Deliverable

D3.1 Survey of educational seismology activities in Europe and globally

Work package	WP 3 Networking Seismo@school outreach programs (NA1)
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Approval	Management Board
Status	Final
Dissemination level	Public
Delivery deadline	31.10.2018
Submission date	31.10.2018
Intranet path	/DOCUMENTS/DELIVERABLES/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730900.

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1 Summary

Seismo@school programmes using observational seismology as an educational tool in schools and non-formal educational settings like museums or citizen-seismology projects are effective methods to bring people in touch with complex scientific concepts and to increase their understanding of earthquake hazards and risk.

The aim of this work package is to connect SERA partners that are already leading seismo@school initiatives, supporting them in sharing best practices. SERA partners will organize workshops to involve teachers and other science outreach professionals in this work package.

This report is a broad survey of the current status of joint-SERA activities, country specific activities and a initial survey of educational activities elswhere in the world.

2 SERA workshops in educational seismology

SERA partnerships offer the chance to access a wide and valuable expertise highlighted in workshops dedicated to high school teachers. The strategy behind these events was to also connect the subject (seismology and Earth science) with other important STEM disciplines, while at the same time expanding the audience.

Figure 1 SERA Romania workshops, 2017; seismology training for teachers from Romania, Moldavia and the Ukraine.

2.1 Romania workshops

In November 2017, a three-day event was organized in Romania focused on demonstrating how seismology and seismic engineering can provide tools and examples of educational activities.

The workshop was structured as a mix of projects presentations, hands-on activities, round-table discussions and thematic visits to research facilities. More than 50 teachers participated in the first day of the SERA workshop. The majority of teachers were from Romania, but there were also several from Moldavia and Ukraine. Four parallel sessions of interactive workshops were held during the three-day event:

Figure 2 Round table discussions at the SERA Romania workshops, 2017; part of National Conference of the Community for Science Education (CNCES2017).

- WS1 – Basics in Seismology
- WS2 – Introducing and Demonstrating Earthquake Engineering to Schools
- WS3 – Mars@School ; WS3 – InSIGHT

The second and third day of the SERA workshop was integrated part of the National Conference of the Community for Science Education (CNCES2017) organized in the framework of the European initiative SCIENTIX. The purpose of the conference was to bring together international and local experts from education and science, representatives of research institutes, schools and universities, education and research policy decision-makers, industry and civil society. The conference offered opportunities to present, discuss and experiment with innovative approaches to teaching STEM subjects, as well as to reflect on trends and challenges faced by various actors interested in developing the science/STEM education community.

The conference hosted presentations by key speakers, round-table discussions with expert panels and offered more than 20 hands-on workshops; four were delivered within the framework of the SERA project. More than 150 teachers participating to the CNCES2017 Conference had the opportunity to take part in SERA workshops. The events also allow a very fruitful dialog between SERA partners and SCIENTIX representatives, as well as with other European synergic initiatives (e-Twinning, European Space Agency, ESERO, ERIS, etc). SERA trainers were invited to participate in round table discussions regarding the future of STEM education (*STEM in perspective…trends and challenges*) together with important delegates from the European Institute of Innovation and Technology, European Schoolnet, Ort Israel and the Polish Academy of Science.

Important links have been made with the SCIENTIX project, a landmark platform for the distribution of educational resources developed on research projects.

Figure 3 SERA Romania workshops, 2017; included hands-on activities, round-table discussions and thematic visits to research facilities.

3 Seismology@schools in France

3.1 Introduction

The programmes 'eduseis' then 'edusismo' (numbering some hundred stations installed in metropolitan France, the overseas departments and territories and a few French high schools abroad) is the outgrowth of an experiment conducted in the Southern France some 20 years ago.

The original and innovative aspect of this programme stems from giving students the opportunity to install a seismometer in their school. The recorded signals, reflecting regional or global seismic activity, feed into an online database, a genuine seismic resource centre and a springboard for educational and scientific activities.

Seismology@School Education and Outreach programme can be divided in four main topics :

- seismometer network and online data
- schools resources
- teacher training
- public events

Seismology is studied in the French curriculum in middle and high-schools.

Scientific culture is thus at the heart of seismic risk instruction in France. All of this is in what the 'seismology@school' curriculum is involved, by implementing an educational programme that allows a natural risk culture to be engaged through a scientific and technological approach.

Since then, the programme implemented has gone beyond simply acquiring seismic signals, which has been procured by research and monitoring centres. By appropriating a scientific measurement, the student becomes personally involved and students learn to master complex concepts about geophysics and geosciences. The development of simple devices, and the design of concrete experiments associated with an investigative approach, make it possible to instill in the students, these future citizens, a high-quality scientific culture and an education about risk.

3.2 Network

3.2.1 Mediterranean schools education network

Today, this programme is expanding. New initiatives with Italian, Greek, Romanian, Spanish and Portuguese partners are being put in place to share experiences and data in Europe. Geoazur laboratory (University Côte d'Azur – CNRS – OCA – IRD) leads a new project and network called 'EduMed Observatory'.

'Edumed-Obs' is focused on implementing an interface based on geoscience data about the Mediterranean area, and is dedicated to natural risk education. This observatory for schools aims to facilitate the use of real sensor data in secondary and higher education.

Currently, we manage two seismological schools networks. The historical one is called 'edusismo' with hundred stations installed in metropolitan France, the overseas territories and French high-schools abroad. Since 2016, schools are have been involved in InSight Education[1]. Teachers involve their students in activities around the NASA InSight space mission (using seismology data to explore the deep structure of Mars).

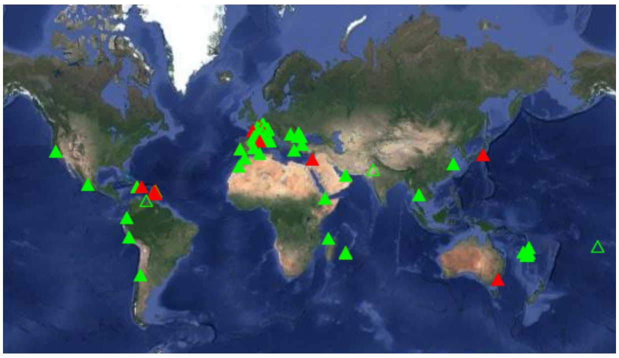


Figure 4 Edusismo network (1996-2018).

Since 2017, Geoazur Education & Outreach (University Côte d'Azur – CNRS) leads a new network called 'EduMed Observatory' with a seismic network for high schools and university students. This network shares data from sensors, connected around the Mediterranean area. The 'EduMed Observatory' website proposes to share data from researchers and schools sensors for educational use. This is also an opportunity to share experiences and data between the different partners (Spain, Portugal, Italy, Greece, Romania and France).

Figure 5 EduMed Obs. seismo network (orange plots) and recent seismicity (purple circles) - http://edumed.unice.fr/

3.2.2 Sensors used in education settings

We propose very cheap and simple sensors for the classroom. We have developed a 'seismobox' which provide a lot of hands-on activities for seismology, geophysics and more. With this kind of material, students can explore how a seismometer works, how to calculate the speed of the waves, how to link the speed of propagation with the material, how the buildings move during an earthquake and how to understand the site effects.

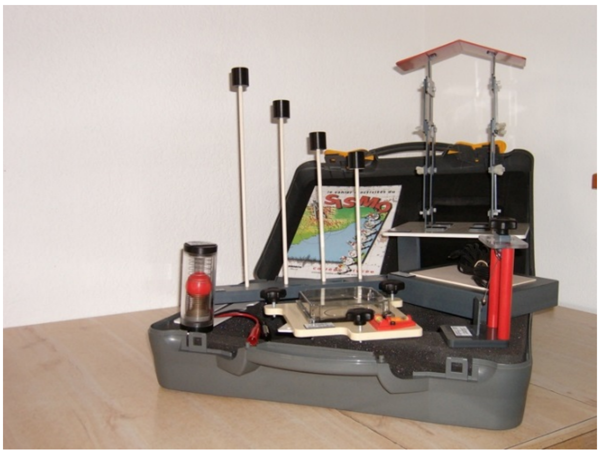


Figure 6 A 'seismobox' with tutorial booklet.

Various sensors are installed at schools; shown in ascending order of cost.

- slinky TC 1 seismometer
- geophone 'staneo vibrato'

[1] https://insight.oca.eu

- Raspberry Shake
- Guralp CMG6 EDU

Schools data is made available online via a dedicated website.

http://www.edusismo.org/

3.3 Teaching resources

To facilitate how to teach seismology at school, we propose hands-on activities ideas and innovative material for the classroom.

When we provide data online, we add case studies examples. Thus, teachers can easily use the data in a specific example and learn more easily how to teach with real and online data. The teachers appreciate this approach. But, teachers tell us also that using data online takes too much time, the data on the websites are not very easy to download or data analysis by the pupils requires specific software. We have made some effort to understand these arguments and to facilitate the use of the data.

