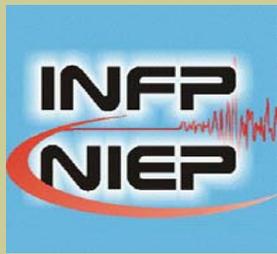


March 4, 1977 earthquake M=7.2

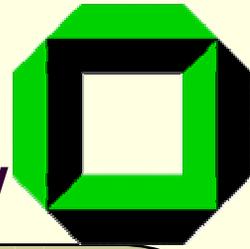
- 61 gas pipes failed
- 382 burnt people in Bucharest
- a lot of damages and 1286 dead



What can be done in the future?¹



National Institute for Earth Physics, Romania
&
Geophysical Institute, Karlsruhe University, Germany



The solution is:

**Early Warning System, Shake and Disaster Maps
for Deep Vrancea Earthquakes Developed in
Romania as Parts in Disaster Reduction and Risk
Management**

Gh.Marmureanu;C.Ionescu;A.Marmureanu and A.Grigore

Davos ,August 25-29,2008

The deep Vrancea earthquakes

- The deep earthquakes ($M_w = 7.9$) generated in Vrancea area are particularly of interest for many countries in Europe since they cause destructive effects at large distances from Moscow to Rome. Romania is an earthquake prone area and it is of crucial importance to obtain quantitative information needed for seismic risk mitigation and related public policies and seismic safety measures.

Innovative content

- EWS is the first European information system for real-time early detection and warning of the seismic waves in case of strong earthquakes.
- It should/**might** be viewed as a part of an European real-time information system that provides rapid **informations**, about an earthquake impending hazard, to the public and disaster relief organizations before (early warning) and after a strong earthquake (shake maps).

What does it do?

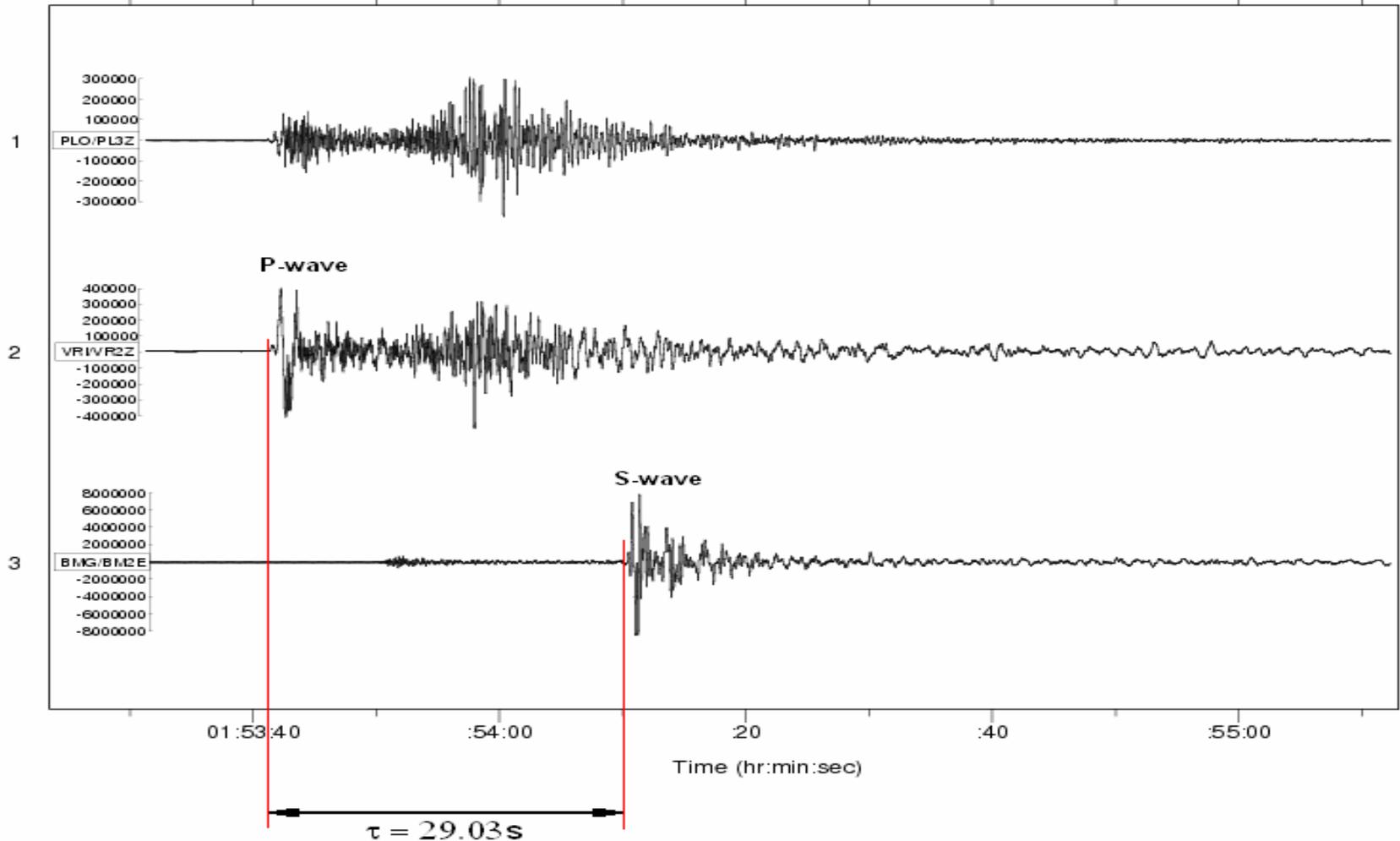
EWS uses the time interval(28-32 seconds) between the moment when earthquake is detected by the borehole seismometers, in the epicenter area, and the time of the wave arrival in the facility wanted to be alarmed earlier. The system can: shut down critical processes in the chemical factories, slowing down the trains, moving in a safety position of elevators, stopping the gas or water in the pipes, alarming the civil protection and hospitals in order to be prepared, starting the backup processes for the databases belonging to banks, police or companies etc.**Users:**The irradiator nuclear installation from Bucharest, nuclear reactor from Pitesti and heavy water factory from Turnu Severin

