Cooperation between The Albanian Seismic Network and the University of Bergen.

Report # 1

Albania seismologcal network, how it works and some recomandations for improvement

September 2019

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The Albanian network has 8 BB stations and 16 strong motions stations. The BB stations are sending data via VSAT communication (at least 4 of them actually) and radio link communication using internet (local provider). Some of the waveform data is received via SeedLink as well, especially from the Montenegrin Seismic Network, Aristotle University of Thessaloniki seismic network (AUTH), the Italian Institute of Geophysics and Vulcanology (INGV), the Euro-Mediterranean Seismic Network (MEDNET) and some stations from AFAD (Turkey). Other data comes through internaqs pluggin as part of the Nanometrics system. These variouse way transmitted waveform data arrive to the central data recording systems Apollo Server and Scream data Server, operating in real time. All channels, also acceleration, go into both SeisComp3 and Apollo and backup on a different computers is made of the continuous data from both systems.

Processing is dual:

Automatic: through SeisComP3 which gives the alarm that an event has occurred. The automatic solution is not very accurate. It is used as a preliminary solution for the alert issue and within 5 min a manual solution, which in general is imediately very acurate, can be made.

Manual: Once an event occurs, data is extracted from the Nanometrics system Apollo and put into Nanometrics Atlas manual and processing done to determine location and magnitude. Mail is sent out automatically.

Post processing for some events involves Seisan, especially for the determination of focal mechanism and spectral analysis.

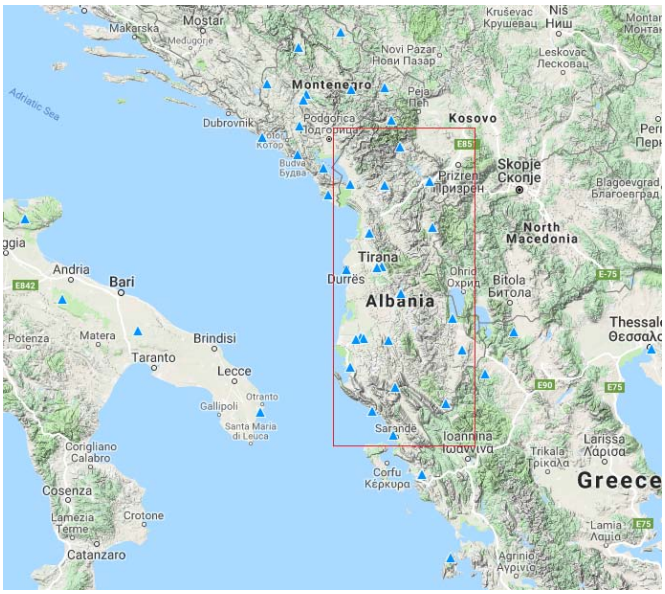

Figure 1. The Apollo Suite seismic stations used by Albanian Seismic Network (the physical network is within the red rectangle)

The manual processing consists of picking phases, locating with Hypoinverse2000 (under Atlas) and Hypocenter in Seisan. Magnitudes of type ML and Md are calculated (manually or automatically). The location model is a local 1D vertical gradient model developed locally and the magnitude scales are those as applied in Hypoinverse 2000, the Richter magnitude scale, and the local parametric scales calibrated by Muço & Minga both for ML and Md.

Source mechanisms are determined from polarities mainly using the Seisan programs (Focmec, Hash, mainly).

Teleseismic data is only processed in special cases.

All processed data are stored in a local data base under Apollo.

The strong motion network consists of 16 stations connected in real time. The data is stored in GCF format.

Strong motion data and BB data are integrated through Seiscomp. These data is used only for some of the stations which has functional GPS time information. Some of them don't have it due to the GPS burning. This is a characteristic of Guralp accelerometer.

