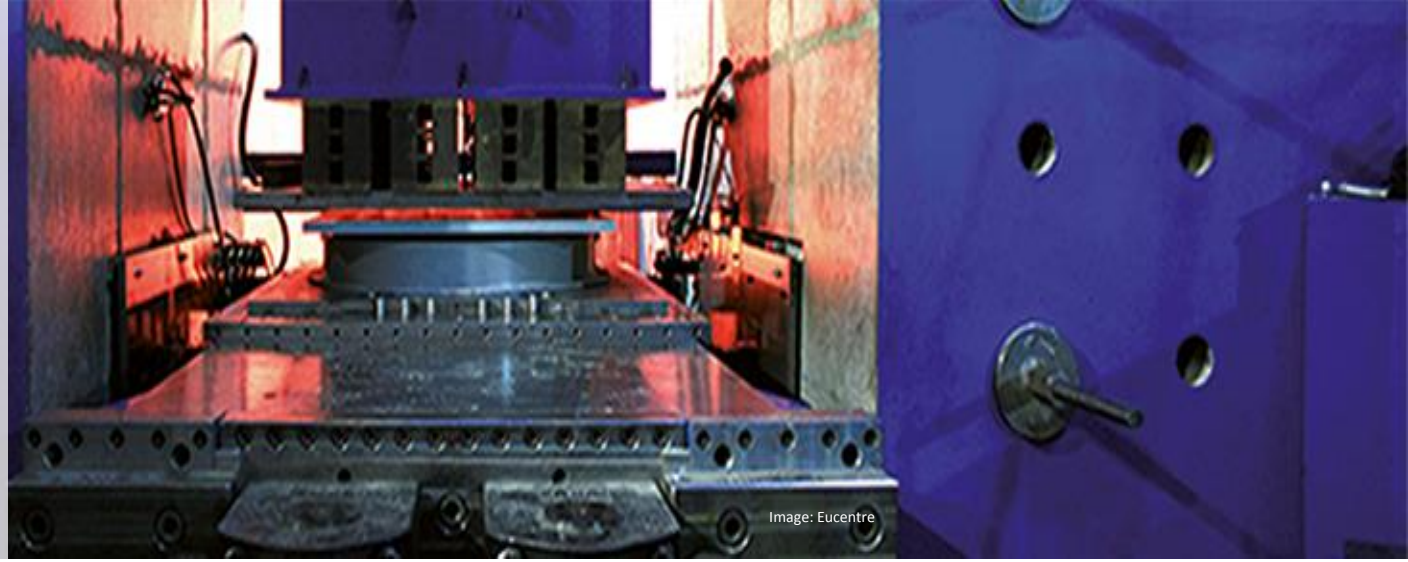
SERA
Seismology and Earthquake Engineering
Research Infrastructure Alliance for Europe



WP7. Networking databases of site and station characterization

CNRS, ETH, INGV, AUTH

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SERA FINAL MEETING, ZÜRICH APRIL 23TH -24TH 2020

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OBJECTIVES

To set up a robust European framework towards high quality and reliable site condition indicators

… consistent with the needs of the broad scientific community

Task1 Networking the European site characterization community (AUTH)

Task 7.3 Road map for strong motion site characterization in Europe (CNRS)

Task 7.2 Best practice and site characterization quality assessment (INGV)

Task 7.4 Towards improvement of site characterization indicators (ETH)

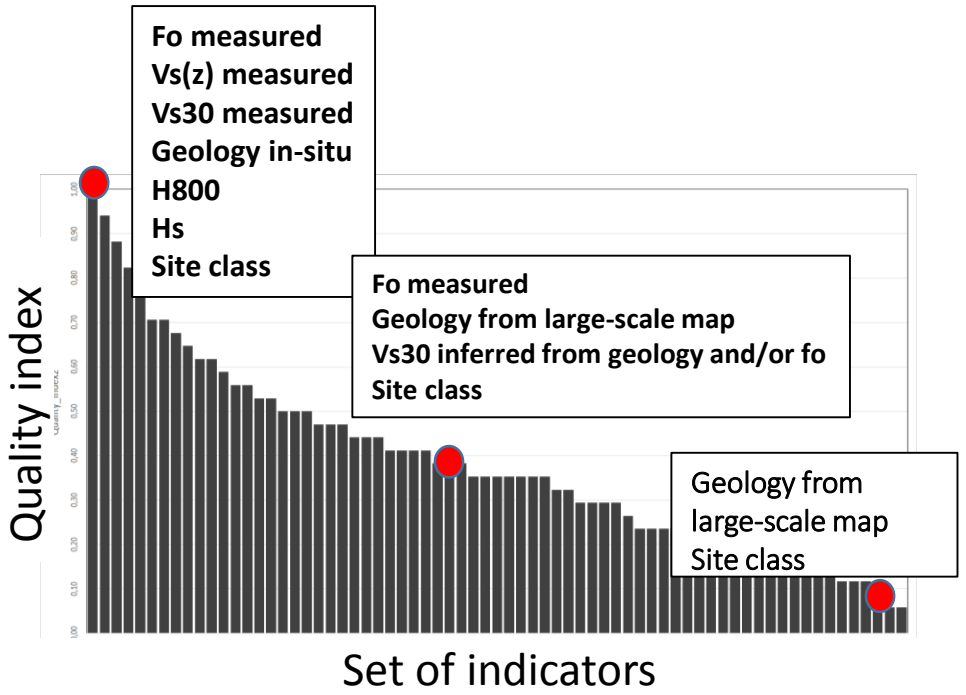
Task 7.5 Pre-operational service activities (CNRS)

