# AN EARTHQUAKE CATALOGUE FOR GERMANY AND ADJACENT AREAS CONSIDERING ENGINEERING DEMANDS


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## 1 Motivation

Currently, various earthquake catalogues are available for the seismic areas of Germany and adjacent countries. Due to obvious discrepancies concerning relevant parameters, the extent of published data and the covered time window, it was decided to create a new, revised earthquake catalogue. Different techniques for data comparison and data management were developed and applied for elaborating the final version.

The basic data are provided by a magnitude $M_L$ - based catalogue, unpublished to date, by L. Ahorner [1], which was developed and maintained over several decades of seismo-engineering and instrumental practice. Recently published reinterpretations of historical earthquakes are included. Fake events and inconsistencies between the catalogues are identified by comparing the original datasets. For a large number of relevant events with intensities $I \geq 5.0$, referenced sources were investigated, leading to the interesting conclusion that over the generation of catalogues the responsible authors have contributed to significant confusion of reported facts and assigned parameters. This is particularly true for macroseismic intensity, epicentral coordinates and source depths. To make the final catalogue entries more transparent, the basic, decision-supporting information will be summarized and published within a series of papers.

Working in this field it becomes clear that more information on earthquakes is available than a catalogue of the common type could preserve. Therefore the catalogue is arranged as a database system and linked to a Geographic Information System (GIS). In ongoing works the prerequisites are provided to include damage cases (pictures, floor plans e.g.), macroseismic as well as shake maps and strong motion recordings. In the final stage of the intended work, catalogue entries are prepared as one module of an extended tool for risk assessment tasks, including the evaluation of regional predominant building types. The earthquake catalogue will be maintained by the Earthquake Damage Analysis Centre (EDAC) at Bauhaus-Universität Weimar.

Phases:

- Phase 1: elaboration of the earthquake catalogue (first draft of EKDAG) → section 4
- Phase 2: internet publication and provision of relevant data → section 5

## 2 Concept

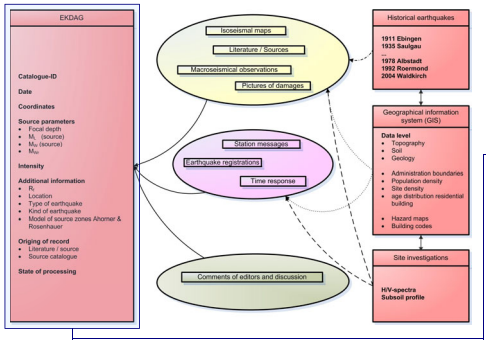



*Fig. 1 Different requirements to the earthquake catalogue*

## 3 Data basis


*Fig. 2 Different source catalogues for the new earthquake catalogue*

The catalogue EKDAG is based on the following catalogues:

- Ahorner (1996) [1],
- Grünthal, Wahlström (2003) [2],
- Leydecker (2004) [3] and
- Leydecker (2005) [4].

The catalogue EKDAG incorporates (s. 4.):

- Investigations and new reinterpretations of earthquakes from the authors and
- Identification of problematic contradictions.

The advantages of a data base are:

- Easy identification of problematic cases,
- Comparison among each other of data base tables,
- Assignment of data sets – information of basic data set is available,
- Access to the data base with different tools,
- Platform independence (Windows, Linux, ...) and
- Easy access via web.

## 4 Procedure of application (Phase 1)

### 4.1 Compilation of data sets

→ s. ***Fig. 2*** (section 3)

### 4.2 Comparison of entries

***Table 1*** *Comparison of parameters between different earthquake catalogues [5]*

| | *Earthquake catalogue [1]* | *Earthquake catalogue [2]* | *Earthquake catalogue [3]* | *Reinterpretation [5]* |
|---|---|---|---|---|
| Date | 4.8.1940 16h58m | Not included | 4.8.1940 16h58m | |
| Coordinates | UTMx = 534.3 *km* | | Rastatt E 9°28' | E 9.38° |
| | UTMx = 5398.2 *km* | | EW N 48°44' | N 48.79° |
| Seismotect. zone | | | | |
| Focal depth | $h_o$ = 5 *km* | | $h_o$ = 5 *km* | $h_o$ = 11 *km* |
| Magnitude | $M_L$ = 3.7 | | $M_L$ = 3.8 | $M_{Mnk}$ = 3.4<br>$M_{SWA}$ = 3.8<br>$M_{Mom}$ = 4.1 ± 0.2 |
| Intensity | $I_o$ = 5.5 | | $I_o$ = 5.5 | $I_o$ = 5.0 (EMS-98)<br>$I_{o,hyp}$ = 5.5 |
| Radius of perceptibility | $R_i$ = 45 *km* | | $R_i$ = 45 *km* | $R_i$ = 50 *km* |
| Source | | | SG1 | [5] |

