SERA
Seismology and Earthquake Engineering
Research Infrastructure Alliance for Europe

DELIVERABLE

D3.2 Integrated results of educational seismology workshops

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Summary

The SERA Networking Seismo@school outreach programs committee organized and delivered several large ‘summer school’ teachers’ workshops between 2017 and 2020. The target countries were Romania, Portugal and Greece. One of the key aims of the summer schools was to share learning and expertise from past initiatives, of the British, French and Swiss education partners, in support these newer educational programs. These meetings were designed to explain a wide number of teaching tools and methods that could be disseminated to a large number of teachers. These key events, took place over five days involving a large number of teachers.

The preparation and organization of these events took place during short meetings with SERA Education partners from each country. During 'planning workshop' meetings, the committee planned the teachers’ summer schools to provide a range of lectures and hands-on activities. These meetings were also an opportunity to involve a wider number of people to promote a broader understanding of SERA activities, in the education and outreach field, beyond the core committee of SERA partners.

Chapter 1 Introduction

Several workshops have been run during SERA WP3. We will distinguish between three-day or longer seminars with many teachers ('summer schools') and shorter meetings ('planning workshops') focused on project management and organisation. All the meetings organised throughout the project are shown on Table 1. This table allows to quickly visualize the mobilization of teachers at the different workshops, as well as the organizational work carried out by the project leaders. Most of the meetings benefited from local or international events. As a result, the SERA meetings were able to have a greater influence and audience in the European educational community.

Each meeting is briefly described in this final report. It contains the main elements concerning the audience, the content of the conferences and the practical workshops proposed. Each workshop tried to highlight a theme by soliciting researchers for the conferences and teachers for the practical workshops. Each theme is also included in Table 1.

Table 1 Summary of the meetings held as part of the SERA project.

TYPE OF ACTIVITY	LEADING PARTNER	TITLE OF ACTIVITY	DATE	PLACE	TYPE OF AUDIENCE	SIZE OF AUDIENCE
WORKSHOP	INFP	Teachers workshop with SCIENTIX	Nov.-2017	Bucharest Romania	Teachers	400
WORKSHOP	UKRI/BGS	International discussion workshop 'citizen and educational seismology'	Feb.-2018	London United Kingdom	Scientific Community (Higher Education, Research)	50
WORKSHOP	ULisboa	Teachers workshop with 'Casa das Ciencias'	July-2018	Guimaraes Portugal	Teachers	400
INTERNATIONAL CONFERENCE	UKRI/BGS	European Seismological Commission General Assembly	Sept-2018	Valetta Malta	Scientific Community (Higher Education, Research)	1200
WORKSHOP	GEOAZUR/CNRS	Insight Education meeting	Jan-2019	Nice France	Scientific Community (Higher Education, Research)	100
WORKSHOP	NOA	Seismology in Education and Society workshop	Jun-2019	Patras Greece	Selected teachers and Secondary Schools STEM Lab representatives	30
MEETING AND WORKSHOP	ETH	SERA meeting and Mars@School workshop	Feb-2020	Sion, Switzerland	Students (8-17)	220

Chapter 2 SERA summer schools for teachers

3.3 Romanian SERA workshop for teachers

Date: 2-4 November 2017

Place: Bucharest, Romania

Local organizing committee: National Institute for Earth Physics

Figure 1 Romanian SERA workshop for teachers.

Organized in the framework of the European project Horizon 2020 SERA "Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe" by the National Institute for Earth Physics in collaboration with the external partners of the WP3 'Networking Seismo@school outreach programs', the event will be focused on demonstrating how seismology and seismic engineering can provide tools and examples of educational activities.

Organized as a 3-day event, the workshop was structured as a mix of projects presentations, hands-on activities, round-table discussions and thematic visits at research facilities. The activities of the first day were carried out in Magurele, Romania, a science hub for many of the Romanian physics research institutes. More than 50 teachers participated in the first day of SERA workshop. The majority were from Romania, but also Moldavia and Ukraine.

SERA trainers are from partners countries: UK (British Geological Survey & University of Bristol), France (CNRS, Geoazur), Switzerland, Greece (National Observatory of Athens), Portugal (Instituto Dom Luiz and IST) and Romania (National Institute for Earth Physics). The first plenary session comprise a set of introductory project presentations deliver to teachers as an introduction in the subject of seismology and engineering and also in the workshop topics.

List of project presentations:

- SERA – Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe project (P. Denton, UKRI/BGS)
- IDEERS – Introducing and Demonstrating Earthquake Engineering Research in Schools (C. Taylor, UBRI)
- INSIGHT MARS project (J. Camponovo, CNRS/Geoazur)
- MOBEE – Mobile Earthquake Exhibition project (D. Tataru, NIEP)
- SSE – Schools Study Earthquakes (G. Chouliaras, NOA)
- Educating for Earthquake Science and Risk in Portugal (G. Silveira, IST)

- Seismo-at-school in Nepal (S. Subedi, ETH)

Four parallel sessions of interactive workshops were held during the 3-day event. A brief description and session pictures are presented in the section below:

WS 1: Basics in Seismology

Workshop goal: Provide participants with a broad overview of the science of observational seismology, complimented with hands on practical demonstrations illustrating some of the key physical principles

Trainers: Fatima Moujdi-Menauge (CNRS), Paul Denton (UKRI/BGS), John Stevenson (UKRI/BGS), Bogdan Zaharia (NIEP)

Workshop topics:

- elastic rebound theory of earthquakes
- seismic wave properties (transverse and longitudinal)
- how seismic waves travel through the Earth
- how seismometers work
- interpreting seismograms

Workshop Description:

After a short introduction to the activities through scientific lectures and educational project presentations for the whole group, smaller groups of teachers participated in a carousel of practical activities. Using dedicated software participants learned how to use technique and tools for data acquisition and from the wealth of hands-on-activities to get new ideas for their science classes.

Figure 2 WS 1: Basics in Seismology workshop activities.

WS 2: Introducing and Demonstrating Earthquake Engineering to Schools

Workshop goal:

To demonstrate ways in which the fundamental scientific principles underpinning earthquake engineering can be explained to young people through simple hands-on, exploratory activities. The workshop will draw on educational resources developed for the IDEERS website (http://www.ideers.bris.ac.uk).

Trainers: Colin Taylor and Luiza Dihoru, UBRI

Workshop topics:

Basic response of buildings in earthquakes, vibrations, natural frequencies, damping, why good buildings stand up and poor buildings collapse, the social and community setting of good earthquake engineering, design and creativity.

Workshop description:

The IDEERS project was developed with teachers and science education specialists to provide a stimulating resource for introducing fundamental science, environmental, design and social science principles within a visceral context, namely the impact of earthquakes on citizens and their communities. It is based around design activities in which learners design, build and test simple earthquake resistant buildings. Although focused on the UK National Curriculum for 12-14 year old pupils, IDEERS has been used successfully from early primary through to university age groups in the UK, Taiwan and other international locations. The workshop will enable participants to explore the IDEERS resources.

Figure 3 WS 2: Introducing and Demonstrating Earthquake Engineering to Schools workshop activities.

WS 3: InSight Education & Mars@School

Part 1 Workshop goal:

Discovery of the website Mars@School (Lessons 1 and 2) and submit this work to the teachers for education level return

Trainers: Anne Sauron and Shiba SUBEDI (ETH)

Workshop topics: astronomy, physics, tectonics and Mars@School

Workshop description:

Access the website Mars@School and test it. It will be really necessary to share the point of view concerning the contents and the quality of the level science attending for this class of ages.

