SECOND EUROPEAN CONFERENCE ON EARTHQUAKE ENGINEERING
AND SEISMOLOGY, ISTANBUL AUG. 25-29, 2014

RAISING EARTHQUAKE AWARENESS IN ROMANIA THROUGH AN EDUCATIONAL PROJECT (ROEDUSEIS)

Bogdan GRECU[1] Dragos TATARU[2] Bogdan ZAHARIA[3] Constantin IONESCU[4]
Speranta TIBU[5,6] Emil-Sever GEORGESCU[7] and Nicoleta BICAN-BRISAN[8]

ABSTRACT

From historical time, science was a tool used mainly by people eager to search and find answers to unresolved questions. Nowadays scientists have also the opportunity to bring their contribution for building a safer and habitable planet.

The Romanian Educational Seismological Network (ROEDUSEIS) is the first educational initiative in Romania in the field of seismology that aims to develop new and comprehensive educational materials, familiarize the students and teachers with seismological data and train them how to analyse and interpret these data, plan, design and test didactic activities based on the concept "learning by doing" and using also informatics and Web-oriented tools and to prove that raising people awareness in high seismic regions could be attained through education and by increasing knowledge about the earthquake phenomena and their effects.

INTRODUCTION

Earthquakes are among natural disasters which have, for century, frightened as well as fascinated the people all around the globe. Due to their potentially destructive character the people have tried since historical times to understand and explain these natural phenomena. The beginning of the "modern era" of seismology started after the 1st of November 1755 when a strong earthquake and tsunami hit and destroyed the city of Lisbon, causing the death of almost 70.000 people. After this event, and taking also advantage of the development of communication and earthquake recording systems that allowed making observations on earthquakes and their effects more easy and quick exchange of this information within communities, the study of earthquakes became more and more scientific.

Despite of the technological and scientific achievements made especially in the recent years and in the last century, earthquakes still cause important damages, loss of lives, socio-economic losses as well as cultural losses. All these damages and losses are not caused by the earthquake mechanism itself, but are mainly caused by the failure of human-made facilities (buildings, dams, bridges,

[1] PhD, National Institute for Earth Physiscs, Magurele, bgrecu@infp.ro
[2] PhD, National Institute for Earth Physiscs, Magurele, dragos@infp.ro
[3] PhD, National Institute for Earth Physiscs, Magurele, bzaharia@infp.ro
[4] PhD, National Institute for Earth Physiscs, Magurele, viorel@infp.ro
[5] PhD, National Institute for Earth Physiscs, Magurele, c_speranta@ise.ro
[6] PhD, Institute of Educational Sciences, Bucharest, c_speranta@ise.ro
[7] PhD, National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Developmen, Bucharest, ssever@incerc2004.ro
[8] PhD, Babeş-Bolyai University, Faculty of Environment Science and Engineering, Cluj, nicoleta.brisan@ubbcluj.ro

transportation systems, etc.). This is very important, since it is primarily up to human beings to prevent such failures. This means that, through good education, training, proper implementation of research and development tools and of comprehensive earthquake preparedness programs, people can learn where and how to build earthquake-resistant facilities, and therefore prevent an earthquake disaster.

Romania is one of the most active seismic countries in Europe, with more than 500 earthquakes occurring every year. The seismic hazard of the country is relatively high and is mainly controlled by the Vrancea subcrustal earthquakes located at the sharp bend of the southeast Carpathians. These earthquakes occur within a narrow, near-vertical focal volume subducted at intermediate depths: 60–220 km. The Vrancea earthquakes could be very devastating earthquakes, causing a lot of damage and loss of lives. Last century, 4 strong earthquakes with magnitudes between 6.9 and 7.7 occurred in Vrancea area in a time period of 50 years (10 November 1940, Mw= 7.7; 4 March 1977, Mw = 7.4; 30 August 1986, Mw = 7.2 and 30 May 1990, Mw = 6.9) (Oncescu et al., 1999), of which the 1977 event was the most destructive. This event killed more than 1,570 people, injured 11,300 persons, caused the collapse of 33 tall buildings in the Romanian capital, Bucharest and resulted in economic losses well in excess of US$ 2 billion (World Bank Report No.P-2240-RO, 1978).

Romania is also characterized by a crustal seismic activity which is not as intense and dangerous as the intermediate-depth seismic activity. However, moderate crustal earthquakes (Mw = 5 - 6) occurred in the past in different seismogenic zones and caused some damages. Thus, it is very important that the Romanian people understands the earthquake threat in Romania, how to behave during earthquakes to minimize personal risk and how to secure home, school or/and work environments to minimize injuries, deaths and economic losses from strong earthquakes. One way to achieve these goals is to introduce seismology in schools and to educate the children using accessible educational materials, proper tools and excellent resources for classroom-based experiments.

