GEOSCIENCE 2020

APPLICATION OF EARTHQUAKE EARLY WARNING SYSTEM FOR GAS DISTRIBUTION PROTECTION

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1. Introduction

The regional seismicity and the objectives of our project (O1 – O4) are presented schematically in Figure 1. In the city of Râmnicu Vâlcea, the seismic protection system will be built by blocking the gases in case of a seismic event in Vrancea. The local sensor is a triaxial accelerometer installed in a borehole near the dispatcher that will provide the warning service.

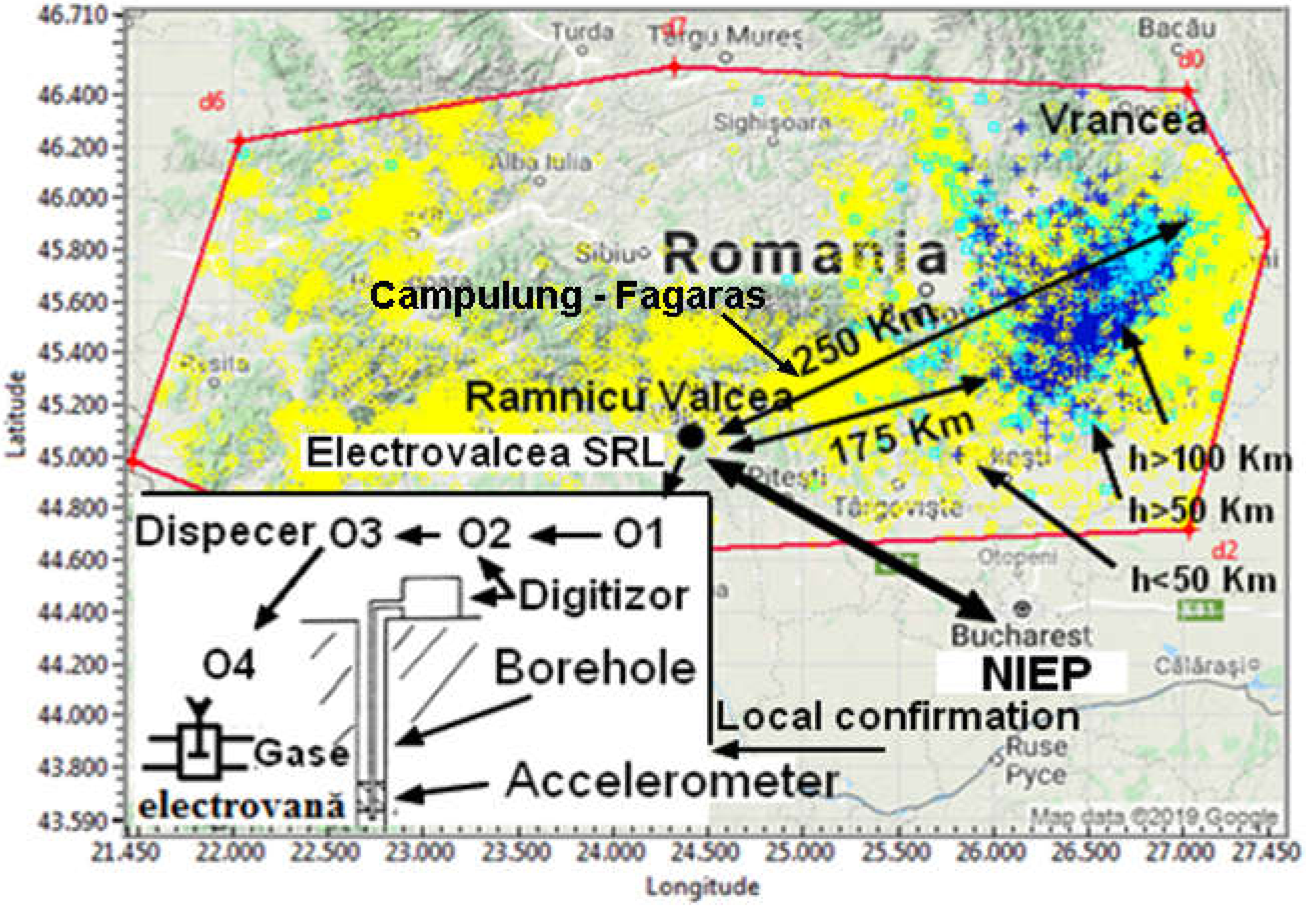


Figure 1. Seismicity in the area of seismic sources (red polygon) and analysis of the possibility of protection of an area located 250 km from the epicenter.

