EFFECT OF STRESS INTERACTION ON PROBABILITY OF OCCURRENCE OF CHARACTERISTIC EARTHQUAKES IN SOUTHERN APENNINES

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Introduction

We computed the effect of stress change due to previous tectonic events on the probability of occurrence of future earthquakes in the Southern Apennines. Following the methodology developed in the last decade, we start directly from the probability of occurrence in the next 50 years for a characteristic earthquake on known seismogenic sources, based on a time-dependent seismic model. The result of this characteristic earthquake defined by previous earthquakes in the same structure is applied. The influence of the stress change on the occurrence rate of characteristic earthquakes is computed taking into account both a permanent (shock-induced) and a temporary (time-rate) perturbation. We apply the method to the computation of earthquake hazard of the main seismogenic structures recognized by the Southern Apennines region, for both historical and paleoseismic data are available.

Method

A standard procedure for the hazard assessment assumes that all relevant earthquakes occur as well known sequences with characteristic mechanisms and rate. The procedure needs the adoption of a probability density function (PDF) to define the seismic hazard of occurrence on each fault, with source areas parametric to their properties, in the model. One can adopt either a simple statistical Poisson occurrence or a Poisson point process. For the former model, the expected occurrence time, T, is the only necessary piece of information. For the latter, also a parameter of the coefficient of variation (also known as sparsely) and the inter-event time is required. The seismic hazard assessment (SHEM) distribution introduced by Dathenberg et al. (2002) is used to express the inter-event time probability distribution for earthquakes on a single source in Italy. This distribution is expressed as

where \(a(t)\) is the seismic activity rate before the stress change, \(\gamma\) is a fault-dependent parameter, \(\Delta t\) is the normal stress effect, \(\Delta t\) is the seismic activity rate after the stress change, and \(\Delta t\) is the seismic activity rate after the stress change.

The database of Italian seismogenic sources

We make use of the most comprehensive source of information available about Italian seismogenic sources, the Database of Individual Seismogenic Sources (DISIS) owned by Istituto Nazionale di Geofisica e Vulcanologia (INGV). This database includes all the available data on the known faults, including the following parameters: location, length, width, fault type, orientation, slip rate, seismicity, and other parameters useful to the physical modeling of the fault.

Data and Results

Table 1. List of seismogenic structures reported by DISIS for the study area of Southern Apennines (DolomitiPicene). Also reported are the minimum and maximum occurrence time and the time elapsed since the last event.

<table>
<thead>
<tr>
<th>DISIS code</th>
<th>Fault name</th>
<th>Date of last event</th>
<th>Magnitude</th>
<th>Minimum recurrence time (years)</th>
<th>Maximum recurrence time (years)</th>
<th>Elapsed time (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT0003</td>
<td>Val D’Arii</td>
<td>1977/12/26</td>
<td>6.3</td>
<td>1977/12/26</td>
<td>2000/12/26</td>
<td>23</td>
</tr>
<tr>
<td>IT0010</td>
<td>Midolfo-Pesaro</td>
<td>1980/06/21</td>
<td>6.2</td>
<td>1980/06/21</td>
<td>2000/06/21</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 2. List of seismogenic structures as in Table 1 for each fault the minimum and maximum probability for an earthquake occurring in the next 50 years given for a time independent Poisson model and for the BPT (P=2) model, respectively. It is most causes the probability computed by the BPT is negligible, due to the short time elapsed since the last event, excepted near the recurrence time.

<table>
<thead>
<tr>
<th>DISIS code</th>
<th>Fault name</th>
<th>Minimum Probability</th>
<th>Maximum Probability</th>
<th>Minimum BPT Probability</th>
<th>Maximum BPT Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT0003</td>
<td>Val D’Arii</td>
<td>6.9 x 10^-7</td>
<td>6.9 x 10^-7</td>
<td>3.6 x 10^-10</td>
<td>3.6 x 10^-10</td>
</tr>
<tr>
<td>IT0010</td>
<td>Midolfo-Pesaro</td>
<td>6.9 x 10^-7</td>
<td>6.9 x 10^-7</td>
<td>3.6 x 10^-10</td>
<td>3.6 x 10^-10</td>
</tr>
<tr>
<td>IT0079</td>
<td>San Gregorio-Magnone</td>
<td>1.6 x 10^-7</td>
<td>1.6 x 10^-7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>IT0079</td>
<td>Pesaro-Pesaro</td>
<td>1.6 x 10^-7</td>
<td>1.6 x 10^-7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Conclusions

1. The occurrence probability for the next strong earthquake in Southern Apennines according to the BPT model is small in comparison with the time independent Poisson model, due to the short time elapsed since the last event with respect to the recurrence time.
2. The permanent effect caused by the stress released by the previous earthquake is generally small.
3. The transient effect is, at the present time, not affecting the probability of future events.
4. The information available from DISIS concerning the recurrence times of the Italian seismogenic sources doesn’t allow a clear evaluation of the seismic hazard.
5. New information about the seismic strain in the region is required to improve the availability of hazard assessment.

References


