Geophysical Research Abstracts,
Vol. 11, EGU2009-6216-3, 2009
EGU General Assembly 2009

Some statistical features of the aftershock temporal behavior after the M7.4 Izmit earthquake of august 17, 1999 in Turkey

D. Gospodinov (1,2), H. Fajtin (1), B. Rangelov (1), and E. Marekova (2)

(1) Geophysical Institute of the Bulgarian Academy of Science, Bulgaria (drago_pld@yahoo.com), (2) Plovdiv University "Paisii Hilendarski", Plovdiv, Bulgaria

An earthquake of magnitude M_w=7.4 struck 8 km. southeast of Izmit, Turkey at 3:02 AM local time on August 17, 1999. The earthquake occurred on one of the world's longest and best studied strike-slip (horizontal motion) faults - the east-west trending North Anatolian fault. Seismologists are not able to predict the timing and sizes of individual aftershocks but stochastic modeling allows determinationof probabilities for aftershocks and larger mainshocks duringintervals following the mainshock.

The most widely applied stochastic model to depict aftershocks temporal distribution is the non- homogenous Poisson process with a decaying intensity, which follows the Modified Omori Formula (MOF) (Utsu, 1961). A more complex model, considering the triggering potential of each aftershock was developed by Ogata (1988) and it was named Epidemic Type Aftershock Sequence (ETAS) model. Gospodinov and Rotondi (2006) elaborated a Restricted Epidemic Type Aftershock Sequence (RETAS) model. The latter follows the general idea that only aftershocks stronger than some cut-off magnitude possess the capability to induce secondary aftershock activity.

In this work we shall consider the Restricted Epidemic Type Aftershock Sequence (RETAS) model, for which the conditional intensity function turns out to be

$$\lambda\left(t|H_t\right) = \mu + \sum_{\substack{t_i < t \\ M_i \geq M_{th}}} \frac{K_0 e^{\alpha(M_i - M_0)}}{(t - t_i + c)^p} \tag{1}$$

Here the summation occurs for all aftershocks with magnitude bigger than or equal to M_{th}, which took place before time. Leaving M_{th} to take all possible values, one can examine all RETAS model versions between the MOF and the ETAS model on the basis of the Akaike Information Criterion AIC (Akaike, 1974)

$$AIC = -2 \max \log L + 2k \tag{2}$$

where k is the number of parameters used in the model and $\log L$ is the logarithm of the likelihood function. Then for the model providing the best fit, we choose the one with the smallest AIC value. The purpose of this paper is to verify versions of the RETAS model (including the MOF and the ETAS model) for the analysis of the aftershock sequence after the M_w=7.4 Izmit earthquake.

The obtained results revealed that the best fit model is ETAS, for which the triggering magnitude coincides with the lower cut-off. In this case each event in the sequence can generate its own secondary events.

The analysis points out that about 12 days before the Duzce earthquake a relative quiescence begins which then turns to a relative activization about 5 days before the strong shock. This can be explained by a possible realization of several stronger aftershocks before the Duzce event, which are considered as its foreshocks. Another result which can be outlined is that the MOF model is not good for a sequence in which we have secondary activity (strong aftershock or several main events).

For a complex aftershock sequence as is the case for the Izmit-Duzce zone, it is adequate to apply the RETAS model which gives more possibilities to model the aftershock activity in time. This allows to perform a better geotectonic interpretation later.

The analysis of the aftershock activity after the strong Izmit earthquake, executed through the RETAS model makes it possible to draw some conclusions when interpreting the results:

- The RETAS model supplies a methodology to identify the best fit model of the relaxation temporal development and in our case this is the ETAS model (each aftershock is capable to trigger secondary activity).

- The recognized best fit model for the sequence provides an opportunity to identify separate periods of relative quiescence and activization. A quiescence period of several days was identified before the strongest aftershock – the Duzce earthquake.

- For standard aftershock sequences the different versions of the RETAS model (ETAS, MOF and the intermediate ones) are closer to each other. For a more complex sequence with strong aftershock activity the RETAS model provides better possibilities to model the temporal aspect of the relaxation process and to perform the most adequate geotectonic interpretation.

References

Akaike, H., 1974, A new look at the statistical model identification. IEEE Trans. Automat. Contr. AC-19, 716–723.

Gospodinov, D., R. Rotondi, 2006, Statistical Analysis of Triggered Seismicity in the Kresna Region of SW Bulgaria (1904) and the Umbria-Marche Region of Central Italy (1997). Pure Appl. Geophys. 163, 1597–1615.

Ogata, Y., 1988, Statistical models for earthquake occurrences and residual analysis for point processes. J. Am. Stat. Assoc. 83, 9–27.

Utsu, T., 1961, A statistical study on the occurrence of aftershocks, Geophys. Mag., 30, 521-605