UNIVERSITÀ
DEGLI STUDI DI TRIESTE

dipartimento di matematica e geoscienze

The DMG Quick Reference Manuals

Regional hazard computations

Seismogenic zones only, scaled point source approximation

QR

Document Name: DMGQuickRegionalHazardSZ.pdf
Document Version: 1.4
Date Issued: 24 March, 2020
Author: Franco Vaccari, Andrea Magrin

University of Trieste
Department of Mathematic and Geosciences
Group of Seismology
via Weiss, 4
34128 Trieste, Italy

Table of Contents

Regional hazard computation with seismogenic zones only

Here we generate a ground shaking scenario based on the available information on historical seismicity, seismogenic zones and structural models for crust and upper mantle. The scenario will be computed for north-eastern Italy, taking into account three seismogenic zones, four structural models and three catalogues of historical seismicity.

Required input files

Required input files can be found in **/XDST/Examples/HazardExamples/Point/Base**. Copy them into a directory dedicated to the computations.

Different computations should be performed in different directories, choosing a different root name for each run.

Changing the name of the run in file makehaz.par implies renaming files .fps, .por, .pos, .spl, .spr so that they root name matches the run name.

Here is what you should have in the directory before you run *`makehaz.out`*:

```
-rw-r--r--  1 vaccari  dstguest      288  6 Mar 11:41 bighazard.par
-rw-r--r--  1 vaccari  dstguest      109  9 Oct  2015 cells.par
-rw-r--r--  1 vaccari  dstguest   165016  9 Oct  2015 cro.eqc
-rw-r--r--  1 vaccari  dstguest      217  9 Oct  2015 cro.poc
-rw-r--r--  1 vaccari  dstguest      511  9 Oct  2015 gusev01.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev02.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev03.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev04.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev05.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev06.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev07.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev08.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev09.xy
-rw-r--r--  1 vaccari  dstguest     1116  9 Oct  2015 gusev10.xy
-rw-r--r--  1 vaccari  dstguest      475 14 Nov  2011 haz_compare.par
-rw-r--r--  1 vaccari  dstguest   107155  9 Oct  2015 ita.eqc
-rw-r--r--  1 vaccari  dstguest      271  9 Oct  2015 ita.poc
-rw-r--r--  1 vaccari  dstguest    36045  9 Oct  2015 itacode.cod
-rw-r--r--  1 vaccari  dstguest     3512  6 Mar 11:35 makehaz.par
-rw-r--r--  1 vaccari  dstguest    98154  9 Oct  2015 slo.eqc
-rw-r--r--  1 vaccari  dstguest      147  9 Oct  2015 slo.poc
-rw-r--r--  1 vaccari  dstguest      949  9 Oct  2015 z1d.fps
-rw-r--r--  1 vaccari  dstguest      539  9 Oct  2015 z1d.poc
-rw-r--r--  1 vaccari  dstguest     1107  9 Oct  2015 z1d.por
-rw-r--r--  1 vaccari  dstguest      762  9 Oct  2015 z1d.pos
-rw-r--r--  1 vaccari  dstguest  2332585  9 Oct  2015 z1d0012.spl
-rw-r--r--  1 vaccari  dstguest  2896972  9 Oct  2015 z1d0012.spr
-rw-r--r--  1 vaccari  dstguest  2333975  9 Oct  2015 z1d0014.spl
-rw-r--r--  1 vaccari  dstguest  2857631  9 Oct  2015 z1d0014.spr
-rw-r--r--  1 vaccari  dstguest  2303373  9 Oct  2015 z1d0016.spl
-rw-r--r--  1 vaccari  dstguest  2824325  9 Oct  2015 z1d0016.spr
-rw-r--r--  1 vaccari  dstguest  2051912  9 Oct  2015 z1d0252.spl
-rw-r--r--  1 vaccari  dstguest  2527099  9 Oct  2015 z1d0252.spr
```

