SERA
Seismology and Earthquake Engineering
Research Infrastructure Alliance for Europe

DELIVERABLE

D7.3 European strong ground motion characterization road map

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Table of Contents

Summary

This deliverable is written within the framework of the project "Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe – SERA" (Project no: 730900), funded by the Horison2020, INFRAIA-01-2016-2017 Programme. Main objective of this deliverable it to evaluate the needs of the seismological community (network operators and end-users) in terms of site characterization within the next years for the European seismological stations. First, this document describes the available site characterization information at permanent strong motion stations in Europe. Second, the needs of the community have been evaluated trough questionnaires sent to network operators and end-users. The results of these questionnaires have been presented in l'Aquila March 11-12, 2019, https://sites.google.com/view/site-characterization-workshop/home). These questionnaires have contributed to identifying the priorities and also the key issues in terms of site characterization information at European strong motion sites: i) about 600 seismic stations will be characterized in the next ten years with a common agreement to focus on stations having the largest number of earthquake recordings, (ii) development of standard dissemination site characterization tools to be implemented at national levels interoperable with European databases is definitely required to allow site characterization dissemination following the FAIR principles, (iii) setting up of quality indicator that also include standard deviation of individual site proxies, (iv) increase the awareness of station characterization for broad band network operators.

1 Introduction

Site characterization is a key input in seismic hazard and risk assessment, e.g. for deriving reference rock/soil velocity profiles for region-specific GMPEs, site-specific hazard assessment, V_S-kappa adjustments, seismic response of engineering infrastructures, risk modeling at urban or regional scale. Although the number of strong-motion stations in free-field and engineered structures has largely increased in Europe over the last twenty years, only a couple of hundreds includes site condition indicators: mostly geology and EC8 soil class, more rarely Vs30 and Vs profiles, without any quality assessment in most cases.

In the last years, several efforts have been carried out at national levels to perform site characterization (e.g. Sandikkaya et al., 2010; Michel et al., 2014; Stewart et al., 2014; Albarello et al., 2016; Felicetta et al., 2017; Hollender et al., 2018) and at European level, within EU projects (NERIES, NERA, SERA, EPOS) to disseminate site characterization information at permanent and temporary seismological stations (Earthquake Strong Motion database (ESM, https://esm.mi.ingv.it/); Luzi et al., 2016; ORFEUS station book (http://orfeus-eu.org/stationbook/); European Geotechnical Database (EGD, http://egd-epos.civil.auth.gr/).

Within this context, the 2017-2020 activities of the "Networking databases of site and station characterization" (WP7-NA5 of the SERA "Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe" Horizon 2020 Project) aim at proposing a reliable and efficient European framework for site characterization, in close connection with actual and future requirements of seismic hazard and risk stakeholders. More specifically, the Task 7.2 ("Road map for strong motion site characterization in Europe") aims to review the existing site characterization information in Europe

and to list the priorities in terms of site characterization needs for the future that fulfil both network operators and end-users needs.

After describing the available site characterization information at permanent strong motion stations in Europe, network operators and end-users from the seismological and engineering communities have been surveyed in order to get feedback regarding the available site characterization, their plans and/or needs for site characterization in the next ten years. The results of these questionnaires have been presented during the l'Aquila workshop (March 11-12, 2019, https://sites.google.com/view/site-characterization-workshop/home). These questionnaires and the community workshop have contributed to identifying the priorities and also the key issues in terms of site characterization information at European strong motion sites.

2 Available site characterization information at European permanent strong motion sites

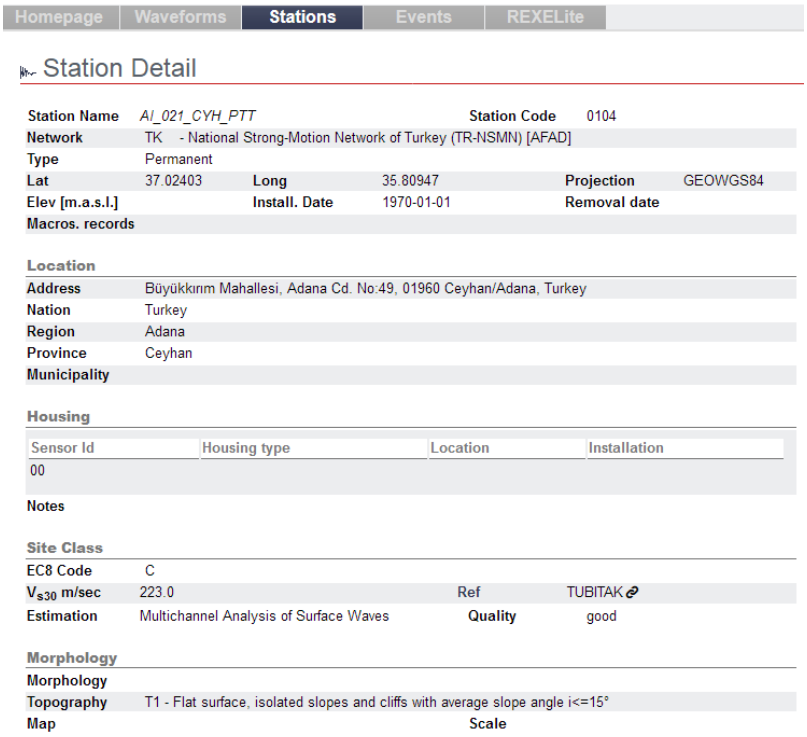
Most of the information on site characterization at strong motion stations in Europe can be found in the European Strong Motion database (ESM; https://esm.mi.ingv.it). When site characterization information is available, ESM reports a synthetic page with details on station settings, EC8 soil class, V_{s30} and related method of estimation and reference paper and morphology (Figure 1). A site monography is also provided with details on some indicators (geological map, V_s profile, SPT profile, resonance frequency, etc.) and, at few sites, a report describing in details site characterization data and processing is available. In addition, the European Geotechnical Database (EGD, http://egd-epos.civil.auth.gr/), under development within EPOS, provides also some site characterization (V_{s30}, resonance frequency, V_s profiles, etc.) at some sites.

