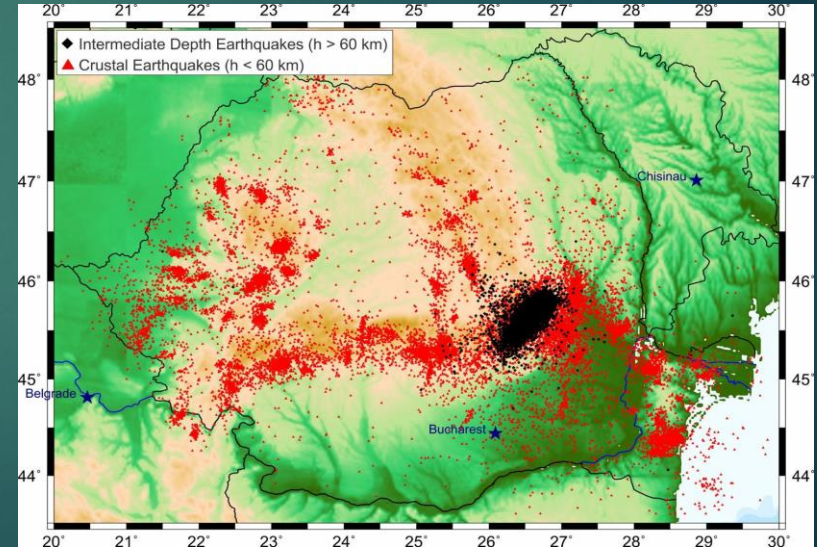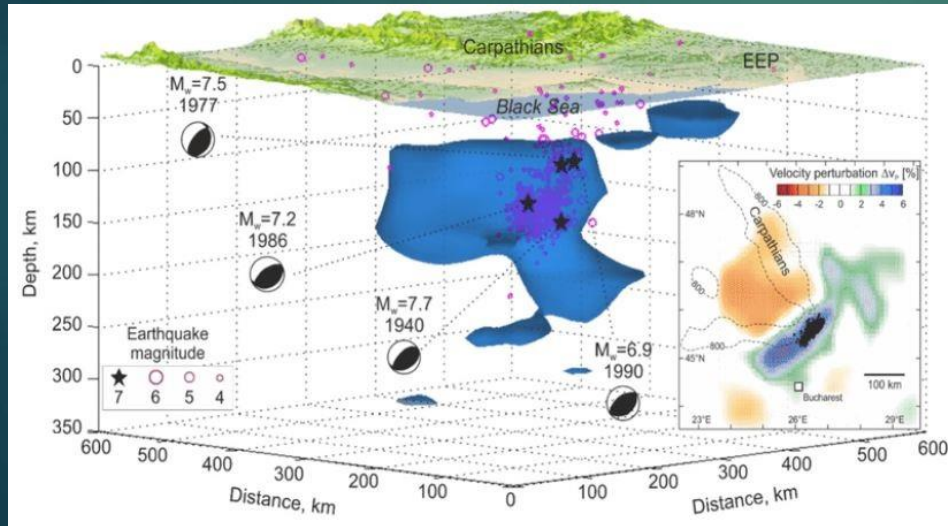# Romanian Seismic Network

CONSTANTIN IONESCU

National Institute for Earth Physics, Romania

European Antelope Users Group Meeting June 2024

Seismic Activity in Romania

- Romania is characterized by moderate seismicity, generated by the occurrence of both crustal and intermediate-depth earthquakes
- Seismic activity is dominated by the subcrustal earthquakes generated in the upper mantle beneath the SE Carpathians (Vrancea Region) confined to a narrow ~100 km(height)×70 ×30 km volume
- These earthquakes are the primary source of seismic hazard for Romania and Eastern Europe, with the most recent largest events reaching Mw 7.7 and 7.4 in 1940 and 1977, respectively, causing substantial damage.

Real Time Romanian Seismic Network
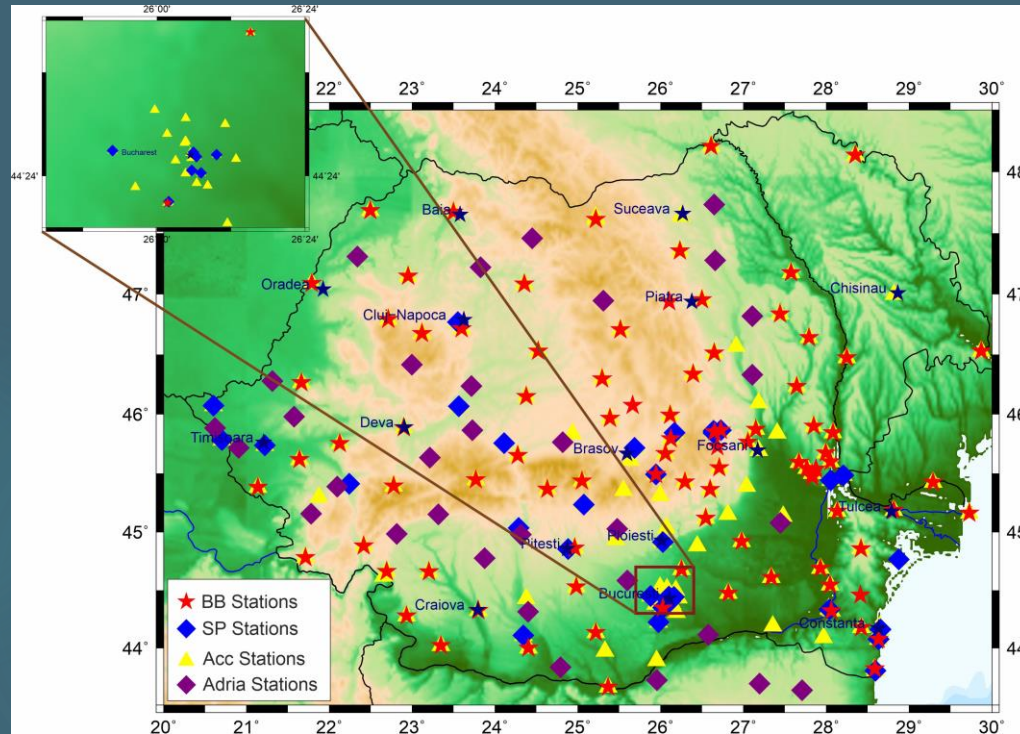
- During last two decades the Romanian Seismic Network (RSN) was upgraded and continuously extended leading to significant improvements in detection and location rate of seismic events
- At present RSN operates 2 seismic arrays and over 150 stations (broadband and short-period) which are sending real-time to the National Data Center (NDC) in Magurele.
- A strong motion network of 184 stations (EpiSensor-2g full scale), is installed to record strong ground motions (21 in Bucharest area). Most of them are collocated with the velocity sensors.
- The RSN consists of different kind of instruments from various manufacturers: short-period sensors (Teledyne-Geotech S13 SH-1, GS21, Mark Products - l4c, L22, Kinemetrics - Ranger), broadband sensors (Guralp CMG3ESP, CMG40T, CMG-3T, Streckeisen STS2, Geotech KS2000, KS54000, MBB2, PBB, GEObit).