How it works?

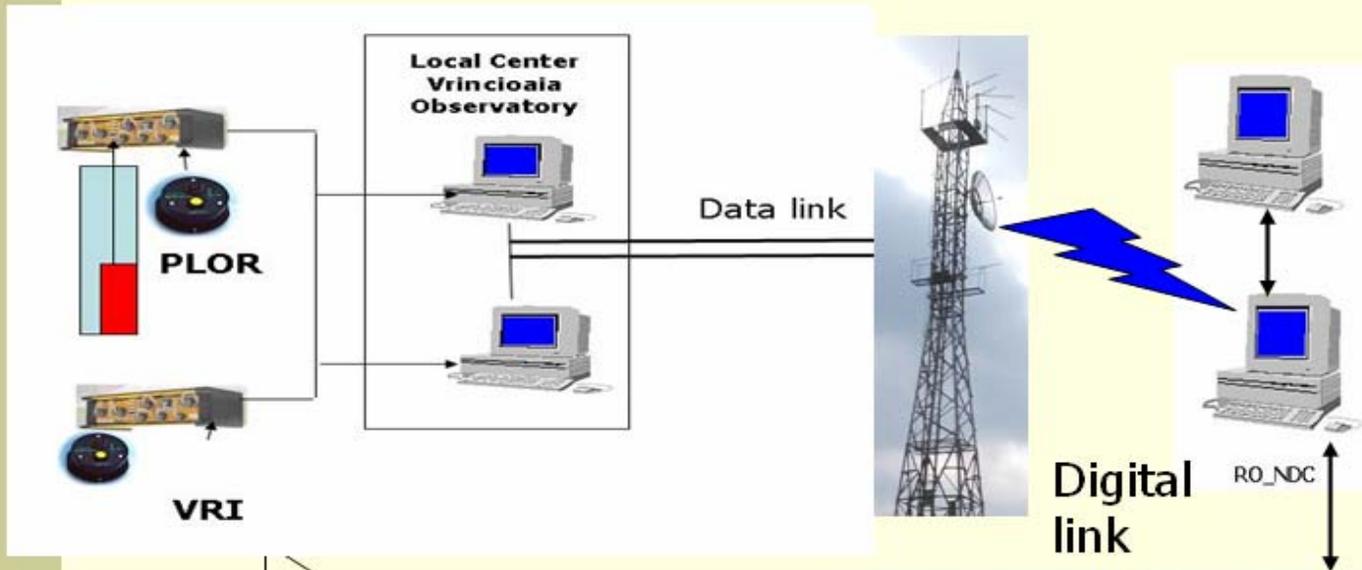
29 seconds the warning time for Vrancea earthquakes at h=150km

