Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation

Report

[Existing data sets meeting the JRA1 goals: Conversion into common format]

Activity:	*JRA1: Waveform modelling and site coefficients for basin response and topography*
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Summary

The aim of this Task is to detect and compile all available data sets among the partners regarding experiments for basin and topographic effects. In order to gather all the existing instrumental data within the NERA consortium, from past temporary experiments, or from permanent networks, for which high quality recordings are available together with high quality mechanical / dynamic and geometrical metadata, an inventory-table was prepared and sent to all participants of NERA-JRA1. Based on the selected tables and discussions during the Rome NERA-JRA1 meeting (2-4 March, 2011) and two additional reports prepared after the meeting for the Fucino, Italy and Argostoli, Greece basins, the following have been proposed:

(i) Old experiments data will be retained by each owner-partner on his data storage bank or database. Data from new experiments to be carried out within NERA-JRA1 can be archived into the EIDA db (http://eida.rm.ingv.it).
(ii) Each partner will fulfil specific metadata fields in a common shape web page that can be seen by the rest of partners facilitating data sharing. NERA portal will be asked to contribute to this issue.
(iii) Argostoli, Greece site has been selected as a new basin experiment (October 2011-March 2012) while the center of Fucino, Italy as a site for dense array deployment (April- July 2012).
(iv) Site selection for topographic effects is going to be decided in June 21st (Zurich, NERA-JRA1 meeting, organized by SED)

1. Introduction

The effects of surface and subsurface geometry on seismic ground motion have been recognized for a long time, and have been the topic of many instrumental and numerical investigations over the last four decades. Yet, their complexity, combined with the limitations of both geophysical investigation techniques and numerical simulation, made it impossible till now to include such effects in earthquake hazard assessment and risk mitigation policies: the vast majority of building codes do not include any provision for basin and surface topography effects.

From experimental point of view, numerous instrumental recordings have been obtained in various valley and mountainous areas (especially Italy, Greece, Switzerland, France), with temporary as well as permanent instrumentations, while developments in data processing techniques now allow to recover experimental site transfer functions even without local reference stations. Special attention was dedicated also to dense array measurements and processing techniques giving rise to a detailed analysis of the wave-field and its evolution with time during an earthquake recordings.

This initial work is to be conducted within the first year of the project, covering the following two actions:

- gather all the already existing instrumental data within the NERA consortium, from past temporary experiments, or from permanent networks, for which high quality recordings are available together with high quality mechanical / dynamic and geometrical metadata.

- identify a few sites that would deserve complementary geophysical surveys or complementary seismological campaigns to enrich the existing data set for basin and topographic effects studies.

2. Description of the Work

2.1. Data from Past Experiments (Metadata & Sharing Scheme)

In order to compile all available data sets an inventory of the existing within the consortium past experiments for basin and topographic effects was created. Such a Table included information about earthquake recordings, number of seismic stations, geo-model, geophysical/geotechnical investigations and any comment about data availability & references.

In Tables 1 to 5 relevant to past experiments information are provided by the partners of NERA-JRA1 module. In total, 18 experimental sites are presented for possible data exploitation within the NERA consortium. A preliminary brief presentation of the majority of these sites was done during the Kick-off meeting in Vienna, 17/11/2010 (see Appendix I).

For each site a detailed presentation of all data and metadata available both for basin and topographic effects was done during the meeting in Rome, 3 March 2011 (see Appendix II). 14 experiment sites with high quality instrumental both for basin and topography effects as well as selected broadband Italian stations for surface topography effects, were presented and discussed. Regarding the minimum required parameters that can characterize the site for basin and topography effects (metadata) the following were proposed:

- Amplification (SSR)

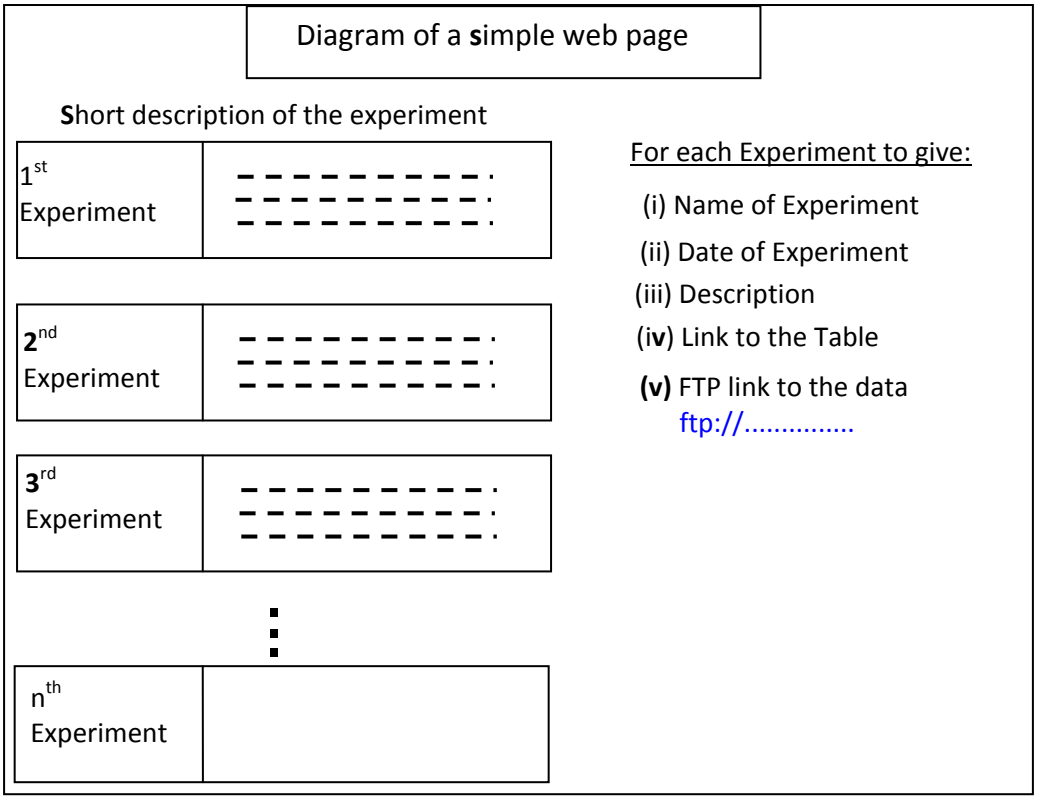
- Fundamental frequency (fo)
- Vs profile (of reference station)
- Vs profile of valley stations, (Vs_{30}, $Vs_{aver\text{-}bed}$: average Vs velocity from surface to bedrock)
- Station-Site classification based on geology (few classes based on age)
- Q, kappa value (if possible)
- Morphology of the 2D/3D basin (depth below station, depth, length, width of valley, edge slope, closest distance to edge)
- Morphology of topography (2D/3D)

It was decided, instead of converting all data sets to a common format, that each partner keeps his own data bank or data base from the past experiments, and make it available to other partners, in the existing formats. The data formats for the six partners are presently as follows:

INGV → in SAC, miniSeed, GSE
SED → in SAC
AUTH → in SAC
GFZ → in SAC , miniSeed
ITSAK → in SAC, Ascii
ISTerre → in SAC, SEGY, miniSeed

It can be seen that a big portion of data are in SAC but there are data sets in other formats as well. It would be preferable that all data are converted to SAC format to facilitate their processing by any interested partner. In any case, it must be assured that same data converters from one format to another are going to be used within the consortium. Finally, each partner will keep its own data and provide all necessary information and metadata for proper data dissemination among collaborating Institutes.

Regarding the scheme of data sharing among NERA partners several ways were discussed (see Appendix 2). Finally, the one adopted by the participants is shown in the diagram below. It includes a simple web page, with the same structure for each partner, providing all necessary parameters and metadata to be used by the data analysts. In addition, through an FTP link one can access recordings stored on a specific server of the owner's Institute.



The NERA portal will be asked to prepare the suitable GUI and re-direct any user searching for a certain experiment data set to the right owner of the data bank. Data archiving of the future experiments will be stored in the EIDA database (NERIES project deliverable, http://eida.rm.ingv.it).

2.2. Past Experiment Sites and New Experiment Site(s) Selection

During the Rome meeting, 2-4 March 2011 (see Appendix 2) the following past experiment sites for basin and topography effects was presented and for each one it is also stated if the geo-data and waveforms are available:

1.Mygdonian basin_EUROSEISTEST area- basin effect
- Geodata available
- Waveforms available

2.CORSSA area-Basin and topo effects
- Geodata available(?)
- Waveforms available(?)
- Proposed for new experiment for basin(?) and surface topography

3.Sion area- basin effect
- Geodata available
- Waveforms available

4.Visp area-basin effect
- Geodata available (? End of 2012)
- Waveforms available (? End of 2012)

5.Wakkerschamatt area-Rockfall
- Randa site-Rockfall
- Graechen site-deep seated landslide

6.L'Aquila are – basin and topo effects
- Geodata available
- Waveforms available

7.Gubbio basin – basin effects
- Geodata available

- Waveforms available

8.Fucino area -basin effects
- Geodata available
- Waveforms available
- Proposed for new experiment for basin and surface topography effects*

9.Nocera Umbra area – topo effects
- Geodata available
- Waveforms available

10.Narni hill – basin and topo effects
- Geodata available
- Waveforms available
- Proposed for new experiment for surface topography effects (more geophysical work needed)

11.Selected broadband Italian stations for surface topography effects
- Geodata available
- Waveforms available

12.Cavola site – landslide
- Geodata available
- Waveforms available

13.Grenoble area – basin effects
- Geodata available
- Waveforms available

14.Grevena – basin effects
- Geodata available
- Waveforms available

15.Argostoli – basin effect
- Geodata available
- Waveforms available
- Proposed for new experiment for basin and surface topography effects*

In order to select one or two sites for the new experiments within the NERA-JRA1 framework, the following criteria were adopted during the Rome meeting, 2-4 March 2011 (see Appendix 2):

1. Previous data availability
2. Surface topography & basin effects
3. Safety of instruments
4. Housing & Electricity
5. NERA-JRA3 near fault strain requirements
6. High seismicity rate
7. Local people to monitor & check (safety, operation etc.)

