



THE STUDY ON SEISMICITY ALONG MOGOD ACTIVE FAULT-2024

Ch. Baldulam, E. Unurmaa, B. Tsogtoo, N. Ichinnorow

Bulgan branch, Institute of Astronomy and Geophysics, Mongolian Academy of Sciences

Emails: baldulam@iag.ac.mn, +976-70342394

Abstract

This research investigates the seismic regime in the active earthquake zone of Mogod soum in Bulgan Province. It determines the levels of seismic activity and the recurrence of earthquakes. The Mogod fault was the source of a strong magnitude 7.5 earthquake that occurred on January 5, 1967, near Tulee Mountain, Mogod soum (latitude 48.1°N, longitude 102.9°E), producing a 45 km-long surface rupture trending from north to south. Between 1900 and 2024, a total of 32,595 earthquakes were recorded in Bulgan Province, of which 8,801 occurred in the Mogod fault region. Data were completed and analyzed using the Gutenberg-Richter law and the linear correlation method to determine seismic activity and recurrence intervals. The activity value a was calculated to be 3.24 and recurrence value b was 0.77, with analysis conducted across three distinct time periods. Windows Explorer and ArcGIS were used for data processing and visualization of epicenter distribution.

Keywords: earthquake, aftershock, magnitude, seismic scale

Introduction

Earthquakes are natural disasters that can cause severe damage such as the collapse of buildings, destruction of infrastructure, power outages, and loss of life. Although it's still not possible to fully predict earthquakes, the first step in risk reduction is mapping general and micro seismic zonation based on long-term research data. (Adiyaa, 2020)

A team of researchers led by academician S. Demberel developed a seismic tectonic map of Mongolia from 2016 to 2018, producing an updated 1:1,000,000-scale seismic zonation map. According to this map, Bulgan Province falls into a seismic hazard zone of 9–10 on the MSK-64 intensity scale (Figure 1). Bulgan is known for its seismic activity. Notably, on June 23, 1958, a magnitude 6.1 earthquake occurred at the confluence of the Orkhon River (48.7°N, 102.9°E), and on January 5, 1967, a magnitude 7.5 earthquake struck near Tulee Mountain, Mogod soum (Figure 2). Research shows active seismicity along the Mogod, Bayan-Agt, and Khutag-Undur faults, with other faults like Ulziit, Khangai, Most Tsagaan, and Batkhaan located within a 300 km radius of the provincial center This study focuses on the Mogod fault zone to investigate its seismic regime.

