

A STUDY ON RECENT EARTHQUAKES IN AND AROUND BANGLADESH

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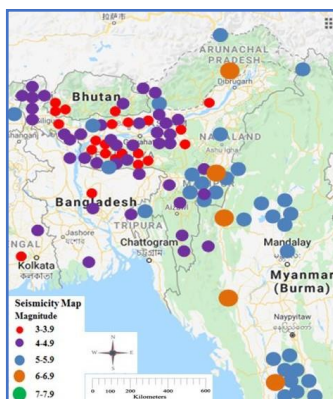
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Graphical abstract



Abstract

Bangladesh is a South Asian country with a dense population situated in a very vulnerable position of earthquake faults where sudden earthquakes can cause a great loss of lives and properties. This paper deals with the magnitude and focal depth of earthquakes that have been felt from 2015 to 2019 having Richter magnitude more than 3. Maximum earthquakes with a magnitude of 3.0 to 4.9 have occurred at the northern side of Bangladesh whereas at the eastern side the values are between 4.0 to 5.9. It was seen that considerable earthquakes occurred in 2019 at the northern side of Bangladesh that indicates a major earthquake may happen in this area from the stored energy and can cause a devastating effect. It has been observed that Earthquake with more than 3 Richter magnitudes has happened in all five years in February, April, August, and September where January and December have comparatively fewer earthquake records. Focal depths have been found to be higher in 2016 related to other years. A correlation equation has been developed between magnitude and focal depth.

Keywords: Recent Earthquake, Seismology, South Asia, Magnitude, Focal Depth.

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1.0 INTRODUCTION

An earthquake is a sudden shaking movement of the earth's surface that is known as a quake, trembled, or tremor. Earthquakes can range in size from those that are so weak that they cannot be felt to those earthquakes violent enough to toss people around and destroy whole cities. The seismic activity of an area refers to the frequency, type, and size of earthquakes experienced over a period of time. Bangladesh is consistently ranked as one of the most vulnerable countries to natural disasters, but this is primarily because of the frequent occurrence of tropical cyclones, floods, heatwaves, and other weather-related disasters, combined with the massive people living in vulnerable conditions. Bangladesh is situated in a modestly dangerous domain and the

density of population here and the infrastructural condition are been always a matter of worry here. A recent earthquake in several parts of the universe and the destruction occurred, clearly showing that Bangladesh has to take necessary steps to face the earthquake at any time in the future.

Bangladesh is surrounded mostly by India and a few by Myanmar and she lies where three tectonic plates-Eurasia, India, and Burma meet making her one of the most tectonically active places in the world. Bangladesh has experienced many devastating as well as mild earthquakes in the past 200 years. Bangladesh has been shaken up by more than 250 earthquakes after the independence in 1971 and some of those were greater than 6.0 magnitude, but the risks cannot be ignored. The 1897 Great Indian Earthquake with a magnitude of 8.7, which is one of the strongest earthquakes in world history by killing 1542

and affected almost the whole of Bangladesh (Oldham, 1899). Recently, Bilham et al. (2001) pointed out that, there is a very high possibility that a great earthquake will occur around the Himalayan region based on the difference between energy accumulation in this region and historical earthquake occurrence. The population increase around this region is the last 50 times than the population of 1897 and city like Dhaka has a population exceeding several million. It is a cause for great concern that the next great earthquake may occur in this region at any time. So that detailed seismic response analysis of his area is necessary. Also, observation of recent earthquake records is needed.

