Bundesanstalt für Geowissenschaften und Rohstoffe

BGR

GEOZENTRUM HANNOVER

ALISE - An Alert and Information System for Earthquakes in Germany

Overview

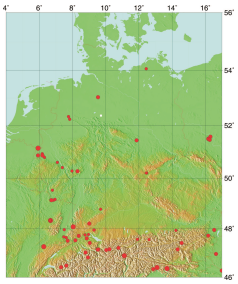
ALISE is a newly developed earthquake alert and information system for Germany that consists of the following main components:

- A seismometer network of selected stations of the German Regional Seismic Network (GRSN) and two additional new stations.
- A communication system based on the CD1.0 protocol that enables near real-time transmission of waveform data from the seismometer stations to the central recording and processing system.
- Newly developed processing software for rapid and reliable event parameter determination.
- A tool for distributing alert messages via SMS and e-mail and to display the results automatically on the Web.
- An interface to a newly developed map server that provides detailed information on the epicenter region and the potential damage.

Until today, two new seismic stations have been built northeast of Hannover and in central Germany close to Bad Hersfeld. The CD1.0 communication protocol ensures immediate access to the most recent data at any time, even after a accommunication link was disrupted.

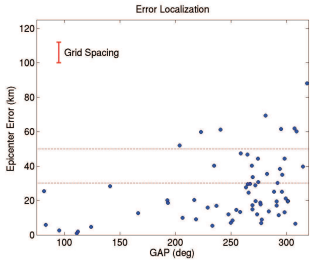
Data processing for the determination of seismic source parameters is the most important element of the alert system. The software makes use of improved procedures for seismic phase identification and phase association. Moreover, several consistency checks are included. The application of these automatic methods provides reliable estimate of the source parameters.

Earthquake Test Data



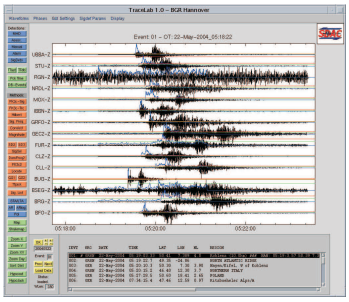
The magnitudes of selected events to test the performance of the alert system are ML>3.5 in Germany and ML> 4.0 outside.

Initial Location Error



Error of initial localization obtained for the test data set as a function of the gap. For events covered by the network with a gap < 180 deg the location difference is less than 30 km.

Graphic User Interface

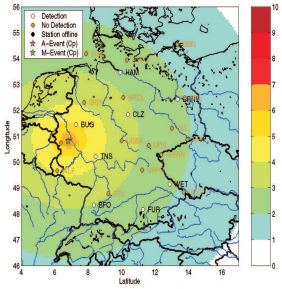


A graphic user interface was developed for testing the algorithms of the automatic data processing. This tool is perfectly suited for processing both, near real time data and files with selected data sets of earthquakes with well known source parameters.
The GUI acts as a front-end of the continuous detection process.

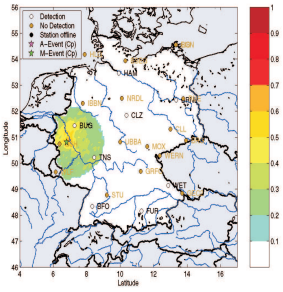
Impact Quantification

To quantify the impact of an earthquake in Germany the instrumental intensity (after MSK) is determined from the source parameters.
Additionally, an estimate of the vulnerability is provided. This calculation takes the population density into account. The corresponding results for a fictitious magnitude 6.0 earthquake south west of Cologne are shown on the right..

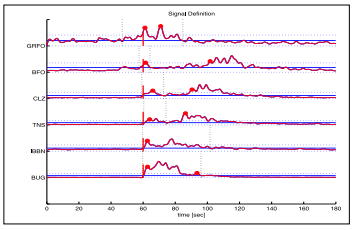
Instrumental Intensity



Vulnerability

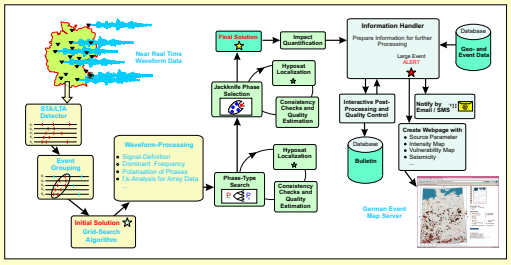


Signal Definition



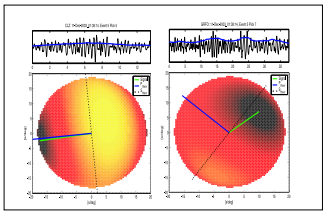
Smoothed envelopes of seismograms are used to define the signal windows. These are needed by the waveform algorithms that compute varius signal parameters such as dominant frequency, polarization etc.

Workflow



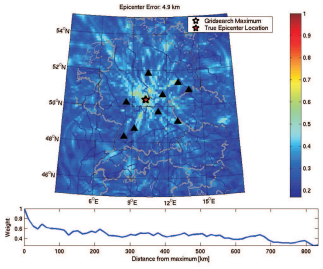
After determination of the final epicenter location and estimation of the earthquake's impact, the results are distributed via SMS and email and displayed on the Web together with additional statistical and geological information provided by the map server.

Polarization Analysis



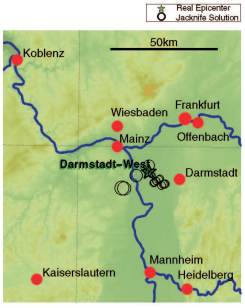
Three component polarization analysis is applied to the seismic signals to determine the back azimuth. The quality of the results depends on the signal to noise ratio and on the geological conditions below the seismometer site. Results of polarization analysis are shown in the two figures above with a P-phase on the left and S-phase on the right side, respectively.

Multiphase Gridsearch



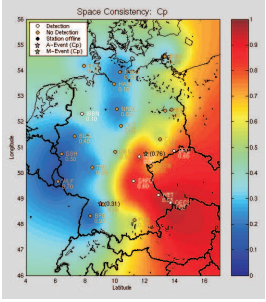
A multiphase-gridsearch algorithm was developed to calculate a stable initial epicenter location which is required for subsequent signal analysis. The figure shows the computed fit between the phases an the corresponding grid points for an event in central Germany. The diagram below shows the fit as a function of distance from the epicenter.

Jackknife Analysis



Phases which bias the localization are determined and removed. This is done by a Jackknife method which performs localizations with a subset of all phases. From the change of the localization error the (good or bad) influence of the omitted phases is deduced. Finally, a set of good hypocenter solutions remain, shown in the figure by black rings whose diameters resemble the spatial error of the solution.

Consistency Checks



Consistency checks are used to assess the quality of the epicenter determination. The result of the spatial consistency is shown on the left. A numerical algorithm is used to calculate the consistency value Cp. This value quantifies the probability whether the epicenter location matches the distribution of stations contributing phases. Results of the automatic data processing with epicenter locations in the blue area are rejected.