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Research Article

A Comprehensive Case Study on the Historical Earthquakes in Major Fault Zones of Bangladesh

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Abstract

An earthquake is a fatal natural disaster that occurs suddenly without any prior signal. Every year the world faces many earthquakes with magnitudes varying from low to high. The uncertain nature of earthquakes makes it almost impossible to predict the exact time of occurrence. So, it is necessary to take precautionary steps before an earthquake hits. To take preventive measures, a proper study of tectonic plates and faults must be done to gain insight into the study area's susceptibility. Due to the geological characteristics and tectonic plate activity, Bangladesh risks facing an Earthquake. Every year, Bangladesh also faces some number of earthquakes of different magnitude. This study analyzes the earthquake events in different fault zone of Bangladesh in the last 49 years. The study showed that the Tripura Fault and Shillong Plateau are the most active among the five major faults. The frequency of these faults is higher than the other ones. Though the past earthquake magnitudes were small, it is still concerning that the Tripura fault and Shillong plateau show much more frequent seismic activities that may indicate a bigger earthquake incident in the near future. The epicenter depth of most earthquakes is within 40 km from the surface, which is a concerning issue because most earthquakes are shallow earthquakes that tend to have more damaging properties than deep ones.

1. Introduction

An earthquake is a sudden shaking of the ground surface that results from a sudden release of energy from Earth's inner layer known as the Lithosphere [1]. In the most general sense, an earthquake can be termed any seismic incident that may be natural or caused by human activity. Each year, the world suffers from at least 500,000 [2] earthquake incidents; 100,000 can be felt, and about 100 can cause damage [3]. Earthquakes are one of the most devastating disasters that affect human life, property, and economy. To understand how deadly this disaster can be, the Earthquake in Tangshan, China, in 1976 can be shown as an example which killed approximately 255,000 people [4]. In 1995, the Kobe earthquake hit the Kobe city of Japan, killing approximately 143,000 people with a $200 billion economic loss [5]. Earthquakes can

range in intensity from weak, which may not be felt by humans, to strong, which can cause heavy damage to human life and properties. Earthquakes can be classified into two types by their epicenter depth: Shallow and Deep. If the depth of the epicenter is 0 to 60 kilometers, then the earthquake can be termed as Shallow; if the depth is more than 300-700 kilometers, it can be termed as deep [6], and earthquakes with a depth of 60-300 are termed as intermediate [7]. Different scales are used to measure the magnitude of an earthquake, such as The Richter Scale, The Moment Magnitude Scale, and The Mercalli Scale [8]. Naturally occurring Earthquakes can occur anywhere, but most earthquakes occur in the fault plains near tectonic plate boundaries. So, to study earthquakes, it is better to study the fault plains and tectonic plates to get better insight into this disaster.

Bangladesh is a country in Southeast Asia that India surrounds. Geographically, Bangladesh has nearby two subduction zones created by two active tectonic plates known as the Eurasian Plate and the Indian Plate [9], and at the ea is the Burmese Plate. Although the Australian and the African plate is moving at a rate of ~2-4 cm/year, the Indian Plate is moving at a rate of ~5 cm/year after breaking from the Gondwanaland [10]. Due to this movement of the Indian Plate, it collides with the Eurasian Plate at a rate of ~4.5 cm/year and with the Burmese Plate at a rate of ~4.6 cm/year [11]. Due to these geological characteristics, Bangladesh is prone to earthquake incidents.

Historically, Bangladesh faced many earthquakes which were mild to devastating in terms of intensity. On Jun. 12, 1897, Bangladesh faced the most devastating earthquake. An earthquake of 8.2-8.3 on the Moment Magnitude Scale (M_w) originating in Assam devastatingly affected this area [12]. Although an earthquake of this magnitude can happen once in a thousand years, earthquakes of magnitude 6-7 on the Moment Magnitude Scale (M_w) can occur much more frequently. After its independence in 1971, Bangladesh faced almost 250 Earthquake incidents [13]. Though most earthquakes in the last 49 years were small ones with a magnitude of 4-5 on Moment Magnitude Scale (M_w), a large earthquake can happen anytime, so a proper investigation is necessary. Due to the lack of recent major earthquake incidents, the people of Bangladesh have been complacent about the risk associated with earthquakes. Proper Seismic Hazard Analysis (SHA) is necessary before starting every single project in this country to reduce the risk associated with earthquakes. However, unfortunately, in Bangladesh, SHA is a quite new concept [14] that still has to be adopted for every single project. For an effective SHA, an updated Seismic Zonation Map is required.

The Geological Survey of India developed Bangladesh's first Seismic Zonation in 1935 [14]. After that, it was adopted by Bangladesh Meteorological Department in 1972 [14]. After that, a seismic zonation map with different seismic coefficients was introduced. For an accurate earthquake hazard zonation map, it is necessary to analyze the past earthquake history to create a probabilistic model that can provide an accurate seismic coefficient.

This paper adds the historical earthquake incidents and their occurrence time, magnitude, and epicenter depth to evaluate the seismic activity of different fault zones. Using the data, this study analyzes the frequency and magnitude of different earthquake incidents in and near the fault zones of Bangladesh to get an idea of the current condition of the fault zones. This will help the engineers and policymakers to have an in-depth idea regarding future earthquake occurrence in the fault zones.

2. Methodology

2.1 Study area

This study includes a comprehensive case study on the historical earthquake incidents of the major fault zones around Bangladesh. Bangladesh is a country in Southeast Asia situated at 23°41'39.52" N 90°20'39.67" E [15]. Bangladesh has geological features that make this country vulnerable to earthquake incidents. Being at the junction of three very active tectonic plates and at the Ganges River delta, the risk of earthquake and tsunami increases. Figure 1 shows different tectonic plate locations around Bangladesh.

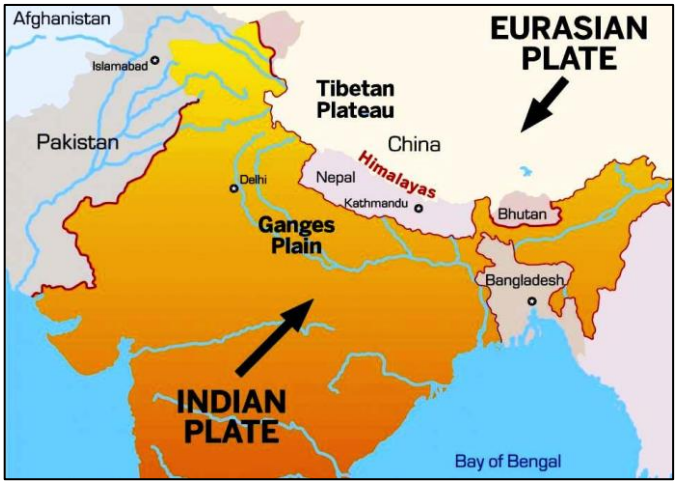

Figure 1. Tectonic plates around Bangladesh [16]

Considering the tectonics, five major fault locations are significant for the occurrence of major earthquake events. These fault zones are:

- Dauki Fault Zone.

- Bogra Fault Zone.
- Tripura Fault Zone.
- Assam Fault Zone
- Shillong Plateau.

The Dauki fault is near the southern part of the Shillong Plateau. It is a 300 km north-dipping reverse fault and is believed to be active based on different geomorphic, geophysical, and geological data [17]. Historically there have been some major earthquake events in this zone.

The Bogra fault is located near Bogra and Jamuna Rivers in Bangladesh. It is a normal or gravity-type fault [18]. The Tripura Fault is located in the Tripura state of India. Bangladesh surrounds this state. The Tripura-Naga orogenic belt is a zone of highly faulted tertiary deposits that results in earthquakes of moderate magnitude [18].

The Assam Fault is located near the Tripura Fault. These faults created a newly discovered megathrust fault zone with a risk of an earthquake of magnitude 9.0 on the Moment Magnitude Scale (Mw) [19].

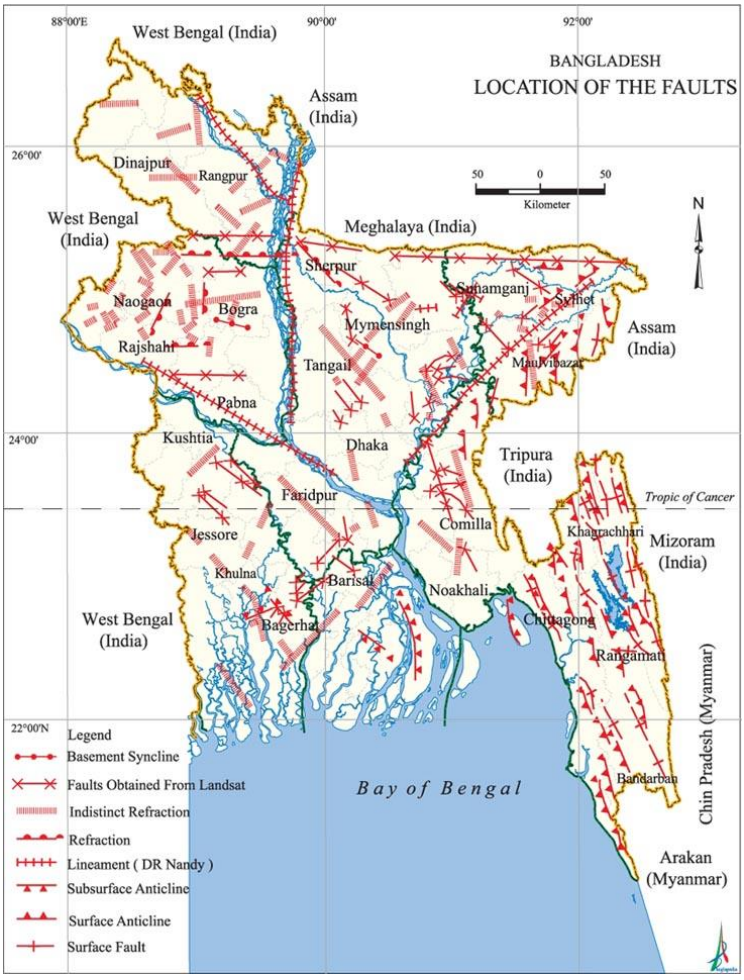

Figure 2. Different fault zones of Bangladesh [20]

The Shillong Plateau is located near Shillong, India. The great 1897 earthquake was generated from the northern edge of the Shillong Plateau [12]. In Figure 2, different fault zones in and around Bangladesh are shown.