Site characterization indicators & quality grading

Bottom-up approach:
International questionnaires and community workshops

Overall quality grading at a site:
- Quality of single indicators
- Number of indicators available and related importance
- Consistency between indicators

Recommended indicators
Fo
Vs(z)
Vs30
Surface geology
Seismological bedrock depth
Soil class
Engineering bedrock depth

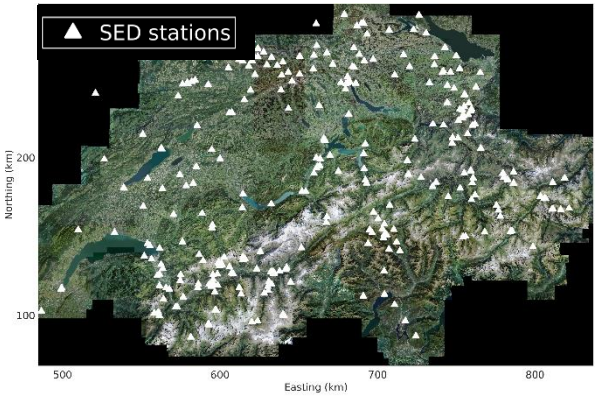


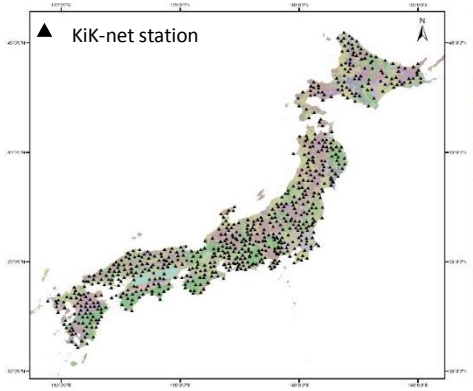
Cultrera et al., 2020. Indicators for site characterization at seismic station: recommendation from a dedicated survey, to be submitted, BEE

Di Giulio et al., 2020. Quality assessment for site characterization at seismic stations, to be submitted, BEE

Are these indicators really meaningfull ?

Task 7.4 Towards improvement of site characterization indicators



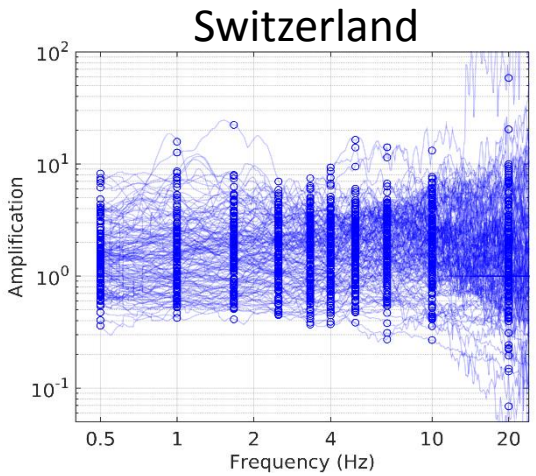


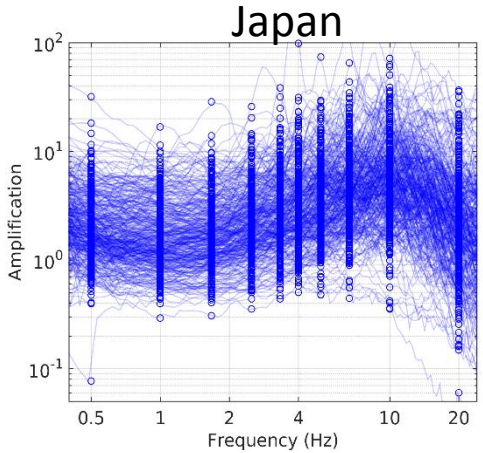
Compilation of > 30 proxies

Geophysical-related proxies:
Vs30, fo, Vs(z), H800, …

Morphology-related proxies:
Slope, curvature, terrain class, …

Geo-lithological proxies:
geology, coarse fraction, soil class, lithology, …





Issue : ! definition of a common geological classification !

