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D6.6 – Databases of seismogenic zones, Mmax, earthquake activity rates, ground motion attenuation relations and associated logic trees

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Revision: 1

Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1 Introduction

SHARE aims to set and adopt new standards in Probabilistic Seismic Hazard Assessment (PSHA) computations by using the IT infrastructure that is jointly developed within SHARE, the Global Earthquake Model initiative (GEM) and further supported by the FP7-project NERA. The infrastructure is sited at ETH Zurich and provides access to seismic hazard and risk models for the Euro-Mediterranean region, to the underlying data and models, and to the software infrastructure for hazard and risk assessment. The model building facility together with the access portal (Deliverable D6.5) are currently constructed withinin SHARE and will be further enhanced under the FP7-Infrastructure project “Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation” (NERA). Within NERA, the European facility for Earhquake Hazard and Risk (EFEHR) is the European component of the OECD-initiated Global Earthquake Model program (GEM, www.globalquakemodel.org).

Databases of SHARE used for the computation of the hazard results are available through the SHARE portal at http://portal.share-eu.org:8080/jetspeed/portal/, linked with the project website www.share-eu.org. The raw data layers that were necessary to develop the SHARE databases for the hazard computation reside at the separate beneficiaries of SHARE. We link to these databases from the portal and the project homepage.

The ground motion prediction equations (GMPEs) are not stored as a database. The ones that have been selected for the application within SHARE have been published in Delavaud et al. (2012). The GMPEs are implemented in the OpenQuake computational engine and documented therein. Thus we do not consider this information as part of the databases to be reported here. For completeness, we provide the logic-tree for the GMPEs (Figure 1).

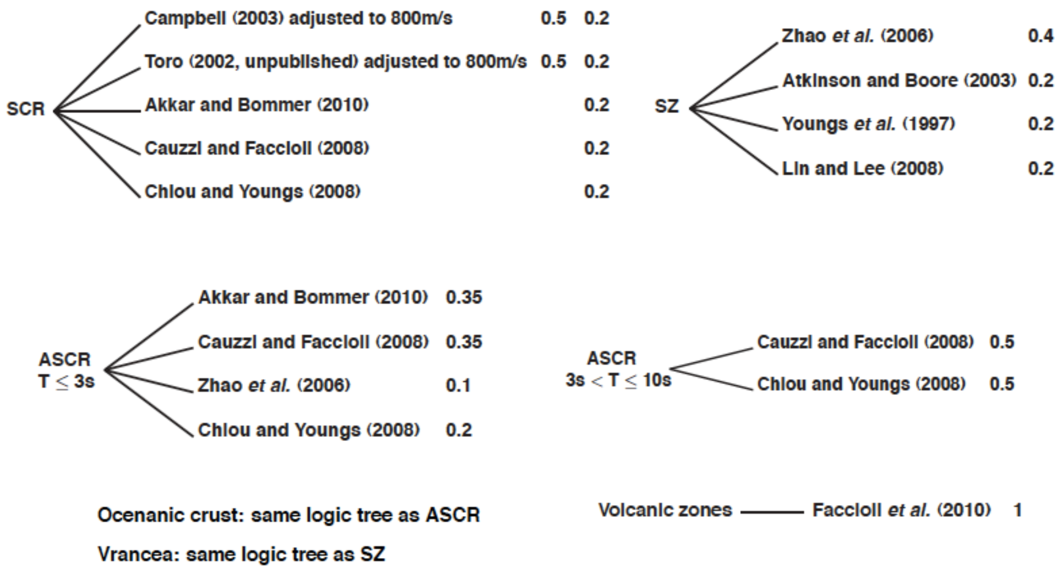


Figure 1: Ground motion prediction equation logic tree for SHARE.

The main databases that we consider are:

1. The earthquake catalog used as basis for the computation.
2. Superzones of completeness regions
3. Superzones of the maximum magnitudes
4. Superzones of tectonic regimes
5. The parameters used for the computation of the area source model branches
6. The parameters of the fault source and background model
7. The parameters of the smoothed seismicity model

We provide the parameters of these datasets in tables. This data is available as SHAPEFILES / ASCII tables.

2 Databases

2.1 Earthquake catalog (SHEEC)

Parameters of the earthquake catalog are described in detail in deliverable D3.2 and details about the compilation of the earthquake catalog are provided. Below is the list of parameters that are used for the computation of activity rates.