At national level, only very few strong motion permanent networks make available site characterization information in terms of EC8 site class and/or more advanced site characterization indicators (V_{s30}, P- and S- waves velocity profiles, resonance frequency, N-SPT profiles, etc.). Among these very few strong motion networks, site characterization information with available very detailed reports describing data acquisition, processing methods and interpretation can be found for Switzerland http://stations.seismo.ethz.chl; Italy http://itaca.mi.ingv.it; Turkey http://kyhdata.deprem.gov.tr).

Since most of the strong motion networks contribute to ESM, we have analysed in the following, the ESM flat file 2018 (https://esm.mi.ingv.it//flatfile-2018/) in order to derive quantitative information about available site characterization indicators.

In total, ESM does provide strong motion recordings for 2071 permanent network seismological stations. Among this total number, EC8 soil class is available at 1455 stations (i.e. 70% of the total number of stations), but measured V_{s30} is available at 469 sites only (i.e. 22% of the total number of stations) (Figure 2). For each EC8 soil class, Table 1 provides the distribution of soil class estimated from measured V_{s30} or inferred from geology. One can easily recognized that most of the site class A sites have been inferred from geology. As regards the method to measure V_{s30}, about 75% of estimates are

from non-invasive surface wave methods (active and/or passive surface wave methods) and 25% from invasive methods (down-hole, cross-hole) (Figure 3).



Homepage | Waveforms | **Stations** | Events | REXELite

Station Detail

Station Name	*AI_021_CYH_PTT*			**Station Code**	0104
Network	TK - National Strong-Motion Network of Turkey (TR-NSMN) [AFAD]				
Type	Permanent				
Lat	37.02403	**Long**	35.80947	**Projection**	GEOWGS84
Elev [m.a.s.l.]		**Install. Date**	1970-01-01	**Removal date**	
Macros. records					

Location

Address	Büyükkırım Mahallesi, Adana Cd. No:49, 01960 Ceyhan/Adana, Turkey
Nation	Turkey
Region	Adana
Province	Ceyhan
Municipality	

Housing

Sensor Id	Housing type	Location	Installation
00			

Notes

Site Class

EC8 Code	C		
V_{s30} m/sec	223.0	**Ref**	TUBITAK
Estimation	Multichannel Analysis of Surface Waves	**Quality**	good

Morphology

Morphology	
Topography	T1 - Flat surface, isolated slopes and cliffs with average slope angle i<=15°
Map	**Scale**

Figure 1. Example of site characterization summary information in the European Strong Motion database (ESM; https://esm.mi.ingv.it)

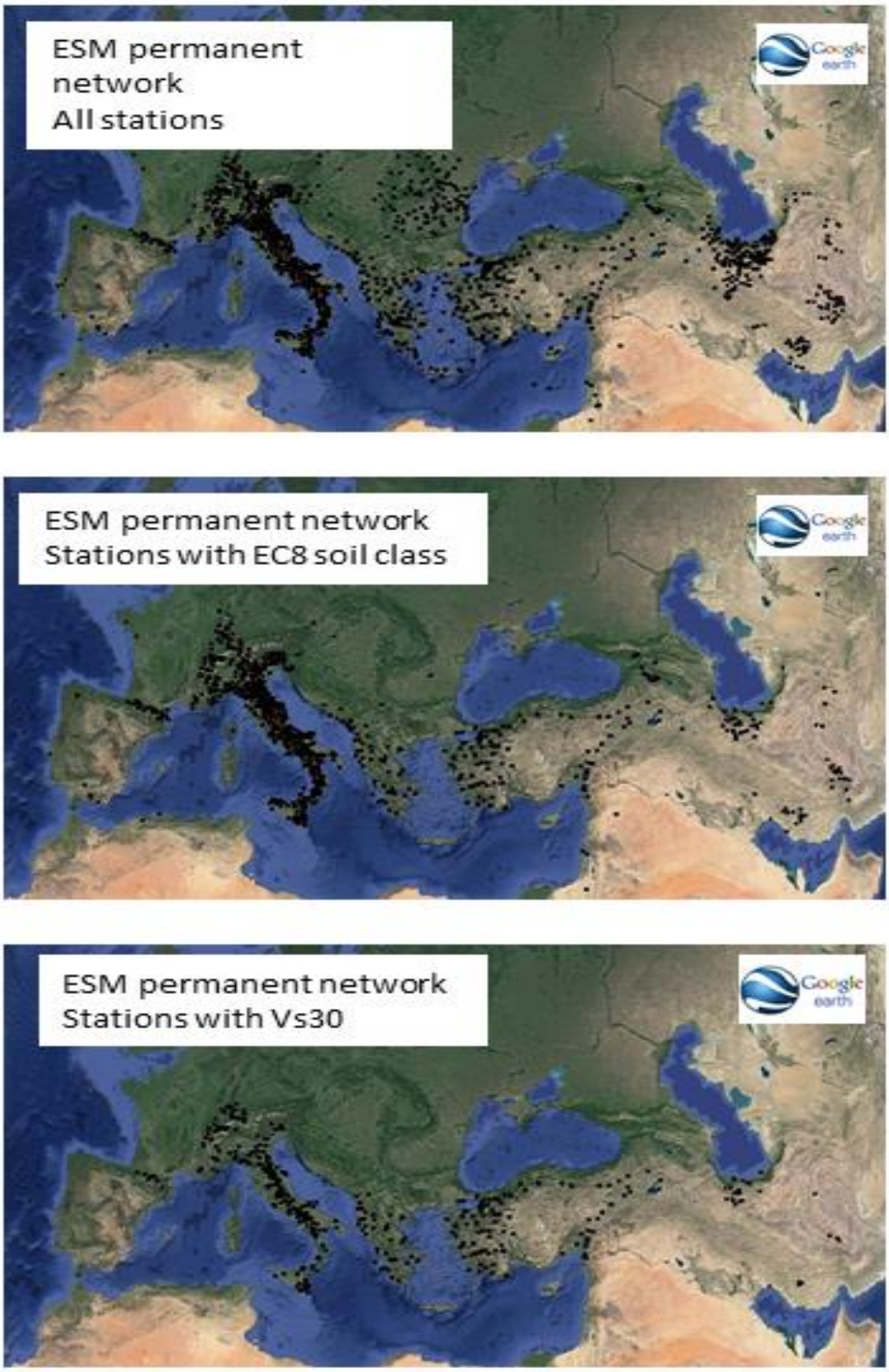


Figure 2. Location of permanent stations in the Earthquake Strong Motion (ESM) database: all stations (top panel); stations with EC8 soil class (middle panel); stations with V_{S30} (bottom panel)

Table 1. Distribution of EC8 soil classes in the ESM 2018 flat file.