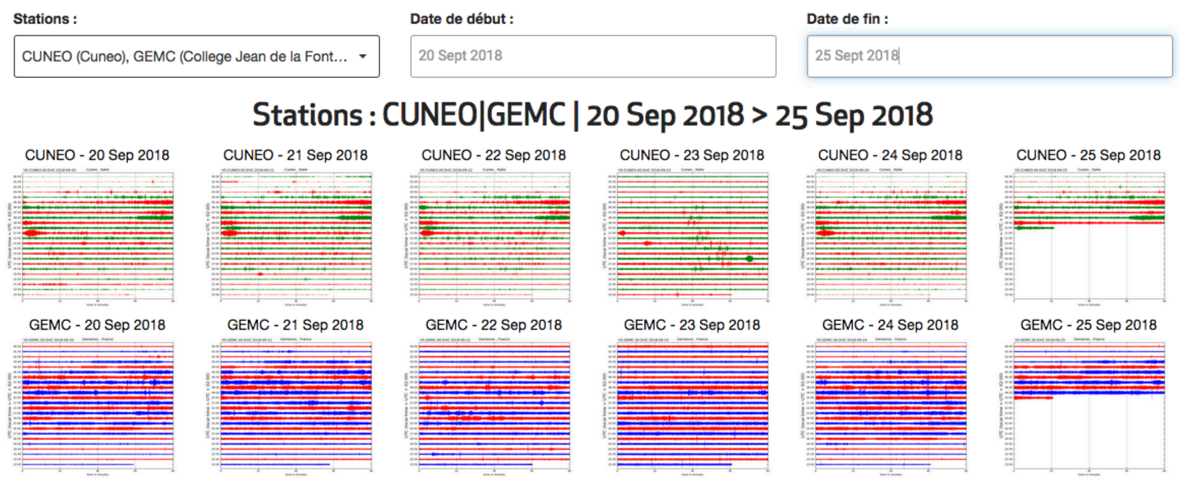


Figure 7 Helicorders from 2 schools stations (Cuneo Italie, and Gemenos, France) - http://edumed.unice.fr/fr/data-center/seismo

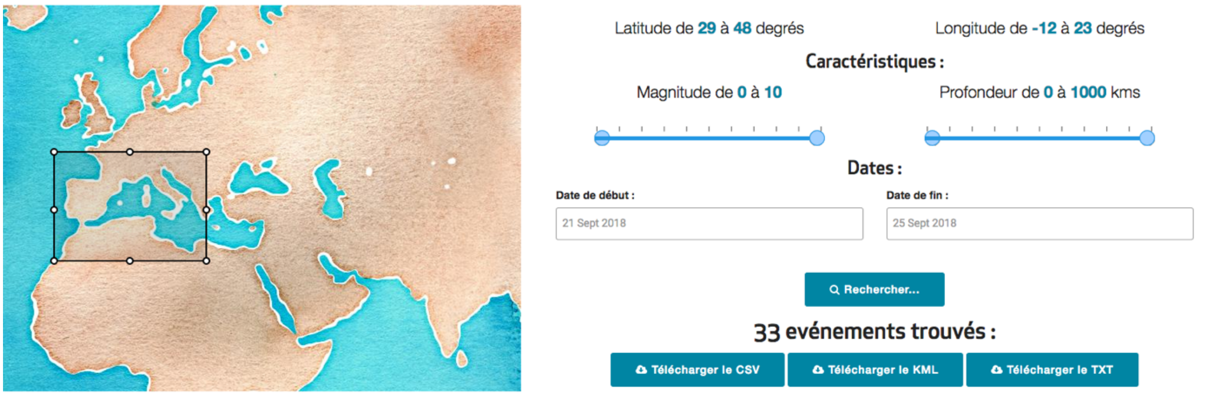


Figure 8 Request seismic catalogs filtered by location, magnitude, depth, time window on various formats (different software usable).

Students can see online and in real time the helicorder from their sensor, they can download specific packages of data with the associated case study (step by step).

It is also important to produce resources such as posters and teaching guides also known as ‘cook-books’. We have produced posters for several different topics :

- tsunami
- macroseismic scale
- seismicity
- school earthquake drills

We have also published examples of hands-on activities with a cook-book (‘cahier du sismo’).

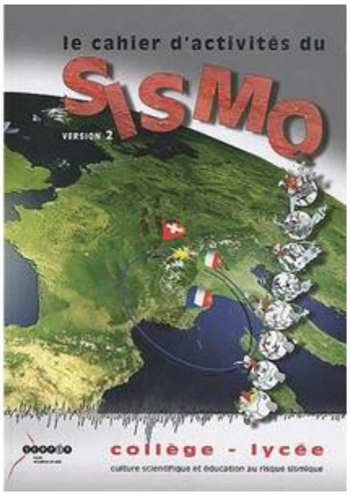


Figure 7 Cahier du Sismo, CRDP Nice.

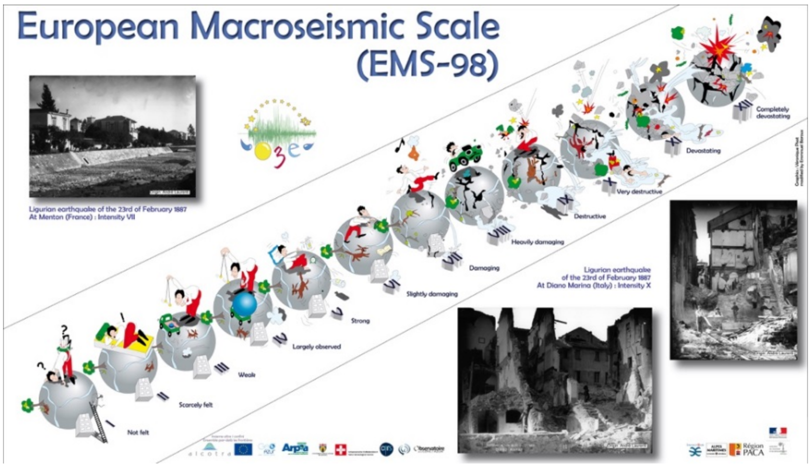


Figure 8 Poster : macroseismic scale (published in three languages).

3.3.1 Teacher training

Once a year, training sessions are delivered to teachers. Typical workshops include presentations by researchers to improve teachers background in geoscience, and practical hands-on activities to discover new materials to teach in the classroom. Workshops also include 'field camps' where teachers practice the use of sensors (seismometers).

The materials developed for the classroom are usually shared online. As a result of the workshops, teachers can propose new hands-on activities that we upload to our websites.

Figure 12 Teachers' 'field camp' March 2018 (15 teachers) France.

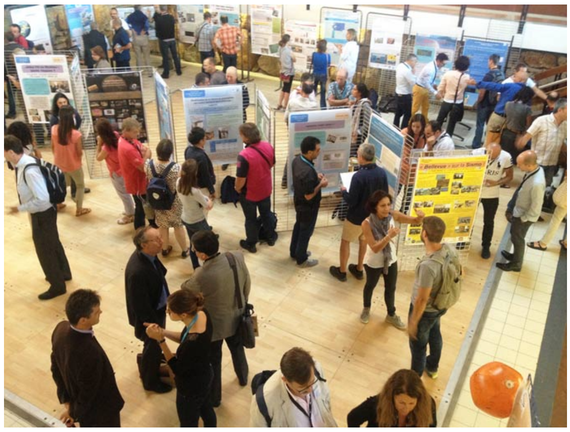


Figure 9 JNE 2017, poster session (50 teachers) France.

Figure 10 Insegnaci, Etna 2018 (20 teachers) Italy.

Figure 11 European InSight Workshop, 2017 (25 teachers) France.

3.3.2 Events, exhibitions and museums

Science fair week

Once a year, across France, there is a big public event called 'fête de la Science'. This event offers an excellent opportunity to distribute our education and outreach tools. It can also be used to promote the work of research teams in geoscience observation and natural risk prevention to the general public (citizen science) and in particular to students (science and research).

Figure 13 Fête de la Science; a four-day 'feast of science' education event, across France

4 Seismology @ School in Greece

4.1 Introduction

Several groups in Greece conduct seismology demos/seminars for schools focused in education and in civil protection preparedness and resilience. Some museums and geoparks make seismology educational material available and they also have introduced demo shaking tables that can be used for earthquake feeling experience for the visiting schools. In general, the Greek curriculum includes some limited information on seismology within the geography course, which involves some general approach to geology and tectonics with focus in Greece.

It is important to note, the existing course, with some material and exercises the Earthquake Planning and Protection Organisation (EPPO) in Greece, has been used and developed over decades. However, it includes limited educational material and it is focused mainly on aspects of civil protection. In the past decade, an attempt has been initiated at NOA to promote seismology education in schools. A school earthquake monitoring program financed by an ERASMUS+ grant has already been completed with a network of schools linking Greece, Cyprus, Turkey, Italy, Bulgaria, Israel and the Azores. This is also under expansion and continuation with another new grant from the ERASMUS+ initiative, aiming to develop a stable basis for school earthquake monitoring and collaboration and knowledge exchange and experiences for schools in Greece and the neighbouring countries.

NOA, with the newly developed Museum of “GeoAstroPhysical Walk” in Thission campus (a walk through the history and displays of instrumentation of the three research institutes at NOA), aims to introduce astronomy, meteorology and seismology/geophysics through showing an experience of more than 150 years of research in Greece connected to education, not only to universities but also to primary and secondary education. The museum gives the opportunity for schools to visit and spend a minimum of two hours, which includes an introduction to seismology and experiments that can be also developed in class. Dedicated NOA staff are involved in these school visits at NOA, and follows up the experience with visits to the schools on a back-to-back basis. The latter involves a communication with schools that builds collaboration and continuation of the programme through time for the future.