VRANCEA, ROMANIA

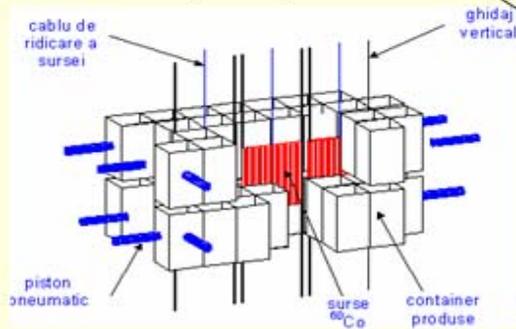
Date	Origin Time	Latitude	Longitude	Depth	MD
14.05.2005	1:53:21.22	45.637N	26.531E	148.5	5.8

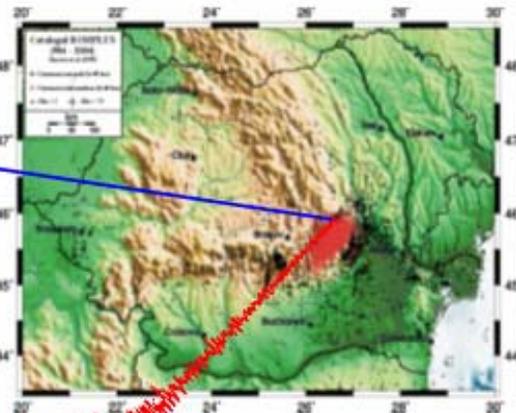
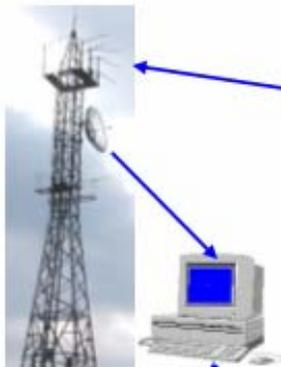


Shutdown Cobalt-60 nuclear radiation source in safe position at IFIN-HH Bucharest

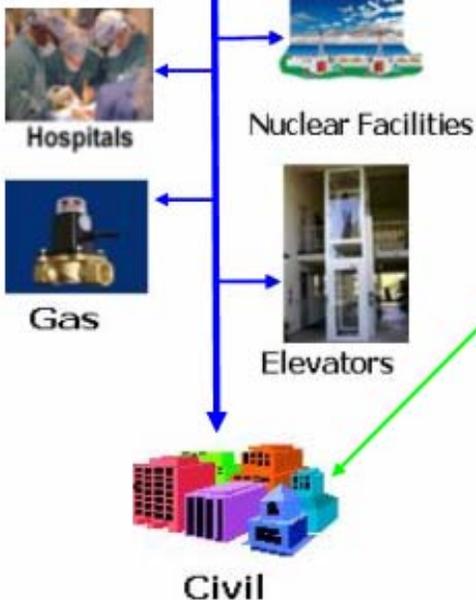


Electrical contact





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30 seconds

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**EARLY WARNING
SYSTEM (EWS)**



