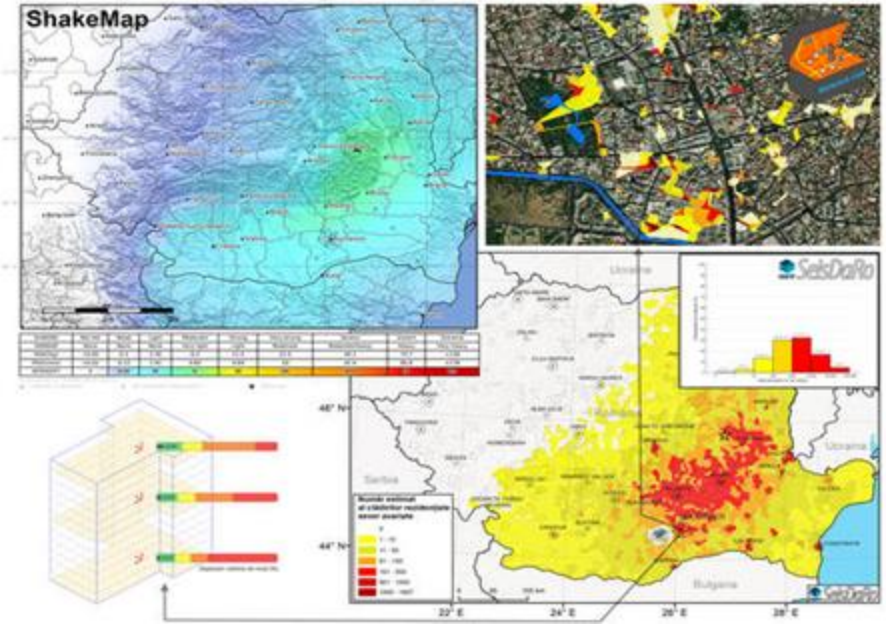
History and current status of Earthquake Early Warning System in Romania

