SEISMIC ANALYSIS OF THE TORREPEROGIL SEISMIC SEQUENCE (SOUTHERN SPAIN)

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This study is concerned with the objective estimation of the background seismicity rate in a small area at southern Spain in which it has started a sequence of low magnitude earthquakes from October 2012. The recent tectonic development of this area is related to the contact between the Eurasian and African tectonic plates, and is controlled by a regional NNW-oriented compression stress field. The seismicity is diffuse, i. e., it is distributed over a relatively broad area where small-to-moderate earthquakes occur instead of a narrower band with larger events (as in the part of northern Algeria or the offshore prolongation toward the Azores islands. The highest earthquakes taking place in southern Spain occurred in historical times and their maximum magnitude is estimated in ~ 6.5 Mw.

The analysis of the principal seismic episodes in southern Spain shows several series in recent years, including: 2000-2001 (Albuñol, Granada), 2005 (Cañete la Real, Málaga) and the series of 1999 (Mula, Murcia), 2002 (Gérgal, Almería), 2002 and 2005 (La Paca, Murcia), 2002 and 2007 (Morón de la Frontera, Sevilla), 2006 (Cañete la Real, Málaga), 2011 (Lorca, Murcia). The majority of them behave like an aftershock series followed by a main shock. There also exist another series which cannot be explained by a single main shock and they act like a swarm.

In a more local scale, the seismicity of the epicentral area of the Torreperogil series is characterised by a low frequency of earthquake occurrences in the past. Seismic rates for threshold magnitudes of 4.0 used in seismic hazard studies covering the tectonic region where the study area is located are in the range of 10^{-1} to 10^{-2} events per year.

The Torreperogil series has begun in October 2012 and it can be considered still active during early 2014. The observed earthquake cluster occurred mainly during the first 6 months with a higher activity in December 2012 and early spring of 2013 and then it started decreasing with time. These events are densely distributed around the towns of Torreperogil and Sabiote within a radius of about 8 km and majority of them have the depth less than 5 km (Figure 1).

The magnitude distribution of the sequence consists of 1464 events during 435 days with a cut-off magnitude 1.2 and is pretty well described by a Gutenberg-Richter relation with a b-value $\simeq 1$ and a maximum observed magnitude of 3.9 m_{bLg} (until Dec. 31st 2013). There are 8 shocks with $m_{blg} \geq 3.5$ and the last one was at Oct. 2013 with an intensity of IV after the major activity period (between Dec.2012 and April 2013) while the area has also felt intensities of V (Figure 2).

The essence of the Torreperogil sequence does not seem to be clear enough. Facing with a cluster feature that is not expressive to our previous understanding of the background seismicity due to the tectonic field in the area, we decided to study this sequence by fitting it with a stochastic point process for declustering earthquakes occurrence in space and time, in order to be able to separate the swarm from the background seismicity. In this way, we would be able to characterize that background seismicity of the area and to provide or to rule out possible causes of the sequence.

The model used for this study is the Epidemic Type Aftershocks Sequence (ETAS) model of Ogata (1988). The estimation of model parameters is carried out by the maximum likelihood method.

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Presenting an aftershock rate for the sequence, we discuss the implications for seismic hazard assessment studies and short-term prediction of events with a given magnitude within a given time span. Additionally, the identification of any probable underlying process of induced seismicity and a comparison with similar cases in Spain are presented.
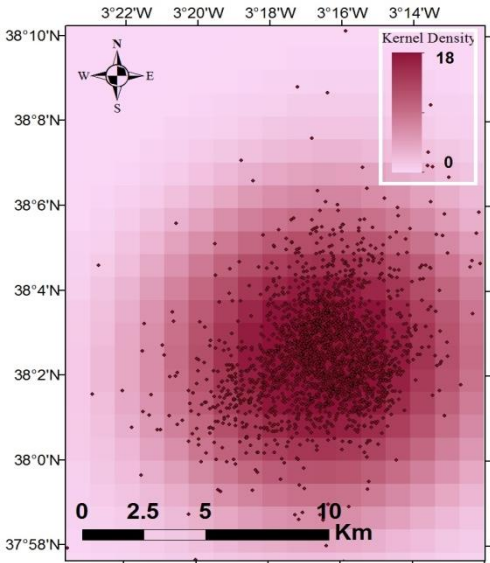

Figure 1. Kernel density of the spatial distribution of the sequence (IGN) with radius of 10 Km for an area of 17×23 km^2.
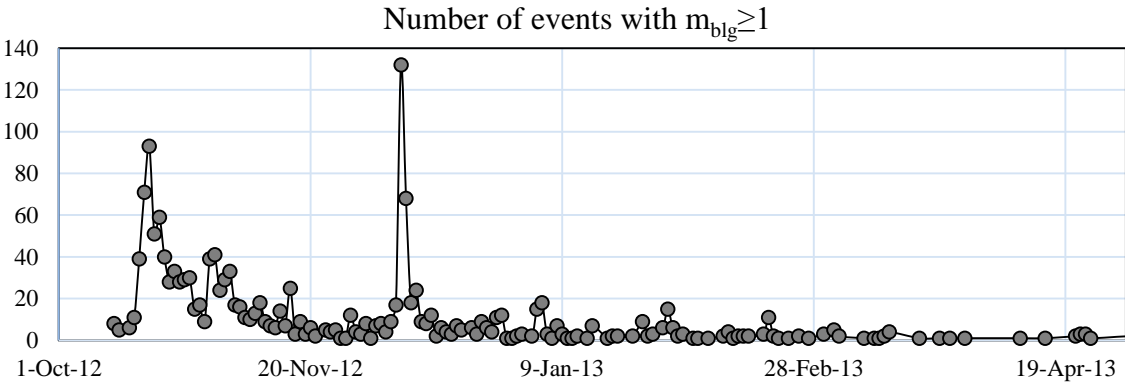

Figure 2. The temporal distribution of the sequence at the first six month

The results and conclusions obtained for this series would be of interest for other seismic areas of Spain, where low-magnitude seismic series are frequent. The occurrence of these series generates significant concern on the population and conclusions of this study would contribute to explain their actual causes.

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