After the aforementioned criteria were applied, two sites were pre-selected for possible new experiment deployment both for basin and topography effects:

(a) The Fucino area, in Italy and
(b) The Argostoli site, in Greece.

Given the budget and manpower limitation it was also decided to carefully investigate whether only one site could serve for both, basin and topography effects. For this reason it was decided, for the pre-selected sites, that a supplementary investigation must be performed by mid April, 2011. This short report should be submitted in order to facilitated further evaluation of the Fucino and Argostoli sites as candidates for the new experiment.

The duration of the new experiment was decided to last between 4 to 6 months, starting early September, 2011. Regarding the availability of partners, instruments and manpower the following were declared:

ITSAK: 13 CMG 6TD 30s, 3 persons, 5 solar panels, (15th August + 6 months)
ISTERRE: 20-25 Taurus with CMG40, 30s, 3persons (including a PhD student)
All station with solar panel, (1st Sept. + 6 months)
INGV: 12 Quantera or Reftek (6 channels Le5s, episensors), 3-4 persons
All station with solar panel, (15th Sept + 6 months)
GFZ: 10 EarthData EDL with Mark 1Hz, and 5 K2 with episensors,2 persons)
All station with solar panel, (15th July + 6 months)
SED: Will know by July 2011
AUTH: Will be asked

Resuming, for the new experiment, at least 4 Institutes will participate (possibly plus another 2), with 55 to 60 mainly broadband seismographs, and around 12 persons for installation and monitoring.

2.3. Discussion on Final Site Selection for New Experiment(s)

After in-situ visits, taking into account previous work done and supplementary short scale measurements applied, two reports were prepared (see in Appendix 3 and Appendix 4).

The main goal of this Task is to gather new data on a valley where we could in some way check some issues that cannot be checked with existing data sets. In this sense we need to guarantee a good harvest of instrumental data over a limited period of time, and that could be analyzed and interpreted in the light of the numerical simulation results for both, basin and topography site effects.

From all available information, both sites seem to be rather unsuitable for surface topography effects. However, both sites seem to be excellent for dense array surveys within the safe fenced areas, with one major difference: the fundamental period of the site (≈0.3 Hz for Fucino and ≈2 Hz for Argostoli).

Therefore, the following propositions can be done:

1. **To separate the experiments on surface topography and basin/alluvial valleys.**

2. **For surface topography, to select a site where earthquake recordings are already available from previous surveys, and focus our NERA-JRA1 work on geophysical investigations. The exact site will be decided during the meeting organized by ETHZ, SED in Zürich, in June 21, 2011.**

3. **For valley effects, to select the Argostoli site because of much higher seismicity, smaller size and simpler geology allowing to get the required information for modeling checks with rather simple and inexpensive geophysics (active and passive measurements, seismic, electric, ...).**

4. **In addition, a dense array in the center of Fucino basin could be deployed just after the Argostoli experiment and with much less broadband instruments. The advantage would be that as a low fundamental frequency site, regional and teleseismic events can provide useful data with good signal/noise ratio. Thus, it would be valuable to have strain/spatial variability measurements on two very different sites.**

Table 1. INGV contribution to JRA1

No	Earthquake Recordings	Number of seismic stations	Model	Geophysical/Geotechnical Investigations	Comment
1	Gubbio basin June. 2005- June 2006 Hundreds of records of local earthquakes (up to M 4.7)	Weak-motion: Variable between 10 and 12 stations during the recording period Strong-motion: 2 permanent accelerometers of RAN (1 stiff and 1 soft site) that recorded the 1997 Umbria-Marche shocks	3D model exists (GFZ, others)	2 down-hole measurements About 200 single station H/V About 30 ambient vibration array measurements 2 Seismic lines	Past cooperation experiment funded by DPC (INGV, GFZ, UNIGE, UNIBAS, UNISI , OGS and others), data available
2	L'Aquila area (urban, Aterno river valley) April to December 2009 Hundreds of records of local earthquakes	About 40 seismometers, and a ten of accelerometers (L'Aquila earthquakes, strong and weak motions)	2D model exists	Hundreds of single station H/V Tens of ambient vibration array measurements	Microzoning studies available (funded by DPC after L'Aquila earthquake)
3	Fucino basin	Weak motion: 18 seismometers from November 2008 to Sept 2009 Strong motion: 3 permanent accelerometers of RAN (2002 Molise and 2009 L'Aquila)	2D sections within the basin. 3D model in progress.	A dozen of single station H/V Several ambient vibration array measurements Deep holes	
4	Nocera Umbra Hill Several tens of local(weak motion) earthquakes	6 seismometers from April to May 1998	2D and3D model		

5	Narni Hill (hundreds of local earthquakes)	Tens of seismometers from Oct. 2008 to June 2009	2D and 3D model		Experiment performed by INGV-MI, agreement needed
6	Broadband stations of the INGV Network installed on topographic irregularities	Number to be decided (Ten?)	3D from DEM		Details to be discussed at the kick-off meeting
7	Cavola landslide Several tens of local (weak motion) earthquakes	100 broadband station at 10-m inter-distance between receivers. Array aperture: 130 x 56 m	2D sections	2 down-holes Several ambient vibration array measurements, MASW, ReMi	Experiment performed by INGV-RM and Cambridge (UK), data available from the consortium.

Table 2. ITSAK contribution to JRA1

No	Earthquake Recordings	Number of seismic stations	Model	Geophysical/Geotechnical Investigations	Comment
1	EUROSEISTEST-Mygdonian basin 1994-2010 (2.0≤M≤6.7)	More than 30 stations Velocimeters: 1994 & 1997 experiments Strong-motion: From 7 up to 15 accelerometers plus 6 downhole	2D cross section 3D model exists (Manakou, Cashima project)	78 refractions 20 surface-waves inversion 10 boreholes to 45 m depth, with seismic and geotechnical tests: 3 cross holes, 5 down-holes. 11 ambient noise arrays	EUROSEISTEST, EUROSEISMOD, EUROSEISRISK projects. Earthquake Data available
2	Thessaloniki Nov. 1993-Feb.1994 (2.0≤M≤4.8)	11 Velocimeters & 11 Accelerometers (Guralp CMG5 , CMG22)	2D cross sections (Anastasiadis et al. 2001, Raptakis et al. 2004, Apostolidis et al. 2005) 3D model (Skarlatoudis et. al 2010)	Numerous boreholes, geotechnical investigations, cross-hole & downhole measurements. More than 30 ambient noise arrays More than 400 single station ambient noise measurement	Franco-Hellenic Collaboration Earthquake Data available Damage map from the 1978 event (M6.5)
3	Argostoli	3 surface	2D cross section	Geotechnical data for 3	Ionia-net accelerometer

	1996-1999 (3.0≤M≤5.0)	accelerometers 1 downhole accelerometer	(Ionian network)	boreholes Geophysical data (?) 2 single station ambient noise measurements	array
4	Grevena Dec. 2008 – Feb. 2009 (2.0≤M≤5.5)	6 velocimeters	1D model (certain sites)	More than 20 boreholes SPT values 4 ambient noise arrays 60 single station ambient noise measurements	SyNaRMa project Earthquake Data available Topography effects apparent during 1995 damaging event (M6.7)

Table 3. SED contribution to JRA1

No	Earthquake Recordings	Number of seismic stations	Model	Geophysical/Geotechnical Investigations	Comment
1	Basel area (urban, 1D-2D) Nov. 2006- July 2007 195 records available at SED (3500 events localized by Geoth. Explorers) To check if available for the project	Variable between 18 and 24 during the recording period	3D model exists / to use the model a project- agreement is needed	About 1400 single station H/V About 30 ambient vibration array measurements Some seismic lines	The dataset is too large to be completely transferred
2	Sion area (urban, 2D, Alpine valley) October 2004 to June 2006 16 records of local earthquakes	13 seismometers from April to October 2004 9 seismometers from June 2005 to April 2006, plus 2 accelerometers	3D model exists and is available in its original form	About 400 single station H/V About 10 ambient vibration array measurements	The dataset is too large to be completely transferred

	available				
3	Visp area (urban, 1D-2D, Alpine valley) Nov. 2008-present Under development Not yet available	8 seismometers from November 2007 to May 2008 2 BB seismometers from November 2007 to May 2008 3 seismometers from November 2008 to May 2009 4 accelerometers from 2010	3D model under development and is not yet available. (also as part of NERA)	About 120 single station H/V 11 ambient vibration array measurements	The dataset is too large to be completely transferred Needs agreement with COGEAR partners.
4	Randa site unstable rock slope May 2009- Oct. 2009 Under development Not yet available	2 seismometers from May 2009 to October 2009	Simplified 3D model under development and is not yet available (also as part of NERA)	3 ambient vibration array measurements	Needs agreement with COGEAR partners.
5	Grächen site unstable sediment slope Nov. 2007- May 2009 Under development Not yet available	1 seismometer from November 2007 to May 2008 1 BB seismometer from November 2007 to May 2008 3 seismometers from November 2008 to May 2009 planned: 1 accelometer from Jan 2011	3D model under development and is not yet available (also as part of NERA)	About 25 single station H/V measurements 4 ambient vibration array measurements	The dataset is too large to be completely transferred Needs agreement with COGEAR partners.

