

# Editorial of the Special Issue “Statistics and Pattern Recognition Applied to the Spatio-Temporal Properties of Seismicity”

Stefania Gentili <sup>1,\*</sup> , Rita Di Giovambattista <sup>2</sup> , Robert Shcherbakov <sup>3,4</sup>  and Filippos Vallianatos <sup>5</sup>

<sup>1</sup> National Institute of Oceanography and Applied Geophysics—OGS, 33100 Udine, Italy

<sup>2</sup> National Institute of Geophysics and Volcanology (INGV), 00143 Rome, Italy; rita.digiovambattista@ingv.it

<sup>3</sup> Department of Earth Sciences, Western University, London, ON N6A 5B7, Canada; rshcherb@uwo.ca

<sup>4</sup> Department of Physics and Astronomy, Western University, London, ON N6A 3K7, Canada

<sup>5</sup> Department of Geophysics-Geothermics, Faculty of Geology and Geoenvironment, School of Sciences, National and Kapodistrian University of Athens, GR 15784 Athens, Greece; fvallian@geol.uoa.gr

\* Correspondence: sgentili@inogs.it

## 1. Summary of the Special Issue Contents

Due to the significant increase in the availability of new data in recent years, as a result of the expansion of available seismic stations, laboratory experiments, and the availability of increasingly reliable synthetic catalogs, considerable progress has been made in understanding the spatiotemporal properties of earthquakes. The study of the preparatory phase of earthquakes and the analysis of past seismicity has led to the formulation of seismicity models for the forecasting of future earthquakes or to the development of seismic hazard maps. The results are tested and validated by increasingly accurate statistical methods. A relevant part of the development of many models is the correct identification of seismicity clusters and scaling laws of background seismicity. In this collection, we present eight innovative papers that address all the above topics.

The occurrence of strong earthquakes (mainshocks) is analyzed from different perspectives in this Special Issue.

Ref. [1] proposes analysis using a medium-term earthquake prediction method (EEPAS) applied to California and New Zealand and analyzes the trade-off between time and the area identified by precursor seismicity.

Ref. [2] aims to establish the mechanical stability of a fault system by analyzing modulations of seismic activity as a function of known perturbations, in order to assess how unstable the faults are for additional stress. The method is applied to Greek seismicity.

Ref. [3] proposes a pattern recognition approach to identify areas where strong earthquakes occur, for application in seismic hazard assessment studies. The method is applied to North and South America, Eurasia, and the Pacific Rim.

Three other papers are related to triggered and clustered seismicity analyses (foreshock and aftershock).

Ref. [4] presents the modeling of aftershock occurrence rates by comparing Omori-Utsu and ETAS laws, and estimates the probability of having the largest aftershock forecasted during a given future time interval using the extreme value theory and the Bayesian predictive framework. A retrospective forecasting of three sequences in Alaska is performed.

Ref. [5] describes a new cluster identification procedure, MAP-DBSCAN, and successfully compares its performance with that of other existing methods in the literature by using synthetic catalogs. The method is then applied to obtain a characterization of Greek seismicity.

Ref. [6] proposes the use of foreshock and aftershock data together with their mainshocks to improve an earthquake prediction technique based on spatially smoothed seismicity. The method is applied to a global catalog with two different magnitude thresholds, 5.5 and 6.5, showing improved performance.



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The last two papers in the collection are closely related to the topic of the previous papers.

Ref. [7] shows an extended version of the maximum likelihood estimation method for estimating the parameters of the tapered Gutenberg–Richter distribution and their uncertainties, in the case of catalogs with a time-varying magnitude of completeness. The method is tested on synthetic catalogs and the global centroid moment tensor catalog.

Ref. [8] proposes an algorithm to simulate synthetic catalogs covering hundreds of thousands of years based on the ETAS model and seismogenic source data. The algorithm allows for obtaining a seismicity catalog, using the seismogenic model of Italian seismicity derived from the DISS catalog, that reproduces sequences characterized by multiple mainshocks of similar magnitude, a typical aspect of northern and central Apennine seismicity.

## 2. Conclusions

The eight papers published in this collection represent a non-exhaustive list of the most recent leading topics in the fields of statistical seismology and pattern recognition applied to the spatiotemporal evolution of seismicity. Given the complexity of the topic, a rigorous methodology to the approach to the study of spatiotemporal properties of seismicity is needed. Descriptions of methods and implementations of modern and advanced methodologies from multidisciplinary approaches are needed for a shared understanding of the topic and as a starting point for new research. Therefore, this collection stands as an important starting point to outline the issues of interest as well as new challenges in this field.

**Conflicts of Interest:** The authors declare no conflict of interest.

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