2.2 Data Collection

This study includes the historical earthquake incident data of different fault zones near Bangladesh. These data were collected from the United States Geological Survey (USGS) database. Data were collected for different fault zones. Collected data were cleaned, and only Date, Place, Latitude, Longitude, Epicenter depth, and magnitude were kept for analysis.

2.3 Data Analysis

For analyzing the obtained data, Microsoft Excel was used. From the data, historical earthquake magnitude was obtained, and the number of earthquakes of each magnitude was shown graphically. After that, the number of yearly earthquake incidents was analyzed to check the yearly increase or decrease of earthquake incidents in a fault zone. Lastly, the relationship between earthquake epicenter depth and magnitude was analyzed to get a close insight into the fault zone regarding the type of earthquake.

3. Result and Discussion

3.1 Dauki Fault

Table 1 represents the earthquake incidents near the Dauki fault from 1973 to 2022. These data are obtained from [21].

Table 1. Earthquake incidents near Dauki Fault

Date	Latitude	Longitude	Depth (km)	Magnitude *(Mw)*	Place
2020-11-02	25.7773	91.1728	10	4.5	30 km NNW of Nongstoin, India
2019-03-21	25.6452	90.9083	10	4.4	38 km WNW of Nongstoin, India
2018-08-17	25.6357	90.9299	10	3.8	36 km WNW of Nongstoin, India
2017-12-11	25.725	90.8605	10	4.6	46 km WNW of Nongstoin, India
2017-09-07	25.275	90.2279	36.67	4.1	26 km S of Tura, India
2017-04-25	25.6263	90.8833	31.19	4.3	40 km WNW of Nongstoin, India
2017-04-18	25.0632	91.6394	34.06	4.5	4 km NW of Chhatak, Bangladesh
2017-02-12	25.548	91.1035	36.94	4.4	16 km WNW of Nongstoin, India
2017-01-24	25.6419	91.8799	35	4.3	8 km N of Shillong, India
2016-05-07	25.4013	91.7893	37.62	4.1	14 km NE of Cherrapunji, India

2016-04-05	25.7595	90.5452	10	5	38 km SE of Lakhipur, India
2014-09-12	25.6524	89.9947	15	4.1	18 km NE of Mankachar, India
2012-09-06	25.455	91.208	45.1	4.5	8 km SW of Nongstoin, India
2011-09-18	25.759	91.178	37.1	4	28 km NNW of Nongstoin, India
2010-09-11	25.72	90.205	22.3	4.5	22 km N of Tura, India
2008-12-23	24.998	91.966	41.7	4	14 km NE of Sylhet, Bangladesh
2007-09-18	25.241	91.13	40	4.3	33 km SSW of Nongstoin, India
2007-01-24	25.686	89.86	19.6	4.1	16 km N of Mankachar, India
2006-06-19	25.529	90.676	40.9	4.2	47 km E of Tura, India
2005-12-31	25.732	90.384	35	4.2	30 km NE of Tura, India
2005-05-03	25.764	91.059	33.6	4.3	34 km NW of Nongstoin, India
2005-02-27	25.371	91.553	24.9	4.2	16 km WNW of Cherrapunji, India
2003-12-06	25.596	90.25	26.7	4.4	10 km NNE of Tura, India
2003-12-02	25.787	90.392	23.1	3.8	28 km SSE of Lakhipur, India
2002-07-20	25.091	92.139	33	4.3	32 km NW of Kar?mganj, India
2000-11-09	25.376	91.426	37.5	4.2	22 km SE of Nongstoin, India
1997-08-06	25.632	92.185	41.3	4.9	31 km ENE of Shillong, India
1996-10-25	25.384	91.759	61	3.8	11 km NE of Cherrapunji, India
1994-09-28	25.63	90.647	10	4	46 km ENE of Tura, India
1993-03-03	25.419	90.23	33	4.5	10 km SSE of Tura, India
1992-12-12	25.473	91.414	40.7	5	15 km ESE of Nongstoin, India
1992-08-08	25.394	91.912	49.5	4.3	19 km S of Shillong, India
1992-04-20	25.842	90.569	54.7	4.2	33 km SE of Lakhipur, India
1991-08-22	25.03	91.33	33	4.7	34 km W of Chhatak, Bangladesh
1991-02-03	25.394	91.662	33	3.8	10 km NNW of Cherrapunji, India
1991-02-02	25.541	91.293	33	4.9	3 km NE of Nongstoin, India
1989-04-29	25.246	91.604	33	4.3	11 km WSW of Cherrapunji, India
1986-10-14	25.035	91.976	33	4.7	18 km NE of Sylhet, Bangladesh
1986-09-10	25.385	92.077	43.1	5.2	28 km SE of Shillong, India
1986-02-19	25.136	91.184	17.5	5.3	42 km S of Nongstoin, India
1985-06-17	25.591	90.229	22.3	4.7	8 km NNE of Tura, India
1984-09-30	25.363	91.468	33	5.1	23 km WNW of Cherrapunji, India
1983-01-19	25.637	91.288	10	4.9	13 km N of Nongstoin, India
1982-09-21	25.147	91.397	33	4.6	30 km WNW of Chhatak, Bangladesh
1982-08-31	25.381	91.472	33	5	24 km WNW of Cherrapunji, India
1982-02-26	25.567	90.749	63.9	4.7	52 km W of Nongstoin, India
1982-01-28	25.174	90.664	33	4.2	32 km NNW of Netrakona, Bangladesh
1980-06-11	25.759	90.213	33	4.8	27 km N of Tura, India
1974-09-21	25.68	90.908	27	4.7	40 km WNW of Nongstoin, India
1974-05-15	25.547	91.799	32	4.5	8 km WSW of Shillong, India
1973-11-02	25.723	91.603	20	4.8	18 km N of Mairang, India