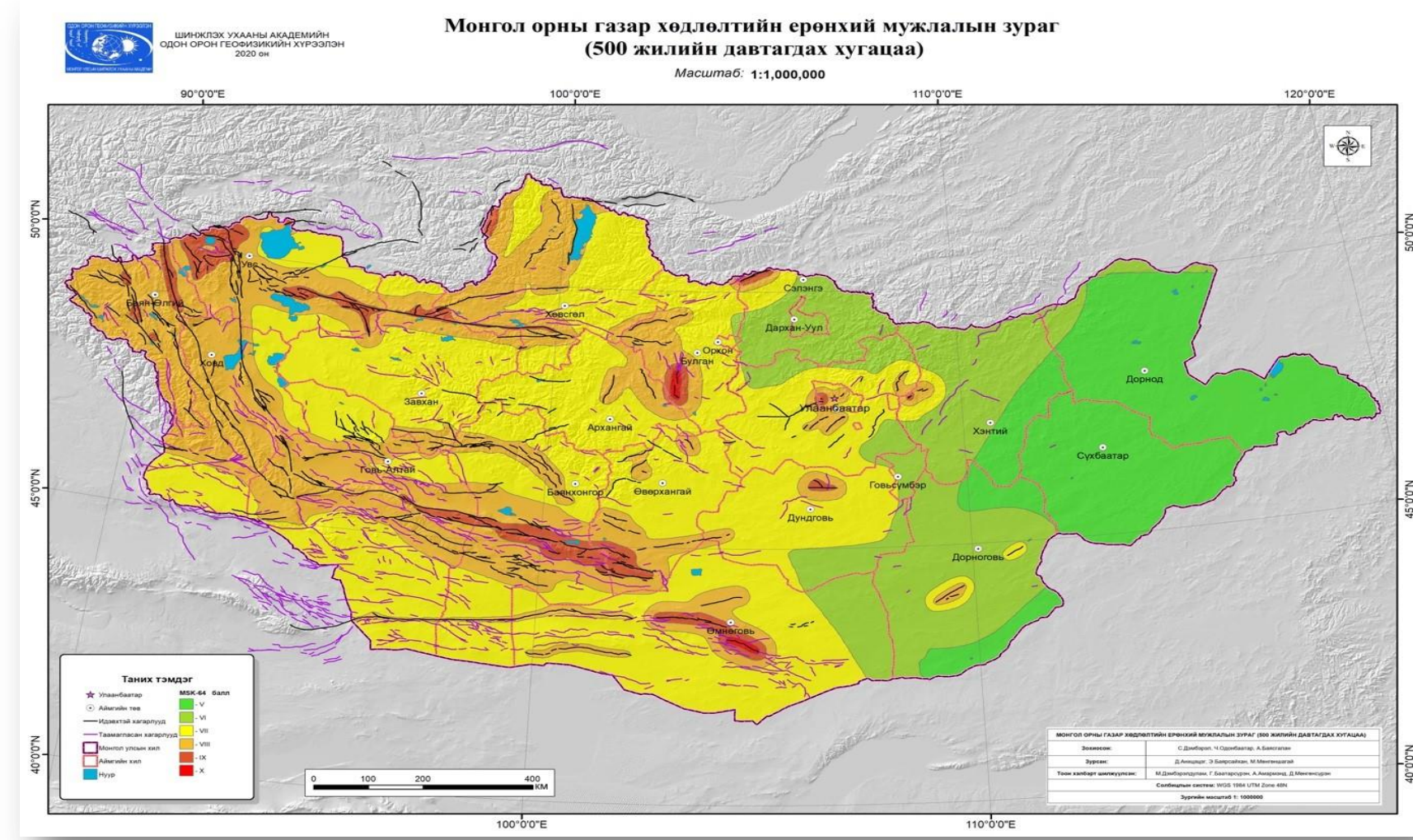


Figure 1. General Seismic Zonation Map of Mongolia (Source: Official website of the Institute of Astronomy and Geophysics)