Early Warning System (EWS) for deep Vrancea earthquakes

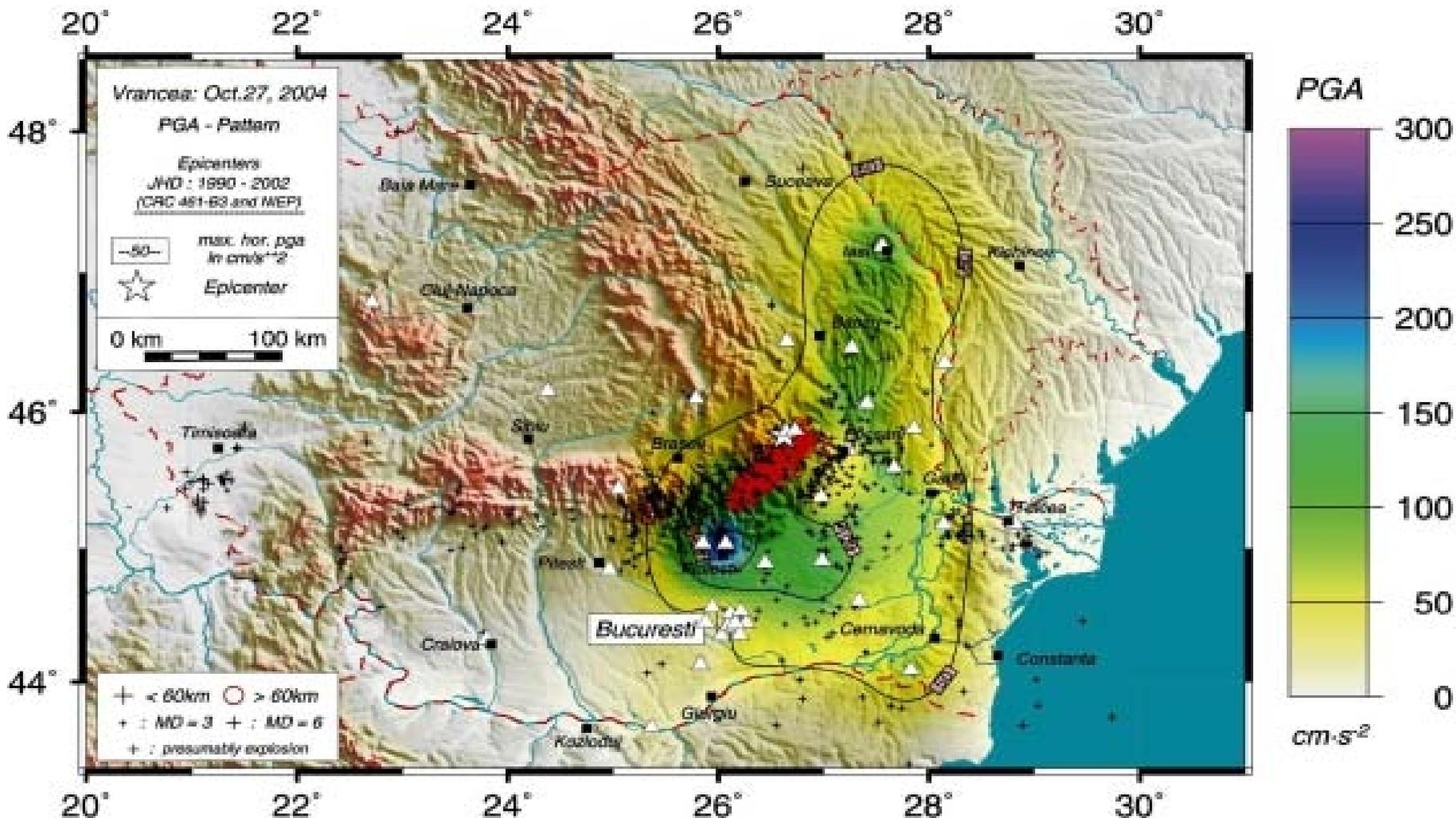
Shake /Quake Map

A Shake/Quake Map is a representation of ground shaking produced by an event and it is generated automatically following moderate and large Vrancea earthquakes. The map allows us to rapidly portray the extent of shaking in a simplified form suitable for **immediate post-earthquake decision-making**.