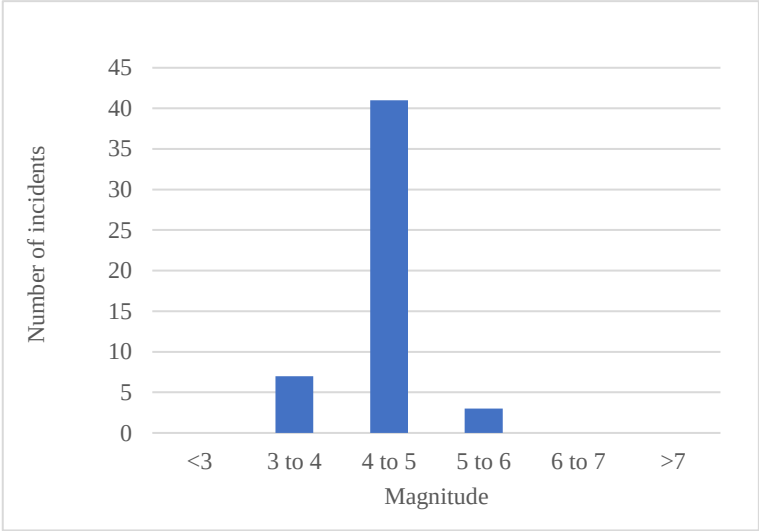

Figure 3. Number of earthquakes of different magnitude

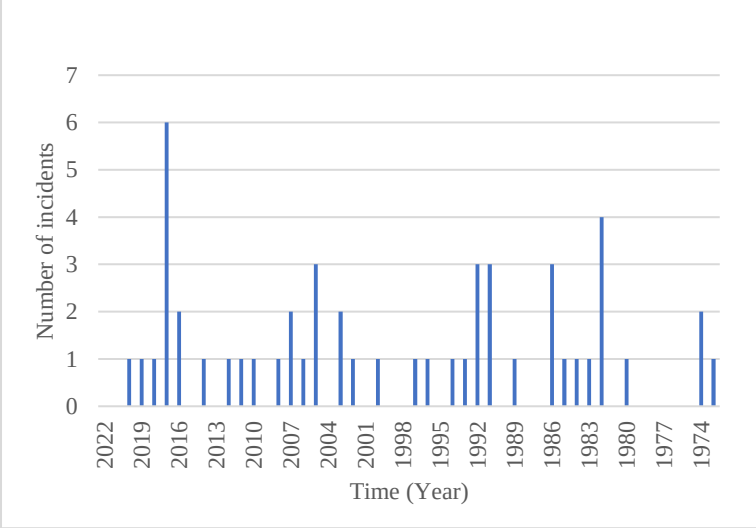

Figure 4. Yearly earthquake incidents

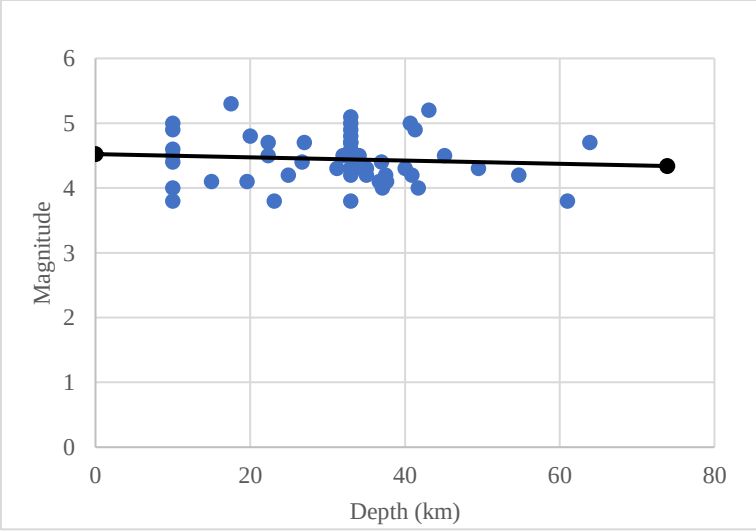

Figure 5. Magnitude vs. Epicenter depth data

Figure 3 shows that most earthquake incidents had a magnitude of 4 to 5 on Moment Magnitude Scale. Major Earthquakes of 7 (Mw) or more magnitude did not happen in the studied timeframe.

Figure 4 shows a yearly variation of earthquake incidents. The trend of incidents looks quite similar for this fault zone. The frequency of earthquakes stays quite low, but after 8-10 years, a sudden increase in incidents can be seen. Also, the recent trend shows an overall increase in yearly earthquake incidents.

In Figure 5, it can be seen that most earthquakes had an epicenter depth of 20-40 km. These earthquakes are shallow.

3.2 Bogra Fault

Table 2 represents the earthquake incidents near the Bogra fault from 1973 to 2022. These data are obtained from [21].

Table 2. Earthquake incidents near Bogra Fault

Date	Latitude	Longitude	Depth (km)	Magnitude *(Mw)*	Place
2020-02-25	24.5467	90.1767	10	4	25 km N of Sakhipur, Bangladesh
2019-02-26	24.0741	90.2941	10	3.7	20 km E of Mirzapur, Bangladesh
2018-01-30	24.5706	89.5825	16.25	4.4	17 km NW of Sirajganj, Bangladesh
2015-12-21	24.413	90.681	14.2	4	3 km SE of Gafargaon, Bangladesh
2014-02-14	24.4221	89.4984	14.43	4.2	21 km W of Sirajganj, Bangladesh
2012-03-18	23.662	90.259	44	4.5	14 km ENE of Dohar, Bangladesh
2008-07-26	24.788	90.536	17.5	4.8	13 km ENE of Mymensingh, Bangladesh
2008-03-20	23.873	90.033	35	3.8	10 km NW of Parvez Ali, Bangladesh
2006-08-05	23.662	89.885	10	4.2	7 km NE of Faridpur, Bangladesh
2001-12-19	23.632	90.376	10	4.5	9 km SSW of Dhaka, Bangladesh

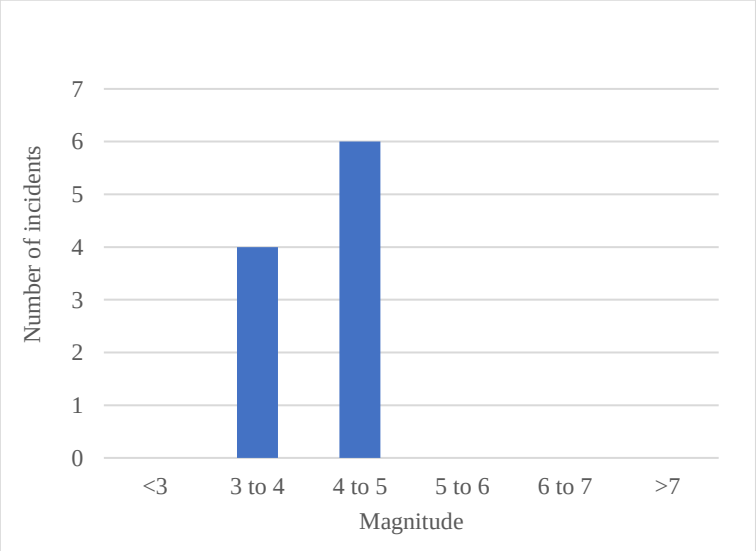

Figure 6. Number of earthquakes of different magnitude

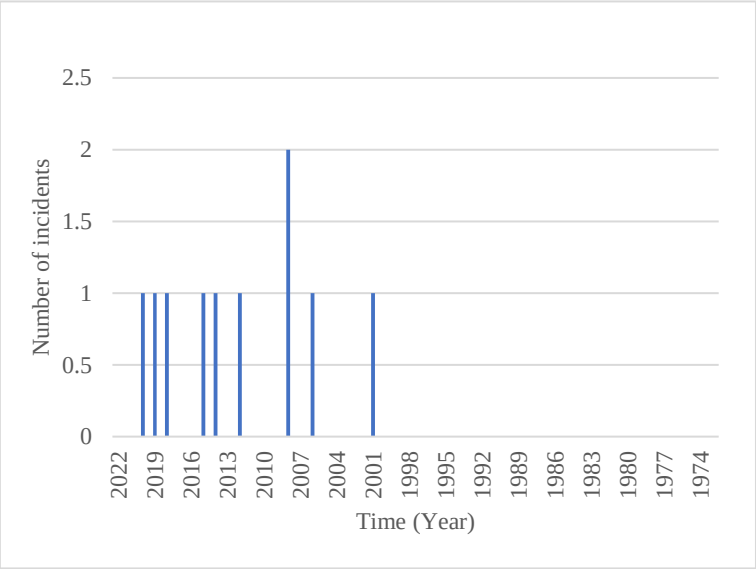

Figure 7. Yearly earthquake incidents

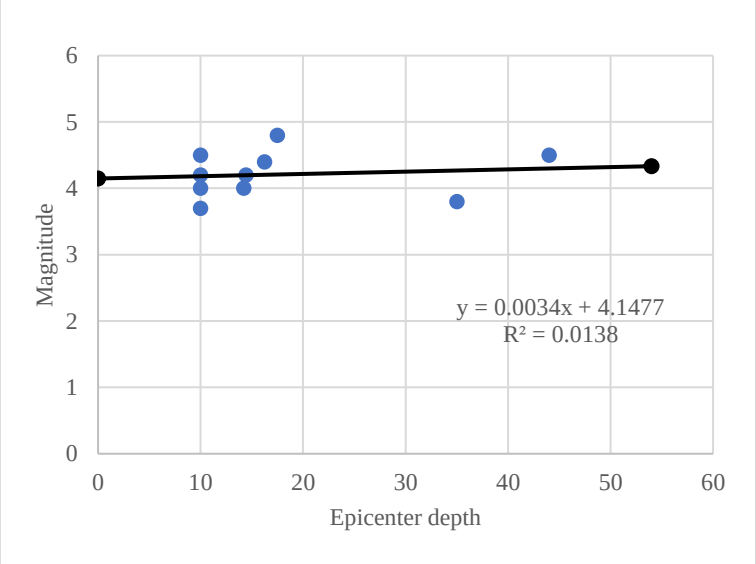

Figure 8. Magnitude vs. Epicenter depth data

Figure 6 shows that most earthquake incidents had a magnitude of 4 to 5 on Moment Magnitude Scale (Mw). Major Earthquakes of 7 on the Moment Magnitude Scale (Mw) or more magnitude did not happen in the studied timeframe.

Figure 7 shows a quite similar trend in the number of earthquakes per year, which is quite low. This indicates that the Bogra fault is inactive, and future earthquake probability is also lower than other faults.

Also, Figure 8 shows that most earthquakes had an epicenter depth of 0-20 km. These earthquakes are shallow.

3.3 Tripura Fault

Table 3 represents the earthquake incidents near the Tripura fault from 1973 to 2022. These data are obtained from [21].