Seismic arrays in Romania
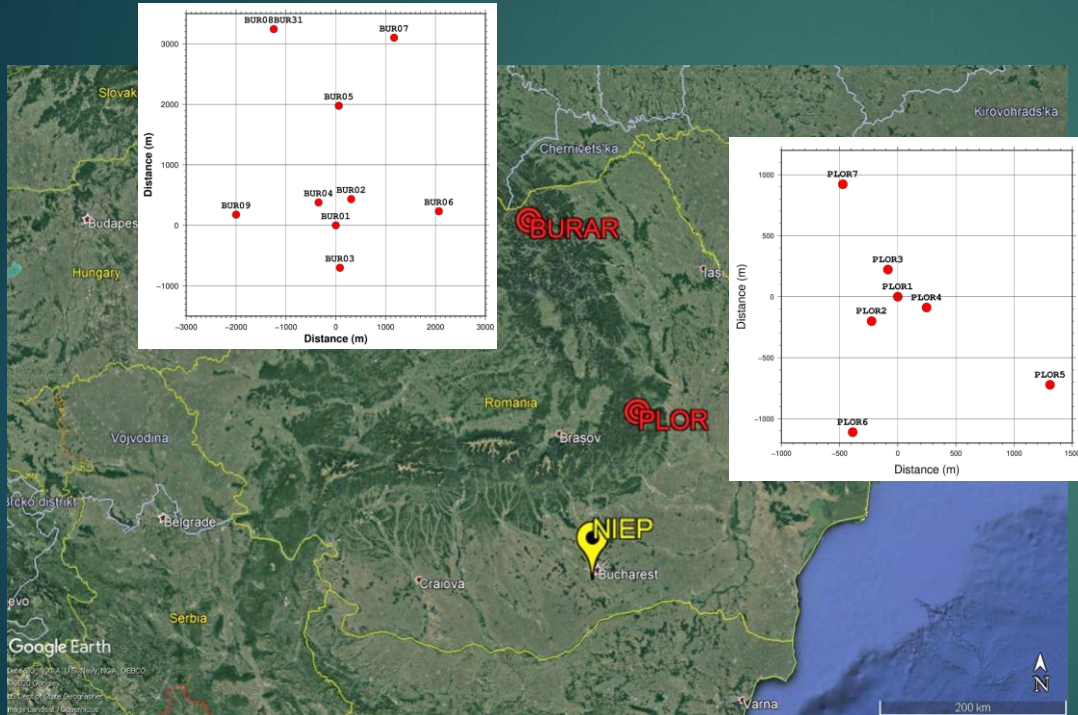
The 10 seismometers of the BURAR array are located in boreholes of 30, 45 and 60 m depth. Nine sites (BUR01, BUR02,…, BUR09) are equipped with vertical 1-C SP GS21 (Geotech Instruments) instruments; the tenth site of array (BUR31) is equipped with 3-C BB instrument: KS54000 (Geotech Instruments) (between 2002 and 2017) and CMG-40T (Guralp) (since August 2017).

The 7 seismometers of the PLOR array are located in vaults of 3 m depth. Six sites are equipped with S13 short period instruments and one (PLOR) - with 3-C BB mbb2 seismometer.

Contribution to Adria Array Network
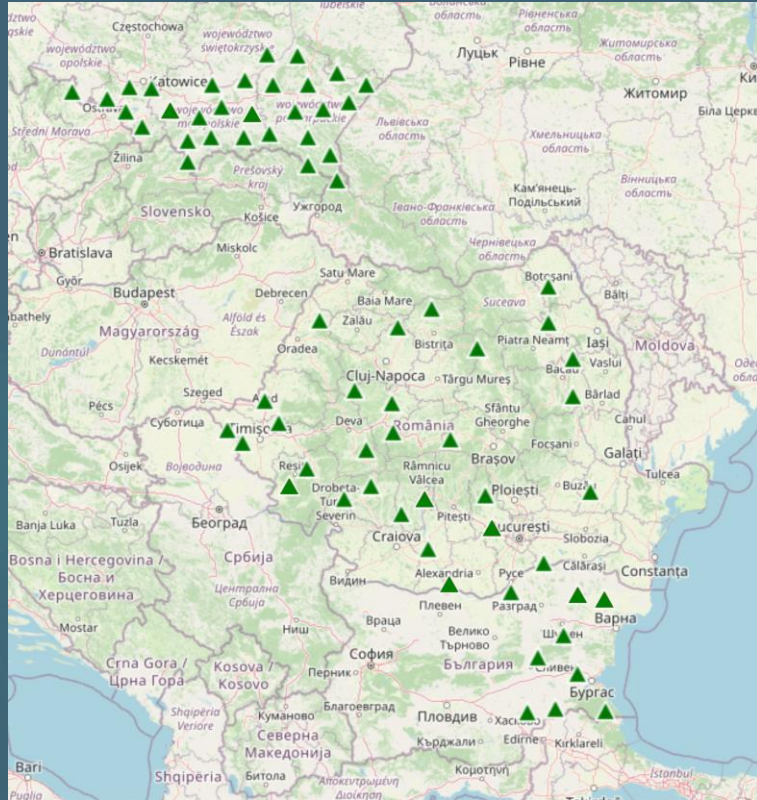
AdriaArray is a multi-national effort to cover the Adriatic Plate and its active margins in the central Mediterranean by a dense regional array of seismic stations to understand the causes of active tectonics and volcanic fields in the region. Plate-scale observations are complemented by local and LargeN experiments in key areas. The AdriaArray region reaches from the Massive Central in the west to the Carpathians in the east, from the Alps in the north to the Calabrian Arc and mainland Greece in the south.

The installation of the AdriaArray temporary stations started in June 2022. Since then, 95% of the approximately 400 planned temporary stations have already been installed in Europe.

