



University of Genova

Department of Earth, Environmental
and Life Sciences

Doctorate Course in Earth and
Environmental Science and
Technology

Earth Science Curriculum

Università degli Studi di Genova



Dottorato in Scienze e Tecnologie
per l'Ambiente e il Territorio

Research Theme n. 4

Titolo: Individuazione della fase preparatoria dei grandi terremoti mediante analisi integrata di dati sismologici e geodetici e approcci di machine learning

Title Detecting the Preparatory Phase of Large Earthquakes through Integrated Seismological and Geodetic Data Analysis and Machine Learning Approaches

Tutor: Daniele Spallarossa

Co-tutor: Matteo Picozzi (OGS Udine)

Program description including the formation program abroad

This project aims to investigate the preparatory phase of large earthquakes through the integrated analysis of seismicity and crustal deformation. Recent studies suggest that transient patterns in seismic activity and geodetic signals may precede large events, although their identification and physical interpretation remain open challenges.

The candidate will analyze seismic catalogs and waveform data from well-documented Italian earthquake sequences (e.g. L'Aquila 2009, Emilia 2012, Norcia 2016), extracting features describing the temporal and spatial evolution of seismicity (e.g. b-value, entropy, fractal properties, source parameters). These will be combined with geodetic time series (e.g. GNSS) to identify transient deformation signals potentially associated with earthquake nucleation processes.

The project will implement machine learning approaches, particularly time-series models (e.g. RNN, LSTM), to detect anomalous patterns deviating from background seismicity and to explore their relationship with physical processes in the crust. The overall aim is to develop an integrated and data-driven framework for identifying possible precursory signals of large earthquakes across different tectonic settings.

The candidate is envisioned to spend a 3 to 6-months period abroad at leading international research institutions (e.g. GFZ Potsdam, ETH Zurich, or other European centers), in order to strengthen expertise in machine learning applications and foster collaboration with international research groups.

Financial support: The financial support will be provided by ongoing and future research projects of the Seismology Laboratory at the DISTAV (Department of Earth, Environmental and Life Sciences, University of Genoa), under the supervision of Prof. Daniele Spallarossa. Workstation, computational resources and access to seismic and geodetic data infrastructures are already available.

Tutor's publications

Karimpouli S., Martínez-Garzón P., Núñez-Jara S., Picozzi M., Spallarossa D., Kwiatek G., Dresen G., Bohnhoff M., Beroza G.C 2026. Preparatory phase of large earthquakes illuminated by unsupervised categorization of earthquake catalog features. Nature Communication 2026 Accepted

Iaccarino A.G., Picozzi M., De Landro G., Spallarossa D. 2024 Preparatory Phase of Major Earthquakes During Campi Flegrei Unrest Journal of Geophysical Research Solid Earth 130(10), e2025JB031777

Bindi D., Oth A., Parolai S., Picozzi M., Spallarossa D. 2025 Interevent Variability in Ground-Motion Prediction Models: The Role of the Source Parameter Selection Bulletin of the Seismological Society of America 115(6), 2857-2866

Parolai S., Spallarossa D., Oth A., Picozzi M. (2025) A Proposal for a High-Frequency Earthquake Magnitude (m3Hz) for Seismic Hazard and Rapid Damage Assessment. Seismological Research Letters 96(3), 1665–1674