Table 3. Earthquake incidents near Tripura Fault

Date	Latitude	Longitude	Depth (km)	Magnitude *(Mw)*	Place
2022-07-26	23.5693	93.2709	42.7	4.6	25 km NE of Khawhai, India
2021-10-19	22.5257	92.7906	35	4.8	19 km W of Saiha, India
2020-10-24	23.1224	92.2965	44.64	4.4	33 km E of Khagrachhari, Bangladesh
2020-08-30	23.41	92.0138	37.66	4.9	33 km N of Khagrachhari, Bangladesh
2020-08-27	23.0656	93.2324	10	4.5	18 km ESE of North Vanlaiphai, India
2020-06-24	23.206	93.2628	4.58	4.5	21 km ENE of North Vanlaiphai, India
2020-06-23	23.9312	93.0128	10	3.6	12 km SE of Darlawn, India
2020-06-21	23.9075	93.1135	41.6	4.9	22 km ESE of Darlawn, India
2019-02-17	22.4139	92.8472	10	4.8	16 km WSW of Saiha, India
2018-03-30	22.1644	92.8036	32.09	4.1	40 km SSW of Saiha, India
2017-11-08	24.0923	91.2855	29.51	4.9	28 km N of Agartala, India
2017-07-21	24.1789	92.2002	38.77	4.4	21 km S of Dharmanagar, India
2017-01-03	24.0151	92.0177	32	5.7	18 km ENE of Ambassa, India
2016-10-26	23.1261	92.8708	50.3	4.7	18 km S of Serchhip, India
2016-06-27	22.7084	92.0667	10	4.7	24 km NE of Raojan, Bangladesh
2015-10-28	24.1002	92.8262	38.49	4.3	13 km NW of Darlawn, India
2015-05-25	22.1323	93.2059	53.29	4.5	46 km SSE of Saiha, India
2015-01-15	22.6215	92.6144	50.37	4.3	32 km SSW of Lunglei, India
2014-12-22	22.4184	93.0824	48.25	4.4	13 km SE of Saiha, India
2014-09-09	22.1989	93.244	10	5.4	42 km SE of Saiha, India
2014-08-17	23.6717	91.4071	38	4.1	7 km NE of Barjala, India
2014-06-09	24.1878	91.5293	31.79	4.1	13 km NNW of Khowai, India
2014-04-04	23.0504	93.1676	41.45	4.2	13 km SE of North Vanlaiphai, India
2014-02-28	23.7432	91.3541	37.8	3.9	10 km S of Ranir Bazar, India
2014-01-20	22.1231	92.7127	32.08	4.1	49 km SW of Saiha, India
2013-12-30	24.1788	93.1207	38.13	4.2	27 km NE of Darlawn, India
2013-07-08	23.84	91.359	10.1	4.1	0 km NW of Ranir Bazar, India
2012-12-30	24.209	91.782	22.5	4.3	5 km WNW of Kamalpur, India
2012-12-13	22.222	92.592	10	4.2	38 km E of Bandarban, Bangladesh
2012-11-25	23.62	91.482	39.8	4.5	9 km N of Udaipur, India
2012-07-17	23.054	93.074	47.6	4.4	8 km S of North Vanlaiphai, India
2012-01-01	23.472	91.834	27.8	4.6	18 km ESE of Amarpur, India
2011-06-23	23.887	91.484	35	4.4	13 km ENE of Ranir Bazar, India
2011-05-03	23.686	91.321	10	4	8 km NNW of Barjala, India
2011-04-19	23.772	92.866	38.1	4.1	15 km ENE of Aizawl, India

2011-02-12	23.248	90.998	10	4.1	12 km W of Laksham, Bangladesh
2011-01-27	23.811	92.9	10	4.1	20 km ENE of Aizawl, India
2009-12-13	21.998	91.822	10	4.9	25 km WSW of Satkania, Bangladesh
2009-12-13	21.999	91.811	17.3	4.6	26 km WSW of Satkania, Bangladesh
2009-12-11	21.096	92.529	34.5	4.1	35 km NE of Teknaf, Bangladesh
2009-06-03	23.356	93.21	45.3	4.3	8 km ESE of Khawhai, India
2009-02-25	23.291	92.82	35	4.5	2 km W of Serchhip, India
2008-11-18	23.981	91.587	35	3.6	Tripura, India region
2008-11-18	23.77	91.142	35	3.8	15 km WSW of Agartala, India
2008-08-22	22.447	92.537	46.7	4.7	42 km NE of Bandarban, Bangladesh
2008-05-08	24.005	91.209	30.6	3.9	20 km NNW of Agartala, India
2008-04-08	22.768	92.428	39.5	4.2	35 km WSW of Lunglei, India
2008-01-31	22.787	92.403	45.1	4.9	36 km WSW of Lunglei, India
2008-01-12	22.761	92.333	33.8	4.9	44 km WSW of Lunglei, India
2007-11-25	22.787	92.325	35	3.7	44 km WSW of Lunglei, India
2007-11-07	22.15	92.388	28.7	5.5	18 km ESE of Bandarban, Bangladesh
2007-10-18	23.497	92.157	35	3.5	47 km NNE of Khagrachhari, Bangladesh
2007-09-07	23.005	92.707	38.6	4.2	12 km NNW of Lunglei, India
2007-07-28	22.83	92.359	32	4	39 km W of Lunglei, India
2007-07-28	22.765	92.255	36.9	4.8	42 km NE of Raojan, Bangladesh
2007-01-21	22.56	93.065	50.5	4	11 km NE of Saiha, India
2006-10-19	22.154	93.046	44.1	4.3	37 km S of Saiha, India
2006-03-25	22.452	92.805	10	3.9	18 km WSW of Saiha, India
2006-02-12	23.889	91.634	50.1	4.2	21 km S of Khowai, India
2005-07-26	23.273	91.406	38.1	4	5 km WNW of Belonia, India
2005-07-21	23.061	92.235	10	4.2	27 km E of Khagrachhari, Bangladesh
2005-07-21	22.936	92.157	10	4.6	27 km SE of Khagrachhari, Bangladesh
2005-05-24	22.845	92.331	24.6	4.2	42 km W of Lunglei, India
2005-04-05	22.491	92.389	10	4.4	37 km NNE of Bandarban, Bangladesh
2004-11-02	23.509	93.148	51.5	4.2	14 km N of Khawhai, India
2004-10-27	22.349	93.167	10	3.9	24 km SE of Saiha, India
2004-09-17	23.779	93.154	47.4	4.3	34 km SE of Darlawn, India
2003-11-09	21.897	92.955	37.9	4.4	65 km S of Saiha, India
2003-08-01	22.837	92.35	10	4.7	40 km W of Lunglei, India
2003-07-27	22.841	92.358	10	4.4	39 km W of Lunglei, India
2003-07-27	22.825	92.343	10	5.5	41 km W of Lunglei, India
2003-07-27	22.601	92.035	10	4.2	13 km ENE of Raojan, Bangladesh
2003-07-27	22.743	92.168	10	4.3	34 km NE of Raojan, Bangladesh
2003-07-27	22.544	92.06	10	4.3	14 km E of Raojan, Bangladesh
2003-07-26	22.854	92.306	10	5.7	44 km SE of Khagrachhari, Bangladesh
2002-10-22	22.381	93.031	33	4.3	13 km SSE of Saiha, India

2002-05-05	22.59	91.847	33	4.5	Bangladesh
2002-05-05	22.074	91.651	33	4.1	34 km SSW of Chattogram, Bangladesh
2001-09-16	21.587	91.605	33	3.5	44 km WNW of Cox's Bazar, Bangladesh
2001-04-18	24.028	91.598	10	3.9	5 km S of Khowai, India
2001-04-14	22.848	91.89	33	4.1	5 km E of Manikchari, Bangladesh
2000-11-13	21.692	92.908	33	5.5	88 km S of Saiha, India
2000-11-09	22.466	92.468	14	4.7	39 km NE of Bandarban, Bangladesh
2000-01-03	22.132	92.771	33	4.6	45 km SSW of Saiha, India
1999-12-31	21.431	91.762	33	4.3	25 km W of Cox's Bazar, Bangladesh
1999-07-22	21.544	91.895	10	5.2	16 km NW of Cox's Bazar, Bangladesh
1999-02-11	22.378	93.074	64	4	15 km SE of Saiha, India
1999-02-08	22.133	92.777	33	4.1	44 km SSW of Saiha, India
1999-02-08	22.067	92.784	33	4.4	51 km SSW of Saiha, India
1998-12-21	22.31	92.762	33	4.3	30 km SW of Saiha, India
1998-06-11	22.478	92.474	100	4	40 km NE of Bandarban, Bangladesh
1997-11-22	22.148	92.607	52.6	4.8	40 km E of Bandarban, Bangladesh
1997-11-21	22.212	92.702	54.4	6.1	42 km SW of Saiha, India
1997-07-31	23.856	93.101	33	4.5	25 km SE of Darlawn, India
1997-07-31	23.887	93.159	33	5.3	27 km ESE of Darlawn, India
1996-11-09	22.037	92.343	33	4.2	21 km SE of Bandarban, Bangladesh
1996-07-26	23.818	90.992	33	3.9	8 km SSE of Nabinagar, Bangladesh
1996-07-05	21.817	92.485	33	4.1	50 km SSE of Bandarban, Bangladesh
1995-12-06	22.448	92.964	100	3.9	5 km SSW of Saiha, India
1995-12-01	24.206	91.815	20	4	2 km WNW of Kamalpur, India
1995-11-18	23.867	93.083	33	4.5	22 km SE of Darlawn, India
1995-07-20	23.092	92.305	33	4.3	34 km E of Khagrachhari, Bangladesh
1994-11-25	21.509	93.27	33	4.7	112 km SSE of Saiha, India
1994-06-01	22.916	92.868	33	4.4	13 km ENE of Lunglei, India
1994-03-11	22.166	93.111	34.1	4.6	38 km SSE of Saiha, India
1993-02-12	23.507	92.337	33	4.3	45 km WSW of Aizawl, India
1992-12-16	23.444	92.562	33	4.1	23 km NW of Thenzawl, India
1992-09-21	23.388	93.149	32.9	4.8	2 km ENE of Khawhai, India
1992-07-19	21.538	92.36	33	4.1	37 km ENE of Cox's Bazar, Bangladesh
1992-06-13	21.63	93.019	33	4.4	95 km S of Saiha, India
1992-05-28	23.184	92.024	33	4.5	10 km NNE of Khagrachhari, Bangladesh
1992-05-03	23.902	91.117	33	4.2	15 km E of Nabinagar, Bangladesh
1991-11-15	21.038	92.591	78.2	4.6	36 km ENE of Teknaf, Bangladesh
1991-01-31	23.574	93.037	33	4.6	23 km NNW of Khawhai, India
1990-11-15	23.895	92.937	49.4	5.2	13 km S of Darlawn, India
1990-10-11	21.232	92.433	33	4	43 km NNE of Teknaf, Bangladesh
1990-05-14	22.706	92.551	33	4.4	28 km SW of Lunglei, India