Description of input files

makehaz.par

This file contains the information that will be used to properly generate the script that will actually perform the computations (the script will be named **hazard)**.

```
Parameters for program makehaz                              (v0006)
-----------------------------------------------------------------
RUN DEFINITION
-----------------------------------------------------------------
z1d                                   Name of the run (max 15 char.)
  11 15           Min and max longitude              (degrees)
  45 47           Min and max latitude               (degrees)
1                 Use seismogenic zones (0=no, 1=yes)
0                 Use nodes (0=no, 1=yes, 2= yes separately)
0                 File with nodes coordinates (max 12 char.)(for nodes only)
0                 Use alerted areas (0=no, 1=CN, 2=M8S)
0                 Use recurrence (0=no, 1=Multiscale GR)
0                 File with recurrence parameters (max 12 char.)
0                 Execution (0=full ,1=until sources,2=until paths,3=obs+sut,4=0 minus plot)
15                Clean level (0=no, 3=save all seismograms, 11=save unscaled, 15 clean all; see
manual)
0                 Grid execution         (igrid)      (1=yes, 0=no)
0                 Big run  (ibig)  (1=yes, 0=no)
-----------------------------------------------------------------
SOURCE DEFINITION
-----------------------------------------------------------------
5.0               Min magnitude associated with the run
0  99             Min and maximum magnitude taken from catalogues
1000 2009         First and last year in catalogue   (years)
  .2              Cell size                          (degrees)
  3               Smoothing radius                   (cells)
  0               Min. events for smooth             (count)
  0  50           Min and max depth                  (km)
999               Source depth                       (sdepth)     (0=sut,999=auto,x=km)
-----------------------------------------------------------------
PATH DEFINITION
-----------------------------------------------------------------
1   0             Min. and max source-site distance km (0=auto,>0 use the value)
0                 Short paths (ishortpaths) (0=elim,1=use rmin,2=adjust)
0                 File (.obs) with observation points (instead of default grid) (max 12 char.)
-----------------------------------------------------------------
TIME SERIES
-----------------------------------------------------------------
  0               Program for Green function computation (igreen) (0 - only MS; 1 - MS and DWN
for short distance; 2 - only DWN)
  1.              Peak frequency         (peakfr)     (1.0 or 10.0)
  1               Interpolation for MS   (npint)      (0-9)
  1               Interpolation for DWN  (npintp)     (0-9)
  1               Seismogram format      (iform)      (0=ASCII, 1=bin)
4096              Time series samples    (npts)       (4096)
  0               Time series length     (iall)       (0=truncated,1=complete)
  1               Type of motion         (itype)      (1=dis, 2=vel, 3=acc)
  1               Vertical component     (ivert)      (1=yes,0=no)
  1  90           Type of scaling        (iscale,iaz) (1=classic,2=pulsyn)(angle)
-----------------------------------------------------------------
OUTPUTS
-----------------------------------------------------------------
  0               Output formats (iouform) (0=ASCII, 1=bin)
itacode.cod       File with code response spectra for computing DGA (max 12 char.)
  0               Plot seismograms        (isis)      (1=yes,0=no)
  0               Compute response spectra (irs)      (0=no, 1=only 5% damping, 2=all dampings)
```

cells.par

This file associates earthquake catalogues (***.eqc**) with regions where they should be used (***.poc**):

```
parameters for program cells (filenames reading format: A20)
ita.eqc
ita.poc
slo.eqc
slo.poc
cro.eqc
cro.poc
```

*.eqc

Earthquake catalogue files have this format:

```
...
...
19941214 338 0 4627  1329 10280  0  0  00
19941214 444 0 4343  1704  0305  0  0  00
1994121421 3 0 4501  1685  7300  0  0  00
199412161224 0 4624  1621 20  0  0  0  00
199412201444 0 4568  1395 11  0  0  0  00
19941221 7 4 0 4284  1847 22300  0  0  00
1994122322 4 0 4257  1775 13220  0  0  00
199412241726 0 4575  1413 12160  0  0  00
19941228 116 0 4259  1736  0360  0  0  00
19941229 348 0 4346  1687  9330  0  0  00
199412301959 0 4526  1455  0  0  0  0  00
...
...
```

*.poc

Region files for catalogues are made of a single polygon:

```
polygon for the Croatian catalogue
catcro0001
            13.0    45.4
            13.0    45.2
            13.2    45.2
            13.2    45.0
            15.0    45.0
            15.0    45.4
```