Bergamo et al., 2020. On the relation between empirical amplification and proxies measured at Swiss and Japanese stations: systematic regression analysis and neural network prediction of amplification, in preparation

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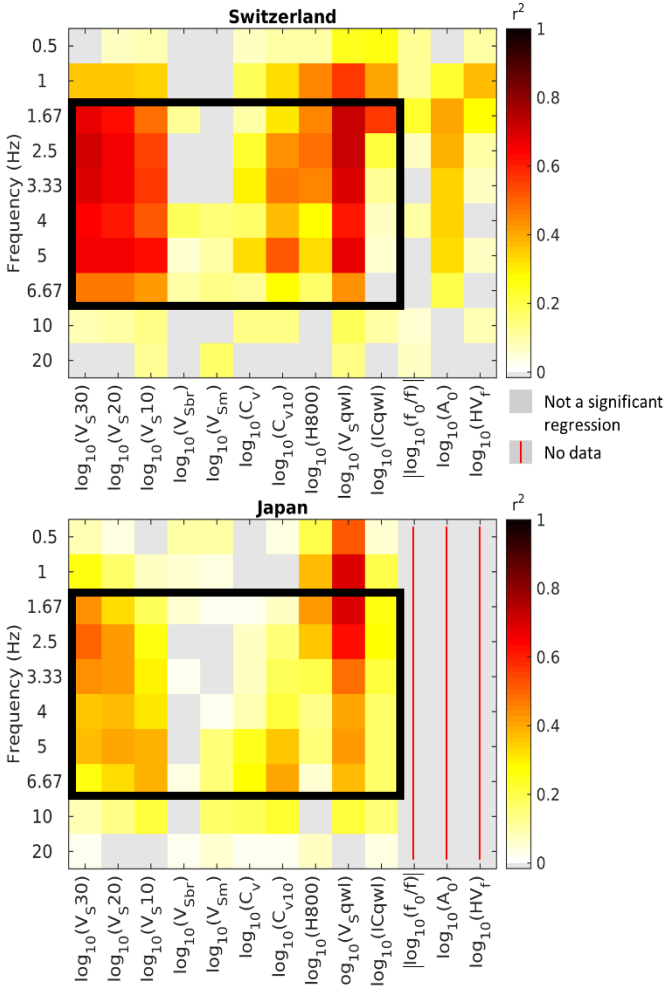
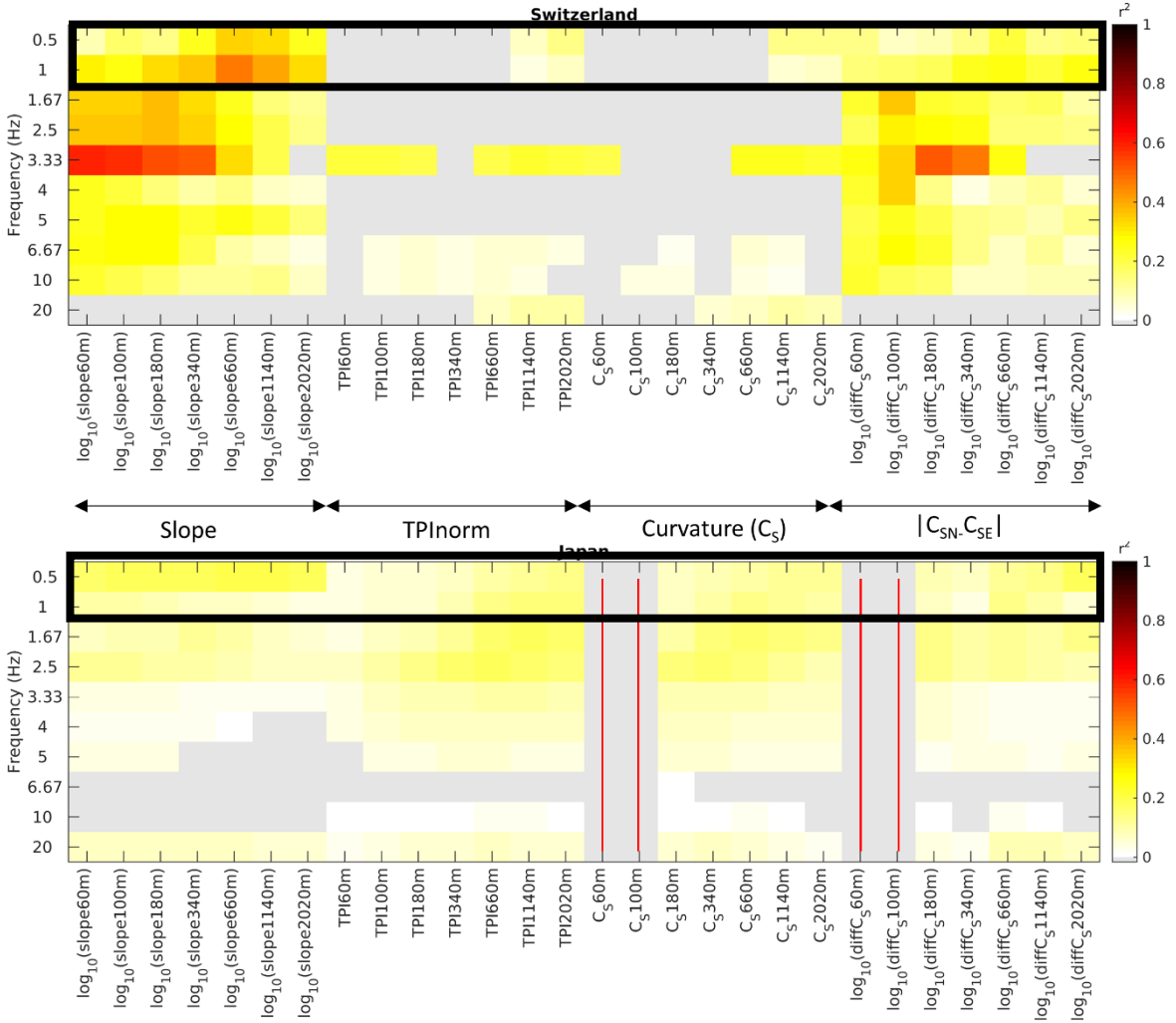
Correlation between proxies and true amplification