ROMANIAN EDUCATIONAL SEISMIC NETWORK (ROEDUSEIS)

The Romanian Educational Seismological Network (ROEDUSEIS) project, started in 2012, ending in June 2016, is the first educational initiative in Romania in the field of seismology involving two research institutes (the National Institute for Earth Physics - NIEP as coordinator, the National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Development - URBAN – INCERC, Bucharest branch), one university (the Babeş-Bolyai University - BBU - Faculty of Environmental Sciences and Engineering) and one private company in software developing (BETA Software). Following similar initiatives already existing in western countries (France and Italy – The Educational Seismology Project, Zollo et al., 2014, Berenguer et al., 2013; 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 and is also promoting the role of education and schools in disaster risk reduction.

Several objectives are foreseen at the end of the project. They are educational, scientific and social. The main educational objectives are to develop new and comprehensive educational materials, familiarize the students and teachers with seismological data and train them how to analyse and interpret these data, planning, designing and testing didactic activities based on the concept “learning by doing” and using also informatics and Web-oriented tools. Generally, the students and teachers from elementary and high schools have difficulties in accessing the research infrastructure which is usually confined to research institutes and universities. Thus, the scientific aim of the project is to introduce real scientific instruments (seismographs) in schools that will be integrated in a school-based seismic network, with the main product being the creation of an earthquake waveform database. The real data will be analysed with specific methods used in seismological researches and will be further integrated with the Romanian seismological database and, eventually, with similar international databases. From the social point of view, this will facilitate the interaction between scientists, teachers and students, thus allowing the students and teachers to be more involved in research activities, on one hand, and the scientists to share their knowledge and to participate in didactic activities, on the other hand. Finally, the project represents an essential tool for increasing the student, teacher and even the general public awareness of seismic risk.

ROEDUSEIS project is implemented in 9 school units in different cities (Brasov, Bucharest, Cluj, Constanta, Focsani, Iasi, Sibiu, Timisoara, Zalau) (Figure 1) which were selected considering the following aspects:

i) the moderate to high seismicity within certain regions (Brasov and Sibiu are affected by crustal earthquakes generated in the Fagaras-Campulung seismogenic zone, Constanta is under the influence of the earthquakes generated at surface in the Shabla zone, near the border with Bulgaria; Focsani is located within the Vrancea epicentral area; Timisoara is under the influence of the surface earthquakes generated in the Banat seismic source zone);

ii) the peculiar characteristics of the strong Vrancea intermediate-depth earthquakes that are causing a lot of damage at large epicentral distances on NE-SW directions (Bucharest and Iasi);

iii) demographic and cultural aspects (Cluj and Zalau are large cities and multicultural diverse).