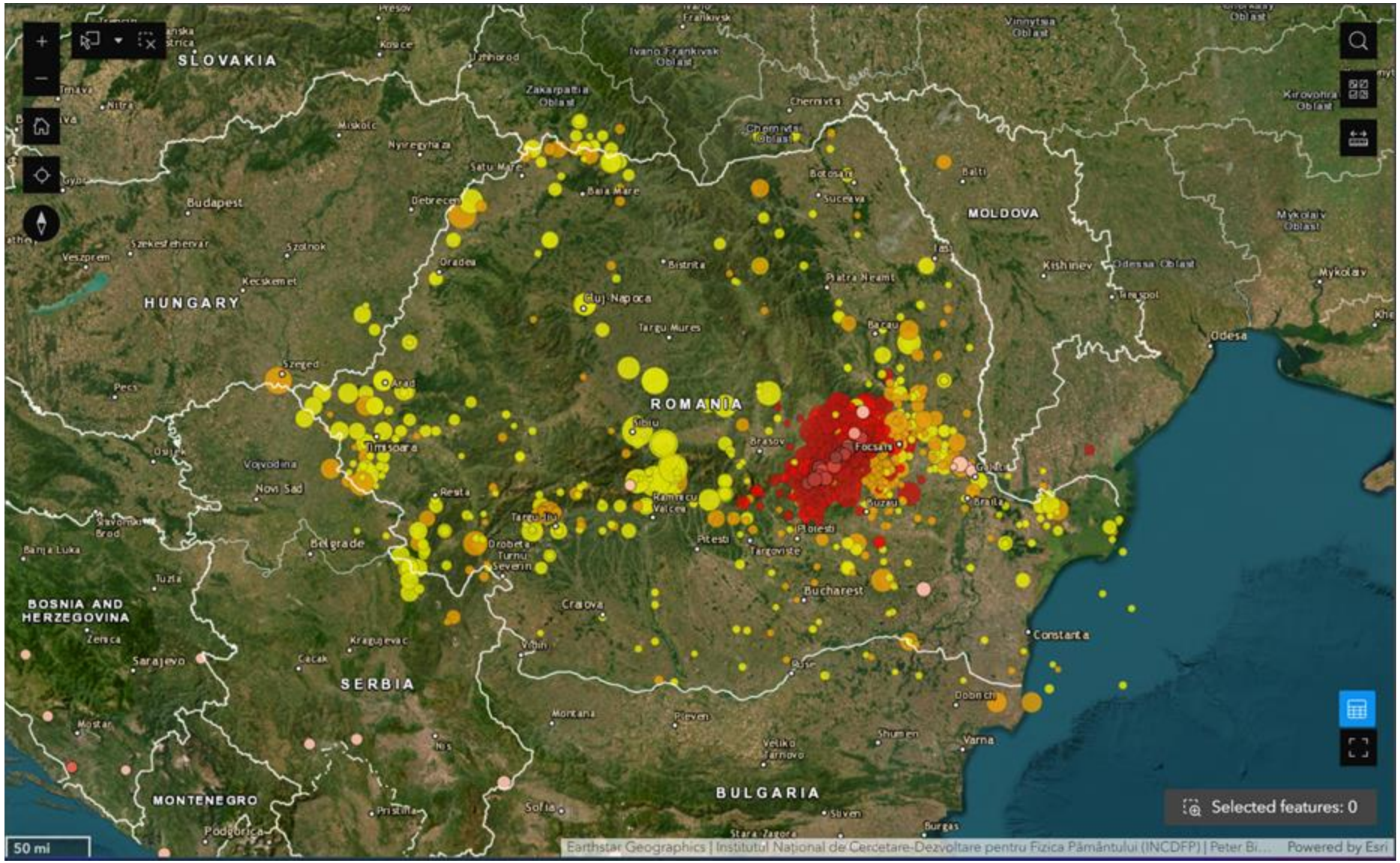


TRANSFORM²

INFP

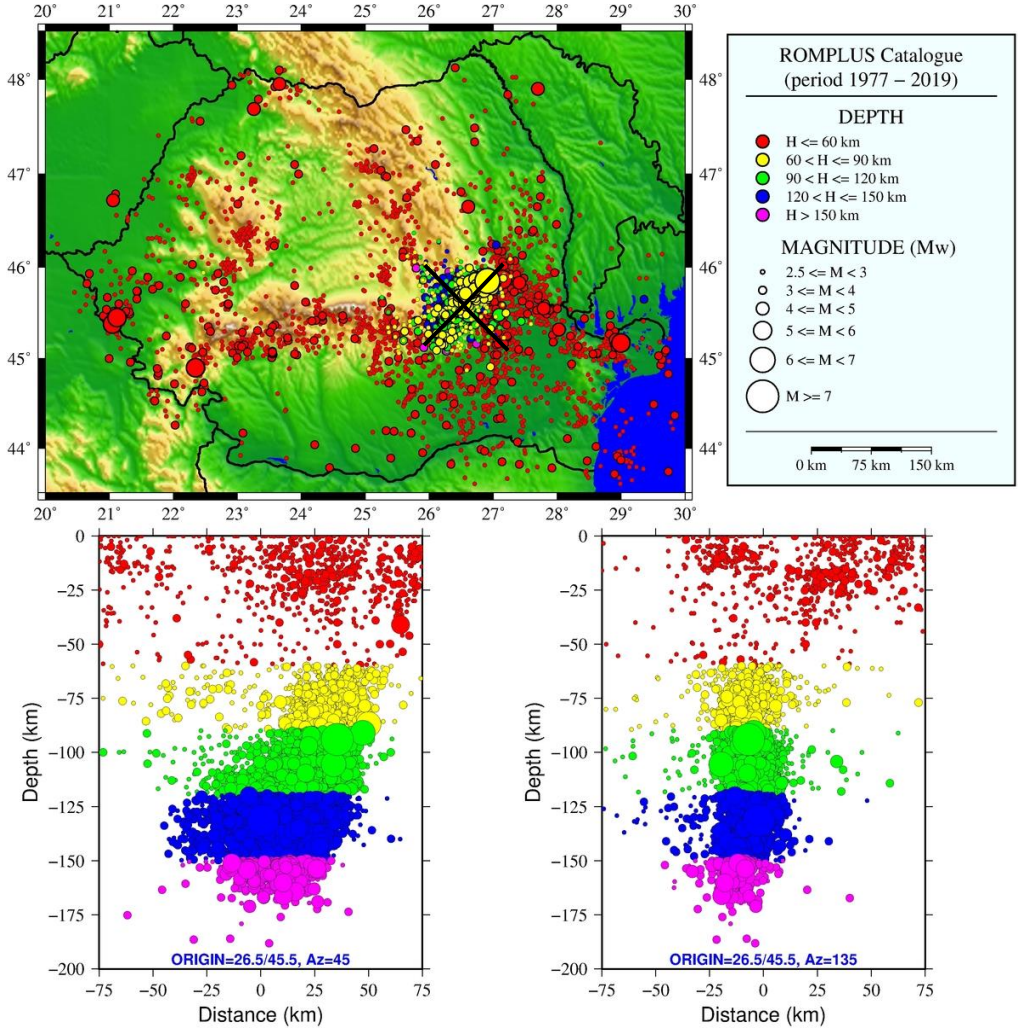
National Institute for Earth Physics – Romania (NIEP)

Romania Seismicity



Seismicity of Romania

- Relatively high seismicity
- **Vrancea** seismic area
- 1977 – present
  - 2 eqs. with Mw > 7.0
  - 3 eqs. with Mw >= 6.0 and Mw < 7.0
  - 24 eqs. With Mw >=5.0 and Mw < 6.0
  - thousands eqs. with Mw < 5.0

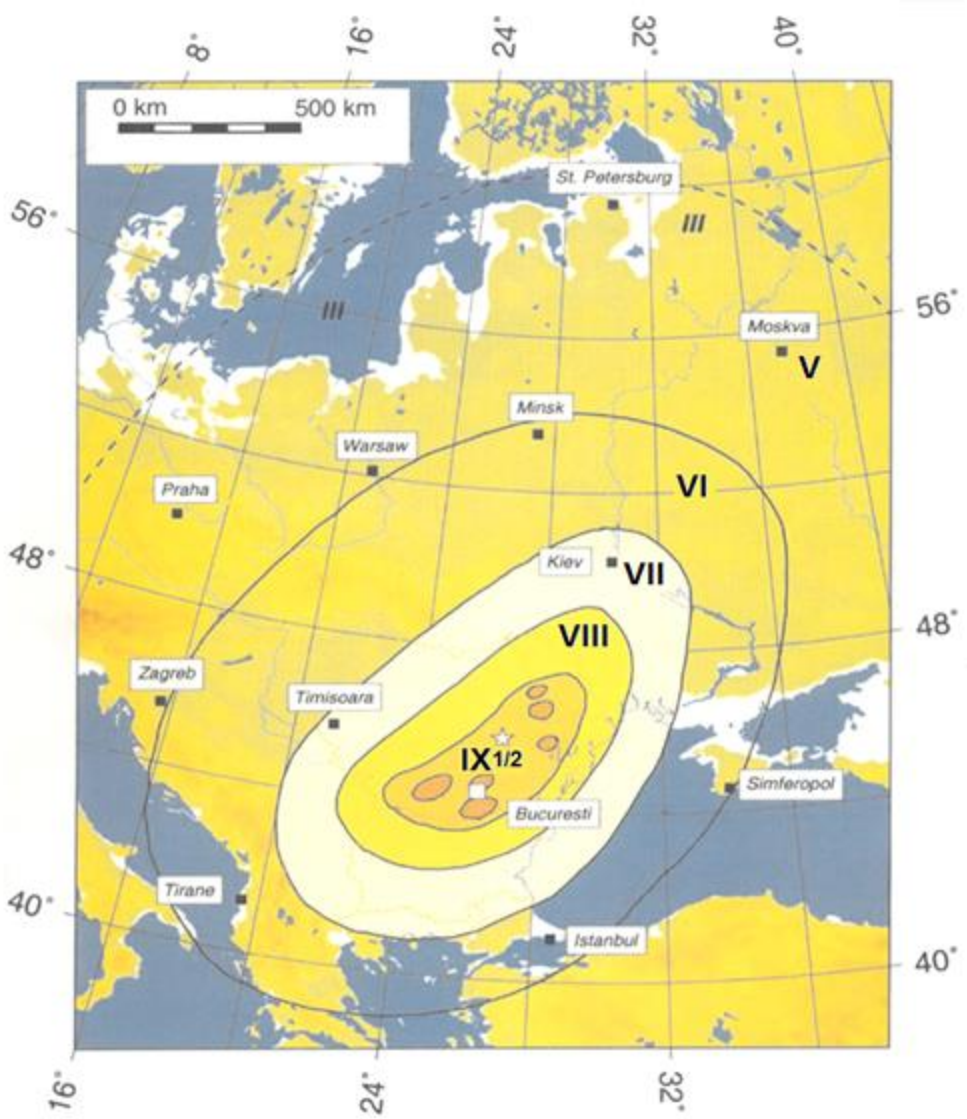


The 1977, Mw=7.5 Vrancea earthquake, h=95 km, Io=8-9 MSK

Bucharest is one of Europe's capital city most exposed to earthquakes.

32 tall buildings completely collapsed over 1500 deaths in Bucharest.
In Bulgaria - 8470 buildings partially destroyed and ruined.