Direct proxies
(Vs-related)

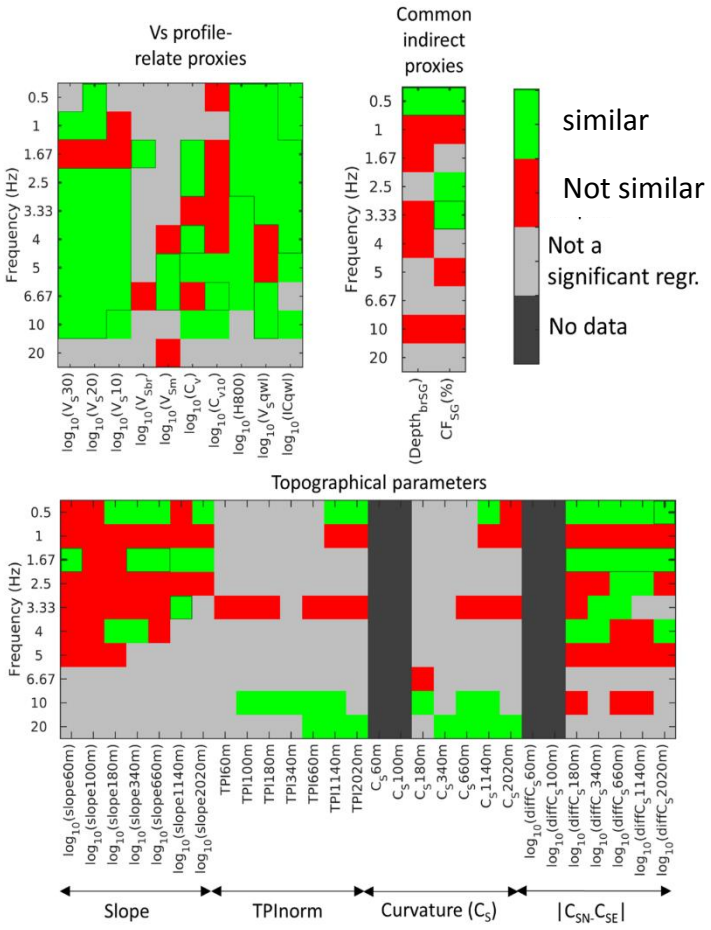


Indirect proxies
(geology, topography)

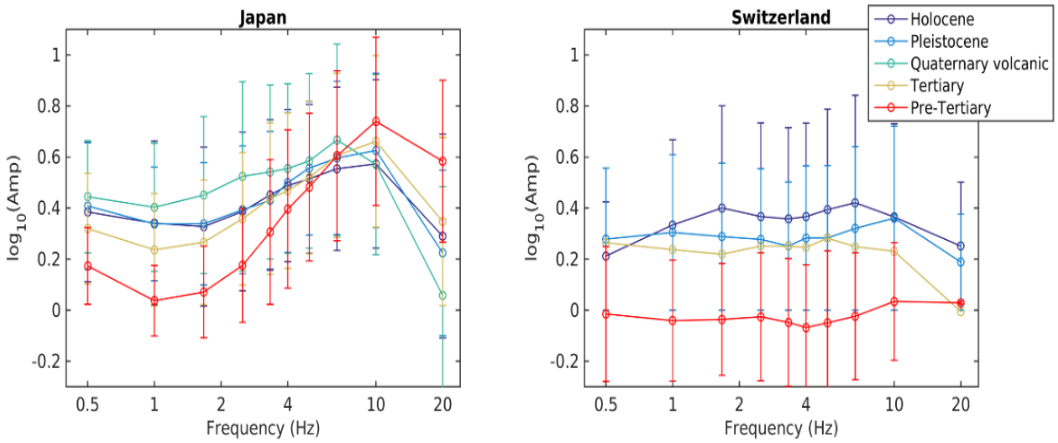


Bergamo et al., 2020. On the relation between empirical amplification and proxies measured at Swiss and Japanese stations: systematic regression analysis and neural network prediction of amplification, in preparation