Finally, at University of Thessaloniki (AUTH), the Research Unit of Soil Dynamics and Geotechnical Earthquake Engineering (SDGEE) have recorded and are going to upload to YouTube channel, tutorial videos presenting very simple experiments concerning earthquake engineering problems. The videos, recorded in Greek and English, are intended for teachers from Greece other European countries. The experiments shown in the videos demonstrate critical earthquake engineering failure mechanisms, with significant impact on structures and soil, to students with no prior knowledge of earthquake engineering.

4.2 Network

4.2.1 Schools study earthquakes, Greece

The 'Schools Study Earthquakes' (SSE) project (2015-2017) and the new 'School Network Alerts Citizens' (SNAC) (2018-2020) project, are coordinated by the Institute of Geodynamics (NOA) and supported by the EU Erasmus+ Program under the key action *Cooperation for innovation and the exchange of good practices*.

Figure 14 Doridis telescope room, National Observatory of Athens; an education event venues used by NOA-IG.

The SSE project created a network of 20 educational seismometers primarily installed in high schools, for studying the different seismic waves produced by local and distant earthquakes. During the project, the use of new technologies and ICT in education have proposed pedagogical practices based on inquiry-based methods that are more effective and raise interest and awareness in science. Pendulum seismometers are used for education in elementary physics as well as seismic wave data. Collaboration of schools from different regions and different countries in the established educational network (Greece, Italy, Cyprus, Bulgaria, Turkey, Israel, and Azores (Portugal)) have created an instructional database of earthquakes and books of good practices for teachers (http://sse-project.eu/).

In the last 18 months, the SSE and SNAC projects have registered several large earthquakes with the educational seismometer network and interest has risen in hundreds of schools that have participated through the seismometer network data dissemination, workshops, presentations and contests.

During the 2017 and also the 2018 school years, the Institute of Geodynamics has organized a National contest with the authorization of the Greek Ministry of Education under the auspices of the President of Greece, titled 'Make your own seismograph'. In this contest, schools from all over Greece were called upon to compete on the design and construction of a seismometer and recording system. More than 100 schools from different parts of Greece have taken part in these contests and more than 700 students have participated. Prizes were awarded to the best 10 schools in special events for schools and parents, on 5 May 2017 at the National Observatory in Athens and on 5 May 2018 at the Athens Science festival.

The SSE/SNAC school network of NOA participated in the Open Schools for Open Societies (OSOS) project workshop, 16-19 June, 2018, in Azores, the European Seismological Society Meeting in Malta, September 3-8, 2018 and the European Researchers Night project in Athens, September 28th, 2018. In collaboration with the Union of Greek Physicists, the Geodynamic Institute has organized and participated in educational workshops for physics students in Lefkas Island, 3-7 September, 2017 and in Aegina Island, 5-7, October, 2018, with the participation of local elementary and high school students and also sessions for participating physics students from the University of Athens.

4.3 Teaching resources

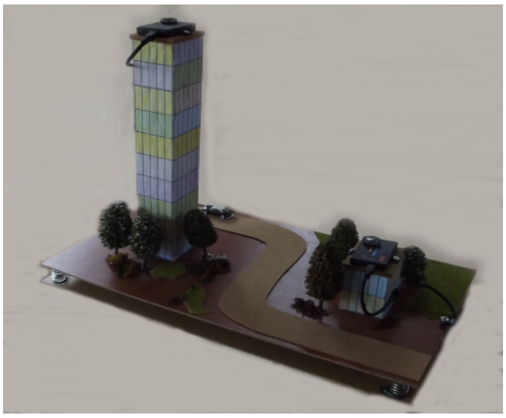
4.3.1 Special projects

Popularization of Science of Seismology plays a crucial role for the mitigation of the consequences of the earthquakes in an area of high seismicity as Eastern Mediterranean is. During the last decade, Institute of Geodynamics developed various activities targeting, mainly, the school community, but to other population groups as well.

Educational presentations

Presentations on 'Earthquakes and Educational Community', 'We are talking about earthquakes' or 'Seismology as a polythematic tool in educational procedure' have been prepared, within which basic concepts of seismology are analyzed, protection measures are described and activities are proposed to be included in the school curriculum. All the aforementioned subjects are demonstrated with the help of experimental devices. We have developed the following models:

- fault modes
- building response
- building strengthening
- building frequency response
- sound wave frequency response



The general idea of these homemade constructions is for the pupils to search the market for cheap materials. The appropriate ones are resulted after testing them for having the best results used for their experiments.

Patras seismometer deployment

NOA-IG has deployed an array of low cost accelerographs (P-Alert devices, manufactured in Taiwan) in the city of Patras. One of them has been deployed at the Arsakeia Schools (a complex of kindergarten, primary and secondary education schools) close to the Rio – Antirrio Bridge, very famous as a long single suspension bridge, but also of the earthquake activity as it is situated at the Western end of the Gulf of Corinth; one of the most tectonically highly active places in Europe. The pupils in the schools feel the earthquakes from time to time and they can use records recorded at their P-Alert 3-component low cost accelerograph to locate as well as to report to local newspapers and the general public through reporting in their website.

Figure 15 SeisGram for Schools was used during school exercises. The Lastquake app from EMSC was explored and pupils were learned to fill in information and become earthquake-alert citizens and to report their experience.

Earthquake engineering projects

At the University of Thessaloniki (AUTH), we have recorded and we are going to upload to the Research Unit of Soil Dynamics and Geotechnical Earthquake Engineering (SDGEE) YouTube channel tutorial videos presenting very simple experiments concerning earthquake engineering problems (e.g. earthquake response of structures resting on soil, soil liquefaction etc.). The videos are recorded both in Greek and English; assuming that the audience will be Greek teachers, as well as teachers from other European countries.

Figure 16 Athanasios Vratsikidis from AUTH is helping teachers to perform and understand the effects of soil liquefaction on the earthquake response of structures.

These experiments were designed to demonstrate critical earthquake engineering failure mechanisms, with significant impact on structures and soil, to students with no prior knowledge of earthquake engineering. The materials used are common and low cost, like sand, water, paper, hammer etc., and can be easily found in sufficient quantities for teaching purposes. The teachers will be able to reproduce these simple experiments in classrooms, while introducing to the students the key ideas of earthquake engineering and civil protection. As a result, the students will have the opportunity to design simple models and test them, discuss the results of the tests and understand the various engineering failure mechanisms. Additionally, through these hands-on activities, they will better understand the effects of the earthquakes to buildings and soil, whilst also learning about earthquake safety and protection regulations.

We presented one of the aforementioned experiments referring to soil liquefaction in a teacher's workshop in Casa da Ciencias in Guimaraes, Portugal, in collaboration with the SERA delegates from the United Kingdom and Romania. The teachers responded well to the presentation and declared themselves capable of showing such experiments to their students.

Future developments

We plan to upload more videos on the SDGEE YouTube channel demonstrating simple earthquake engineering experiments. The main purpose of these experiments is to present the key ideas of earthquake engineering by just using simple materials to make small-scale models. These experiments are going to be designed specifically for people with no prior knowledge of earthquake engineering and taking into consideration the young age of the students we address. Through these hands-on experiments the students can understand the disastrous effects that earthquakes can have to structures.

4.3.2 Events, exhibitions and museums

The presentations mentioned above (section 5.3.1) take place either at the National Observatory of Athens in the Doridis telescope room (visitor capacity of 40 people) or in school facilities, for larger audiences. Presentations are tailored to different educational levels (from kindergartens up to groups of students), including teachers, proposing an interdisciplinary program at school aiming to understand the phenomenon of the earthquake and the protection measures. The project demonstrates the impact of earthquakes on individuals across different groups of the population.

Figure 17 NOA-IG educational visit to the Acropolis of Athens for Erasmus+ students.

NOA-IG scientific staff support educational excursions having geological, tectonic or seismological interest. The activity aims to high school pupils or university students of related specialties (civil engineers, geologists, rural engineers etc). Students of civil engineering are also offered excursions to areas affected by strong earthquakes. Of special interest is the educational visit at the Acropolis of Athens from the perspective of seismology, describing geological, tectonic, seismological and historical information in conjunction with the accelerographic array that IG deployed.

Figure 18 Participation in the Athens Science Festival and in the Researcher's Night.

NOA-IG also participates in popularization of science events like the Athens' Science Festival, a four-day event, or the Researcher's Evening, demonstrating seismographic instruments, experimental devices and explanatory posters.

5 Seismology@schools in Portugal

5.1 Introduction

In recent years, several teams in Portugal have carried out a number of mostly independent initiatives that contribute to the education for seismic risk and science in Portuguese schools.

Some of these initiatives are:

- Seismometers in schools, by IDL and ICT
- Open Days, by IDL, UP and ICT
- Seismic engineering concepts, by IDL, IST, FEUP and LNEG

IDL's outreach program is organized and sustained by researchers and students of Instituto Dom Luiz (IDL) of the Faculty of Science of the University of Lisbon and of Instituto Superior de Engenharia (ISEL). Established in 1853 as the first Portuguese Meteorological and Geophysical Observatory, IDL has developed into an integrated Earth System Institute, with research in solid Earth, Ocean and Atmospheric processes, their interactions, and their relevance for a sustainable society.

The Seismology@Schools initiative has been supported by the seismology group at IDL since the 1990s, with a renewed strength since 2014. This outreach program aims to provide materials and explanations that are tailored to different age groups and learning levels.