2. Case Study

We present a case study to understand how the system works. general structure of monitoring network is in Figure 1 presented. A recent earthquake, 22.10.2020, with the magnitude ML = 4 R activated the NIEP warning system (Figure 2). Vrancea generates important intermediate depth earthquakes between two main points: Nereju and Gura Teghii, our case.

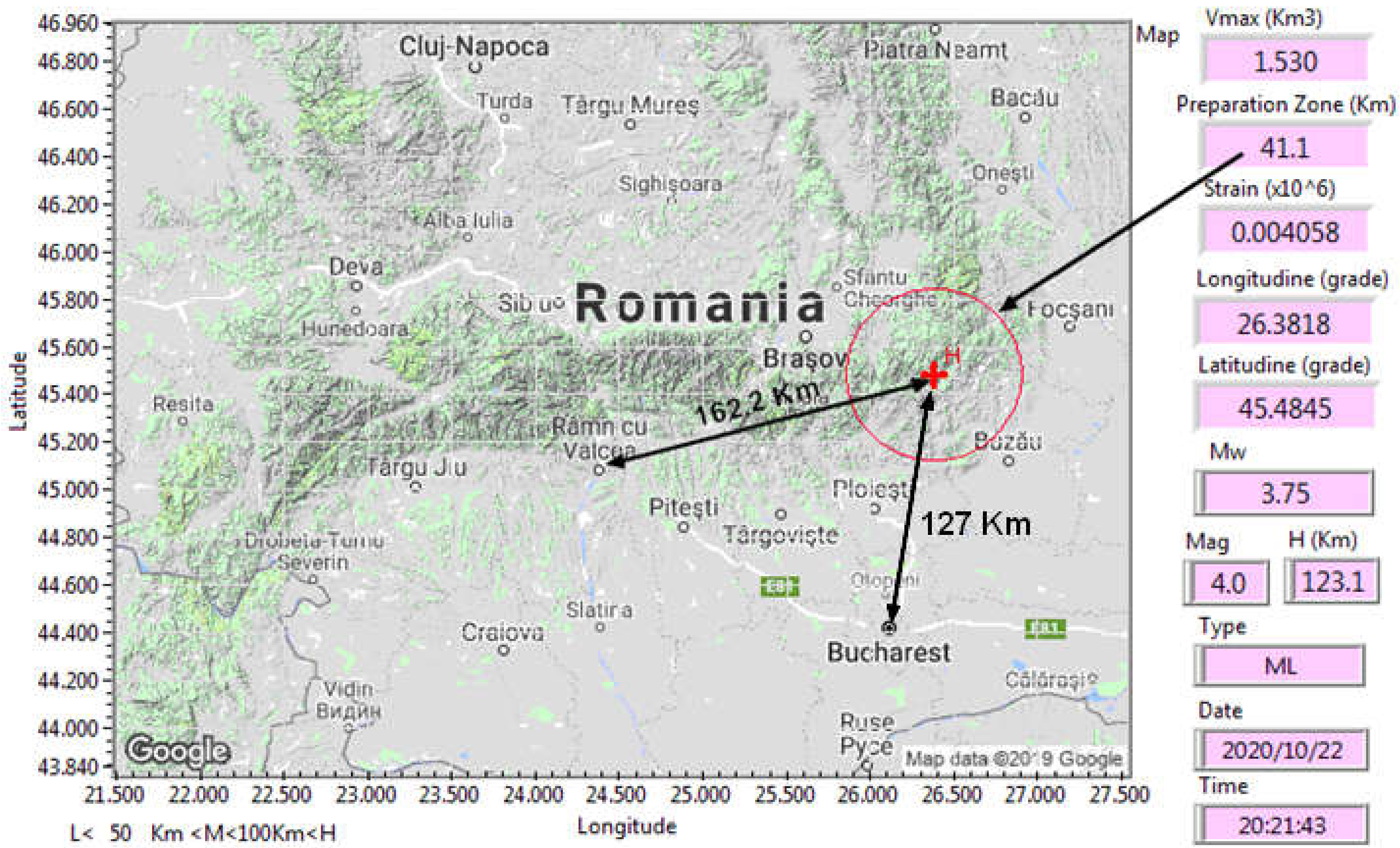


Figure 2. Earthquake localization map, 22.10.2020, ML = 4 R, 123 Km deep.

The NIEP seismic warning system is designed to detect Vrancea events. We will analyze step by step how this system works from the notification of an earthquake to the shutdown of gases through a special device (Figure 3).