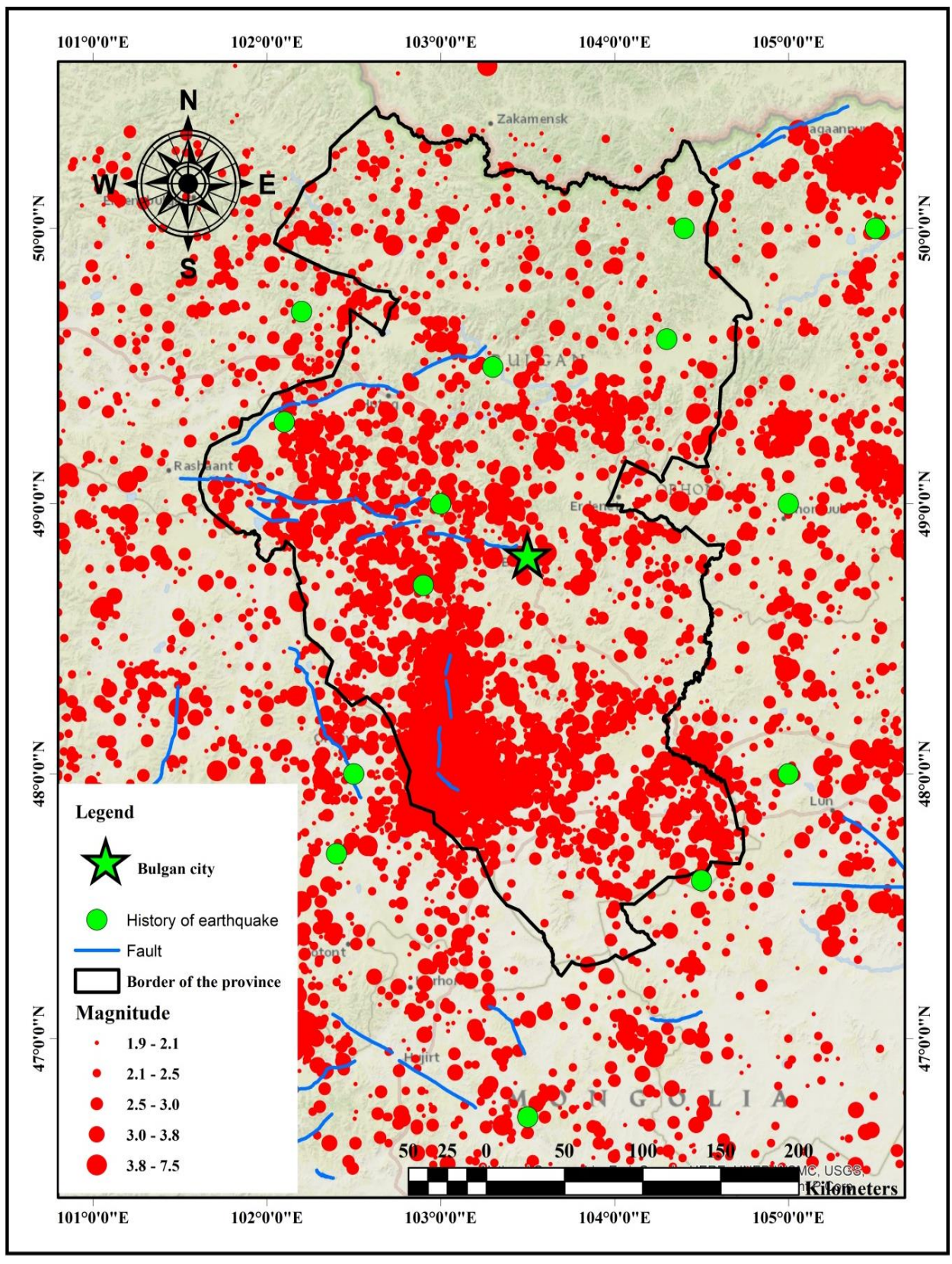


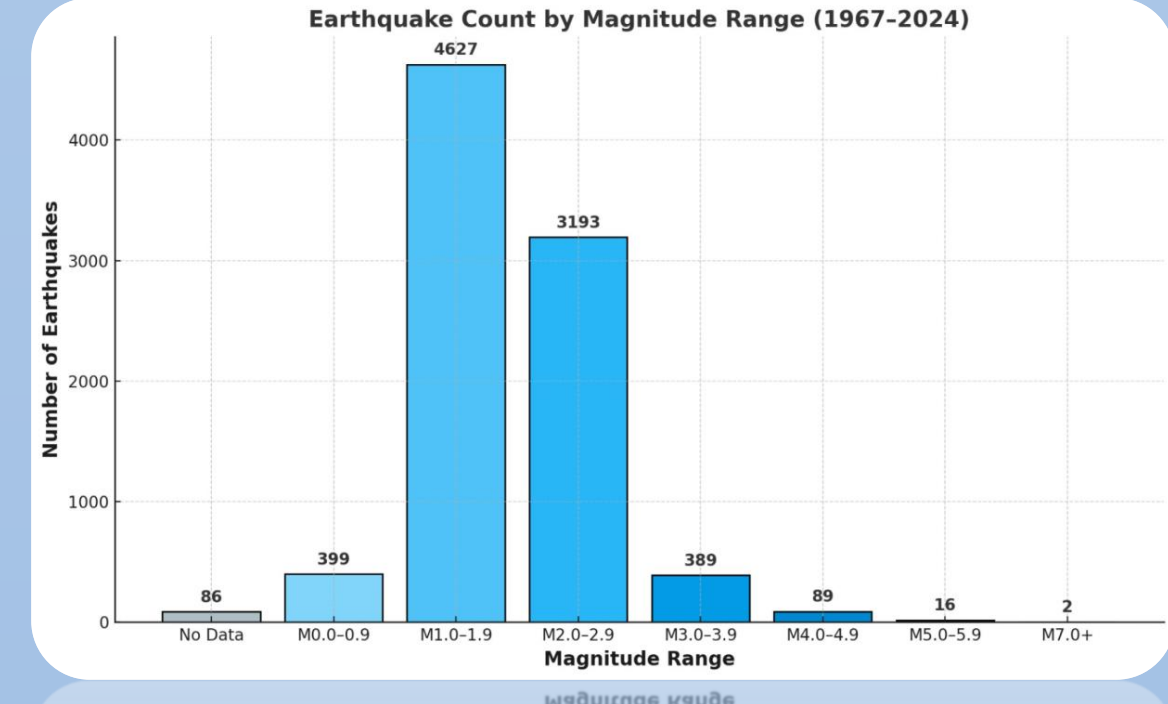
Figure 2. Epicenter Distribution Map of Bulgan Province (Based on earthquakes with $M \leq 2.0$ from 1900 to 2024)