*.por

A set of polygons is then defined to describe the regions associated with average structural models for which the normal modes (***.spl**, ***.spr**) have been already computed:

```
Polygons that define different structural regions (lon,lat)
stzone0012
            12.000  45.900
            12.900  46.250
            13.500  46.250
            13.500  45.711
            13.346  45.655
            13.238  45.692
            13.129  45.667
            13.093  45.612
            12.913  45.600
            12.408  45.409
            12.307  45.229
            12.336  45.094
            12.545  45.000
            12.000  45.000
stzone0014
            12.900  46.250
            13.500  46.250
            13.500  45.900
            13.680  45.900
            13.680  46.000
            13.541  46.015
            13.721  46.198
            13.492  46.321
            13.707  46.440
            13.728  46.643
            12.459  46.687
            12.127  47.000
            12.000  47.000
            12.000  45.900
...
...
```

*.pos

One more set of polygons is defined in files with extension **.pos** to describe the seismogenic zones where earthquakes will be considered:

```
zonazione sismogenetica zs9 2004
sozone0904
             13.825  46.125
             14.323  45.789
             14.130  45.447
             13.546  45.877
             13.825  46.125
sozone0905
             13.825  46.125
             13.546  45.877
             13.160  46.156
             12.639  45.992
             12.232  45.789
             11.898  45.630
             11.900  46.047
             12.967  46.501
             13.651  46.501
             13.786  46.151
             13.825  46.125
sozone0906
             11.900  46.047
             11.898  45.630
             11.690  45.554
             11.269  45.327
             11.000  45.300
             11.000  45.885
             11.179  45.880
             11.358  45.811
```

*.fps

A file containing the average focal mechanism associated with each seismogenic zone is defined. It should contain a single mechanism for each polygon defined in .pos file. The association is made looking at the coordinates of the event and the coordinates of the polygon vertices.

```
-------------------- FPGNDT.DAT ---------------------------------------------
NUMBEA YEARMODY HRMISEC LA.TITN LON.GITE DEPT MLMDMSMBMA AGEN AREADESCRI
NUMBEF ST1 D1 RA1  ST2 D2 RA2   PDI PI  TDI TI  BDI BI Q REFE AREADESCRI
NUMBEM M00 SF REFE DURA F2 M0XX ER1 M0YY ER2 M0ZZ ER3 M0XY ER4 M0XZ ER5 M0YZ ER6
NUMBET HDR SF M0 TVAL TD TAZ NVAL ND NAZ PVAL PD PAZ AST AD ARA BST BD BRA REFER
NUMBEU SF SMRR ER1 SMTT ER2 SMFF ER3 SMRT ER4 SMRF ER5 SMTF ER6
-------------------------------------------------------------------------------
00904A 00000000 0000000 45.786N  13.935E  000  0 0 0 044      ZONA904
00904F 145 76 180
00905A 00000000 0000000 46.200N  12.861E  000  0 0 0 066      ZONA905
00905F 289 23 140
00906A 00000000 0000000 45.660N  11.500E  000  0 0 0 049      ZONA906
00906F 051 29 316
```

*.spl, *.spr

These are the files containing the modes already computed for the bedrock models associated with the regional polygons defined in *.por file. File .spl contains the Love modes, file .spr contains the Rayleigh modes. See the manual “1D modal summation” for details about their generation.

gusev*.xy

Those files contain the scaled point source amplitude spectra, and should not be modified.

Commands execution

The command that will generate the hazard script based on the configuration prepared in `makehaz.par` is:

`makehaz.out` will prepare the *`hazard`* script

For a short run, like the one prepared in the example:

`hazard` will perform the computations and produce the plots

For a typical run that requires hours to complete, it is better to submit the job in background. The suggested way to do this is:

```
echo "hazard > my.log" | at now
```

In such a way the job will start within a very short time. Until the job is queued, you will see it waiting for execution with command

```
atq
```

If *`atq`* produces no output, then the job execution has started, and you can check the status by looking at the content of the log file (`my.log` in the example).

Main output files

The *`hazard`* script will create a *`Results`* folder where plots (PostScript and PDF) and relevant output data files will be stored, and an `Input` folder where the input files will be saved so they can be easily reused. All intermediate files will be deleted, unless the “Clean Level” parameter is set to “0” in *`makehaz.par`* file.

