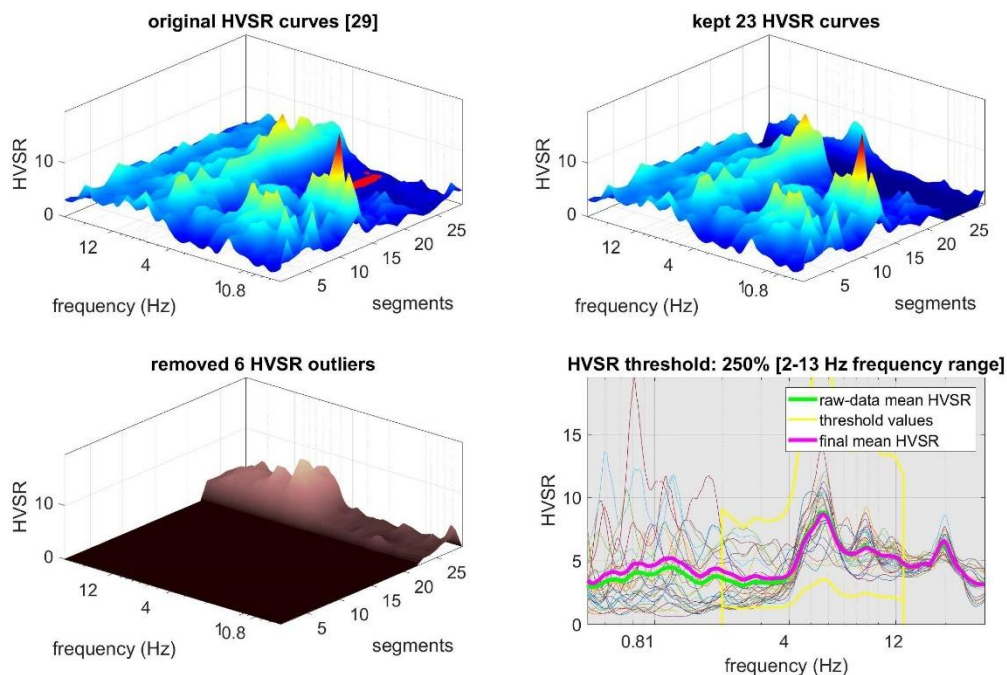
#4. $[f_{\text{peak}}[Ah/v(f) \pm \sigma_A(f)] = f_0 \pm 5\%]$: (OK)

#5. $[\sigma_{\text{maf}} < \epsilon(f_0)]$: $0.751 > 0.285$ (NO)

#6. $[\sigma_A(f_0) < \theta(f_0)]$: $1.083 < 1.58$ (OK)

Please, be aware of possible industrial/man-induced peaks or spurious peaks due to meaningless numerical instabilities.

Remember that SESAME criteria should be considered in a flexible perspective and that if you modify the processing parameters the results may change.



show current data reset

step1 (optional) - decimate

F4 ILU new frequency resample

step2 - HV computation

remove events (X: Pos. A: Tr.) clean axes

20 window length (s)

5 tapering (%)

Min. freq.: 0.5 Hz

5 amplitude threshold

250 HVSR threshold

10% spectral smoothing (triangular window)

6 detrending order

HOL 3C-2 Hz

built output

prelude motions, all HVSRs, time series values

close windows

save videos

quadratic mser

compute

continuity

show 3D motion

directivity analysis

required for highlights: 1.0 5.0 10.0 ILU compute

save-option1: save HVSR as it is

save HV from 0.5 to 30 Hz

save HV curve (as file)

picking HV or amplitude spectra

HVSR

pick data

save picked HV

compute

quick analysis (F=Vs/4H)

average Vs (m/s)

from surface to bedrock

20

scale of the bedrock (m)

1000

1/s of the bedrock

close

compute

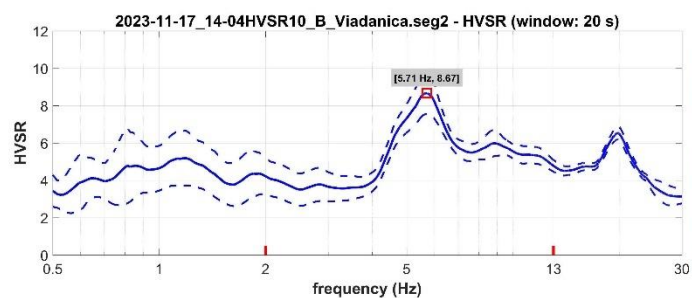
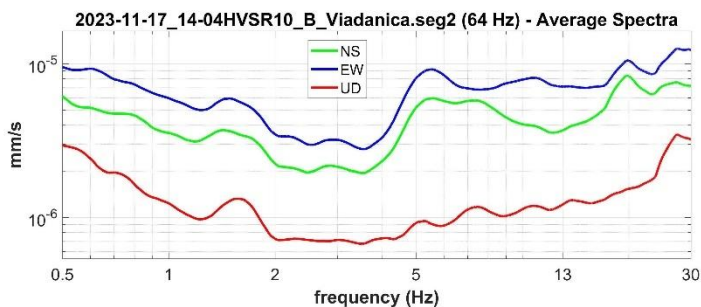
highlight a frequency

drawn highlight 10 Hz

upload HVSR curve

directivity over time

directivity to time time 10 s



To model the HVSR (also jointly with MASW or ReMi/ESAC data), go to the "Velocity Spectrum/a. Modeling & Picking" panels and upload the saved HV curve