Note of the contributor: The datasets are generally too large. So the amount of work to bring the data in another database is out of reach for SED. It is not necessary to recollect all data again, but to provide information were and how to get the datasets

Table 4. AUTH contribution to JRA1

No	Earthquake Recordings	Number of seismic stations	Model	Geophysical/Geotechnical Investigations	Comment
1	EUROSEISTEST Location: Mygdonian basin 30km NE from Thessaloniki Greece Operating since 1995 More than 300 earthquakes were recorded Available at AUTH	21 : 15 Surface and 6 down-hole	3D model exists (detailed)	All kind of geophysical surveys and geotechnical field and laboratory tests, including, single and array microtremors, boreholes, SPT, CPT, C-H, D-H, SWI, SASW, RC, CTX (See Fig. 1)	The site is adequate for theoretical and experimental studies related to complex site effects i.e. valley, 1D- 2D-3D, vicinity of normal fault in the linear and non-linear range
2	CORSSA (Corinth Soft Soil Array) Location: At the city of Aegion, Greece 473 earthquakes were recorded (2002 – 2008) A project agreement will be signed for the availability of the recordings.	7 (3 surface and 4 down-hole) The two surface are up-hill and they have not recorded all earthquakes It is scheduled to install two more surface stations in the near future	2D model exists (detailed)	Geophysical prospecting and geotechnical tests Geotechnical boreholes, SPT, CH-DH, SWI, Single-station and array microtremors Lab tests (standard and dynamic) on soil samples	The site is adequate for theoretical and experimental studies related to complex site i.e. 1D-2D effects, topography, normal fault, basin edge effects in the linear and non-linear range

Table 5. LGIT contribution to JRA1

No	Earthquake Recordings	Number of seismic stations	Model	Geophysical/Geotechnical Investigations	Comment
1	Grenoble, Dense array 6 months, around 10-15 EQ (local, regional, teleseismic) weak motion	29 stations (CMG40 and L22 sensors)	3D model exists (Chaljub et al. 2008)		Data available (condition: to quote authors)

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APPENDIX 1

Minutes of the JRA1 Kick-off meeting
Vienna–VCE Office, 17/11/2010, 15:00-17:30pm

Present:

P.-Y. Bard, J. Burjanek, E. Chaljub, C. Cornou, G. Cultrera, J. Kristek, P. Moczo, S. Parolai, K. Pitilakis, A. Rovelli, A. Savvaidis, N. Theodulidis.
Could not come : D. Fäh

After a short round table for presentations, P.-Y. Bard presents an outline of the JRA1 work content (attached file), and a few points arise from the general discussion:

- The deadlines are short and should be kept in mind for a relasitics program (Stefano)
- The available money is limited, son only very specific and well targeted experiments should be considered and carefully designed to enlighten key issues (Kyriazis)
- The parameter numerical sensitivity study is critical in identifying what should be looked for in nex experiments (Kyriazis)
- As much as possible, the instrumental surveys should be performed on a site where different issues could be simultaneously analyzed (basin, surface topography and ground stains) (Cécile, Giovanna)

Each task is then briefly presented and discussed by the task leader :

Literature review and data gathering **[T1, N. Theodoulidis]**

- From the rapid survey launched prior to the meeting, a total of 19 existing data sets could be available within the consortium, a few of which need some agreements with external partners for use within the consortium (because obtained within previous and different frameworks)
- 7 from INGV, 5 from ITSAK, 5 from ETHZ, 1 from LGIT, 1 from GFZ
- Need for clarifications
  - Written agreement on the use of the shared data (dissemination, publications etc…)
  - What kind of meta data is readily available or could be rather easily obtained ?
  - How to made the data usable for everybody without heavy work on reformatting / archiving → contacts with WP4 welcome

Critical evaluation of observed site effects and basin effects [**T2, S. Parolai]**

- The design of new experiments calls for a clear definition of the goals
- Would one single site suit the requirements for 11.2 (basin), 11.4 (topography) and JRA3 (ground strains) ?
- What are the characteristics of the available instruments (each partner), and the requirements for the identified goals ?
- Keep in mind the deadlines for planned deliverables

Modelling of basin effects **[T3, Em. Chaljub]**

- Should we consider all possible basin configurations ? Certainly no ! Only select some relevant ones for designing and calibrating "simple" aggravation factor (functional forms and level)
- Which numerical codes are available within the group ?
  - Linear : DGM at ETHZ, SEM at LGIT/ISTerre, FDM at FMBA
  - NL : FLAC + ABAQUS at AUTH

- Do we need a preliminary verification and to which precision level ?
- The design of the simple models should keep in touch with EC8 site classification

Controlled experiments on surface topography effects **[T4, A. Roveli]**

- A significant numbers of datasets in Italy; often with directionality / anisotropy
- Key missing information: good geophysical characterization
- Interrogations on the effects of existing fractures on polarization and/or directional amplification

Development and calibration of simple, engineering-oriented correlations **[T5, P-Y. Bard & G. Cultrera]**

- Considering Donat's scepticism about this Task, it is decided that it will be led by Giovanna and PY.

It is agreed that an early meeting is needed for important decisions on the following items:

- Which site for the experiments, which goals, when, how (which instruments and how many) ?
- Goal and contents of sensitivity numerical studies

This meeting will be held at INGV in Roma on March 2-4, 2011.

Tentative agenda / goal for the Rome meeting

1 - Background knowledge and gaps (≈ ½ day)

- Literature review on basin effects and topography effects
- Literature review on aggravation factor
- Establishing a list of key soil and geometrical parameters to look for correlations
- Potential techniques to look for correlations

2 - Numerical modelling (≈ ½ day – need for more ?)

- Numerical modelling : needs in the linear and non-linear domains
- What can we do within the time constraints?
    - Available tools / codes and required checks
    - "Canonical" structures vs real sites
    - Forward / Reciprocal computations
    - Ground motion parameters to be computed
- Decisions on who does what and when

3 - Existing and new instrumental data (≈ ½ day – need for more?)

- How to evidence and quantify 2D / 3D effects (basin, topography) from pure data processing ? : possible processing techniques
- Examining existing data sets : past processing and results, metadata, possibilities of complementary processing
- Format and availability issues : links with WP4
- Listing potential sites for detailed instrumental surveys
- Selecting the only or the two sites
- Setting up the goals of the experiment, + schedule and needs (seismological and geophysical surveys) vs actual availability of instruments within the consortium (which sensors, data loggers, timing, etc.) + small group work / discussions as needed

Required : volunteers for presentations

P-Y. Bard volunteered for some presentation on

- Review on surface topography effects (AGU'09)
- Aggravation factor : possible models

APPENDIX 2

Minutes of sub-meeting on Data Sharing Scheme and New Experiment
Roma 3 March 2011, 09:00am-14:00pm

Participants for Data Sharing Scheme & New Experiment

AUTH:K. Pitilakis (first part then moved to modelers' meeting)
INGV: G. Cultrera, G. Milana, G. DiGiulio, F. Cara, D. Famiani, P. Bordoni
SED:D. Faeh, Jan Burjanek
ITSAK: N. Theodoulidis
GFZ: S. Paolai, Ang. Strollo
ISTERRE: C. Cornou

To discuss and conclude about:

1. Sites with good quality of data (presentations)
2. Old data gathering and dissemination (web database, format…)
3. New experiment (site selection 1 or 2)
    - where
    - when
    - instruments available
    - manpower needed & participate

Sites presented

1.Mygdonian basin_EUROSEISTEST area- basin effect
    - Geodata available
    - Waveforms available
2.CORSSA area-Basin and topo effects
    - Geodata available(?)
    - Waveforms available(?)
    - Proposed for new experiment for basin(?) and surface topography
3.Sion area- basin effect
    - Geodata available
    - Waveforms available
4.Visp area-basin effect
    - Geodata available (? End of 2012)
    - Waveforms available (? End of 2012)
5.Wakkerschamatt area-Rockfall
    - Randa site-Rockfall
    - Graechen site-deep seated landslide
6.L'Aquila are – basin and topo effects
    - Geodata available
    - Waveforms available
7.Gubbio basin – basin effects
    - Geodata available
    - Waveforms available

8.Fucino area -basin effects
- Geodata available
- Waveforms available
- Proposed for new experiment for basin and surface topography effects*

9.Nocera Umbra area – topo effects
- Geodata available
- Waveforms available

10.Narni hill – basin and topo effects
- Geodata available
- Waveforms available
- Proposed for new experiment for surface topography effects (more geophysical work needed)

11.Selected broadband Italian stations for surface topography effects
- Geodata available
- Waveforms available

12.Cavola site – landslide
- Geodata available
- Waveforms available

13.Grenoble area – basin effects
- Geodata available
- Waveforms available

14.Grevena – basin effects
- Geodata available
- Waveforms available

15.Argostoli – basin effect
- Geodata available
- Waveforms available
- Proposed for new experiment for basin and surface topography effects*

List of parameters required for basins & surface topography studies

- Amplification (SSR)

- Fundamental fo
- Vs profile (of reference station)
- Vs profile (of valley stations, Vs-aver-bed, Vs30)
- Station-Site classification based on geology (few classes based on age)
- Q, kappa value(?)

