frontiers | Frontiers in Earth Science

TYPE Original Research
PUBLISHED 20 February 2023
DOI 10.3389/feart.2023.1082832

OPEN ACCESS

EDITED BY
Zefeng Li,
University of Science and Technology of China, China

REVIEWED BY
Mikhail Rodkin,
Institute of Earthquake Prediction Theory and Mathematical Geophysics (RAS), Russia
Sergey Alexander Pulinets,
Space Research Institute (RAS), Russia

*CORRESPONDENCE
Bikash Sadhukhan,
bikash.sadhukhan@tict.edu.in

SPECIALTY SECTION
This article was submitted to Solid Earth Geophysics,
a section of the journal
Frontiers in Earth Science

RECEIVED 28 October 2022
ACCEPTED 31 January 2023
PUBLISHED 20 February 2023

CITATION
Sadhukhan B, Chakraborty S, Mukherjee S and Samanta RK (2023), Climatic and seismic data-driven deep learning model for earthquake magnitude prediction.
Front. Earth Sci. 11:1082832.
doi: 10.3389/feart.2023.1082832

Climatic and seismic data-driven deep learning model for earthquake magnitude prediction

Bikash Sadhukhan[1,2]*, Shayak Chakraborty[3], Somenath Mukherjee[4] and Raj Kumar Samanta[5]

[1]Department of Computer Science and Engineering, Maulana Abul Kalam Azad University of Technology, Kolkata, West Bengal, India, [2]Department of Computer Science and Engineering, Techno International New Town, Kolkata, West Bengal, India, [3]Department of Computer Science and Engineering, National Institute of Technology, Silchar, Assam, India, [4]Nazrul Center of Social and Cultural studies, Kazi Nazrul University, Asansol, India, [5]Department of Computer Science and Engineering, Dr. B. C. Roy Engineering College, Durgapur, India

The effects of global warming are felt not only in the Earth's climate but also in the geology of the planet. Modest variations in stress and pore-fluid pressure brought on by temperature variations, precipitation, air pressure, and snow coverage are hypothesized to influence seismicity on local and regional scales. Earthquakes can be anticipated by intelligently evaluating historical climatic datasets and earthquake catalogs that have been collected all over the world. This study attempts to predict the magnitude of the next probable earthquake by evaluating climate data along with eight mathematically calculated seismic parameters. Global temperature has been selected as the only climatic variable for this research, as it substantially affects the planet's ecosystem and civilization. Three popular deep neural network models, namely, long short-term memory (LSTM), bidirectional long short-term memory (Bi-LSTM), and transformer models, were used to predict the magnitude of the next earthquakes in three seismic regions: Japan, Indonesia, and the Hindu-Kush Karakoram Himalayan (HKKH) region. Several well-known metrics, such as the mean absolute error (MAE), mean squared error (MSE), log-cosh loss, and mean squared logarithmic error (MSLE), have been used to analyse these models. All models eventually settle on a small value for these cost functions, demonstrating the accuracy of these models in predicting earthquake magnitudes. These approaches produce significant and encouraging results when used to predict earthquake magnitude at diverse places, opening the way for the ultimate robust prediction mechanism that has not yet been created.

KEYWORDS

climate change, earthquake prediction, transformer model, LSTM—long short-term memory, bidirectional long short-term memory (Bi-LSTM), global temperature anomaly

1 Introduction

Climate change is defined as an alteration in the climate as measured by statistical parameters such as the global mean surface temperature. The term "climate" here refers to the long-term pattern of meteorological conditions that has prevailed over the past three decades. Climate is made up of many factors, such as temperature, humidity, precipitation, air pressure, wind speed, evaporation, cloud cover, condensation, radiation, and evapotranspiration. The climate and temperature of Earth are increasingly influenced by both natural forces, such as variations in solar radiation, and human activities, such as the burning of fossil fuels and deforestation. Changes in the relative amounts of solar radiation