SEISMIC NETWORK OF THE REPUBLIC OF SLOVENIA

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Introduction

ARSO was established on 27 April 2001 in the framework of the reorganization of the Ministry for Environment, Spatial Planning and Energy, by merging former Hydrometeorological Institute of Slovenia, Slovenian Nature Protection Authority, and Geophysical Survey of Slovenia. It consists of the Environmental Office, Meteorological Office, Seismology Office, Monitoring Office and Office of General and Financial Affairs.

The Seismology Office carries out monitoring and recording of geological, seismological, and other geophysical phenomena, their categorization and zonation; earthquake protection of buildings, protection and early warning against earthquake phenomena. Its main tasks are routine data analysis, informing public and the authorities in case of the felt earthquake, international data exchange, seismic hazard studies, research projects in seismology, modernization of Slovenian seismological network, ...),

Presently the Seismology Office staff includes 3 Ph.D., 5 M.Sc. and 9 B.Sc. out of 23 employed.

SNRS (Seismic Network of the Republic of Slovenia)

After the M=5.8 earthquake on 12 April 1998 the Seismology Office started to build a new national network. At present (September 2004) it operates a network of 21 permanent seismological stations. All are broadband stations sending data in real time to the SNRS data centre at Seismology Office in Ljubljana (continuous (19) or event data (2)). The standard equipment of stations that are sending continuous data consists of Quanterra Q730 datalogger and Guralp CMG-40T seismometer, five of them have also Episensor accelerometer (Tab.1). Four stations are borehole installations. Sampling rates are 200sps, 20sps and 1sps. There is approx. 90 min data buffer at each site. Real time data transfer is done using Antelope software package. The data is daily archived on DLT tapes. At the end of the project of the modernization of the Seismic Network of the Republic of Slovenia (end of 2005), it will consist of 25 broadband stations (Fig.1). The Seismology Office also has a few portable stations and a small network of 8 digital strong motion instruments.

Seismology Office regularly contributes parametre and waveform data to the international seismological data centres. We are sending automatic detections to EMSC, our weekly bulletins to neighboring countries, NEIC and EMSC, and final monthly bulletins to ISC.

(Near) real-time data transfer

At the data centre, we are receiving the data in real time from the selected stations from ZAMG, Austria, the Department of Earth Sciences of the Trieste University (DST) and from the National Institute of Oceanography and Experimental Geophysics (OGS) from Trieste (Fig.2). Using orb2orb connections we receive the data from the DST broadband network, as well as from OGS broadband and short period networks. We also installed guralp2orb process that collects data from several stations in Croatia. This data exchange is the result of the activities within EC MEREDIAN project and the waveforms are regularly forwarded to the ORFEUS data centre. Some of the SNRS stations are part of the European VEBSN.

Tab.1: Seismic stations and instrumentation

Code	Latitude (N)	Longitude (E)	Elev. (m)	Station type (1)	Sensor type (2)	Recording equipment (3)	Data Transfer (4)	Instalation (5)
BISS	46.6479	15.1270	490	3C BB	CMG-40T	RD3-1605	event leased lines	Vault 2m
BOJS	45.5042	15.2519	252	6C BB	CMG-40T (STS-2) Episensor	Q730	RT leased lines	Vault 4m
CADS	46.2263	13.7329	700	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
CESS	45.9732	15.4632	372	3C BB	CMG-40T	HRD24-2432	event leased lines	Surface pier
CEY	45.7381	14.4221	579	3C BB	CMG-40T (STS-2)	Q730	RT leased lines	Surface pier
CRES	45.826	15.4569	431	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
DOBS	46.1024	14.7016	518	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
GCIS	45.8631	15.6093		3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
GOLS	46.0113	15.6239	550	3C BB	CMG-40T/PH	Q730	RT leased lines	Borehole 17m
GORS	46.317	13.3995	1086	6C BB	CMG-40T, Episnsor	Q730	RT leased lines	Vault 4m
GROS	46.4608	15.5017	930	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
JAVS	45.8931	15.0643	1120	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
KNDS	45.5276	14.3775	1010	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
KOGS	46.4481	16.2503	296	6C BB	CMG-40T, Episnsor	Q730	RT leased lines	Vault 4m
LEGS	45.9485	15.3177	391	3C BB	CMG-40T/PH	Q730	RT leased lines	Borehole 15m
LJU	46.0438	14.5278	396	6C BB	CMG-40T, STS-2, Episnsor	Q730	RT leased lines	Cellar 2m
PDKS	46.0791	14.9976	705	3C BB	CMG-40T/PH	Q730	RT leased lines	Borehole 16m
PERS	46.6365	15.1139	795	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
ROBS	46.2450	13.5103	280	3C BB	CMG-40T	Q730	RT leased lines	Cave 2m
VISS	45.8029	14.8383	421	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m
VOJS	46.0317	13.8883	1073	3C BB	CMG-40T	Q730	RT leased lines	Vault 4m