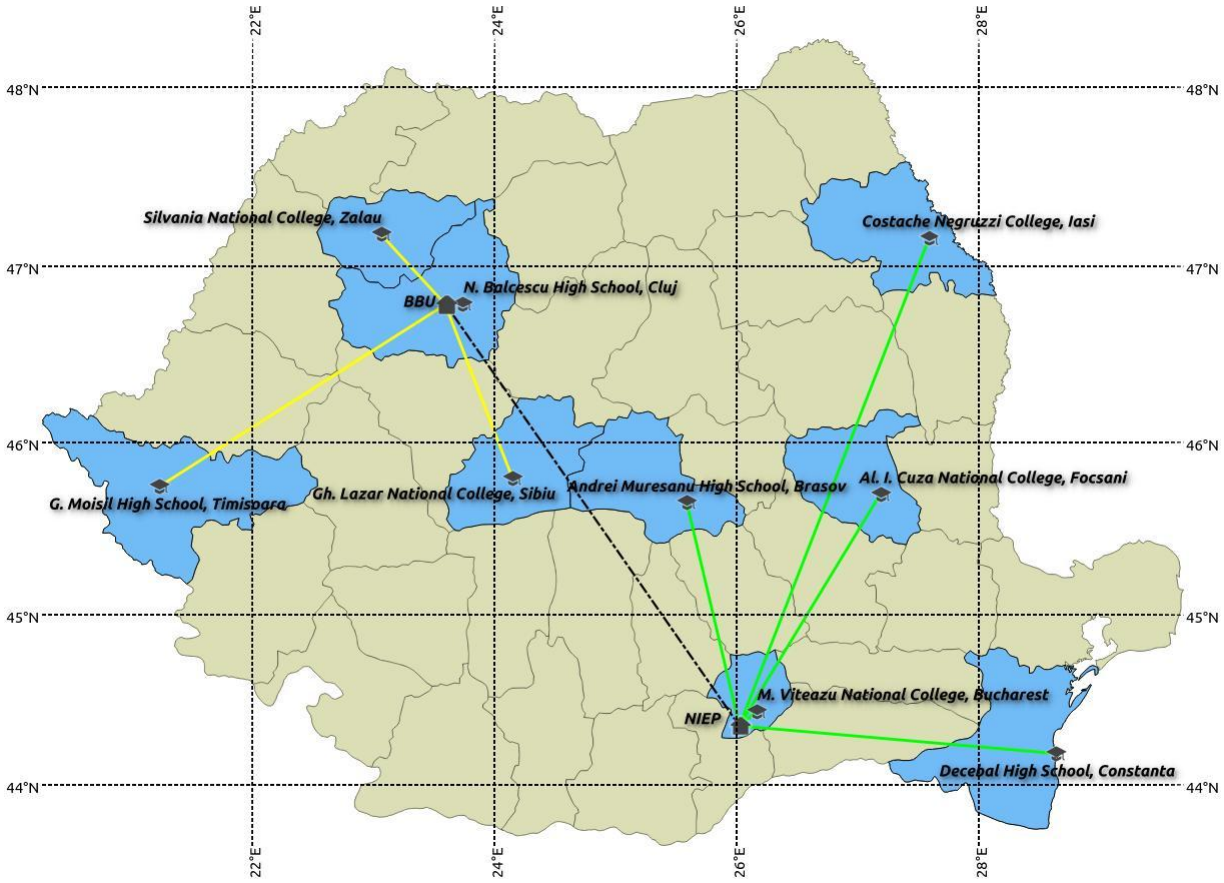

Figure 1. Pilot schools participating in the project

NEEDS ANALYSIS

One of the project goals is to develop educational materials related to seismological education. To properly calibrate our products to the needs of beneficiaries (students and teachers), we were interested to find out if the Romanian schools were opened for piloting such initiatives, if there is any interest in this theme, whether such activities are presently carried out in schools or if students and teachers have access to different types of resources. In this direction we conducted, during October-November 2012, a needs analysis study in the participating schools. The study consisted of online questionnaires applied on a sample of 266 students aged between 9 and 18 and 75 teachers from all educational levels (Figure 2). The results shows that 78.8% of students did not participate ever to programs/activities on earthquakes theme and 60% say they know somehow, little or don't know how to behave in case of an earthquake (Figure 2). On the other hand, 90% of teachers believe that activities/seismological educational programs are required (Figure 2). Regarding the practical ways of doing activities, students don’t want theoretical aspects about the earthquake activities; they prefer

activities that address practical issues in an interactive and a relaxed atmosphere (specific to non-formal activities rather than formal). The study provided an opportunity for students and teachers to voice their needs and expectations and also made possible the connection between the authors/researchers and Romanian school environment. The educational materials developed have largely integrated the suggestions outputted by this needs analysis study.