The entire catalog and raw data can be accessed at: http://www.emidius.eu/SHEEC/

Parameter	Description	Unit
Lon	Longitude	geogr. Degree
Lat	Latitude	geogr. Degree
Year	Year	
Mo	Month	
Da	Day	
Ho	Hour	
Mi	Minute	
Se	Second	
Mw	Moment magnitude	
H	Hypocentral Depth	km
event_id	Event ID	
LatUnc	Uncertainty in latitude	km
LonUnc	Uncertainty in longitude	km
HUnc	Uncertainty in hypocentral depth	km
MwUnc	Uncertainty of Moment magnitude	
McModel1	Completeness vector (superzones)	
	Complete (1), not complete (0)	
CSZ_ShortName	Short name of completeness superzone	
Main	1: Mainshock, 0: dependent event	
McModel2	Completeness vector (single area zones)	
	Complete (1), not complete (0)	
IDAS	ID of area source	

McModel1 uses information about completeness from the completeness superzones. McModel2 includes information on completeness adjusted for single area sources. Main results from the declustering procedure with the windowing method by Burkhardt and Grünthal (2009). The vectors indicate the completeness for the crustal events with a depth between 0 – 40km. For the subduction sources and the deep source in Vrancea, these are not valid.

2.2 Superzones for completeness

SHARE uses large completeness zones for the earthquake data. The table indicates the completeness value and the year that this value is valid. The earliest date in each row indicates that before this date, no events are considered. The rows are separated in regions and the short names of the completeness superzones. The zones A-Y indicate completeness for crustal earthquakes (depth range $0 \leq H \leq 40$km), the last for indicate the same for events deeper than 40km. For many events, however, the depth is either not given or very uncertain. Thus, in these numbers are understood as indicators. This is why the catalog file list the completeness vectors in the columns McModel1 and McModel2 only for the crustal areas.

	Region	CSZ Shortname	≥3.7	≥4.1	≥4.3	≥4.5	≥4.7	≥4.9	≥5.1	≥5.3	≥5.5	≥5.7	≥5.9	≥6.1	≥6.5	≥7.1
A	Iceland	ICEL	-	1990		1950						1930	1700			
B	Offshore Portugal	OFFP		1960											1700	
C	Iberia	IBER		1950				1800						1500	1300	
D	Betic region	BETI		1920				1500			1350				1200	
E	France - Belgium	FRAB	1960	1900		1750			1550			1450				
F	British Isles	BRIT	1965	1900		1500										
G	Northern Europe	NEUR	1970	1890			1800				1700					
H	Central Europe	CEUR	1970	1900	1850			1780		1500						
I	Alps	ALPS	1970	1900		1800				1500				1300		
J	Northern Italy	NITA	-		1980		1920	1830	1530		1300				1200	
K	Central Italy	CITA			-	1960		1830	1725		1500				1200	
L	Southern Italy	SITA			-		1980	1820				1650			1450	
M	Sicily	SICI			-	1968	1900		1700			1500		1150		

	Region	CSZ Shortname	≥3.7	≥4.1	≥4.3	≥4.5	≥4.7	≥4.9	≥5.1	≥5.3	≥5.5	≥5.7	≥5.9	≥6.1	≥6.5	≥7.1
N	**East Adriatic - Ionian**	**EADI**		-		1960			1900					1800	1600	
O	**Northern Balkans**	**NBAL**	-		1900				1850						1650	
P	**Southern Balkans**	**SBAL**		-	1975	1950			1890				1750		1650	
Q	**Aegean**	**AEGE**		1970					1900			1650			1450	
R	**Marmara Region**	**MARM**		1960			1930			1700					1250	
S	**Mediterranean background**	**MEDB**		1980				1900			1800					
T	**Western Turkey**	**WTUR**		1980				1960		1920		1850		1800		
U	**Atlantic**	**ATLA**		-	1990		1970					1930				
X	**Eastern Turkey**	**ETUR**		1980		1960				1925		1850		1800		
Y	**Cyprus**	**CYPR**		1990				1960						1700		
QI	**Aegean Intermediate**			1970		1950			1925			1900				
TI	**Turkey Intermediate**			1970		1960						1925				
VI	**Vrancea Intermediate**		-	1970		1930						1900		1750		1450
YI	**Cyprus Intermediate**			1990		1980						1960				

Table 1: Completeness levels for the several completeness supezones as indicated in Figure 2.