Station deployment in Romania
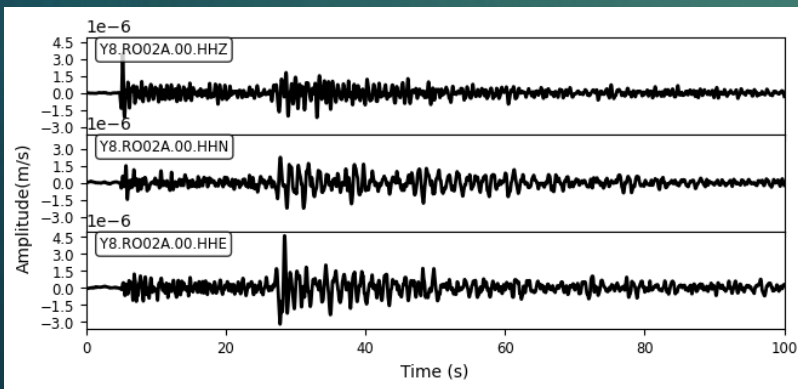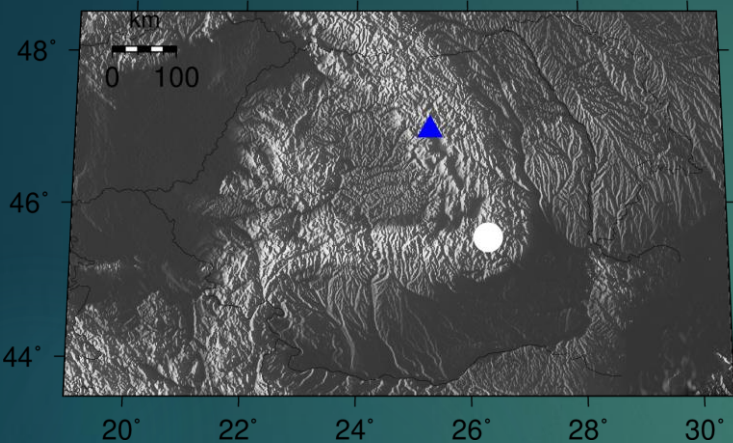

TOPLITA -free field installation

VRANCEA Earthquake
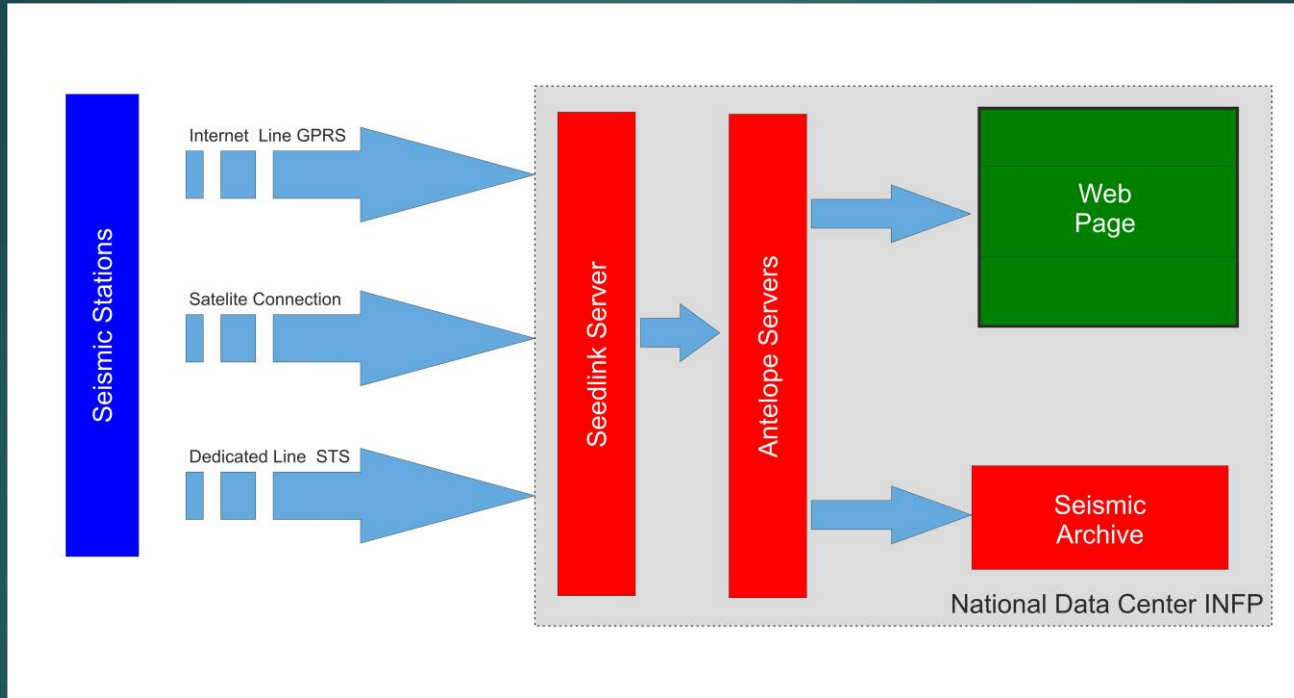
2022/09/13:02:50:15.77; H~144km; Mw=4.1

GNSS - Network
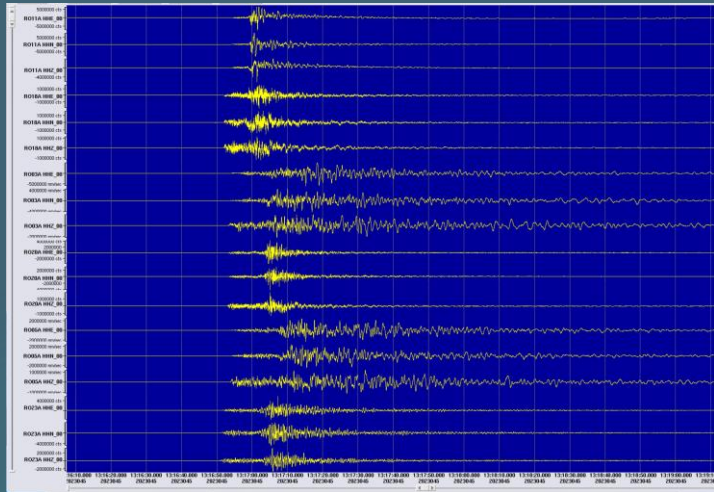
32 Real Time GNSS station