EC8 soil class	A	B	C	D	E
From measured Vs30	74 *(23%)*	213 *(31%)*	158 *(38%)*	8 *(44%)*	16 *(84%)*
Inferred from geology only or geology and DEM (slope)	253 *(77%)*	466 *(69%)*	254 *(62%)*	10 *(56%)*	3 *(16%)*
Total number of stations in each class	327	679	412	18	19

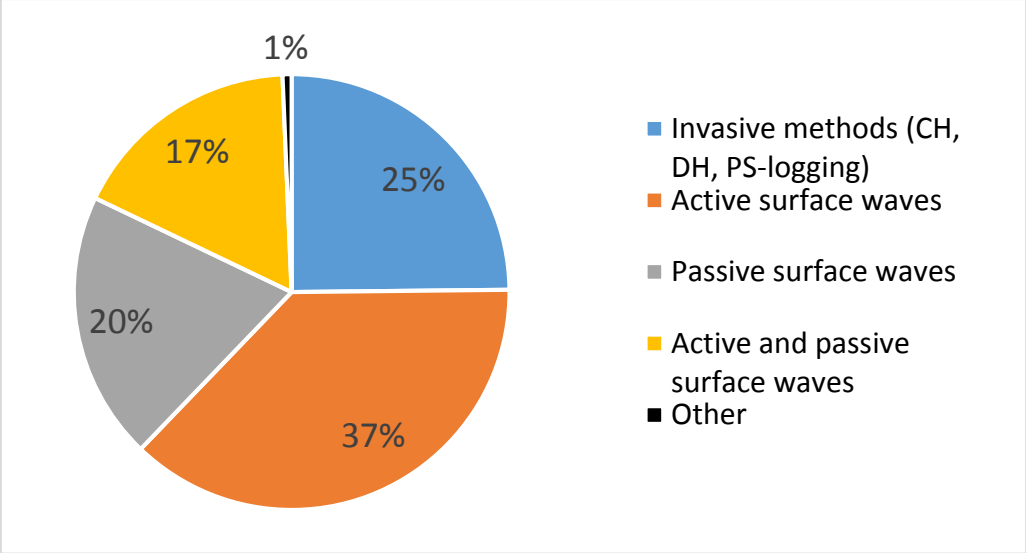


Figure 3. ESM Flat file 2018. Distribution of methods used to measure V_{s30}

3 Road map: lessons from questionnaires

In order to get feedback for both end users and network operators regarding the permanent seismic stations to be characterized in the future, we distributed two surveys: one targeting the seismological network operators and one targeting scientists using European strong ground motion data. In the following sections, we present the results of these two questionnaires.

3.1 Viewpoint of seismic networks

The main objectives of the questionnaire sent to the seismological network operators consisted in:

- mapping the existing site characterization information
- getting the objectives of the network operator in terms of site characterization within the next years
- identifying possible difficulties to perform site characterization and/or to disseminate the site characterization information

The questionnaire (see Appendix 1) was sent to strong motion, short period and broad-band network operators in 21 countries. The main difficulties getting back information is that head of seismic network

is not always aware of site characterization information for its own network, which most probably reflects either the lack of dedicated site characterization metadata attached to the waveform data, or the lack of awareness of the interest / need for such metadata. We got answers from 12 network operators, managing a total of 2340 seismic stations (see Table 1). In the following, results of this questionnaire are provided and synthetized.

Table 1. List of network operators that answered to the questionnaire

Institution / Observatory	Country	Type of network	Number of stations
RESIF / ISTerre	France	Strong ground motion network	160
Seismological Survey of Serbia	Serbia	Strong ground motion network - Broad band network - Short period network	37
ITSAK-EPPO	Greece	Strong ground motion network - Broad band network	250
Uppsala University	Sweden	Broad band network	68
Ataturk University	Turkey	Strong ground motion network - Broad band network	17
Instituto Português do Mar e da Atmosfera	Portugal	Strong ground motion network - Broad band network - Short period network	84
Slovenian Environment Agency	Slovenia	Strong ground motion network - Broad band network	26
Institut Cartogràfic i Geològic de Catalunya	Spain	Strong ground motion network - Broad band network	37
Boğaziçi University, Kandilli Observatory and Earthquake Research Institute	Turkey	Strong ground motion network	115
Royal Observatory of Belgium	Belgium	Strong ground motion network - Broad band network - Short period network	30
INGV	Italy	Strong ground motion network - Broad band network - Short period network	450
Swiss Seismological Service	Switzerland	Strong ground motion network - Broad band network - Short period network	170
AFAD	Turkey	Strong ground motion network - Broad band network	1056

3.1.1 Storage and dissemination of site characterization information

Although half of the site characterization information is stored in databases and a third through reports (Figure 4Figure 4), only a third of the information is available through institutional web page, while most of the available information (about two third) is reported as being available only upon request to specific scientists. This clearly illustrates the need for standard metadata format in order to reach long-term sustainability of information.

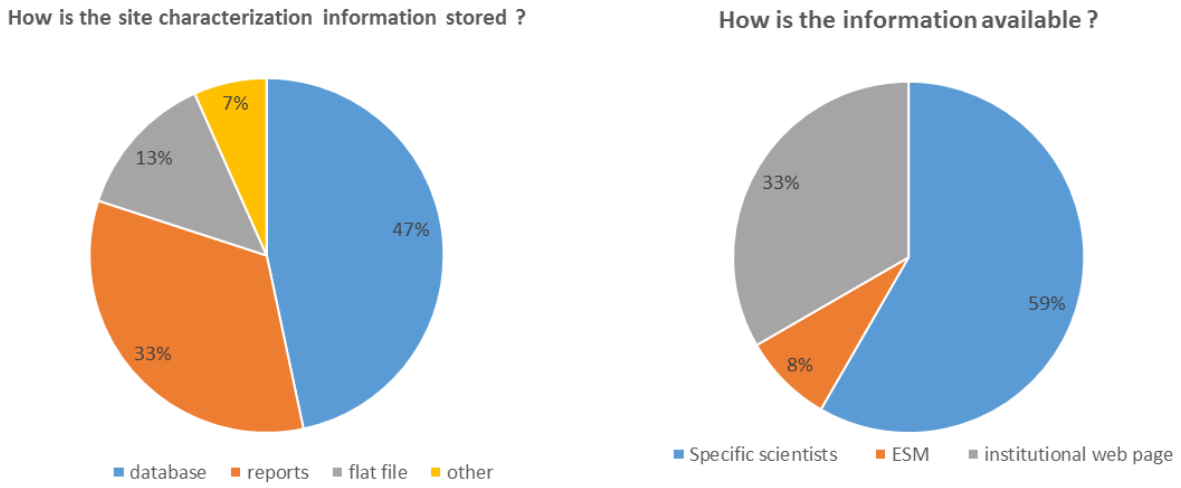


Figure 4. Storage (left panel) and dissemination (right panel) of site characterization information by network operators.