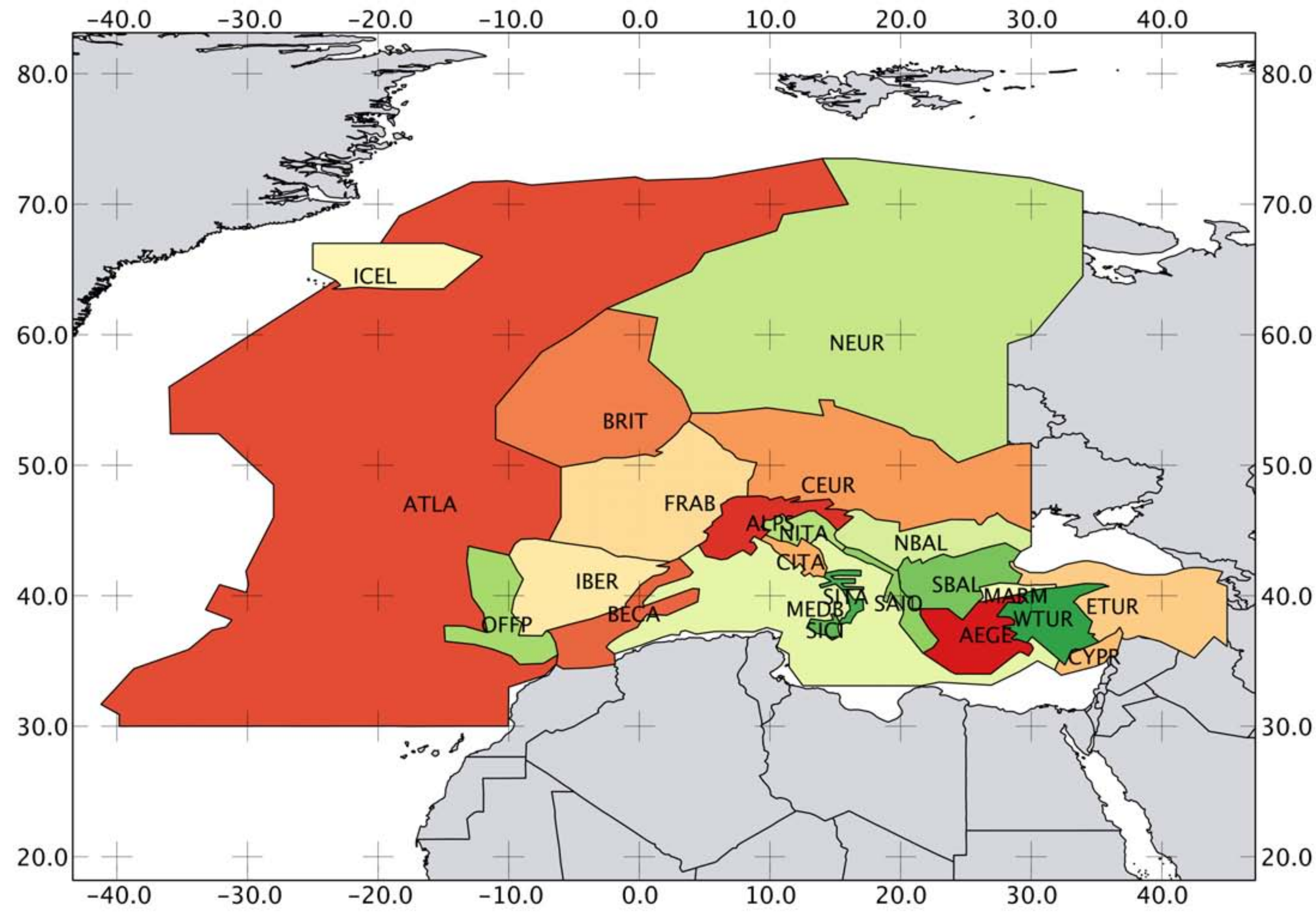


Figure 2: Completeness superzones for crustal events.

2.3 Superzones for tectonic regime

The tectonic regimes are used as resource for the selection of the correct ground motion prediction equations. The extend of the regions are conform with the outline of the area sources.

Tectonic Regime	Description
Active	Active tectonic regime
Azores-Gibraltar	Specific regions treated as active shallow crust
OC	Oceanic crust
Ridge	Oceanic ridges / Transform faults
SCR-Ext	Extended stable continental regime
SCR-NonExt	Non-extended oceanic ridge
SCR-Shield	Shield regime in stable continental regions
Volcanic	Active volcanic tectonics

Table 2: Table of parameters for the tectonic regimes used in SHARE.