1989-05-09	22.879	92.504	104.5	4	24 km W of Lunglei, India
1989-03-13	22.598	91.967	33	4.1	8 km NE of Raojan, Bangladesh
1989-01-10	24.103	92.463	33	4.3	18 km NW of Saitlaw, India
1988-10-22	22.445	92.888	33	4.6	10 km WSW of Saiha, India
1988-05-12	22.61	93.259	33	4	31 km ENE of Saiha, India
1987-07-16	23.697	92.594	33	4.4	13 km WSW of Aizawl, India
1986-02-08	23.903	92.987	39	5.4	13 km SSE of Darlawn, India
1986-01-02	22.677	92.837	33	4.8	25 km NW of Saiha, India
1985-12-22	24.135	93.209	49	4.5	31 km ENE of Darlawn, India
1985-11-03	23.585	91.505	32.9	4.9	6 km NNE of Udaipur, India
1984-12-26	21.075	93.099	43	4.4	86 km ENE of Teknaf, Bangladesh
1984-05-21	23.721	91.588	33	5.3	22 km NNW of Amarpur, India
1983-01-13	22.857	93.067	150.9	4.7	30 km S of North Vanlaiphai, India
1981-11-21	22.693	93.233	48.5	4.7	34 km NE of Saiha, India
1980-10-30	23.934	91.292	33	5	10 km N of Agartala, India
1979-05-12	23.966	92.451	33	4.7	5 km NW of Mamit, India
1978-12-29	23.559	92.97	33	4.8	25 km NW of Khawhai, India
1978-04-07	22.664	92.425	40	4.6	41 km SW of Lunglei, India
1978-03-28	23.205	92.896	33	4.8	10 km SSE of Serchhip, India
1978-03-18	24.283	92.866	39	4.6	20 km ENE of Kolasib, India
1977-12-23	23.636	92.386	33	5.1	33 km SW of Sairang, India
1977-05-12	21.747	92.99	40	5.7	82 km S of Saiha, India
1977-02-06	24.306	92.882	42	4.7	22 km ENE of Kolasib, India
1974-07-23	21.974	93.122	35	4.4	59 km SSE of Saiha, India
1974-01-20	22.837	92.936	33	4.8	20 km ESE of Lunglei, India

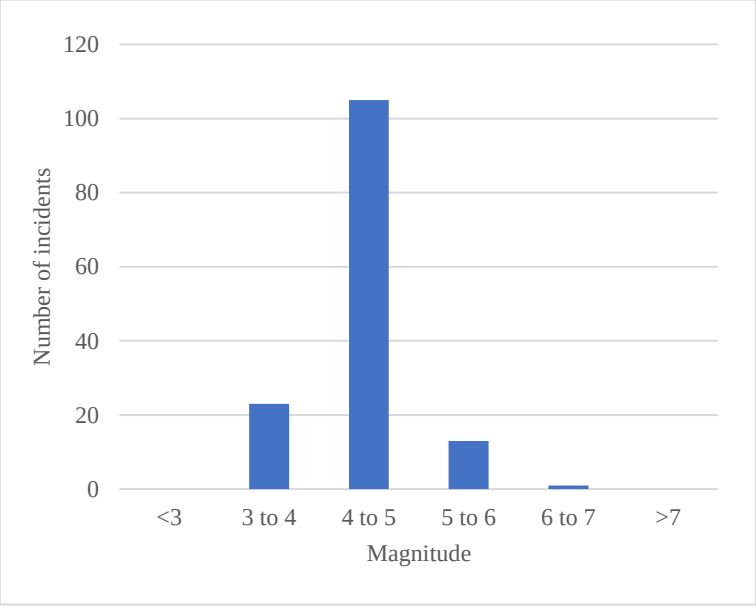

Figure 9. Number of earthquakes of different magnitude

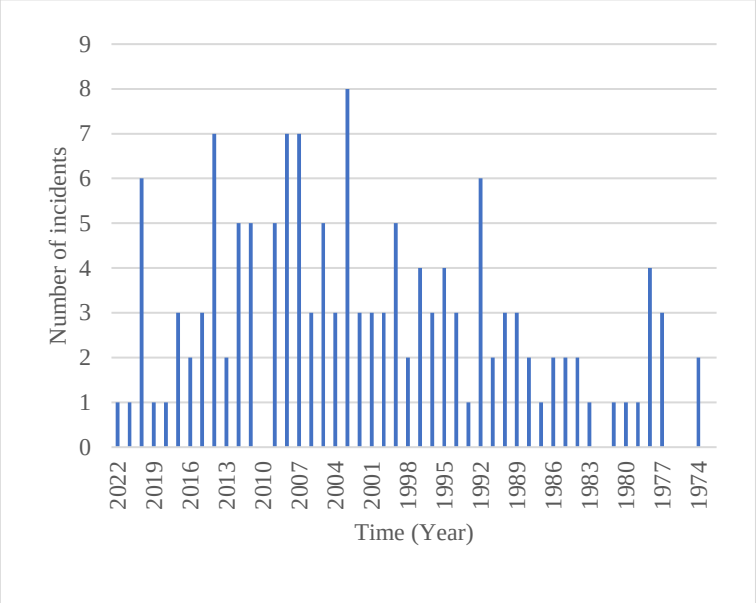

Figure 10. Yearly earthquake incidents

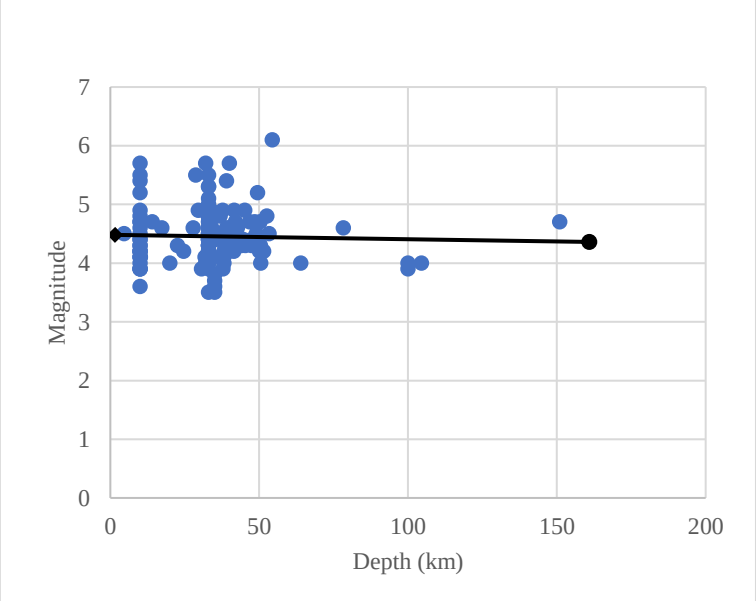

Figure 11. Magnitude vs. Epicenter depth data

Figure 9 shows that most earthquake incidents had a magnitude of 4 to 5 (Mw). Major Earthquakes of 7 (Mw) or more magnitude did not happen in the studied timeframe. The largest earthquake in this area had a magnitude of 6.1.

Figure 10 shows a wide number of earthquakes in this fault zone. The trend shows an increase in earthquakes from 1990 to 2015. From 2015 to 2022, the activity of this fault zone is lower than the previous years. Still, this fault zone is much more active than the other fault zones near Bangladesh.

Also, Figure 11 shows that most earthquakes had an epicenter depth of 0-50 km. These earthquakes are shallow.

