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INTEGRATION OF CATALOGUES OF HISTORICAL AND INSTRUMENTALLY RECORDED EARTHQUAKES IN GERMANY IN A COMMON DATABASE – CONCEPTS, USES, AND PRODUCTS

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Introduction

The systematic and complete compilation of earthquake parameters forms the basis for the evaluation of the observed seismicity, e.g. for the publication of seismological bulletins and for seismic hazard analysis. In many seismological institutions databases of instrumentally recorded earthquakes exist whereas historical events are documented in simple textual lists only. Also the Federal Institute for Geosciences and Natural Resources (BGR) maintained the data separately in the past. An approach is outlined to integrate the (historical) earthquake catalogue for Germany for the years 800-2008 with about 12000 events of magnitude ML ≥ 2.0 (Leydecker, 2011; see Figure 1) and the "Data Catalogue of Earthquakes in Germany and Adjacent Areas" with currently approximately 21000 instrumentally analysed earthquakes since 1975 (BGR, 2014) into a common database. The concepts that have to be considered in this process, the different uses of the catalogue, and the resulting products are discussed here.

Concepts and uses

The use cases (the essential applications), and the corresponding concepts (the requirements of the data model and the requirements of the functionality of the application to utilize the database) are determined and compiled in Table 1.

Products

The most important products that will be generated from the new common database are:

- Complete catalogue and catalogue excerpts in various formats (e.g. CSV, XML)
- List of misinterpreted events (so called "fakes")
- Catalogue of investigated historical earthquakes with evaluation of the historical sources
- Bibliographies for each historical earthquake with associated scheme of relationships among the references (publications and documentary sources)
- Epicenter maps
- Catalogue with homogeneous magnitude values
- Macroseismic intensity maps and focal depths
- Web portal earthquake information system

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Table 1. Use cases and corresponding concepts of the common database of historical and instrumentally recorded earthquakes

Use Cases The concepts presented extend the application spectrum of the database:	**Concepts** To meet the demands of both instrumental seismology and historical earthquake research utilizing the common database, some requirements in terms of data model and functionality have to be met:
A. Requirements for the database structure (data model)	
Reconstruction of modifications of the earthquake catalogue.	Tracking of modifications of updated records with indication of the reason for change.
Documentation of erroneously inserted events in the catalogue (fakes / misinterpretations).	Labelling and persistent storage of erroneously inserted events.
Compilation and evaluation of macroseismic information.	Storing of intensity data points with information on time, location, isoseismal radii and earthquake effects.
Construction, flexible extension, and retrieval of the scheme of relationships among the references for an event.	Storing of references (publications and historical documentary sources) and of the link to an event, as well as storage of the dependencies between references.
Defining the priority for epicentre, magnitude and intensity of an event with the possibility to combine information from various reporting institutions.	Flexible prioritization of epicentres, magnitudes and intensities.
B. Required functionality	
Integration of earthquake catalogues from national and international seismological services.	Automatic synchronization with catalogues from other institutions based on the location and time difference of the epicentres.