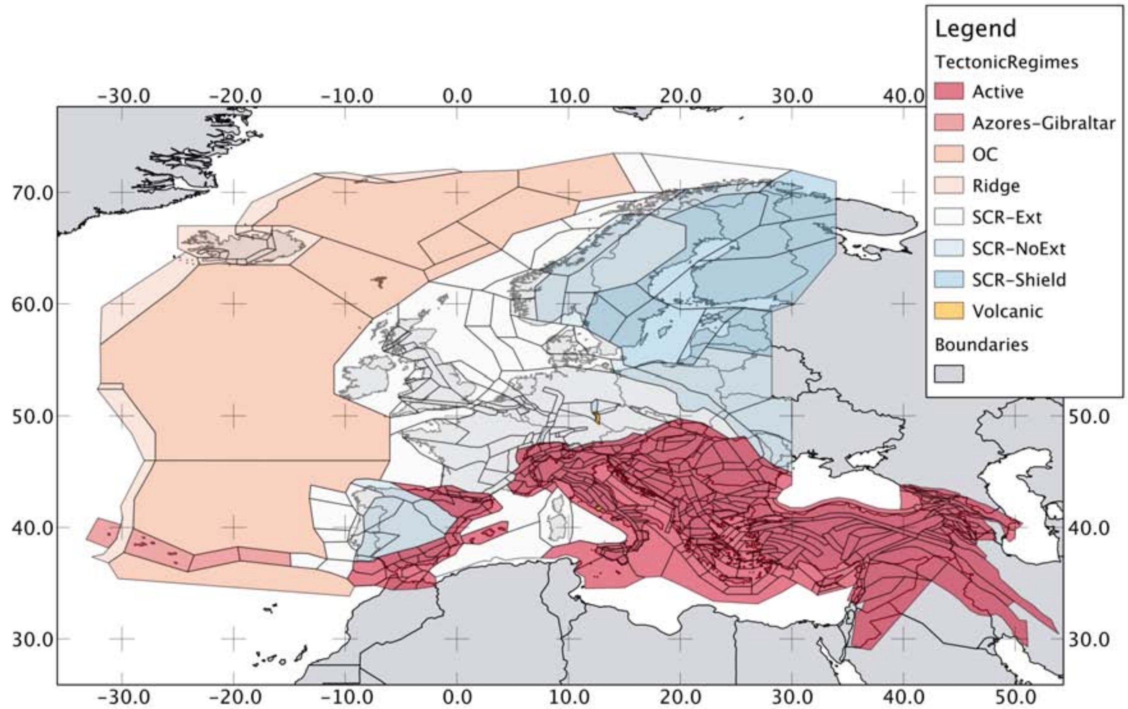


Figure 3: Figure of the tectonic regimes for illustration.