### 4.3 Identification of differences

***Table 2*** *Diversity of requirements to the earthquake catalogue [3], [6], [7]*

| *Categories* | | | *example* |
|---|---|---|---|
| 1. | **Data form** | Date and time (24 h, 60 min, 60 s, month> 12, ...) | Data sets with equal date and time can be duplicate. |
| 2. | **Different values** | Coordinates, intensity, magnitude, radius of perceptibility, ... | Wunsiedel 9.1.1862<br>$I_{o,Spon} = IV \Leftrightarrow I_{o,Ley04} = V$ |
| 3. | **Reevaluation** | Reinterpretation of data set available | Schurwald (Göppingen) 4.8.1940<br>$I_{o,EKDAG} = V \Leftrightarrow I_{o,Ley04} = V - VI$ |

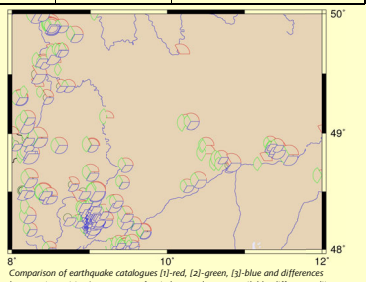



*Fig. 3 Comparison of earthquake catalogues [1]-red, [2]-green, [3]-blue and differences between intensities (no segment of a circle = no data set available, different radii = different values of intensity): a preliminary attempt to identify differences considering a grid of elements*

### 4.4 Reinterpretation and final statement

***Table 3*** *contents of a questionnaire with the maximum observed shaking effects of the earthquake on 4th August 1940 [5]*

| *Location* | *Strümpfelbach (Weinstadt)* |
|---|---|
| **Date and time** | 04.08.1940 18:50 |
| **Location observer** | *Im 1. Stock des Schulhauses in Strümpfelbach in einem Klassenzimmer.* |
| **Location soil** | *Fels* |
| **Movement** | *Von unten - kurzer heftiger Ruck.* |
| **Shaking effects** | *Klirren der Fensterscheiben, Krachen der Wände, Abbröckeln des Verputzes; sonstige Gebäudebeschädigungen wurden nicht bemerkt, doch war der Stoß so heftig, dass der Beobachter sich ins Freie begab.* |
| **Number observers** | *nicht bekannt* |
| **Notice questionnaire** | 5-(6) |
| **List** | 5.5 |
| **Reinterpretation** | V |

*c) Intensity attenuation*

*b) Generated macroseismic map*

*a) Macroseismic shaking map*

*Fig. 4 Further information about the earthquake near Goeppingen on 4th August 1940 [5]*

## 5 Engineering demands and selected aspects

### 5.1 Seismic hazard assessment

The whole earthquake catalogue consists recently of 16721 earthquake data. Specific applications in Deterministic or Probabilistic Seismic Hazard Assessment require a selection of data sets from the catalogue. Therefore depending to a particular engineering demand the catalogue has to be adjusted.

**a) Deterministic Seismic Hazard Assessment (DSHA)**


**b) Probabilistic Seismic Hazard Assessment (PSHA)**

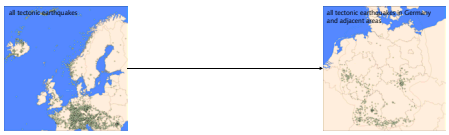



*Fig. 5 Different versions of the catalogue due to the requirements to the earthquake catalogue [6], [8]*