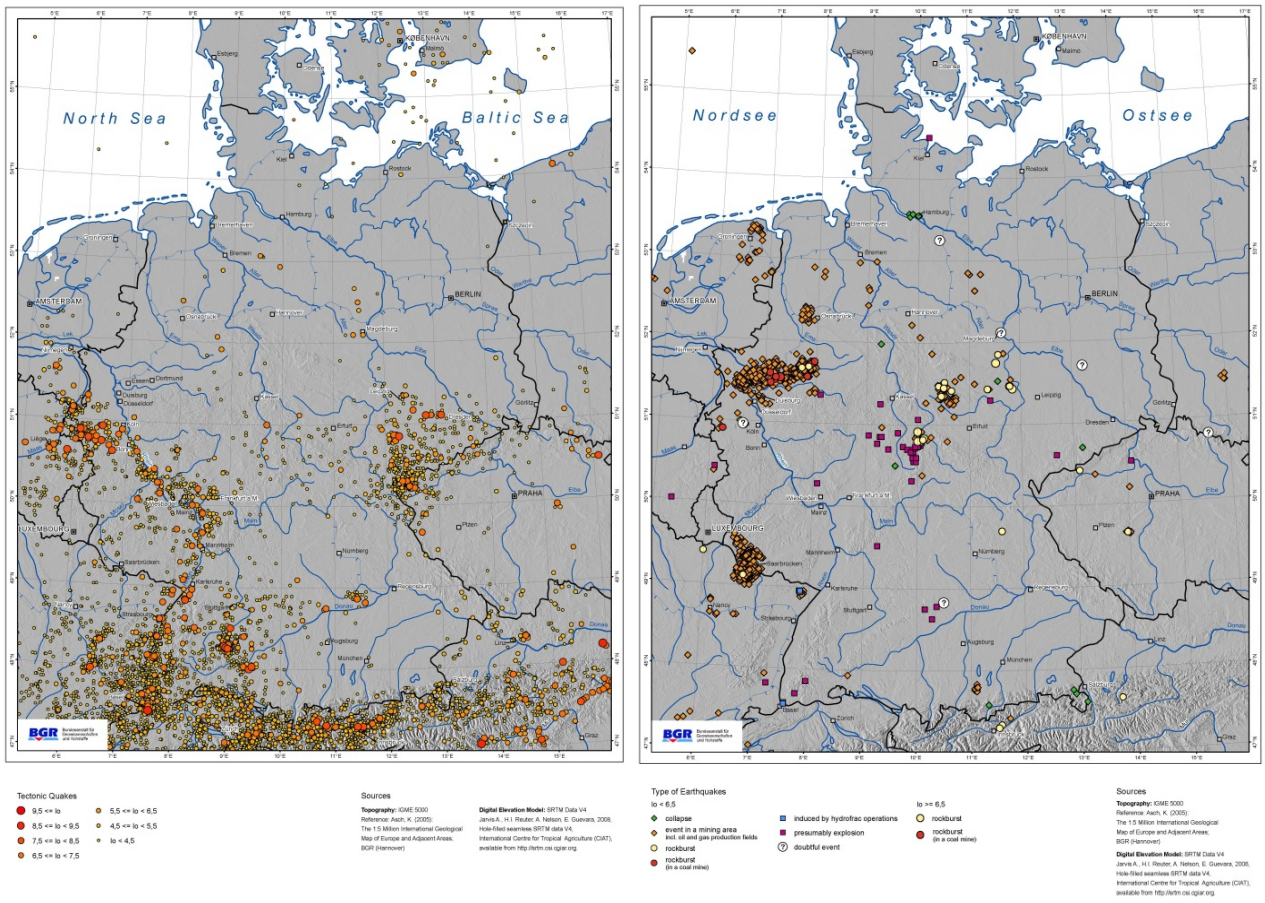

Figure 1. Tectonic earthquakes (left) and non-tectonic and doubtful events (right) in Germany for the years 800 – 2008. Data from Leydecker (2011).

Implementation

To implement the required concepts, changes of the data model of the existing database are necessary:

New tables are created for the storage of the macroseismic information of the event such as macroseismic intensity points, isoseismal radii, the observed effects and the macroseismic analysis of the event.

The so-called literature genealogy table stores the information on the dependency between two references, i.e. it links a reference to its source reference, and is itself connected to the event via an intermediate table. This simple table set allows the build-up and flexible extension of the scheme of relationships among the references.

All modifications to the events are stored in separate tables with the name of the changed table, the key fields of the record, the name of the person in charge, the time of the change, the mode of the change (e.g. update, insert, delete), and the field name with the old and new values of the changed fields.

The flexible prioritization of epicenter, magnitude and intensity is realized by inserting a table which stores the event number and the preferred combination of the source institution of each parameter.

Labeling of erroneously inserted events is enabled by simply adding the new event type 'rejected/fake' to the event type list.

To implement the necessary functionality to use the new data base, a web application is developed. It allows the user to query events based on attribute or spatial criteria, to export the selection or the catalogue as a whole, to plot the results of the query on a map, to edit single events with automatic logging of the changes, and to import and merge catalogues from other institutions.

Conclusions

1. Considering basic concepts, databases for instrumentally recorded earthquakes can be extended to include the information from historical earthquake research.
2. In this way an efficient and combined instrumental and macroseismic analysis is possible.
3. Utilization of the catalogue is efficient and inconsistencies are minimized.
4. Including the schemes of relationships among the references and sources in the database offers the potential for new enquiries and efficient evaluations of historical earthquakes.

REFERENCES

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