The GNSS permanent stations have different equipment, most of them are produced by Leica Company: GRX 1200 GG Pro, GRX 1200 + GNSS, GR10, GR30 si GR50 Professional and antenna models used are LEIAT 504, LEIAT 504 GG, LEIAR 10 şi LEIAR 20 and three stations Septentrio
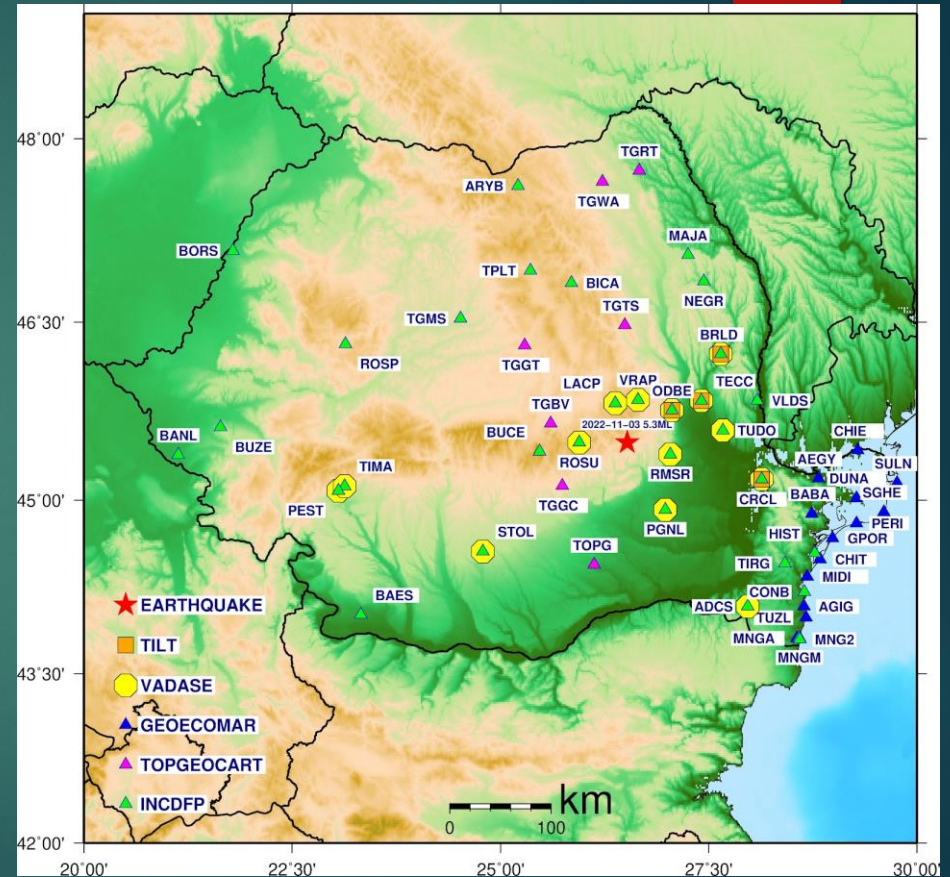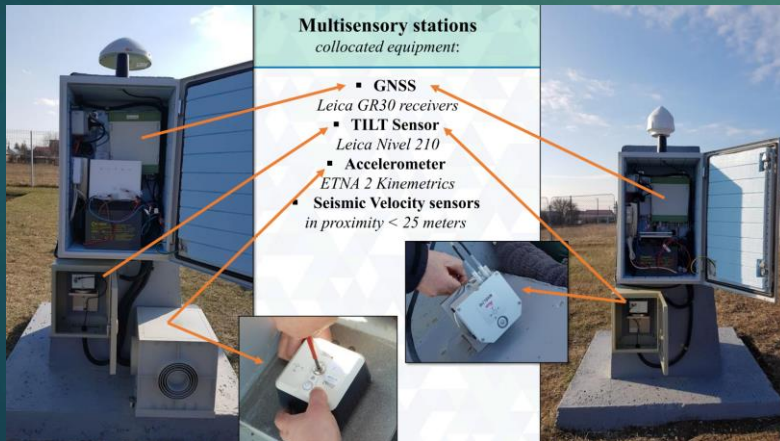
Data Flow

Antelope Software

Gorj, Romania – ML=5.7, 14-02-2023,13:16 UTC

Turkey– Mw=6.3, 20-02-2023,17:04 UTC

Automatic processing:
- P-wave picking
- event association
- event localization
- computation of magnitude
- sending e-mail / SMS alerts
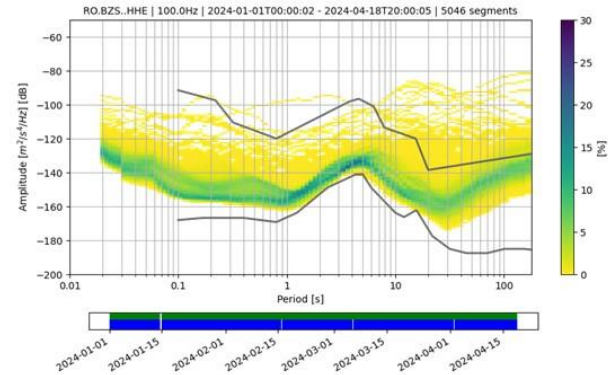-   Generating ShakeMaps