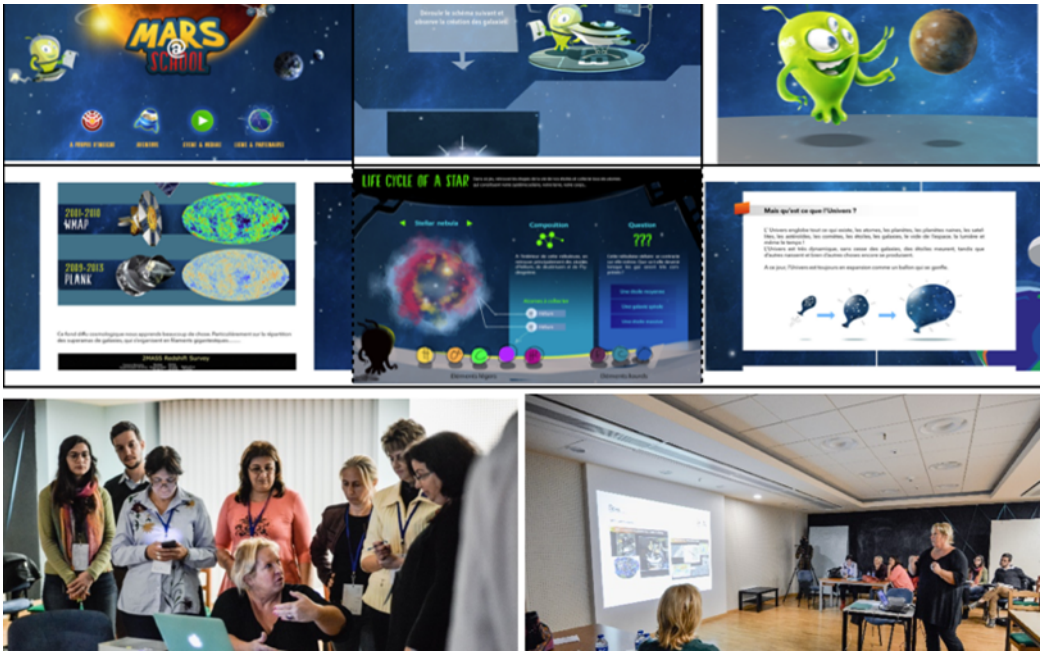

Figure 4 Part 1 WS 3: InSight Education & Mars@School workshop activities.

Part 2 Workshop goal:

How the InSIGHT space mission is teaching in French High schools, from preparations on Earth to Mars landing and deployment of geophysical sensors.

Trainers: Jérémy Camponovo and Fatima Moujdi-Menauge, CNRS/Geoazur.

Workshop topics:

- How to send a rocket to Mars?
- The egg drop, or how to protect the lander against its impact on ground?
- Solar constant and size of photovoltaic panels for a mission to Mars
- How to determine Martian wind velocity and density of the atmosphere ?
- How to estimate location of marsquakes with only one sensor?

Workshop description:

With simple models and free software, hands-on activities help propose answers to the workshop topic questions. These hands-on activities have been tested and validated in French high schools. The

different technical challenges of the InSIGHT mission are tackled in order to discover the different solutions that underpin this mission.

Figure 5 Part 2 WS 3: InSight Education & Mars@School workshop activities.

WS 4: Citizen seismology in education

Workshop goal:

Explore the terms “earthquake magnitude” and “intensity” and show with hands-on practical demonstrations their usefulness in citizen information immediately after a strong earthquake.

Trainers: Nikolaos Melis, Ioannis Kalogeras and Dragos Toma-Danila, NOA.

Workshop topics:

- Earthquake magnitude: definition, history, how to calculate it and automation today
- Macroseismic intensity: definition, history, questionnaires, ‘DYFI’ approach, the instrumental approach and smartphone applications
- Shake maps: what do they present? How can they be combined with other geographic information to serve civil protection agencies and the general public? (i.e. PAGER).
- A code to interpreting photographs from earthquake scenes

Workshop brief description:

After a short introduction to the activities through scientific lectures and educational project presentations for the whole group, smaller groups of teachers participated in a carousel of practical activities. Using dedicated software participants learned how to use technique and tools for data acquisition and from the wealth of hands-on-activities to get new ideas for their science classes.

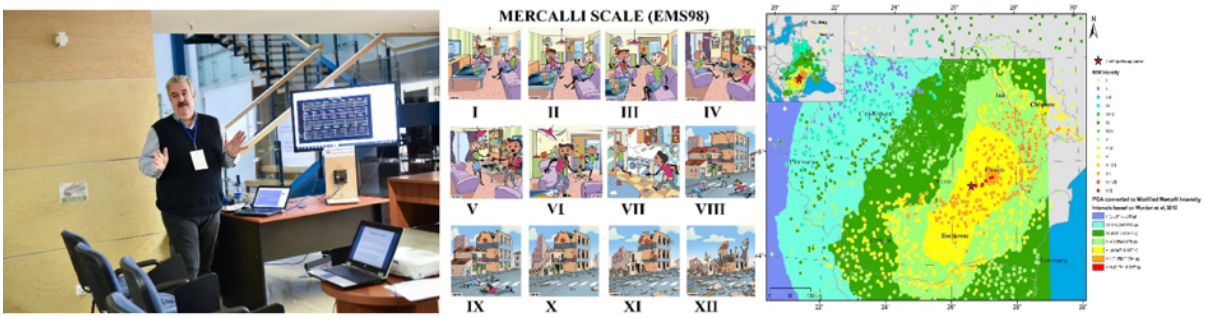

Figure 6 WS 4: Citizen seismology in education workshop activities.

National Conference of the Community for Science Education (CNCES2017)

The 2nd and 3rd day of the SERA workshop was integrated part of the National Conference of the Community for Science Education (CNCES2017) organized in the framework of European initiative SCIENTIX. The purpose of the conference is 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 that will be presenting, discussing and experimenting with STEM's innovative approaches, as well as to reflect on trends and challenges faced by various actors interested in developing the Science /STEM Education Community.

The conference presented interventions by key speakers, hosts round tables, a panel of experts, and offer more than 20 hands-on workshops (4 delivered in the framework of SERA project). More than 150 teachers participating to the CNCES2017 Conference had the opportunity to take part in SERA workshops. The events also allowed a very fruitful dialog between SERA partners and SCIENTIX representative, as well as with other European synergic initiatives (e-Twinning, European Space Agency, ESERO, ERIS, etc).

SERA trainers were invited and participate in round table discussion regarding the future of STEM education (STEM in perspective…trends and challenges) together with important delegates from European Institute of Innovation and Technology, European Schoolnet, Ort Israel, Polish Academy of Science, etc. Important links were made with the SCIENTIX project, a landmark platform for the distribution of educational resources developed on research projects.

Figure 7 CNCES 2017, presentations and round table discussions.

The teachers also had the opportunity to visit Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH) one of the most important public R&D organizations in Romania. The institute is dedicated to the research and development in physical and natural sciences, mainly nuclear physics and nuclear engineering, and in related areas including astrophysics and particle physics, field theory, mathematical and computational physics, atomic physics and physics of condensed matter, life and environmental physics.

3.3 Portugal SERA workshop for teachers

Date: 2-4 July 2018

Place: Guimarães, Portugal

Local organizing committee: Casa das Ciencias, Institute Dom Luiz

Figure 8 Portugal SERA workshop for teachers.