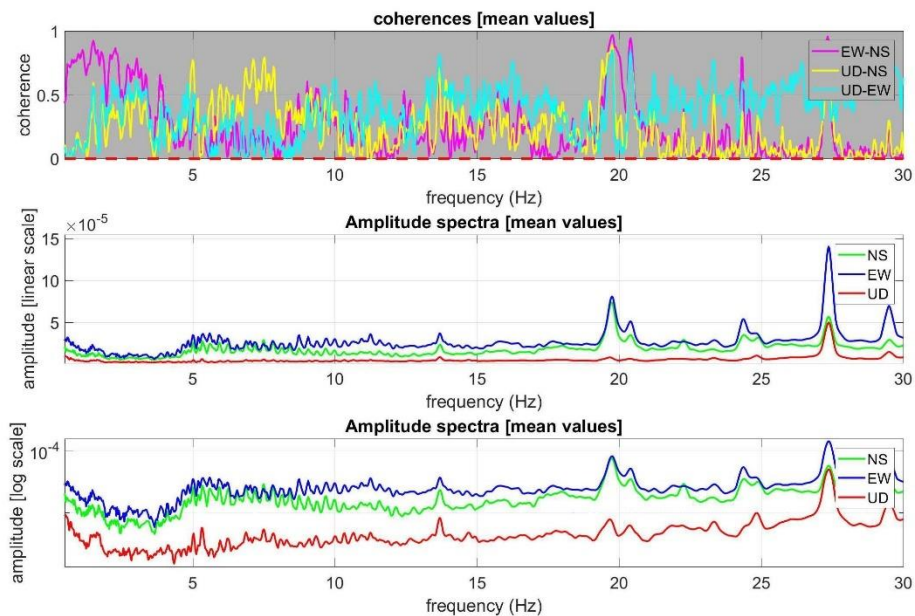
open working folder

show location

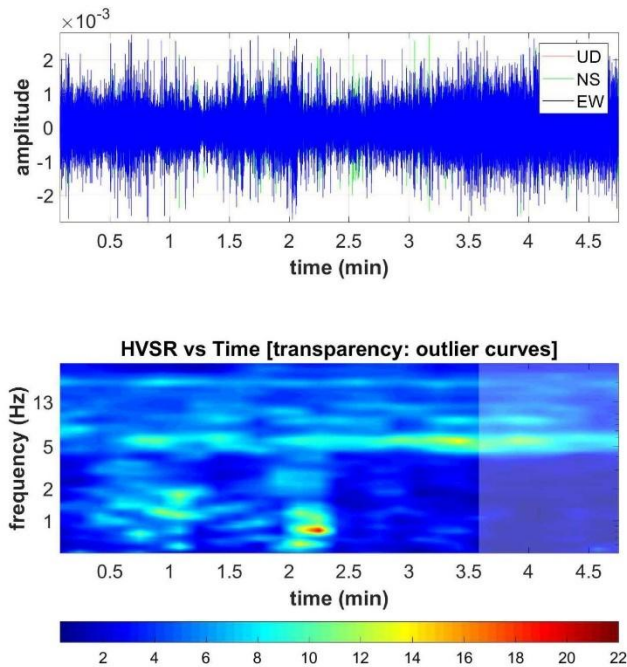
field notes

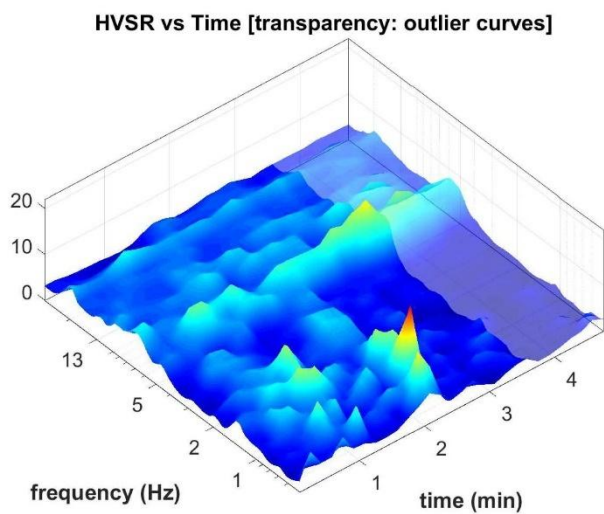
your comment

default axes

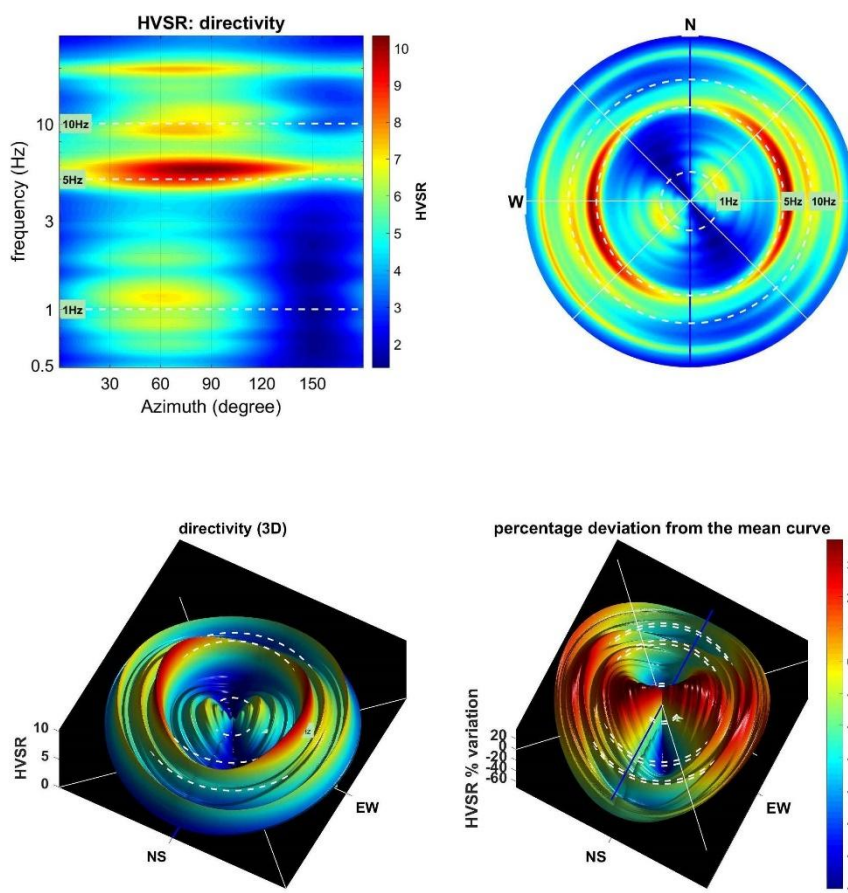


Continuity (Persistence) of the H/V Spectral Ratio





Directivity of the H/V Spectral Ratio



winMASW & HoliSurface - Surface Waves and Beyond

1.4. INDAGINE HVSR_4

winMASW & HoliSurface: Horizontal-to-Vertical Spectral Ratio

Dataset: 2023-11-17_14-24HVSR10ViadanicaC.seg2

DATA ACQUISITION

Date and time:

DATA PROCESSING

Date: 22 11 2023

Time: 16 46

Sampling frequency (Hz): 64

Window length (sec): 20

HVSR computation: quadratic mean

Minimum frequency soundly determined [10 cycles]: 0.5Hz

Length of analysed dataset (min): 10.0

Tapering (%): 5

Smoothing (%): 15

SESAME criteria

In the following the results considering the data in the 0.5-20.0Hz frequency range

Peak frequency (Hz): 8.8 (q3.5)

Peak HVSR value: 4.2 (q0.5)

Criteria for a reliable H/V curve

#1. $[f_0 > 10/L_w]$: $8.832 > 0.5$ (OK)

#2. $[n_c > 200]$: $6889 > 200$ (OK)

#3. $[f_0 > 0.5\text{Hz}; \sigma_A(f) < 2 \text{ for } 0.5f_0 < f < 2f_0]$ (OK)

Criteria for a clear H/V peak (at least 5 should be fulfilled)

#1. [exists f^- in the range $[f_0/4, f_0]$ | $AH/V(f^-) < A_0/2$]: yes, at frequency 2.2Hz (OK)

#2. [exists f^+ in the range $[f_0, 4f_0]$ | $AH/V(f^+) < A_0/2$]: yes, at frequency 13.4Hz (OK)

#3. $[A_0 > 2]$: $4.2 > 2$ (OK)

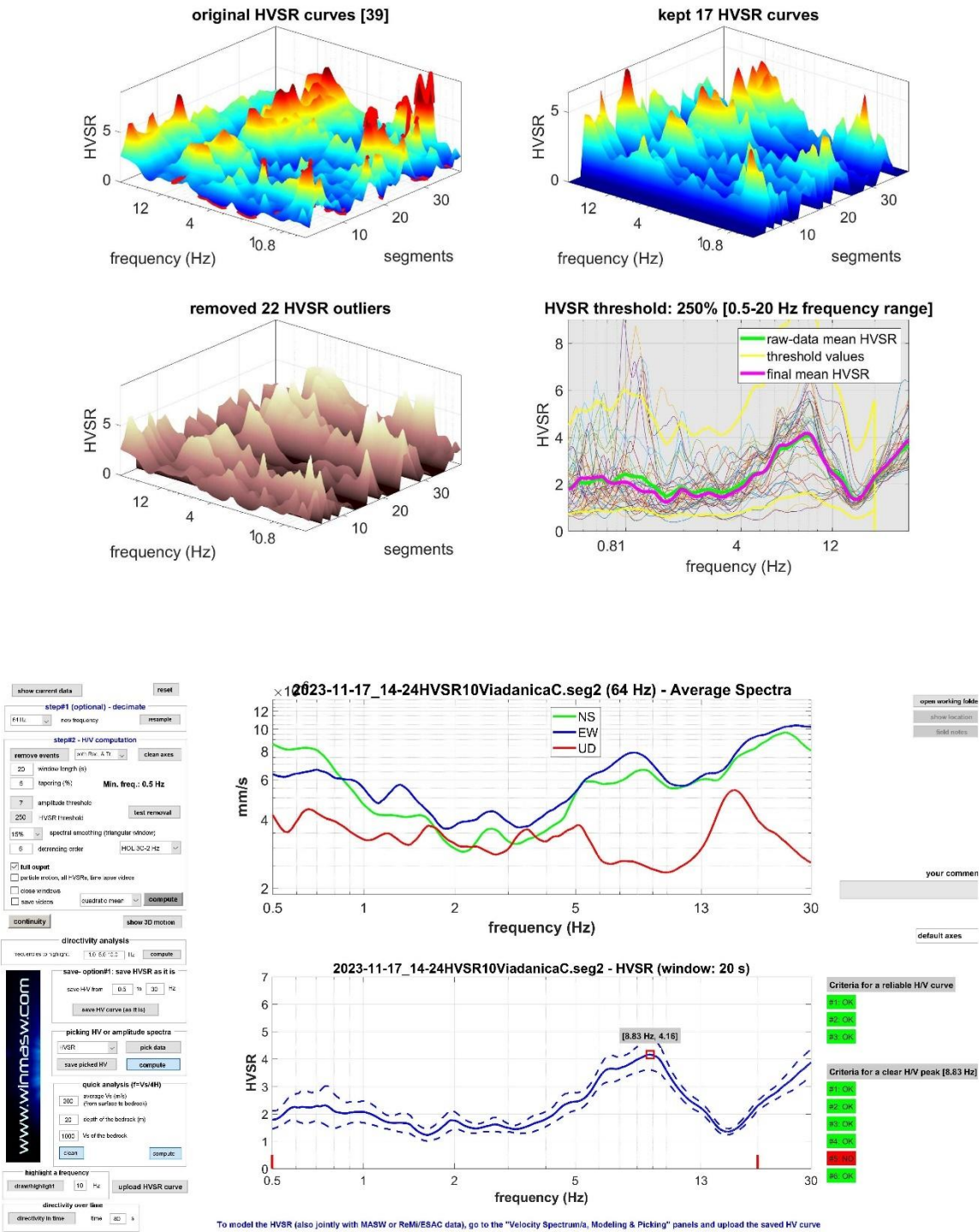
#4. $[f_{peak}[A_h/v(f)] \approx \sigma_A(f)] = f_0 \pm 5\%$: (OK)