Manual processing:
- phase picking
- event association
- computation of magnitude
- creation of database
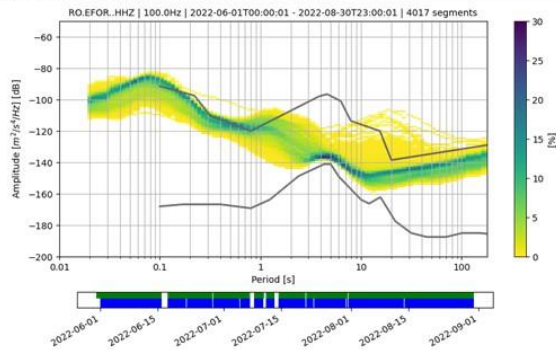- sending reports/ bulletins
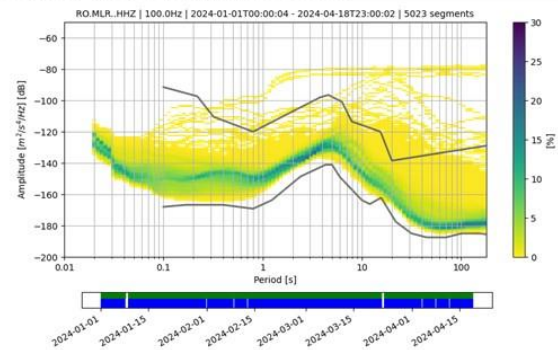- Generating ShakeMaps
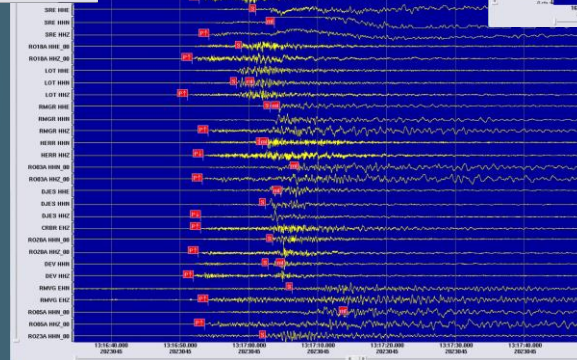
Data Quality Assessment
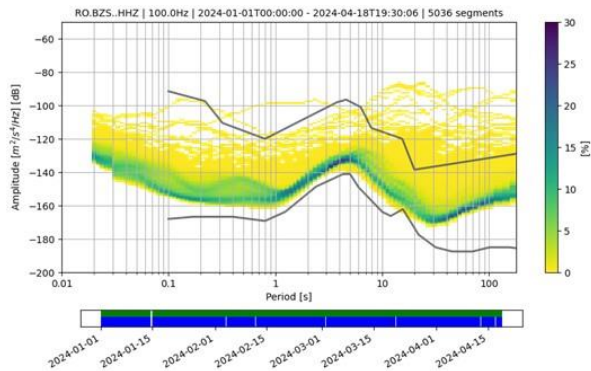
Shake Map

➢ Allows the rapid estimation of the intensity and severity of the ground motion after an important earthquake;

➢ PGA, PGV, SA and intensity maps are usually generated within 3-4 minutes after the earthquakes;

➢ ShakeMap output is input for any system for estimating seismic damage (in Romania, near-real time SEISDARO);

➢ Implemented in Romania in 2007.

Shake Map 3.5
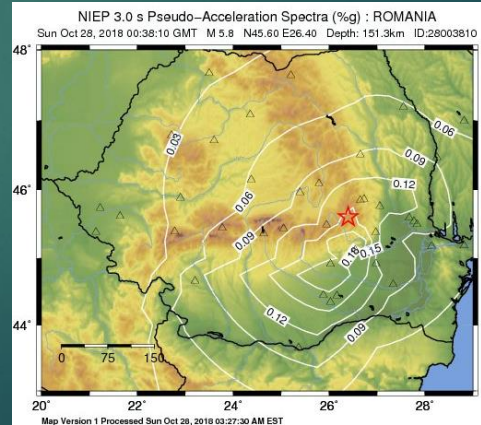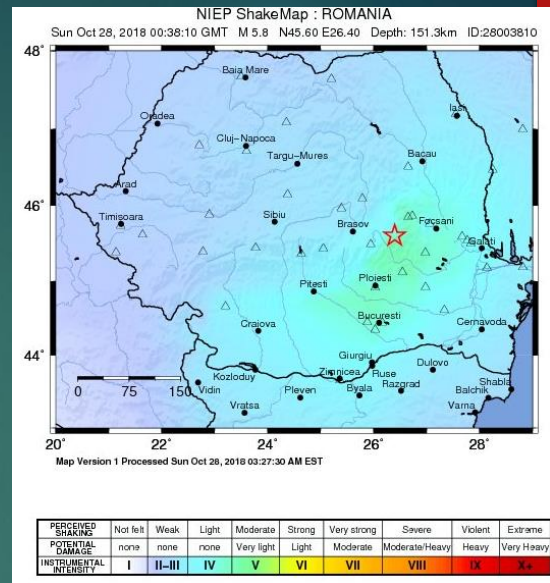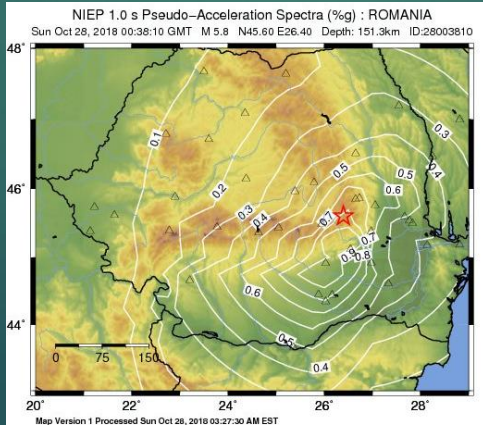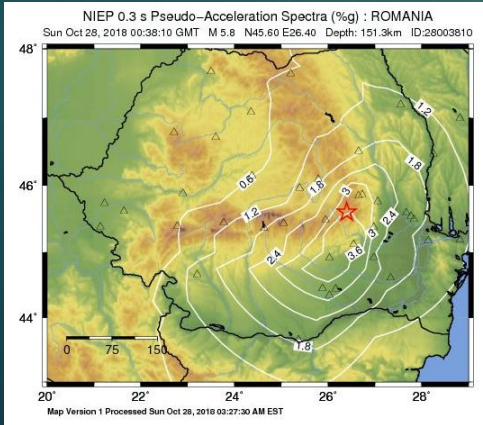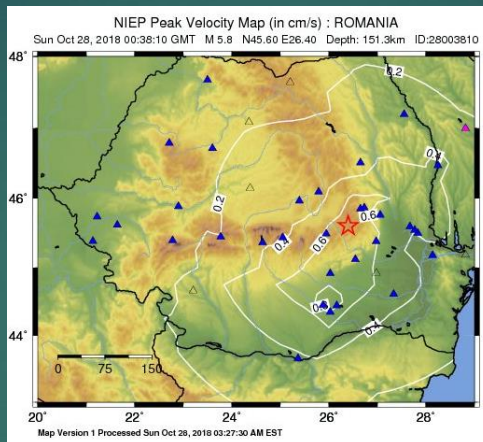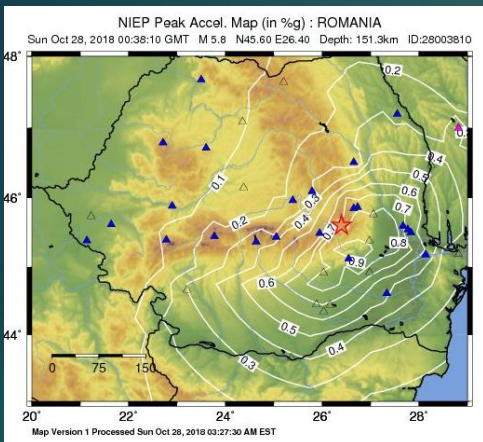
Vrancea, 28 October 2018, Mw=5.5, Depth=148 km