WS 1: Experimental seismology in the classroom

Workshop goal: Locate earthquakes using P and S waves using a case study in Iceland

Trainers: Paul Denton (UK) and Luis Matias (PT)

Workshop brief description:

In 2014, scientists from the University of Cambridge volcanology group were monitoring the seismic activity on the ice cap called Vatnajokull in Iceland, using a network of 72 seismometers. In total more than 30,000 earthquakes with magnitudes between 0.5 and 4 were located during this volcanic episode. The data collected by these seismometers allowed the mapping, with an unprecedented detail, the underground movement of the magma from Bardarbunga to Holuhraun, which allowed us to better understand how magma systems work beneath volcanoes.

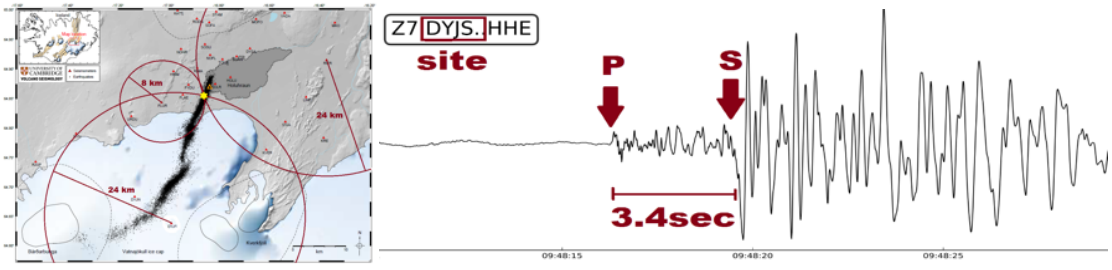

Figure 9 WS 1: Experimental seismology in the classroom workshop activities.

WS 2: Seismic engineering in schools

Workshop goal:
To demonstrate ways in which the fundamental scientific principles underpinning earthquake

engineering can be explained to young people through simple hands-on, exploratory activities (http://www.ideers.bris.ac.uk).

Trainers: Colin Taylor (UK), Athanasios Vratsikidis (GR), Alexandru Tiganescu (RO) and Guilherme, Weishar (PT).

Workshop description:

Using topics from the Discover IDEERS project (Introducing and Demonstrating Earthquake Engineering Research in Schools):

- make the best earthquake resistant model building
- what causes earthquakes and how do they happen?
- find out how earthquake affect people worldwide
- learn how engineers make buildings that survive earthquakes
- discover what researchers are doing to make safer structures

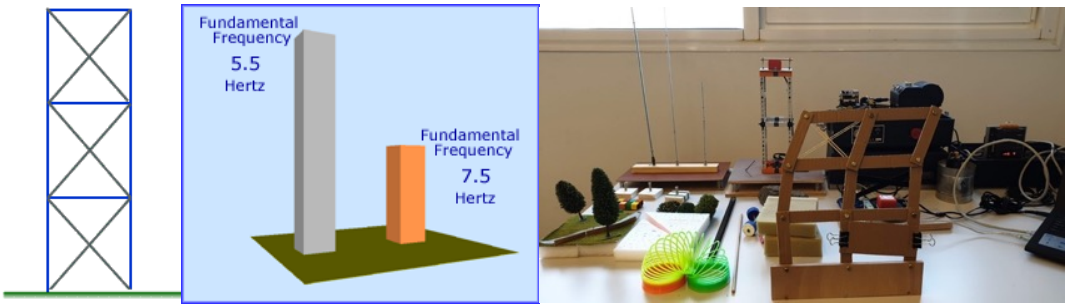

Figure 10 WS 2: Seismic engineering in schools workshop activities.

WS 3: Regional seismic of Iberia-Açores

Workshop goal:

Portugal has been affected throughout its history by destructive earthquakes, both on the mainland and in the Azores. Workshop activities explored some fundamental concepts to better understand the seismic activity of our region.

Trainer: Susana Custódio (PT)

Workshop description:

- evolution of the Iberia-Açores region
- current deformation of the Iberia-Açores region
- historical seismicity and seismic information in real time

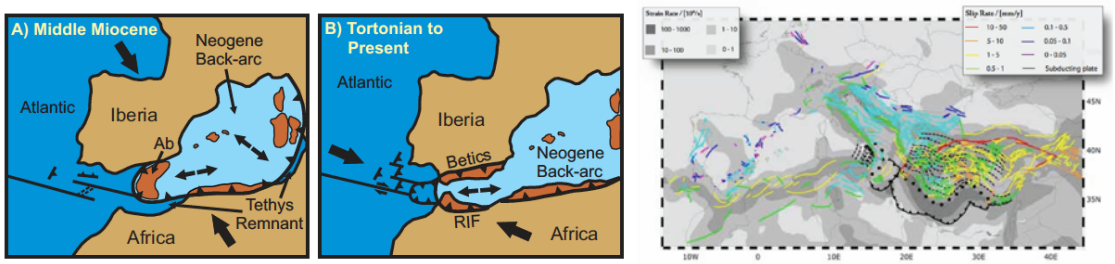

Figure 11 WS 3: Regional seismic of Iberia-Açores workshop activities

WS 4: Mars@School, seismology and tectonics for children

Workshop Description:

In this session we showed how the InSIGHT mission can be taught in schools, aiming at 6-12 year-olds, from preparations on Earth to Mars landing and deployment of geophysical sensors. With simple models and free software, we answered key scientific questions. Materials were also presented to explain fundamental concepts on seismology and tectonics to 6-12 year-olds. Seismology activities were also presented to help understand these concepts.

Trainers: Guilherme Weishar (IDL), Paul Denton, UKRI/BGS and Prof Colin Taylor (UBRI)

Target audience : Secondary schools teachers

Figure 12 Mars@School, seismology and tectonics for children.

WS 5: InSIGHT space mission on Mars

Workshop goal: Several practical experiments for schools were proposed to the participants.

Trainer: Jean-Luc Berenguer (FR) and Susana Custódio (PT)

Workshop description:

- blind test (data topic): access to synthetic seismic data from Mars and from the Moon, and discover methods to locate quakes
- crater impact (telluric topic): model meteorite crater impact, and learn about energy, craters size and impact records
- Earth to Mars (journey topic): Challenge several aspects of the journey : trying to leave the Earth to landing on Mars.
- solar energy (signal topic): Mars is far enough for the Erath … how the solar light or energy decrease with the distance.
- make your own sensor (sensor topic): model and create a sensor like InSight with an accelerometer

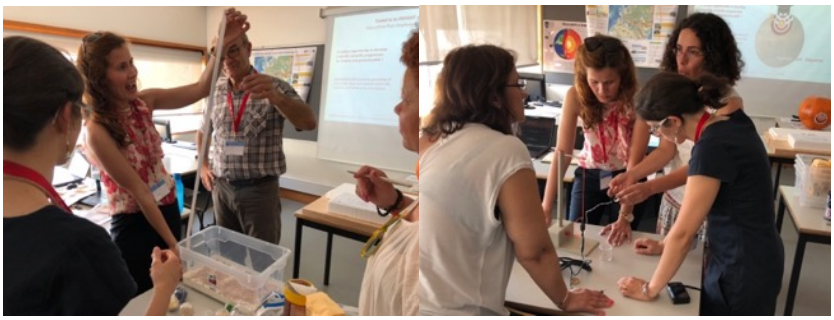

Figure 13 WS 4: InSIGHT space mission on Mars workshop activities.