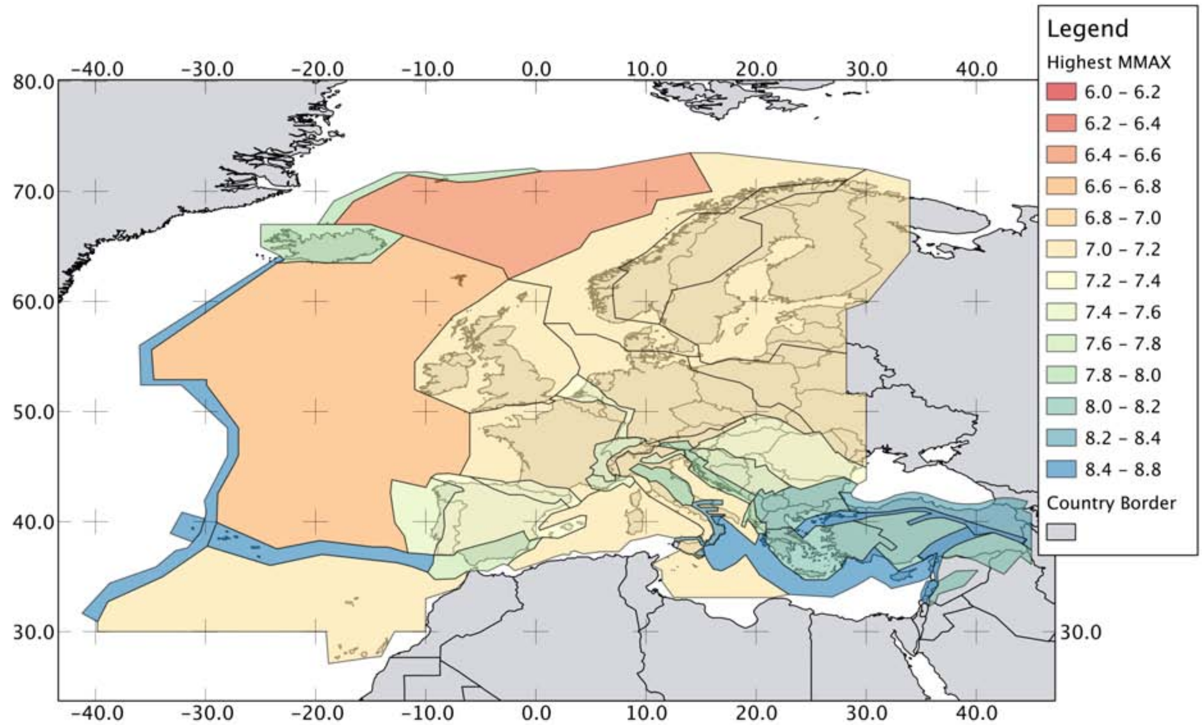
2.4 Superzones for maximum magnitude

The **grey highlighted fields** were used to generate the maximum magnitudes for the input source models according with the SHARE source model logic tree as defined in Deliverable D5.2. A detailed description of the approach to estimate Mmax is given in deliverable D3.3.

Note that the other fields presented in the table are additional information useful for data processing or they are presented herein due to their importance for further analyses and applications.

Parameter	**Description**	**Unit**
SUPERZONE	Number of Superzone	
TECREG	Tectonic Regime (see Table 1)	
MOBSSHEEC	Max. Magnitude in SHEEC	
MOBSUNC	Max. Magnitude in SHEEC + uncertainty	
SOURCENAME	Composite Seismogenic Source (CSS) with largest WMEANMAX in superzone	
WMEANMAX	Weighted mean of Mw values (see Table 4)	
STDEV	Standard deviation of WMEANMAX	
MAXMAG01	First maximum magnitude value	
MAXMAG02	Second maximum magnitude value	
MAXMAG03	Third maximum magnitude value	
MAXMAG04	Forth maximum magnitude value	
WMAXMAG01	Weight for MAXMAG01	
WMAXMAG02	Weight for MAXMAG02	
WMAXMAG03	Weight for MAXMAG03	
WMAXMAG04	Weight for MAXMAG04	
VMIN	Lowest maximum magnitude	
VMAX	Highest maximum magnitude	
BAR	Difference VMAX-VMIN	
MINMW	Minimum weighted Mw from CSS	
MAXMW	Maximum weighted Mw from CSS	

Table 3: Parameters of the superzones for the determination of maximum magnitudes.



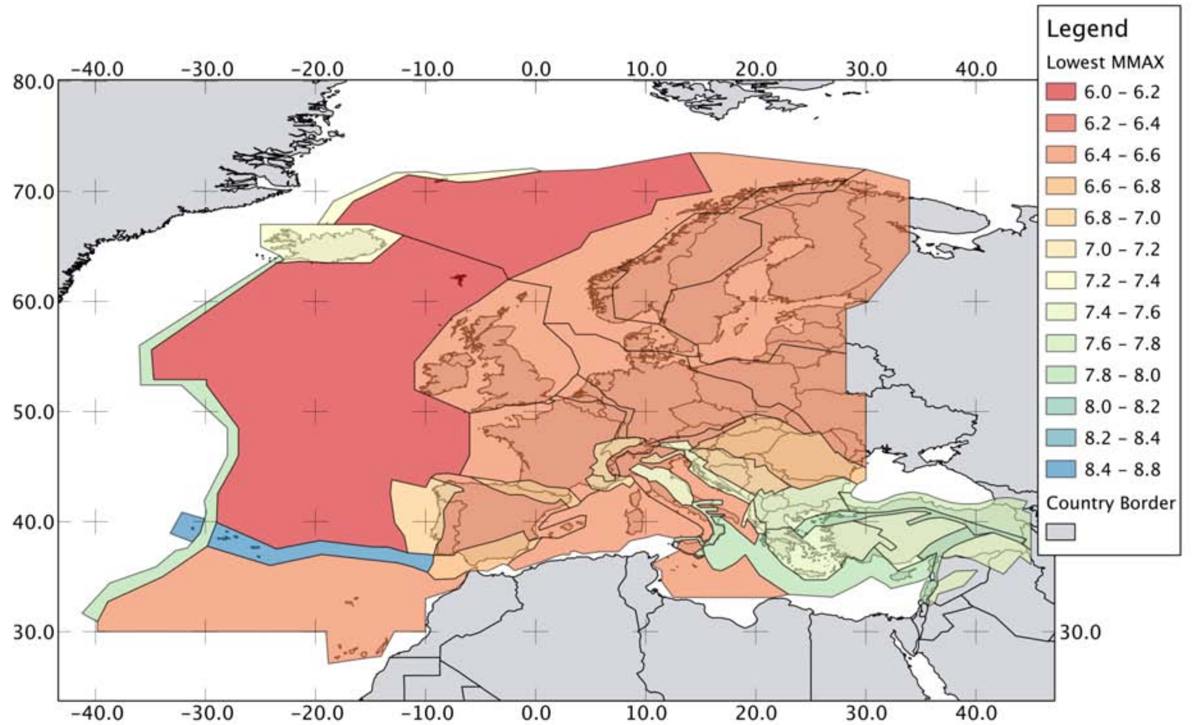


Figure 4: Maps of lowest (top) and highest (bottom) maximum magnitude (Mmax) used in the SHARE model.