3.4 Assam Fault

Table 4 represents the earthquake incidents near the Assam fault from 1973 to 2022. These data are obtained from [21]

Table 4. Earthquake incidents near Assam Fault

Date	Latitude	Longitude	Depth (km)	Magnitude (*Mw*)	Place
2020-07-17	24.6057	92.3782	39.89	4.3	20 km WSW of Hailakandi, India
2020-07-16	24.6068	92.3957	39.62	4.4	18 km WSW of Hailakandi, India
2020-06-03	24.8316	91.1391	30.48	4.2	41 km NNW of Baniachang, Bangladesh
2020-01-27	24.7732	91.7364	10	4.5	10 km SE of Jahedpur, Bangladesh
2017-11-08	24.0923	91.2855	29.51	4.9	28 km N of Agartala, India
2017-07-21	24.1789	92.2002	38.77	4.4	21 km S of Dharmanagar, India
2017-01-03	24.0151	92.0177	32	5.7	18 km ENE of Ambassa, India
2016-11-15	24.6475	92.3284	32.42	4.6	23 km W of Hailakandi, India
2016-10-19	24.7872	91.2146	29.79	4.4	33 km NNW of Baniachang, Bangladesh
2015-10-29	24.6819	92.4488	36.31	4.8	11 km W of Hailakandi, India
2014-08-17	23.6717	91.4071	38	4.1	7 km NE of Barjala, India
2014-06-09	24.1878	91.5293	31.79	4.1	13 km NNW of Khowai, India
2014-02-28	23.7432	91.3541	37.8	3.9	10 km S of Ranir Bazar, India
2013-07-08	23.84	91.359	10.1	4.1	0 km NW of Ranir Bazar, India
2013-03-02	24.677	92.222	38.7	5.2	25 km SSW of Karimganj, India
2012-12-30	24.209	91.782	22.5	4.3	5 km WNW of Kamalpur, India
2012-08-05	24.714	91.863	56.8	4.2	20 km S of Sylhet, Bangladesh
2011-07-22	24.532	92.072	43.7	4	20 km NNW of Dharmanagar, India
2011-06-23	23.887	91.484	35	4.4	13 km ENE of Ranir Bazar, India
2011-05-03	23.686	91.321	10	4	8 km NNW of Barjala, India
2008-12-23	24.998	91.966	41.7	4	14 km NE of Sylhet, Bangladesh
2008-11-18	23.981	91.587	35	3.6	Tripura, India region
2008-11-18	23.77	91.142	35	3.8	15 km WSW of Agartala, India
2008-05-08	24.005	91.209	30.6	3.9	20 km NNW of Agartala, India
2006-11-10	24.536	92.326	42.5	4.9	24 km NE of Dharmanagar, India
2006-04-11	24.419	91.369	21.3	3.6	6 km NW of Habiganj, Bangladesh
2006-02-12	23.889	91.634	50.1	4.2	21 km S of Khowai, India
2005-02-15	24.55	92.524	35.2	5	9 km W of Lala, India
2004-12-09	24.757	92.539	34.7	5.4	8 km NNW of Hailakandi, India
2004-12-07	24.41	92.429	72.2	4.3	24 km SW of Lala, India
2002-10-14	24.692	91.772	33	4.9	19 km SE of Jahedpur, Bangladesh
2001-08-12	24.391	92.109	33	4.6	6 km WNW of Dharmanagar, India
2001-04-18	24.028	91.598	10	3.9	5 km S of Khowai, India
2001-02-11	24.742	92.143	38.7	4.2	25 km WSW of Karimganj, India

2000-04-16	24.671	92.443	33	3.8	12 km W of Hailakandi, India
1997-05-08	24.894	92.25	34.9	6	11 km WNW of Karimganj, India
1996-07-26	23.818	90.992	33	3.9	8 km SSE of Nabinagar, Bangladesh
1995-12-06	24.735	91.563	39.4	4.1	14 km SW of Jahedpur, Bangladesh
1995-12-01	24.206	91.815	20	4	2 km WNW of Kamalpur, India
1994-06-09	24.375	92.282	33	4.4	11 km E of Dharmanagar, India
1992-05-03	23.902	91.117	33	4.2	15 km E of Nabinagar, Bangladesh
1992-01-13	24.439	92.557	33	4.5	14 km SSW of Lala, India
1991-09-02	24.608	90.837	33	4.7	19 km NNE of Kishorganj, Bangladesh
1991-08-22	25.03	91.33	33	4.7	34 km W of Chhatak, Bangladesh
1991-04-13	24.44	91.345	33	4	8 km S of Baniachang, Bangladesh
1990-02-05	24.877	92.425	33	4.1	7 km E of Karimganj, India
1989-04-13	24.472	92.505	33	5.5	14 km SW of Lala, India
1989-01-10	24.103	92.463	33	4.3	18 km NW of Saitlaw, India
1988-02-28	24.7	91.571	28.9	4.6	16 km SSW of Jahedpur, Bangladesh
1988-02-17	24.522	91.432	39.3	4.5	7 km E of Baniachang, Bangladesh
1988-02-06	24.688	91.57	33	5.9	18 km SSW of Jahedpur, Bangladesh
1987-07-16	23.697	92.594	33	4.4	13 km WSW of Aizawl, India
1986-10-14	25.035	91.976	33	4.7	18 km NE of Sylhet, Bangladesh
1984-05-21	23.721	91.588	33	5.3	22 km NNW of Amarpur, India
1982-01-11	24.695	92.065	33	4.7	29 km SE of Sylhet, Bangladesh
1980-10-30	23.934	91.292	33	5	10 km N of Agartala, India
1979-05-12	23.966	92.451	33	4.7	5 km NW of Mamit, India
1979-01-28	24.61	91.166	33	4.9	21 km WNW of Baniachang, Bangladesh

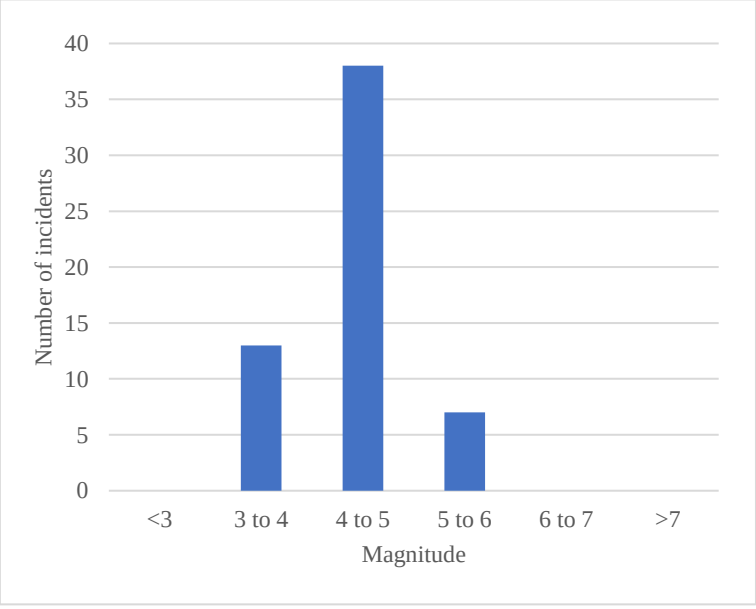

Figure 12. Number of earthquakes of different magnitude

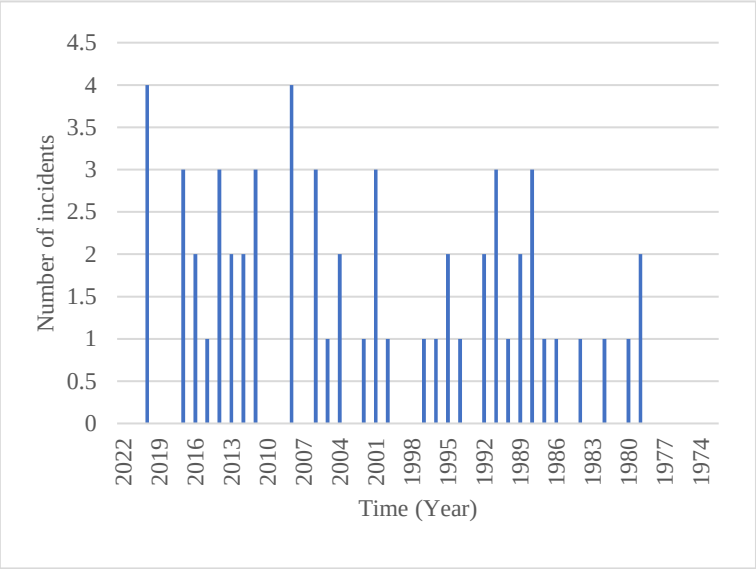

Figure 13. Yearly earthquake incidents

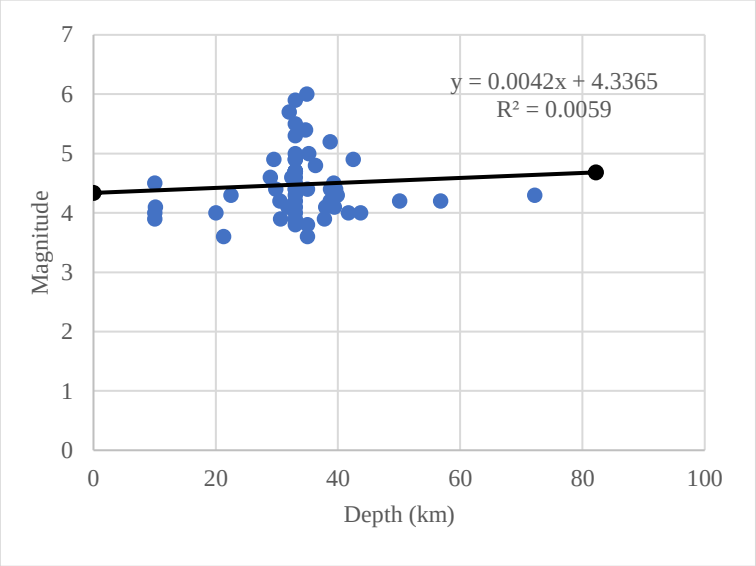

Figure 14. Magnitude vs. Epicenter depth data

Figure 12 shows that most of the earthquake incidents had a magnitude of 4 to 5 (Mw). Major Earthquakes of 7 (Mw) or more magnitude did not happen in the studied timeframe.