Comparison of correlation between proxies and true amplification for Japan and Switzerland



Surface geology



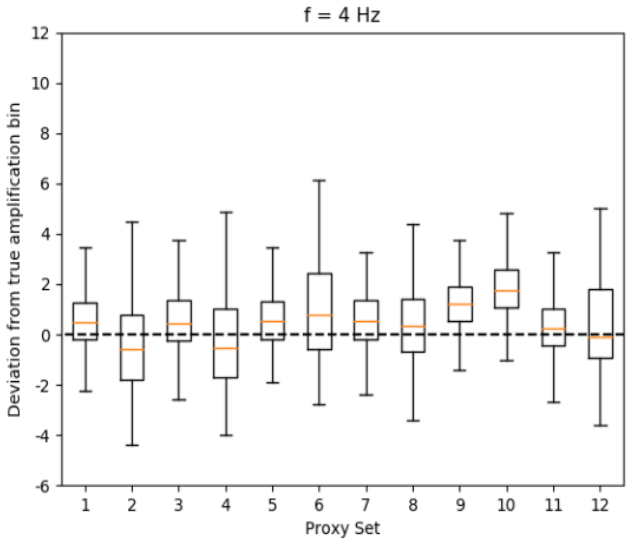
- Vs-related proxies: similar correlation with local amplification whatever the region
- Geology and topography : correlation with amplification is region-dependent
  => local validity of geological or topographical related proxies + spatial scale

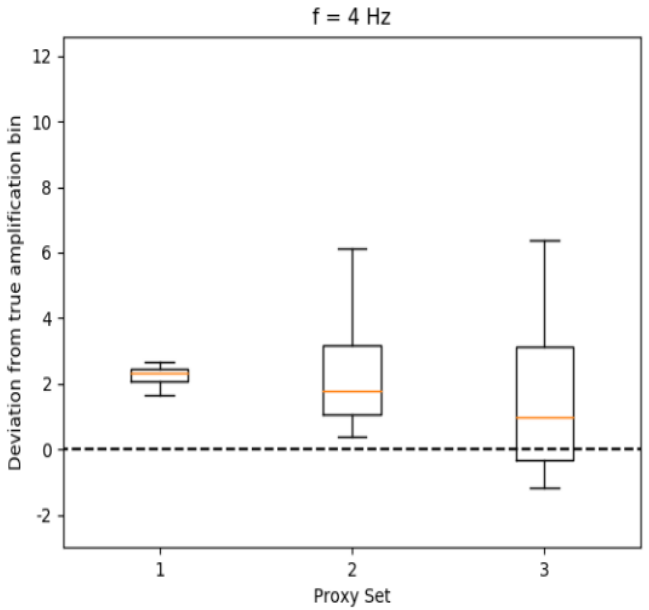
Bergamo et al., 2020

Amplification prediction performance of proxies

Neural network approach

Type of proxy	Number of proxy set	Contained proxies	«best proxies»
Direct proxies	1	V_{S30}	1.67 – 6.77 Hz
	2	V_{S30}, H800	
	3	V_{S10}, V_{S20}, V_{S30},	
	4	V_{S10}, V_{S20}, V_{S30}, H800, C_{V10}	
	5	V_{S30}, f_0	
	6	V_{S30}, H800, f_0	
	7	V_{S10}, V_{S20}, V_{S30}, f_0	
	8	V_{S10}, V_{S20}, V_{S30}, H800, C_{V10}, f_0	0.5 – 6.77 Hz
	9	V_{S10}, f_0	
	10	V_{S10}, V_{S20}, f_0	
	11	V_S^{QWL}, I_C^{QWL}	0.5 – 20 Hz
	12	V_S^{QWL}, I_C^{QWL} f_0	0.5 – 20 Hz
Indirect proxies	1	Rock genesis code, rock age, bedrock depth, % of coarse fraction	
	2	TPI_{norm}, slope	
	3	Combination of indirect proxy set 1 + 2	0.5 – 20 Hz