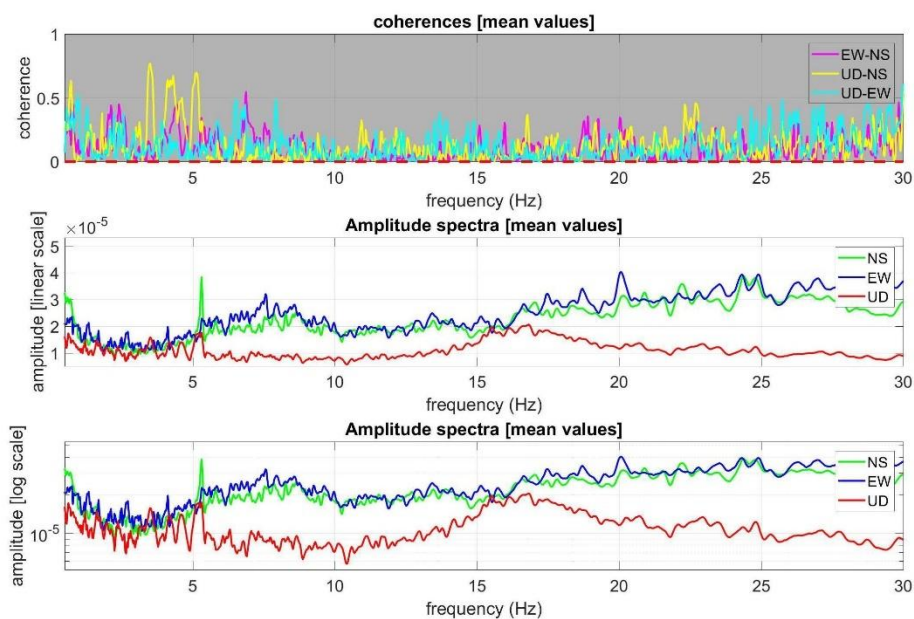
#5. $[\sigma_A(f) < \epsilon(f)]$: $3.505 > 0.442$ (NO)

#6. $[\sigma_A(f_0) < \theta(f_0)]$: $0.988 < 1.58$ (OK)

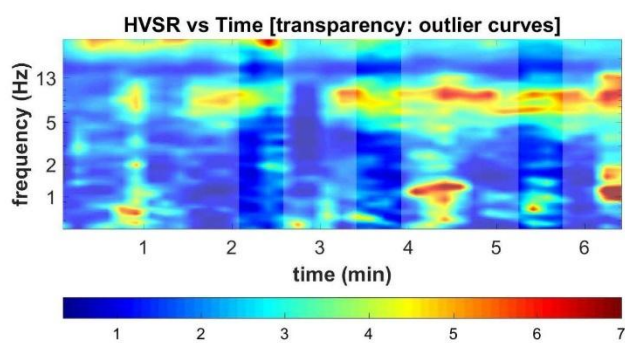
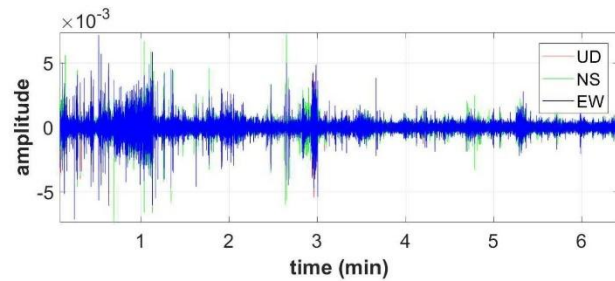
Please, be aware of possible industrial/man-induced peaks or spurious peaks due to meaningless numerical instabilities.

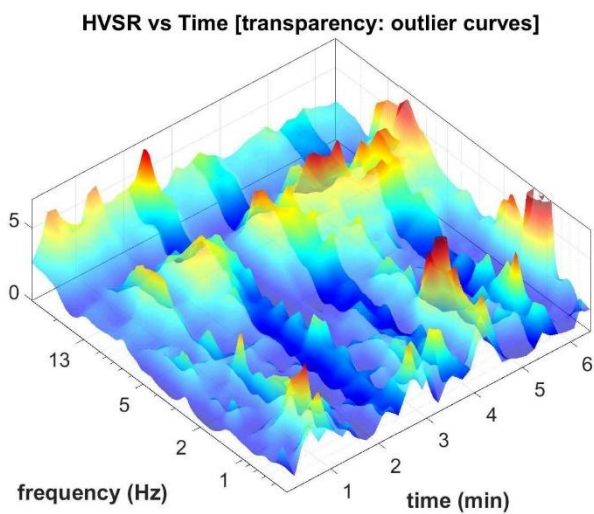
Remember that SESAME criteria should be considered in a flexible perspective and that if you modify the processing parameters the results may change.



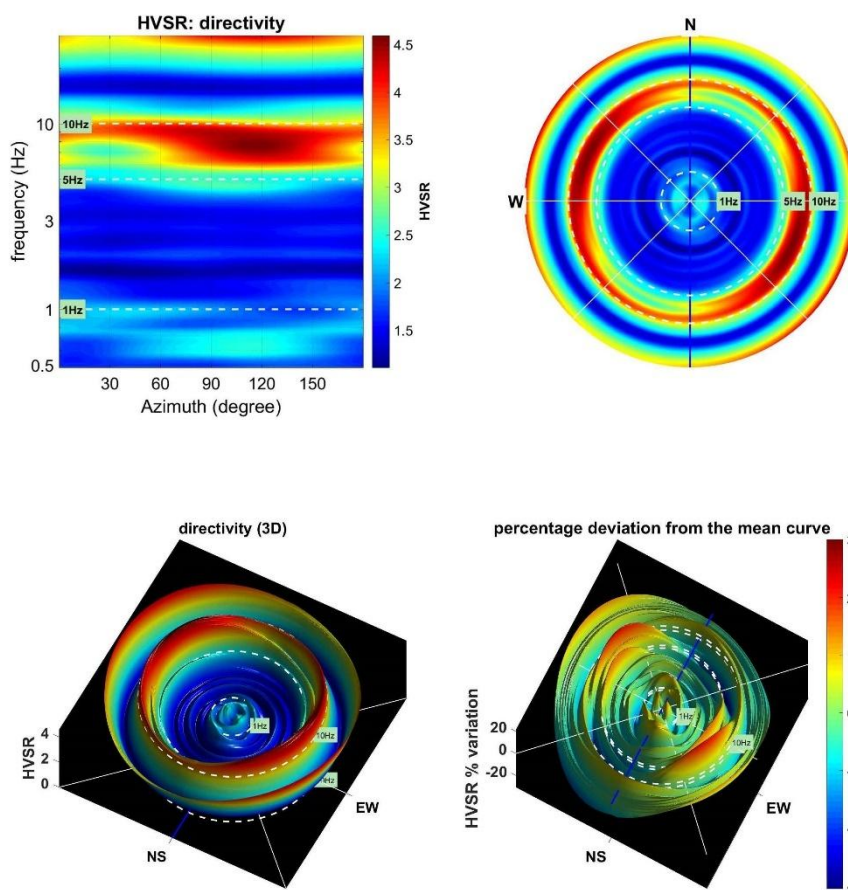


Continuity (Persistence) of the H/V Spectral Ratio





Directivity of the H/V Spectral Ratio



winMASW & HoliSurface - Surface Waves and Beyond

1.5. INDAGINE HVSR_5

winMASW & HoliSurface: Horizontal-to-Vertical Spectral Ratio

Dataset: 2023-11-17_15-14HVSR10ViadanicaD.seg2

DATA ACQUISITION

Date and time:

DATA PROCESSING

Date: 22 11 2023

Time: 14 40

Sampling frequency (Hz): 64

Window length (sec): 20

HVSR computation: quadratic mean

Minimum frequency soundly determined [10 cycles]: 0.5Hz

Length of analysed dataset (min): 10.0

Tapering (%): 5

Smoothing (%): 15

SESAME criteria

In the following the results considering the data in the 5.0-20.0Hz frequency range

Peak frequency (Hz): 13.6 (±1.8)

Peak HVSR value: 1.5 (±0.3)

==== Criteria for a reliable H/V curve =====

#1. $[f_0 > 10/L_w]$: 13.632 > 0.5 (OK)

#2. $[n_c > 200]$: 10633 > 200 (OK)

#3. $[f_0 > 0.5\text{Hz}; \sigma_A(f) < 2 \text{ for } 0.5f_0 < f < 2f_0]$ (OK)

==== Criteria for a clear H/V peak (at least 5 should be fulfilled) =====

#1. $[\text{exists } f^- \text{ in the range } [f_0/4, f_0] \mid A_H/V(f^-) < A_0/2]$: yes, at frequency 3.4Hz (OK)

#2. $[\text{exists } f^+ \text{ in the range } [f_0, 4f_0] \mid A_H/V(f^+) < A_0/2]$: yes, at frequency 18.3Hz (OK)

#3. $[A_0 > 2]$: 1.5 < 2 (NO)

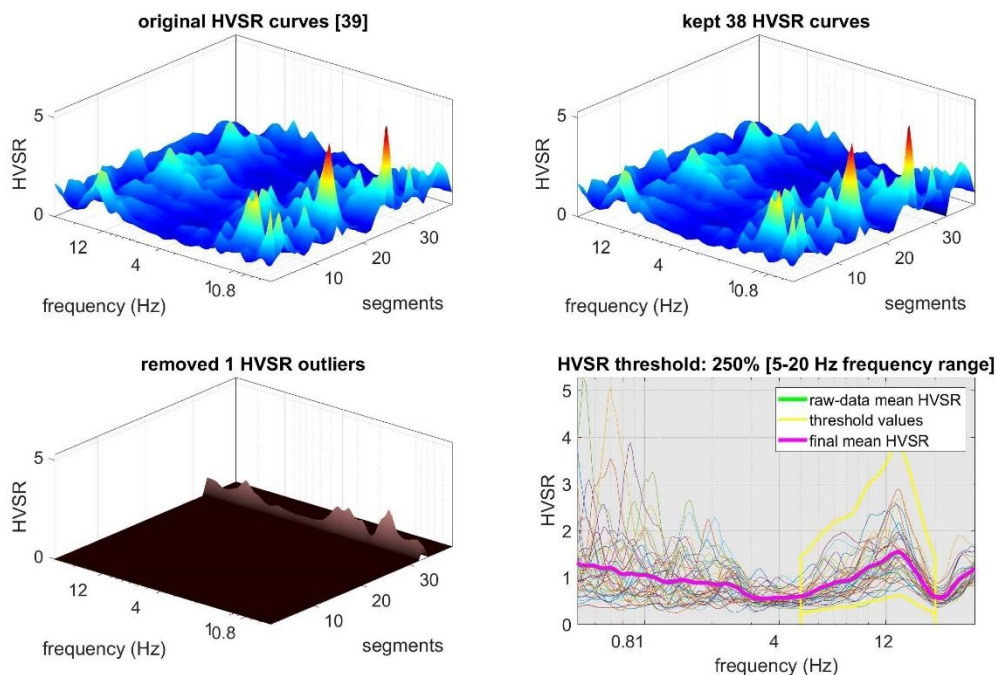
#4. $[f_{\text{peak}}[A_H/V(f) \pm \sigma_A(f)] = f_0 \pm 5\%]$: (OK)

#5. $[\sigma_A(f) < \epsilon(f)]$: 1.824 > 0.682 (NO)

#6. $[\sigma_A(f_0) < \theta(f_0)]$: 0.304 < 1.58 (OK)

Please, be aware of possible industrial/man-induced peaks or spurious peaks due to meaningless numerical instabilities.

Remember that SESAME criteria should be considered in a flexible perspective and that if you modify the processing parameters the results may change.



show current data reset

step#1 (optional) - decimate

F4 file new frequency resample

step#2 - HV computation

remove events (x: Pos. A Tr.) clean axes

20 window length (s)

5 tapering (%)

7 amplitude threshold

250 HVSR threshold

10% spectral smoothing (triangular window)

6 detrending order

HOL 3C-2 Hz

test removal

build output

prelude motions, all HVSRs, time series values

close windows

save videos

quadratic mser

compute

continuity

show 3D motion

directivity analysis

required axes or highlight

compute

save-option#1: save HVSR as it is

save HV from 0.5 to 30 Hz

save HV curve (as file)

picking HV or amplitude spectra

HVSR

pick data

save picked HV

compute

quick analysis (F=Vs/4H)

average Vs (m/s)

from surface to bedrock

20

depth of the bedrock (m)

1000

Vs of the bedrock

compute

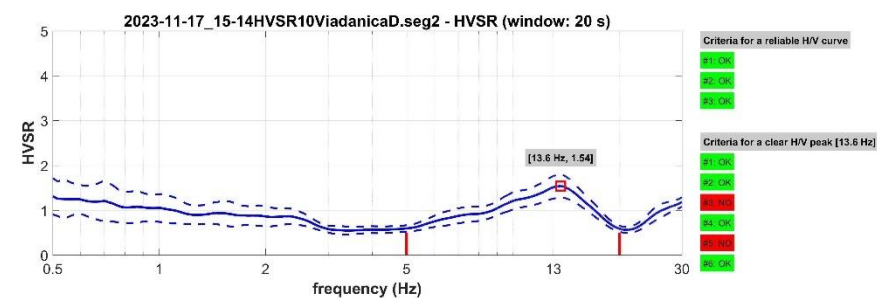
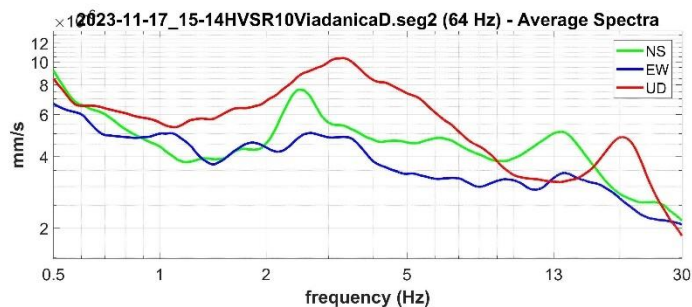
highlight a frequency