Figure 3. Mogod Fault (Source: Official website of the Institute of Astronomy and Geophysics)

Data compilation

From 1967 to 2024, a total of 8,801 earthquakes occurred in the Mogod fault zone. Between 2012 and 2025, the highest number of $M \geq 3$ earthquakes occurred in 2013 (15 events), while the strongest quake in this period was $M_{4.64}$ on January 10, 2016 (47.93°N, 103.04°E). Of the 8,801 events:



Removing aftershocks, 3,686 $M \geq 2$ earthquakes remained for analysis and were mapped using ArcGIS (Figures 4 and 5).

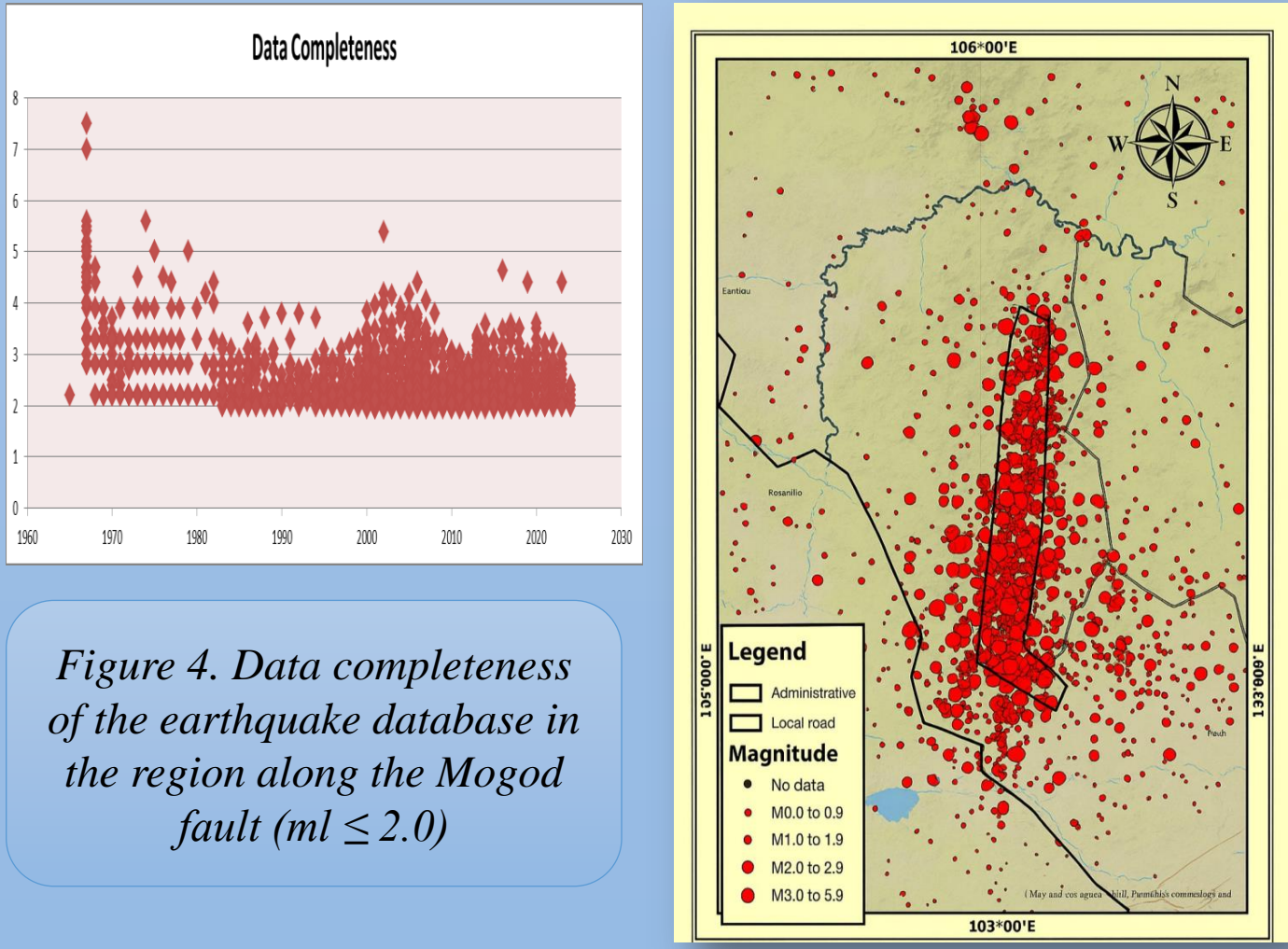


Figure 4. Data completeness of the earthquake database in the region along the Mogod fault ($m \leq 2.0$)