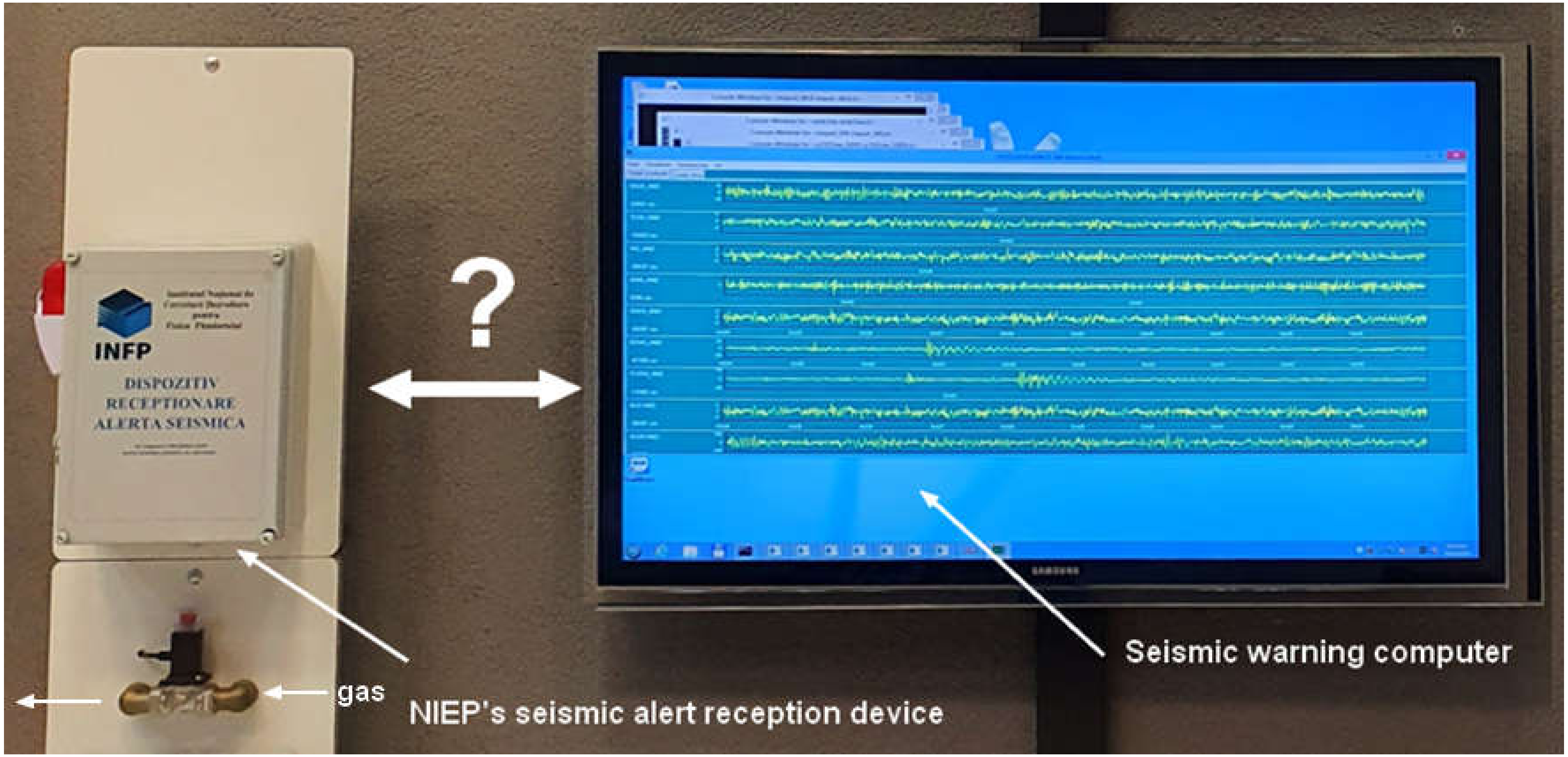