2.0 METHODOLOGY

2.1 SEISMOLOGY OF BANGLADESH:

Bangladesh is located close to the borders of two active plates (Indian plate in the west and Eurasian plate in the east and north) the country has always been under threat of an earthquake that might be so catastrophic by killing people in less than a minute. Calcutta, Assam, Tripura are the three very earthquake-prone regions that are joined to Bangladesh in the boundaries in the northern, western and north-eastern part respectively. If we consider the tectonics and geology, five major faults are significant for the occurrences of devastating earthquakes:

1. Bogra Fault Zone
2. Tripura Fault Zone
3. Shilong Plateau
4. Dauki Fault Zone
5. Assam Fault Zone

Bogra fault is a normal fault and is very close to the Bogra town and Jamuna River that was active in Palaeogene and Neogene times. The movement along the Bogra fault tends to the deposition of a large amount of sedimentary pile within the zone. Tripura is one of the states of India surrounded by Bangladesh and two other states Mizoram and Assam of India, are surrounded by Koplili fault; Kaladan fault etc. that have

produced many earthquakes. The Tripura Naga orogenic belt is a zone of highly faulted Tertiary deposits that have witnessed earthquakes of moderate magnitudes and Shillong Plateau is characterized as a seismically active and geologically complex region located on the collision boundary between Indian and Eurasian plate in the Meghalaya state of India. The general altitude of the Plateau is about 1500 m. The plateau is composed of the Precambrian Metamorphic rocks and the Tertiary and Quaternary deposits are limited on the southern foothills of the Shillong Plateau that indicates the successive uplift of the Shillong Plateau and the process started from the Pliocene time. Dauki fault zone is a 300 km long north dipping reverse fault along the Meghalaya-Bangladesh border and inferred to go through the southern margin of Shillong plateau. It has a major role in deforming the surrounding areas. The Dauki fault is considered to be active in the past. Though it is inactive in recent times still it is considered as one of the major threats for Bangladesh for the occurrence of devastating earthquakes. Figure 1 shows the tectonic framework of Bangladesh.

Dhaka city, the economic, political, cultural, and religious center of Bangladesh is highly vulnerable to the earthquake disaster due to the high density of population, unplanned infrastructure and close proximity with India and Myanmar's active seismic area, poor economic condition, poor emergency preparation, and recovery capability. Bangladesh was divided into four main earthquake zones in BNBC (Bangladesh National Building Code) 2014 where four zones have PGA (Peak Ground Acceleration) values varied to 0.12, 0.20, 0.28 and 0.36. Figure 2 shows the seismic zoning map of Bangladesh according to BNBC 2014. A seismicity map of Bangladesh is shown in figure 3.

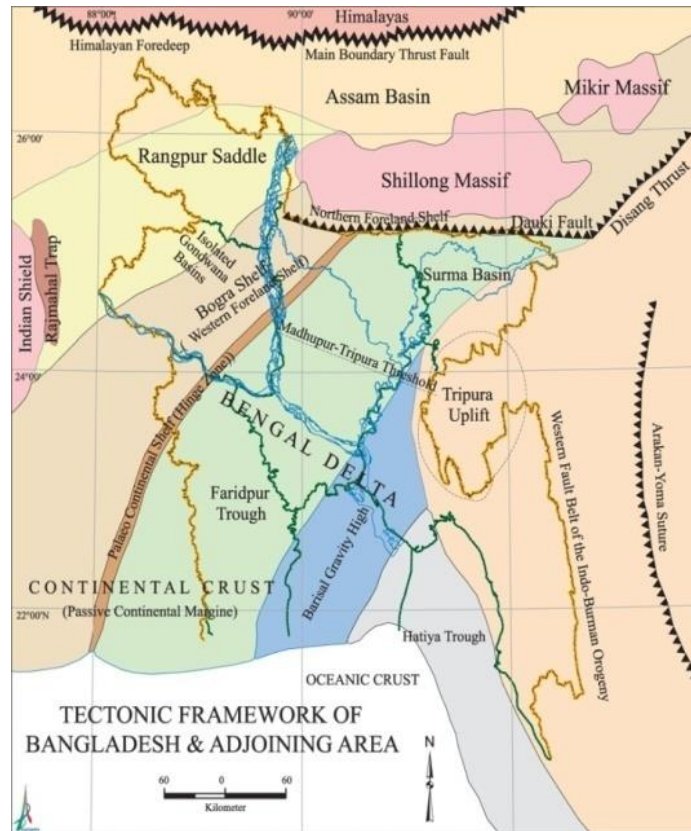


Figure 1 Tectonic Framework of Bangladesh (Banglapedia, 2015)