Figure 13. shows an increase in the yearly earthquake incidents in this fault zone. The increase in number is an alarming issue as bigger earthquake incidents can happen in this zone. Also, Figure 14 shows that most earthquakes had an epicenter depth of 20-40 km. These earthquakes are shallow.

3.5 Shillong Plateau

Table 5 represents the earthquake incidents near Shillong Plateau from 1973 to 2022. These data are obtained from [21].

Table 5. Earthquake incidents near Shillong Plateau

Date	Latitude	Longitude	Depth (km)	Magnitude (*Mw*)	Place
2022-05-15	26.3342	92.3725	10	4.1	9 km NNE of Morigaon, India
2021-11-20	25.9374	91.4838	10	4.2	21 km SSW of Palasbari, India
2021-07-09	25.9749	90.3995	10	4.3	11 km ESE of Lakhipur, India
2021-07-07	25.9603	90.3499	10	5.3	8 km SSE of Lakhipur, India
2021-05-06	26.5945	92.4813	48.29	4.2	12 km S of Dhekiajuli, India
2020-12-10	26.1291	90.5453	10	4.3	9 km WSW of Goalpara, India
2020-11-02	25.7773	91.1728	10	4.5	30 km NNW of Nongstoin, India
2020-10-03	26.2024	91.3108	44.3	4.2	21 km WSW of Hajo, India
2020-09-21	26.2803	91.3167	39.62	4.4	21 km W of Hajo, India
2020-04-05	26.4085	92.7724	46.31	4.5	25 km S of Tezpur, India
2020-02-29	26.4904	92.1052	45.39	4.2	5 km SW of Kharupatia, India
2020-02-08	26.3386	90.7847	10	5	10 km E of Abhayapuri, India
2019-11-21	26.145	91.1372	48.16	4.3	23 km SSE of Barpeta, India
2019-04-27	26.4403	93.0258	43.81	4.6	31 km SE of Tezpur, India
2019-03-21	25.6452	90.9083	10	4.4	38 km WNW of Nongstoin, India
2018-09-25	26.0547	90.8859	10	4.4	29 km ESE of Goalpara, India
2018-09-12	26.3711	90.1611	10	5.3	5 km NE of Sapatgram, India
2018-08-17	25.6357	90.9299	10	3.8	36 km WNW of Nongstoin, India
2018-06-11	26.3263	92.6686	47.34	4.9	18 km NE of Raha, India
2017-12-11	25.725	90.8605	10	4.6	46 km WNW of Nongstoin, India
2017-04-25	25.6263	90.8833	31.19	4.3	40 km WNW of Nongstoin, India
2017-02-12	25.548	91.1035	36.94	4.4	16 km WNW of Nongstoin, India
2017-01-24	25.6419	91.8799	35	4.3	8 km N of Shillong, India
2016-10-23	26.0659	90.2619	24.31	4.6	5 km NW of Lakhipur, India
2016-10-06	26.443	92.773	56.85	4.3	21 km S of Tezpur, India
2016-05-16	25.9006	90.2255	35.12	4.3	16 km SSW of Lakhipur, India
2016-04-05	25.7595	90.5452	10	5	38 km SE of Lakhipur, India
2016-03-28	25.9519	90.6891	10	4	25 km SSE of Goalpara, India
2016-03-13	26.245	92.2565	53.71	4.5	9 km W of Morigaon, India
2015-11-25	26.4076	92.9745	54.52	4.7	30 km SE of Tezpur, India
2015-09-25	26.5308	91.6928	48.82	4.4	11 km NE of Rangia, India
2015-09-05	26.1923	92.8261	47.23	4.2	21 km N of Hojai, India
2015-08-20	26.0142	90.2598	42.95	3.9	4 km WSW of Lakhipur, India
2015-06-30	26.0436	90.7596	42.34	4	19 km SE of Goalpara, India
2014-12-29	26.2946	91.6204	45.02	4	10 km ENE of Hajo, India
2014-09-12	25.6524	89.9947	15	4.1	18 km NE of Mankichar, India
2014-05-30	26.5567	90.227	10	4	17 km NNW of Kokrajhar, India
2014-05-18	26.4109	92.9493	52.02	4.2	28 km SSE of Tezpur, India
2014-04-01	26.2313	92.9947	41.23	4.4	28 km NNE of Hojai, India

2013-10-07	26.2602	92.9225	7.87	4.2	29 km NNE of Hojai, India
2013-07-12	26.267	90.7	48.2	4.1	6 km SSE of Abhayapuri, India
2013-04-16	26.06	91.979	43.8	4.4	19 km ESE of Dispur, India
2012-10-30	26.117	92.337	62	4.6	14 km S of Morigaon, India
2012-08-19	26.561	92.622	57	4	18 km NE of Dhing, India
2012-08-19	26.599	92.57	48.9	4.8	14 km SE of Dhekiajuli, India
2012-05-27	26.491	91.1	34.7	4.3	13 km E of Barpeta Road, India
2012-05-11	26.175	92.889	43.3	5.4	19 km N of Hojai, India
2012-05-01	26.252	92.274	35	4.2	7 km W of Morigaon, India
2011-09-18	25.759	91.178	37.1	4	28 km NNW of Nongstoin, India
2010-12-29	25.488	92.432	29.8	4.1	55 km E of Shillong, India
2010-09-11	25.72	90.205	22.3	4.5	22 km N of Tura, India
2009-10-29	26.548	90.018	30.4	4.8	13 km NNE of Goshaingaon, India
2009-08-19	26.556	92.47	10	5	9 km N of Dhing, India
2009-04-25	26.112	91.446	37.8	4.4	9 km W of Palasbari, India
2008-11-07	25.817	92.847	50.8	3.9	20 km S of Hojai, India
2008-05-29	26.308	91.791	45.5	4.5	14 km NNE of North Guwahati, India
2008-05-05	26.1	92.046	35	3.6	24 km E of Dispur, India
2008-04-17	26.07	92.244	43.8	4.6	22 km SSW of Morigaon, India
2008-04-03	26.312	92.982	45.6	4.3	36 km NNE of Hojai, India
2008-03-18	26.472	92.841	56.2	4.1	18 km SSE of Tezpur, India
2007-02-14	26.326	91.339	35	3.7	20 km WNW of Hajo, India
2006-06-19	25.529	90.676	40.9	4.2	47 km E of Tura, India
2006-02-24	26.385	92.415	10	3.8	10 km SSW of Dhing, India
2005-12-31	25.732	90.384	35	4.2	30 km NE of Tura, India
2005-12-12	25.961	92.313	35	4.3	32 km S of Morigaon, India
2005-09-12	25.881	90.529	35	4.2	27 km SE of Lakhipur, India
2005-05-03	25.764	91.059	33.6	4.3	34 km NW of Nongstoin, India
2004-11-02	26.442	92.584	48.3	4.2	11 km ESE of Dhing, India
2004-09-27	26.134	92.149	37.4	4.2	23 km WSW of Morigaon, India
2004-08-04	25.923	90.262	61.7	4.2	12 km SSW of Lakhipur, India
2004-07-13	26.208	92.784	71.5	4.2	23 km NNW of Hojai, India
2004-01-12	26.358	91.897	38	3.9	16 km SW of Mangaldai, India
2003-12-06	25.596	90.25	26.7	4.4	10 km NNE of Tura, India
2003-12-02	25.787	90.392	23.1	3.8	28 km SSE of Lakhipur, India
2003-03-31	26.528	91.827	57.7	3.9	22 km WNW of Mangaldai, India
2002-07-10	26.338	92.105	37.4	3.8	13 km SSE of Mangaldai, India
2002-03-27	26.514	93.041	43.7	4.5	27 km ESE of Tezpur, India
2001-10-26	26.273	92.985	10	4.5	32 km NNE of Hojai, India
2001-06-20	26.356	92.634	60.5	4.3	17 km NE of Raha, India
2001-05-18	26.458	92.936	33	4	23 km SE of Tezpur, India