Figure 5. Epicenter distribution map of earthquakes in the region along the Mogod fault (based on 1967–2024 data)

Region along the Mogod Fault:

Mogod soum is located over 150 kilometers from the center of Bulgan province. In this region, a strong earthquake that occurred on January 5, 1967, caused a segmented surface rupture approximately 45 kilometers long, oriented from north to south. This powerful earthquake was felt at intensity VI–VII in the center of Bulgan province and at intensity IV–V in Ulaanbaatar city (Baljinnym et al., 1975, p. 24). For this area, the seismic activity parameter a and the recurrence parameter b of strong earthquakes were calculated by dividing the data into time periods. The time classifications were selected based on major earthquakes in the region and the modernization of technical equipment at seismic recording stations.

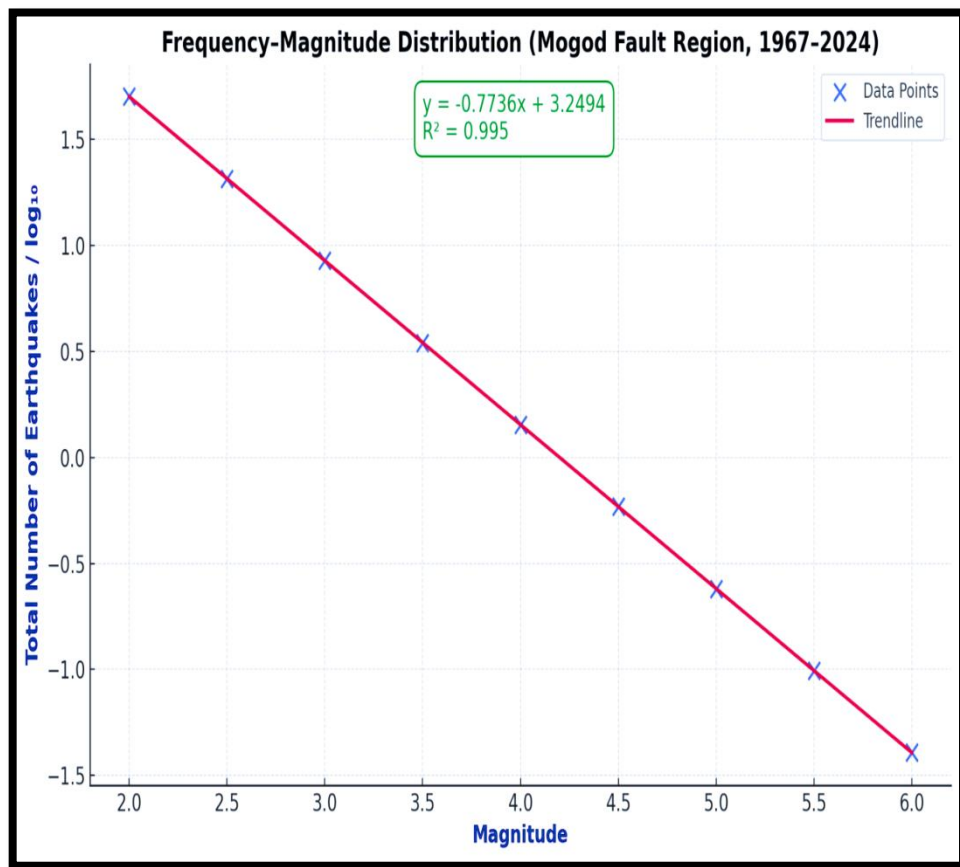


Figure 1. Seismic Frequency Curve in the Mogod Fault Region (Based on data from 1967 to 2024)

