

The Montenegrin Seismic Network: Current Status and Development

Network Overview

MSO operates a seismic network consist of 10 short-period stations spanning the entire territory of the country and one broadband station (donation of MedNet). Every field seismic station is equipped with short-period vertical seismometer Teledyne – Geotech S-13 type. The seismic station at Podgorica is equipped with the broadband seismometer STS-2, digitizer Quanterra 730 and accelerometer EpiSensor. All eleven stations are on the Internet in real-time.



Seismic station	Station code	Network code	Channel code	Latitude (E)	Longitude (N)	Altitude (m)	Seismometer
Podgorica	PDG	ME	EHZ	42.42967	19.26083	40	S-13, Smart-24D
Podgorica	PDG	MN	HHZ	42.42967	19.26083	40	STS-2, EpiSensor
Podgorica	PDG	MN	HHE	42.42967	19.26083	40	Quanterra 730
Piljevlja	PLE	ME	EHZ	43.32987	19.39426	1181	S-13, Smart-24D
Berane	BEY	ME	EHZ	42.87175	19.89811	945	S-13, Smart-24D
Plav	PVY	ME	EHZ	42.59500	19.97350	1250	S-13, Smart-24D
Bratogošt	BRY	ME	EHZ	42.90072	18.54394	1367	S-13, Smart-24D
Nikšić	NKY	ME	EHZ	42.81285	18.99817	1142	S-13, Smart-24D
Herceg Novi	HCY	ME	EHZ	42.44749	18.49836	273	S-13, Smart-24D
Ulcinj	ULC	ME	EHZ	41.96337	19.24970	465	S-13, Smart-24D
Budva	BUM	ME	EHZ	42.30080	18.89860	724	S-13, Smart-24D
Unač - Piva	UPM	ME	EHZ	43.20290	18.91000	1721	S-13, Smart-24D

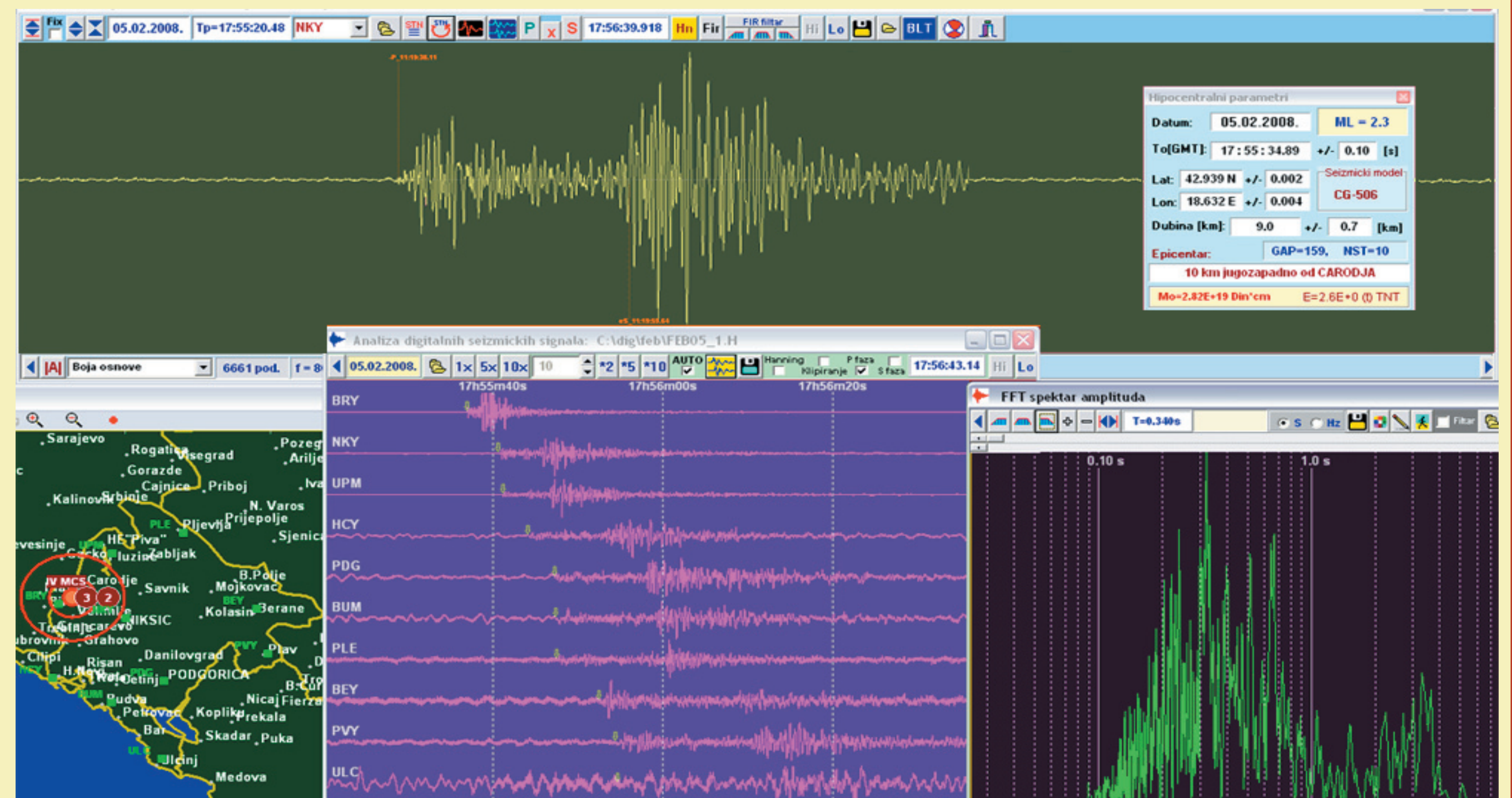
The data recorded by the short-period stations are digitized on the field with 100 samples per second, 24 bit resolution (Smart-24D) and transmitted to the data recording center at Podgorica.