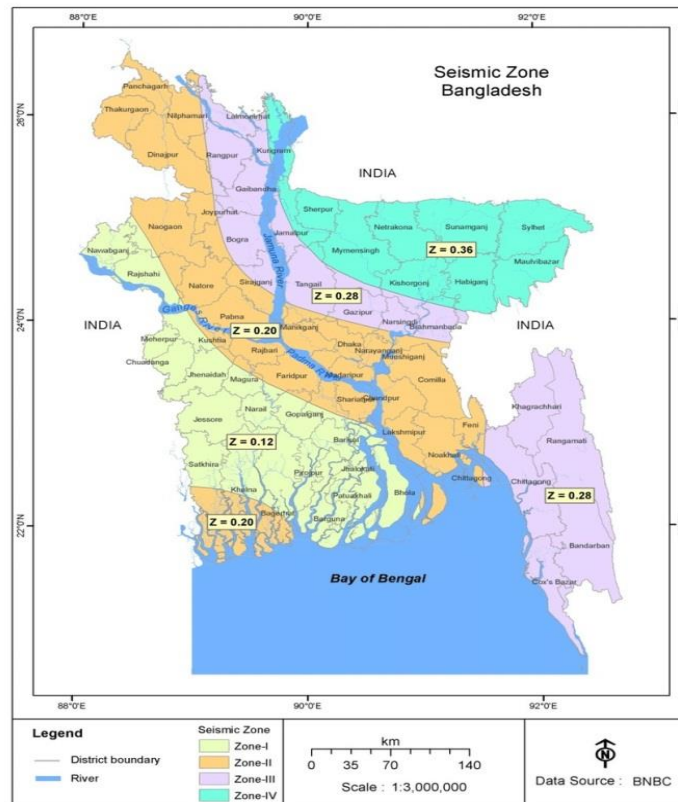


Figure 2: Earthquake zones of Bangladesh (BNBC 2014)

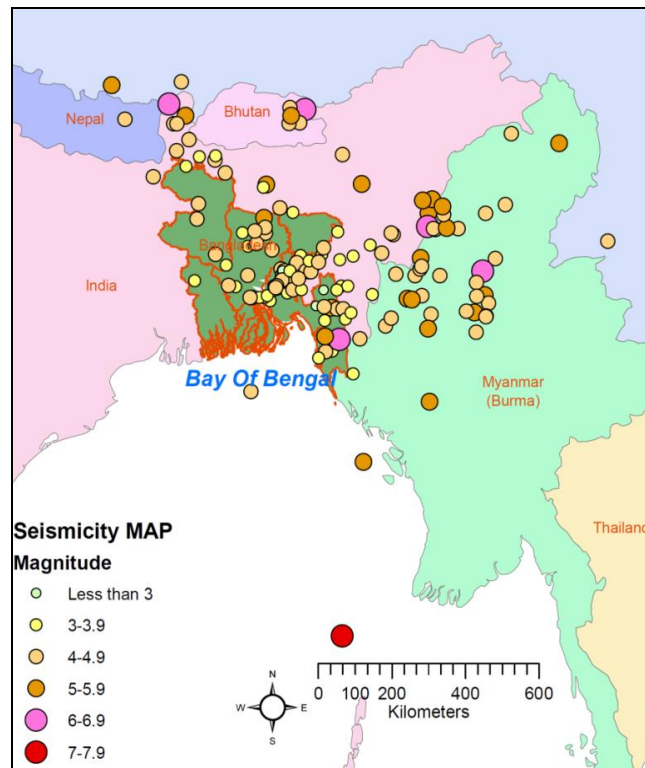


Figure 3: Seismicity Map of Bangladesh (M. A. Ansary, 2018)

3.0 RESULTS AND DISCUSSION

from 2015 to 2019 (up to October) near Bangladesh are represented in table 1 to table 5 below.