Shake Map 4.0
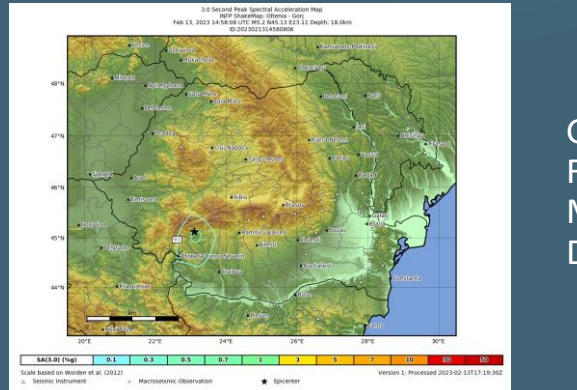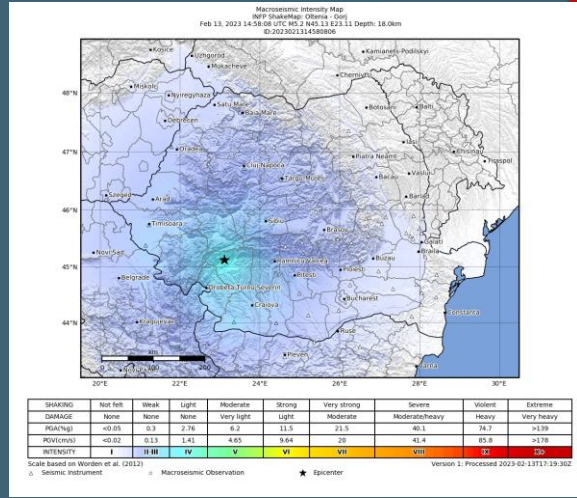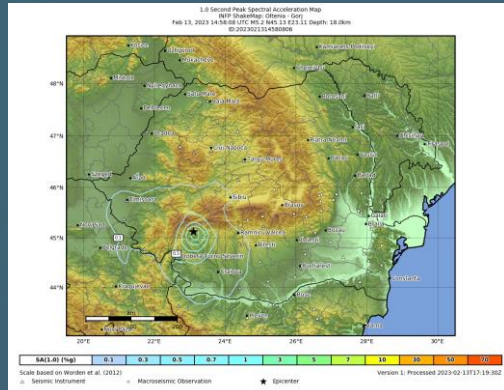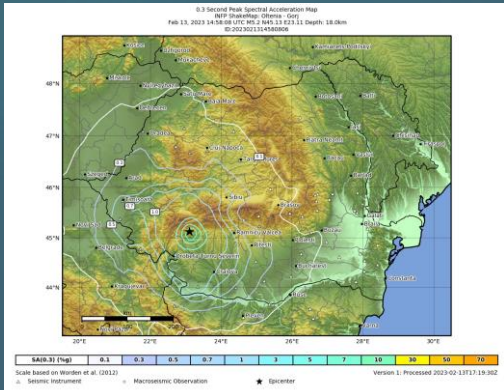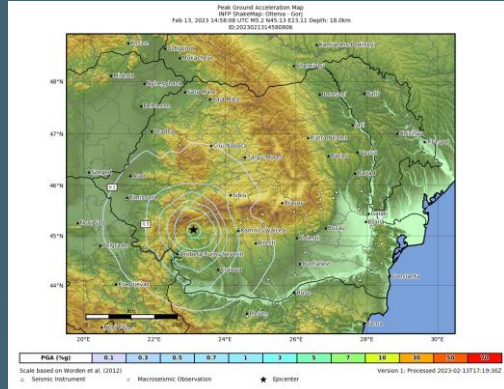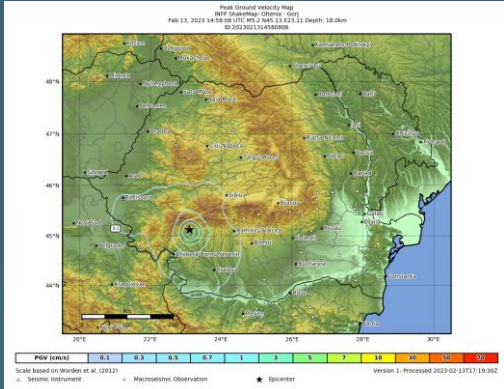
Gorj, 13 February 2023, ML=5.2, Depth=18 km

SEISDARO

- SeisDaRo (The System for Rapid Estimation of Seismic Damage in Romania) estimates with 2 different methodologies (PAGER and SELENA) the potential number of casualties and affected buildings, at national level directly based on intensities or at city/commune level based on acceleration values.
- This product is addressed to emergency management

Stakeholders using Seisdaro
• General Inspectorate for Emergency Situations in Romania (IGSU)
• S.C. OMV PETROM S.A.
• 4 prefectures in Romania, for Defense plans against earthquakes and landslides.
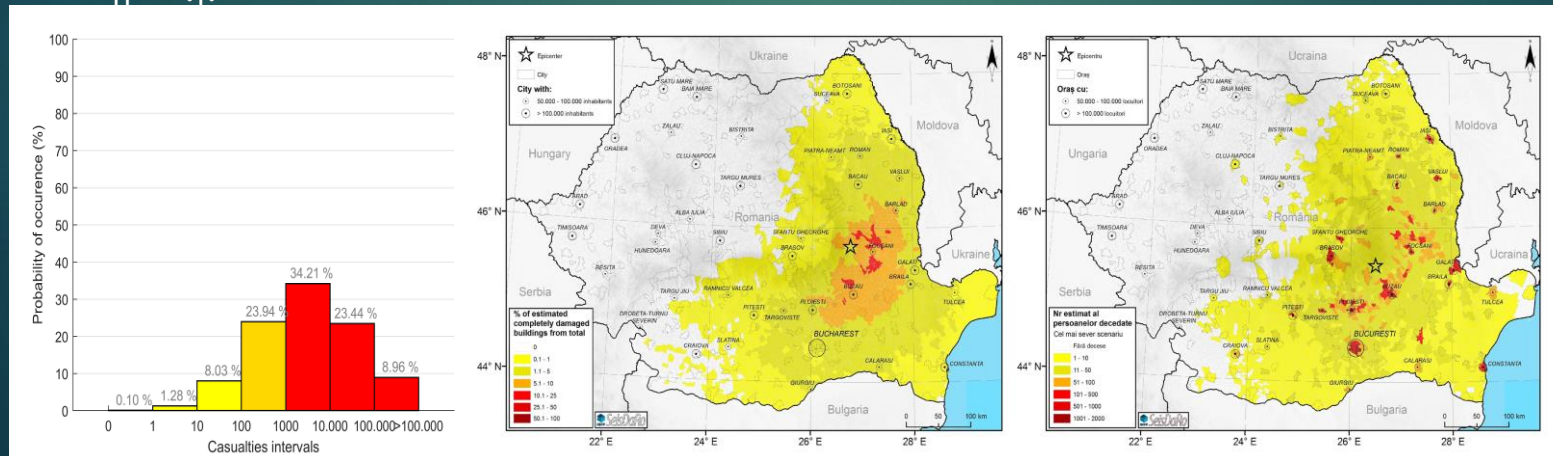
SeisDaRo input for the SEISM 2019 exercise