- Morphology of the basin (2D/3D)(depth below station, depth, length, width of valley, edge slope, closest distance to edge)

- Morphology of topography (2D/3D)

Data gathering and dissemination

1. Simple web page

Short description

1st Experiment	
2nd Experiment	
3rd Experiment	

⋮

(i) Name of Experiment

(ii) Date of Experiment

(iii) Short description

(iv) Link to the Table

(v) FTP link to the data

2. GEOMIND db

The Partners complete an *.xls with specific description

The *.xls → converted to XML file [tool provided by GEOMIND]

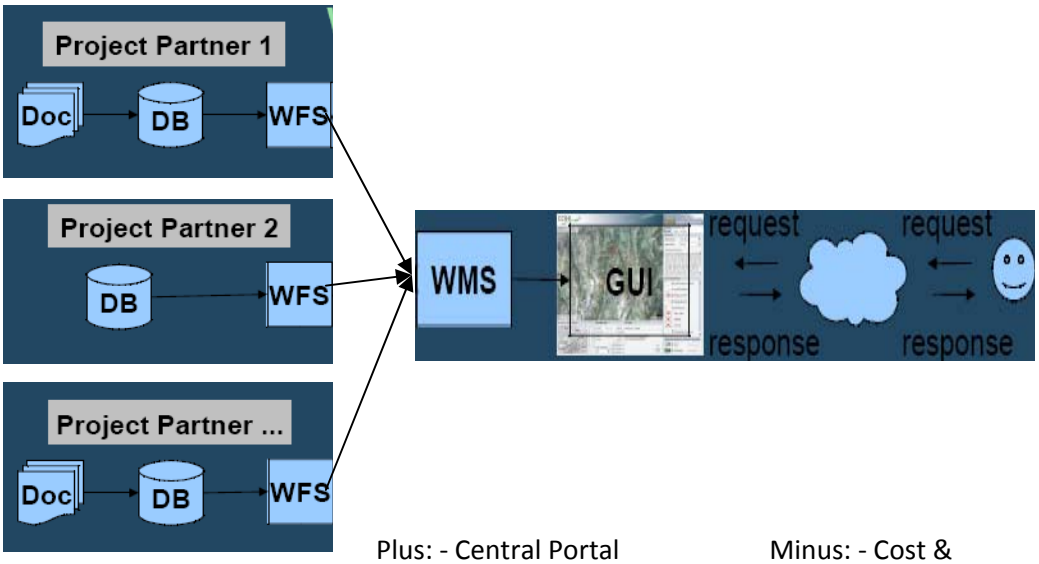
XML file uploaded to GEOMIND db by each Partner

Plus: - Central Portal
- Distributed data

Minus: - Cost & Time to create FTP
- Sustainability???

3. Use of WFS [like COGEAR project]

Each Partner has/create its own database (or create one and distribute among Partners)



Plus: - Central Portal
- Distributed data
- sustainable

Minus: - Cost &
-Time to create FTP

Data Sharing Scheme Discussion

(i) Format of the data remains as it is for each Institute (SAC, miniseed, GSE, CGY, ascii)
(ii) For new experimental data → EIDA data archiving db

To do within next 2 months:

1. To ask NERA portal help for GUI and WMS
2. To prepare description of metadata fields-XML
3. To prepare web page and distribute to all partners (within 2-3 months??)

Selection Criteria for the New Experiment Sites

8. Previous data availability
9. Surface topography & basin effects
10. Safety of instruments
11. Housing & Electricity
12. NERA-JRA3 near fault strain requirements
13. High seismicity rate
14. Local people to monitor & check (safety, operation etc.)

Guliano Milana & Nikos Theodoulidis to check for the details of the 2 sites selected (Fucino & Argostoli) and inform participants by April 15, 2011.

New experiment

Duration 4-6 months starting from 1st Sept. 2011.

Availability of Participants – Instruments - Manpower
ITSAK: 13 CMG 6TD 30s, 3 persons, 5 solar panels, (15th August + 6 months)
ISTERRE: 20-25 Taurus with CMG40, 30s, 3persons (including a PhD student)
All station with solar panel, (1st Sept. + 6 months)
INGV: 12 Quantera or Reftek (6 channels Le5s, episensors), 3-4 persons
All station with solar panel, (15th Sept + 6 months)
GFZ: 10 EarthData EDL with Mark 1Hz, and 5 K2 with episensors,2 persons)
All station with solar panel, (15th July + 6 months)
SED: Will know by July 2011
AUTH: Will be asked

Concluding for the new experiments:

- Available 55 to 60 instruments
- 4 Institutes
- 12 persons

APPENDIX 3

NERA-JRA1 Short Report
INFORMATION ON ARGOSTOLI EXPERIMENT SITE AREA

by N. Theodoulidis and A. Savvaidis (ITSAK)

1. Introduction

The town of Argostoli is situated in the western Greece, on the Cephalonia island, in the Ionian sea (Figs 1, 2).

Fig. 1. The town of Argostoli, Cephalonia island, in western Greece.

Fig. 2. The town of Argostoli and the proposed test site.

2. Seismotectonic Information

Argostoli was completely destroyed by a sequence of destructive shocks, the largest of which occurred on 12 August 1953 with M7.2, at an epicentral distance less than 20km from the town. Another large magnitude event, M7.0, occurred on 17 January 1983, at an epicentral distance of about 30km, with low damage impact on Argostoli.

The island of Cephalonia, falls in the northwesternmost boundary of the Aegean plate that is dominated by the Cephalonia Transform Fault (CTF in Fig. 3) (Scordilis et l., 1985). The slip direction of the CTF, N213°, is in agreement with a southwestwards motion of the Aegean. The rate of seismic slip in the CTF is ~3cm/year, the highest observed in the whole Aegean area (Papazachos and Kiratzi, 1996).

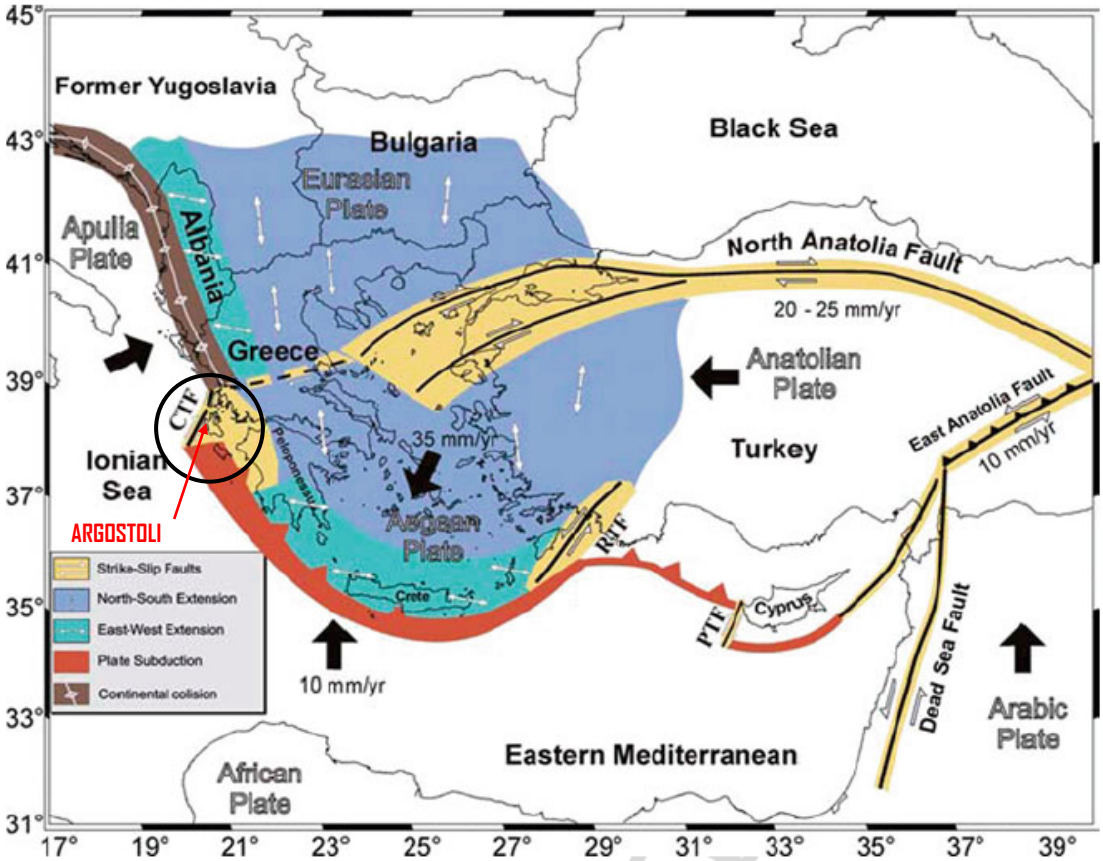


Fig. 3. Plate motions that affect active tectonics in the Aegean and surrounding area (Papazachos et al., 1997).

The seismicity of the broader Argostoli, Cephalonia area is the highest in Greece. In Figure 4 a preliminary seismicity map of the last 3 months is given.

In Fig. 5, a plan view of the Argostoli test area (zoom in). The R1, R2, R3, R4, R5 (along with their altitudes) are the points where single station ambient noise measurements were performed for topographic effect investigation. All of them fall in an archaeological area that is very rarely visited by tourists. After discussion with archaeologists it was assured that we may safely deploy 4-5 instruments on the hill. The area included within the yellow polygon often swamps during the winter time (December to February).