3.1.2 Content of site characterization information

Figure 5a shows the existing site characterization information. Most of the networks report the following indicators (Figure 5a, indicators available for at least 50% of the networks): surface geology, morphology/topography, building soil class, Vs30, engineering and seismological bedrock depths, V_S of the seismological bedrock, resonance frequency, V_S profile, H/V curve. However, when asking for the actual proportion of stations (binned in three groups: less than 10%, between 10 and 50% and at least 50% of the total number of stations) with such information, the most common available information at most of the seismological stations are clearly surface geology, morphology/topography, followed by seismological and engineering bedrock, V_{S30} and resonance frequency f_0 (Figure 5b). These answers are very consistent with site characterization information available in ESM Flat file 2018 (Table 1).

3.1.3 Site characterization objectives within the next years

To the question related to the objectives of the networks in terms of site characterization within the next 10 years, networks plan to perform site characterization at a total of about 630 stations (Table 2). In addition to retrieving basic information (EC8 soil class, V_{S30}), 70% of the networks plan to extract intermediate information (V_S profile, f_0) and 40% more detailed information ones (site amplification, attenuation, non-linear properties, etc.) (Table 2). Selection criteria to perform future measurements is varying depending on the network (Table 2). However, the main reported criteria are

- stations with already a large number of recordings,
- new seismic station
- on soft/urbanized sites.

Interestingly, site characterization at rock sites is not explicitly mentioned. Regarding the cost / site to perform site characterization, 40% of the network operators were not able to provide a value. For the remaining networks, reported cost is highly variable, from 1 o 17 keuros. Some costs appear extremely low, especially if networks want to extract intermediate and detailed indicators. After presentations of

the road map results in the SERA workshop in l'Aquila (March 11-12, 2019, https://sites.google.com/view/site-characterization-workshop/home), some network operators reported they did only consider the cost for doing field measurements, and thus did not account for a consolidated budget, which should also include salary of scientists (data acquisition and processing) and equipment depreciation. The two networks that reported cost larger than 10 keuros/site are those who are used to subcontract the data acquisition and/or the processing.

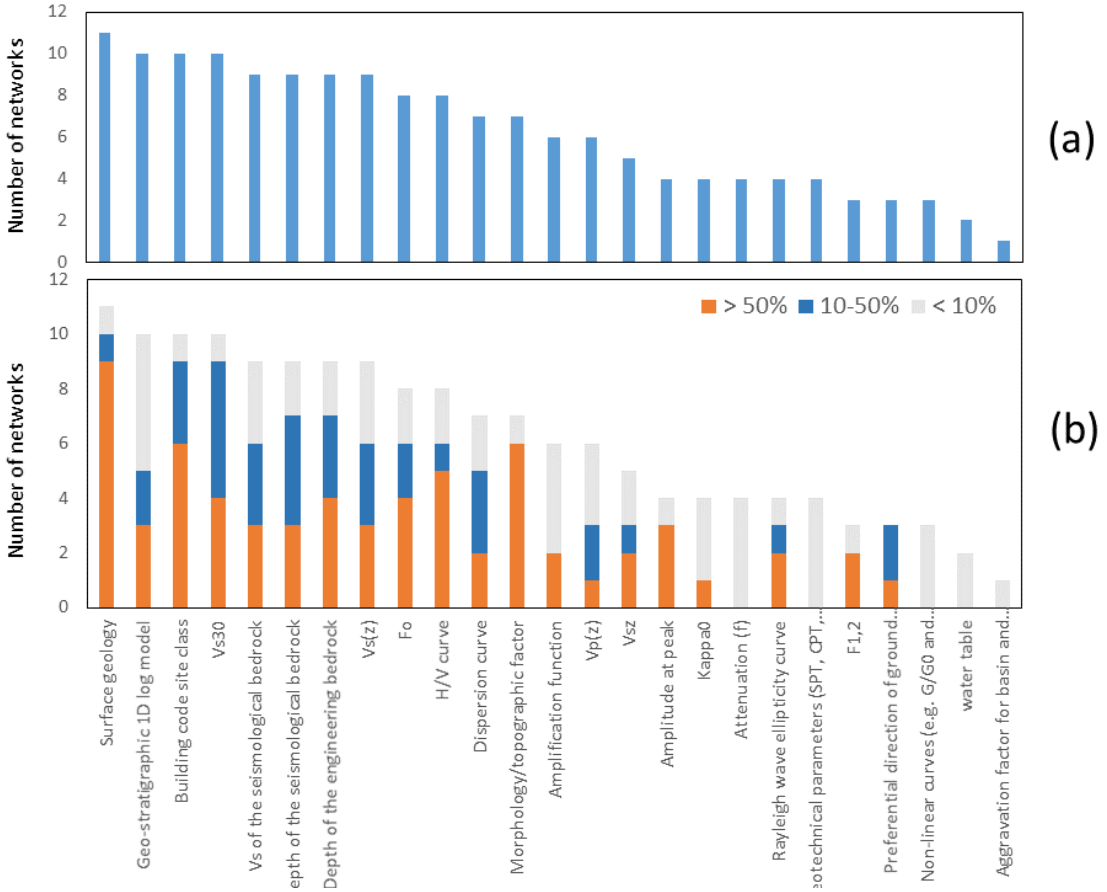


Figure 5. (a) Site characterization information available at seismological network; (b) Distribution of the information: less than 10%, between 10 and 50% and at least 50% of the total number of stations.