At the data center acquisition of seismic signals is performed by the three systems: DASP acquisition system (B. Glavotovic), SeisComP3 (GFZ) and SmartGeoHub (Geotech) system.

Manual and Automatic Seismic Data Processing

Software ANALYSIS (B. Glavotović) is used for the routine analysis of digital seismograms and processing of earthquake parameter data for local, regional and teleseismic events. Software implements great number of modern solutions in processing of seismic data including: graphical and numerical seismic analysis, automatic event location, focal mechanism solution, seismic signal filtering, generation of earthquake report in form of alert message and sending that message to specific e-mail addresses, automatic creating and sending e-mail message for press media that contains short textual report and map with epicentral location, web page generating and web site refreshment, preparation of seismological bulletin and catalog of earthquake data and many other features.

Program package SMARTQuake® is used for fully automated earthquake data processing and real-time exchange of earthquake information. It is integrated with SMARTGeoHub® multi-threaded, data acquisition system for real time operation. SMARTQuake® starts by picking arrival times on selected pre-filtered channels.



The waveforms after the picks are analyzed to discriminate between local and regional earthquakes and teleseisms. S waves are also picked in case of local events. Duration magnitude is computed for local earthquakes and the body wave magnitude mb for teleseisms.

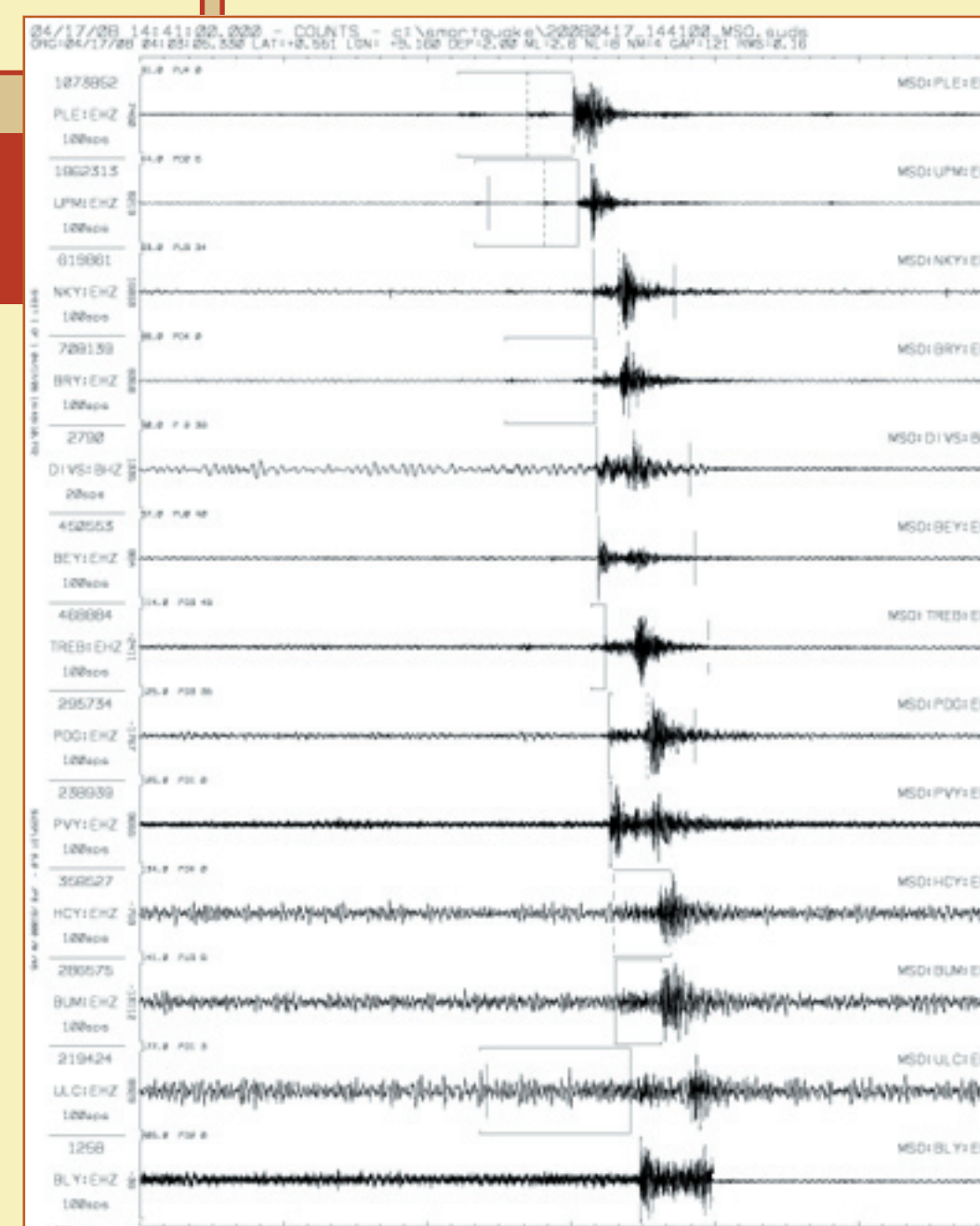
SQ performs moment tensor inversion for local earthquakes based on spectral amplitudes of body wave trains. Location results, waveforms with picks and color epicentral maps are output on a PostScript printer and on-screen. Event files are archived and converted to common seismological data formats. The location results are sent by email and SMS to a list of addresses/numbers immediately after the earthquake detection. The emails are already formatted as required by some of the most important seismological centers. (EMSC, NEIC, Swiss Seismological Service, etc).