3.1 Recent Earthquake Record (Magnitude And Focal Depth)

The magnitude, focal depth and locations of five year's earthquake having Richter magnitude more than 3 that was felt

Table 1: Earthquake Record of 2019 (Up to October)

Date	Time	Earthquake Location	Earthquake Parameters	
			Magnitude	Focal Depth (Km)
07 Oct	6:35 PM	Mongar, Bhutan	4.7	10
03 Oct	12:24 PM	Imphal, Manipur, India	4.8	66.4
26 Sep	8:39 PM	East Garo Hills, Meghalaya, India	3.2	5
23 Sep	10:27 PM	West Garo Hills, Meghalaya, India	3.1	10
20 Sep	3:40 AM	East Garo Hills, Meghalaya, India	3.2	5
09 Sep	12:40 PM	Kashmir- India Border Region	5.0	17
04 Sep	2:43 AM	Nadia, West Bengal, India	4.3	33
31 Aug	9:09 PM	Shwebo, Sagain, Myanmar	5.5	10
28 Aug	7:40 PM	169 KM NNE of Bamboo Flat, India	5.0	43.1
18 Aug	9:24 AM	Pyu, Bago, Myanmar	5.3	40
06 Aug	2:08 AM	Dhubri, Assam, India	3.4	33
04 Aug	7:26 AM	Andaman Islands Region, India	5.1	10
03 Aug	4:59 PM	Howrah, West Bengal, India	3.6	10
28 Jul	4:44 PM	East Garo Hills, Meghalaya, India	3.6	70
20 Jul	4:54 AM	Eastern Xizang-India Border Region, India	5.2	10
19 Jul	3:22 PM	Bomdila, Arunachal Pradesh, India	5.5	16

17 Jul	10:55 PM	Andaman Islands Region, India	5.0	10
22 May	6:39 AM	Andaman Islands Region, India	5.6	10
18 May	1:05 AM	Nicobar Islands, India	5.0	10
17 May	2:23 PM	Nepal-India Border Region	5.0	10
08 May	4:27 AM	West Khasi Hills, Meghalaya, India	3.0	10
04 May	5:04 PM	Mon, Nagaland, India	5.1	100
27 Apr	12:27 PM	Tezpur, Assam, India	4.8	46
24 Apr	2:14 AM	Along, Arunachal Pradesh, India	6.1	40
19 Apr	3:58 AM	Nicobar Islands, India	5.2	10
19 Apr	3:52 AM	Nicobar Islands, India	5.0	10
13 Apr	12:12 PM	Nicobar Islands, India	5.0	10
11 Apr	9:50 AM	Nicobar Islands, India	5.0	10
08 Apr	7:54 AM	Andaman Islands Region, India	5.0	10
06 Apr	7:23 PM	Nicobar Islands, India	5.0	10
06 Apr	7:54 AM	Andaman Islands Region, India	5.0	10
04 Apr	1:45 PM	Phek, Manipur, India	5.3	63
01 Apr	2:11 PM	Nicobar Islands, India	5.4	10
01 Apr	1:59 PM	Darrang, Assam, India	3.5	5
01 Apr	7:23 AM	Nicobar Islands, India	5.0	10
21 Mar	8:30 PM	Nongstoin, Meghalaya, India	4.7	10
28 Feb	6:00 AM	Nicobar Islands, India	5.0	114
26 Feb	10:49 AM	Mirzapur, Gazipur, Bangladesh	3.4	10
17 Feb	8:58 AM	India-Bangladesh Border Region	4.9	10
10 Feb	9:10 AM	Myanmar-India Border Region	5.1	10
01 Feb	4:30 PM	Dahanu, Maharashtra, India	4.1	5
17 Jan	8:53 AM	Nicobar Islands, India	6.0	84
17 Jan	8:52 AM	Nicobar Islands, India	5.8	10
17 Jan	5:56 AM	Samtse, Samchi, Bhutan	3.9	10