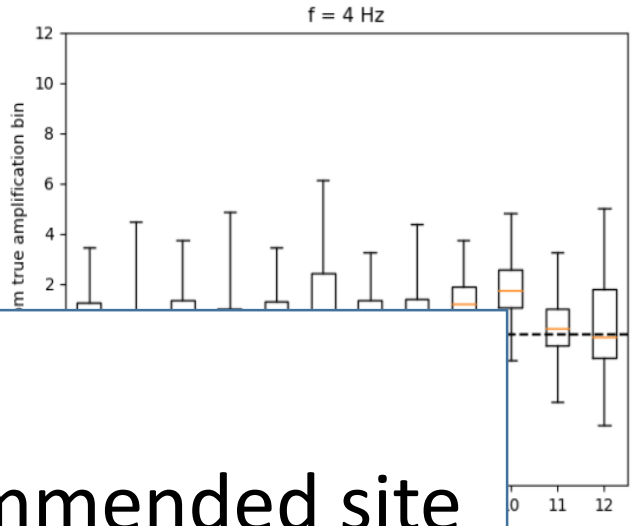
Bergamo et al., 2020

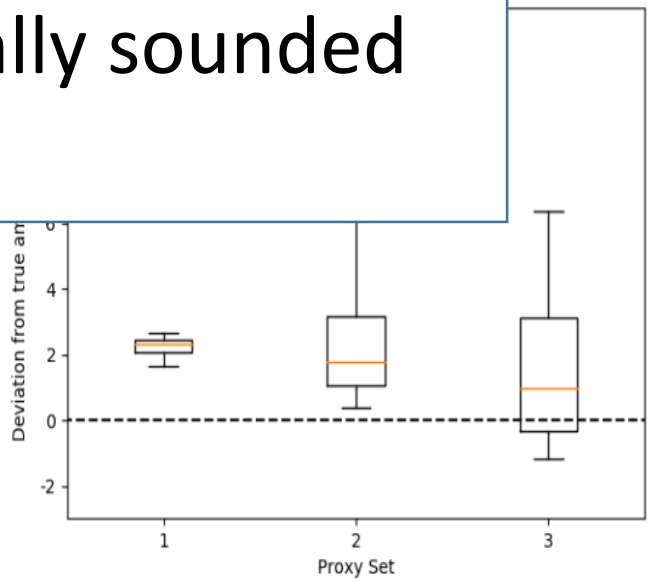
Amplification prediction performance of proxies

Neural network approach

Type of proxy	Number of proxy set	Contained proxies	«best proxies»
Direct proxies	1	V_{s30}	1.67 – 6.77 Hz
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12		
Indirect proxies	1	Rock genesis code, rock age, bedrock depth, % of coarse fraction	
	2	TPI_{norm}, slope	
	3	Combination of indirect proxy set 1 + 2	0.5 – 20 Hz

The recommended site condition indicators are scientifically sounded





Bergamo et al., 2020

How to exchange site characterization information from network operators to European services ?

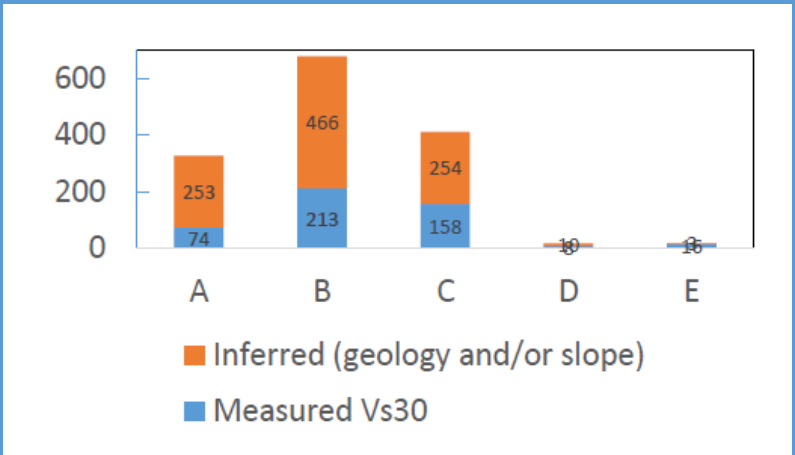
What is the information available
(now and in the future) ?

Which European services ?

How is the information stored
at network operator level ?

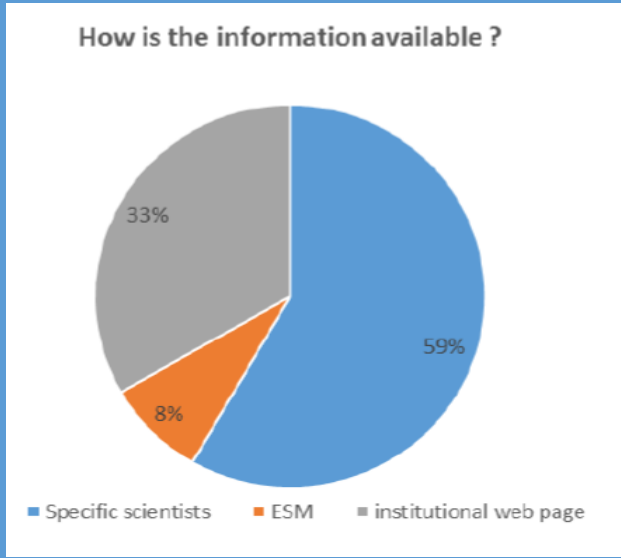
Information available at European scale

70% of stations with EC8 class (1455 stations) – ESM2018 flatfile



600+ site characterization planned in the next 10 years by network operators

[priority: Vs30, site class, fo, Vs(z) at stations with largest number of recordings]



60% available information upon request to scientist

No standard for reporting / storage of information

No (few) running site characterization databases by network operators

Services that expose site characterization information at European level

ESM Strong motion sites

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					

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**

ORFEUS Broad-band & strong motion sites

Station Book Orfeus Data Center within NERA

Description EIDA data & Ownership

Network	CH	**Latitude [°]**	47.366830 N	**Country**	Switzerland
Station Code	EWZT0	**Longitude [°]**	8.496750 E	**Station Name**	Zuerich
Affiliation	-	**Elevation [m]**	462	**Description**	Zuerich, Triemli, ZH
Shared / Restric.	Yes / No	**Owner Name**	-	**Owner Phone**	-
Start	2009	**Owner Department**	-	**Owner Email**	-
End	-	**Owner Agency**	-	**Owner Address**	-

Station Details Morphology, Ground type, Geology, etc.