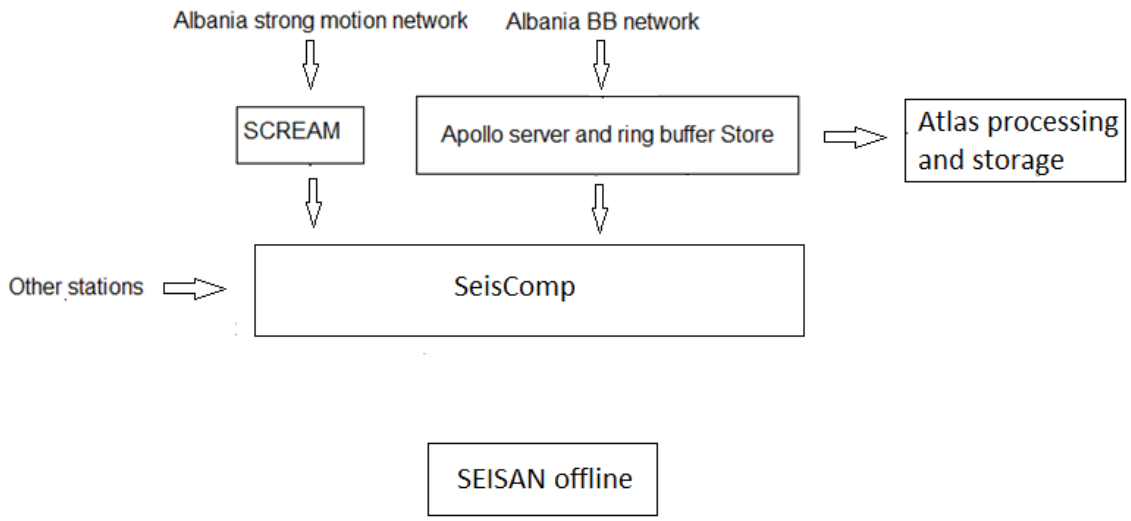

Figure 2 Current Albanian seismic network data streams.

Data

Readings

Bulletins in Hypoinverse output format is available back to 2014. Before 2014 and until 2010, there are various formats from the bulletins available in electronic format. Before 2010, phase data and locations can be taken from ISC since data always has been sent to ISC. Reading can also be extracted for individual events from the Atlas system

Digital data

Since the installation in 2010, all event files have been saved in both y-format and miniseed format. Before 2010, some data is available from GBV recorders for some selected events. Before that only analog bulletins and analog seismograms are available. Most seismograms back to the installation of the first seismic station in 1968 are preserved.

Continuous data is saved from 2006 until now in Nanometrics-X-private format. In 2018, after the improvements in the system, it is gradually passed from NaqsServer to its new and upgraded version named ApolloServer, in which ring buffer memory system, data is archived in miniseed format. Since late 2015, continuous data also started to be saved in miniseed ring buffer, in SeedLink.

Obviously, there is no one place where all data is available due to the different formats and different ways of storing the data. For more detailed processing it is also time consuming to transfer the data to SEISAN for further processing.

Recommendation for a new organization of the data and processing

SEISAN was installed on an independent Linux computer. The continuous data in the Seiscomp system is then directly accessible to SEISAN, either from a future disk storage or, as now, from the ring buffer in the Seiscomp system. When an event occurs, the MULPLT program in SEISAN can inspect the data and directly export it to the SEISAN data base from which it can be located immediately. All relevant data, including strong motion and external network data, for the event, is then in the SEISAN data base ready for other analysis like fault plane solutions and all the channels available in Seiscomp can be used. The next step is to install the SC2SEI software that automatically transfer the data from Seiscomp to SEISAN. SEISAN also has a command for sending a processed event to EMSC by mail and ISC also accepts data in SEISAN (Nordic format) so no reformatting is needed.

The strong motion data is processed in Guralp requiring GCF format. In the future it would be simpler to use a public domain software that accepts data in miniseed format or similar and access the data directly from the SEISAN database.

Currently Albanian data entering the Sesicomp system must pass through NaqsServer and SCREAM. This is an unnecessary complication for a future system which will lock the network into a particular manufacturer without any advantages. In the future all data should go directly from the field station to the Seiscomp system and a whole unnecessary and complicating layer can be eliminated. Both Guralp and Nanometrics now sell stations sending out miniseed directly so if a future replacement of Guralp and Nanometrics equipment is desired, it should be bought with this option. However, by eliminating NAQS and SCREAM, other manufactures can also provide equipment and the network becomes independent of particular manufactures.