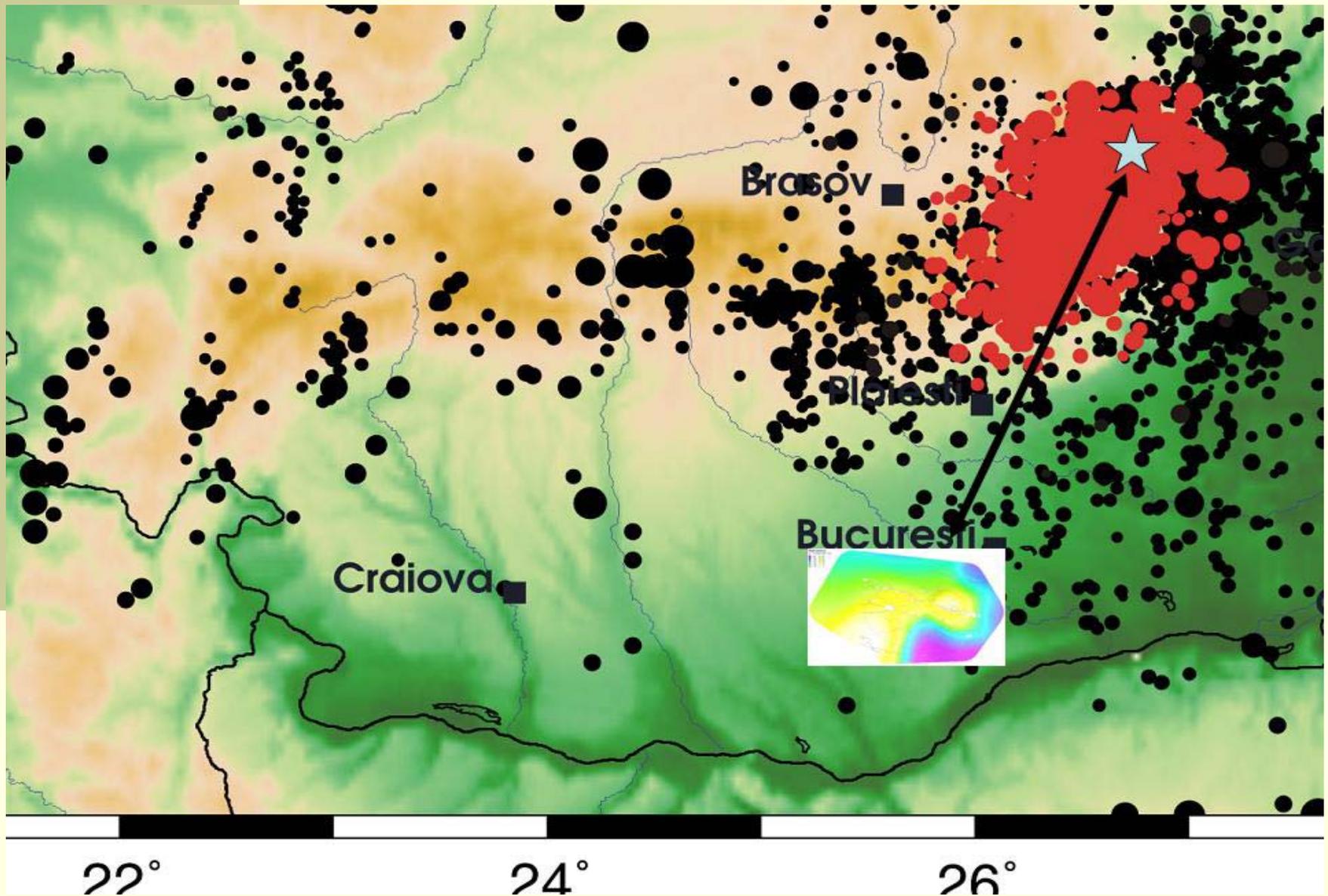
Shake Map will provide much clearer picture of the nature and extent of ground motion following the next significant Vrancea earthquake and will provide a sound starting point for immediate loss estimation using such methods.