WS 6: Seismology in Schools

Workshop goal:

Currently, it is possible for any school to participate in seismic activity observation using low-cost sensors or even without sensors, using only an Internet connection. In this workshop, we presented several ways in which Schools can participate and showcase several activities using a personal computer and a connection to the internet.

Trainer: Luis Matias (PT)

Workshop description:

- what is a seismometer and how it works
- how to build a seismometer and what are the instruments available in the market
- Jamaseis: a tool to install a seismic station in any school, with or without a local sensor
- Jamaseis: detection, analysis and location of earthquake epicentres
- The Portuguese Seismology@School project

Figure 14 WS 5: Seismology in Schools workshop activities.

3.3 Workshop for 'InSight@School', Nice, France

Date: 16-17 January 2019

Place: International Campus of Valbonne Sophia Antipolis on

Local organizing committee: Geoazur, University Cote d'Azur

On the occasion of the successful landing of the InSight space mission on Mars, a seminar for teachers was organized in France. This seminar was also the opportunity to organise a meeting of the SERA committee.

The seminar consisted of a series of lectures on the space mission, its initial results, a series of practical activities and a poster session presented by the teachers.

Figure 15 InSight Education Exhibition: Teachers' posters session, InSight Education Expo, virtual reality with Insight lander on Mars!

All the programme and lectures are online at : https://insight.oca.eu/fr/news-insight/478-2019-janvier-16-17-insight-education-scientix-workshop.

Presentations:

- InSight space mission by Lucie Rolland from Geoazur (University Cote d'Azur)
- Dive into Mars atmosphere with InSight by Aymeric Spiga (Laboratoire de Météorologie Dynamique, Paris)
- Bepicolombo space mission to discover by Alain Doressoundiram (Observatory of Paris)
- Live video broascast from JLP NASA by Philippe Lognonné (IPGP, Paris)
- The community for science education in Europe by Noelle Billon (Scientix), Project Officer – Science Education Department – EuropeanSchoolnet

Practical activities:

- blind test data in the classroom
- seismology at school
- using sensors for experiment in the lab

Figure 16 Typical classroom activities and presentations from the Nice workshop, 2019.

This event was supported by the European Commission's H2020 programme – project Scientix 3 (Grant agreement N. 730009), coordinated by European Schoolnet (EUN). The event is the sole responsibility of the organizer and it does not represent the opinion of the European Commission (EC) or EUN, and neither the EC or EUN are responsible for any use that might be made of information contained

3.3 Seismology in Education and Society workshop, Patras, Greece

Date: 25-26 June 2019

Place: Patras, Greece

Local organizing committee: Institute of Geodynamics & Arsakeia Schools

Figure 17 Seismology in education and society workshop, Patras, Greece

The National Observatory of Athens – Institute of Geodynamics and the Arsakeia Schools of Patras in collaboration with the Center of Sciences of Patras organized a two-day workshop on "Seismology in Education and Society" on 25-26 June 2019 at the Center of Sciences of Patras (Platani).

The workshop called for Primary and Secondary Education teachers with interest in STEM training and the subject of seismology (indicatively for teachers with general directions: physics, geology, mathematics, informatics, technology and civil Engineering). The number of teachers participated was 27 and the number of trainers eight. The two-day workshop was free of charge within the framework of the collaboration between the Institute of Geodynamics and the Arsakeia Schools of Patras and the SERA EU-H2020 project: four teams were assigned and each team followed in turn the STEM workshops covering various topics. Participants were provided with material and work plans for use at their school, as well as an attendance certificate for the two-day event.

WS 1: Basic knowledge of seismology in education

Workshop goal: To provide participants with a broad overview of the science of observational seismology, completed with hands on practical demonstrations illustrating some of the key physical principles

Trainers: Paul Denton, UKRI/BGS and Jean-Luc Berenguer, Université Côte d'Azur - OCA/CNRS/IRD.

Target audience: Primary and Secondary school teachers (physics or general science)

Workshop description

There was a short introduction to the activities through scientific lectures and educational project presentations. These were followed by practical laboratory like activities, where the participants could spend over 20 minutes at each activity. Using dedicated software, participants learned how to use techniques and tools for data acquisition and from the wealth of hands-on-activities they got new ideas for their science classes. Topics covered:

- elastic rebound theory of earthquakes
- seismic wave properties (transverse and longitudinal)
- how seismic waves travel through the Earth
- how seismometers and seismographs work
- interpreting seismograms for location and magnitude estimation

Figure 18 Basic knowledge of seismology in education workshop activities.

WS 2: Engineering seismology in education

Workshop goal:

To demonstrate ways in which the fundamental scientific principles underpinning earthquake engineering can be explained to young people through simple hands-on, exploratory activities. The workshop used educational resources developed for the IDEERS web site (http://www.ideers.bris.ac.uk), as well as liquefaction experiments developed at Aristotle University of Thessaloniki.

Target audience: Primary and secondary school educators

Trainers: Prof Colin Taylor, UBRI, UK, Athanasios Vratsikidis, Aristotle University of Thessaloniki Greece and Dragos Tataru, National Institute for Earth Physics, Romania

Workshop topics:

Basic response of buildings in earthquakes, vibrations, natural frequencies, damping, why good buildings stand up and poor buildings collapse, the social and community setting of good earthquake engineering. Design and creativity. Liquefaction and choice of soil for safe building.

Workshop Description:

The IDEERS project was developed with teachers and science education specialists to provide a stimulating resource for setting fundamental science, environmental, design and social science principles within a visceral context, namely the impact of earthquakes on citizens and their communities. It is based around design activities in which learners design, build and test simple earthquake resistant buildings. Although focused on the UK National Curriculum for 12-14 year old pupils, IDEERS has been used successfully from early primary through to university age groups in the UK, Taiwan and other international locations. The workshop enabled participants to explore the IDEERS resources. Moreover, liquefaction effects with demo lab were explained, using resources developed at the Aristotle University of Thessaloniki.

Figure 19 Engineering seismology in education workshop activities.

WS 3: Early warning / information systems in school and society

Workshop goal:

Demonstrate possible ways to use early warning information systems at school, as they operate in other countries. In our case it was introduced the Taiwan P-Alert system and the approach to use it in schools. Macroseismic observations, did you feel it questionnaires, the EMSC Lastquake App and the intensity/isoseismal maps were introduced and explained. Simple hands-on, exploratory activities were used.

Target audience: Primary and secondary school educators

Trainers: Nikolaos S. Melis, and Ioannis Kalogeras, National Observatory of Athens, Greece

Workshop topics:

Intensity and magnitude measurements and their differences. Maximum acceleration values from strong ground motion produced in earthquakes. Macroseismic observations and MMI versus EMS98 scale. Isoseismal maps: historical examples and today's USGS ShakeMap approach. Hands-on activity; manually producing a map of isoseismal information. P to S arrival time difference and the use of this time delay to alerting. Information given from P-wave and estimation of magnitude and seismic energy arriving at the location site of observing/recording.

Workshop Description:

The P-Alert Seismology Cloud project in Taiwan was introduced. The Academia Sinica TEC school seismology project was explained, using the P-Alert sensors that today operate as a pilot array in Patras city and especially at Arsakeia Schools that hosted the Workshop. The real time estimation of the impact of earthquakes on citizens and their communities was explained in the use of: Macroseismic observations, USGS ShakeMaps and citizen sourced observations at EMSC. The possibility to develop a project for warning in class was discussed with the school educators.

