Abstract

The Gutenberg-Richter (GR) power law stands as a cornerstone in seismology, elucidating the relationship between earthquake magnitude and frequency. Central to this relationship is the b-value, a key parameter that typically hovers around 1.0 in seismically active regions but can fluctuate based on geological conditions. This b-value reveals the stress regime of the Earth's crust: lower b-values signify higher stress levels and a heightened risk of larger earthquakes, while higher b-values suggest a prevalence of smaller quakes and lower stress. Monitoring variations in the b-value, both temporally and spatially, can thus offer crucial insights into impending seismic events. A sudden drop in the b-value may signal increasing stress and the potential for a major earthquake, making it an essential tool for forecasting and risk assessment.

In the northeastern region of India, the Kopili fault and its surrounding area present a significant tectonic feature. Stretching through Assam and Meghalaya, this fault zone is part of the intricate tectonic framework of the eastern Himalayas and the Indo-Burma ranges (IBR), known for its active seismicity and substantial tectonic movements. The history of significant earthquakes in this region highlights the importance of continuous research, monitoring, and preparedness to manage seismic hazards effectively.

While pinpointing the exact location and timing of future earthquakes remains elusive, a thorough analysis of earthquake precursors like the b-value offers valuable insights for seismic hazard analysis and safety measures in seismically active regions worldwide. Accordingly,

Chapter 1 offers a captivating overview of earthquakes, delving into the factors that influence their occurrence. This chapter unfolds with a discussion on earthquake precursors and the intriguing application of the GR power law in predicting

major seismic events through b-value monitoring. Additionally, it explores previous studies conducted in this region, setting the stage for the primary objectives of the thesis. To provide a clear roadmap, the chapter concludes with a detailed outline of the entire thesis.

Chapter 2 provides an insightful introduction to b-value analysis. It starts by outlining the crucial steps for compiling an earthquake catalog, including homogenization, declustering, and completeness analysis. The chapter then delves into the methods for

calculating the b-value, such as the Least Square Fit (LSF) method and Maximum Likelihood Estimation (MLE), highlighting both their advantages and limitations. Additionally, it explores the application of the b-value in the Gumbel extreme value (GEV) method to estimate seismic parameters, such as the mean return period (T(m)), the most probable maximum earthquake (H(t)), and the probabilities of earthquakes occurring over various time frames (P(t)).

Chapter 3 embarks on a fascinating exploration of potential seismic zones within a 300 km radius centered at Tezpur in the Kopili fault region, using b-value analysis. This analysis reveals four distinct seismic zones: the Northeast Himalayan Seismic Zone (NEHSZ), the Shillong–Assam Seismic Zone (SASZ), the Bengal Subsurface Seismic Zone (BSSZ), and the Indo-Burma Seismic Thrust Zone (IBSTZ). The chapter further estimates the T(m), the H(t), and the P(t) for each of these zones.

Chapter 4 delves into the spatio-temporal and depth-wise analysis of b-values preceding several recent major earthquakes, including the April 28, 2021 Assam earthquake (M_W 6.4), the November 26, 2022 Mizoram earthquake (M_W 6.1), the February 6, 2023 Gaziantep, Türkiye earthquake (M_W 7.8), and the November 9, 2022 Nepal earthquake (M_W 6.3). This analysis covers both the Kopili fault region and global observations. Unlike traditional visual inspections, this chapter employs the non-parametric Kolmogorov-Smirnov (K-S) test for a more rigorous b-value analysis.

Chapter 5 leverages the GEV approach, complemented by b-value analysis, to estimate seismic parameters for the Kopili fault zone, Indo-Burma zone (IBZ), and East Anatolian fault zone (EAFZ). This chapter meticulously calculates the T(m), the H(t), and the P(t) for each of these critical seismic zones.

Chapter 6 explores the intriguing correlation between two independent earthquake precursors: b-value anomalies and radon gas concentrations. This chapter investigates how these distinct indicators may interrelate, offering new insights into their combined predictive power for earthquake forecasting.

Finally in ***Chapter 7,*** the major outcomes of each chapter are discussed. Furthermore, the future perspective of the b-value analysis for better seismic hazard analysis has been incorporated.

Keywords: b-value, Gumbel extreme value, K-S test, Radon gas anomaly, Kopili fault zone.