Earthquake from 14 October 1802 (Mw-7.7). Intensity distribution from Bucharest to Moscow, Roma, Cairo and Istanbul

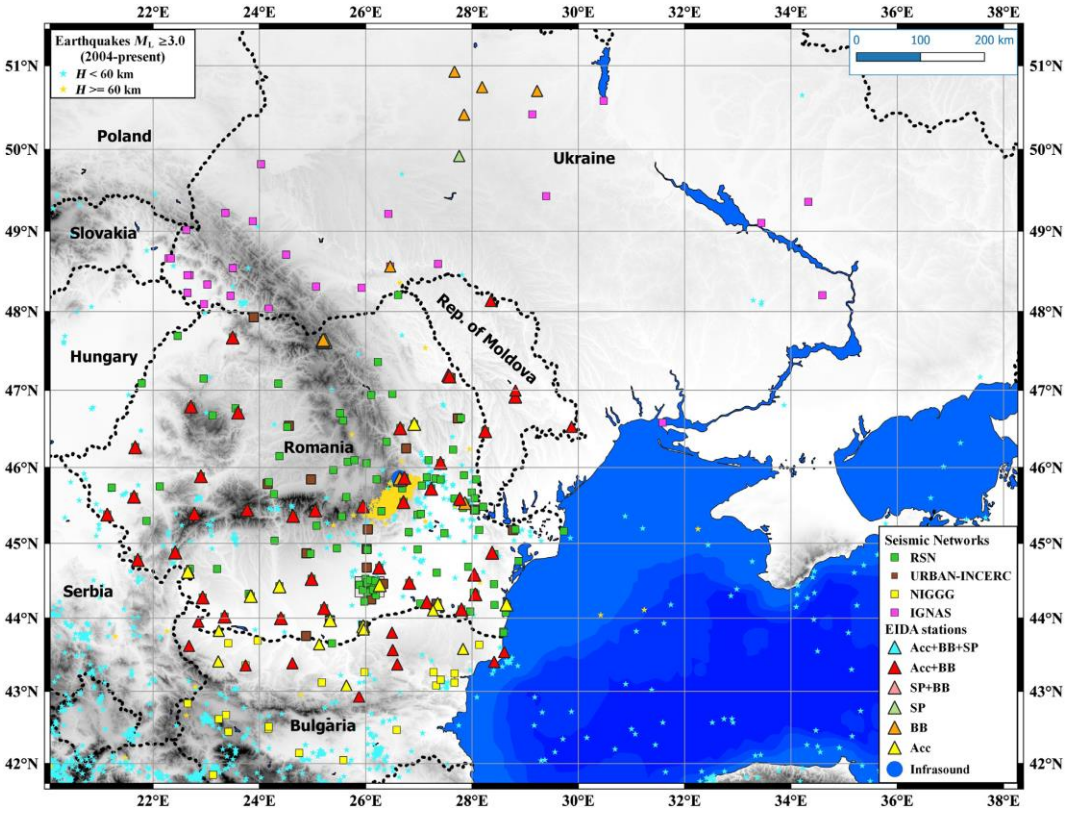


In 1802, at Lomonosov University in Moscow it was felt and statues in the courtyard collapsed. In the courtyard were Aleksandr Sergheevici Puşkin together with his nanny that described the effects of this Vrancea earthquake

Romanian Seismic Network (RSN)

➢ Present day configuration

- 98 BB Stations
- 52 SP stations
- 188 Strong Motion stations
- 2 seismic arrays



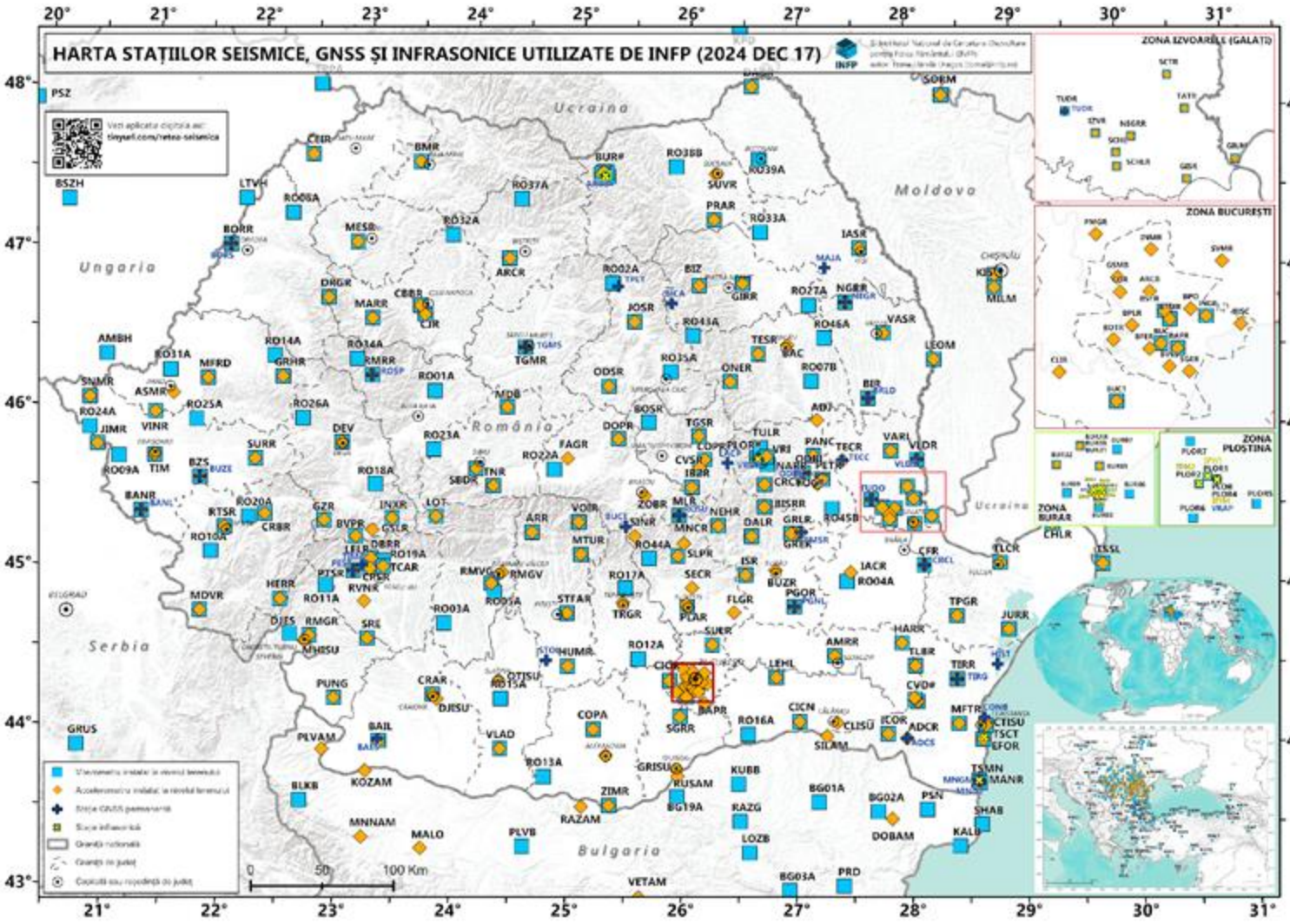
➢ EIDA node

- ALL RONET (RO)
- 5 stations (MD)
- 18 stations (BS)
- 6 stations (UD – Ukraine)
- 7 stations Slovenia (KARST NFO)

