The Central and Eastern European Earthquake Research Network - CE3RN

Pier Luigi Bragato[1], Giovanni Costa[2], Antonella Gallo[2], Stefania Gentili[1], Andrej Gosar[3], Nikolaus Horn[4], Wolfgang Lenhardt[4], Luca Moratto[1], Marco Mucciarelli[1], Damiano Pesaresi[1], Rudolf Steiner[4], Peter Suhadolc[2], Lara Tiberi[2], Mladen Živcic[3], and Giuliana Zoppé[2]

1) OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale), Italy 2) Department of Mathematics and Geoscience of the University of Trieste (DMG), Italy
3) Agencija Republike Slovenije za Okolje (ARSO), Slovenia 4) Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Austria

Abstract

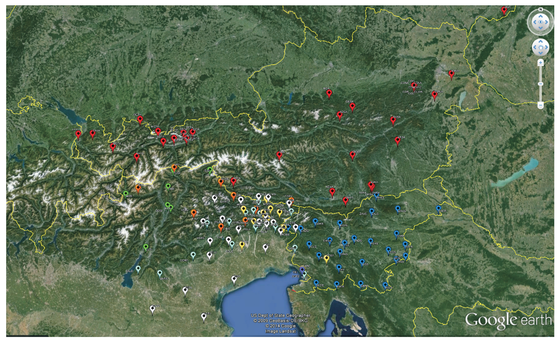
The region of the Central and Eastern Europe is an area characterised by a relatively high seismicity. The active seismogenic structures and the related potentially destructive events are located in the proximity of the political boundaries between several countries existing in the area. An example is the seismic region between the NE Italy (FVG, Trentino-Alto Adige and Veneto), Austria (Tyrol, Carinthia) and Slovenia. So when a destructive earthquake occurs in the area, all the three countries are involved. In the year 2001 the Agencija Republike Slovenije za Okolje (ARSO) in Slovenia, the Department of Mathematics and Geoscience of the University of Trieste (DMG), the OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) in Italy and the Zentralanstalt für Meteorologie und Geodynamik (ZAMG) in Austria signed an agreement for the real-time seismological data exchange in the Southeastern Alps region. Its aim was to improve the monitoring of seismic activities in the border regions and to enhance the collaboration between countries and seismological institutions in Central Europe.Soon after the Interreg IIIa Italia-Austria projects "Trans-National Seismological Networks in the South-Eastern Alps" and "FASTLINK" started. The main goal of these projects was the creation of a transfrontier network for the common seismic monitoring of the region for scientific and civil defense purposes. Since the beginning the network is well known as one of the first and likely the best example of an international collaboration in seismology between neighboring countries. It is therefore foreseen to extend such collaboration to other neighboring countries.

During these years the high quality data recorded by the transfrontier network has been used, by the involved institutions, for their scientific research, for institutional activities and for the civil defense services. Several common international projects have been realized with success. The instrumentation has been continuously upgraded, the installations quality improved as well as the data transmission efficiency. ARSO, DMG, OGS and ZAMG decided to name the cooperative network "Central and Eastern European Earthquake Research Network CE3RN". The national/regional seismic networks actually involved in the CE3RN network are:

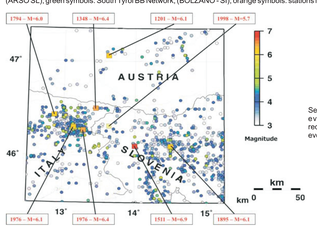
Austrian national BB network (ZAMG - OE)
Friuli Veneto SP network (OGS - FV)
Friuli VG accelerometric network (DMG - RF)
NE Italy BB Network, (OGS & DMG - NI)
Slovene national BB network (ARSO SL)
South Tyrol BB Network, (BOLZANO - SI)

The CE3RN represents an excellent example of international high quality research infrastructure and the starting point for the enlargement of the transfrontier network to all countries and their seismological institutions of the Central and Eastern Europe region. Furthermore, one of the main goals of the CE3RN is to intensify the cooperation between these and other institutions through common research activities and preparation of international projects.