Fig.1: Seismic Network of the Republic of Slovenia (SNRS)

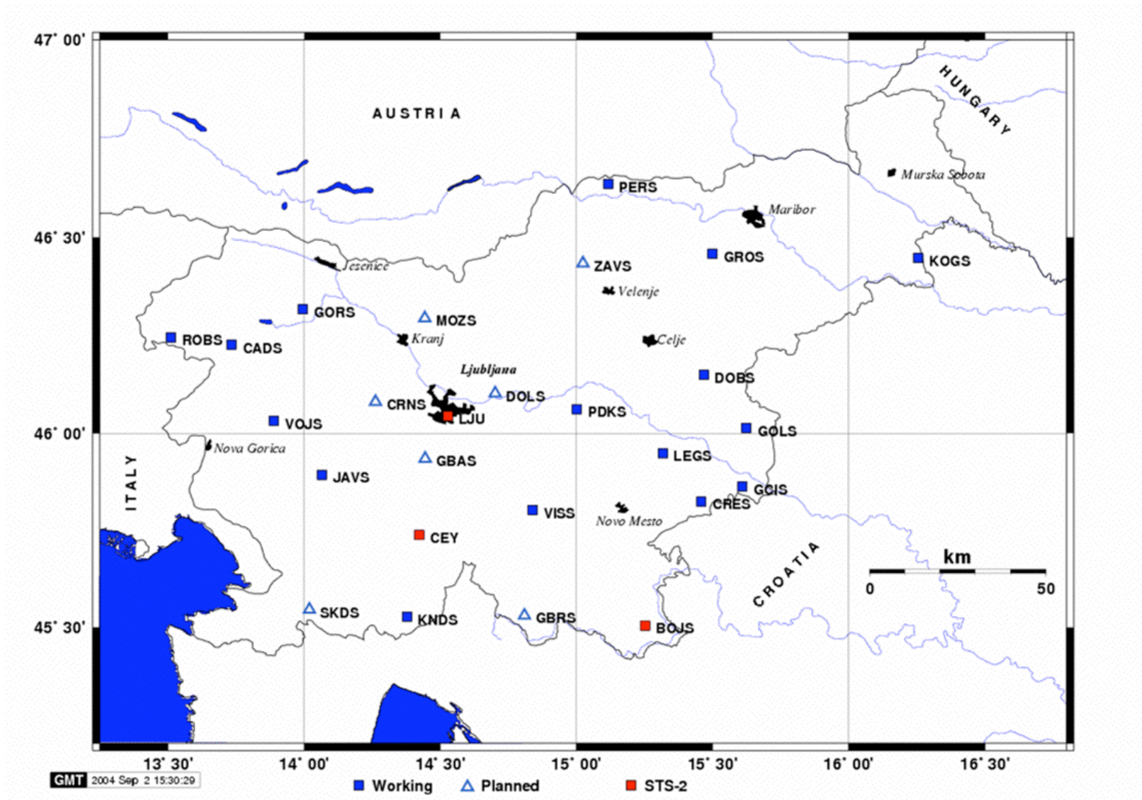
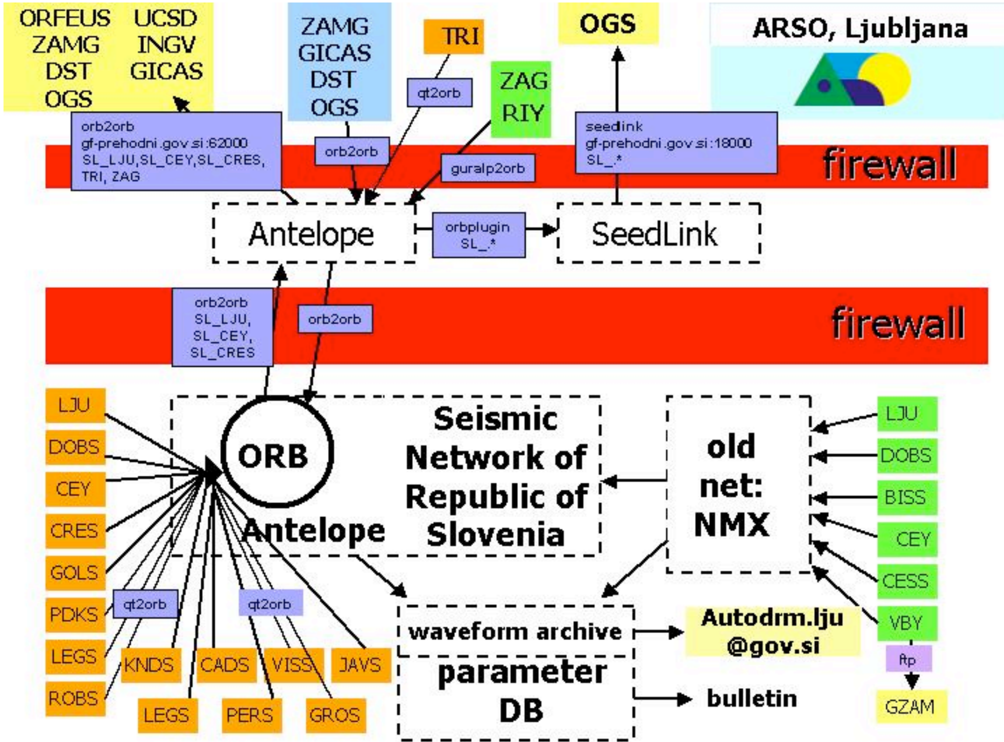