HAZARD AND RISK MAPS

Probabilistic seismic hazard and risk maps (1000 years mean return period) computed by INFP, UTCB and URBAN-INCERC during the RO-RISK Project (2017)
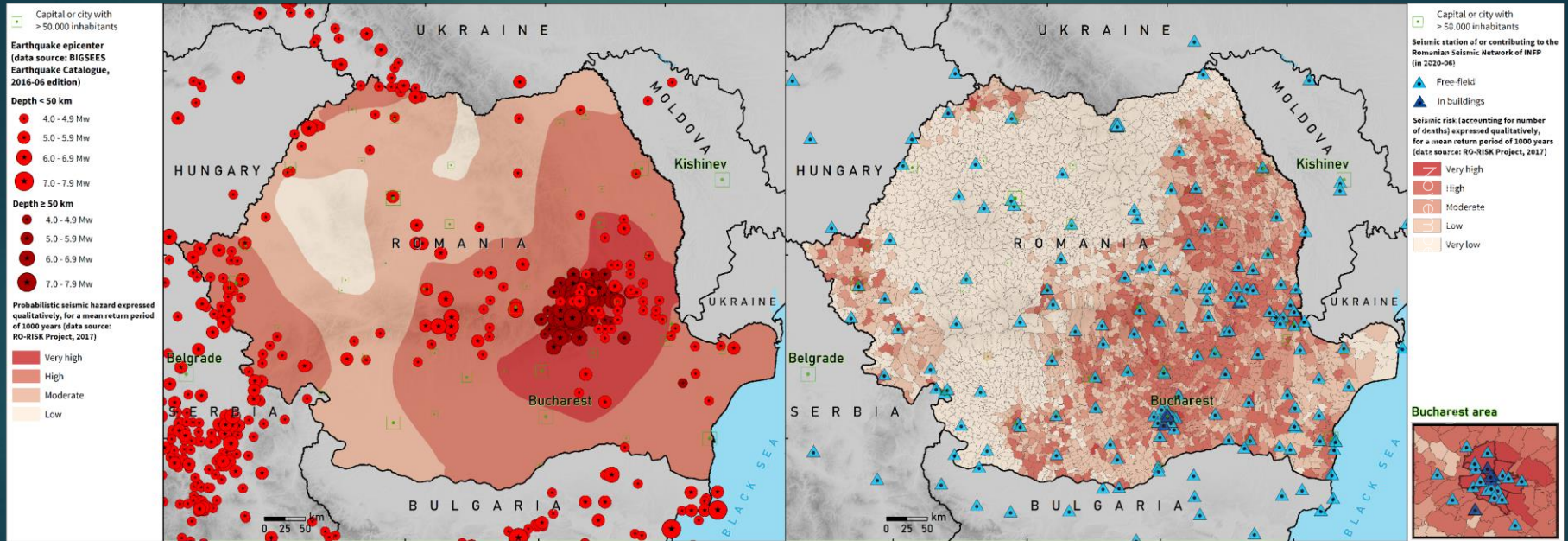
PROJECTS:

SEISMIC MONITORING OF BUILDINGS

The Institute of Atomic Physics building monitored in Magurele, and example of Antelope Bighorn implementation, using real data recorded in a building and various response spectrum
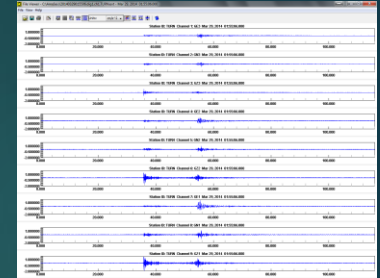
10 buildings currently monitored in real-time in Romania by INFP:

- 7 in Bucharest
- 1 in Magurele
- 1 in Focsani
- 1 in Eforie Nord

Strong motion network
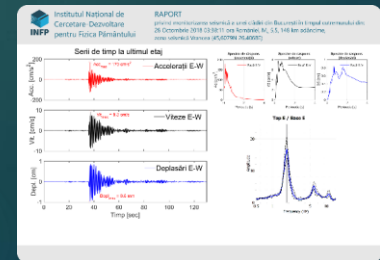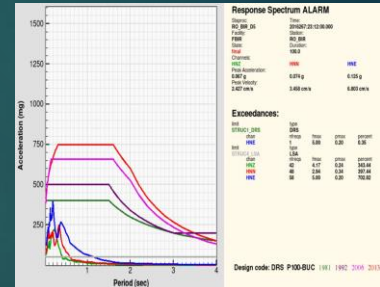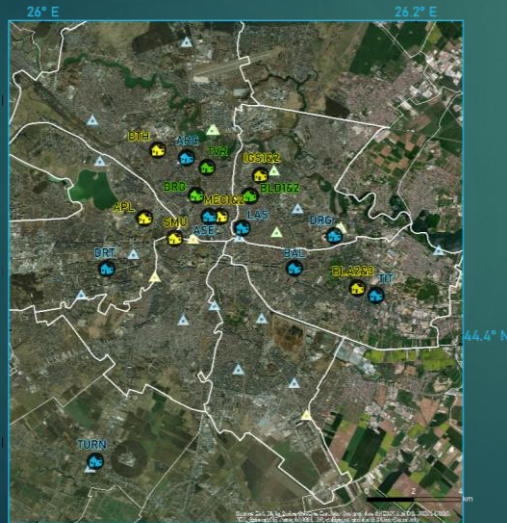
EEW in Romania