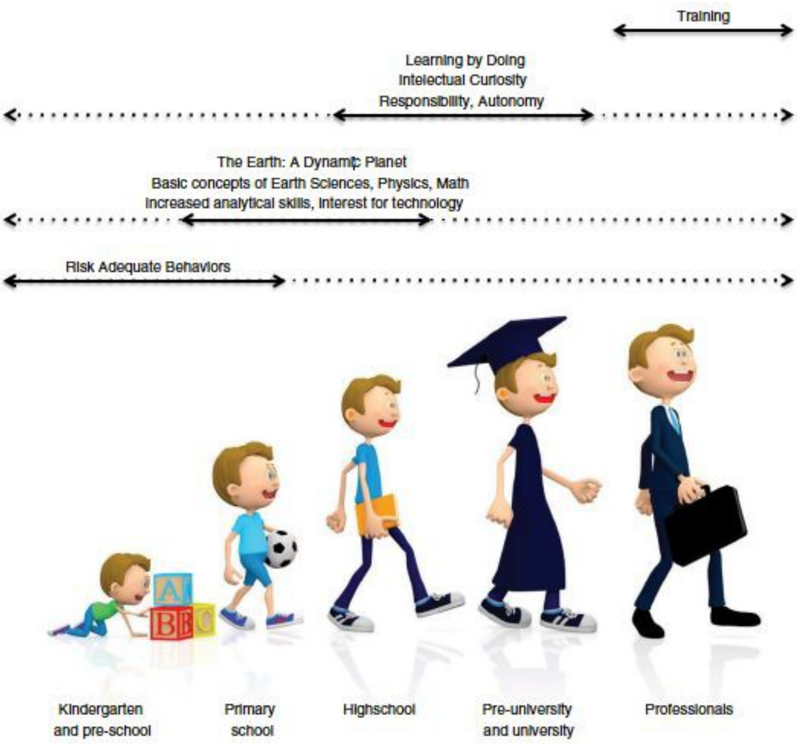


Figure 19 Different groups of people that we engage with, split in terms of age. These age groups have different perspectives in risk-adequate behaviors and earthquake science. Although both should be promoted at all ages, we find it more useful to emphasize risk-adequate behavior in activities for small children and families and to emphasize science and technology with older students. Teenagers are more interested in technologies, making seismology an especially attractive topic. Pre-university and university students should take responsibility for their activities and can act as educators of youngsters. The training of professionals (e.g., teachers and civil protection agents) allows us to reach a much wider public than using only our own resources (Custódio et al, 2016).

5.2 Network

5.2.1 Portuguese school network

There are currently a total of five seismometers installed and running in Portuguese schools. This number has been quite variable throughout the years. Four of these stations are in schools located in the Lisbon Metropolitan area and one in the Algarve. The schools are responsible to keep the stations active and connected to the network. Teachers and students alike get a real sense of doing science with their seismometer. It is a great way to keep them engaged in science. We aim to enlarge the current network, with the installation of new seismometers in more schools.

Figure 20 Map of Portugal with the seismometer stations that we installed in schools. Some of these stations are connected to IRIS servers so that the data may be used for research. We also give access to a livefeed of every station of network in our website (see http://idl.campus.ciencias.ulisboa.pt/sismologianaescola/).

5.2.2 Sensors used in educational settings

The ICT outreach activity has concentrated mostly on seismology but two of the prototypes developed are dedicated to demonstrate the basics of earthquake engineering, a model to explore the shaking effects of an earthquake and one model of a shaking table. ICT students have also developed a model for a 3-component seismometer.

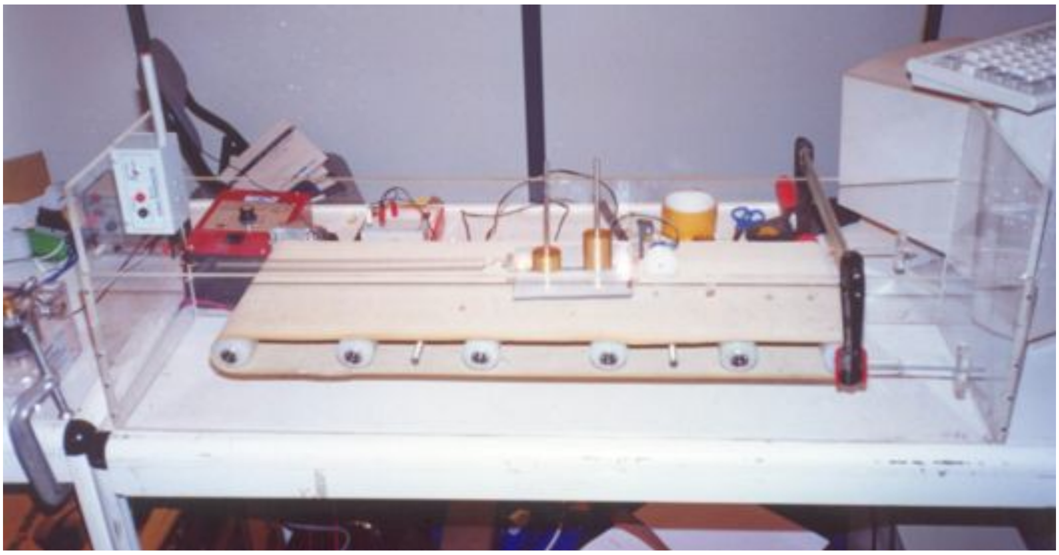


Figure 21 The "earthquake machine" built by ICT.

5.3 Teaching resources

Lending material for schools

Several schools in Portugal face severe resource constraints. Part of our outreach program is to provide schools with innovative experimental materials that they otherwise would not have easy access to. To this end, we maintain copies of our educational materials to support the teaching of seismology at schools.

One set of materials is reserved for lending for independent use by schools, civil protection, museums, and so on. Lending of the material is preceded by training of the educators. This strategy eases the load on our staff, gives responsibility and independence to schools and other educational partners, and allows time for users to explore the materials thoroughly.

Figure 22 A portable shake table was borrowed by a high school, which invited nearby primary schools to come learn about earthquakes. This was all organized by the teachers and the school, we simply delivered the shake table.

IDL has an outreach room dedicated to teach kids different concepts of Seismology and Geophysics. We receive regular visits from schools, with students ages varying widely, from as young as 6 until 17-year olds. IDL researchers receive the students and give a guided tour through the different activities that are set up.

Outreach room

We have for example a shake table with a typical desk that we use to aid in teaching safety behaviour in case of earthquake. This is a great way for teenagers to have a better perception of earthquake risk. By experiencing, even if 'fake shaking', they will get a physical sense of what can potentially happen. We also have several types of seismometers on display connected to a live feed on the computer. In this activity, we ask the kids to jump to generate seismic waves and visualize them on the computer. Another activity that we use is a tub of water where we can simulate tsunamis. We also use a skateboard with metal shafts where we can simulate resonance in buildings and the consequences of having buildings with varying heights next to each other. This room filled with simple experiments has been a great success to engage teachers and students alike in seismology.

5.3.1 Special projects

Partnership with civil protection agency

The civil protection agency in Portugal has several layers of organization. IDL works mostly with the municipal level, a small group of professionals dedicated to raise the awareness on safety measures for natural hazards. These professionals do not have specific scientific training or the background to fully understand earthquakes; so they come to us to receive this information. We organize training sessions for them to complement their knowledge about seismology. In turn, they significant outreach work that complements our own outreach work. For example, they create information material about natural hazards such as earthquakes and tsunamis to give out to the population. They always come to us to review this information to make sure everything is scientifically correct and up to date. These agents

Figure 23 Examples of the work that the civil protection agency those in the field of seismology. Top left is an example of a risk map assessment, bottom left is showcasing their lectures in schools where they teach kids safety measures in advent of an earthquake. The pictures on the right are examples of material about earthquakes that are given to the population.

also go to schools to give lectures on these topics. Another important contribution is that they create mechanical devices such as shake tables and reproduce our experimental outreach materials for their own use.

ICT – Institute of Earth Sciences - Évora University Pole
ICT has a regular activity of outreach involving the high-school students, teachers and the population in general, at least since 1998. We will report here only the most recent activities and ongoing projects.

One Horizon so close to us
One Horizon so close to us is a project that is ongoing today between the ICT, the University of Évora and the high-school of Severim de Faria. This project aims to introduce to the more advanced students the first contact with the science that is performed at the University level. ICT has been responsible for promoting the Geophysics domain where several initiatives and experimental models in Seismology are being explored: i) one seismic platform to provide the earthquake "feeling"; ii) the operation by the students of a broadband seismic station deployment on the school grounds; iii) several interactive prototypes that are shown in "science fairs" and other School initiatives. Under this project 3 sets of seminars per year are organized so that the students can present the results of their work along the year. This project is the follow-up a previous one, EXPER. Both have provided a continuous outreach activity since 2006.

Students learn about Science during summer holidays
This is a very popular program in Portugal stimulated by the Portuguese Science Foundation. ICT has been using these yearly activities to promote Seismology by teaching high-school students how the seismic observation is done, from deploying the sensors to data analysis.

Figure 24 Students deploying a seismometer during the summer camp.

5.3.2 Teacher training

ICT has also a regular activity promoting workshops and training courses on seismology addressed to the high-school teachers. The main subjects have been "Talking about earthquakes", "Earthquakes, where and why do they happen", "Seismic and Volcanic hazards" and "Why the Earth shakes". Other topics that have been addressed include the structure of the earth and the local seismicity.