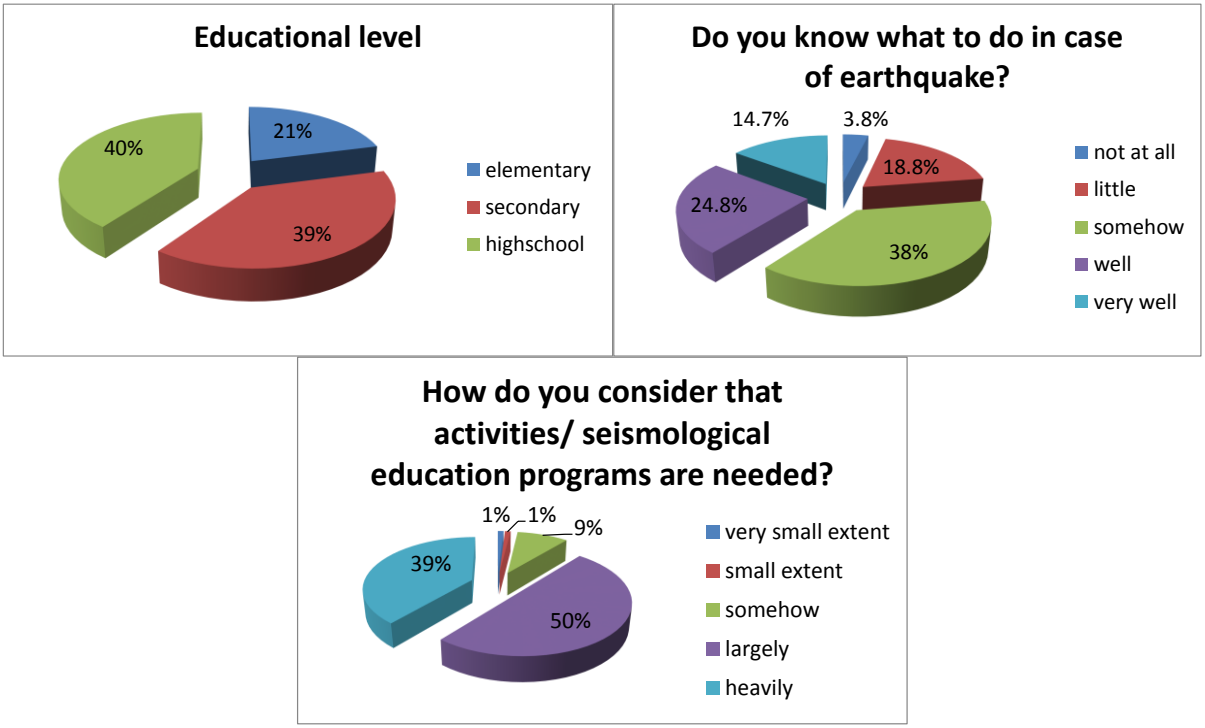

Figure 2. Results of needs analysis

EDUCATIONAL MATERIAL DEVELOPMENT

Based on the output of the needs analysis, the educational materials developed in the first stage of the project consist in a collection entitled "Earthquakes and their effects" (Figure 3) (Zaharia et al., 2013) and address all the pre-university education levels (kindergarten, primary, secondary and high school). Except the preschool level, the collection is organized in a guide for teachers accompanied by a booklet for students. The motto of the collection "We learn. We experiment. We protect ourselves" illustrates very well the structure of the educational material which is divided in theoretical chapters followed by sections with activities and experiments adapted to the level of understanding particular to each educational cycle. The collection covers the following topics: i) Defining an earthquake ii) Why and how the earthquakes occur iii) Measuring the earthquakes iv) Earthquakes effects on the natural environment and v) Earthquakes effects on the built environment, protection and safety measures. The developed material has a highly educational character and do not require a high level of scientific knowledge in order to understand the concepts and activities.

PROMOTING THE INITIATIVE AND WORKSHOPS FOR TEACHERS

During March – April 2013 the ROEDUSEIS consortium made visits to all participating schools in the project. Throughout these visits the project and the collection of educational materials (Figure 4) that aim to be used in school classes were presented to interested teachers and school boards. In the same time one SEP educational seismometer was installed in each school (Figure 5).

In summer of 2013 the consortium of ROEDUSEIS organized two regional workshops in Cluj and Bucharest (Figure 6) where the teachers from the participating schools were invited to participate.

The purposes of the workshops was to show how Earth Science topics can be learned in schools, in other ways than the traditional ones, and were more concentrated on activities and experiments and guided by the principle "learning by doing" (Zaharia et al., 2013). Practical examples and methodological suggestions were presented for teachers who want to work with students on subjects covering aspects of Science and Geography Programmes (the Rock and Soil Circuits, Spot that Rock: sorting rocks the scientific way (Years 3/4), How the Earth Works in Your Classroom; applicable to the Geological sections (Dynamic Rock Cycle; Earth Science Out-of-Doors; Earth Science Around Your School; Spot that Rock), targeted at the Earth-related parts of each of the science specifications (The Earth and Plate Tectonics, Earth Physics (ages 16-19) The Seismology Story; The Geophysics Story).

Figure 3. Earthquakes and their effects book covers

Figure 4. Pictures from school visits for promoting the initiative

During the workshops, the teachers found out how they can use the seismological data recorded in their own schools for simple earthquake related activities such as earthquake recordings analysis, location and magnitude estimation, and how these informations can be related to the subject of their discipline. Natural sciences teachers learned how seismic signals can be used to explore the Earth, how to map a cross-section of a subduction zone using historical seismicity catalogues, and how to determine the location of an earthquake epicenter with different graphical methods. Physics teachers found out that seismology can be an interesting way to study wave propagation: a natural introduction of period and frequency concepts. Finally, the workshops gave the opportunity to each teacher to see what can be integrated in his own course or what seems to be less interesting for them.

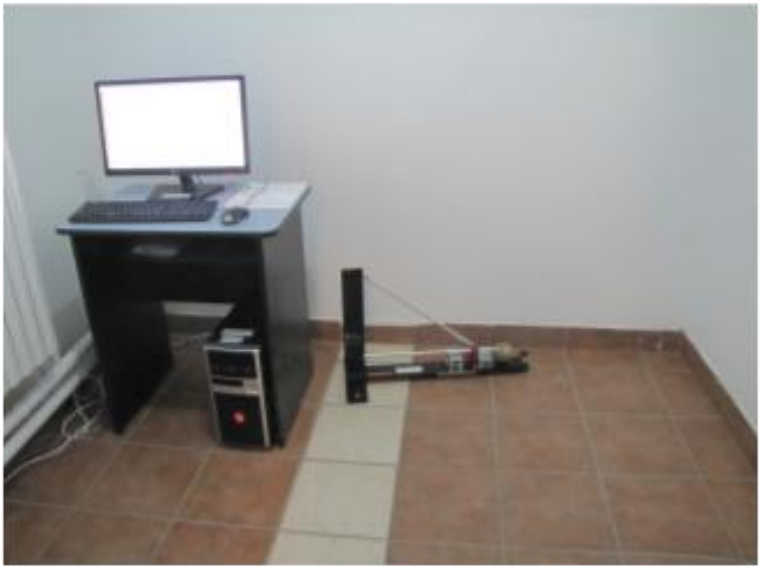

Figure 5. SEP seismometer system and installing

Figure 6. "Teaching Earth Science in High School" Workshops for teachers in Cluj-Napoca (left) and Bucharest (right)