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EVENT: (001)  .526m  4.238km  4.273km  .000m  .2  IT S
ERROR ELLIPSE: Major/2 = 5.942km  Minor/2 = 4.561km  Major/Minor/2 = 1.300
STATION  CEN  DEL  AZM  RHO  INT  ARRIVAL TIME  WAVE  D-C  WT
1  PVY  ERE  36  4  93  0  1  14129136.510  P  0  -119  3.000
2  PDG  ERE  57  280  92  0  1  14129136.510  S2  -599  .25
3  PDG  ERE  57  280  92  0  1  14129136.510  S2  -456  3.000
4  ULC  ERE  57  280  92  0  1  14129144.200  S2  1.106  .13
5  ULC  ERE  66  230  92  0  1  14129137.760  P  2  .823  .50
6  BEY  ERE  66  350  92  0  1  14129140.130  S2  2.424  .04
7  BEY  ERE  66  350  92  0  1  14129137.410  P  1  .260  .75
8  BUM  ERE  66  350  92  0  1  14129141.800  S4  -4.268  .00
9  BUM  ERE  66  350  92  0  1  14129140.750  P  2  .619  .50
10  NKY  ERE  66  270  91  0  1  14129134.400  S2  2.292  .04
11  NKY  ERE  97  300  91  0  1  14129141.700  P  2  .434  .50
12  NKY  ERE  97  300  91  0  1  14129137.490  S4  2.394  .00
13  HCY  ERE  119  279  91  0  1  14129140.160  P  2  -0.019  .50
14  HCY  ERE  119  279  91  0  1  14129137.840  S2  2.401  .04
15  PLE  ERE  122  340  91  0  1  14129151.000  P  2  18.978  .00
16  UPM  ERE  132  321  91  0  1  14129140.140  P  0  .016  3.000
17  UPM  ERE  132  321  91  0  1  14129137.370  S2  2.529  .04
18  PVY  ERE  133  302  91  0  1  14129151.190  P  4  2.168  .00
19  PVY  ERE  133  302  91  0  1  14129137.840  S2  2.107  .04
20  TRD  ERE  138  291  91  0  1  14129147.840  P  4  -1.005  .00
21  TRD  ERE  138  291  91  0  1  14129137.190  S4  1.049  .00
22  HRYD  ERE  150  332  91  0  1  14129150.745  P0  -1.04  1.00
    
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On-going Project

MSO is in the role of the leading country partner in the regional Project "Harmonization of Seismic Hazard Maps for the Western Balkan Countries", financed by the Science for Peace and Security Programme. The main objective of the project is to estimate seismic hazard in the region respecting uniform methodological approach and according to the state of the art in seismic hazard analysis. Also, the Project should provide background for tailoring the seismic provisions of the participating countries harmonized with EU standards. Participating countries are: Montenegro, Croatia, Bosnia and Herzegovina, Serbia, Macedonia and Albania. Project Web Address: www.wbseismicmaps.org.



NATO SFP Project 983054 Harmonization of Seismic Hazard Maps for the Western Balkan Countries

This project is supported by: The NATO Science for Peace and Security Programme

Disaster Preparedness and Prevention Initiative

DPPI STABILITY PACT FOR SEE EUROPE

HARMONIZATION OF SEISMIC HAZARD MAPS FOR THE WESTERN BALKAN COUNTRIES
SFP Project 983054

PROJECT DIRECTORS:
Branislav Glavotovic, Podgorica, Montenegro, PPD
Sinan Akkar, Ankara, Turkey, NPD

PROJECT CO-DIRECTORS:
Shyqyri Aliaj, Tirana, Albania
Amer Zoranic, Sarajevo, Bosnia and Herzegovina
Vlado Kuk, Zagreb, Croatia
Mihail Garevski, Skopje, FYR Macedonia
Svetlana Kovacevic, Belgrade, Serbia

PROJECT IS TO BE CARRIED OUT BY:
12 institutions from 7 countries
7 Co-Directors and 48 key members

PROJECT LEADING COUNTRY: Montenegro

PARTICIPATING COUNTRIES:
Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro and Serbia

PROJECT WILL LAST FOR: 3 years (2007 - 2010)