### 5.2 Site specific information (GIS layers)

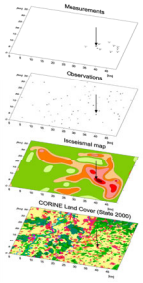



*Fig. 6 Identification of a study point [9] using data from [10], [11]*

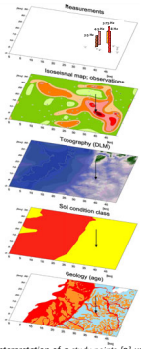



*Fig. 7 Interpretation of a study points [9] using data from [10], [12], [13], [14]*

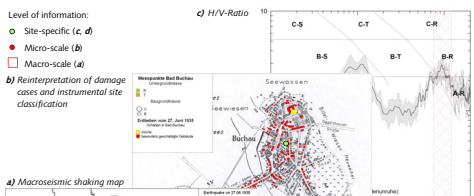
### 5.3 Elaboration of relevant information

Level of information:

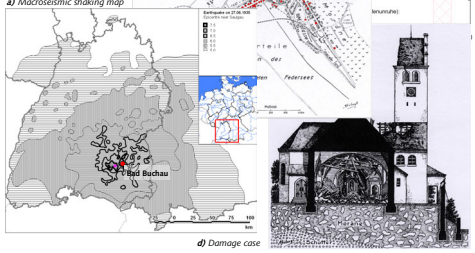
- Site-specific (***c***, ***d***)
- Micro-scale (***b***)
- Macro-scale (***a***)

***b)*** *Reinterpretation of damage cases and instrumental site classification*

***c)*** *H/V-Ratio*




***a)*** *Macroseismic shaking map*




***d)*** *Damage case*

*Fig. 8 Macroseismic shaking map of the earthquake (star = epicentre) on 27th June 1935 with epicentre near Saulgau [15] and further information about this earthquake [9]*

### 5.4 Instrumental investigations of site effects

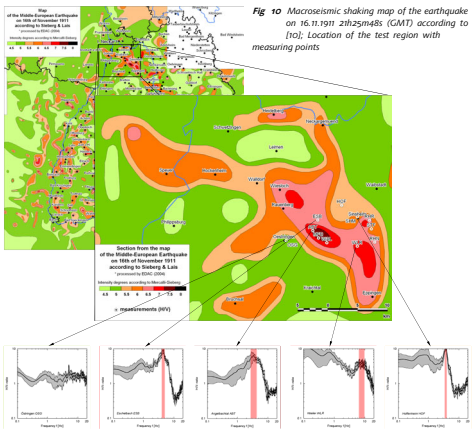
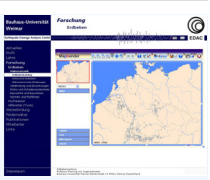



*Fig. 10 Macroseismic shaking map of the earthquake on 16.11.1911 21h25m48s (GMT) according to [10]; Location of the test region with measuring points*

*Fig. 9 Investigated anomaly in test region I. Necker I and spectral H/V-Ratio of the natural noise with labelling the range of dominant site frequency $f_o$*

### 5.5 Outlook – next steps (Phase 2)

**Implementation of the earthquake catalogue as a web-mapping application on the EDAC homepage:**
**http://www.edac.biz**




**Data and information, that could be available for a certain earthquake:**

- Uniform reconstruction of data / macroseismic maps (s. 5.3 *Fig. 8a)*)
- Strong motion data (recordings)
- Correlations (Magnitudes $M_L$ – $M_W$; Magnitude $M$ – Intensity $I$; Attenuation relationship f ($I$,$h$); $S_a$, $S_v$-attenuation)
- H/V-Ratios (s. 5.3 *Fig. 8 b) and Fig. 8c)*; 5.4 *Fig. 9*)
- Pictures of damages; documentation of damage cases (s. 5.3 *Fig. 8d)*

**Incorporation of recent earthquakes**

example: Waldkirch 05.12.2004 02h52m (MEZ) [16]

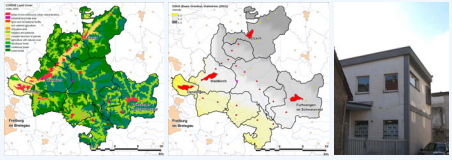


*Fig. 10 CORINE Land Cover with labelling of the visited places (red); star = epicentre [12], [16]*

*Fig. 11 DSHA on Basis of [2] with labelling of the visited places (red); star = epicentre [16]*



*Fig. 12 Damages to a two storey residential building[16]*

## 6 References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