ROEDUSEIS NETWORK

The ROEDUSEIS seismic network was set-up by installing nine educational seismometers in the participating schools (Figure 1). Two more educational seismometers were installed in Magurele at NIEP and in Cluj at BBU. The purpose of this network is to make advanced, research-level instruments and data analysis tools available to schools and to increase students' attention to observations of Earth phenomena and Earth science in general. Presently, the recorded waveforms are

available to the schools that are part of the project and are stored locally. Every seismic station from each participating school contains one SEP seismometer and one desktop PC with jAmaseis (http://www.iris.edu/hq/programs/education_and_outreach/software/jamaseis) package software installed for data acquisition. The main scientific objective is to create school based earthquake waveform database, which can be integrated with national (NIEP) and similar international databases (Incorporated Research Institutions for Seismology - IRIS, British Geological Survey - BGS). The teachers participating in the project will assure the functioning of the educational seismometer installed in their school. During the project, technical aids and support will be given by NIEP for the operation of the educational seismic equipment.

The first valuable records of the ROEDUSEIS network were obtained on October 6, 2013 when an earthquake with local magnitude 5.5 occurred in Vrancea area at a depth of 134 km. Only three seismometers were functioning at that time and recorded the earthquake (Figure 7). Since then, other 5 local earthquakes, 2 regional events and 1 teleseism were recorded by the educational seismometers (Table 1). Using the P and S arrival times read with jAmaseis software, only 4 earthquakes recorded by the ROEDUSEIS network could be located. This is due mainly because of the electrical shutdowns in schools that affect the functioning of the educational seismic stations. Figures 8 and 9 show the results of the locations performed using jAmaseis software for two earthquakes, one local event in Romania, in Vrancea area (23 January 2014, ML = 4.7), and one regional event in Greece (3 February 2014, Mw = 6.0).

Table 1. Parameters of the earthquakes recorded by ROEDUSEIS network

Nr. Crt.	Origin time	Epicenter coordinates	Magnitude	Depth (km)	Region
1.	03.04.2014 12:38:57	45.47 N; 26.40 E	4.6	124	Vrancea, Romania
2.	29.03.2014; 19:18:05	45.61 N; 26.48 E	5.0	134	Vrancea, Romania
3.	03.02.2014; 03:08:45	38.26 N; 20.32 E	6.0	2	Greece
4.	03.02.2014; 00:26:31	45.67 N; 26.47 E	4.3	134	Vrancea, Romania
5.	26.01.2014; 13:55:43	38.19 N; 20.41 E	6.1	18	Greece
6.	23.01.2014; 06:15:05	45.42 N; 26.26 E	4.7	126	Vrancea, Romania
7.	25.10.2013; 17:10:17	37.22 N; 144.69 E	7.1	10	Off East Coast of Honshu, Japan
8.	15.10.2013; 19:33:12	45.64 N; 26.56 E	4.7	136	Vrancea, Romania
9.	06.10.2013; 01:37:21	45.64 N; 26.69 E	5.5	134	Vrancea, Romania