Possibilities of demonstrating the use of such system in schools in Greece was also explored with example approaches.

Figure 20 WS 3: Early warning / information systems in school and society workshop activities.

WS 4: Earthquake hazard/risk and preparedness/resilience at schools and community.

Workshop goal:

Explain seismic hazard and earthquake risk. Demonstrate approaches for improving resilience and preparedness at schools and how to transfer this knowledge from schools to community. Show approaches to involve citizens and make communities aware of seismic hazard through school activities connecting pupils/students and parents, hence the local communities. Exercises and drills at schools improving resilience and develop better earthquake prepared schools.

Target audience: Primary and secondary school educators

Trainers: Anne Sauron, HES-SO Valais/Wallis, Institute of Systems Engineering, Sion, Switzerland, Dragos Tataru, National Institute for Earth Physics, Romania and Ioannis Kalogeras, National Observatory of Athens, Greece

Workshop topics:

Earthquake hazard and risk. Citizens observing earthquake effects and the use of this data through focused applications to return useful maps to civil protection agencies, scientists and the general public. Possible applications in Greece to improve resilience and raise awareness.

Workshop Description:

Focused lectures on earthquake hazard and risk. Connect USGS ShakeMaps and WS3 material (i.e. EMSC Lastquake App approach) to citizen and society awareness through school involvement in the local communities. Pilot projects for Patras city and especially the involvement of Arsakeia Schools that hosted the Workshop. Discussion with participated educators and their approaches to increase resilience and improve awareness for preparedness in earthquake risk. Possibilities of demonstrating the use of such approaches in schools in Greece was also explored with example approaches.

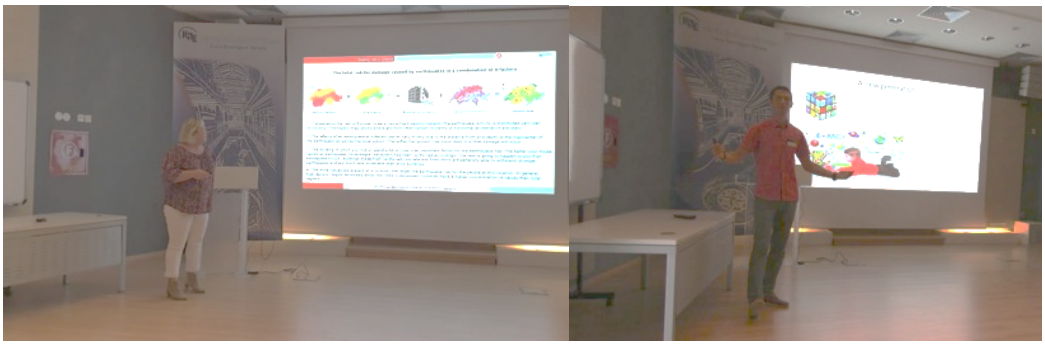

Figure 21 WS 4: Earthquake hazard/risk and preparedness/resilience at schools and community workshop presentations.

Figure 22 Teachers also visited the Patras Science Centre.

3.3 Earthquakes and Marsquakes; how to learn about seismicity on rocky planets workshop, Switzerland

Date: 4-6 February 2020

Place: OXFB, St Luc, Switzerland

Local organizing committee: Institute of ETH/HES-SO Valais-Wallis

Workshop goal:

The goal of the workshop was to develop knowledge of earthquakes, introduce planetary science concepts and the use of 'marsquakes' as a tool for teaching. The last M6 earthquake in the local area occurred in 1946. Such large magnitude events are predicted to occur +/- 20-year cycles. Hence it is a strong political goal of the Valais area to stimulate earthquake awareness, preparedness; before, during and after an earthquake amongst students, teachers and the general public.

The OFXB Astronomical Observatory and Saint-Luc Planetarium, was used as the setting for these workshops as it is Switzerland's only observatory that is dedicated towards education for the public and schools. The altitude of its location increases the chances of clear skies and hence it is an excellent location for planetary observation and study.

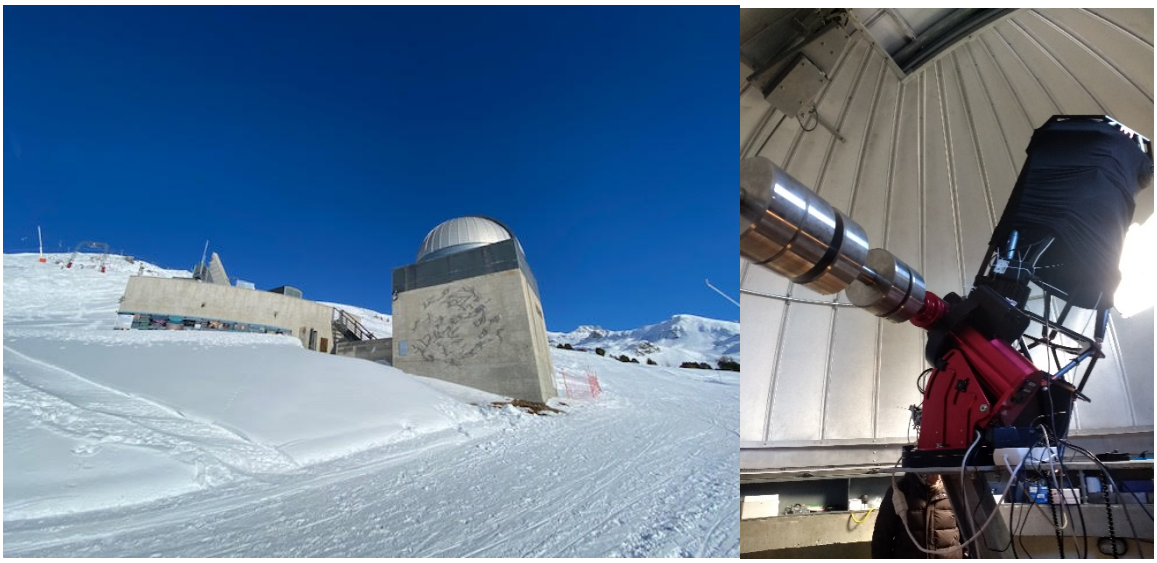

Figure 23 OFXB Astronomical Observatory, Saint-Luc.

WS 1: Mars InSight Mission

Workshop goal:

To explain background science to Mars InSight mission and how students can study MarsQuakes in the classroom.

Target audience: Secondary school teachers

Trainers: Paul Denton, UKRI/BGS and Jean-Luc Berenguer, Université Côte d'Azur - OCA/CNRS/IRD.

Workshop description: In this session we described the InSIGHT mission, from preparations on Earth to Mars landing and deployment of geophysical sensors. We showed how the InSIGHT mission can be taught in schools, aiming at secondary school students.

Figure 24 Mars InSight Mission teacher presentation.

WS 2: Mars-at-school

Workshop goal:

In this session we described the InSIGHT mission, from preparations on Earth to Mars landing and deployment of geophysical sensors. With simple models and free software, materials were presented to explain fundamental concepts on seismology and tectonics. Seismology activities were also presented to help explain these concepts.

Target audience: Secondary school students

Trainers: Jean-Luc Berenguer, Université Côte d'Azur - OCA/CNRS/IRD and Paul Denton, UKRI/BGS

Figure 25 Mars-at-school student workshops, OXFB Observatory.