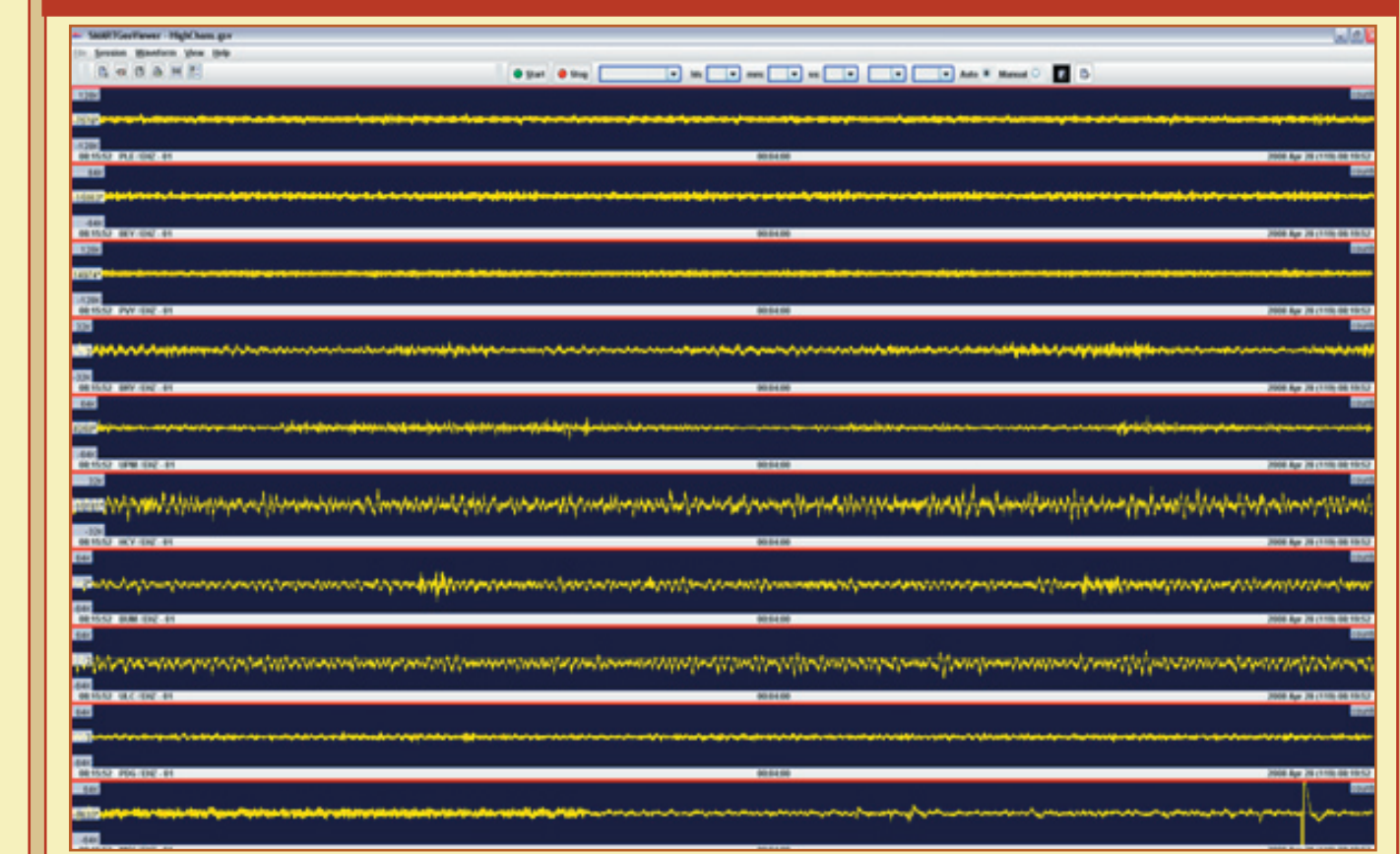
The NATO Science for Peace and Security Programme
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Virtual Regional Seismic Network

Virtual network of the Montenegro Seismological Observatory includes more than 50 seismic stations: stations of Montenegrin National Seismic Network (ME) and selected seismic stations of other institutions from European countries. SeisComP3 with Seed-Link protocol is used for real-time data acquisition and exchange with collaborating seismological centers. Data flow to/from networks: MN (MedNet), SL (Slovenia), IV (Italy), RS (Republic of Srpska), RO (Romania), BS (Bulgaria), MK (Macedonia) and HT (Greece).



Stream monitoring



Future Developments

- Upgrading of existing analogue to digital seismic telemetry
- Extending the existing short-period network with broadband seismic stations
- Installation of 3 integrated (weak & strong motion) stations through NATO SFP Project
- GPS permanent stations network establishment