drawn highlight 10 Hz

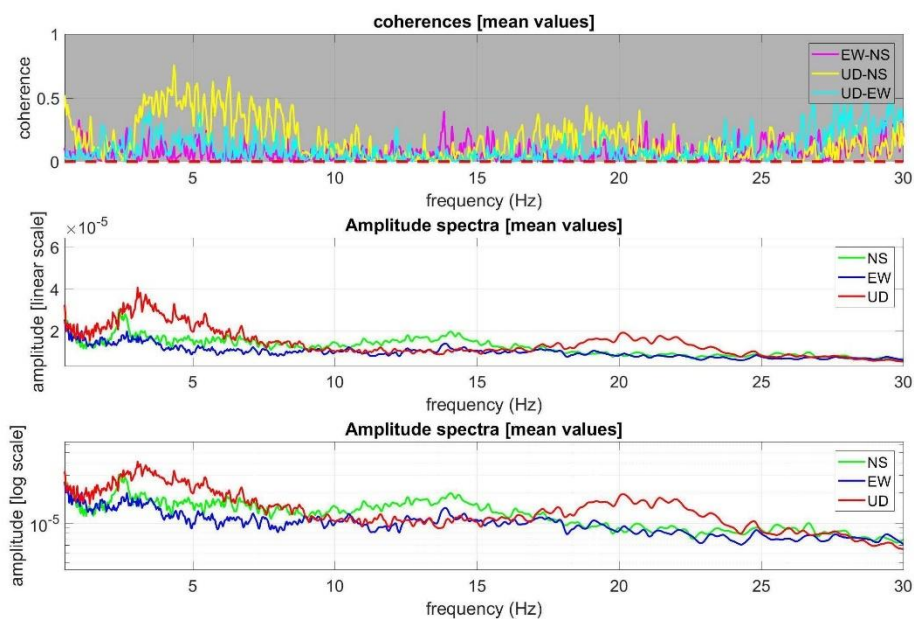
upload HVSR curve

directivity over time

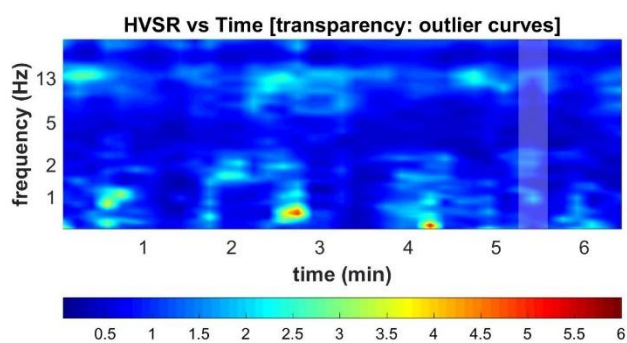
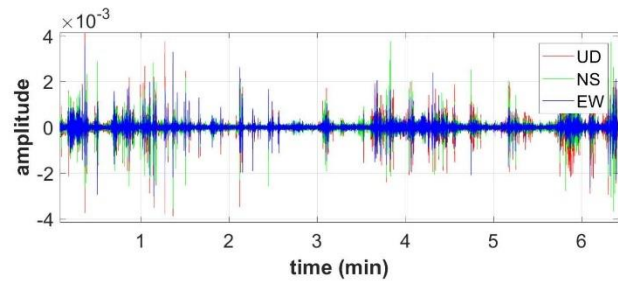
directivity to time time 10 s

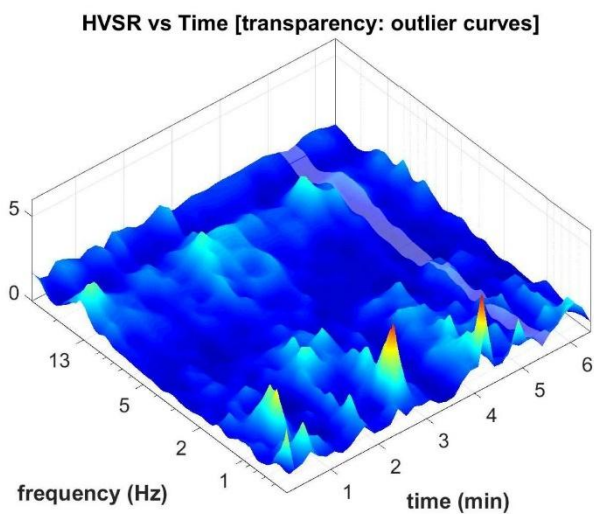


To model the HVSR (also jointly with MASW or ReMi/ESAC data), go to the "Velocity Spectrum/a. Modeling & Picking" panels and upload the saved HV curve

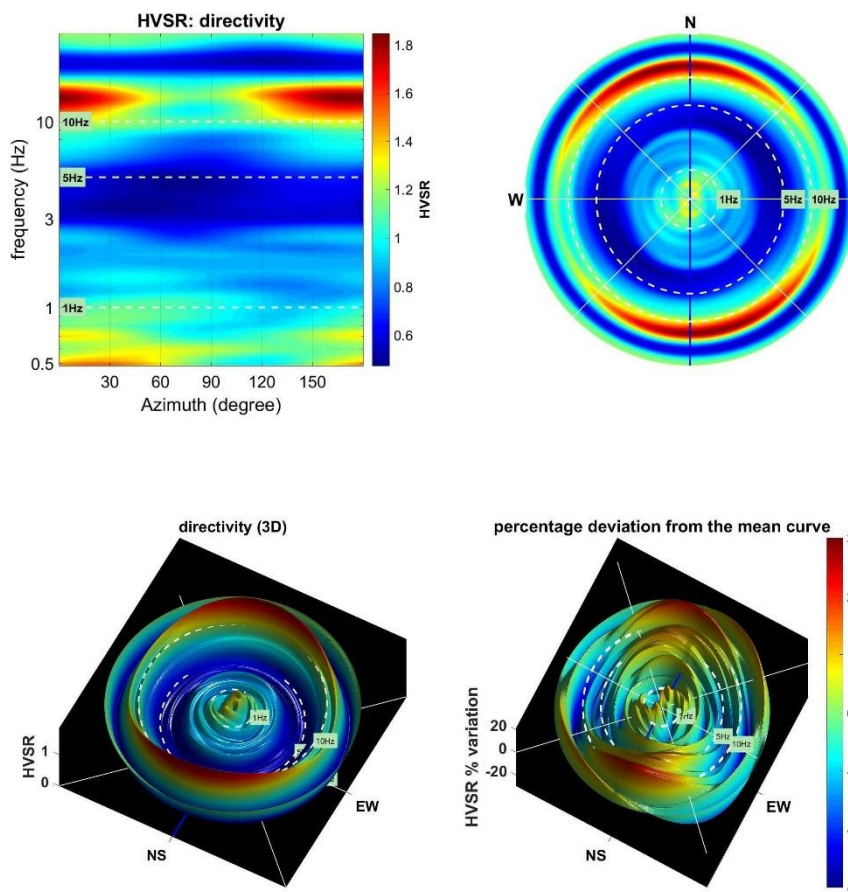


Continuity (Persistence) of the H/V Spectral Ratio





Directivity of the H/V Spectral Ratio



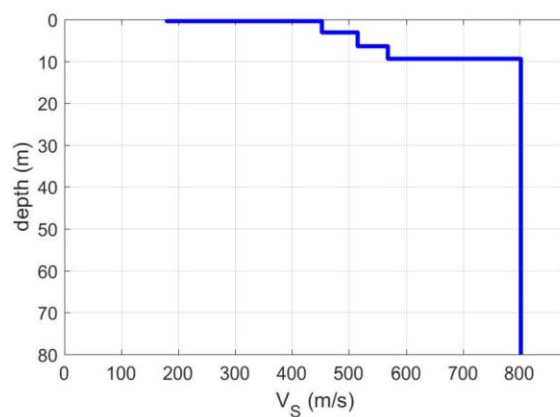
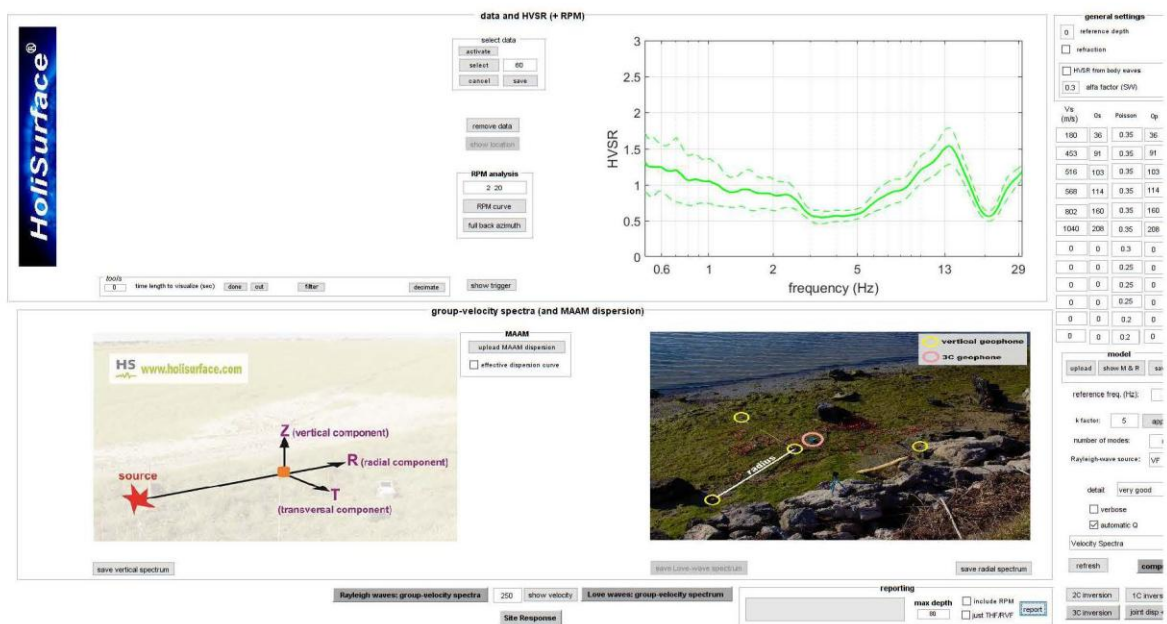
winMASW & HoliSurface - Surface Waves and Beyond