Geological Unit -
Morphology Class -
Classes: T1, T2, T3, T4; *based on the Italian building code*
Morphology Description -
Ground type EC8 -
EC8 types: A,B,C,D,E,S_1,S_2; *more info here*
Groundwater Depth [m] -
Vs 30 [m/s] -
f_0 [Hz] -
Fundamental frequency at the site
Amp(f_0) -
H/V amplitude at f_0
Basin Flag -
Bedrock Depth [m] -
Depth to the engineering bedrock (with Vs ~ 800 m/s)

European Geotechnical Database (EGD)

permanent stations & non-permanent sites

EGD European Geotechnical Database
Within EPOS – European Plate Observing System

HOME | DATABASE | NEWS | ABOUT | eviriga@civil.auth.gr

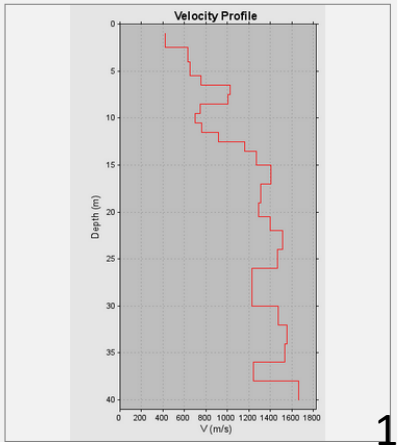
SITE OVERVIEW

Country	GR	**Code**	???	**Instrumentation**	Permanent
Latitude (°)	37.99511	**Owner**	SDGEE_AUTH	**StationID**	ATH4
Longitude (°)	23.73833			**LocationID**	00
Altitude (m)				**Network**	HI
				Sensor alt. (m)	
				Bldg/Shelter Desc.	Basement of a 3-st R/...
Morphology		**V_{s30} (m/s)**	970	**V_S Profiles**	1
Topography Scheme A	T1	**V_{s30} Method**	Crosshole	**V_P Profiles**	0
Topography Scheme B		**V_{s30} Index**	3.5	**Q_S Profiles**	0
Surface Geology	Old talus cones	**V_{s30} Ref.**	O.A.S.P. 8048	**Q_P Profiles**	0
Map Scale	1:50,000	**f_0 (Hz)**	8.992	**Borehole Profiles**	1
Geology Ref.	IGME, Geological Maps of Gr...	**f_0 Method**	Inferred	**CPT Profiles**	0
OneGeology		**f_0 Index**	2.0		
Bedrock Depth (m)	11	**f_0 Ref.**	Pitilakis et al. (2013)		
EC8 Class	A				

2ND LEVEL DATA

V_S Profile | Boreholes

Short Reference
O.A.S.P. 8048
Method
Crosshole
Datafile
View
Preferred profile



- Most complete information
- Basic to detailed level of information

Strategy to exchange site characterization information for permanent seismological stations

Absence of running site characterization databases by network operators & standard WS