Fig.2: Schematic representation of data acquisition and data exchange at SNRS data centre.



Data analysis, storage, archiving and availability

Collected data are daily analysed with Antelope software package. For detailed analysis of teleseismic events we also use Seismic Handler. The waveform data are stored in the Antelope database and available through autodrm service (autodrm.lju@gov.si). The parametric data are stored localy in the seisan database (from the year 1996). Our final monthly bulletins are also available in the ISC database.

Our plan in future is to organize a unified database for parametric data, where we will also include earlier data (before year 1996), as well as macroseismic and instrumentation data. The environment is not clearly defined yet.

Seismology Office maintains the macroseismic archive, where questionnaires, as well as other data sources for Slovene earthquakes are kept. The network of permanent observers is activated after an earthquake is felt on Slovenian territory, and the questionnaires are sent. There are more than 5900 people involved in this activity (pop. of Slovenia is approx. 2 000 000).

Specific needs and long-term vision

Depending on the available funds, ARSO, Seismology Office plans to complete building and installing the 25 stations Seismic Network of the Republic of Slovenia in 2005. For the financial reasons, low quality and narrower band Guralp CMG-40T seismometers were originally purchased. In 2004 three Streckeisen STS-2 seismometers were bought and will be installed by the end of the year. Our goal is to find funds and to gradually introduce more STS-2 seismometers and thus significantly increase the quality and dynamic range of the recorded data. This improvement will enable the use of the data for research purposes as well.

For six stations, mobile phone connections are used for the data transfer to the data center. The lines are very unreliable and there is a significant fraction of the data received with latencies exceeding 1 hour, as well as considerable data loss. These lines should be replaced with more reliable ones and, as a first remedy, local data storage introduced. To ensure data availability also

in case of strong earthquake it is mandatory to have redundant communication means, e.g. radio links or satellite communications.
Using the existing infrastructure that was built for analogue stations we plan to establish several regional data centres that will act as data buffers in case of larger failure on the communication lines to the SNRS data center.
Strong motion network is still rather sparse and the stations are haphazardly located in unsuitable environment. It is planned to seek funds and to build a new national strong motion network in the period 2006 – 2010.