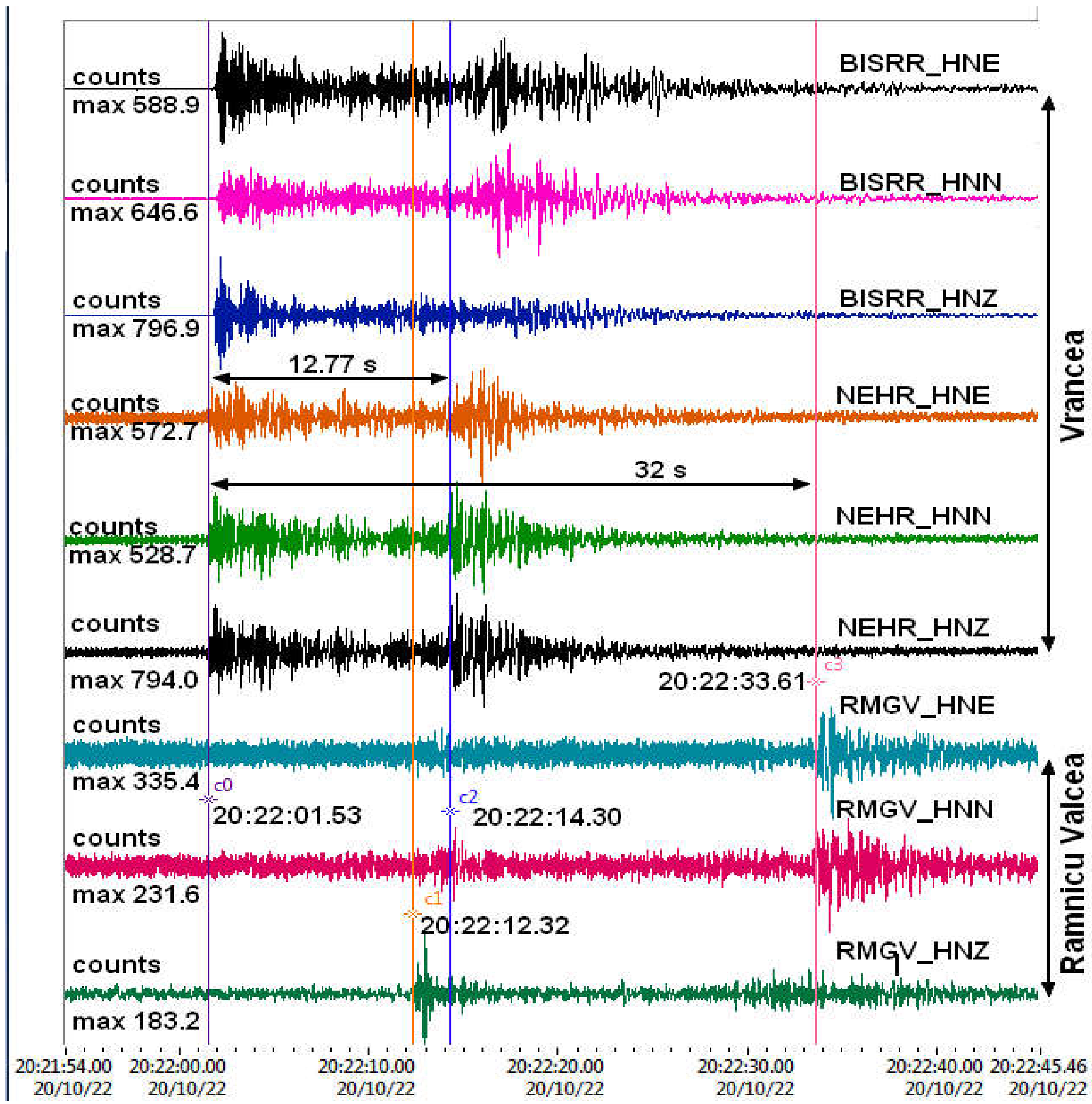