SHAKE MAP FOR LAST ROMANIAN MOST SIGNIFICANT EVENT

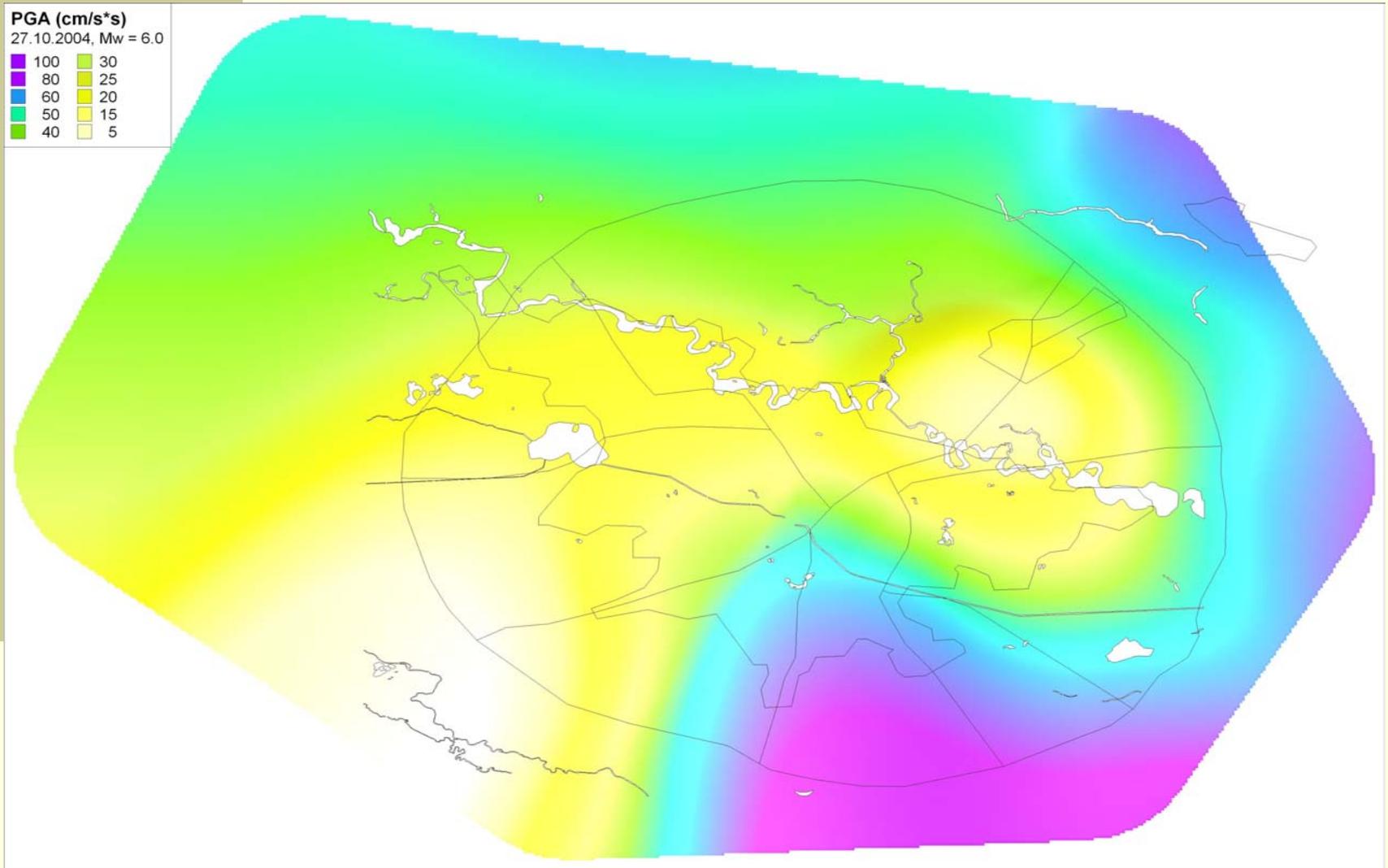
Location: Vrancea; Magnitude (Mw)=6.00; Depth: 100 km; October 27, 2004