The scientific potentiality of the CE3RN infrastructure is described along with some examples of research results realized during the first 13 years of network activity.



Map of the Southern Alps area with the CE3RN stations, red symbols: Austrian national BB network (ZAMG - OE); white symbols: Friuli Veneto SP network (OGS - FVG); yellow symbols: Friuli VG accelerometric network (DMG - RF); light blue symbols: NE Italy BB Network, (OGS & DMG - NI); blue symbols: lovene national BB network (ARSO SL); green symbols: South Tyrol BB Network, (BOLZANO - SI); orange symbols: stations installed in the framework of HAREIA project.

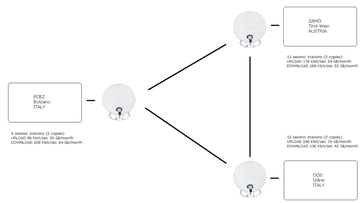


Seismicity map of the Southern Alps area. In the map the events with magnitude >3 are shown. In the rectangle the date and magnitude of the major historical events are reported

HAREIA Interreg IV project

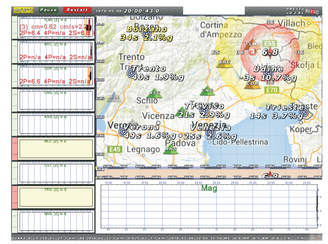
"Principal sketch and typical instrumental setup for testing at the Conrad Observatory in Austria, and installation on site."

SeismoSAT Interreg IV project



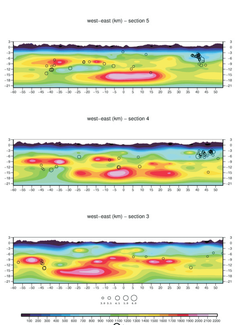
At the moment the data exchange between the seismic data centres relies on internet: this however is not optimal for civil protection purposes, since internet reliability is poor. For this reason in 2012 the Protezione Civile di Bolzano in Italy joined OGS, ZAMG and ARSO in the Interreg IV Italia-Austria "SeismoSAT" Project (Pesaresi et al., 2013) aimed in connecting the seismic data centres in real time via satellite. The Figure up shows SeismoSAT schematic diagram with data bandwidth requirements.

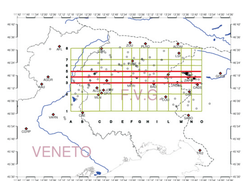
PRESTo Earthquake Early Warning



In order to extend the seismic monitoring in North-eastern Italy, Slovenia and Southern Austria, towards earthquake early warning applications, at the end of 2013 OGS, ARSO and ZAMG teamed with the RISSCLab group (http://www.rissclab.unina.it/) of the Department of Physics at the University of Naples Federico II in Italy. The collaboration focuses on massive testing on OGS, ARSO and ZAMG data of the EW platform PRESTo (Probabilistic and Evolutionary early warning SysTem) developed by RISSC-Lab (http://www.prestoews.org/). PRESTo is a stand-alone software system that processes live accelerometric streams from the stations of a seismic network to promptly provide probabilistic and evolutionary estimates of location and magnitude of detected earthquakes while they are occurring, as well as shaking predictions at the regional scale (Satriano et al., 2010). Since the beginning of 2014 PRESTo is also running on OGS, ARSO and ZAMG data, by collecting and analysing in real-time the data streams from 20 stations. To date, due to the lack of relevant seismic events, the analysis mainly focused on playing-back the waveforms of small events (i.e. M between 2 and 3) recorded in the recent past, but also of the strong motion data of the Mw 6.5, 1976 Friuli Earthquake (Figure up), for which PRESTo estimated from the P-wave amplitudes a Mw 6.8 at the instant when only three stations have triggered and the first alert is issued.