The current data processing and storage rely on too little and too weak equipment. There should be a more powerful Linux computer for the processing and a disk system which automatically backs up all continuous data from the Seiscomp system. This can be done simply with slarchive program. The system size should be large enough to hold continuous data for a few years from all channels used in the daily processing. Currently the backup is done manually and there is no easy ways for a user to access a time period of data.

In order for this data base to be useful for future research, it is also recommended to restore as much as possible of the old data. SEISAN has many research type programs which then can be used directly.

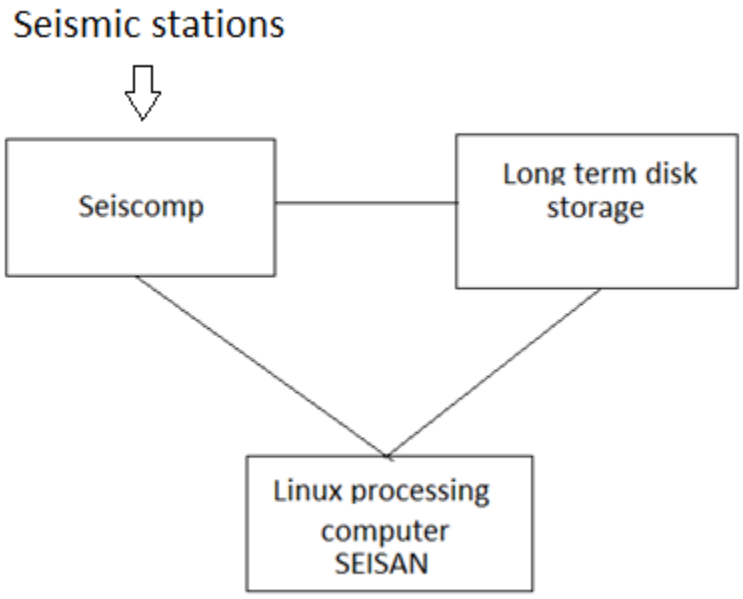

Figure 3 Recommended setup of recording and data processing. Currently SEISAN reads the continuous data for the ring buffer on the Seiscomp system but in the future it should read from the disk storage. The seismic stations enter Seiscomp directly without any need for other software.

Restoring old data to the SEISAN data base

This process consists of first recovering old bulletins, converting them to Nordic format and then recovering the corresponding waveform files. The waveform file names must then be put into the S-files which can be done in the following way:

-put one month of s-files in a local directory in a local directory

-put all waveform files in same directory

-autoreg waveform files in same directory to create corresponding s-files

-merge s-files within a given time interval, either automatically with associ or manually through EEV. The automatic merging has the disadvantage of getting the headers from the wav-sfiles as first header so the hypocenter is not seen. So a better way with more control is to use EEV. To find next two events near in time, use EEV command s.

-check each event that it can located with a reasonable location (location and magnitude should not be too different form the original location), there might be some errors when converting from the bulletins

to Nordic format. These errors must be corrected manually. It would also be useful to plot all the epicenters for the month. Finally check that calibration files are available and correct. Plot data.

-once all merged and checked, put wav files in wav structure and s-files in REA data base (use collect and split).

Making multichannel waveform files

If e.g. trace-files for single channels are available in miniseed format they can be merged to multi channel event files:

-make a dirf of the trace-type files

-rewrite the trace-type files to get file names starting with yyyy-mm…, use program seisei or wavetool, output format miniseed. This step is needed since, in order to generate a chronological list of files with dirf, the file names must start with yyyy-mm…

-make a dirf of the new files

-combine channels to event files with seisei, use TIR as agency name

NOTE: some trace-type files are more than 2h long due to gaps in the files and they cannot be used unless they are manually cut, a lot of work. An alternative is using y-files. For older data there might be other formats to consider.

Restoring old continuous data to the new data server

All old continuous data should be put into a new data server in Seiscomp format. This can be done with program dataselect.