- 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
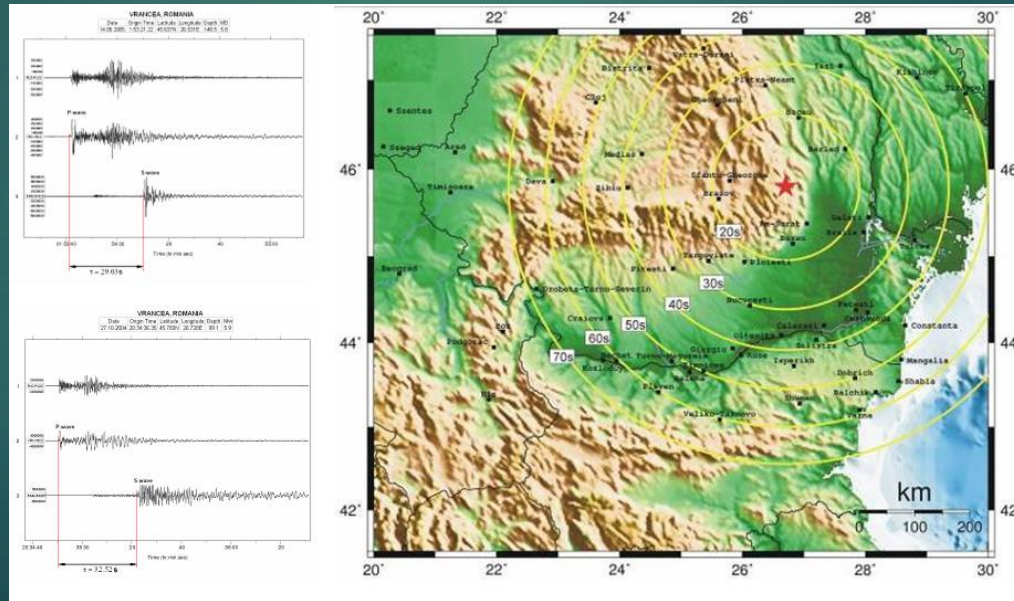
EEW in Operation: Romania – Current End Users

❖ **Nuclear Research Institute, Bucharest**

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

❖ **Pasajul Basarab Bridge, Bucharest**

During an EEW alert, traffic light stops

cars entering bridge

❖ **Vidraru Dam, Romania**

Alert use to trigger data collection

❖ **Other End Users:**

Nuclear Power Plants in Romania and Bulgaria – just for information

Emergency response institutions in Romania and Bulgaria

Governmental agencies involved in rapid intervention in case of a strong earthquake
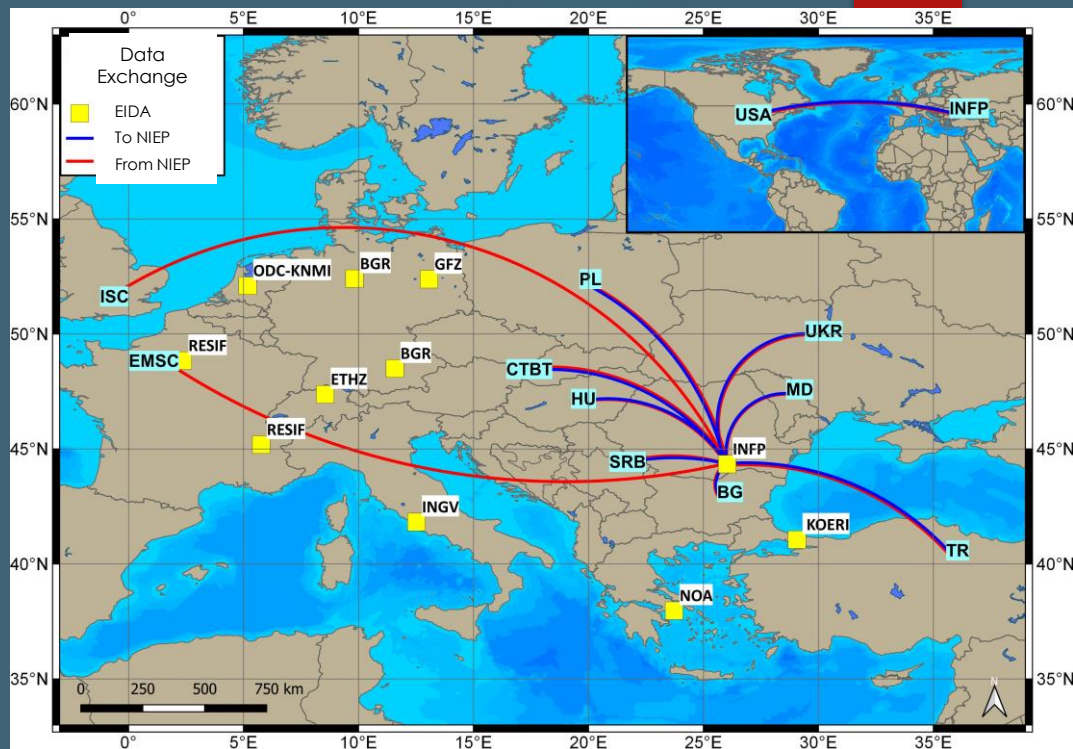
Data Exchange

NIEP is and EIDA Node since 2014

EIDA (European Integrated Data Archive) is a European data center that archives and provides access to seismic waveforms and related instrumentation within European research infrastructures.

EIDA Node **NIEP** archives a total number of **259** stations. This node archives data for networks:
BS MD RO UD Y8

http://www.infp.ro/index.php?i=eida

Data Exchange

Data is accessible through the web services:

- FDSNWS - Dataselect http://eida-sc3.infp.ro/fdsnws/dataselect/1/
- FDSNWS - Station http://eida-sc3.infp.ro/fdsnws/station/1/

The routing service is a web service that routes requests for different services between EIDA Nodes

- http://eida-sc3.infp.ro/eidaws/routing/1/

WFCatalog is a webservice that provides detailed information on the content of waveform data including quality control parameters.

- http://eida-sc3.infp.ro/eidaws/wfcatalog/1/

Seismic Control Room at NIEP

Thank You for your attention!