2.5 Database parameters used for the Area Source Model

The following parameters were used for parameterization of the Area Source Model to be used with OpenQuake Software. The **grey highlighted fields** were used to generate the input source model according with the SHARE source model logic tree as defined in Deliverable D5.2.

Note that the other fields presented in the table are additional information useful for data processing or they are presented herein due to their importance for further analyses and applications.

<table>
<tr><th>Parameter</th><th colspan="2">Description</th><th>Unit</th></tr>
<tr><td>OBJECTID</td><td colspan="2">Unique Identifier in SHAPEFILE</td><td></td></tr>
<tr><td>LONC</td><td colspan="2">Centroid longitude of the source polygon [used for spatial data manipulation and validation]</td><td>decimal degree</td></tr>
<tr><td>LATC</td><td colspan="2">Centroid latitude of the source polygon [used for spatial data manipulation and validation]</td><td>decimal degree</td></tr>
<tr><td>IDAS</td><td colspan="2">ID of Areas source</td><td></td></tr>
<tr><td>A</td><td colspan="2">a(M=0) GR value (Gutenberg-Richter relation)</td><td>per year</td></tr>
<tr><td>B</td><td colspan="2">b-GR value (Gutenberg-Richter relation)</td><td></td></tr>
<tr><td>TECREG</td><td colspan="2">Tectonic Regime
Note: this field links each area source to the corresponding GMPE logic tree and for detailed definition of each tectonic region see Table 1 / Page 10)</td><td></td></tr>
<tr><td>SS</td><td>Percentage of strike-slip faulting.</td><td rowspan="3">Note: These percentages are actually converted and used as weights for each focal mechanism. [To add: Table of Focal Mechanism definitions]</td><td rowspan="3">%</td></tr>
<tr><td>NF</td><td>Percentage of normal faulting</td></tr>
<tr><td>TF</td><td>Percentage of thrust faulting</td></tr>
<tr><td>MINDEPTH</td><td colspan="2">Minimum depth of earthquakes – to be used only for Shield and Stable Continental Regions</td><td>km</td></tr>
<tr><td>HYPODEPTH1</td><td colspan="2">First hypocentral depth value – to be considered only in the case of Active, Azores-Gibraltar, Oceanic Crust, and Volcanic regions</td><td>km</td></tr>
<tr><td>HYPODEPTH2</td><td colspan="2">Second hypocentral depth value – to be considered</td><td>km</td></tr>
</table>

Parameter	Description	Unit
	only in the case of Active, Azores-Gibraltar, Oceanic Crust, and Volcanic regions	
HYPODEPTH3	Third hypocentral depth value – to be considered only in the case of Active, Azores-Gibraltar, Oceanic Crust, and Volcanic regions	km
MAXDEPTH	Maximum depth of earthquakes - to be used only for Shield and Stable Continental Regions	km
WHDEPTH1	Weight of Hypocentral depth 1	%
WHDEPTH2	Weight of Hypocentral depth 2	%
WHDEPTH3	Weight of Hypocentral depth 3	%
MAXMAG01	First maximum magnitude value (corresponding to the maximum magnitude logic tree definition and based on maximum magnitude super-zones)	Mw
MAXMAG02	Second maximum magnitude value (corresponding to the maximum magnitude logic tree definition and based on maximum magnitude super-zones)	Mw
MAXMAG03	Third maximum magnitude value (corresponding to the maximum magnitude logic tree definition and based on maximum magnitude super-zones)	Mw
MAXMAG04	Forth maximum magnitude value (corresponding to the maximum magnitude logic tree definition and based on maximum magnitude super-zones)	Mw
WMAXMAG01	Weight for MAXMAG01	%
WMAXMAG02	Weight for MAXMAG02	%
WMAXMAG03	Weight for MAXMAG03	%
WMAXMAG04	Weight for MAXMAG04	%
Strike1	Mean fault strike determined from DISS within the area source: $0 \leq s < 90$	decimal degree
Strike2	Mean fault strike determined from DISS within the area source: $90 \leq s < 180$	decimal degree
Strike3	Mean fault strike determined from DISS within the area source: $180 \leq s < 270$	decimal degree
Strike4	Mean fault strike determined from DISS within the area source: $270 \leq s < 360$	decimal degree
Dip1	Mean Dip of faults for Strike1	decimal degree
Dip2	Mean Dip of faults for Strike2	decimal degree