The Concept of Alert Map

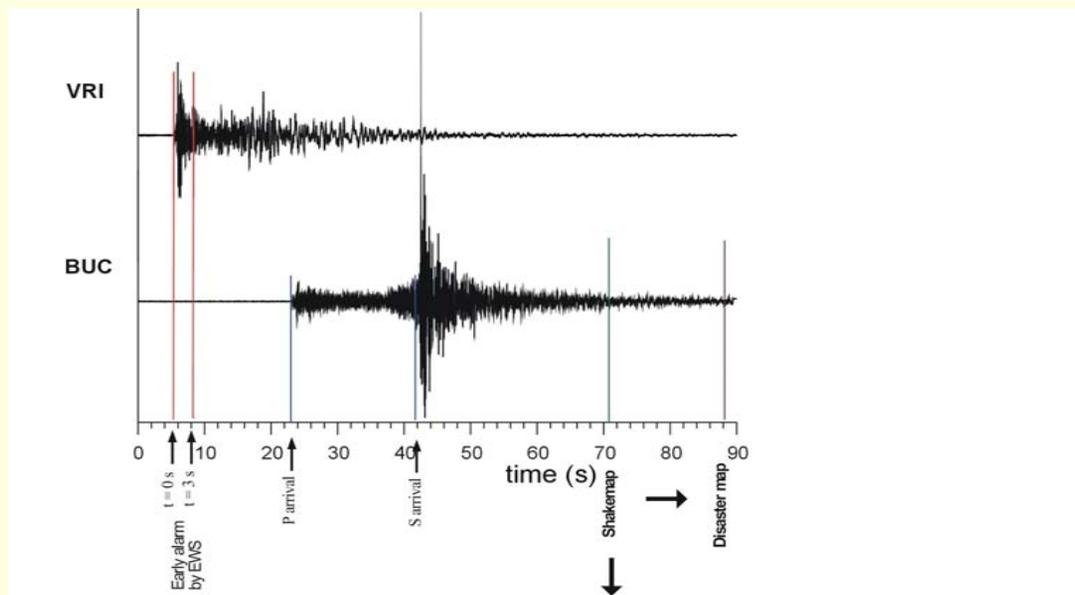


Alert Map for Bucharest for last Vrancea strong earthquake on October 27, 2004; $M=6.0$; $h=100$ km

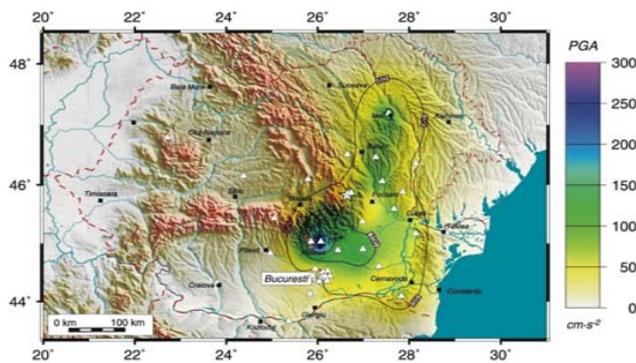


- **The innovation** with comparable or related systems worldwide is that NIEP will use the EWS to generate a virtual shake map for Bucharest (140 km away of epicentre) immediately after the magnitude is estimated (in 3-4 seconds after the detection in epicentre) and later make corrections by using real time dataflow from each K2 accelerometers installed in Bucharest area, inclusively nonlinear effects. Thus, developing of a near real-time shake map for Bucharest urban area is of highest interest, providing valuable information to the civil defense, decision makers and general public on the area where the ground motion is most severe. **EWS made by NIEP can be considered the first stage to generate and develop the shake map for Bucharest to deep Vrancea earthquakes.**

The place of EWS and Shake Map in seismic risk management



On March 16, 2006 the European Commission has selected Romanian "Early Warning System for Strong Earthquakes" made by the National Institute for Earth Physics (Bucharest) as winner of the European Programme for Information Society Technologies in 2006 (www.ist-prize.org)



Disaster Map

An earthquake damage computation model was developed for 16 identified counties and Bucharest city. The Government of Romania, within the framework of the loan obtained from the World Bank has entrusted the Ministry of Administration and Interior with the responsibility of implementing the project "Development of a Vrancea Earthquake Scenario" through its Project Management Unit. Data on various assets exposed to earthquake risk i.e. buildings, lifelines and utility systems that will be used as input to the damage computation model are collected for 16 counties and Bucharest city. The scenario will form the basis for updating emergency plans and procedures, as well as for developing and conducting training exercise programs for agencies and personnel to identify shortfalls and needs. The project covers the Southern and Eastern part of Romania including areas that are most exposed to the effects of Vrancea earthquakes with main focus on Bucharest city and 16 counties that fall in the vulnerable zone.

The damage computation model is designed to allow import of shake maps developed by National Institute for Earth Physics, in tabular format for real time damage computation.

Conclusions

- EWS is a device for shutting down of the dangerous industrial processes before strong earthquakes arrives and provide rapid information about an earthquake impending hazard, to the public and disaster relief organizations before **(early warning)** and during or after a strong earthquake **(shake map)**.
- Early Warning Systems (EWS) make a substantial contribution to overall risk reduction objectives by enabling vulnerable groups to take timely action to mitigate loss and damage in advance of an **i m p e n d i n g h a z a r d e v e n t**.
- Shake Map, new product of NIEP provides a sound starting point for immediate loss estimation using such methods around of Europe for **immediate post-earthquake decision-making**.
- Disaster map as last part of this chain developed in Romania will give the possibility to Romanian authorities to mitigate and to reduce disaster effects given by strong Vrancea earthquakes and to make a bridge between science, risk governance, technology perspectives, problem solving and capacity building in this part of Europe.