5.3.3 Events, exhibitions and museums

Earthquake Engineering
Educational activities addressing the high-school population and outreach initiatives to the general population on earthquake engineering topics in Portugal are less common than on seismology. Still, some of them deserve to be mentioned:

2005 - Earthquake Resistant Building Contest, Faro

Profiting from the 250th anniversary of the great 1st November 1755 earthquake and tsunami, the "Science Alive Centre of Algarve" (CCVA) organized among all country high-schools an Earthquake Resistant Building Contest. 20 participants had their models tested by the seismic platform installed at the CCVA and displaced to the Mall in Faro for greater visibility. The three most resistant models received generous prizes offered by associated partners.

2016 - Earthquake Resistant Building Contest, P. Delgada, Azores

In 2016, the Portuguese Society for Seismic Engineering, organized an Earthquake Resistant Building Contest. Three teams from the Architecture Faculty participated. The models were tested with a variable frequency oscillation provided by the Shake Table from IST.

IDL - Seismic engineering outreach activities

Starting in 2010 IDL began to offer the visitors of the outreach room and began to include on their outdoors outreach activities the model BOSS (Building Oscillation Seismic Simulation) inspired on the "Seismic Sleuths" published by FEMA/AGU (1995). The model illustrates the concepts of resonance, natural frequency and damping. It can also be used to demonstrate the destructive effect of ponding, when two buildings of different height are vibrating side by side. This model was on display at the "Lisbon Earthquake" exhibition, promoted by the Lisbon City-Hall, from the 1st November 2015 till the 1st March 2016.

Seismic Engineering concept models

In 2017 and 2018, IDL developed two new models to illustrate additional Seismic Engineering concepts. One of these models is a three-storey building that demonstrates the behaviour of one building with multiple degrees of freedom. The other model illustrates the concept of "tuned mass damper" as it is used in very high buildings to attenuate the oscillations caused by wind or earthquakes. In both cases the movement of the building floors can be recorded by an accelerometer and visualized on a PC using an Arduino as interface.

Figure 25 Tuned mass damper model, built by a 3rd year bachelor student - Raquel Pontes.

Laboratório Nacional de Engenharia Civil (LNEC)

Like most national laboratories and research institutes in Portugal, LNEC opens its facilities to the general public once per year, when they concentrate their outreach activities. One of these is a demonstration of the resonances of a building with multiple degrees of freedom, developed by Sergio Oliveira at the "Núcleo de Modelação Matemática e Física".

Instituto Superior Técnico (IST)

The Civil Engineering Department of IST receives the visits of young students and the general public during the 'open days' initiative. It also participates in outdoor activities when requested. IST has one SDOF shake table that is able to move building models up to 7 kg in mass. The shake table is used to demonstrate the basic concepts in seismic engineering, resonance, natural frequency and damping.

Instituto Politécnico de Setúbal (IPS), Escola Superior de Tecnologia do Barreiro

This Institute has a regular activity of promoting the knowledge on seismic engineering concepts through dedicated sessions on high-schools and kindergartens. The oral presentations on Seismology and Seismic Engineering are complemented with practical activities like building the paper Bururu model that illustrates the concept of seismic structural reinforcing.

Figure 26 Open day of the University of Porto.

Civil Eng. Department - School of Technology and Management Polytechnic of Leiria

Like IPS, this Institute promotes the basic seismology and seismic engineering concepts through presentations on high-schools. The paper Bururu model is used to illustrate the concept of seismic structural reinforcing. In addition, students build very simple structural models that are then tested on a handmade shaking table monitored by an accelerometer.

UP - Civil Engineering Department of the Porto University

The Civil Engineering Department of the Porto University receives the visits of young students and the general public during the "open days" initiative. It also participates in outdoor activities when requested. This institute has a set of prepared activities to demonstrate many Civil Engineering concepts, among them the resonance of buildings and the effects of liquefaction.

6 Seismology@schools in Romania

6.1.1 Introduction

National Institute for Earth Physics (NIEP) is the Romanian institute responsible for the development and operation of the infrastructure needed for the acquisition, processing and distribution of high-quality seismic data to a local and regional audience of national authorities, researchers, educators, and interested public. Making use of the exponential development of computer technology and scientific expertise among its membership institutions, NIEP makes also a normal and necessary step to substantial contributions to earth science education.

Since the inceptions of such education and outreach activities, the institute, through media and online channels and also from direct feedback, has been exploring the needs of the different audience, trying to tailor the future programs to address those needs. Using the funding opportunity provided by the national research programs, we try to provide products and programs for a variety of audiences. To have a proper framework for engaging new communities and build partnerships, with benefit for all parties involved, a series of pilot projects have been initiated in the last 5 years, all culminating with participation in the SERA project.

6.2 Network

6.2.1 Romanian educational seismic network

Primary audiences for outreach include the K-12 students and educators and post-secondary students from national colleges and universities. The framework for addressing these audiences was created by the national-funded research project called Romanian Educational Seismic Network (ROEDUSEIS 2012-2016). Following similar initiatives already existing in western countries (France and Italy – The Educational Seismology Project [3], UK – School Seismology Project), in USA (IRIS – Seismographs in Schools), ROEDUSEIS is focused on increasing the level of knowledge of teachers and pupils on earthquake phenomena, earthquake effects, preparedness measures, promoting in the same time the role of education and schools in disaster risk reduction. In this project, seismology is considered a subject that allows teachers to deliver STEM integrated activities, with outcomes for all STEM subjects (science; technology; engineering; mathematics and computing).

The project is piloted in nine schools, extended to 15 in the present, targeting one class from each educational level (3rd grade, 7th grade and 11 grades). Educational materials were developed comprising theoretical aspects, activities and experiments related to earthquakes and their effects. The booklets contain an illustrated overview of these topics with suggestions for teachers on how to introduce the ideas in the classroom, plus student activity sheets and notes for teachers.

Figure 27 The Romanian Educational Seismic Network website, www.roeduseis.ro, provides a variety of resources including activity packs, posters and working plans.

The first Romanian educational seismic network was built by equipping each school with educational seismographs that can record earthquakes in real-time.

A database with earthquakes recorded with educational seismographs have been developed and published on the project website (http://www.roeduseis.ro/category/cutremure-si-date/). For locating earthquakes recorded by school seismographs educational software have been used (Jamaseis, SeisGram educational version, EduCarte).

6.2.2 Sensors used educational settings

Different type of educational instruments have been used (e.g SEP, improved TC-1 with 3D printed components) in conjunction with professional sensors at the same locations.

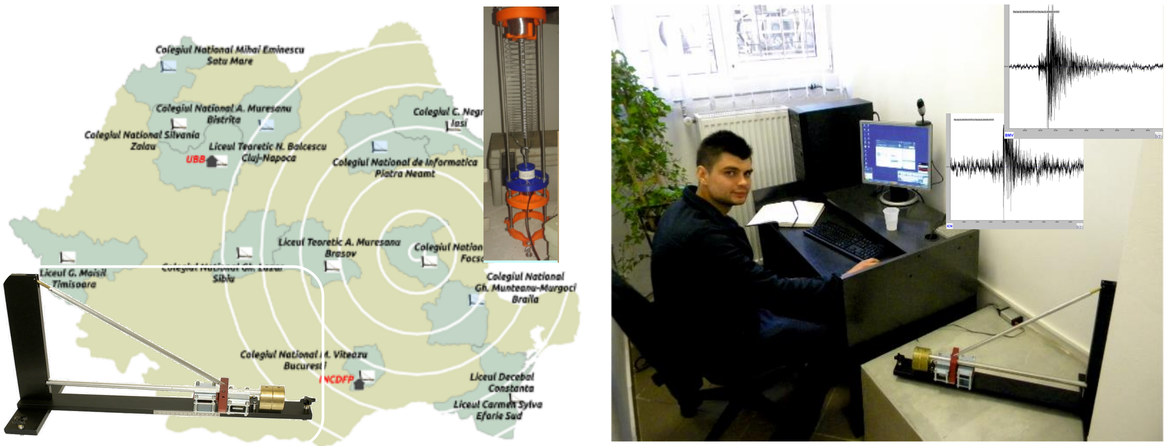


Figure 28 SEP and TC-1 sensors deployed within the Romanian Educational Seismic Network.

6.3 Teaching resources

6.3.1 Special projects

Integration and citizen science perspective

The education and citizen science projects shown below offer a complementary set of activities and deliverables meant for supporting the implementation of a strategic education, outreach and training programs in Romania, in the field of seismology, an opportunity to improve understanding of earthquake related concepts and to change the way these concepts are taught and disseminated. The strategic plan intends to establish the framework to be used by educators, researchers and other organizations to meet the educational needs and technological challenges of future K-12, graduate and undergraduate students, practitioners and interested public.

6.3.2 Teacher training

Workshops for teachers were organized with the purpose of showing how Earth science topics can be taught in classrooms based on developed materials and using the concept 'learning by doing'.

Figure 29 ROEDUSEIS teacher training workshops, Bucharest.

Teachers are key players in project implementation. This requires dedicated support actions for their professional development in the field of Earth science in general and seismology in particular. In the first stages the project consortium members had been in each school, discussing and organizing teachers working groups, followed by yearly workshops, were involved teachers from the participating schools (mainly science and geography teachers) participated.

A special module of the workshops was integrated to identify the specific ways for applying in schools, at all educational levels, the didactic activities based on the educational resources developed during ROEDUSEIS project. Two primary options were investigated: first one, conducting certain activities in the context of different compulsory disciplines (e.g. geography, physics) and second and the most preferred one - the possibility to introduce seismology in the curriculum as an optional discipline. Together with teachers, an optional curriculum was developed for all the pre-university educational levels.