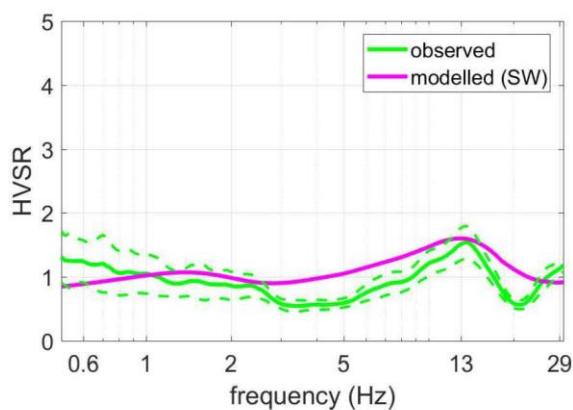
HoliSurface - Holistic Analysis of Surface Waves

www.holisurface.com

Date: 22 11 2023

Time: 15 6





Vs (m/s): 180.00 453.00 516.00 568.00 802.00 1040.00

thickness (m): 0.40 2.70 3.30 3.00 110.00

Shear modulus (MPa) (approximate values): 59 423 558 684 1425 2473

Vs30 and VsE (m/s): 659 473

Vs model (Vs30 & VsE @ surface: 659 473 m/s)

layer	Vs (m/s)	thickness (m)	depth (m)
1	180	0.4000	0.4000
2	453	2.7000	3.1000
3	516	3.3000	6.4000
4	568	3	9.4000
5	802	110	119.4000
6	1040	0	0

Pay attention

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B - Rocce tenere e depositi di terreni a grana grossa molto addensati o terreni a grana fina molto consistenti, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 360 m/s e 800 m/s.

C - Depositi di terreni a grana grossa mediamente addensati o terreni a grana fina mediamente consistenti con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 180 m/s e 360 m/s.

D - Depositi di terreni a grana grossa scarsamente addensati o di terreni a grana fina scarsamente consistenti, con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 100 e 180 m/s.

E - Terreni con caratteristiche e valori di velocità equivalente riconducibili a quelle definite per le categorie C o D, con profondità del substrato non superiore a 30 m.

Per qualsiasi condizione di sottosuolo non classificabile nelle categorie precedenti, è necessario predisporre specifiche analisi di risposta locale per la definizione delle azioni sismiche.

References

HoliSurface and MAAM

On the efficient acquisition and holistic analysis of Rayleigh waves: Technical aspects and two comparative case studies (Dal Moro G., Al-Arifi N., Moustafa S., 2019). *Soil Dynamics and Earthquake Engineering*, 125. On-line: <https://www.sciencedirect.com/science/article/pii/S0267726118310613>

Effective Active and Passive Seismics for the Characterization of Urban and Remote Areas: Four Channels for Seven Objective Functions (Dal Moro G., 2019). *Pure and Applied Geophysics*, 176, 1445-1465. Available on-line: <https://rdcu.be/bbT04>

Improved Holistic Analysis of Rayleigh Waves for Single- and Multi-Offset Data: Joint Inversion of Rayleigh-wave Particle Motion and Vertical- and Radial-Component Velocity Spectra (Dal Moro G., Al-Arifi N., Moustafa S.R., 2017), *Pure and Applied Geophysics*, on-line: <https://link.springer.com/content/pdf/10.1007%2Fs00024-017-1694-8.pdf>

Single- and multi-component inversion of surface waves acquired by a single 3-component geophone: an illustrative case study (Dal Moro G. and Puzzilli L.M.), *Acta Geodyn. Geomater.*, 14, 4 (188), 431-444, online: https://www.irms.cas.cz/materialy/acta_content/2017_doi/DalMoro_AGG_2017_0024.pdf

Analysis of Rayleigh-Wave Particle Motion from Active Seismics (Dal Moro G., Al-Arifi N., Moustafa S.R., 2017) *Bulletin of the Seismological Society of America (BSSA)*, 107, 51-62

Shear-wave velocity profiling according to three alternative approaches: a comparative case study (Dal Moro G., Keller L., Al-Arifi N., Moustafa S.R., 2016), *Journal of Applied Geophysics*, 134, 112-124

Four Geophones for seven possible objective functions: active and passive seismics for tricky areas (Dal Moro G.) Invited presentation and Extended Abstract for the Urban Geophysics workshop of the 22nd EAGE Near Surface Geoscience conference (4-8 September 2016 - Barcelona, Spain)

Less is more: from van der Rohe to the 4-channel system for the efficient and holistic acquisition and analysis of surface waves. An urban case study. (Dal Moro G., Moustafa S.R., Al-Arifi N., 2015). *Proceedings of the GNGTS (Gruppo Nazionale Geofisica della Terra Solida - ogs.trieste.it) congress (17-19 November 2015 - Trieste, Italy)*

Geophysikalische In-situ-Bestimmung der Eingangsparameter in die seismischen Standortanalysen am Beispiel des Ambassador House Opfikon (Keller L., Weber T., Dal Moro G., 2015). *Proceedings of the 14th D-A-CH conference of the Swiss Society for Earthquake Engineering and Structural Dynamics*, Zurich, August 21-21, SIA D0255, ISBN 978-3-03732-060-0

A Comprehensive Seismic Characterization via Multi-Component Analysis of Active and Passive Data (Dal Moro G., Keller L., Poggi V., 2015), *First Break*, 33, 45-53

Efficient acquisition and holistic analysis of Rayleigh waves (Dal Moro G., Moustafa S.R., Al-Arifi N.), *Proceedings of the Near-Surface EAGE 2015 congress (Turin - Italy)* [having received a very high score from the reviewers, the work was invited to be published in *Near Surface Geophysics*]

Joint Inversion of Rayleigh-Wave Dispersion and HVSr of Lunar Seismic Data from the Apollo 14 and 16 sites (Dal Moro G., 2015), *ICARUS*, 254, 338-349

Unconventional Optimized Surface Wave Acquisition and Analysis: Comparative Tests in a Perilagoon Area (Dal Moro G., Ponta R., Mauro R., 2015), *Appl. Geophysics*, 114, 158-167

Surface Wave Analysis for Near Surface Applications (Dal Moro G., 2014), Elsevier, ISBN 978-0-12-800770-9, 252pp (theory, field practice and advanced joint analysis) [see in particular paragraphs 2.2, 7.2 and case studies #2, 6, 8, 12 and 14]

GHM method [building vibration modes]

Gaussian-filtered Horizontal Motion (GHM) plots of non-synchronous ambient microtremors for the identification of flexural and torsional modes of a building (Dal Moro G., Weber T., Keller L., 2018). *Soil Dynamics and Earthquake Engineering*, 112, 243-255

Influenza della modellazione degli edifici sulla determinazione della loro vulnerabilità sismica (Sancin L., Dal Moro G., Amadio C., Romanelli F.,