Attenuation Tomography

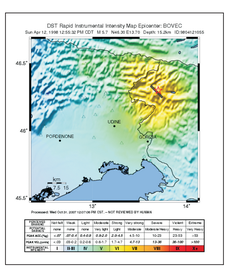




UP
Red diamons: 28 used recording seismic stations;
Tomographic grid in green

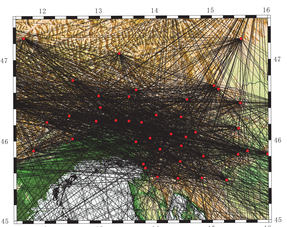
LEFT
The Friuli Venezia Giulia Italian region and the western Slovenia are very peculiar from the tomographic point of view, due to the large lateral variation of velocity and Vp/Vs ratio, that is related to the high level of fracturing and on the east, to the inhomogeneity of the medium. In this work (Gentili and Gentile, 2013) we make for the first time the attenuation tomography of Friuli Venezia Giulia Italian region and western Slovenia.

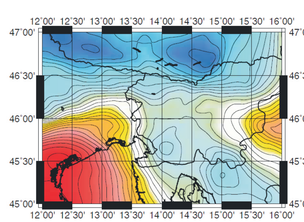
ShakeMaps



in the framework of the INGV-DPC projects: OGS and UniTS implemented the ShakeMap (Wald et. Al, 2009; Moratto et al, 2008) in southeasthern Alps. In the figure the example of Intensity synthetic map used to calibrartion with the transfrontier network data.

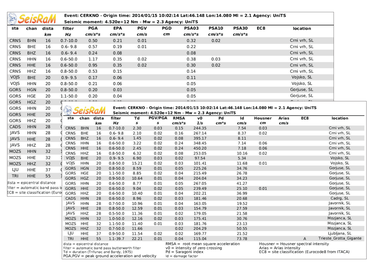
Seismic noise tomography





Above the data (CE3RN plus few more stations outside the network limit) coverage in Sotheastern Alps. The data are used by ICTP (Guidarelli M., Aoudia K. personal comunication) in the framework of a collaboration with UniTS for the noise tomography of the area. Right an example of a group velocity map.

Automatic near-real-time strong motion data analysis for Civil Protection purposes



Example of the ground motion parameters table contained in the near real-time report implemented at University of Trieste, using CE3RN data, and, on the right, an example of the corrsponding Housner map.

REFERENCES

- Gallo, A., Costa, G., and Suhadolc, P.: Near Real-Time Automatic Moment Magnitude Estimation, Bull. Earthq. Eng., 12, 185-202, doi:10.1007/s10518-013-9565-x, 2014.
- Gentili, S., and Gentile, G.F.: Attenuation tomography of Friuli Venezia Giulia Italian region, XXXII GNGTS, Trieste, Italy, 19-21 November 2013, 2013.
- Moratto, L., Suhadolc, P., and Costa, G.: ShakeMaps for three relevant earthquakes in the Southeastern Alps: Comparison between instrumental and observed intensities, Tectonophysics, 509, 93-106, 2011.
- Pesaresi, D., Lenhardt, W., Rauch, M., Živčic, M., Steiner, R., Fabris, P., and Bertoni, M.: The Interreg IV Italia-Austria "SeismoSAT" Project: connecting Seismic Data Centers via satellite, EGU General Assembly 2013, Vienna, Austria, 7-12 April 2013, 2013.
- Satriano, C., Elia, L., Martino, C., Lancieri, M., Zollo, A., and Iannaccone, G.: PRESTo, the earthquake early warning system for Southern Italy: concepts, capabilities and future perspectives, Soil Dyn. Earthq. Eng., 31(2), 137–153, 2010.
- Wald, D. J., Quitoriano, V., Heaton, T. H., Kanamori, H., Scrivner, C. W., and Worden C. B.: TriNet "ShakeMaps": Rapid generation of peak ground motion and intensity maps for earthquakes in southern California, Earthq. Spectra, 15, 537-555, 1999.