➢ Data exchange

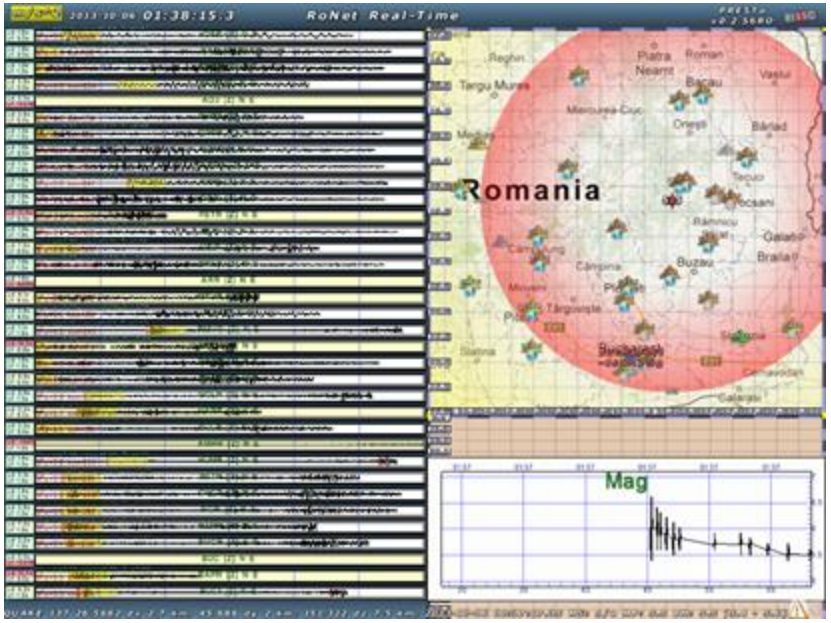
- send data with: Bulgaria, CTBT, Czech Republic, GFZ, ISC, Montenegro, ORFEUS, Serbia, Turkey, USA, etc.
- receive data from: Bulgaria, China, Greece, Hungary, Italy, Poland, Russia, Serbia, Ukraine, USA, etc.

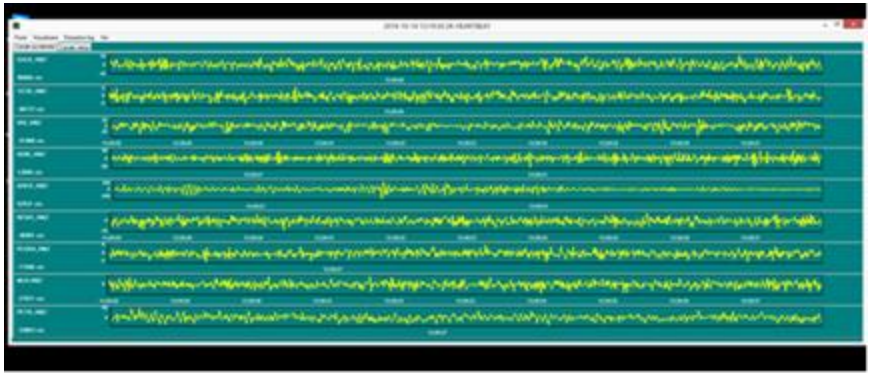
Romanian Seismic Network



BB 113 /**SP** 55 / **ACC** – 208 (collocated with velocity). In EIDA 298 - RO, Y8, UT, PL, S5, BS, RQ

Vrancea EWS network



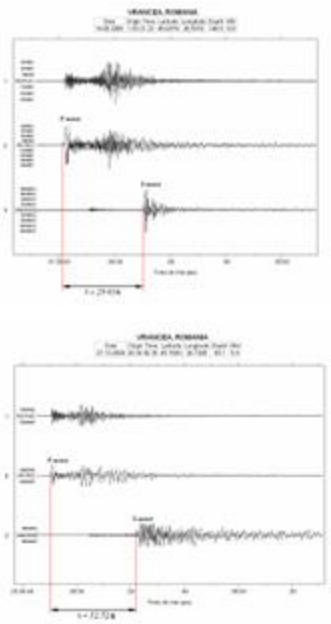


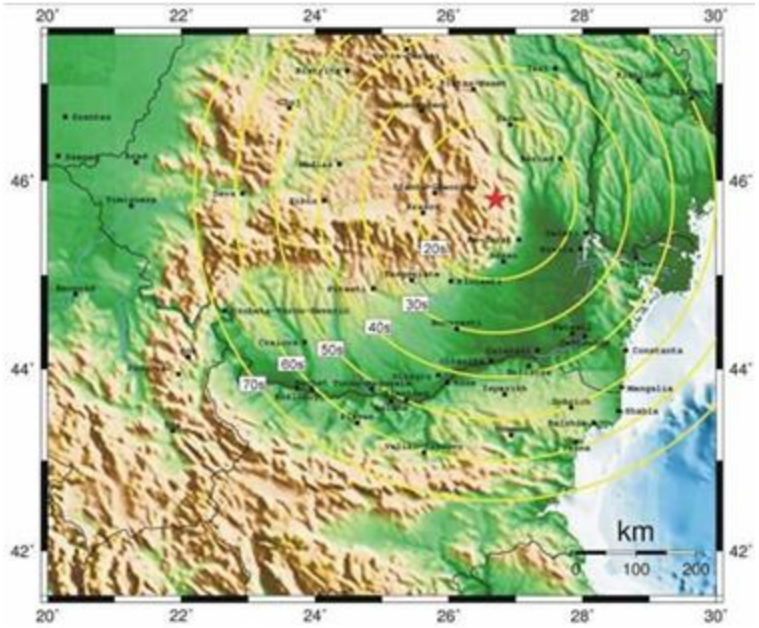
- Currently, PRESTo uses 35 real-time strong-motion stations, located in the Vrancea area, to compute magnitude and location, and the secondary system uses nine stations to compute magnitude and validate the event.