2. INDAGINI SISMICHE MASW

2.1. INDAGINE MASW_1

winMASW - Joint Analysis of Rayleigh & Love-Wave Dispersion

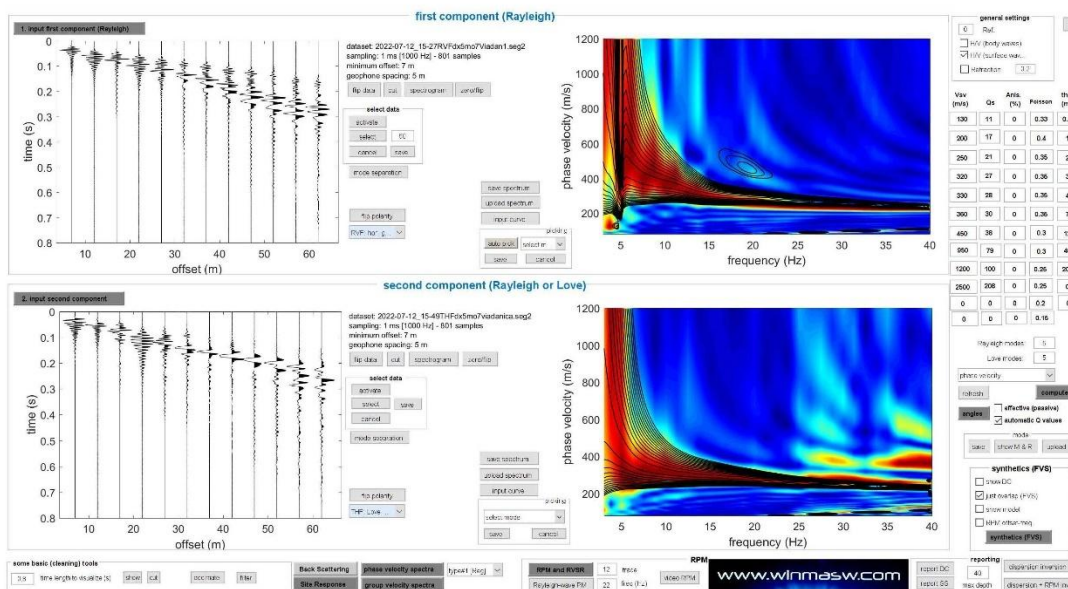
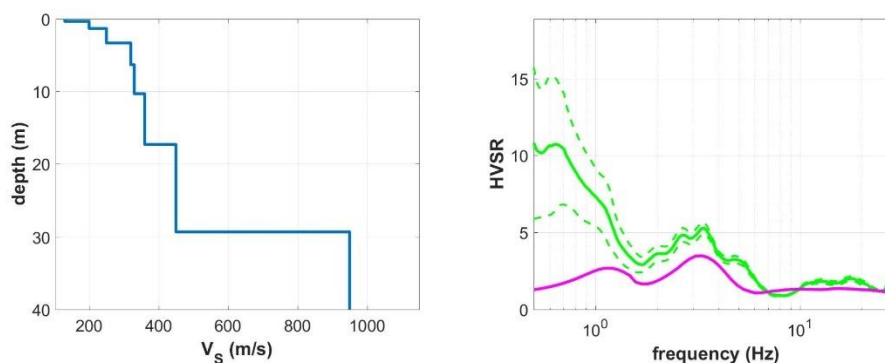
www.winmasw.com

Date: 13 7 2022

Time: 11 12

Rayleigh dataset: 2022-07-12_15-27RVFdx5mo7Viadan1.seg2

Love dataset: 2022-07-12_15-49THFdx5mo7viadanica.seg2



Retrieved model

Vsv (m/s): 130 200 250 320 330 360 450 950 1200 2500

Vsh (m/s): 130 200 250 320 330 360 450 950 1200 2500

Thickness (m): 0.3 1.0 2.0 3.0 4.0 7.0 12.0 40.0 200.0

Model

layer	Vs (m/s)	thickness (m)	depth (m)
1	130	0.3000	0.3000
2	200	1	1.3000
3	250	2	3.3000
4	320	3	6.3000
5	330	4	10.3000
6	360	7	17.3000
7	450	12	29.3000
8	950	40	69.3000
9	1200	200	269.3000
10	2500	0	0

Density (gr/cm3): 1.72 1.84 1.90 1.97 1.97 2.00 2.06 2.26 2.33 2.53

Seismic/Dynamic Shear modulus (MPa) (approximate values): 29 74 119 201 215 259 417 2041 3349 15797

Estimated static shear modulus (MPa): 0 0 0 0 0 0 0 1296 3909

Approximate values for Vp and elastic moduli (please, see manual)

Vp (m/s): 258 490 520 666 687 749 842 1777 2078 4330

Poisson: 0.33 0.40 0.35 0.35 0.35 0.35 0.30 0.30 0.25 0.25

Vs30 and VsE (m/s): 359 353

Pay attention

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B - Rocce tenere e depositi di terreni a grana grossa molto addensati o terreni a grana fina molto consistenti, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 360 m/s e 800 m/s.

C - Depositì di terreni a grana grossa mediamente addensati o terreni a grana fina mediamente consistenti con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 180 m/s e 360 m/s.

D - Depositì di terreni a grana grossa scarsamente addensati o di terreni a grana fina scarsamente consistenti, con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 100 e 180 m/s.

E - Terreni con caratteristiche e valori di velocità equivalente riconducibili a quelle definite per le categorie C o D, con profondità del substrato non superiore a 30 m.

Per qualsiasi condizione di sottosuolo non classificabile nelle categorie precedenti, è necessario predisporre specifiche analisi di risposta locale per la definizione delle azioni sismiche.

2.2. INDAGINE MASW_2

winMASW - Joint Analysis of Rayleigh & Love-Wave Dispersion

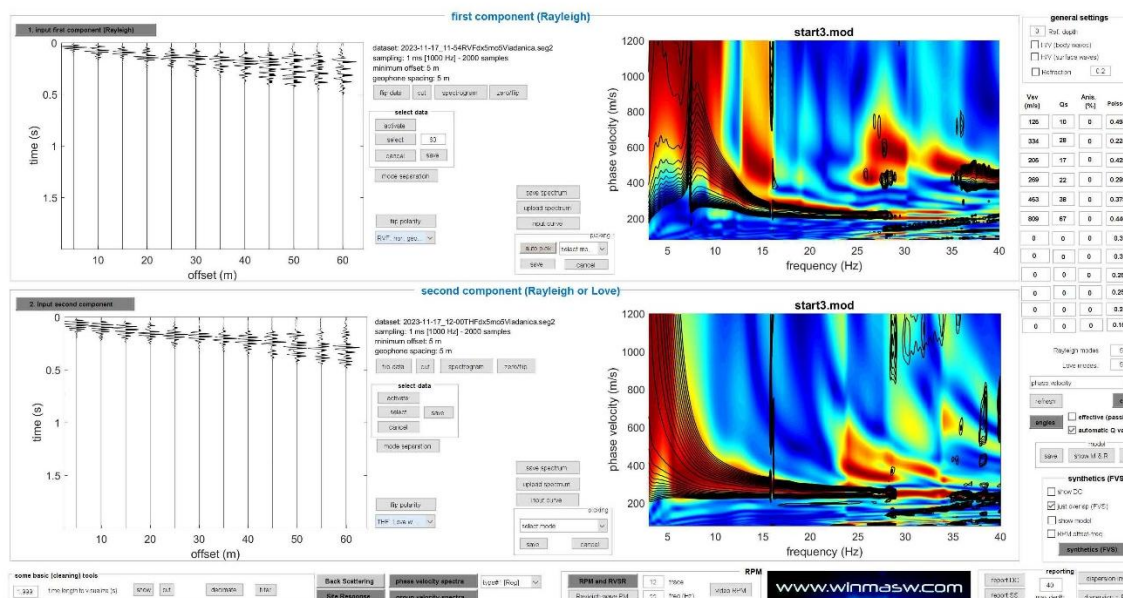
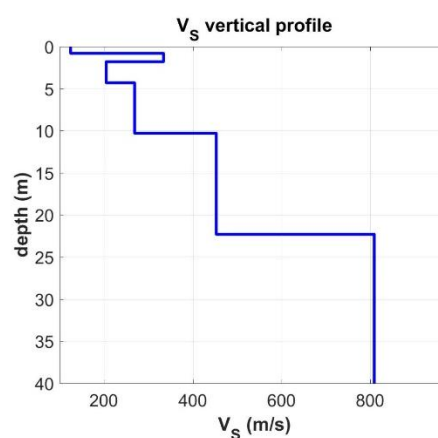
www.winmasw.com