Table 2. Objectives of the network operators in terms of site characterization within the next ten years (number of stations, criteria and cost)

Network	How many stations do you plan to characterize within the next 10 years ?	What is your goal ?	What are your criteria for choosing the stations to be characterized in priority ?	What is the approximate cost/site ?
1	50	intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve)	1- number of earthquake records - 2- quality of the site installation, quality of the records - 3- accessibility of the site for characterization	10000 euros

2	20	simple building code indicators (EC8 class, Vs30) - intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve)	Stations with larger number of recordings	1000 to 1500 euros
3	30	simple building code indicators (EC8 class, Vs30) - intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve)	Strong-motion sensor sites in areas of softer soils.	
4	26	simple building code indicators (EC8 class, Vs30) - intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve)	not defined yet	
5	25	simple building code indicators (EC8 class, Vs30) - intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve) - detailed indicators (e.g. site amplification, Kappa0, attenuation, non-linear curves, aggravation factors, ...)	characterization of the broad band seismic network, next strong motion network.	about 1000 euros per station (including fieldwork and processing)
6	115	detailed indicators (e.g. site amplification, Kappa0, attenuation, non-linear curves, aggravation factors, ...)	Stations in areas having high population -high building density.	
7	30	intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve)	Unsufficient knowledge on the geological characteristics. - A preference for soft-sediment site	1000 euros
8	80	simple building code indicators (EC8 class, Vs30) - intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve)	strategic infrastructure site, recordings available at the station, high seismic hazard, anomalous peak values and magnitude estimation	4000 euros
9	30-70	detailed indicators (e.g. site amplification, Kappa0, attenuation, non-linear curves, aggravation factors, ...)	New strong motion stations are priority, then permanent broadband stations.	17000 euros, including measurements, analysis, manpower.
10	200	detailed indicators (e.g. site amplification, Kappa0, attenuation, non-linear curves, aggravation factors, ...)	New stations strong motion stations.	

3.2 Viewpoint from end users

The main objectives of the questionnaire sent to the end users consisted in getting:

- feedback regarding site characterization information availability and quality in Europe
- priority criteria for site characterization at strong ground motion stations in the next years

The questionnaire (see Appendix 2) was sent to 39 scientists belonging to the academic and non-academic institutions in Europe who have already used (and published) European strong motion data. This survey was not really successful since we only got back 7 answers, mainly from the scientific community of Ground Model Prediction, Generalized inversion or PSHA. The lack of answers preventing making any robust statistics, we do provide answers of the scientists in the following sections.

3.2.1 Feedback on available site characterization information

All the seven scientists use the Earthquake Strong Motion Database (ESM), followed by RESORCE and national databases to get site characterization information. Interestingly however, most of them also mention use of information reported in scientific articles or by scientists in charge of strong motion networks (Table 3). As already outlined in the previous section, this outlines the lack of information dissemination through public websites (ESM or national databases).

A majority of scientists reports "doubtful site characterization" information for 10-50% of the stations, on the basis of their own experience of inconsistencies between empirical ground motion amplification and 1D ground motion prediction, or self-inconsistency within the databases or finally lack of some key information such as installation layout (Table 4).

Table 3. Answers of end-users regarding the availability of site characterization information

Scientist	Where have you collected site characterization information ?
1	Earthquake Strong Motion database (ESM flat file) - Site characterization national databases – Scientific papers - Asking scientists in charge of strong ground motion networks
2	Earthquake Strong Motion database (ESM flat file) - RESORCE database - Site characterization national databases - Scientific papers - Asking scientists in charge of strong ground motion networks
3	Earthquake Strong Motion database (ESM flat file) - Site characterization national databases - Scientific papers
4	Earthquake Strong Motion database (ESM flat file) - Site characterization national databases - Scientific papers
5	Earthquake Strong Motion database (ESM flat file) - RESORCE database - Site characterization national databases - Scientific papers
6	Earthquake Strong Motion database (ESM flat file) - RESORCE database
7	Earthquake Strong Motion database (ESM flat file) - RESORCE database - Site characterization national databases - Scientific papers - Asking scientists in charge of strong ground motion networks

Table 4. Answers of end-users regarding the quality of site characterization information

Scientist	Are there sites with doubtful site characterization ?	Proportion of site characterization information	How could you conclude it was doubtful ?
1	Yes	10-50% of site characterization information	Anomalies in amplification from residual analysis, empirical site response not consistent with Vs profiles or 1D theoretical response
2	Yes	10-50% of site characterization information	Significant differences between predicted (e.g. 1D-SH) and empirical evidence (e.g. spectral inversion of FAS).
3	Yes	10-50% of site characterization information	information in database are not coherent among them (< 10%); - Vs30 inferred from geological map (50%). -
4	Yes	10-50% of site characterization information	Quality of data and reliability of interpretations
5	No		

6	No		
7	Yes	10-50% of site characterization information	I would not say that the site characterization information was doubtful, I think that in some cases the information on the station installation set up or housing is as important as the velocity profile (e.g. station installed in a tunnel or at depth or in a building) and often not well clearly provided

3.2.2 Criteria and quality for site characterization within the next years

As regards as the priority criteria to be given for characterizing strong ground motions in the future, end-users report – by order of importance - :

1) stations with a lot of earthquake recordings,
2) stations allowing a good spatial coverage over the network geographical area of site characterization information,
3) hard and soft rock sites
4) soft (sediment) sites (Table 5).

Although surveys sent to end-users and network operators were different, one may notice that objectives and needs provided by both parties do not fully converge, except for stations with the highest number of recordings, which could outline the lack of scientific and technical workshops on a regularly basis between network operators and end-users. Such kind of workshops could be organized within the umbrella of ORFEUS. Finally end-users of European strong motion data have also pointed out the need to characterize broad-band seismological stations especially fort the low-to-moderate seismicity countries.

To the question regarding the most relevant quality grading to be provided for site characterization, all scientists promote standard deviation or a confidence level on the site condition indicators, followed by quantitative or qualitative index (Table 6). The very first scheme for quantitative grading of site characterization has been proposed in SERA Task7.2 (see deliverable D7.2) in order to promote and homogenize qualification of site characterization in Europe. However, participants of the l'Aquila workshop (March 11-12, 2019, https://sites.google.com/view/site-characterization-workshop/home) have also outlined the need of standard deviation on each single site characterization indicator. This specific issue was beyond the goal of SERA WP7 and will be addressed in the future within the framework of COSMOS (Consortium of Organizations for Strong Motion Observation Systems) site characterization guidelines development.