WS 3: Earthquake hazard, risk and preparedness

Workshop goal:

Explain earthquake preparedness, hazard and risk

Target audience: Primary school students, School of Vissoie (110 students)

Trainers: Anne Sauron, ETH/HES-SO Valais-Wallis and Jean-Luc Berenguer, Université Côte d'Azur - OCA/CNRS/IRD.

Workshop description

Focused lectures on earthquake preparedness, hazard and risk. As part of this session an E-learning module was introduced and used to facilitate learning across several goals. Using an earthquake simulator (range M3 to M6) students learn how to react when they are in schools during an earthquake. Further details available at the CPPS website www.cpps-vs.ch. After using the E-learning module, students have a good feeling of what an earthquake is and what to do in the event of an earthquake. They also learn how earthquake waves are propagated through the Earth, calculate distances and learn about the hazard and risk associated with an earthquake.

Figure 26 WS 3: Earthquake hazard, risk and preparedness workshops.

WS 4: Observatory presentations/animations

Workshop goal:

To introduce key concepts within planetary science

Target audience: Secondary school students

Trainers: Eric Bouchet, OXFB, St Luc. Scientific Animation

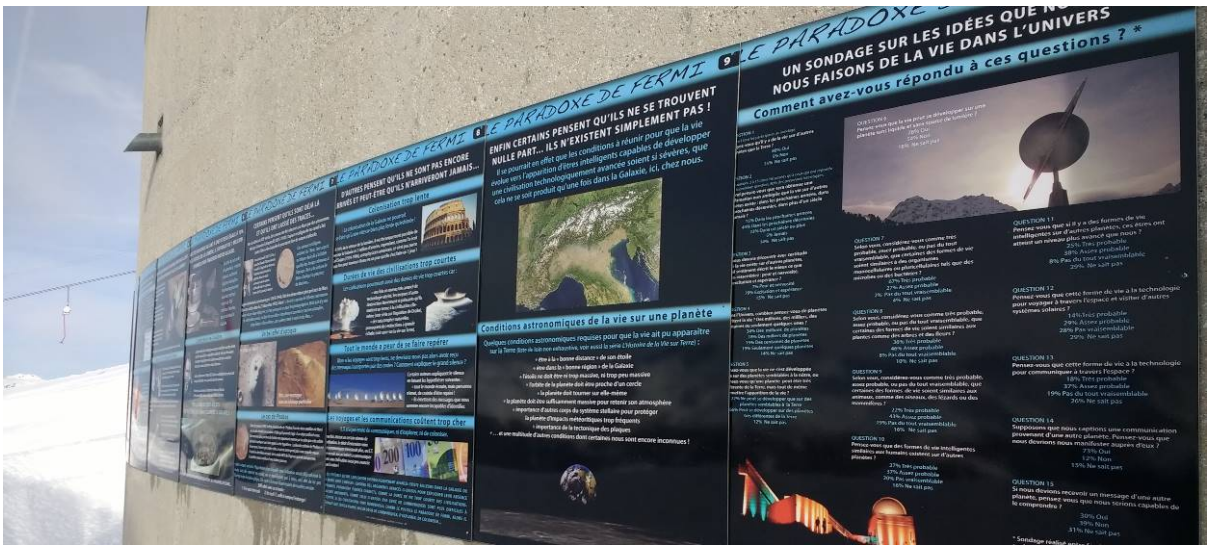

Figure 27 OXFB, St Luc scientific animations in introduced key concepts within planetary science to 28 secondary school students.

WS 5: Observatory night-time telescope observations

Workshop goal:

Aims to familiarize teachers with the starry sky using the best tools available; telescopic observations using an instrument of 610mm in diameter.

Target audience: Secondary school teachers

Trainers: Eric Bouchet and Michael Cottier, OXFB, St Luc. Scientific Animation

Workshop description

Local teachers (28) were invited to use powerful telescopes to look at the night sky. They were able to look at the surface of the moon in fine detail where landscape features and meteorite craters could clearly be seen. The observations highlighted the shear density of stars in the sky not visible to the naked eye. Observations focused in on features such as Orion's nebular, one of the brightest nebulae that is sometimes visible to the naked eye in the night sky, but is seen much brighter through telescopes.

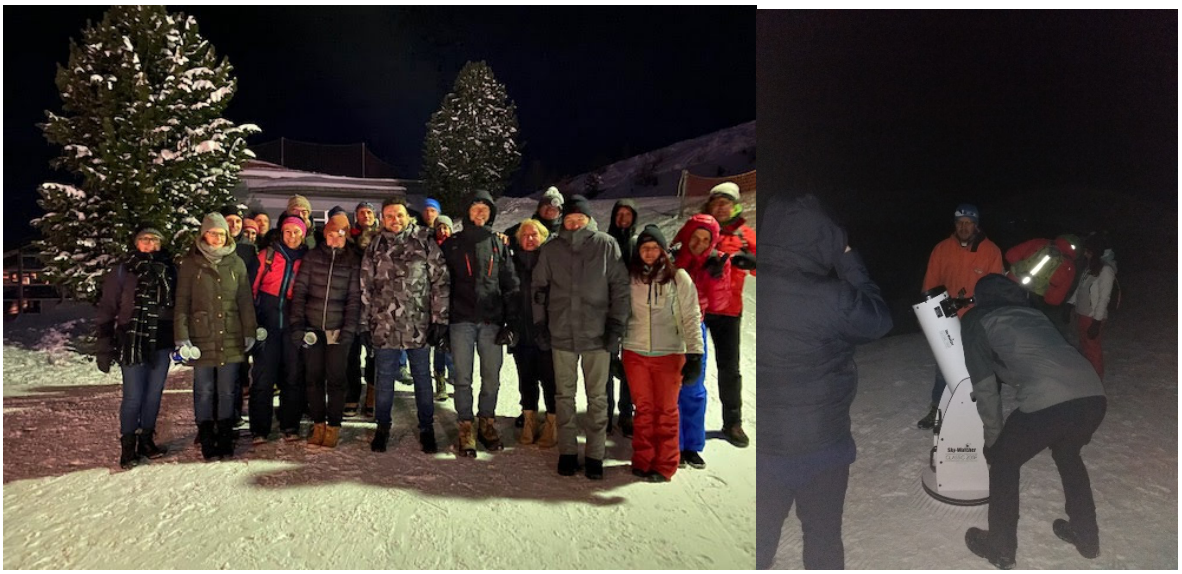

Figure 28 WS 5: Observatory night-time telescope observations.

Chapter 3 Conferences, technical workshops and organizing committee meetings

Delegates from each participating country of the SERA Seismo@school outreach program were invited to meetings to plan the teachers' summer schools. The committee planned the teachers' summer schools to provide a range of lectures and hands-on activities. These meetings were integrated into the initial teachers' summer schools and other events such as the workshop for educational and citizen seismology (2018). These short working meetings of the SERA organising committee were also an opportunity to integrate summer schools into local education and outreach events in order to better disseminate the actions of SERA to local teachers and the wider education and outreach field.