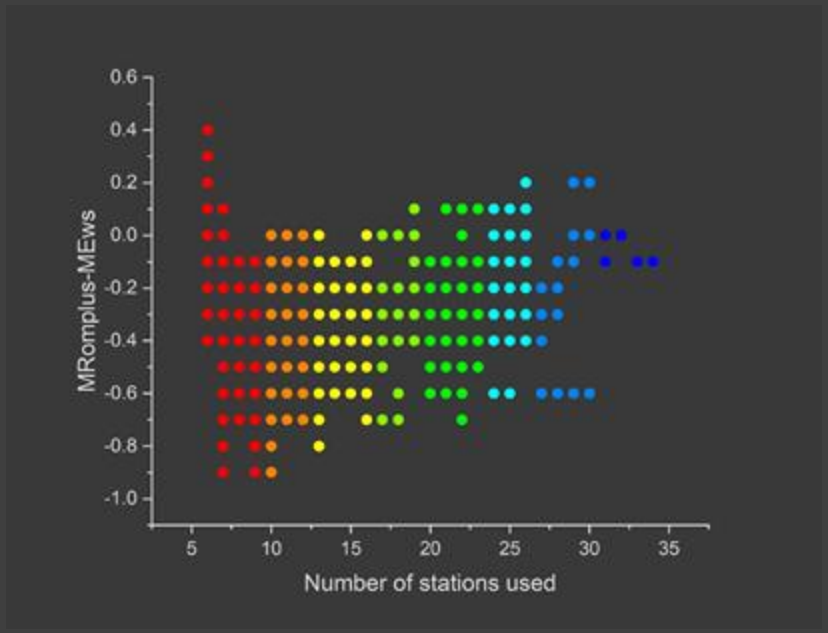
- The current system is able to provide between 25 and 31 s theoretical warning time for Bucharest, depending on the depth of the event. This system has issued 76 alerts since 2013,

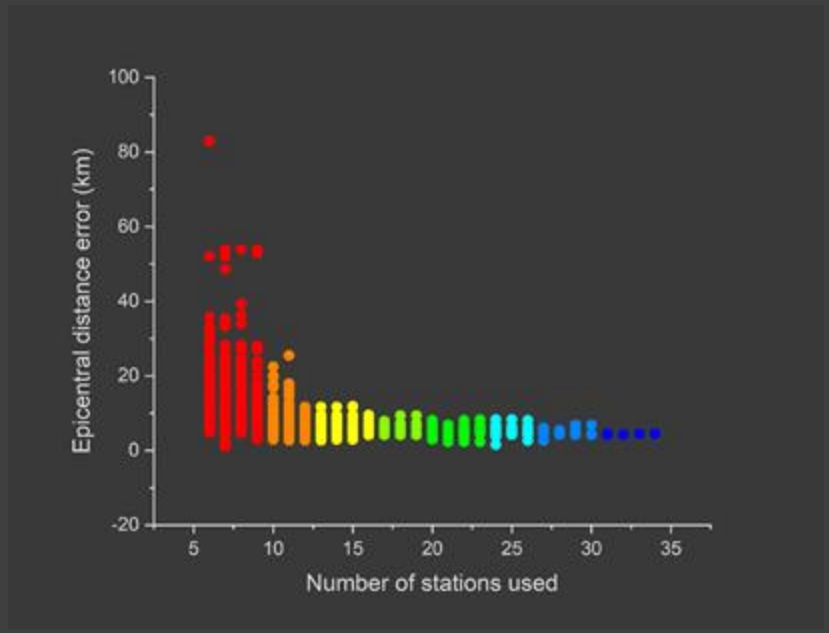
EEW in Operation: Romania

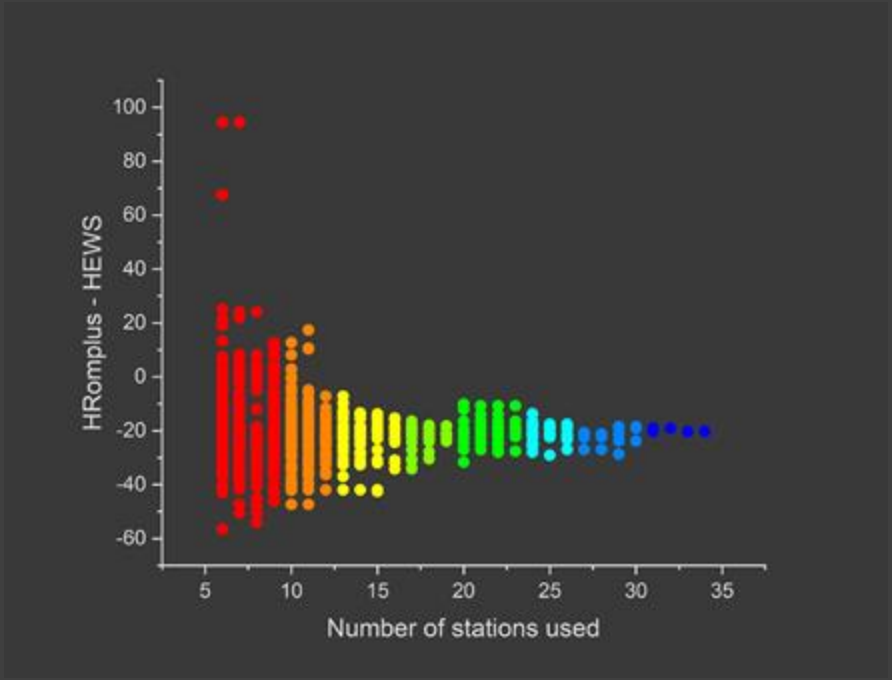
- Seismic risk in Romania dominated by deep Vrancea earthquakes
- 4 events M6.9 – M7.7 from 1940 – 1990. M7.5 1977 >1500 casualties, mainly in Bucharest.
- Current Operational EEW System uses a network of 35 stations centred on Vrancea providing location and magnitude focusing only on these deep events
- 25 – 35 s warning for Bucharest 130km to South
- **Until now 83 alerts were sent to authorities !!!!**
- The Vrancea earthquake early warning system (EWS) is a free transnational service that covers Romania, Bulgaria, and Moldova.






MRomplus-MEws
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
5
10
15
20
25
30
35
Number of stations used


Epicentral distance error (km)
100
80
60
40
20
0
-20
5
10
15
20
25
30
35
Number of stations used


HRomplus - HEWS
100
80
60
40
20
0
-20
-40
-60
5
10
15
20
25
30
35
Number of stations used

Current End Users

Nuclear Research Institute, Bucharest

Nuclear source used for sterilization is **automatically secured** during an EEW alert

Vidraru Dam, Romania

Alert use to trigger data collection

Private company warehouse

Other End Users:

Nuclear Power Plants in Romania and Bulgaria – <u>just for information</u>

Emergency response institutions in Romania and Bulgaria. Currently, the alert is sent by SMS and email to ~ 450 official people from emergency response agencies in Romania through a SMS or e-mail governmental gateway.