Figure 3. The main computer that detects and generates seismic events and a gas blocking terminal.



Some of the signals that generated the seismic warning are shown in Figure 4. We choose the closest epicenter stations, Nehoiu (NEHR) and Bisoca (BISRR) and destination in Râmnicu Vâlcea (RMGV).

The time between the primary wave (P) and the destructive wave S is 12.7 seconds. The seismic wave arrives in Râmnicu Vâlcea after 10.79 seconds after the earthquake in Vrancea was detected, enough for the seismic warning with industrial application. The data processing time for detecting and locating an event is 4 seconds from the moment of seismic motion notification.

Figure 4. Recordings of acceleration signals in the epicentral area and in Râmnicu Vâlcea.

After the event, the warning message is taken over by 3 servers to which its beneficiaries are connected (Figure 5). The information transfer goes through several stages: the seismic warning is received (1) which is transmitted through a client server (2) to dedicated applications (3a) where it is determined if the epicenter falls in the desired area, then the warning level is set (3b) and the location of the earthquake (3c) is displayed.

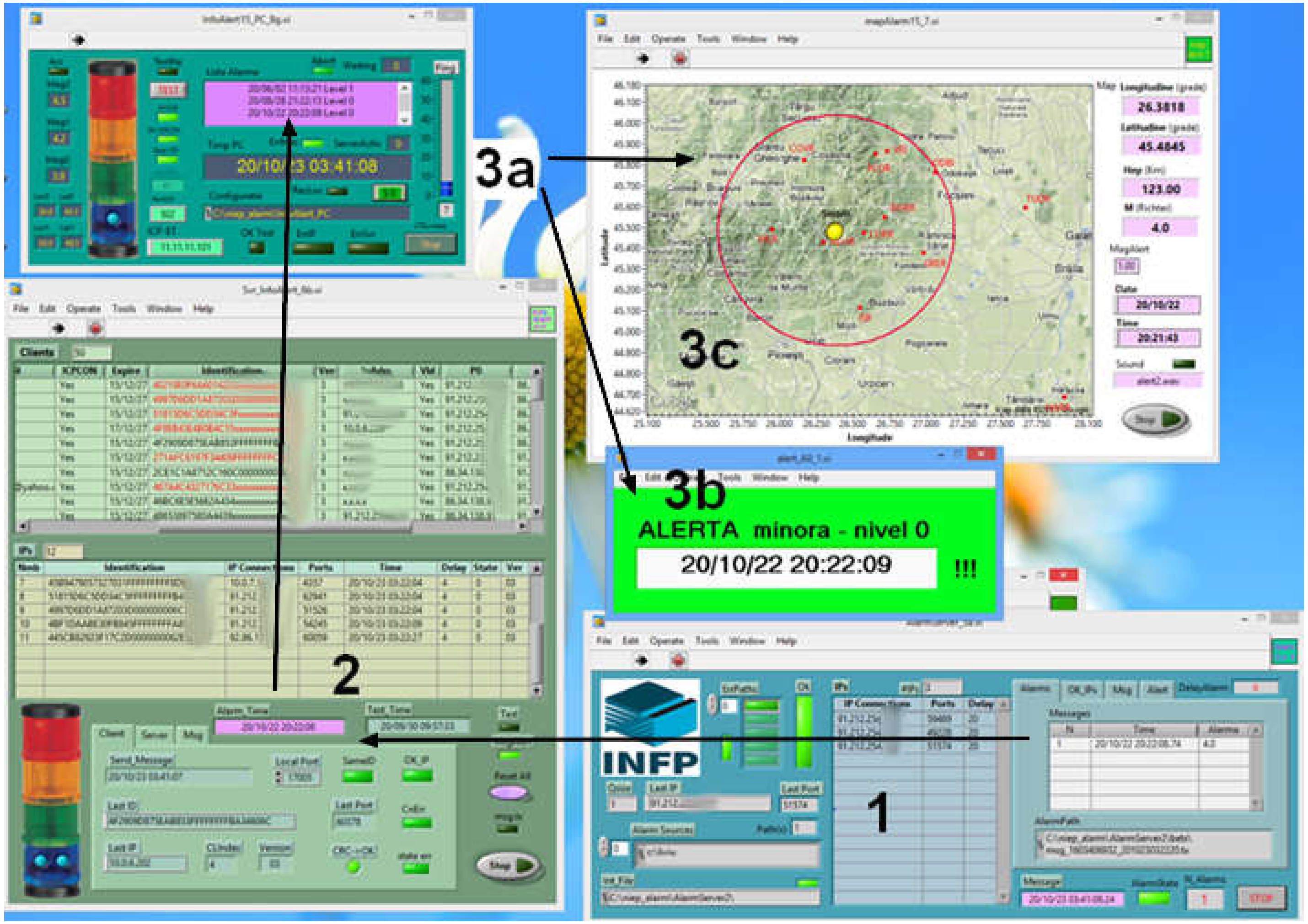
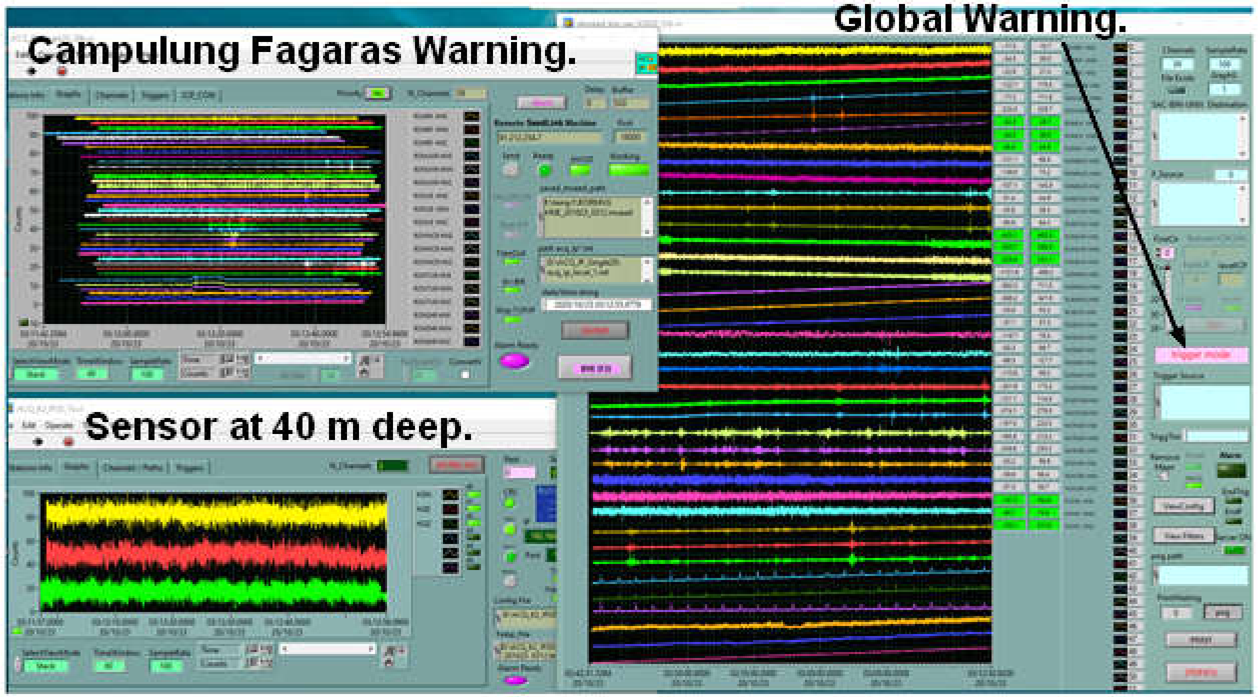


Figure 5 Sending the alert message.