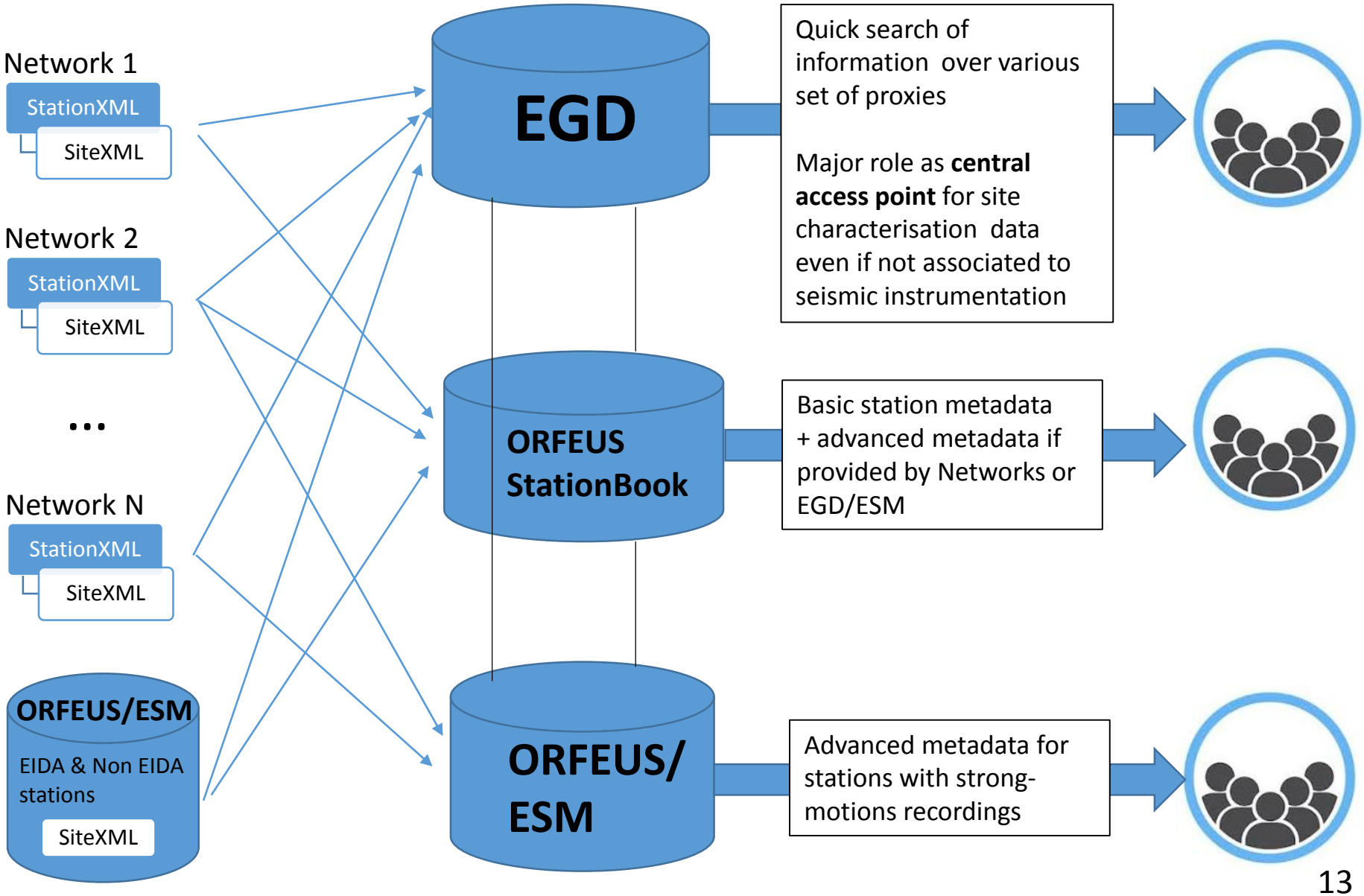
Pragmatic solution : make use of internationally accepted and used standard FDSN Station Response Web Service

- Site characterization metadata is described by a .XML file (siteXML)
- siteXML is introduced in the <ExternalReference> element in the StationXML structure by the network operator of an authoritative data center

```
<TotalNumberChannels>24</TotalNumberChannels>
<SelectedNumberChannels>24</SelectedNumberChannels>
<ExternalReference>
  <URI>https://gitlab.com/resif/site-characterization/-/raw/master/XML/SiteOGPC_SERA_v1.1.xml</URI>
  <Description>Site characterization for station OPGC, network RA, updated 2020-04-12 </Description>
</ExternalReference>
<Channel locationCode="00" code="HNE" startDate="1998-08-25T10:00:00" endDate="2001-03-29T09:49:00" restrictedStatus="open">
  <Latitude>45.1371</Latitude>
```

- The station owner is responsible to maintain and update the SiteXML file
- Through the query output of StationXML, the SiteXML file can be retrieved in real-time and site characterization content can be expose in EGD, ORFEUS-StationBook or ORFEUS-ESM service.

Strategy to exchange site characterization information for permanent seismological stations



Content of SiteXML

- Indicators of EGD (1st level) + additional indicators and quality grading of SERA
- Based on QuakeML2.0 draft schema + EGD schema + introduction of new fields for SERA specific indicators
  Schema: https://gitlab.com/resif/site-characterization/-/tree/master/schema
- First siteXML available, currently tested by EGD and ORFEUS
- Production phase for RESIF stations ready

Next steps

- This siteXML format is not an international standard or community standard yet
- How to make it standard and to promote it ?
  - Link with COSMOS / FDSN definitely needed
  - Work to continue in the framework of EPOS TCS Seismology .

Key objectives

3. Substantial advance in the integration of seismology and earthquake engineering.

First step in structuring site characterization community at european level

Bottom-Up approch through questionnaires, international workshops & focus groups targeting end-users, network operators and experts in site characterization

Involvement of the international scientific community (end-users, COSMOS)

Definition of «most consensual» site characterization indicators (including related data, method, cost)

Comprehensive framework for the quality assessment of site characterization indicators

Deep (and broad) investigation of performance of proxies => new proxies to consider in the future (QWL velocity, coarse fraction , …) + warning on geological description

Pragmatic approach to exchange site characterization information from network operators to European services running under EPOS