frontiers | Frontiers in Earth Science

TYPE Editorial
PUBLISHED 02 September 2022
DOI 10.3389/feart.2022.990648

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Geohazards and Georisks, a section of the journal Frontiers in Earth Science

RECEIVED 10 July 2022
ACCEPTED 16 August 2022
PUBLISHED 02 September 2022

CITATION
Lyubushin A (2022), Editorial: Statistical and machine learning approach to earthquake forecast: Models, laboratory and field data.
Front. Earth Sci. 10:990648.
doi: 10.3389/feart.2022.990648

Editorial: Statistical and machine learning approach to earthquake forecast: Models, laboratory and field data

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KEYWORDS

complex network analysis, road network, earthquake forecast, water level in wells, seismic noise, global seismicity, probabilistic earthquake prediction, wavelets

Editorial on the Research Topic
Statistical and Machine Learning Approach to Earthquake Forecast: Models, Laboratory and Field Data

The history of earthquake prediction is replete with reports of anomalous behavior of many geophysical and geochemical characteristics. Here are some of them: electrical resistance and electromagnetic radiation of rocks, intensity of seismoacoustic emission ("underground sound"), fluctuations in the level of groundwater in deep wells and changes in their chemical composition, intensity of gas release from faults, variations in linear and volumetric deformations, as well as tilts of the crust, change in the ratio of the velocity of seismic S-waves to the velocity of P-waves, etc.

It is noteworthy that the anomalous behavior before an earthquake of almost each of the above characteristics has a reliable foundation from the corresponding physical and chemical laws of the behavior of geomaterials. Many precursor effects theoretically result from models followed by systems of differential equations derived "from first principles". Moreover, all or almost all elements of predictive behavior have received their experimental confirmation in laboratory experiments, which are long-term loading (up to destruction) of samples of geomaterials and thus simulating the preparation of a geocatastrophe source. Modern geophysics can answer many questions about the seismic process that begin with the words "why". The paradox is that this body of knowledge does not help answer questions that begin with the words "when" and "what strength".

This state of affairs is clearly in conflict with the traditional approach adopted in modern natural science, especially in that part of it that is closely related to physics (this also includes geophysics), the approach according to which you first need to understand all the "cogs" of the phenomenon, decompose it into elementary constituents, "atoms", amenable to formal mathematical description. After that, it is considered that the phenomenon is known, since it, like a toy from a children's designer, can be assembled from completely known elements.

It is now generally accepted that all critical phenomena have similar features. The study of these features can be combined under the general name "sciences of critical phenomena." Initially, critical phenomena were understood mainly as phase transitions and, therefore, it was the diocese of statistical physics and thermodynamics. However, later, when it was realized that the mathematical apparatus that describes the destruction of a building structure, the phase transition in a liquid, and the formation of caustics in optics has an amazingly much in common, the mathematical theory of catastrophes was born. The accumulation of experience in analyzing critical phenomena from a general position has led to a qualitative formulation of a relatively small number of so-called "catastrophe flags", i.e., the most general qualitative features of the behavior of any systems approaching the point of a sharp change in their state.

Due to the lack of a generally accepted physical approach to earthquake prediction, which has confirmed its effectiveness, a statistical approach based on the joint processing of a large volume of observed data in order to extract the most general informative characteristics of these data in the hope of detecting stable precursors of seismic events is of great importance. This Research Topic presents four articles that present the experience of data analysis for earthquake prediction and seismic hazard assessment.

In (Wei et al.) artificial intelligence methods were used to assess the damage and seismic risk as a result of the Wenchuan catastrophic earthquake for the transport system in China. Discriminant data analysis and machine learning methods were applied to jointly process observations of groundwater level fluctuations in wells and magnetic field variations in Georgia to build a seismic event prediction system in Georgia for magnitudes starting from 3 (Chelidze et al.). The paper (Lyubushin) gives an assessment of seismic hazard based on observations of low-frequency global seismic noise over 25 years of observations (1997–2021) and establishes the trigger effect of the irregular rotation of the Earth on seismic energy release. Using continuous wavelet analysis of time series of seismic events and subsequent classification of the results of such processing, trial forecasts of strong earthquakes for a number of regions of the Earth were constructed (Herrera et al.).

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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