Figures 6 represent the reception of the message sent by NIEP (for Vrancea events) and in Figure 7 the implementation of two event detection systems that can occur in the Câmpulung Făgăraș area and the confirmation of events using the accelerometer from the local drilling. These programs run on a server in Râmnicu Vâlcea and ensure the detection of events in an area close to the locality (the last major earthquake occurred in 1916 with Mw = 6.4) and avoid blocking the gas by checking the acceleration through the local sensor.

Figure 7 Local event detection.



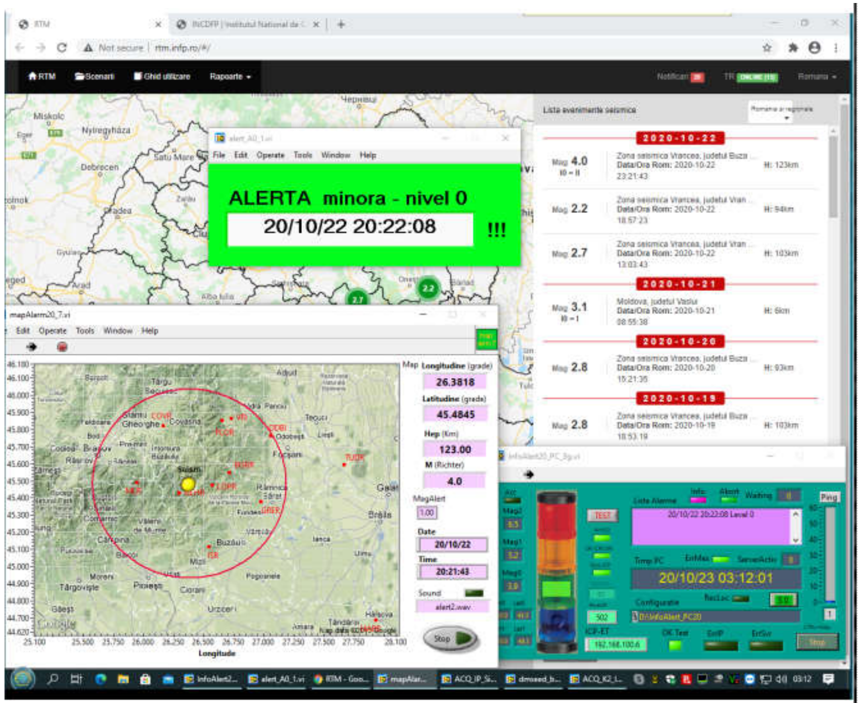


Figure 6 Reception of the warning message in Râmnicu Vâlcea.

The global warning includes the message sent by NIEP (Figure 6), the detection of Câmpulung Făgăraș (it will also be active for Vrancea) and the local drilling. If these 3 conditions are met, the gas lock command is transmitted.

Our project also includes a patent application which also uses of a radon sensor installed near the local drilling. We use radon, temperature, humidity and atmospheric pressure monitoring equipment produced by Sarad (Figure 8). It is unlikely to react before the earthquakes in Vrancea, but it will contribute to the study of the less studied but dangerous Câmpulung Făgăraș fault in the conditions in which it is close to Râmnicu Vâlcea. The data will be correlated with other information about radon from stations located in Vrancea. We will be able to have some conclusions after at least one monitoring year in which we will be able to see the daily, seasonal and annual variations.