2001-04-27	26.09	91.489	33	4.1	6 km SW of Palasbari, India
2001-04-20	25.878	90.595	33	4.5	33 km S of Goalpara, India
2001-04-06	26.385	92.69	42.7	4.4	23 km ESE of Dhing, India
2001-02-27	26.486	90.616	20.2	4.9	5 km E of Bongaigaon, India
2000-09-17	26.275	91.496	33	4	4 km NW of Hajo, India
2000-08-16	26.535	92.416	33	4.4	9 km NW of Dhing, India
2000-04-21	26.145	93.009	33	4	21 km NE of Hojai, India
1999-10-09	26.398	91.926	40.9	4.2	11 km WSW of Mangaldai, India
1999-10-05	26.26	91.926	33	5.2	18 km NE of Dispur, India
1999-06-20	26.204	92.779	33	4.3	23 km NNW of Hojai, India
1999-05-11	26.307	92.788	33	4.4	28 km ENE of Raha, India
1999-01-20	26.495	92.725	33	4.5	17 km SSW of Tezpur, India
1998-01-06	26.045	91.839	33	4.5	10 km SSE of Dispur, India
1997-08-06	25.632	92.185	41.3	4.9	31 km ENE of Shillong, India
1996-08-18	25.875	90.156	17.8	4.4	22 km SW of Lakhipur, India
1996-07-17	26.039	91.935	33	4.3	16 km NNE of Nongpoh, India
1996-05-14	26.551	92.397	36.8	4.6	11 km NW of Dhing, India
1996-03-05	26.48	92.96	33	4.1	23 km SE of Tezpur, India
1996-02-17	26.138	90.687	50	4.3	7 km SE of Goalpara, India
1995-12-01	26.195	92.237	57.6	4.4	12 km WSW of Morigaon, India
1995-08-08	26.223	90.202	28.1	4.4	3 km WSW of Bilasipara, India
1994-09-28	25.63	90.647	10	4	46 km ENE of Tura, India
1994-04-18	26.3	92.955	33	3.7	34 km NNE of Hojai, India
1994-04-15	25.927	90.488	33	4.2	21 km ESE of Lakhipur, India
1994-03-24	26.371	91.27	33	4.3	26 km ENE of Barpeta, India
1993-02-17	26.258	92.805	27.7	4.2	28 km N of Hojai, India
1992-07-30	26.543	92.218	33	4	7 km ENE of Kharupatia, India
1992-04-20	25.842	90.569	54.7	4.2	33 km SE of Lakhipur, India
1991-11-11	26.377	93.005	33	4.4	34 km SE of Tezpur, India
1991-09-19	26.323	92.211	33	4.7	15 km WNW of Morigaon, India
1991-04-09	26.358	93.025	67.2	4.4	37 km SE of Tezpur, India
1991-02-02	25.541	91.293	33	4.9	3 km NE of Nongstoin, India
1990-10-29	26.521	92.405	33	4.9	9 km NW of Dhing, India
1989-06-11	26.419	90.763	33	4.6	10 km SE of Bijni, India
1988-09-04	26.285	91.769	33	4	10 km NNE of North Guwahati, India
1988-04-30	25.913	91.574	33	4.2	23 km S of Palasbari, India
1987-12-11	26.025	90.94	54.6	4.6	33 km SSW of Barpeta, India
1986-12-31	26.475	92.938	49.3	4.8	22 km SE of Tezpur, India
1985-06-17	25.591	90.229	22.3	4.7	8 km NNE of Tura, India
1984-09-22	26.524	92.188	33	5.2	4 km E of Kharupatia, India
1983-01-19	25.637	91.288	10	4.9	13 km N of Nongstoin, India

1982-12-30	26.321	92.05	33	4.6	13 km S of Mangaldai, India
1982-12-30	26.159	91.641	40.6	5	7 km E of Soalkuchi, India
1982-11-18	26.107	91.563	33	4.8	2 km SE of Palasbari, India
1982-07-06	25.91	90.315	33	5.1	13 km S of Lakhipur, India
1982-06-20	26.497	90.206	33	4.5	12 km NNW of Kokrajhar, India
1982-02-26	26.199	92.174	33	4.6	18 km WSW of Morigaon, India
1982-02-26	25.567	90.749	63.9	4.7	52 km W of Nongstoin, India
1980-06-11	25.759	90.213	33	4.8	27 km N of Tura, India
1979-02-26	26.272	91.203	33	4.2	20 km ESE of Barpeta, India
1978-11-18	26.24	92.097	55	4.4	23 km SSE of Mangaldai, India
1974-09-21	25.68	90.908	27	4.7	40 km WNW of Nongstoin, India
1974-05-15	25.547	91.799	32	4.5	8 km WSW of Shillong, India
1973-11-02	25.723	91.603	20	4.8	18 km N of Mairang, India

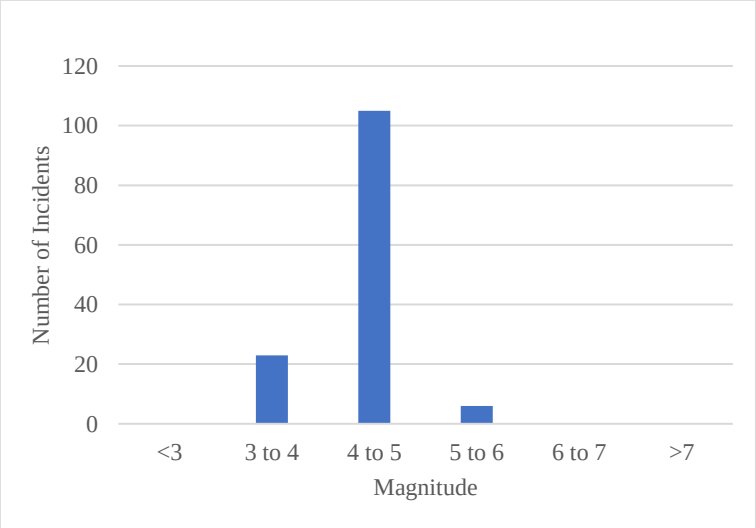

Figure 15. Number of earthquakes of different magnitude

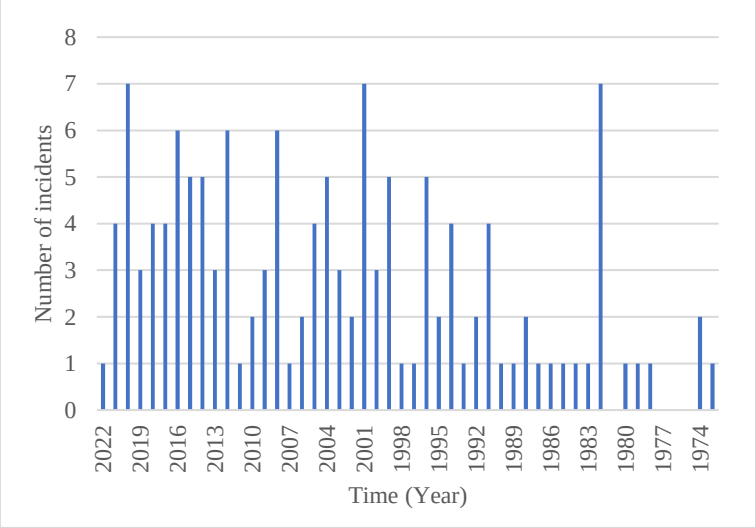

Figure 16. Yearly earthquake incidents

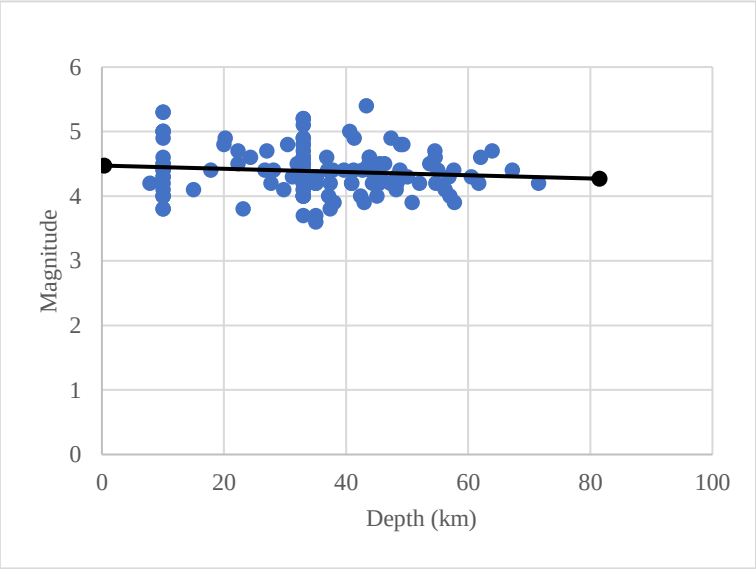

Figure 17. Magnitude vs Epicenter depth data

Figure 15 shows that most of the earthquake incidents had a magnitude of 4 to 5 (Mw). Major Earthquakes of 7 (Mw) or more magnitude did not happen in the studied timeframe. The highest magnitude of an earthquake in this zone is 5.1 (Mw).

Figure 16. shows an increase in the yearly activity of this fault zone. This figure also shows that this fault zone is most active in a timeframe of 20 years or so. Also, Figure 17 shows that most earthquakes had an epicenter depth of 20-60 km. These earthquakes are shallow.

4. Conclusions

From this study regarding different fault zones in and around Bangladesh, it can be said that the most active earthquake fault zones are the Tripura Fault Zone and Shillong Plateau Zone. These two zones have the highest number of recent incidents. In the last 49 years, the only earthquake with a magnitude of 6.1 (Mw) originated at the Tripura fault zone. Other earthquakes had a lower magnitude and ranged from 3 to 5 on Moment Magnitude Scale (Mw). Also, the number of earthquake incidents is increasing in the Tripura Fault and Shillong Plateau zone. This is alarming as an increase in incidents can indicate future large earthquakes. Although this may seem like lower activity of faults, much more vigorous data analysis, geological, geophysical, and geographical condition analysis should be done to get more accurate results regarding the activity of the faults. Also, the earthquake epicenter depth in these fault zones is 100 km from the surface, and most importantly, many are within 40 km, which is a concerning issue as shallow earthquakes damage more than deep ones. This study only included the last 49 years of seismic activity. By taking more data

and conducting further data analysis or implementing a machine learning algorithm, future seismic activity can be predicted much more accurately.

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