Parameter	Description	Unit
Dip3	Mean Dip of faults for Strike3	decimal degree
Dip4	Mean Dip of faults for Strike4	decimal degree
DirWeight1	Percentage of fault patches with strike in range of STRIKE1 compared to total number	%
DirWeight2	Percentage of fault patches with strike in range of STRIKE2 compared to total number	%
DirWeight3	Percentage of fault patches with strike in range of STRIKE3 compared to total number	%
DirWeight4	Percentage of fault patches with strike in range of STRIKE4 compared to total number	%
PrefStrike	Preferred strike value according to DirWeight1-4	decimal degree
PrefDip	Preferred dip value according to DirWeight1-4	decimal degree

Table 4: Parameters of the Area Source Model.

2.6 Database parameters of the Composite Seismogenic Sources (Fault Source Model)

The database of Composite Seismogenic Sources is described in detail in D3.4. Here we show as **grey highlighted fields** those that were used to generate the input source model according with the SHARE source model logic tree as defined in Deliverable D5.2.

The Note that the other fields presented in the table are additional information useful for data processing or they are presented herein due to their importance for further analyses and applications.

The full database is hosted at INGV. The link to access the full database is: http://diss.rm.ingv.it/SHARE/

Field name	Description
IDBG	Identifier code of the fault source background zone to link to FSBG table
IDSource	Identifier code of the fault source to link to database table
FaultType	Type of faulting: RR = reverse; NN = normal; RL = right-lateral; LL = left lateral
TectoType	Type of tectonic setting: AMR = active margin region; SCR = stable contnental region ; SSR = strike-slip region; ### = undetermined.
TectoCode	Ordinal used for practical reasons: 1 = AMR; 2 = SCR; 3 = SSR; -1 = undetermined.
TECREG	Tectonic Regime Note: this field links each area source to the corresponding GMPE logic tree and for detailed definition of each tectonic region see Table 1 / Page 10)
Preferred	TRUE for validated fault; FALSE for deprecated fault.
MinDepth	Depth (km) to the fault top
MaxDepth	Depth (km) to the fault bottom
StrikeMin	Strike (deg) of the fault CW from North
StrikeMax	Strike (deg) of the fault CW from North
DipMin	Dip angle (deg) of the fault from horizontal
DipMax	Dip angle (deg) of the fault from horizontal
RakeMin	Rake angle (deg) of the fault CCW from horizontal
RakeMax	Rake angle (deg) of the fault CCW from horizontal
MWOriginal	Magnitude originally assigned to fault source by the database compiler(s)
MinMw	Minimum Mw value from MWC94RLD through MLE10A

Field name	Description
MaxMw	Maximum Mw value from MWC94RLD through MLE10A
Range	Range of Mw values from MWC94RLD through MLE10A
MeanMw	Mean Mw values
StDevMw	Standard deviation of Mw values
WMeanMw	Weighted mean of Mw values
WStDevMw	Weighted standard deviation of Mw values
NMagVal	Numer of valid Mw values
MwDiff	Difference between WMeanMw and MWOriginal
TotalL	Total length (km) of the fault along the trace
StraightL	Length (km) of fault from end to end
TotalW	Width (km) of fault downdip
TotalA	Area (sq km) of fault obtained from TotalL*TotalW
StraightA	Area (sq km) of fault obtained from StraightL*TotalW
AspectRatio	Aspect ratio of the fault obtained from TotalL/TotalW
EffectiveAR	Aspect ratio of the fault restrained to AR = 3 where applicable
EffectiveL	Length of fault rupture actually used for calculating Mw values
EffectiveA	Area of fault rupture actually used for calculating Mw values
SRMin	Fault slip rate minimum value (mm/y)
SRMax	Fault slip rate maximum value (mm/y)

Table 5: Parameters of the composite seismogenic sources.

2.7 Database parameters of Background Sources

Parameters are exactly the same as in the Area source model. The **grey highlighted fields** were used to generate the input source model according with the SHARE source model logic tree as defined in Deliverable D5.2.

Note that the other fields presented in the table are additional information useful for data processing or they are presented herein due to their importance for further analyses and applications.