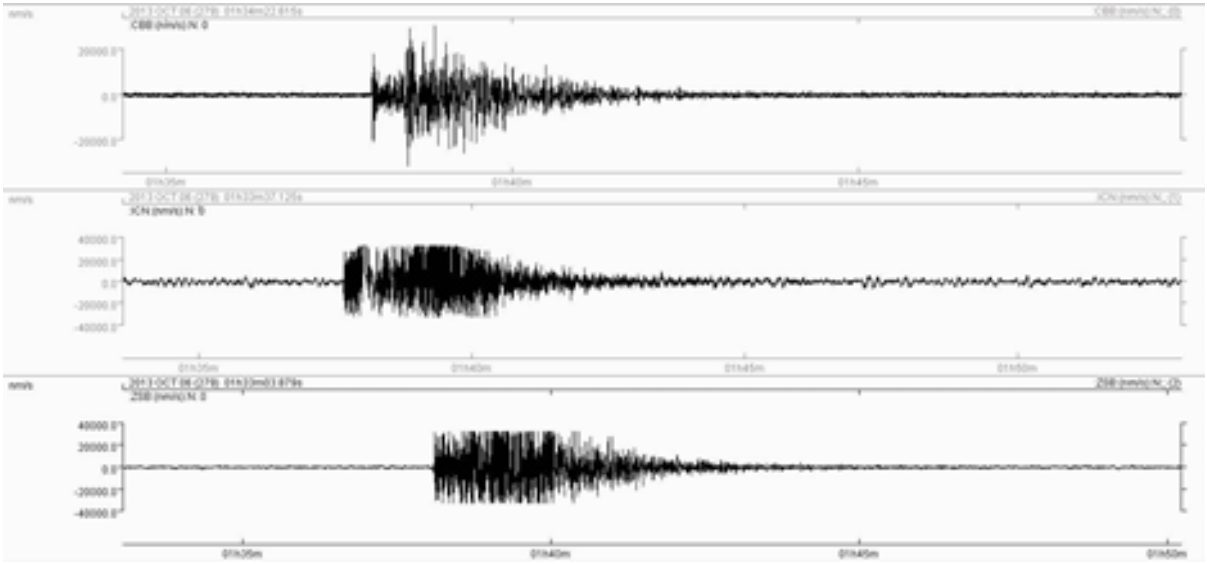

Figure 7. October 6, 2013 M_L = 5.5 Vrancea earthquake recorded by ROEDUSEIS network

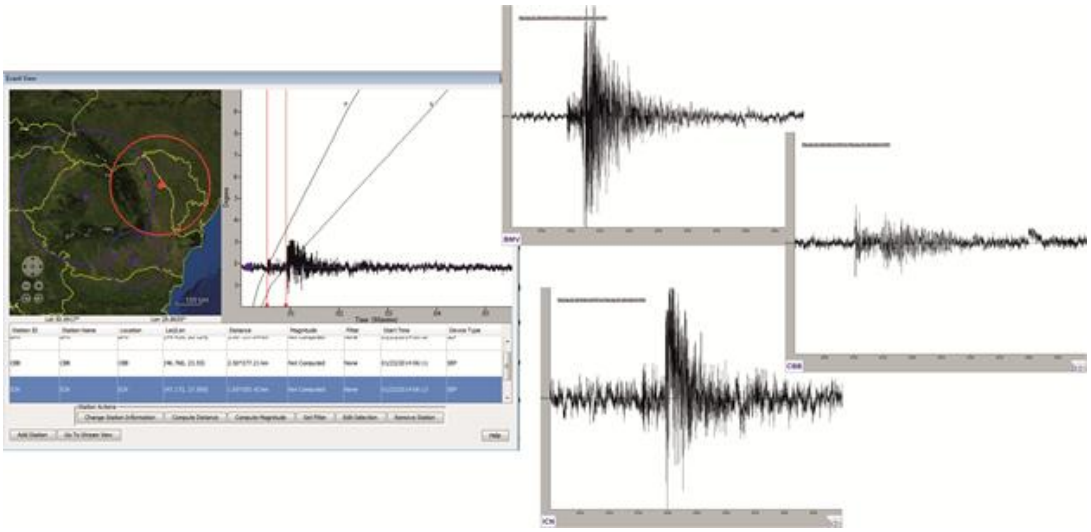

Figure 8. January 23, 2014 M_L = 4.7 Vrancea earthquake recorded and located by ROEDUSEIS network