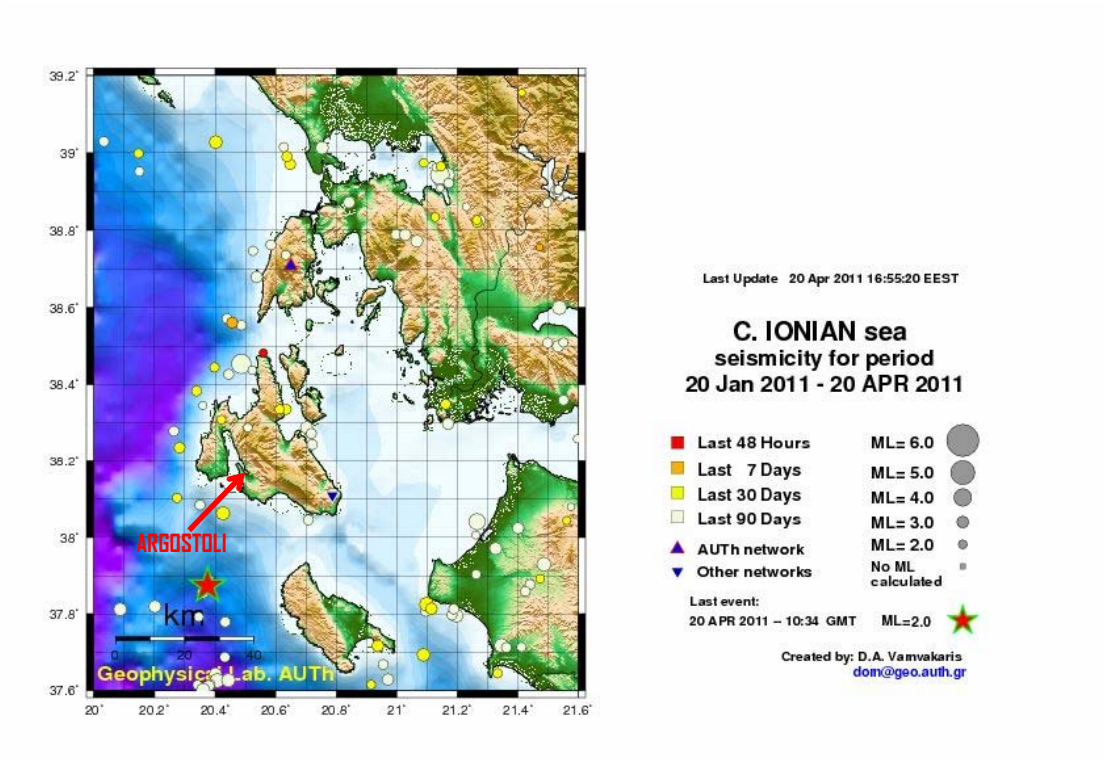


Fig. 4. Seismicity of Greece (preliminary location of epicentres) during the last 3 months in the vicinity of Argostoli, Cephalonia, Ionian Sea.

3. Test Site Information

Fig. 5. Plan view of the Argostoli test area. B1, B2, B3 the available boreholes. R1, R2, ...,R5 the sites on the hill with their altitude, HKLM the protected fenced area.

Fig. 6. Zoom in the protected fenced area

In Fig. 6, the protected fenced area, own by the local Forestry Inspection Agency, is shown. The sizes of its polygon side are: HK=45m, KL=82m, LM=78m, MH=88m.

An ambient noise array experiment took place close by the test area. The array's centers and radiuses are as follows:
C1: The center of the 1st circle, radius=15m (white color), C2: The center of the 2nd array, radius=41m (blue color) and C3: The center of the 3rd circle, average radius 70m (green color)

In Fig. 7, a photo taken from northwest of the test site shows the single station ambient noise measurement sites (R1, ..., R5) as well as the B1, B2 borehole sites.

In Fig. 8, the proposed cross section 2D model of the Argostoli valley by Protopapa et al. (1998) is shown. At sites EF1 (downhole), EF2, EF3 around 180 accelerograms were recorded during the period 1996-1997 (3.0≤M≤5.0). Further analysis of this data *is in progress*. The strong motion array (EF1-2-3) is out of operation long time ago.

Geophysical and geotechnical measurements were also performed at the sites B1, B2, B3 and will be presented along with the ambient noise array results *(work in progress).*

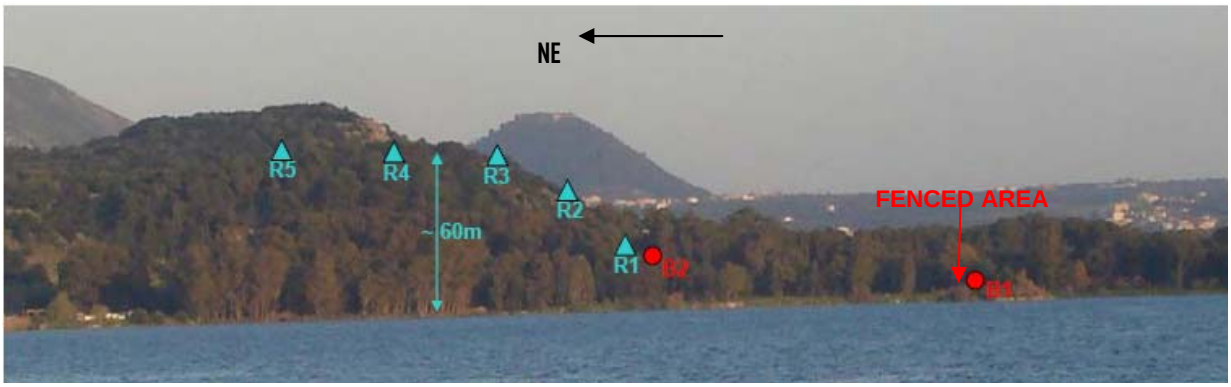


Fig. 7. View of the valley from northwest of the test site.

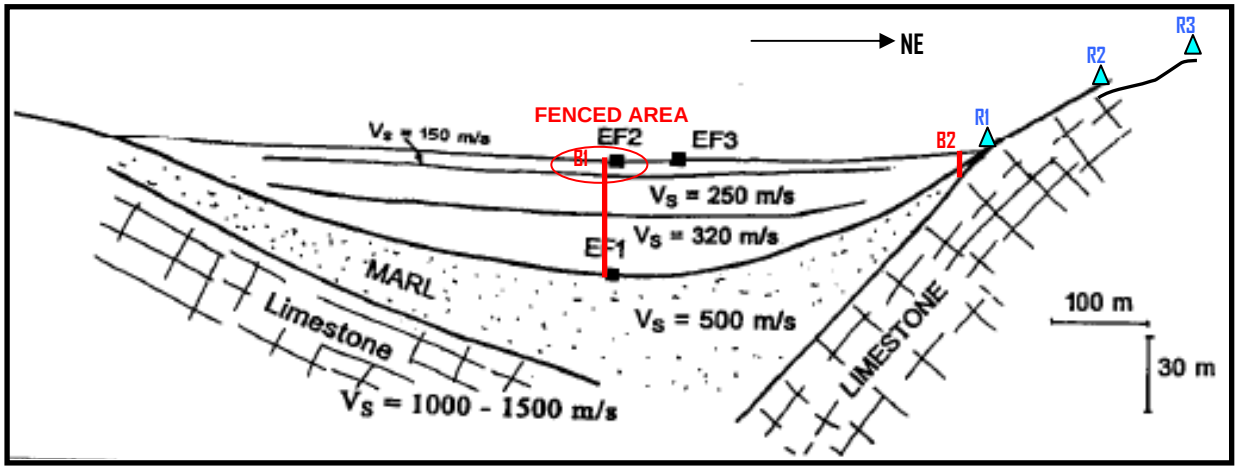


Fig. 8. Proposed cross section 2D model of the Argostoli valley (by Protopapa et al. 1998)