Table 5. End-users priority criteria for site characterization in the future

Scientist	Stations with a lot of earthquake recordings	Hard rock sites	Soft rock sites	Sediment sites	Good spatial coverage over the network geographical area of site characterization information
1	Very important	Very important	Important	Important	Important
2	Very important	Very important	Very important	Very important	Very important
3	Very important	Important	Important	Important	Very important
4	Important	Important	Important	Important	Very important
5	Very important	Important	Very important	Very important	Important
6	Very important	Important	Important	Important	Important
7	Very important	Very important	Important	Important	Important

Table 6. Expected quality metrics by end-users

Scientist	Expected quality metrics
1	A quantitative quality index (e.g. from 0 to 1) related to each site characterization indicator - A quantitative quality index (e.g. from 0 to 1) related to the overall site characterization - Standard deviation or confidence interval related to each site characterization indicator
2	A quantitative quality index (e.g. from 0 to 1) related to each site characterization indicator - Standard deviation or confidence interval related to each site characterization indicator
3	A qualitative quality index (e.g. 'very good', 'good', 'poor', ...) related to each site characterization indicator - Standard deviation or confidence interval related to each site characterization indicator
4	Standard deviation or confidence interval related to each site characterization indicator
5	A qualitative quality index (e.g. 'very good', 'good', 'poor', ...) related to each site characterization indicator - Standard deviation or confidence interval related to each site characterization indicator
6	Standard deviation or confidence interval related to each site characterization indicator
7	A qualitative quality index (e.g. 'very good', 'good', 'poor', ...) related to each site characterization indicator - A quantitative quality index (e.g. from 0 to 1) related to each site characterization indicator - Standard deviation or confidence interval related to each site characterization indicator

4 Recommendations

Analysis of the available site characterization information for European strong motion sites have clearly outline the lack of available site characterization information, especially measured site condition indicators ranging from basic indicators such V_{S30} , f_0 or more advanced ones such as V_S profiles.

Definitely, this lack of information prevents the best exploitation by scientists all other the world of European strong motion data, as it is the case for example in Japan for the KIKNET network that provides very detailed V_S profiles for each strong motion stations.

The questionnaires sent to both network operators and end-users clearly outline the future needs and key issues to tackle in the future in order to enhance use of strong motion data:

1) Network operators plan to perform site characterization at about 600 European seismological stations within the next ten years. Both network operators and end-users agree – at least - to increase the number of site characterization at those stations exhibiting the largest number of earthquake recordings;

2) A large proportion of the site characterization information (about half of the available information as reported by network operators ?) is currently available upon request to specific scientists or through scientific papers, which is a critical issue if one wants to promote scientific research and engineering use of European seismological data following the FAIR principles (Findable, Accessible, Interoperable, Reusable). The European Geotechnical Database (EGD), in development within EPOS, ESM or ORFEUS station book are definitely European databases that could gather in a systematic way and with harmonized format site characterization information available at European seismological networks. Development of such European databases have however to be accompanied by development of interoperable dissemination tools and standards to be implemented at national levels, network operators being solely in charge to provide site characterization authoritative metadata.

3) Increase the awareness of station characterization for broad band network operators;

4) The need to set up a quality indicator, mixing standard deviation for each individual site proxy and some overall quality metrics. While the SERA Task 7.2 (D7.2) propose an overall quantitative quality metrics, the site characterization scientific community still needs to put efforts on evaluating common rules for estimating standard deviation on single indicators.

In order to address these needs and accompany at best the site characterization envisioned in the future by network operators, scientific and technical workshops should be conducted on a regularly basis between network operators and end-users. Such workshops could be conducted within the umbrella of ORFEUS/EPOS.

5 References

Albarello D, Francescone M, Lunedei E, Paolucci E, Papasidero MP, Peruzzi G, Piaruccini P (2016) Seismic characterization and reconstruction of reference ground motion at accelerometric sites of the Italian national accelerometric network (RAN). Nat Hazards. doi: 10.1007/s11069-016-2310-4

Felicetta, C., D'Amico, M., Lanzano, G., Puglia, R., Russo, E., & Luzi, L. (2017). Site characterization of Italian accelerometric stations. *Bulletin of Earthquake Engineering*, *15*(6), 2329-2348.

Hollender, F., Cornou, C., Dechamp, A., Oghalaei, K., Renalier, F., Maufroy, E., ... & Boutin, V. (2018). Characterization of site conditions (soil class, VS30, velocity profiles) for 33 stations from the French

permanent accelerometric network (RAP) using surface-wave methods. Bulletin of Earthquake Engineering, 16(6), 2337-2365.

Luzi, L., Puglia, R., Russo, E., D'Amico, M., Felicetta, C., Pacor, F., ... & Duni, L. (2016). The engineering strong-motion database: A platform to access pan-European accelerometric data. *Seismological Research Letters*, *87*(4), 987-997.