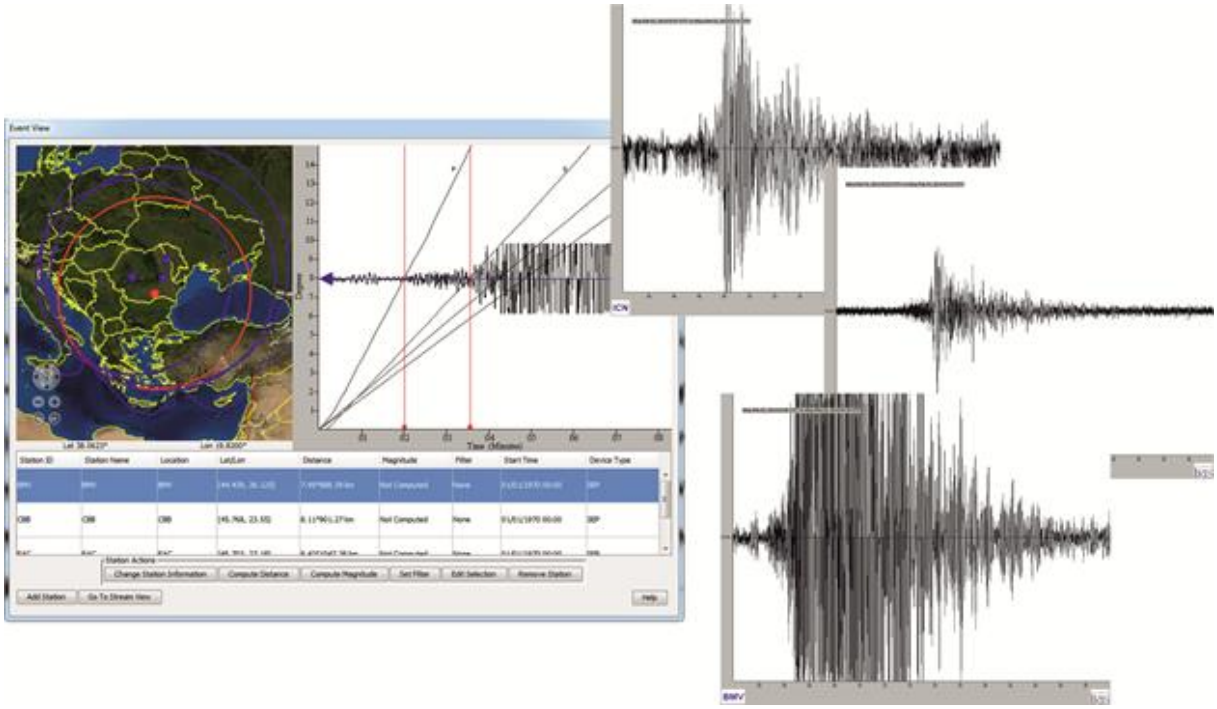

Figure 9. February 3, 2014 Mw = 6.0 regional earthquake from Greece recorded and located by ROEDUSEIS network

E-LEARNING PLATFORM

The main product of the project is the E-Learning platform (http://www.roeduseis.ro). Still in development stage, the platform will host, integrate and manage a data portal for the data recorded by the ROEDUSEIS network, educational modules (courses, activities, questionnaires, games), dedicated modules for the interaction between researchers and teachers (forum), distance education course proposals for teachers as well as dissemination modules for the activities carried out within the project. The concept of this platform is well detailed in Figure 10.

At present, the platform includes information about the ROEDUSEIS project (objectives, partners, participating schools, activities and results), offers access to the developed educational materials, integrates a tool (Forum) for interaction between the members of the consortium of the

project and the members of the developed educational network and the general public and hosts specials sections where participating schools can upload materials developed within school activities (in the form of photos, videos and text). There is also a section which shows the recent earthquakes occurred in Romania and neighboring countries that is updated regularly.

CONCLUSIONS

Raising people awareness in high seismic regions, like Romania, could be attained through educating them and increasing their knowledge about the earthquake phenomena and their effects at the earth surface. The ROEDUSEIS is the first initiative in Romania that introduces seismology in Romanian schools and aims to develop and provide new and innovative educational resources, familiarize students and teachers with seismological data and earthquake recording instruments, involve them in scientific experimental activities and in learning methods governed by "learning by doing" modern approaches.

The project has started in June 2012, and in the first stage new educational materials for kindergarten, primary, secondary and high school were developed based on the results of a need analysis that was performed in the 9 schools participating in the project. The topics of the materials cover all the aspects related to earthquake phenomena, from defining an earthquake to prevention measures before, during and after an earthquake.