<table>
<tr><th>Parameter</th><th colspan="2">Description</th><th>Unit</th></tr>
<tr><td>OBJECTID</td><td colspan="2">Unique identifier in shapefile</td><td></td></tr>
<tr><td>IDBG</td><td colspan="2">ID of Background Source</td><td></td></tr>
<tr><td>IDAS</td><td colspan="2">ID of corresponding Area source (if exiting)</td><td></td></tr>
<tr><td>LONC</td><td colspan="2">Centroid longitude of the source polygon [used for spatial data manipulation and validation]</td><td>decimal degree</td></tr>
<tr><td>LATC</td><td colspan="2">Centroid latitude of the source polygon [used for spatial data manipulation and validation]</td><td>decimal degree</td></tr>
<tr><td>Preferred</td><td colspan="2">0: not used in computation; 1 used</td><td></td></tr>
<tr><td>TECREG</td><td colspan="2">Tectonic Regime
Note: this field links each area source to the corresponding GMPE logic tree and for detailed definition of each tectonic region see Table 1 / Page 10)</td><td></td></tr>
<tr><td>SS</td><td>Percentage of strike-slip faulting</td><td rowspan="3">Note: These percentages are actually converted and used as weights for each focal mechanism. [To add: Table of Focal Mechanism definitions]</td><td rowspan="3">%</td></tr>
<tr><td>NF</td><td>Percentage of normal faulting</td></tr>
<tr><td>TF</td><td>Percentage of thrust faulting</td></tr>
<tr><td>MINDEPTH</td><td colspan="2">Minimum depth of earthquakes – to be used only for Shield and Stable Continental Regions</td><td></td></tr>
<tr><td>HYPODEPTH1</td><td colspan="2">First Hypocentral depth value – to be considered only in the case of Active, Azores-Gibraltar, Oceanic Crust, and Volcanic regions</td><td>km</td></tr>
<tr><td>HYPODEPTH2</td><td colspan="2">Second Hypocentral depth value – to be considered only in the case of Active, Azores-Gibraltar, Oceanic Crust, and Volcanic regions</td><td>km</td></tr>
<tr><td>HYPODEPTH3</td><td colspan="2">Third Hypocentral depth value – to be considered only in the case of Active, Azores-Gibraltar, Oceanic Crust, and Volcanic regions</td><td>km</td></tr>
<tr><td>MAXDEPTH</td><td colspan="2">Maximum depth of earthquakes - to be used only for Shield and Stable Continental Regions</td><td>km</td></tr>
<tr><td>WHDEPTH1</td><td colspan="2">Weight of Hypocentral depth 1</td><td></td></tr>
<tr><td>WHDEPTH2</td><td colspan="2">Weight of Hypocentral depth 2</td><td></td></tr>
</table>

Parameter	Description	Unit
WHDEPTH3	Weight of Hypocentral depth 3	
MAXMAG	Maximum magnitude value corresponding to the threshold magnitude differentiating activity on fault and on background	
WMAXMAG04	Weight for MAXMAG04	
AREA	Area of the polygon	sq km
A	a(M=0)-value (Gutenberg-Richter relation)	
B	b-value (Gutenberg-Richter relation)	
EVENTS	Number of events (complete, declustered) from catalog	

Table 6: Parameters of the background sources.

2.8 Database parameters for the smoothed seismicity model

The smoothed seismicity models integrated in the SHARE model provide the occurrence rates of earthquakes with moment magnitude of $M_W \geq 4.5$ for the target region on a 0.05x0.05 grid, whatever the smoothed seismicity model is based on. Additional parameters relevant for the computation of hazard, such as the tectonic regime, are added from the other databases. The smoothed seismicity model in the end contain the following parameters.

Parameter	Description	Unit
ID	ID number	
Name		
tectonicRegion	Tectonic Regime taken from Table 1	
LON	Center longitude of cell	decimal degree
LAT	Center latitude of cell	decimal degree
UpperSeismoDepth	Upper seismogenic depth	Km
LowerSeismoDepth	Lower seismogenic depth	km
MinMag	Minimum magnitude of the forecast; fixed to 4.6 as binWidth=0.2, thus spanning from 4.5-4.7	
binWidth	Magnitude bin width	
occurRates	Vector of occurrence rates for all magnitude bins	Event rate / year
nodalPlane1	Probability with strike & dip given, rake =0	
nodalPlane2	Probability with strike & dip given, rake =90	
nodalPlane3	Probability with strike & dip given, rake =-90	
hypodepth		km
depth		km

Table 7: Parameters of the smoothed seismicity model

3 References

Burkhard, M., Grünthal, G. (2009): Seismic source zone characterization for the seismic hazard assessment project PEGASOS by the Expert Group 2 (EG 1b). Swiss Journal of Geosciences, 102, 1, 149-188.

Delavaud, E., et al. (2012). Towards a ground-motion logic tree for probabilistic seismic hazard assessment in Europe, J. of Seismology, doi:10.1007/s10950-012-9281-z.