4. Preliminary Results & Discussion

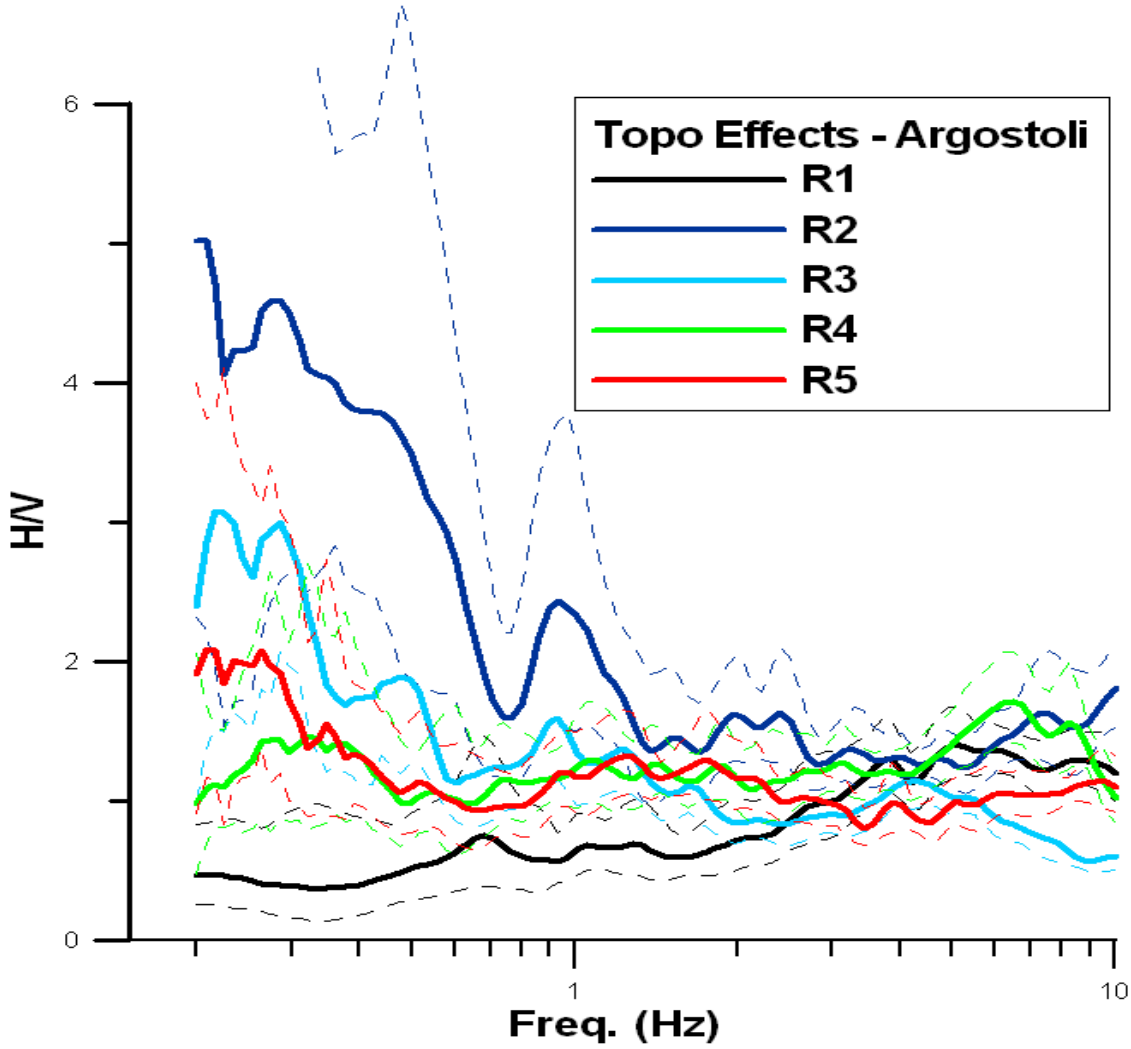


Fig. 9. Ambient H/V average spectral ratios (±1sd) at the 5 selected on the hill sites.

Ambient noise measurements were performed for 30min at each site. Results of ambient noise H/V spectral ratios for the hill sites are shown in Fig. 9. It seems at for sites R2 and R3, where the H/V amplitude exceeds the 2, there is a fundamental (?) frequency in low frequency range (0.25-0.4Hz). A second "peak" for these two sites is also apparent around 1Hz (though for R3 its amplitude is <2).

Ambient noise measurements were also performed at the center of the valley (borehole B1) as well as at a rock outcrop site, similar to R1. Measurements' duration was 7 hours to investigate djurnal variation as well. Results of the H/V spectral ratios are given in Figs. 10 and 11. A clear (ideal!) "peak" appears at 1.8Hz with an amplitude between 4 to 6, at the center of the valley. Another "peak" appears at 0.3Hz, though not so clear. The "peak" at 1.8Hz is in good agreement with the 1D model fundamental frequency of the first ~40meters of alluvia overlain the marl (see Fig. 8).

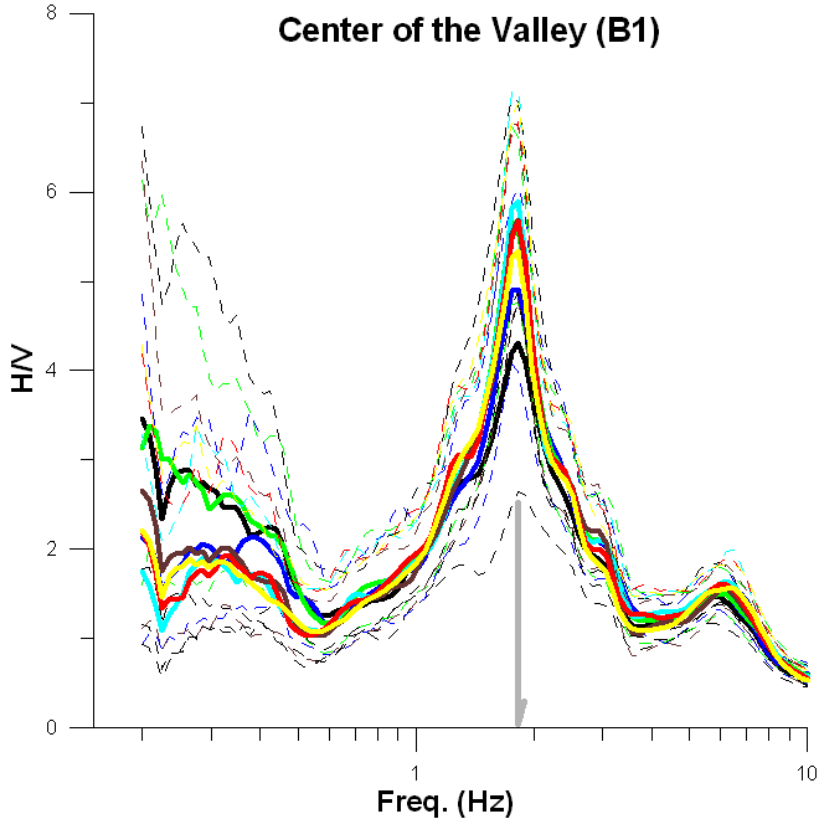


Fig. 10. H/V average spectral ratios (±1sd) at the center of the valley (site B1).

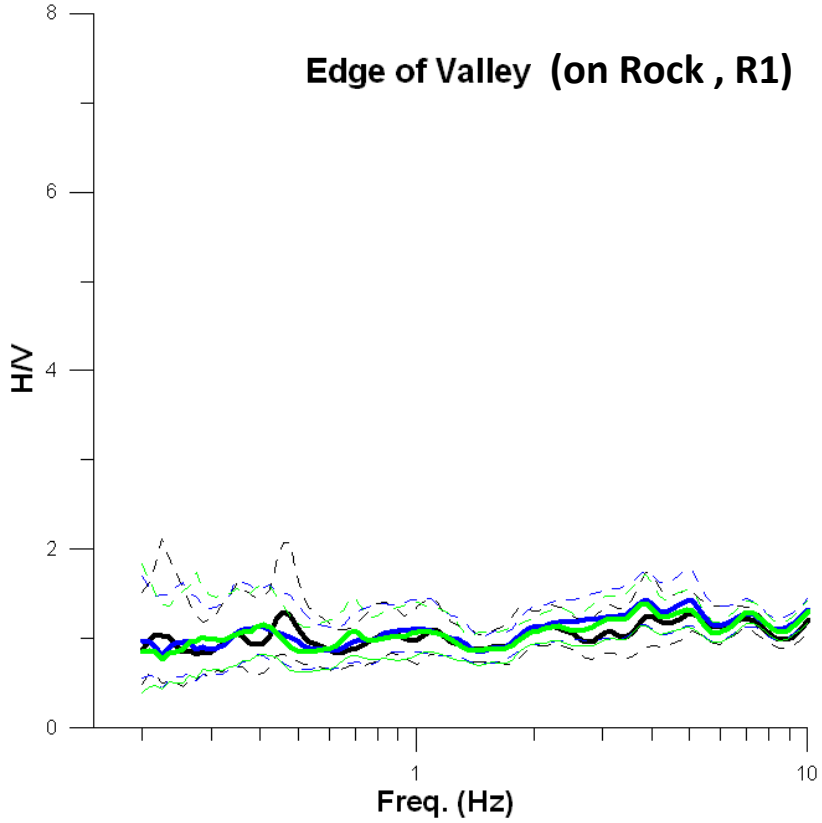


Fig. 11. H/V average spectral ratios (±1sd) at the edge of the valley on rock site.

APPENDIX 4

NERA-JRA1 Short Report
INFORMATION ON FUCINO EXPERIMENT SITE AREA

by Milana G. et al. (INGV)

This short report summarizes some information about Fucino basin to be used for selecting the site for NERA experiment.

Basin experiment

As showed in the last meeting in Rome the Fucino Basin represents one of the biggest sedimentary basin into Apennines range in Central Italy. The origin of the basin is tectonic and a large number of active faults, mainly NW-SE trending normal faults, are present in the area. The area was interested by one of the largest events in Central Italy (1915 Avezzano event, magnitude around 7) that caused a huge amount of casualties and almost completely destroyed all the city and villages in the epicentral area. The extension of the basin is quite big and reaches 20 kilometers in the EW direction and 10-12 kilometers in the NS direction (Figure 1), the maximum depth is of about 800 meters in the eastern sector.