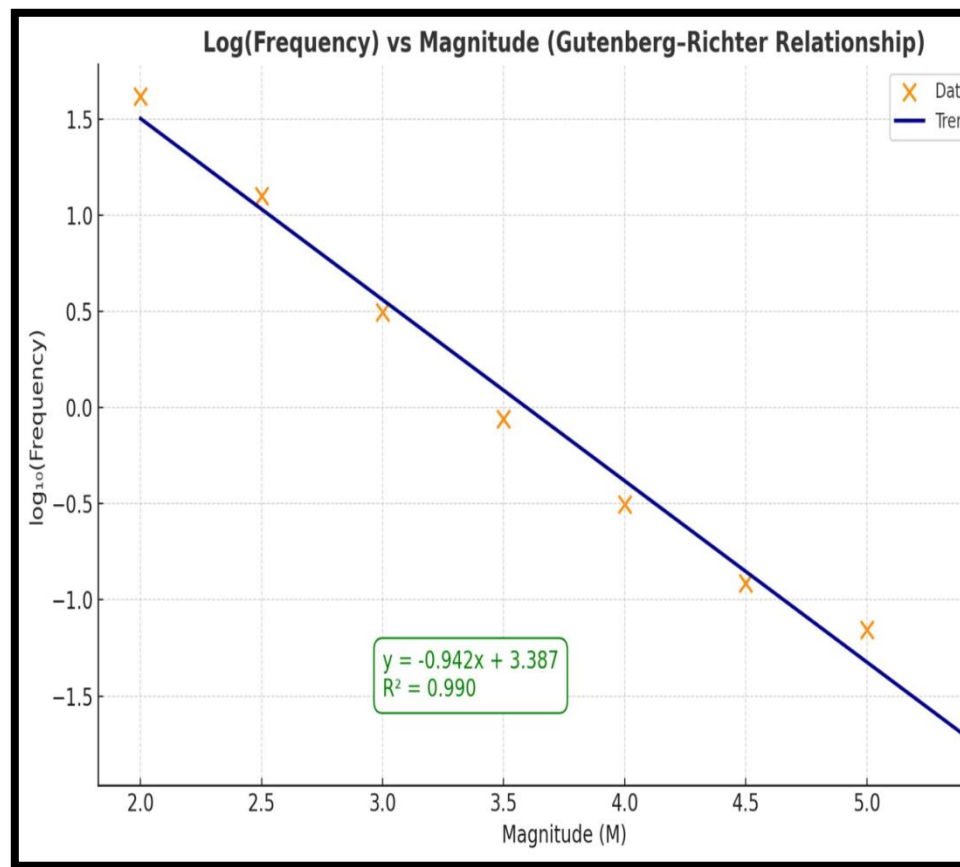


Figure 2. Seismic Frequency Curve in the Mogod Fault Region (Based on data from 1974 to 2024)