3.1 Workshop for educational and citizen seismology

Date: 15-16 February 2018

Place: Geological Society of London, UK

Local organizing committee: British Geological Survey/UKRI

Background

Most of what we know about Earth's structure, dynamics, hazards, resources and exploration for raw materials comes from seismology but it is only recently, thanks to the availability of cheap computers and the internet, that it has become possible to introduce the subject in schools and include live displays in museums and Geoparks for the general public. For these purposes high quality sealed observatory-type units are not ideal and a variety of small simple comprehensible low cost seismometers and software have been developing across the globe. They range from laboratory sized replicas of the Milne-Shaw type, through ones using slinkies and lego building blocks to smart phones which are used for detection and communication. Data from these varied devices are pooled and stored at data centres to facilitate data exchange and discussion. As the educational value of the subject is becoming more widely appreciated the need for an international discussion workshop for Educational and Citizen Seismology became apparent. This was held at the Geological Society meeting rooms in London 15-16 February 2018, with financial support from The British Geophysical, UNESCO and the EU.. At the meeting it was noted that MarsQuake project data from NASA's InSight mission to Mars launched on May 5 2018 will provide a set of teaching resources and activities.

The meeting was designed as a forum for experts in educational and citizen seismology to get together and discuss areas of mutual interest and discover potential synergies and future collaborations. The meeting was scheduled with a balance between keynote talks and discussion or demonstration sessions. The format was to have some keynote addresses from the most experienced experts in developing equipment and running school and citizen seismology programmes to facilitate future collaboration and encourage the growing number of institutions round the globe interested in developing such programmes. There were breakout discussion groups on motivating leaders and maintaining engagement, hardware and software development, data sharing standards and archiving.

In the USA school seismology emerged from the IRIS (Incorporated Research Institutions for Seismology) consortium funded by the National Science Foundation since 1992 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 the UK this process has been overseen and supported by the British Geological Survey under the direction of Paul Denton who developed the interest while he was at the University of Leicester where the national pool of seismic equipment is housed and maintained. In 2017 a new EU Horizon 2020 funded project SERA (Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe) was approved and included 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. This is typified by the Raspberry Shake project, which arose from a successful Kickstarter campaign in 2016 by seismologists in Panama and already has over 600 participants across the world, all recording and sharing seismic data on inexpensive raspberry pi/geophone based sensors (www.raspberryshake.org). Within Europe the European-Mediterranean Seismological Centre (EMSC) has led the way in citizen seismology with smartphone and web based citizen seismology activities. The worldwide educational potential of the activity is indicated by the support provided by the UNESCO.

Participants

The meeting was attended by 47 registered delegates from 16 different countries (Australia, France, Greece, Ireland, Israel, Italy, Nepal, New Zealand, Palestine, Panama, Portugal, Romania, Spain, Sweden, Switzerland, Trinidad, UK, and the USA) who have been doing school seismology in a variety of different ways, some for decades and some just starting. Groups everywhere usually included seismologists from a local university or regional network working with teachers and officers from national educational bodies. We are also seeing the emergence of amateur seismologists as the costs of simple instruments

and computers including smart phones are now affordable. There were senior participants who retired from the seismic instrument industry and are applying their expertise to making affordable versions of sophisticated observatory instruments for school and amateur use.

Motivations

Each group has a slightly different motivation for setting up their projects. In countries with high seismicity a strong motivation was 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 it is 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.

Keynote talks

The first keynote address was by Remy Bossu, the Secretary General, European-Mediterranean Seismological Centre (EMSC) on Why is LastQuake a successful citizen Science project. LastQuake is an app which people launch when they feel an earthquake. The location of the phone launching the app is immediately plotted on a map at a data centre. Eyewitnesses act as seismic sensors: they feel the ground shaking and by launching the app (or visiting our websites) report the time and location of their observation. The response is very fast and as more launches occur a dotted area emerges and outlines the affected area and provides a lot of useful information about the origin of the earthquake.

Messages can be sent to the people with the app saying where the earthquake is and this in turn generates more responses as they launch. The response pattern is complicated by the magnitudes. For large earthquakes there is a 'doughnut effect' i.e. a blank zone near the epicentre where people know there is an earthquake and don't need to launch the app to find out where it is. They may call for advice which is readily provided. Magnitudes can be estimated qualitatively as being small, medium, or large. It was an exciting demonstration of how useful Apps can be in contributing to risk reduction.

The second Keynote talk was one of the meeting highlights presented by Angel Rodrigues of Panama on the past, present and future of the Raspberry Shake, a sensor digitiser that can record earthquakes from about magnitude 2 and higher within a radius of 50 miles, and a magnitude 4 and higher in a radius of 300 miles. It will also record earthquakes of larger magnitudes farther away but with some loss of information. Raspberry Shake can detect and record short period (0.5 - 15 Hz) earthquakes but the range of recordable frequencies falls off with distance. The hardware can hardly be cheaper. However the software is costly but comprehensive and easy to use. In just 14 months over 500 stations have been installed, 133 of these in Europe. It is cheap and fun to use for vibrations ranging from washing machines, goals at football matches and pop-concerts to small earth tremors from earthquakes and volcanoes. It is affordable by amateurs and has obvious application in citizen and school seismology. They can be deployed in large numbers and detect earthquakes too small to be detected by Regional Networks.

The presentation by Richard Allen, Director, Berkeley Seismology Lab on Earthquake alerts from crowdsource sensing was on a similar theme. It uses the myriad of data from the accelerometers in smartphones to create alerts by its remarkable ability to distinguish earthquake signals from the much

larger ones resulting from the noise due the motion of the smartphone carried by the user. A network detection algorithm MyShake can confirm that an earthquake is underway and estimate the location and magnitude in real time. This information can then be used to issue an alert of forthcoming ground shaking. could be used to enhance EEW in regions with traditional networks and could provide the only EEW capability in regions without. In addition, the seismic waveforms recorded could be used to deliver rapid microseism maps, study impacts etc. In the US alerts were generated for earthquakes of magnitudes down to 1.6. The potential was demonstrated by an earthquake in Nepal where there are few conventional seismic stations but several million smartphones.

John Taber, the Director of Education and Public Outreach in IRIS gave the third Keynote presentation on the comprehensive Educational Seismology programme in the USA. Its activities ranged from formal educational and professional development to less formal activities on the web, and displays using social media for the general public. The programmes started from Princeton in 1992 with 80 schools using low cost versions of the Guralp feedback seismometer which is widely used in observatories. The AMASEIS software was developed to permit real time streaming of data to a data centre for use in locating and studying earthquakes. Schools anywhere in the world can register to download and upload data from and to the system. The educational value of being able to do this is enormous. Over the years regional networks have developed in the US with tens of schools whose teachers work with seismologists in the classroom. In Indiana there is an annual student research symposium. The school students value spending a day at the campus and presenting their data. Teachers value linking with universities which in turn benefit from making contact with high quality students. There is ongoing collaboration with the UK and Ireland. Over 150 US schools and 200 international schools use the IRIS facility. There is a plan to expand it to include the data from Mars. Problems encountered in the US and elsewhere include overcoming firewalls in schools, and the lack of teacher continuity which can interrupt teachers helping each other.

A different kind of school project, AUSIS the Australian School Seismic Network was described in the 4th Keynote talk by Michelle Salmon from the ANU. It is a partnership between research and outreach. Research quality Guralp seismometers are installed and connected to school computers in schools and used to increase the density of the country's sparse network. So far 47 schools have such instruments. There are some problems due to fact that the hardware and software are not ideal for schools which are sometimes too remote for interaction with seismologists. A lot of useful contacts and suggestions were made to improve the working of the partnership.