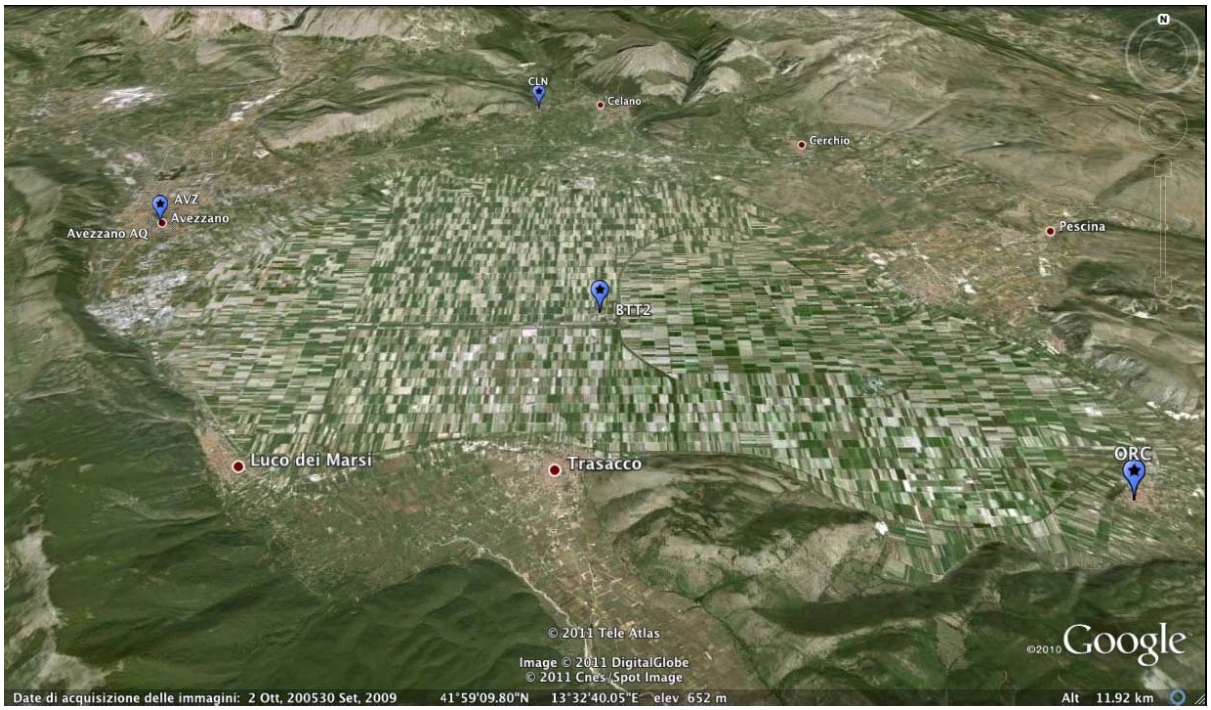


Figure 1) Aerial view of Fucino basin. Blue markers indicate the permanent strong motion stations belonging to the Italian Strong Motion Network (RAN).

The basin is surrounded by hills and mountain ranges that can be suitable for topographic effects studies. The basin is filled by a thick layer of recent sedimentary deposits that consist mainly of clay and sandy clay. In the northern edge of the basin these deposits are covered by more recent gravel deposits related to the limestone reliefs often dislocated by active normal faults. The presence of these materials in the northern sector of the basin can produce a velocity inversion in the first meters of soil that introduces some complexities in the response of the basin. The basin was monitored in 2008-2009 by INGV in the framework of a project financed by Italian Civil Defense. At that time a temporary seismic network based on 18 stations equipped with high sensitivity seismic data loggers and extended band seismometers (Lennartz LE3D-5s) was operating for few monts recording many events mainly related to the L'Aquila April 6th seismic sequence.

The deployment of the network was partially guided by the logistic of the site where the lack of security and power problems did not allow covering some important section of the site.

Two stations were deployed on rock and worked as reference sites, one outside the basin in the NW area (RO01), the second in the SE parte of the basin where a limestone outcrop is present in the village of Ortucchio (PI03). This last station is located in the RAN site ORC, also the RAN site AVZ was monitored by a weak motion instrument during the experiment. The configuration of the instruments installed in 2008- 2009 is shown in Figure 2.

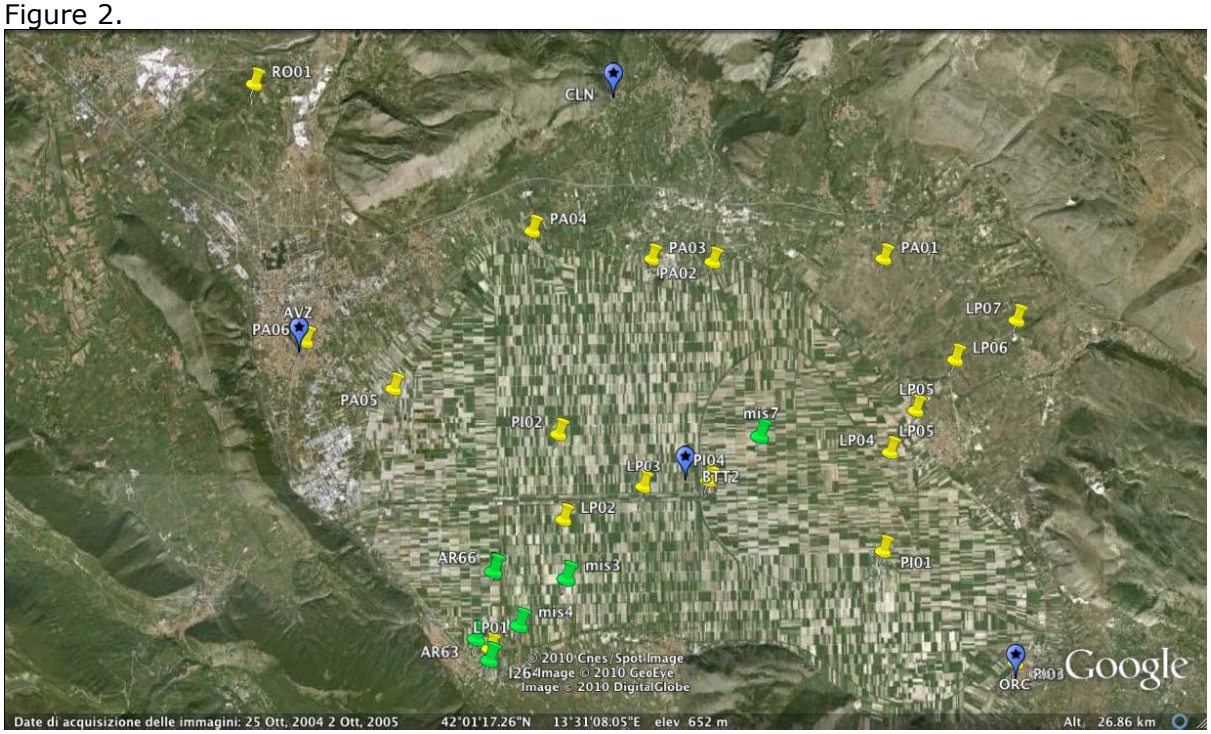


Figure 2) Configuration of the temporary network installed in 2008-2009 (yellow markers). Green markers refer to short duration ambient noise extra measurements.

The station PI01 is installed in the area of Telespazio Space Center, a telecommunication center located in a fenced area with a diagonal extension of about 800-900 meters. The area (Figure 3) is suitable for installing a dense array based on about 12 stations to study waveform's composition and strain.

Figure 3) The area of Telespazio Space Center.

The data collected during the 2008-2009 experiment allowed to infer many information about the resonance frequency fo and on the depth and velocity in the soft sedimentary layer. This is particularly true for the southern section of the basin where the soft sediment seems to be more homogeneous both laterally and vertically. The complexities of the northern part of the basin deserve some extra work to be fully understood. A paper now under revision on Bulletin of Earthquake Engineering, which i enclose to this report, presents the main results available up to now. Following what discussed before we propose the northern section of the basin as site to investigate in the framework of NERA project, Figure 4. Due to the density of both private and public buildings in the area we believe that the logistic of the site can be successfully resolved with a site survey if the site is selected for the experiment.

Figure 4) The yellow line represents the proposed area for the deployment of the seismic network to be installed in the NERA experiment.

Figure 5) Geometry of 2D ambient noise array installed in Avezzano.

It is interesting to notice that an array measurement was already performed, with quite good results, in the Avezzano area for characterizing the RAN strong motion site, Figure 5-6. Following that experience we believe that the installation of a dense array also in the city of Avezzano can be feasible in the fenced area marked by the red ellipse in Figure 5.

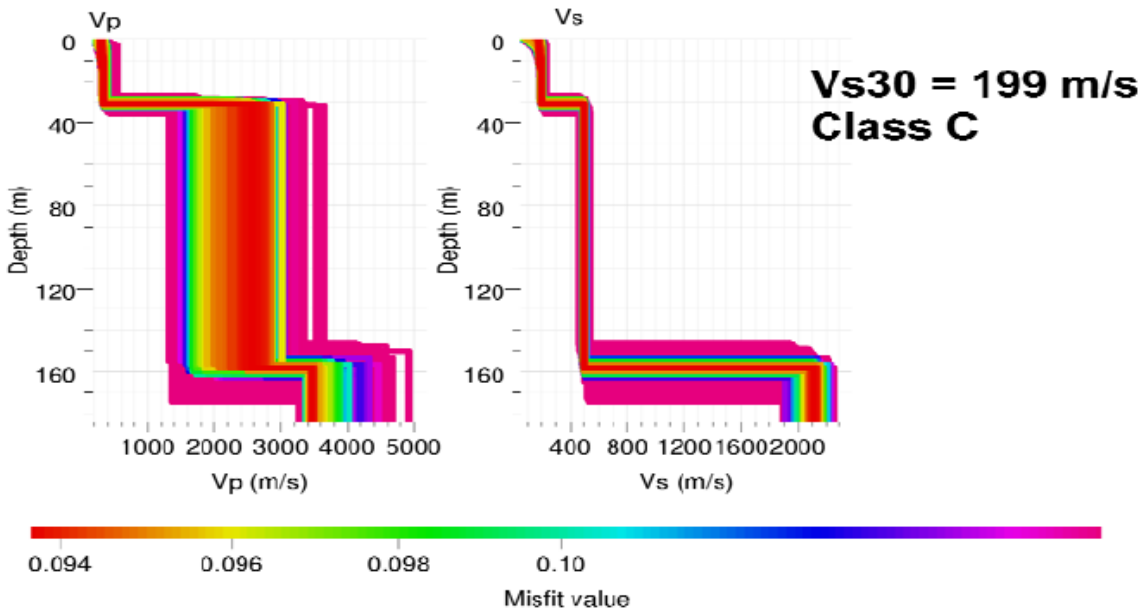


Figure 6) Velocity model proposed for Avezzano RAN site using 2D ambient vibration array.