The list of PostScript files produced is:

`cro.poc.ps`	Polygon of validity for a single earthquake catalogue
`ita.poc.ps`	“
`slo.poc.ps`	“
`z1d.gmt.ps`	Focal mechanisms associated with seismogenic zones
`z1d.no.ung.ps`	Sources that should be possibly included within seismogenic zones
`z1d.noall.ung.ps`	All sources excluded from seismogenic zones
`z1d.obs.ps`	Grid points for which the ground shaking will be computed
`z1d.poc.ps`	Full set of polygons of validity for earthquakes catalogue
`z1d.por.ps`	Polygons associated with structural models
`z1d.pos.ps`	Polygons associated with seismogenic zones
`z1d.ung.ps`	Gridded seismicity
`z1d.unm.ps`	Smoothed seismicity
`z1d.zs.uni.ps`	Smoothed seismicity within seismogenic zones (sources)
`z1df0res.amx.ps`	Ground shaking: peak displacement, resultant horizontal component
`z1df0res.amx.t.ps`	Ground shaking: period corresponding to the max spectral amplitude (displacement)
`z1df0rzz.amx.ps`	Ground shaking: peak displacement, vertical component
`z1df0rzz.amx.t.ps`	Ground shaking: period corresponding to the max spectral amplitude (displacement)
`z1df1res.amx.ps`	Ground shaking: peak velocity, resultant horizontal component
`z1df1res.amx.t.ps`	Ground shaking: period corresponding to the max spectral amplitude (velocity)
`z1df1rzz.amx.ps`	Ground shaking: peak velocity, vertical component
`z1df1rzz.amx.t.ps`	Ground shaking: period corresponding to the max spectral amplitude (velocity)
`z1df2max.dga.ps`	Ground shaking: Design Ground Acceleration (DGA), max horizontal component
`z1df2res.amx.ps`	Ground shaking: peak acceleration, resultant horizontal component
`z1df2res.amx.t.ps`	Ground shaking: period corresponding to the max spectral amplitude (acceleration)
`z1df2rzz.amx.ps`	Ground shaking: peak acceleration, vertical component
`z1df2rzz.amx.t.ps`	Ground shaking: period corresponding to the max spectral amplitude (acceleration)
`z1df2max.dga.ps`	Ground shaking: Design Ground Acceleration (DGA), vertical component

Try a couple of scenarios changing some source properties.

Plotting

To plot most of the input data files and the output ground shaking scenarios the script

hazgmt.sh

can be called. One of `makehaz.par` or `hazgmtregion` files has to be present in the directory. The former is used to get the range of longitude and latitude to be considered in the plot. The latter allows for a more granular configuration, with legend position, basemap style, axes ticks spacing, paper orientation, map projection etc.

Creating the required color palettes

Before running the script, cpt files (color palettes) must be created in the directory containing the data. The hazard script generated by makehaz.out creates them automatically. If you just have a file to be plotted without dealing with makehaz.out, you can create the cpt files with commands

hazcpt.out	for standard plots
hazlegend.out	for plots with symbols

Generating the plots

In its simplest form, the datafile(s) are passed as parameters:

```
hazgmt.sh myFile.ung
hazgmt.sh *.amx
hazgmt.sh *.po?
```

When plotting input data files, like those containing magnitudes (`.uni, .ung, .unm`), if the corresponding polygon file of interest exists (`.pos, .poc`), will be automatically be plotted together with the data.

Adding extras to the plot

If another specific file has to be plotted, typically, a polygon file named differently than the run, it can be passed prepended by a + or _ option (to plot it above or below the data):

```
hazgmt.sh a.ung +a.pos
hazgmt.sh af2res.amx _a.por
```

Plot options

Many other options exist. A few often needed are listed below:

-b to plot in black/white (grayscale actually…)

-y to plot with symbols instead of circles (-y -b can be used to get black/white symbols)

-t1 to plot topography in color (t2 or t5 for larger scales)

-i1 to plot topography with grayscale illumination (i2 or i5 for larger scales)

Full syntax of the command

```
hazgmt.sh [-option1 -option2 ... +file_over _file_under VARNAME=VARVALUE]
filename [filename2 filename3 …]
```

The full list of options can be obtained by calling hazgmt.sh without any parameter

Import results in XeRiS Web Application

Inside Results folder you can run this command:

```
zipHazardResForWeb.sh
```

that produces a zip archive of the results (`z1d.WebHazResults.zip`) that can be imported in the XeRiS web application.