Initiated by the SERA project, new educational activities developed by partners institutions have been delivered in the dedicated existing NIEP outreach environment (Education-Outreach-Training EOT Seismolaboratory) during day-by-day (informal out-of-class) activities or special planned event (Summer School). The target group have been school students from all pre-university educational levels.

Figure 30 Daily outreach activities performed within NIEP Seismolaboratory.

6.3.3 Events, exhibitions and museums

The MOBEE (MOBile Earthquake Exhibition 2014-2017) initiative intends to tackle the same very problematic topic for the present and future of Romania: the quality of education, in the perspective of a future major earthquake. And not just in a declarative, formal way, but in a practical manner, by translating modern approaches in science, arts and computer science into end-products with a direct impact in forming and developing the interest for earth science, at different levels and at a significant scale. In case of MOBEE project, the target group is much larger, the public-in-large, no matter age, education or region.

The MOBEE exhibition is to be unique and innovative in terms of the subject it approaches and also of the elements it reunites (interactive exhibits, spaces for interaction, mobile technologies and apps). It makes use of the latest existing technologies on matter of structure, exhibits and digital content, precisely to offer an increasing flexibility, mobility and in the same time impact on the museum experience.

Figure 31 The MOBEE (MOBile Earthquake Exhibition 2014-2017).

Summer school

A special event dedicated to high school student from Romania was held during the summer; the first Summer School of Science and Technologies, Magurele, Romania, 2018. This was a national initiative that also made full use of the expertise and best practices from the SERA project. Forty students choose from 15 science topics to develop a physics-based project inside a research institute. Two projects were hosted by NIEP, which reflect the two main SERA topics: seismology and engineering and the and the vital impact they have on society.

During one week, ten of the students worked together to understand the important role of environmental monitoring using various types of sensors and how these are translated to building monitoring and lead to improved structural earthquake resistance. At the same event, 30 teachers learned about STEM projects and existing resources they could use during or after school classes.

7 Seismology@schools in Switzerland

7.1 Introduction

The Seismo@School earthquake education and awareness program has evolved into CPPS & Mars@School programs, which is now more open to the protection of the population and to natural hazards events , such as avalanches, landslides, tsunamis, volcanoes, etc and through the InSight mission on understanding the formation of telluric planets etc, which in classrooms can be very varied indeed. In addition, Scotland has a different school system entirely and a small minority of schools offer examinations in either geology or astronomy (which includes quite a lot of planetary science).

Much of practical work with schools using educational seismology resources therefore centres on either using seismology as an example of more general scientific principles or using seismology as the focus of an extra-curriculum activity like a science fair competition.

7.2 Network

Currently, the seismometers network associated with the Seismo@School is no longer operating. It was operational for five years producing 103 Matura's students works and trained 25 teachers in Switzerland and internationally through European programs O3E (three years) and NERA (three years).

7.3 Teaching resources

7.3.1 Special projects

Mars@school

Through the Mars@school website, kids, students and their teachers follow the Adventures of Marsty, Manon and Wallis to take stock of the location of the Universe, Galaxies, Stars; the solar system; the Insight mission; and the exploration of Mars.

Figure 32 Mars@school website hosted by HES-SO Valais-Wallis, Switzerland.

7.3.2 Teacher training

CPPS Training centre

CPPS (Centre Pédagogique pour la Prévention des Séismes) is a complete educational concept covering aspects that range from understanding the occurrence of earthquakes and consequences, learning how to protect yourself and giving you the basic skills to help on site.

Manon

In order to provide young people and the wider population with effective training and preparation for the case of an earthquake, the University of Applied Sciences HES-SO Valais-Wallis has developed an innovative earthquake education program that makes it possible to feel and experience the different characteristics of an earthquake.

The masterpiece of this exhibition is a 5m x 6m simulator that can reproduce earthquakes up to magnitude 8.

Training programs

Currently, more than 30.000 people have already participated in training within the CPPS, distributed as follows:

Wallis

During the school year, the CPPS receives 140 students per day in six classes of approximately 23 students. Each student spends three hours in the CPPS, one hour per Module (as described below).

Since 2016, 420 teachers have been trained by CPPS through six-hour training sessions every week. These workshop offer researcher's presentations to improve the teachers background knowledge in geoscience, and practical hands-on activities with the materials presented at CPPS Center.

These students come with their teachers, most of whom have followed CPPS training. These teachers can visit the CPPS for the interactive exhibition part without asking for the help of a scientific animator or can receive this help from the CPPS.

For Module 3 "AIDS" Two Samaritans are facilitators for groups of 23 students; trained by the Swiss 144 and army doctors aided by CPPS scientific animators for the security part.

During the school holidays, the CPPS run scientific activity courses for children.

The CPPS is also intended to be a training centre for civil protection, security, hospitals, insurance, etc. for the canton and outside the cantons. Its training courses are available on request. Each month, three civil protection training courses are given; 40 people per course.

Teaching resources for schools

Our mascots Manon and Wallis lead you on scientific adventures. Currently films/animations are being developed and are already developed on all the themes presented to the CPPS. These animations exist today in three languages: French, English, German

http://www.cpps-vs.ch/en-us/Documentation/Videos-Youtube. Scientific presentations are also posted on the CPPS website. The flyers and posters are and are about to be posted on the website as well.

7.3.3 Events, exhibitions and museums

CPPS Teaching Modules

The activities offered by the CPPS are divided into three modules:

- Interactive exhibition
- Seismic platform
- Aid

These cover the different themes to help young people and the public familiarise themselves with earthquakes. Resources for schools include: animations/movies, flyers, games etc. are developing to illustrate these approaches.

Interactive exhibition

This module, designed as an interactive exhibition, explains the phenomenon of earthquakes and the natural consequences they may have. Instruments and vibrating models enable visitors to experiment with the principles of earthquake-resistant construction.

Seismic platform: what an earthquakes feels like

The second module is associated with the simulator and its objective is to bring alive the experience of an earthquake i.e. what an earthquakes feels like. This module raises visitors' awareness of the impact that an earthquake has on their immediate environment, and teaches them how to react quickly and effectively.

Aids: reacting after an earthquake

The Aid module aims to teach the actions to be taken to ensure personal safety, to deliver first aid and to save lives. It has been developed in collaboration with medical care professionals (Samaritans and civil protection organisations).

8 Seismology@schools in the UK

8.1 Introduction

Educational seismology in the UK is a mature program, having started in 2006. It has gone through its growth and expansion phase and is now in the business of maintaining interest amongst teachers and stakeholders in a very busy school environment. The overall strategy for keeping interest in the program has been to introduce new topics and activities every couple of years to keep the project fresh and exciting.

Seismology and the curriculum in secondary schools

Earth science is not taught as a separate subject in UK schools, with the result that different geoscience topics are taught in different lessons (and usually by different teachers). For example plate tectonics is usually taught in the geography curriculum, the rock cycle in the chemistry curriculum and longitudinal and transverse wave in the physics curriculum. However, the actual situation is more complicated as in England there are four different (competing) examination boards who each interpret the curriculum in a different way, so what is actually taught in classrooms can be very varied indeed. In addition, Scotland has a different school system entirely and a small minority of schools offer examinations in either geology or astronomy (which includes quite a lot of planetary science).

Much of practical work with schools using educational seismology resources therefore centres on either using seismology as an example of more general scientific principles or using seismology as the focus of an extra-curriculum activity like a science fair competition.

8.2 Network

8.2.1 The UK school observational network

A number of different instruments are used by UK schools as part of an observational program. Since 2006 over 500 schools have acquired a simple mechanical horizontal pendulum system called the SEP seismometer. This instrument has a natural period of about 15-20 seconds and is ideally suited to detect S and Surface waves from distant large earthquakes. Schools that are diligent with the installation and running of these sensors have detected signals from over 40 large earthquakes in one year.

8.2.2 Sensors used in education settings

SEP seismometer

The SEP seismometer, although popular with schools is not always used effectively. The biggest barrier to its use being finding a suitable location within the school to put it where it would remain undisturbed and was not subject to even minute amounts of ground tilt. In modern new-build schools with suspended beam floors it is generally impossible to find a sufficiently stable location for these instruments to work.

Most of these instruments are now no longer in use or are used purely for demonstration purposes when an earthquake topic is being taught (once per year)

The manufacturer of these instruments ceased production in 2016 and a number of alternative designs are now being used in schools, generally short period vertical sensors (with response down to 1 Hz) which are cheaper and much less sensitive to ground tilt so can be deployed in more locations around the school.

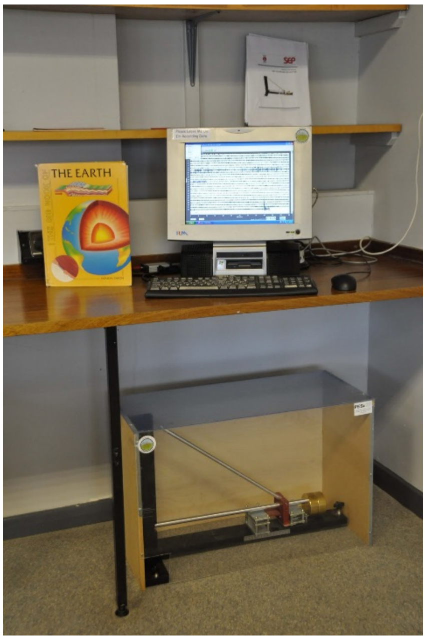


Figure 33 The SEP horizontal pendulum is a large device that needs to be located on a solid ground floor location and protected from temperature variations and air currents

Slinky sensor

Figure 34 The slinky sensor uses a simple mass on a spring design inside a transparent tube. The sensor is cheap (about £30) but not very robust.