Table 2: Earthquake Record of 2018

Date	Time	Earthquake Location	Earthquake Parameters	
			Magnitude	Focal Depth (Km)
28 Nov	4:17 PM	Myanmar-India Border Region	5.5	10
27 Dec	6:35 AM	Mawlaik, Sagain, Myanmar	5.0	91
01 Dec	9:07 PM	Tawang, Arunachal Pradesh, India	4.8	10
29 Nov	8:43 PM	Kashmir-Xizang Border Region	5.2	8
10 Nov	11:15 PM	Churachandpur, Manipur, India	5.2	51
10 Oct	4:28 PM	Pyu, Bago, Myanmar	5.1	10
01 Oct	7:24 PM	Andaman Islands, India Region	5.1	38
25 Sep	9:47 AM	Barpeta, Assam, India	4.3	10
14 Sep	1:51 PM	Nicobar Islands, India Region	5.2	85.6
12 Sep	10:50 AM	Sapatgram, Assam, India	5.3	10
24 Aug	4:49 PM	Andaman Islands, India Region	5.5	22
18 Aug	1:04 AM	Nongstoin, Meghalaya, India	3.9	10
11 Aug	4:04 PM	Panbang, Shemgagb, Bhutan	3.8	10

06 Aug	10:35 AM	Nicobar Islands, India Region	5.1	10
22 Jul	4:04 PM	Off West Coast of Northern Sumatra	5.2	10
05 Jul	2:34 AM	Dawel, Tanintharyi, Myanmar	5.1	10
04 Jul	1:12 PM	Andaman Islands, India Region	5.2	10
17 Jun	9:07 PM	Mangan, Sikkim, India	4.4	50
17 Jun	7:21 PM	Pyu, Bago, Myanmar	5.0	10
11 Jun	10:53 AM	Dhing, Assam, India	4.9	10
28 May	8:00 AM	Nicobar Islands, India Region	5.0	101
14 May	12:20 AM	Nicobar Islands, India Region	5.0	10
24 Apr	6:33 PM	Pyu, Bago, Myanmar	5.1	10
24 Apr	10:08 AM	Mawlaik, Sagain, Myanmar	5.2	105
21 Apr	4:29 AM	Pyu, Bago, Myanmar	5.0	17
11 Apr	5:45 AM	Singrauli, India	4.6	10
18 Mar	1:59 AM	Pyu, Bago, Myanmar	5.1	19
09 Mar	3:13 AM	Nay Pyl Taw, Mandalay, Myanmar	5.3	10
13 Feb	8:39 AM	Andaman Islands, India Region	5.5	10
29 Jan	3:02 AM	Meghalaya, India	3.4	10
25 Jan	9:48 AM	Nicobar Islands, India Region	5.1	10
25 Jan	7:15 AM	Nicobar Islands, India Region	5.7	10
20 Jan	7:14 AM	India-Bangladesh Border Region	4.6	10
12 Jan	12:44 AM	Pyu, Bago, Myanmar	5.2	10
12 Jan	12:42 AM	Pyu, Bago, Myanmar	5.2	10
12 Jan	12:38 AM	Pyu, Bago, Myanmar	5.3	10
12 Jan	12:26 AM	Pyu, Bago, Myanmar	6.0	10
07 Jan	12:47 PM	Wangjing, Manipur, India	5.5	22
06 Jan	2:23 AM	Assam, India	3.4	10
03 Jan	2:47 AM	Nicobar Islands, India Region	5.1	13

Table 3: Earthquake Record of 2017

Date	Time	Earthquake Location	Earthquake Parameters	
			Magnitude	Focal Depth (Km)
29 Dec	5:29 PM	Nicobar Islands, India Region	5.2	10
29 Dec	2:23 AM	Monywa, Sagain, Myanmar	5.0	86
22 Dec	9:58 PM	Andaman Islands, India Region	5.1	10
11 Dec	9:35 AM	Nongstoin, Meghalaya, India	4.7	10
08 Dec	11:55 PM	Meghalaya, India	3.0	10
06 Dec	9:19 PM	Western-Xizang Border region, India	5.0	10
03 Dec	5:43 AM	Naya Bazar, Sikkim, India	4.2	10
08 Nov	10:50 AM	India-Bangladesh Border Region	4.7	10
07 Sep	8:32 PM	Tura, Meghalaya, India	4.4	10
06 Sep	6:10 AM	Andaman Islands, India Region	5.4	10
03 Sep	12:52 PM	Nicobar Islands, India Region	5.0	10
03 Aug	12:18 AM	Churachandpur, Manipur, India	5.2	53
05 Jun	10:40 PM	India-Bangladesh Border Region	3.0	96
05 May	11:58 PM	Andaman Islands, India Region	5.0	10