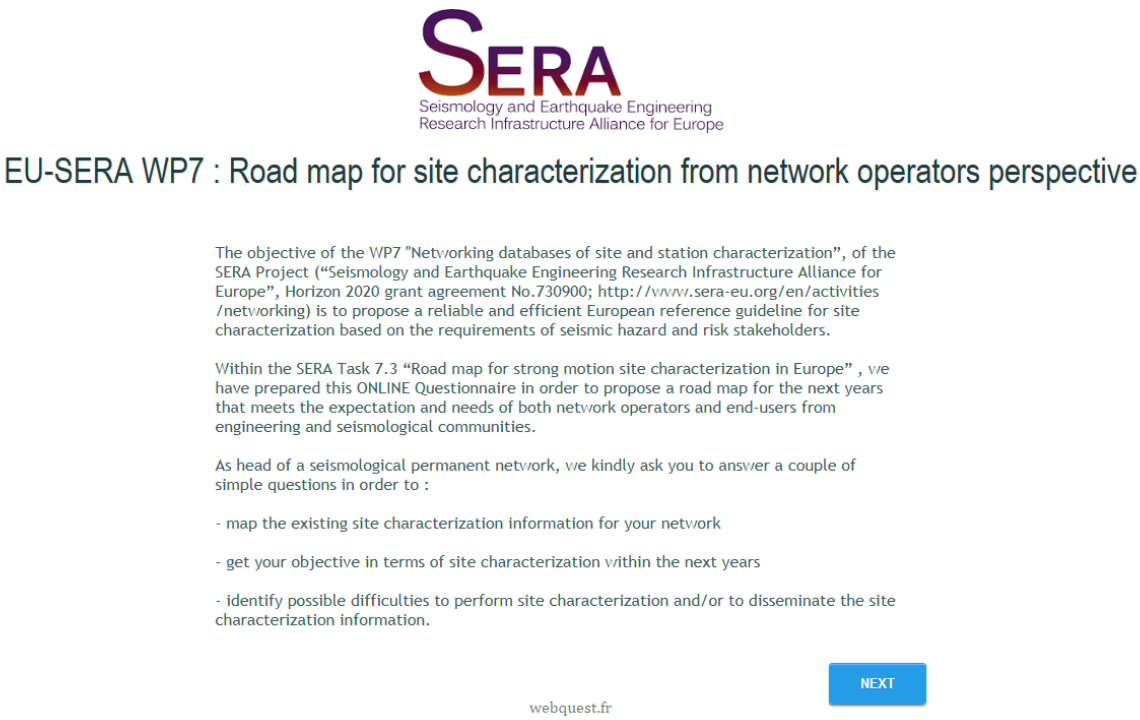
Michel C, Edwards B, Poggi V, et al (2014). Assessment of Site Effects in Alpine Regions through Systematic Site Characterization of Seismic Stations. Bull Seismol Soc Am 104:2809–2826.

Sandıkkaya MA, Yılmaz MT, Bakır BS, Yılmaz Ö (2010) Site classification of Turkish national strong-motion stations. J Seismol 14(3):543–563

Stewart J.P., Klimis N., Savvaidis A., Theodoulidis N., Zargli E., Athanasopoulos G., Pelekis P., Mylonakis G., and Margaris B. (2014). Compilation of a local Vs profile database and its application for inference of V_{S30} from geologic and terrain-based proxies, Bull. Seism. Soc. Am., 104(6), doi: 10.1785/0120130331.

6 Appendix 1

Description of the survey sent to network operators



SERA
Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe

EU-SERA WP7 : Road map for site characterization from network operators perspective

The objective of the WP7 "Networking databases of site and station characterization", of the SERA Project ("Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe", Horizon 2020 grant agreement No.730900; http://www.sera-eu.org/en/activities/networking) is to propose a reliable and efficient European reference guideline for site characterization based on the requirements of seismic hazard and risk stakeholders.

Within the SERA Task 7.3 "Road map for strong motion site characterization in Europe" , we have prepared this ONLINE Questionnaire in order to propose a road map for the next years that meets the expectation and needs of both network operators and end-users from engineering and seismological communities.

As head of a seismological permanent network, we kindly ask you to answer a couple of simple questions in order to :

- map the existing site characterization information for your network

- get your objective in terms of site characterization within the next years

- identify possible difficulties to perform site characterization and/or to disseminate the site characterization information.

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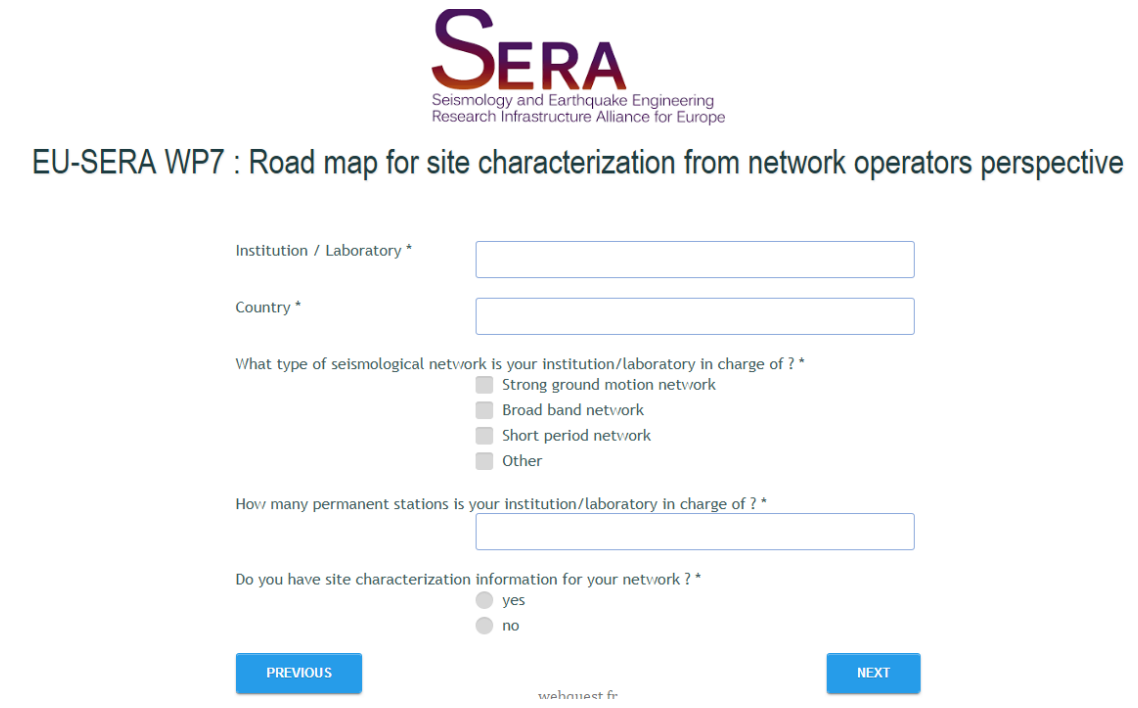

SERA
Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe

EU-SERA WP7 : Road map for site characterization from network operators perspective

Institution / Laboratory *

Country *

What type of seismological network is your institution/laboratory in charge of ? *

- Strong ground motion network
- Broad band network
- Short period network
- Other

How many permanent stations is your institution/laboratory in charge of ? *

Do you have site characterization information for your network ? *

- yes
- no

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How many permanent stations is your institution/laboratory in charge of ? *

Do you have site characterization information for your network ? *

- yes
- no

What are the reasons for not having site characterization ? (mutliple choices possible) *

- Not a scientific priority
- Lack of scientific expertise on this field
- Lack of fundings or human resources
- Lack of well accepted guidelines