Lego sensor

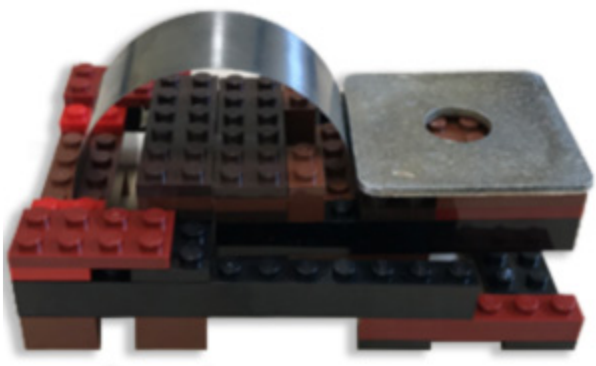


Figure 35 The Lego sensor is a compact folded-leaf-spring design with a response down to 2 Hz. It has proven very popular with teachers.

Raspberry Shake

Figure 36 The citizen science product Raspberry Shake is proving popular with hobbyists, but is perhaps too expensive for schools. It also presents some networking issues with firewalls in UK schools.

Other teaching equipment
The UK School Seismology Project has developed a partnership with educational resource provider MindsetsOnline who sell seismology related equipment including shake tables, earthquake simulation kits and seismometers (https://mindsetsonline.co.uk/product-category/science/seismology/). This equipment is bought by schools across the UK and elsewhere.

8.3 Teaching resources

The BGS via the UK School Seismology Project offers a number of teaching resources on its website: www.bgs.ac.uk/schoolseismology/ The resources include background science, classroom activities and practical help with earthquake detection, recording and location. A background science booklet 'Innovations in Practical Work' along with classroom resources (pdfs and ppts) are available for download from STEM Learning (www.stem.org.uk/resources/elibrary/resource/27385/seismology). Users need to first register to download materials from this website.

8.3.1 Teacher training

Teacher training in the UK for teachers focuses on working with either physics teachers or geology teachers, with bespoke training workshops offered at conferences and events that these teachers are attending already. For physics and science teachers these include the annual physics teachers' conference organized by the Institute of Physics and workshops for lead educators in the National Space Academy network. For geology teachers, teacher training is available at annual conferences organized by the Earth Science Teachers Association.

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Figure 37 Teacher training for geology teachers at the Earth Science Teachers Association conference, 2018

8.3.2 Events, exhibitions and museums

Not all learning takes place in schools and educational seismology finds a good home in museums and exhibitions. In the past few years, a number of small permanent exhibits have been constructed at regional museums and visitor centres across the UK, centred around the idea of live seismic information about current earthquakes. Exhibits are typically combined with an interactive element, e.g. 'jump to make your own earthquake'.

Figure 38 Map of museum educational seismology exhibits across the UK.

Figure 39 A simple museum exhibit showing live seismic data from a schools sensor.

8.3.3 Special projects

In order to maintain levels of interest in educational seismology it is useful to try new topics or special projects. Recent examples in the UK include football quakes and 'marsquakes'.

Football quakes

In 2016, a special project as started in Leicester with a number of city centre schools in collaboration with the geology department at Leicester University. A simple, short period vertical seismic sensor was located in a city centre school about 0.8 km from the stadium of Leicester City Football Club. Over the course of the football season the site recorded clear football-quake records each time the club scored a home goal (causing 30,000 fans to all leap to their feet at the same time). These seismic events were tagged as 'vardyquakes' by the students on social media and as Leicester City Football Club went on to win the league cup that year the 'vardyquake' story generated a huge media storm (at one point there were four TV crews from different stations queueing up to interview students at the school).

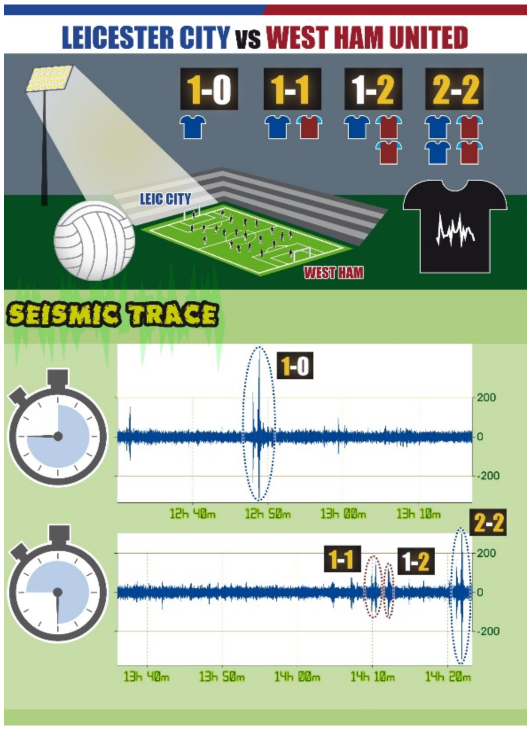

Figure 40 Football quakes or 'vardyquakes' caused a few minor earthquakes amongst the football community.

A summary of this football-quake project was published in the Seismological Research Letters; 'Football Quakes as a Tool for Student Engagement' Seismological Research Letters (2018) 89 (5): 1902-1907.

https://doi.org/10.1785/0220180078

Marsquakes

The NASA INSIGHT mission to mars plans to record seismic data from the red planet for the first time. The lander contains two separate seismometers, one UK built MEMS accelerometer short period sensor and one French built Very Broad Band force feedback design. The mission was due to launch in 2016 but the launch was delayed and it finally left earth in 2018 (due to land in Nov 2018).

In order to build on the excitement of this mission and the potential to see 'marsquake' data for the first time a set of educational resources (classroom activities and background science booklet) were produced to support the mission. www.bgs.ac.uk/marsquakes

Figure 41 The MarsQuake project is led by the British Geological Survey in the UK. The project has delivered background science information, practical classroom experiments and teacher training.

This resource booklet is being shared with the European community through the SCIENTIX web portal which provides facilities to translate the resource into multiple languages (currently a translation is available in Hungarian with plans to include add Romanian, Portuguese, French and Greek over the course of the SERA project) http://www.scientix.eu/

9 Global overview of school seismology

In the USA, school seismology emerged from the IRIS (Incorporated Research Institutions for Seismology) consortium, funded by the National Science Foundation since 1992. IRIS was developed to meet the demands of scientists in universities and research institutions for large numbers of instruments, operators and software in a wide variety of projects.

In 2017, a the EU Horizon 2020 funded project SERA (Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe) was approved, including support for school seismology groups from UK, France, Switzerland, Romania, Portugal and Greece to work closely together, with specific interests in developing collaborations and finding synergies with the growing citizen science movement involved in seismology. Within Europe, the European-Mediterranean Seismological Centre (EMSC) has led the way in citizen seismology with smartphone and webbased activities. The worldwide educational potential of the activity is indicated by the support provided by UNESCO.

9.1 International discussion workshop

In February 2018, representatives from seismology@school SERA attended the first international discussion workshop for Educational and Citizen Seismology in London. The meeting was attended by 47 registered delegates from 18 different countries: Australia, France, Greece, Ireland, Israel, Italy, Nepal, New Zealand, Palestine, Panama, Portugal, Romania, Spain, Sweden, Switzerland, Trinidad, UK and the USA. This two-day meeting was intended to be truly participatory and to provide a balance between talks, discussion groups and demonstration sessions. Every participant was invited to deliver a two minute 'nano presentation' as a way of introducing themselves to the other delegates and to promote active discussions as part of the formal sessions and after the meeting had closed.

Prior to the meeting, delegates had varying levels of understanding of seismology@school or citizen science projects underway elsewhere in the world. The meeting provided valuable detail with regard to the extent of school networks, software and hardware used and teaching strategies and resources deployed.

Figure 42 World map of education and citizen seismology project delegates that attended the London International discussion workshop, 2018.

The published outcomes of the meeting provide a wealth of information about educational seismology worldwide; delegate presentations and keynote talks were uploaded to YouTube and can be found at the links below:

Keynote talks

https://www.youtube.com/playlist?list=PLxpzCdkdwTWATfRu9KpSRSK83-SJKaQVM

Nano presentations by delegates

https://www.youtube.com/watch?v=11UqwFI6vI8

Project motivations
Amongst the London meeting delegates, each group had a slightly different motivation for setting up its project. In countries with high seismicity, a strong motivation is education of the population about seismic hazard and risk. In the case of citizen projects this also spreads into a motivation to move towards integration with earthquake early warning systems. In countries with low seismicity, the educational motivation is more towards a desire to stimulate interest in geoscience at school level and hence build capacity in geosciences at graduate level. More broadly, the Earth has been used as a stimulating laboratory for introducing many physics concepts including gravity, magnetism, electricity and radioactivity. But only recently has it been possible to include the many physical concepts embraced by the propagation, detection and analysis of seismic waves which have had complex paths through the Earth. School seismology therefore has a role to play in stimulating more students to study physics and mathematics at school.