The school programme in New Zealand was rather different. A talk on RU: The New Zealand Network for Seismology in Schools was presented via Video link by Kasper van Wijk, Associate Professor, University of Auckland. There is a strong cultural link with the earth as complicated belts of high seismic and volcanic activity define plate boundaries which go through New Zealand. There is a history of large earthquakes and there a national network Geonet whose data as well as those from the USGS are accessible. The school seismometers were based on slinkies with magnets at the end and connected to a raspberry pi running Jamaseis software. The students were involved in assembling 17 school seismometers from kits which were distributed throughout New Zealand with one on a small island to the east. They can download data, plot record sections, identify P and S waves, and draw circles to produce seismicity maps. One interesting refinement is the addition of notch filters to remove ocean noise as was fashionable in observatories nearly a century ago. It is a highly effective programme but is poorly funded and will be difficult to maintain. IT support is very small. As in other parts of the world, they are working towards getting seismology into the school Curriculum to increase and maintain teacher interest.

Jean-Luc Berenguer, Science Teacher & French seismo network Project leader gave the 5th keynote talk on Tuned in to Mars… from 'SISMOS à l'Ecole' with SEIS InSight. The French have been doing teaching seismology for over 20 years in French schools all over the world. Seismology is in the curriculum and there are Geoscience teachers able to teach the subject in geography, physics, and maths courses. There is a database for education. Seismometers may be of the blackbox or TC1 variety depending on

the preference of the school. Special software like AMASEIS has been created for them. These are supplemented by laboratory models to simulate earth materials – lasagne and warm or cold chocolate from the fridge were mentioned. Non- computer literate students find these particularly useful. Schools are encouraged to communicate with each other and with the project HQ to exchange ideas and information. Schools have invited to apply for selection to work on data from the seismic data from the InSight space mission data from Mars. 15 schools accepted the challenge and will be selected on how they perform with a set of synthetic data they were sent to work on.

Susana Custodia of the University of Lisbon gave an illuminating talk on the interface between citizen science and civil protection in Portugal which has the largest earthquakes in Europe. Indeed the largest earthquake in Europe was the devastating 1755 offshore Lisbon Earthquake which occurred on All Saints Day and was regarded as another act of God. But it was the starting point of modern seismology as people began to enquire about the effects in the rest of Europe including the UK and Ireland. There was a magnitude 7.9 earthquake in 1969 so there is a high degree of awareness and the University is called upon to advise on seismology in schools and in the country at large. Interestingly the enquiries in schools come from biology teachers who seek help from physicists in building their own detectors and even shake tables to study the effects on buildings. One graduate student is using Ocean Bottom Seismometers to study the sounds of whales. The civil authorities are actively involved with making risk maps and developing civil protection measures.

Similar objectives relating earthquake damage were mentioned by participants from other seismic areas – Nicos Melis in Greece, Francesco Finazzi in Italy, Shiba Subedi and Surya Acharya from Nepal, Wist Bloch Israel. Rondell Liverpool is involved with a new school programme in Trinidad and Tobago where the Caribbean Seismic Network is based and needs to expand to the volcanic islands some of which already have French and American stations to link with.

Other citizen seismic issues mentioned during the meeting were the monitoring of fracking by Anna Horleston of Bristol and Jefferson Chang of Oklahoma, landslides by Emma Bee and the CTBT by Thomas Blake from the Dublin Institute for Advanced Studies.

A common problem which was mentioned in the discussions was that of maintaining the interest of secondary school teachers where the seismology was not in the curriculum. But occasionally the converse occurs with enthusiastic teachers who obtain spectacular results. A good example is Vika Moisey, a primary school teacher from the Birdwell Academy in Bristol who was able to get 9 year old pupils enthused about earthquake waves, damage, and convection in the earth. They even built their own detector. They entered and won the young scientists competition in 2014 and there is a paper in the young scientists journal Issue 17. It is a useful pointer for the future as there is a need to get younger people interested in physical science as early as possible to fill university places in science and engineering to address the issue of manpower shortages in these areas.

Outcomes

The meeting was the first international meeting of its kind and was welcomed as school and citizen seismology was an important fast moving subject being developed with limited resources in most cases. The doors are open for a continuing exchange of ideas and future collaboration. The activities benefit from the outreach element from the existing Regional Networks of sparsely distributed sophisticated instruments. There are huge additional potential benefits to be gained from the large numbers of simple instruments acquiring data.

The initiation by the SERA group and support from UNESCO are good pointers for the future. There is a long way to go and the need for regular meetings was emphasised. It was agreed that the coordination would continue with planned shared sessions at the ESC meeting in Malta in September 2018 and the 2019 joint assembly of IASPEI and IUGG in Montreal.

The meeting received financial support from SERA, UNESCO, the BGA , the BGS, and the University of Leicester; use of rooms from the Geological Society; and administrative support from the BGS and RAS.

Presentations

All of the presentations at the meeting were filmed and are available to view at:

http://www.bgs.ac.uk/discoveringGeology/hazards/earthquakes/schoolSeismology/seismoATschool/EduCitiSeis2018.html

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3.2 European Seismological Commission General Assembly, Malta

Date: 2 - 7 September 2018

Place: Valetta, Malta

Local organizing committee: ESC, Malta

Conveners:

Nicos Melis, NOA, Greece

Remy Bossu, EMSC, France

Silvia Peppoloni, INGV, Italy

Giuseppe di Capua, INGV, Italy

Iain Stewart, Plymouth, UK

Graça Silveira, Lisbon, Portugal

Susana Custódio, Lisbon, Portugal, educational seismology and civil protection

Tataru Dragos ,INFP, Romania

Paul Denton, BGS/UKRI, UK

This session aimed to bring together seismologists working in the fields of educational seismology, citizen seismology and geoethics. The common theme being the process of communicating the science of seismology to non-specialists. Seismology has an important role to play in modern society and seismologists should be having two-way communications with a wide variety of stakeholders across all levels of society, encompassing schools, engineers, general public, other scientists, politicians and civil protection professionals. In educational seismology projects across the world practical studies of seismology can be used to enhance the scientific literacy not just within the school but also within the wider community through family interactions. Nowadays non-specialist citizens are becoming increasingly involved with the collection and dissemination of seismological information through a growing number of citizen seismology networks, maybe by reporting directly or indirectly felt effects or by instrument based programmes. This session aimed to promote the discussion on social aspects involved in seismic risk communication and (geo)ethical implications. Improving the relationships between scientists, decision makers, and general public means to increase the resilience of the human communities, and to make seismologists more aware of the responsibility in conducting their activity.

3.3 Final deliverables planning meeting, Switzerland

Date: 4-6 February 2020

Place: OXFB, St Luc, Switzerland

Local organizing committee: Institute of ETH/HES-SO Valais-Wallis

Participants: John Stevenson (WP leader, UKRI/BGS, UK), Anne Sauron (ETH, CH), Paul Denton (Consultant, Denton Seismo, UK), Dragos Tataru (NIEP Ro), Jean-Luc Berenguer (Geoazur Fr) and Nicos Melis (NOA, Gr, via Skype).

Meeting aim: to finalise material for Deliverable report D3.2, refine approaches for reports D3.4 and D3.5. Set deadlines for writing and review to keep on track for final submission to the SERA management board on 14 April.

Deliverable report titles:

D3.2 Integrated results of educational seismology workshops

D3.4 Science with seismo@school: results and targets

D3.5 Integration between educational and citizen initiatives, achievements and strategies

Liability claim