Date: 20 11 2023

Time: 12 17

Rayleigh dataset: 2023-11-17_11-54RVFdx5mo5Viadanica.seg2

Love dataset: 2023-11-17_12-00THFdx5mo5Viadanica.seg2



Retrieved model

Vsv (m/s): 125 334 205 269 453 809

Vsh (m/s): 125 334 205 269 453 809

Thickness (m): 0.8 1.0 2.5 6.0 12.0

Model

layer	Vs (m/s)	thickness (m)	depth (m)
1	125	0.8000	0.8000
2	334	1	1.8000
3	205	2.5000	4.3000
4	269	6	10.3000
5	453	12	22.3000
6	809	0	0

Density (gr/cm3): 1.71 1.98 1.84 1.92 2.06 2.22

Seismic/Dynamic Shear modulus (MPa) (approximate values): 27 221 78 139 423 1452

Estimated static shear modulus (MPa): 0 0 0 0 0 0

Approximate values for Vp and elastic moduli (please, see manual)

Vp (m/s): 1184 560 577 502 1022 2597

Poisson: 0.49 0.22 0.43 0.30 0.38 0.45

Vs30 and VsE (m/s): 375 317

Pay attention

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B - Rocce tenere e depositi di terreni a grana grossa molto addensati o terreni a grana fina molto consistenti, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 360 m/s e 800 m/s.

C - Depositati di terreni a grana grossa mediamente addensati o terreni a grana fina mediamente consistenti con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 180 m/s e 360 m/s.

D - Depositati di terreni a grana grossa scarsamente addensati o di terreni a grana fina scarsamente consistenti, con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 100 e 180 m/s.

E - Terreni con caratteristiche e valori di velocità equivalente riconducibili a quelle definite per le categorie C o D, con profondità del substrato non superiore a 30 m.

Per qualsiasi condizione di sottosuolo non classificabile nelle categorie precedenti, è necessario predisporre specifiche analisi di risposta locale per la definizione delle azioni sismiche.

winMASW - Surface Waves & Beyond

www.winmasw.com

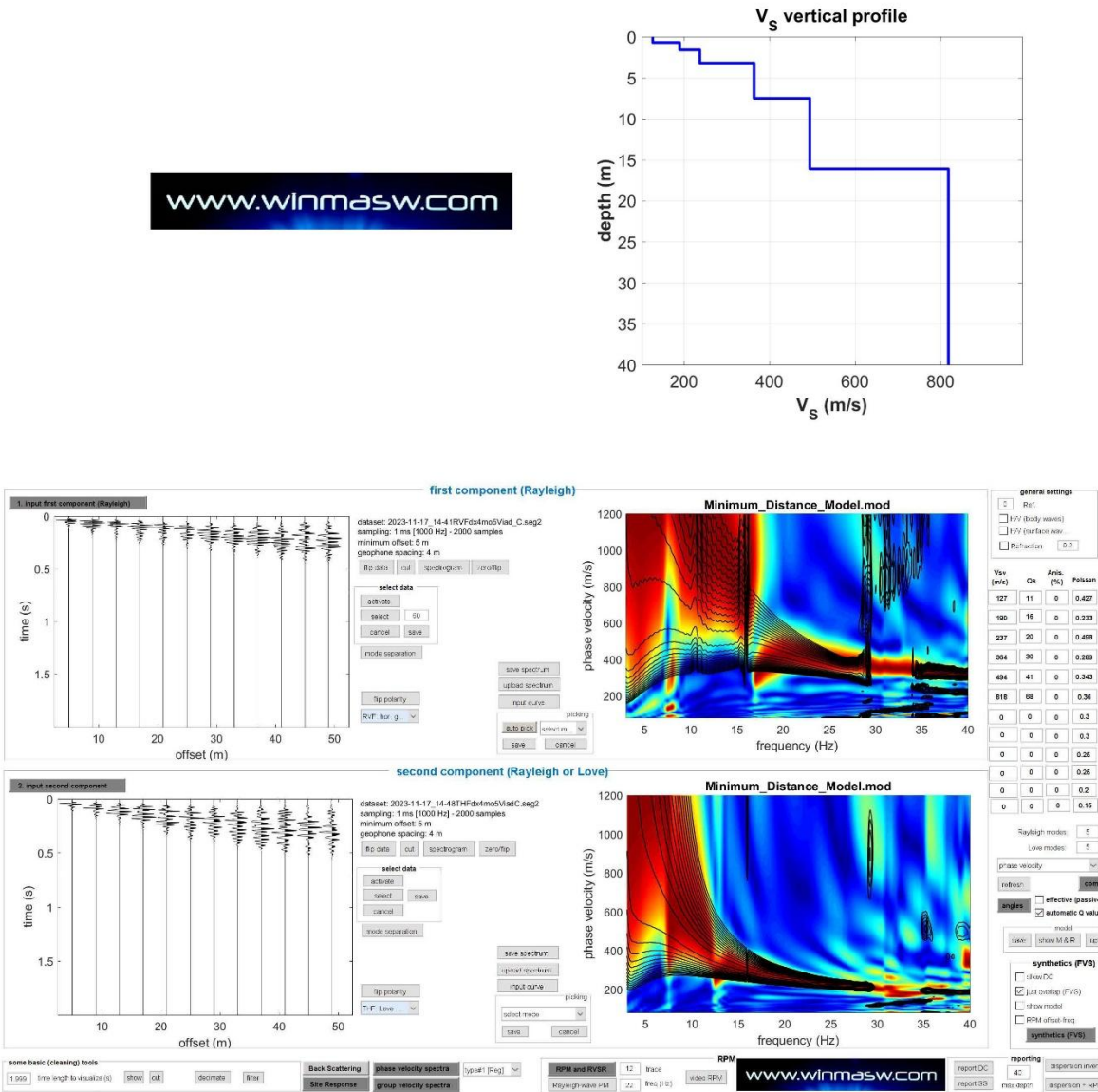
2.3. INDAGINE MASW_3

winMASW - Joint Analysis of Rayleigh & Love-Wave Dispersion

www.winmasw.com

Date: 22 11 2023
Time: 10 14

Rayleigh dataset: 2023-11-17_14-41RVFdx4mo5Viad_C.seg2
Love dataset: 2023-11-17_14-48THFdx4mo5ViadC.seg2



Retrieved model

V_{sv} (m/s): 127 190 237 364 494 818

V_{sh} (m/s): 127 190 237 364 494 818

Thickness (m): 0.7 0.9 1.6 4.3 8.6

Model

layer	Vs (m/s)	thickness (m)	depth (m)
1	127	0.7000	0.7000
2	190	0.9000	1.6000
3	237	1.6000	3.2000
4	364	4.3000	7.5000
5	494	8.6000	16.1000
6	818	0	0

Density (gr/cm³): 1.72 1.82 1.88 2.00 2.08 2.22

Seismic/Dynamic Shear modulus (MPa) (approximate values): 28 66 106 265 508 1486

Estimated static shear modulus (MPa): 0 0 0 0 0 0

Approximate values for V_p and elastic moduli (please, see manual).

V_p (m/s): 356 322 3761 668 1010 1750

Poisson: 0.43 0.23 0.50 0.29 0.34 0.36

V_{s30} and V_{sE} (m/s): 475 348

Pay attention

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B - Rocce tenere e depositi di terreni a grana grossa molto addensati o terreni a grana fina molto consistenti, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 360 m/s e 800 m/s.

C - Depositati di terreni a grana grossa mediamente addensati o terreni a grana fina mediamente consistenti con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 180 m/s e 360 m/s.

D - Depositati di terreni a grana grossa scarsamente addensati o di terreni a grana fina scarsamente consistenti, con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 100 e 180

m/s.

E - Terreni con caratteristiche e valori di velocità equivalente riconducibili a quelle definite per le categorie C o D, con profondità del substrato non superiore a 30 m.

Per qualsiasi condizione di sottosuolo non classificabile nelle categorie precedenti, è necessario predisporre specifiche analisi di risposta locale per la definizione delle azioni sismiche.

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www.winmasw.com