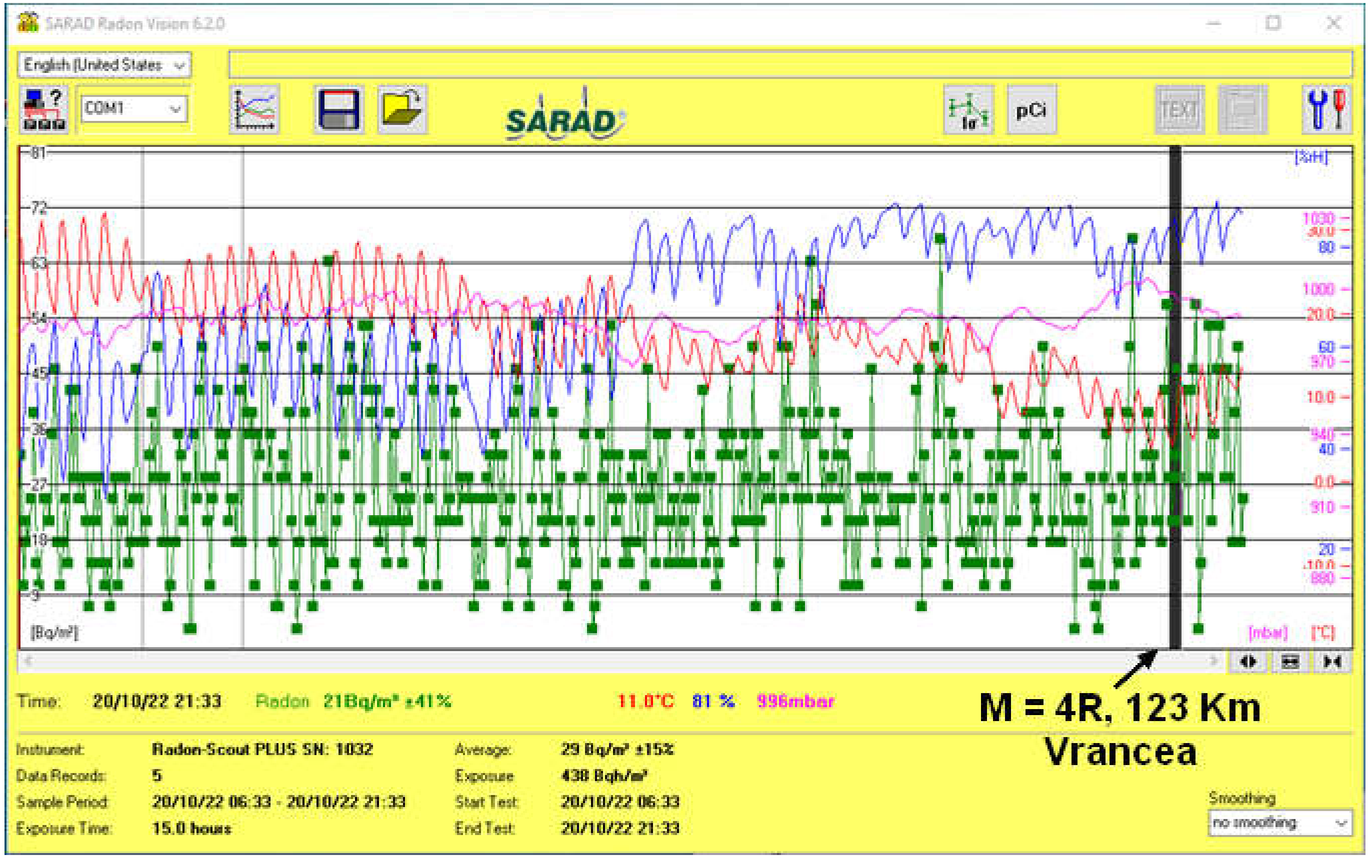


Figure 8 Local event detection.

3. Conclusions

The purpose of this project is to protect the population from the effects of earthquakes by stopping gas at the entrance to homes or blocks of flats. The same system can be extended to the protection of industrial objectives such as the dam on Olt river, the OLTCHIM chemical plant located in Râmnicu Vâlcea. In the case study presented, the magnitude of the earthquake is too small to cause gas blockage. The minor alert in Figure 6 is just information but can be used to test the entire decision chain. A map of the epicenter (red circle, Figure 6) can be seen on the map locating the earthquake. This is the training area where the vibrations should be felt. Even if the magnitude is higher, it is possible that at Râmnicu Vâlcea the accelerations will be below the decoupling limit. The establishment of thresholds will be done using the records from the seismic database of NIEP.

Figure 9 NIEP Information and Alert Center.

Thank you !

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