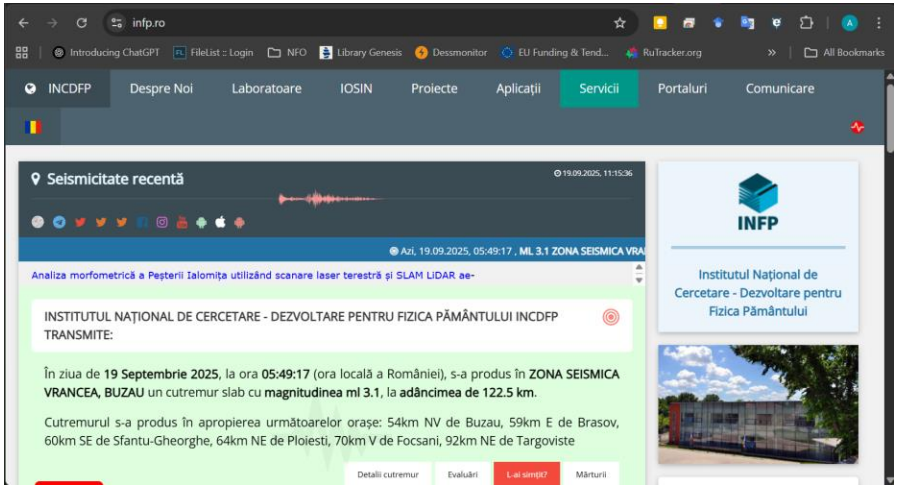
The alert notification is also sent to 16 dedicated early warning receivers located at the governmental emergency response units located in Bulgaria and Romania.

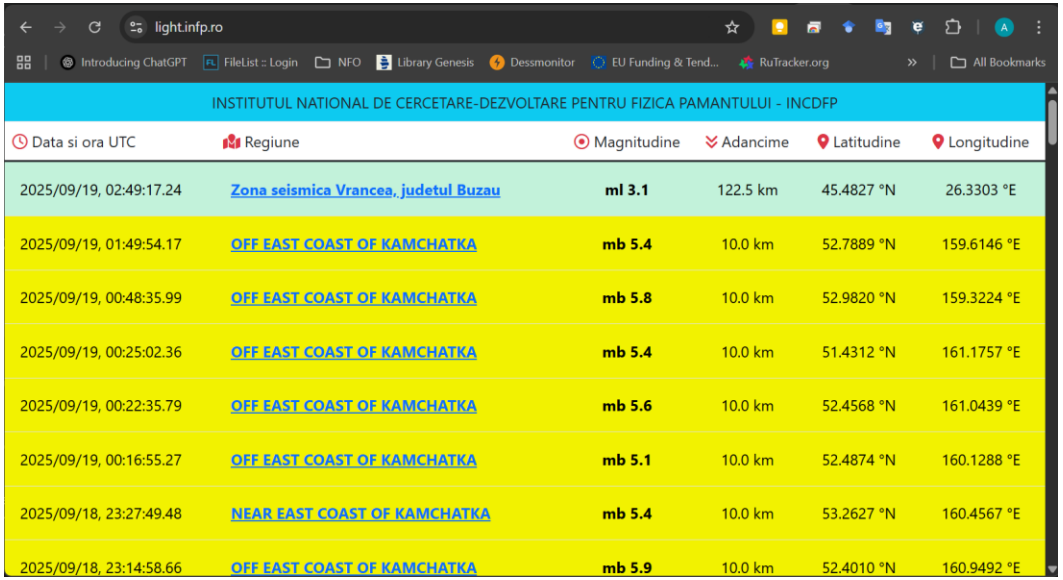
Governmental agencies involved in rapid intervention in case of a strong earthquake.