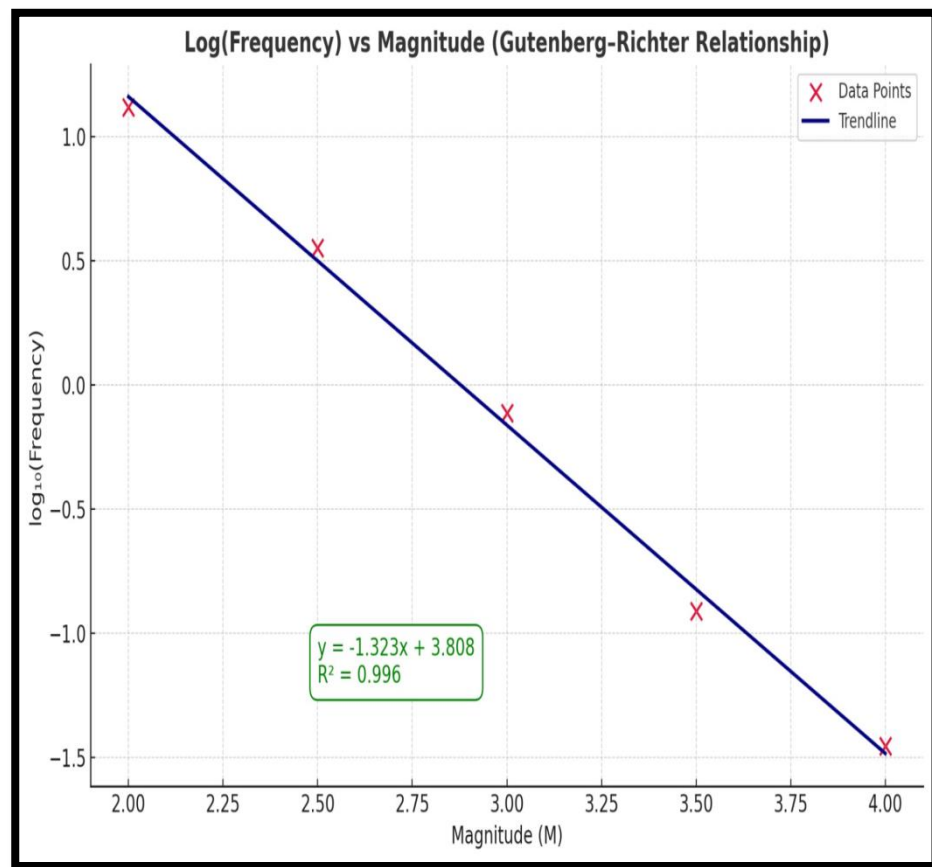


Figure 3. Seismic Frequency Curve in the Mogod Fault Region (Based on data from 2011 to 2024)

1. Calculations were made using earthquake data from 1967 to 2024. On January 5, 1967, an earthquake with a magnitude of 7.5 occurred near Tulee Mountain in Mogod soum. Aftershocks following this major quake were excluded, and 3,686 earthquakes were used for the calculation. The seismic activity value a was determined to be 3.24 and the recurrence value b was 0.77. This suggests that the region has high seismic activity, influenced by the recurrence of strong earthquakes.

2. Information from 1698 earthquakes recorded between 1974 and 2024 was used for calculations. The reason for selecting this period is linked to the increased capability for earthquake registration due to the establishment of a new earthquake recording station in Bulgan Province in 1973. As a result of the calculations, the value of seismic activity a was 3.33, while the value of repetition b was 0.94.

3. In September 2011, the GURALP station was established in 3 units and began recording near and far earthquakes by installing a wave receiver in a 2m deep hole in the basalt layer at the top of a mountain in the area of "Tasarkhain Sair" in the Achuut region of Orkhon soum, Bulgan aimag. (Bulgan station, 2022). As a result of the calculations, the value of seismic activity a was 3.8, while the value of repetition b was 1.3.