Topography experiment

While the basin area is suitable, both from scientific and logistic points of view, to host the NERA experiment some doubt arises about the possibility of detecting topographic effects in the area. As described before topography is an important feature in the area since Fucino basin stands at an elevation of about 700 meters asl while the surrounding mountains can reach an elevation of more than 2000 meters. Unfortunately the logistic, both in term of security and power supply, is not favorable and it is not easy to find and area for the NERA topo experiment.

We propose the hill range that borders the western side of the basin close to the city of Avezzano, Figure 7.

Figure 7) The hill range proposed for topo experiment. The site of Madonna di Pietracquaria (PTQR), located on top of the ridge, hosts a permanent station of the italian seismic network run by INGV.

The difference in elevation between the hill top and the city of Avezzano is of about 350 meters. The length of the profile drawn in figure 7 is of about 900 meters, the average width of the ridgeranges between 1.3 and 1.8 kilometers. Besides the site on the hill top it is possible to find a second site along the slope to install a station of the seismic temporary network. Starting from the continuous recording available at PTQR we performed rotated HVNSR analysis on few one hour long time windows recorded during the night. The results are reported in Figure 8.

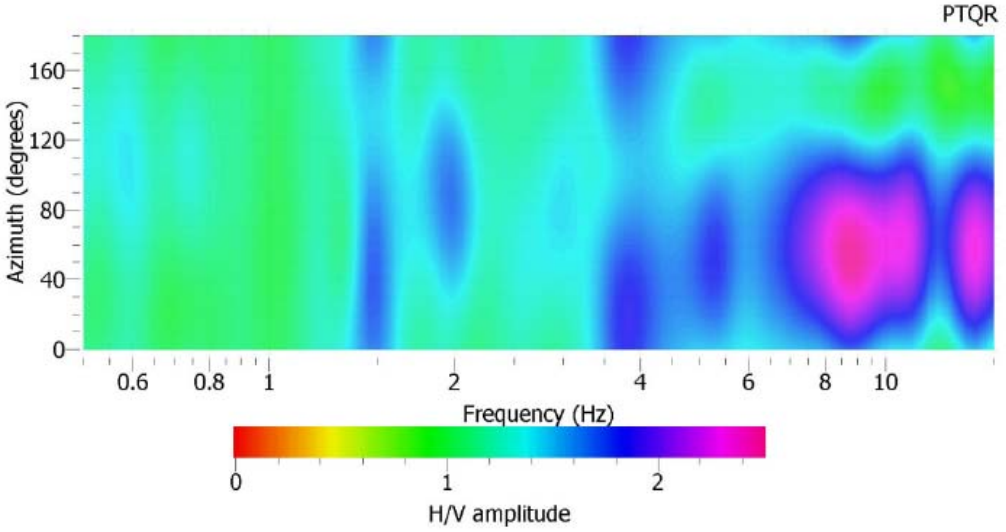


Figure 8) Ambient noise rotational H/V for PTQR station.

From the figure it is clear the presence of an amplification peak at 8.5-9.0 Hz with amplitude of about 2.5 and orientation of about 60 degrees. The orientation of rotated H/V is almost perpendicular to the elongation of the Pietracquaria hill range. We repeated the analysis using some teleseismic events, namely the mainshock of Japan earthquake of March 2011, one of its major aftershock and an event from southeastern Asia. Even though the energy of these events is quite small in the high frequency range, the signal to noise ratio is between 2 and 3 at the frequency where the amplification appears. Also using teleseismic events the peak is present and appears to be enhanced with respect to the one found using ambient noise, Figure 9.

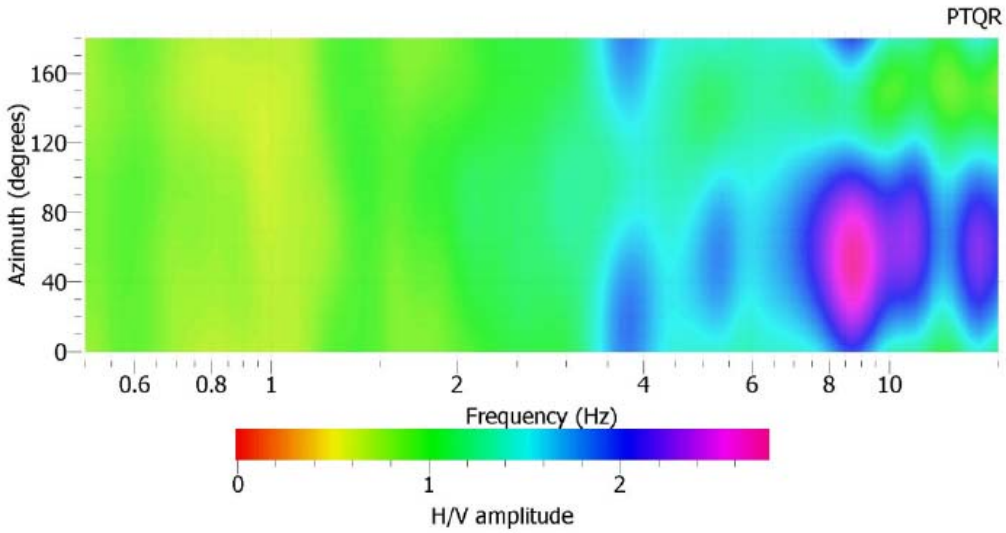


Figure 9) Rotational H/V for PTQR station for the magnitude 8.9 Japan earthquake of March 2011.

Seismicity of the area

The Fucino area was historically interested by a destructive event, as already discussed, but beside this very important event the seismicity rate of the area is quite low if compared with adjacent areas in Central Italy. The basin can record the seismic activity related to many source areas distributed all around it and connected to extended normal fault systems. During the past two years the major contribution to the recorded seismicity was related to L'Aquila sequence, culminated with the magnitude Mw 6.3 event of April 6th. Nowadays the L'Aquila sequence seems to be decreasing in terms both of magnitude and number of events and the main activity is due to some local events located close to the NW side of the basin. The magnitude of these events is quite small and reached the maximum value of 3.9 with the event of January 9th 2011. The table 1 shows the list of events with local magnitude greater than 2.0 recorded at a distance minor than 30 kilometers around the city of Avezzano.

Table 1) Events with magnitude greater than 2.0 at distances below 30 kilometers from Avezzano.

Date	Time	Lat.	Long.	Depth	Ml
4/23/2011	03:44.0	41.874	13.645	8.6	2.7
4/21/2011	44:35.0	41.944	13.274	9.9	2.0
4/16/2011	57:37.0	42.068	13.246	9.0	2.2
4/15/2011	48:14.0	42.053	13.26	8.5	2.4
4/11/2011	45:50.0	41.784	13.57	9.1	2.2
3/9/2011	23:37.0	42.093	13.67	7.7	3.1
2/23/2011	29:47.0	42.174	13.45	7.9	2.0
2/19/2011	48:19.0	42.096	13.72	22.2	2.1
2/10/2011	24:38.0	42.052	13.448	9.7	2.1
2/6/2011	35:14.0	41.858	13.666	7.1	2.0
1/26/2011	08:31.0	41.795	13.552	8.9	2.1
1/13/2011	55:17.0	42.103	13.327	7.9	3.3
1/9/2011	58:20.0	42.108	13.334	8.1	3.9

Conclusive remarks

In this short report we tried to summarize the main aspect to be considered before choosing the Fucino basin as site for the NERA experiment. A greater detail on the characteristics of the area can be found in the attached manuscript. In our opinion the Fucino basin is quite interesting from the point of view of the response of alluvial basins. Even though a lot of work has already be done and a lot of independent data are available, the complexity of the basin suggests some more work to better understand the behavior of its northern side. This is particularly important since the most populated cities and villages of the area are just located on that sector of the basin. Regarding the topographic effects, logistic problems tend to exclude the possibility of monitoring, with temporary stations, the areas more suitable for producing them; this reduces the choice to the ridge of Pietracquaria where some polarized amplification effect is observed. This feature is quite stable even if the frequency of the amplification peak is quite high and can not easily be put into relation with the geometry of the ridge that would suggest amplification at a lower frequency range. Actually, in our opinion, the weakest point of the Fucino site can be found in the low seismicity rate associated with it. After the sequence related to L'Aquila earthquake the rate of activity decreased and now the probability to record some event with a moderate to high magnitude is low. This can affect the experiment in particular if the recording window does not exceed the duration of three or four months.