Current End Users

NIEP Webpage

Trigger a low version of website



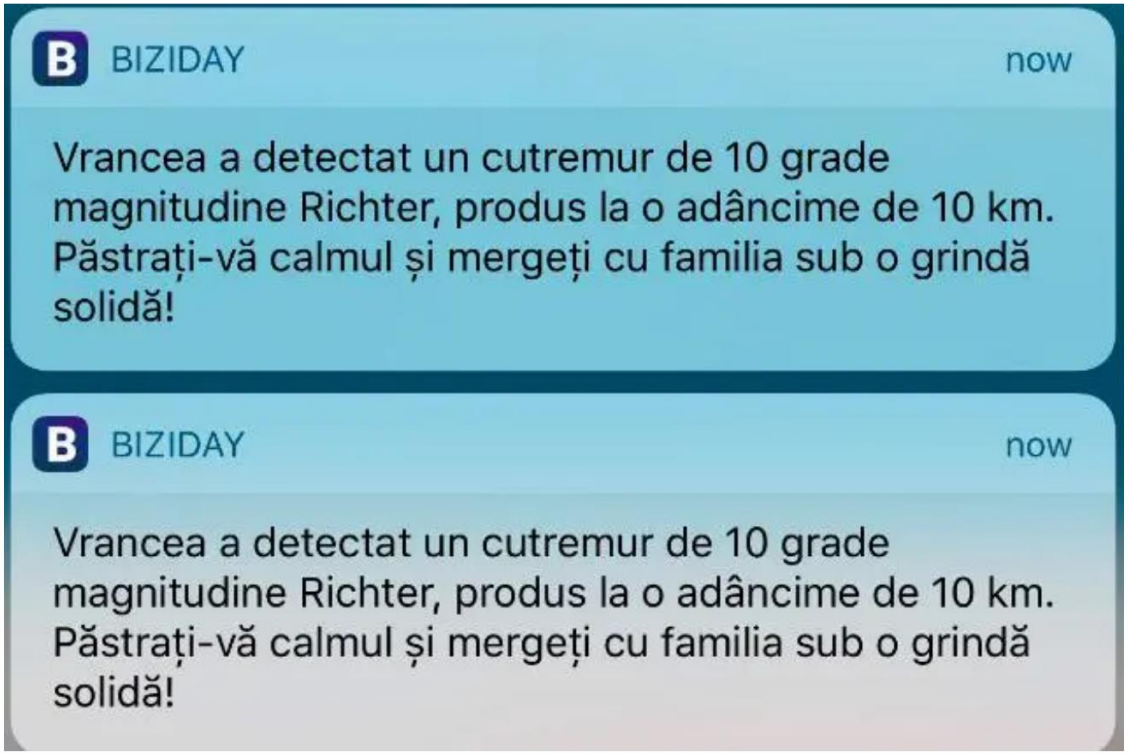


Data si ora UTC	Regiune	Magnitudine	Adancime	Latitudine	Longitudine
2025/09/19, 02:49:17.24	Zona seismica Vrancea, judetul Buzau	ml 3.1	122.5 km	45.4827 °N	26.3303 °E
2025/09/19, 01:49:54.17	OFF EAST COAST OF KAMCHATKA	mb 5.4	10.0 km	52.7889 °N	159.6146 °E
2025/09/19, 00:48:35.99	OFF EAST COAST OF KAMCHATKA	mb 5.8	10.0 km	52.9820 °N	159.3224 °E
2025/09/19, 00:25:02.36	OFF EAST COAST OF KAMCHATKA	mb 5.4	10.0 km	51.4312 °N	161.1757 °E
2025/09/19, 00:22:35.79	OFF EAST COAST OF KAMCHATKA	mb 5.6	10.0 km	52.4568 °N	161.0439 °E
2025/09/19, 00:16:55.27	OFF EAST COAST OF KAMCHATKA	mb 5.1	10.0 km	52.4874 °N	160.1288 °E
2025/09/18, 23:27:49.48	NEAR EAST COAST OF KAMCHATKA	mb 5.4	10.0 km	53.2627 °N	160.4567 °E
2025/09/18, 23:14:58.66	OFF EAST COAST OF KAMCHATKA	mb 5.9	10.0 km	52.4010 °N	160.9492 °E

EEW in Operation: Romania – Current End Users

Public free alerts:

Biziday NEWS application

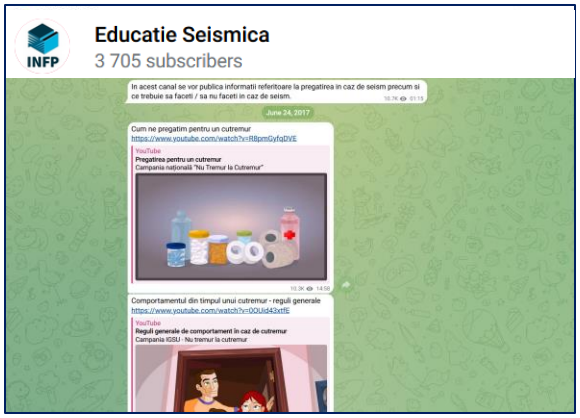


An earthquake of magnitude 10 on the Richter scale has been detected in Vrancea at a depth of 10 km. Stay calm and take shelter with your family under a sturdy beam or solid support!

Discontinued after Biziday servers were hacked. (150 000 people received a false alert. Mw 10) – March 3, 2017 (40 years after 1977 earthquake)

EEW in Operation: Romania – Current End Users

***Telegram** app(IoS/Android)*



Two info channels: educational and updates (maintenance).

No events > 6 Mw

Four alerts channels:
Integration of a new type of message (including date and time, latitude, longitude, depth, and magnitude range).

EEW in Operation: Romania – Current End Users

Public free alerts:

III) Skype app(IoS/Android)
discontinued

II) Andoid app (discontinued)

IV) Webpage alerta.infp.ro

V) X (@cutremurinfo)

VI) www.earthbot.ro - discontinued

http://ews.infp.ro/

Main issues:

No control on time delivery of messages !

Communication issues with authoritative agencies!

ShakeMap - NEW integration with EWS

VRANCEA EWS ROMANIA

Fri, 23 Sep 2016, 23:11:16 | Mag 5.8 | Depth 111.816 km | Lat 45.747 °N | Lon 26.6523 °E

Fri, 23 Sep 2016, 23:11:16 » ML 5.8 EARTHQUAKE IN VRANCEA EWS ROMANIA, AT A DEPTH OF 111.816 km.

SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.05	0.3	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.02	0.13	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

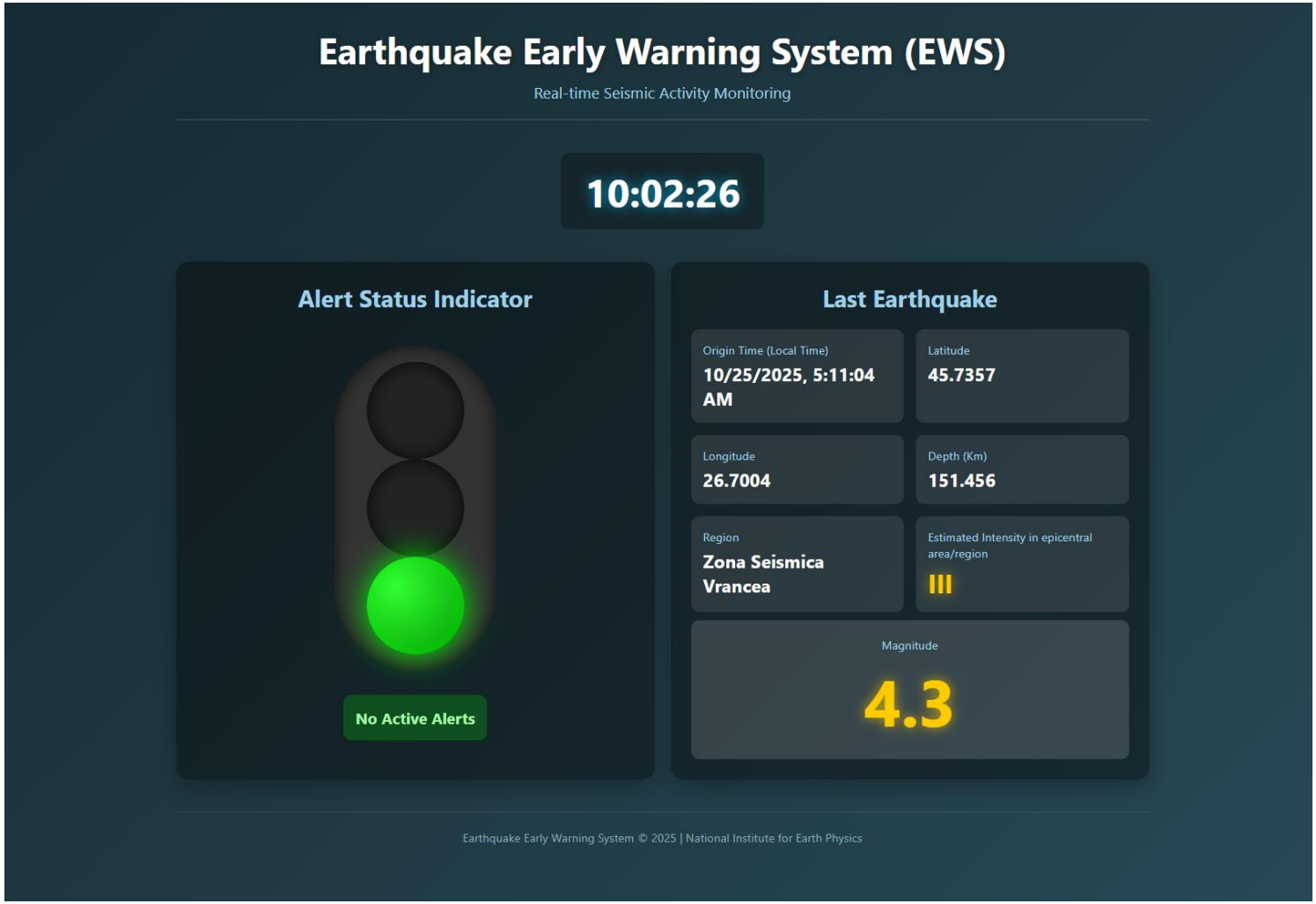
Scale based on Worden et al. (2012)