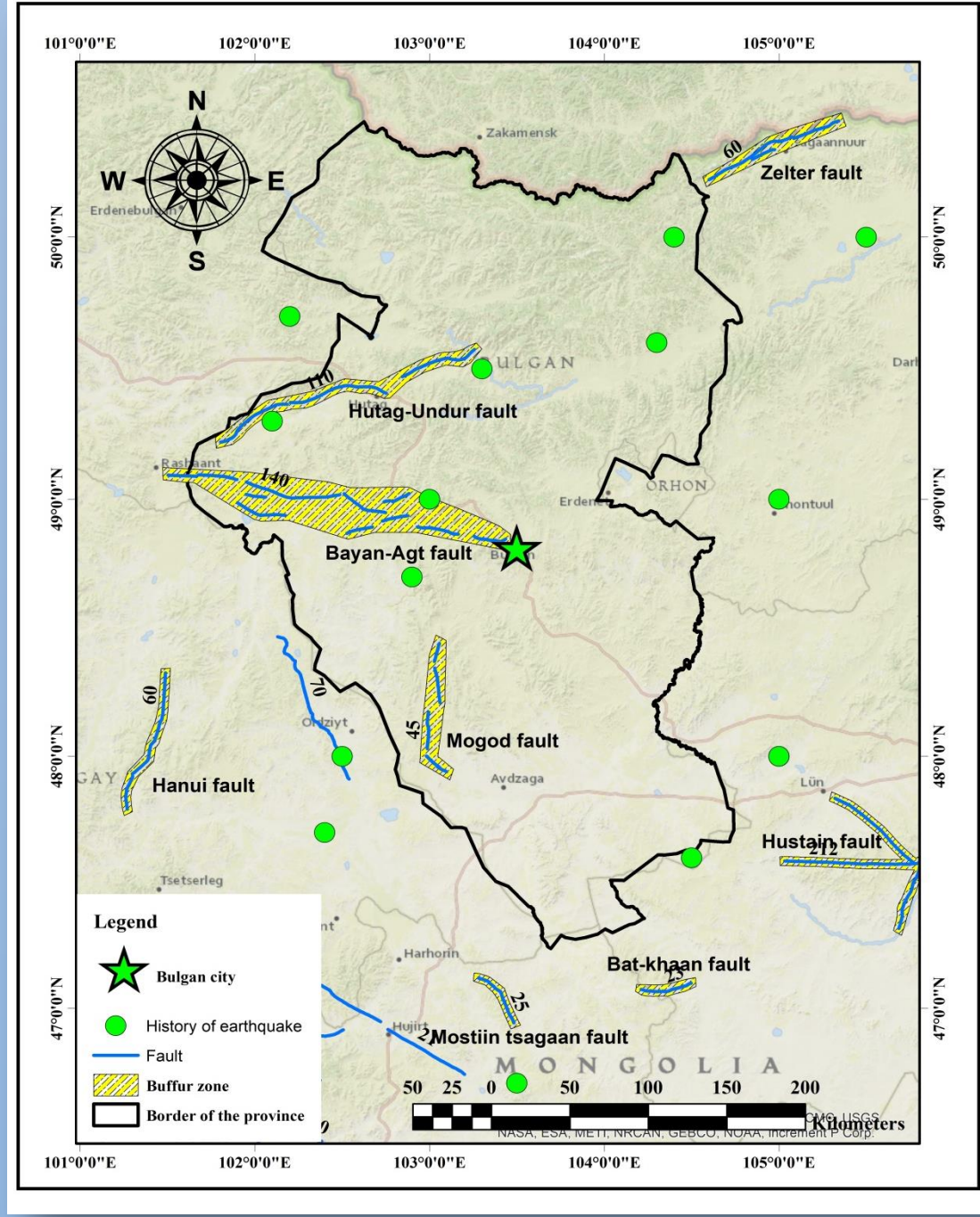
Results

Mogod soum is located 150+ km from Bulgan city. The 1967 earthquake created a 45 km-long surface rupture that reached seismic intensities of VI–VII in Bulgan and IV–V in Ulaanbaatar (Baljinnym et al., 1975).. Based on previous seismic regime studies conducted in the Mogod fault zone using data from 1964 to 2008, the seismic activity parameter a was estimated at 5.686, and the recurrence rate parameter b was 1.01 (Adyaa, 2010). In contrast, the results of this current study, based on data from 1967 to 2024, yielded an a -value of 3.24 and a b -value of 0.77. Compared to earlier findings, the activity appears to be lower; however, the lower b -value indicates a higher probability of strong earthquake occurrences. Based on the selected time intervals, the Mogod fault region experienced two magnitude 7.0 earthquakes over the past 57 years, one magnitude 5.5 earthquake over the past 50 years, and two magnitude 4.5 earthquakes in the last 13 years.

Three time periods were analyzed:

Time Period	a Value	b Value	R ²
1967–2024 (57 yrs)	3.2494	0.7736	0.995
1974–2024 (50 yrs)	3.3869	0.9419	0.990
2011–2024 (13 yrs)	3.8076	1.3229	0.9965

Figure 6. Earthquake Fault Zones within the Territory of Bulgan Province



The Mogod fault is located over 150 km from the center of Bulgan province, more than 200 km from the densely populated city of Erdenet, and about 350 km from the capital city Ulaanbaatar. This geographic proximity highlights the potential for significant disaster risk and damage in the event of a strong earthquake in the region. Therefore, continuous monitoring of the a and b values in this seismically active zone is an important step toward the early prediction of large earthquakes. Ongoing studies like this one provide valuable foundational data for earthquake hazard assessments within Bulgan province and contribute to the development of a comprehensive seismic database, making it highly practical for disaster preparedness and risk reduction.

References

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Research Methodology

Seismic regime studies analyze the spatial, temporal, and energy characteristics of earthquakes and are vital for seismic hazard assessment, recurrence prediction, and zonation mapping. These studies contribute significantly to national and urban seismic maps and carry major economic importance. Key criteria for conducting seismic regime studies include:

- Precise time records of earthquakes in the selected area
- Geological analysis of the faulted region
- Analysis of how wave attenuation and seismic direction are influenced by geology

The main seismic regime parameters—activity (a) and recurrence (b)—are calculated using the Gutenberg-Richter formula:

$$\log N = a - bM$$

Where:

N is the number of earthquakes
 M is the magnitude