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Do you have site characterization information for your network ? *

- yes
- no

How is the site characterization information stored ? *

- Database
- Reports
- Flat file (values stored in an excel type file)
- Other

Is the site characterization information available ? *

- yes
- no

How ? *

- through an institutional/laboratory web page
- through Earthquake Strong Motion database (ESM)
- through asking specific scientists
- Other

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Do you have site characterization information for your network ? *

- (•) yes
- ( ) no

How is the site characterization information stored ? *

- [ ] Database
- [ ] Reports
- [ ] Flat file (values stored in an excel type file)
- [ ] Other

Is the site characterization information available ? *

- ( ) yes
- (•) no

What prevents site characterization information to be available ? *

- [ ] Lack of human ressources or fundings
- [ ] Lack of metadata standards
- [ ] Data property

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Among the following indicators related to site seismic response listed in the SERA questionnaire focused on defining the most relevant site characterization indicators , which are the existing ones for your network ?

	no	yes (< 10%)	yes (10-50%)	yes (> 50%)	I don't know
Fundamental Resonance Frequency (f0) *					
Higher resonance frequencies (f1 f2 f3....) *					
Amplitude at resonance frequencies (A0 A1 A2...) *					
Site Amplification Function *					
Kappa0 *					
Frequency-dependant attenuation (e.g. Q, damping, kappa(f) ...) *					
Preferential direction of ground motion *					
Vsz (travel time-averaged value at various depths) *					
Vs of the seismological bedrock *					
Depth of the seismological bedrock *					
Depth of the engineering bedrock *					
Vs(z) *					
Vp(z) *					
Water table depth *					
Dispersion curve *					
Rayleigh wave ellipticity curve *					
H/V curve *					
Geo-stratigraphic 1D log model *					
Building code site class *					
vs30 *					
Surface geology *					
Morphology/topographic factor *					
Aggravation factor for basin and topography *					
Non-linear curves (e.g. G/G0 and damping curves) *					
Geotechnical parameters (SPT, CPT, qc, ...) *					

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Road map for site characterization in Europe

Does your institution/laboratory plan to perform site characterization within the following years ? *

- (•) yes
- ( ) no

How many stations do you plan to characterize within the next 10 years ? *

What is your goal ? *

- [ ] simple building code indicators (EC8 class, Vs30)
- [ ] intermediate indicators (e.g Vs profile, resonance frequency, dispersion curve)
- [ ] detailed indicators (e.g. site amplification, Kappa0, attenuation, non-linear curves, aggravation factors, ...)
- [ ] other

What are your criteria for choosing the stations to be characterized in priority ? *

What is the approximate cost/site ?

In case you want to receive the results of your questionnaire and to be informed on the outcomes of the questionnaire, please indicate your email address

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7 Appendix 2

SERA
Seismology and Earthquake Engineering
Research Infrastructure Alliance for Europe

EU-SERA WP7 : Road map for site characterization from end-users perspective

The objective of the WP7 "Networking databases of site and station characterization", of the SERA Project ("Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe", Horizon 2020 grant agreement No.730900; http://www.sera-eu.org/en/activities/networking) is to propose a reliable and efficient European reference guideline for site characterization based on the requirements of seismic hazard and risk stakeholders.

Within the SERA Task 7.3 "Road map for strong motion site characterization in Europe" , we have prepared this ONLINE Questionnaire in order to propose a road map for the next years that meets the expectation and needs of both network operators and end-users from engineering and seismological communities.

As researchers using European strong motion data , we kindly ask you to answer a couple of simple questions in order to :

- get your feedback regarding site characterization information available in Europe

- get your priority criteria for site characterization at strong ground motion stations in the next years

EU-SERA WP7 : Road map for site characterization from end-users perspective

Institution / Laboratory *

Country *

What type of research studies do you conduct with strong ground motion data from Europe ? *

- [ ] GMPE
- [ ] Generalized inversion / Spectral inversion
- [ ] Attenuation
- [ ] High frequency spectral decay
- [ ] Strong motion simulation
- [ ] PSHA
- [ ] Other

Have you used site characterization information (if available) in your study ? *

- ( ) yes
- ( ) no

EU-SERA WP7 : Road map for site characterization from end-users perspective

Institution / Laboratory *

Country *

What type of research studies do you conduct with strong ground motion data from Europe ? *

- [ ] GMPE
- [ ] Generalized inversion / Spectral inversion
- [ ] Attenuation
- [ ] High frequency spectral decay
- [ ] Strong motion simulation
- [ ] PSHA
- [ ] Other

Have you used site characterization information (if available) in your study ? *

- (•) yes
- ( ) no

Where have you collected site characterization information ? *

- [ ] Earthquake Strong Motion database (ESM flat file)
- [ ] RESORCE database
- [ ] Site characterization national databases
- [ ] Scientific papers
- [ ] Asking scientists in charge of strong ground motion networks
- [ ] Other

From your past studies, have you identified some sites with doubtful site chararacterization ? *

- ( ) No
- (•) Yes

Proportion of site characterization information *

- ( ) < 10% of site characterization information
- ( ) 10-50% of site characterization information
- ( ) > 50% of site characterization information

How could you conclude it was doubtful ?

EU-SERA WP7 : Road map for site characterization from end-users perspective

According to your research needs, what are the priority criteria to consider for site characterization at strong ground motion sites in the next years ?

	Very important	Important	Not important
Stations with a lot of earthquake recordings *	○	○	○
Hard rock sites *	○	○	○
Soft rock sites *	○	○	○
Sediment sites *	○	○	○
Good spatial coverage over the network geographical area of site characterization information *	○	○	○

What kind of quality metrics would you expect for site characterization ?

*

- ☐ A qualitative quality index (e.g. 'very good', 'good', 'poor', ...) related to each site characterization indicator
- ☐ A qualitative quality index (e.g. 'very good', 'good', 'poor', ...) related to the overall site characterization
- ☐ A quantitative quality index (e.g. from 0 to 1) related to each site characterization indicator
- ☐ A quantitative quality index (e.g. from 0 to 1) related to the overall site characterization
- ☐ Standard deviation or confidence interval related to each site characterization indicator

Is there an interest in characterizing broadband stations ? *

- ◉ yes
- ○ no

For what purposes ?

In case you want to receive the results of your questionnaire and to be informed on the outcomes of the questionnaire, please indicate your email address

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