Version 1: Processed 2025-01-23T07:54:45Z

△ Seismic Instrument ○ Macroseismic Observation ★ Epicenter

Free website: https://eqtrack.infp.ro/ews/

GREEN = earthquake alert M< 4
YELLOW = earthquake alert M ≥ 4 and M< 6
RED = earthquake alert M > 6



New implementation
for entire country

Virtual Seismologist

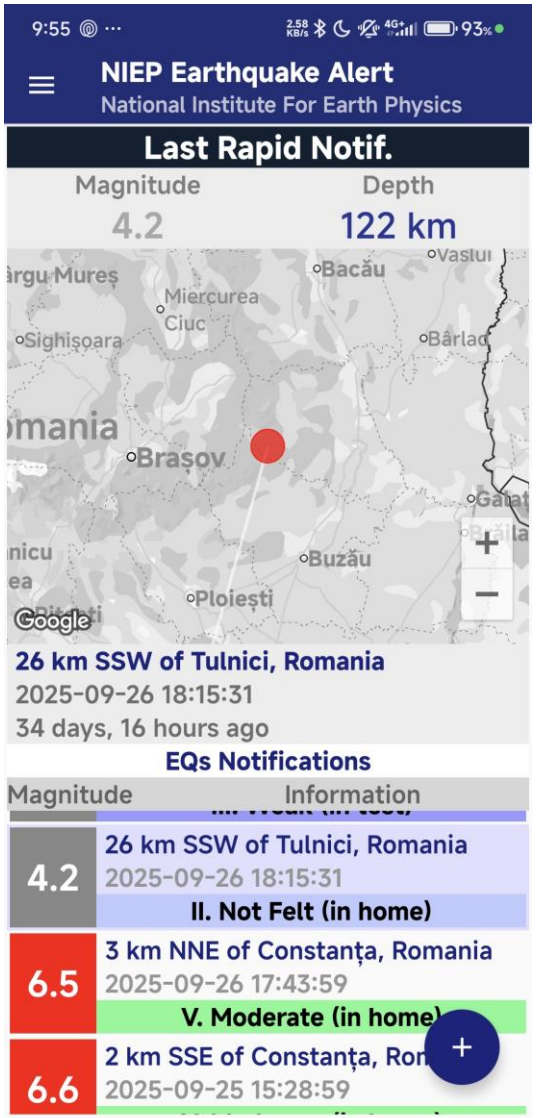
in testing phase

Bulletin (UTC time): 2014/11/22 19:14:17.11 45.8683 27.1517 H= 40.9 ml 5.7

Tdiff	Type	Mag.	Lat.	Lon.	Depth	origin time (UTC)	Lik.	Or.	Ma.	Str.	Len.	Author	Creation t.	Tdiff(current o.)
11.16	MVS	5.82	45.36	26.87	5.00	2014-11-22T19:14:15.75Z	0.99	11	10			scvsmag@7	2014-11-22T19:14:28.77Z	13.02
12.16	MVS	5.61	45.36	26.87	5.00	2014-11-22T19:14:15.75Z	0.99	11	10			scvsmag@7	2014-11-22T19:14:29.77Z	14.02
13.16	MVS	5.48	45.38	26.88	5.00	2014-11-22T19:14:16.21Z	0.99	12	11			scvsmag@7	2014-11-22T19:14:30.77Z	14.56
14.16	MVS	5.60	45.38	26.88	5.00	2014-11-22T19:14:16.21Z	0.99	12	12			scvsmag@7	2014-11-22T19:14:31.77Z	15.56
15.16	MVS	5.53	45.38	26.88	5.00	2014-11-22T19:14:16.21Z	0.99	12	12			scvsmag@7	2014-11-22T19:14:32.77Z	16.56
16.16	MVS	5.45	45.44	26.90	11.27	2014-11-22T19:14:16.47Z	0.99	13	12			scvsmag@7	2014-11-22T19:14:33.77Z	17.31
17.16	MVS	5.42	45.44	26.90	11.27	2014-11-22T19:14:16.47Z	0.99	13	13			scvsmag@7	2014-11-22T19:14:34.78Z	18.31
18.17	MVS	5.33	45.89	27.15	20.94	2014-11-22T19:14:17.59Z	0.99	20	19			scvsmag@7	2014-11-22T19:14:35.78Z	18.19
19.17	MVS	5.38	45.89	27.15	20.94	2014-11-22T19:14:17.59Z	0.99	20	19			scvsmag@7	2014-11-22T19:14:36.78Z	19.19
20.17	MVS	5.44	45.89	27.15	20.94	2014-11-22T19:14:17.59Z	0.99	20	18			scvsmag@7	2014-11-22T19:14:37.78Z	20.19
21.17	MVS	5.43	45.90	27.15	19.63	2014-11-22T19:14:17.64Z	0.99	23	21			scvsmag@7	2014-11-22T19:14:38.78Z	21.14
33.18	MVS	5.37	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:50.80Z	33.18
34.18	MVS	5.36	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:51.80Z	34.18
35.18	MVS	5.36	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:52.80Z	35.18
36.18	MVS	5.39	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:53.80Z	36.18
37.19	MVS	5.39	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:54.80Z	37.19
38.19	MVS	5.39	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:55.80Z	38.19
39.19	MVS	5.39	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:56.80Z	39.19
40.18	MVS	5.39	45.88	27.16	20.24	2014-11-22T19:14:17.61Z	0.99	36	34			scvsmag@7	2014-11-22T19:14:57.80Z	40.18

Vs first alert – OT = ~11 seconds

First solution SCAUTOLOC
2014/11/22 19:14:28 [info/Autoloc]
Detailed info for Origin 1



SEISMIC CONTROL ROOM at NIEP HQ