9.1.1 Global school seismology networks map

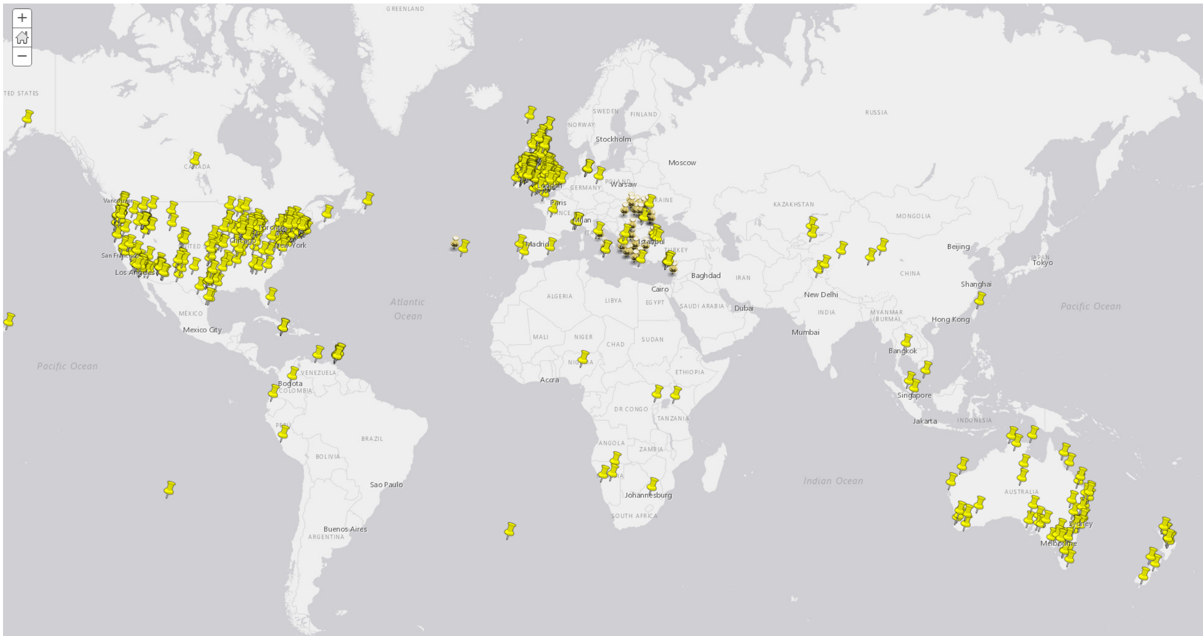

Figure 43 Global school seismology stations map.

It is evident from the above map that there is high density of school seismometer deployments across Europe, North America and Australia. However, the map doesn't show how many of the seismometers are still in use and are visible to other users on an education network. Firewalls within schools can be a barrier to placing sensors on open networks; this polled as an issue at the London International discussion workshop, 2018 (8/30 educators found firewalls to be a frequent software issue).

Table 1 School seismology networks and education projects worldwide. (This table is most likely incomplete and does not include similar networks that may exist in the Far East for example Japan, Taiwan and South Korea).

COUNTRY	NETWORK NAME	NETWORK WEBSITE	MANAGED BY	SENSORS TYPICALLY DEPLOYED
AUSTRALIA	Australian Seismometers in Schools	www.ausis.edu.au/	Australian National University in Canberra	Guralp
FAROE ISLANDS			UK School Seismology	SEP
FRANCE	Sismos à l'Ecole	www.edusismo.org	University Côte d'Azur	TC1, geophone, Rshake, Guralp
GREECE	Seismology @ School	http://sse-project.eu/	NOA-IG	SEP, TC1
IRELAND	Seismology in Schools (Seismeolaíocht sa Scoil)	www.dias.ie/sis/	Dublin Institute for Advanced Studies	SEP
JAMAICA				AS-1
MALTA				SEP
NEPAL				RShake
NEW ZEALAND	Rū New Zealand Seismometers in Schools	https://ru.auckland.ac.nz/	University of Auckland	TC1
PANAMA	Rasberry Shake	https://raspberryshake.org/	OSOP	RShake
PORTUGAL	Sismologia na Escola	http://idl.campus.ciencias.ulisboa.pt/sismologianaescola/	Instituto Dom Luiz (IDL)	SEP, TC1
ROMANIA	Seismology @ School	www.roeduseis.ro/en/	National Institute for Earth Physics (NIEP)	SEP, slinky
SPAIN				SEP
SWITZERLAND	Centre pédagogique pour la prévention en cas de séismes |(CPPS)	www.cpps-vs.ch/en-us/	HES-SO Valais-Wallis	n/a
TRINIDAD	Seismology in Schools	www.facebook.com/sistrinidadandtobago/	NIHERST	SEP
UK	UK School Seismology Project	www.bgs.ac.uk/schoolseismology/	British Geological Survey	SEP, slinky, Lego, Guralp
USA	Seismographs in Schools Program	www.iris.edu/hq/sis	IRIS	AS-1, EQ1, TC1, Rshake, Guralp

9.1.2 Software used in teaching

During the London meeting, delegates were asked to poll for their views on various topics relating to the use of educational seismology applications. The in-session results are shown below. Further research is required to poll accurate results across a greater proportion of the global educational seismology community.

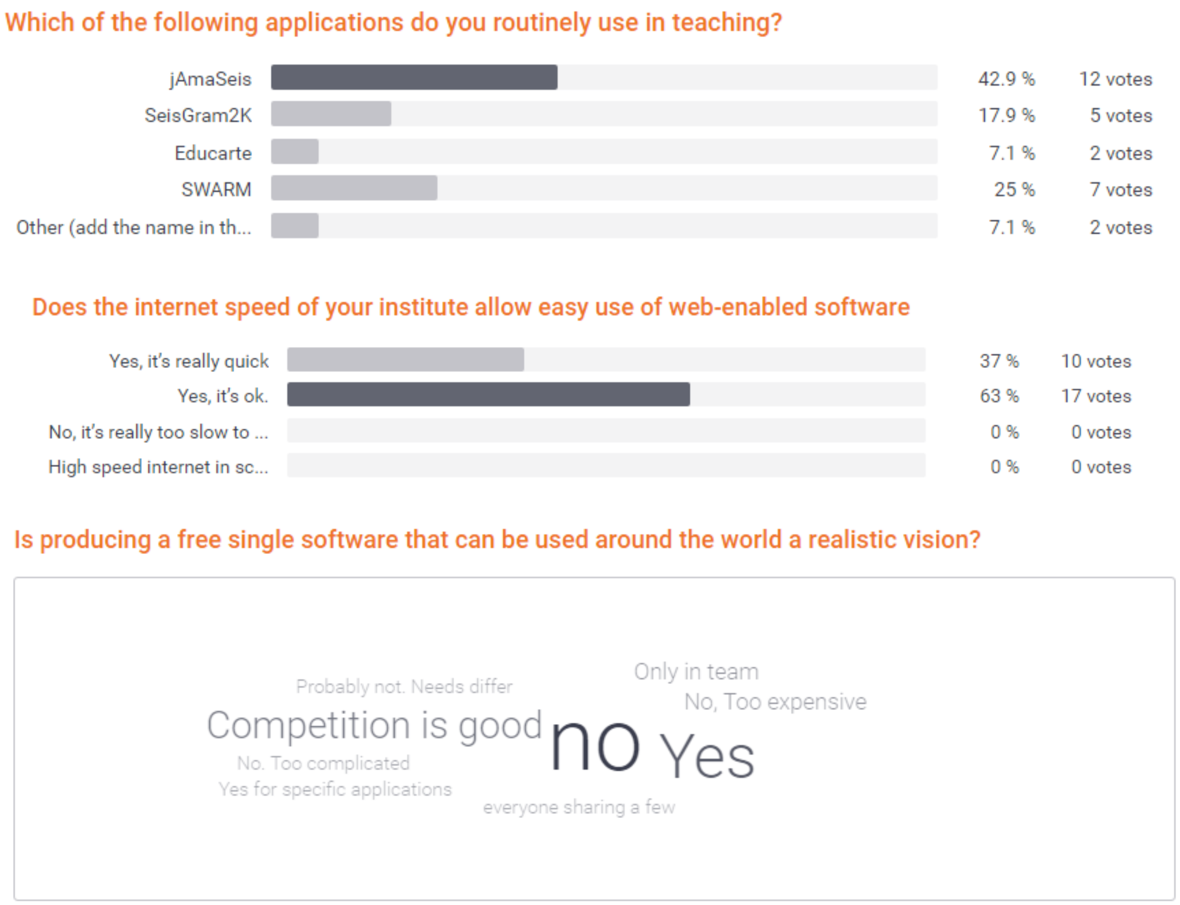

Figure 44 In-session polling results of the London International discussion workshop, 2018.

JamaSeis (seismogram analysis software)

https://www.iris.edu/hq/inclass/software-web-app/jamaseis

SeisGram2K (seismogram viewer)

http://alomax.free.fr/seisgram/SeisGram2K.html

EduCarte (visualize and superimpose geoscience data (earthquakes, volcanoes, GPS data, seismic stations)

http://www.edusismo.org/docs/outils/educarte/index_e.htm

Swarm (seismic wave analysis and realtime monitor)

https://avo.alaska.edu/Software/swarm/

10 Acknowledgements

The production of this report would not have been possible without the valuable contributions provided by the SERA education partners shown in the table below:

Country	
France	Jean-Luc Berenguer
Greece	Dr Nicos Melis and Dr Gerasimos Chouliaras
Portugal	Susana Custódio
Romania	Dr Dragos Tataru
Switzerland	Anne Sauron-Sornette
UK	Paul Denton