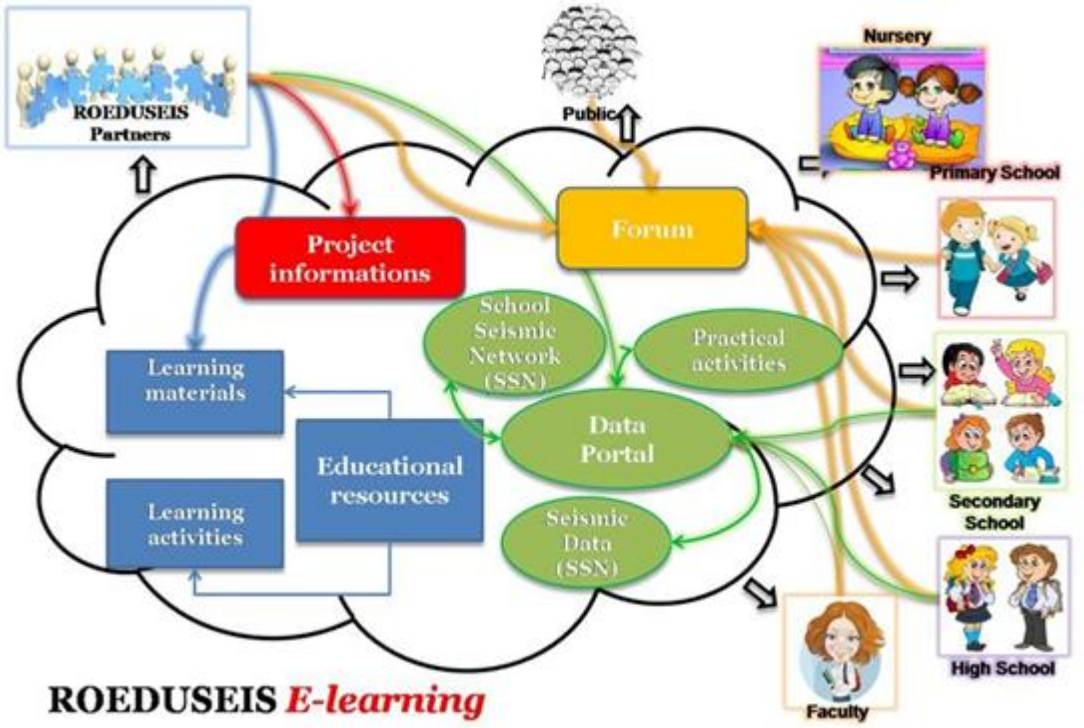

Figure 10. Concept of ROEDUSEIS e-learning platform

Another important result is the development of the educational seismic network. This network consists of 9 SEP educational seismometers installed in the participating schools and two more seismometers installed one at NIEP in Magurele and one at BBU in Cluj. Since the installation of the network 6 local earthquakes generated at intermediate-depth in Vrancea region, 2 regional events occurred in Greece and one teleseism from Japan were recorded by the network. Four of them could be located using jAmasesis software that is running at each station site.

In the future stages the project aims to produce and maintain a comprehensive list of educational materials. More than that, the ROEDUSEIS consortium, including the involved teachers from participating schools, will provide a framework for development of new curriculum modules that use

educational seismology topics to introduce a series of science concepts regarding the Earth as a system.

Another declared and pursued goal of the project is to facilitate the teacher-student-scientist interactions. Here we consider all the activities starting with teacher professional development through dedicated workshops, classroom learning activities, collaboration among schools using web based tools and provided communication interfaces.

Assessment of the initiative was and will be done in each step of the implementation. On-site and online questionnaires will be used to evaluate and improve the effectiveness and impact of project materials and activities. The initial evalutions undertaken since the beginning of the project have already outlined several strengths and also weaknesses of the project. The strengths of the project, as identified by respondents are related to: the possibility to come in contact with updated and trustful information on the earthquake theme, the educational materials, the involvement of the children in practical activities, the ROEDUSEIS network of schools, the usefulness of an educational seismograph as a technical support for the activities and the online platform as an efficient resource tool and experience exchanges opportunity. The weaknesses underlined are related to the Romanian educational system which is overloaded and did not offer enough time for additional activities shaped on teachers` and children's own interests, the difficulty in the integration of the project into the school current activity which is very much aligned with centralised school programs and very little shaped on the schools own wishes and needs.

Recommendation for decision makers on the bases of the good practices will be formulated at the end of the project and efforts will be made in order to largely disseminate the results of the project, for the benefit of the whole Romanian educational community.

Even if it is the first such initiative in Romania, in the field of seismology and earth science in general, the project seeks to coordinate and find synergies with other programs and more important to be integrated in European and international educational programs to benefit from their expertise and outcomes.

ACKNOWLEDGEMENTS

This work was done in the framework of ROEDUSEIS project, nr.220/2012 suported by UEFISCDI, program Partnership 2012.

REFERENCES

http://www.iris.edu/hq/programs/education_and_outreach/software/jamaseis

Berenguer JL, Courboulex F, Tocheport A, Bouin MP, (2013) "Tuned in to the Earth … from the school EduSismo: the French educational seismological network", Bulletin de la Societe Geologique de France, , v. 184, p. 183-187, doi:10.2113/gssgfbull.184.1-2.183

Oncescu MC, Marza V, Rizescu M, Popa M (1999) "The Romanian earthquakes catalogue between 984-1997", In: Vrancea Earthquakes: Tectonics, Hazard and Risk Mitigation, edited by F. Wenzel, and D. Lungu, Kluwer Academic Publishers, pp. 43-47, 1999.

World Bank Report No.P-2240-RO, 1978

Zaharia B, Tataru D, Borleanu F, Bican-Brisan N, Georgescu ES (2013) Earthquakes and their effects, CD PRESS Editor, ISBN 978-606-528-157-8 (in Romanian)

Zollo A, Bobbio A, Berenguer JL, Courboulex F, Denton P, Festa G, Sauron A, Solarino S, Haslinger F, Giardini D (2014) "Workshop and laboratory-based approaches, The European experience of educational seismology", In Geoscience Research and Outreach.Schools and Public Engagement.Series: Innovations in Science Education and Technology, Vol. 21. Tong, Vincent C. H. (Ed.) 2014, IX, 340 p. Springer