18 Apr	8:01 PM	Meghalaya, India	4.3	10
18 Apr	11:11 AM	Kashmir-India Border Region	5.1	10
16 Apr	2:08 PM	Assam, India	3.3	24
15 Apr	4:35 AM	Assam, India	3.5	10
30 Mar	1:14 AM	Assam, India	3.5	18
27 Mar	3:42 AM	Gangtok, Sikkim, India	4.5	10
21 Mar	9:40 PM	India-Bangladesh Border Region	3.9	37
14 Mar	8:51 AM	Nicobar Islands, India Region	5.9	10
13 Mar	8:19 PM	Tharrawaddy, Bago, Myanmar	5.1	10
07 Mar	4:28 PM	Samtse, Samchi, Bhutan	3.9	10
04 Mar	8:11 AM	Phek, Manipur, India	5.1	75
24 Feb	6:02 AM	Churachandpur, Manipur, India	5.0	61
12 Feb	10:05 AM	Nongstoin, Meghalaya, India	4.5	33.2
06 Feb	11:03 PM	Rudraprayag, Uttarakhand, India	5.1	16.1
20 Jan	1:18 AM	Tawang, Arunachal Pradesh, India	4.1	10
04 Jan	12:49 AM	Mawlaik, Sagain, Myanmar	5.0	110
03 Jan	3:09 PM	Ambassa, Tripura, India	5.7	32

Table 4: Earthquake Record of 2016

Date	Time	Earthquake Location	Earthquake Parameters	
			Magnitude	Focal Depth (Km)
01 Dec	10 52 PM	Nepal-India Border Region	5.0	18
28 Nov	5:35 AM	Namche Bazar, Nepal	5.4	10
23 Oct	9:56 PM	India-Bangladesh Border Region	4.6	28
19 Oct	1:20 PM	India-Bangladesh Border Region	4.4	36
15 Sep	8:30 AM	Andaman Islands, India Region	5.1	10
24 Aug	4:34 PM	Chauk, Magway, Myanmar	6.8	84
23 Aug	8:11 AM	Mawlaik, Sagain, Myanmar	5.3	106
11 Aug	4:55 PM	Nicobar Islands, India Region	5.2	10
27 Jun	6:27 AM	India-Bangladesh Border Region	4.7	10
12 May	1:54 PM	Myanmar-India Border Region	5.3	10
09 May	10:03 PM	Andaman Islands, India Region	5.3	39
20 Apr	2:32 AM	Andaman Islands, India Region	5.0	10
19 Apr	11:22 PM	Mangan, Sikkim, India	4.3	60
13 Apr	7:55 PM	Mawlaik, Sagain, Myanmar	6.9	134
05 Apr	1:42 PM	India-Bangladesh Border Region	5.0	18
13 Mar	4:30 PM	Marigaon, Assam, India	4.3	58
12 Mar	10:15 PM	Birpara, West Bengal, India	3.9	14
22 Feb	12.10 AM	Nepal-India Border Region	5.1	11
21 Feb	12:09 PM	Nepal	5.5	10
14 Feb	3:37 AM	Samtse, Samchi, Bhutan	3.7	46
05 Feb	10:20 PM	Kathmandu, Nepal	5.2	10
04 Jan	5:05 AM	Imphal, Manipur, India	6.7	55

Table 5: Earthquake Record of 2015

Date	Time	Earthquake Location	Earthquake Parameters	
			Magnitude	Focal Depth (Km)
23 Dec	3:22 PM	<u>Hojaj, Assam, India</u>	4.3	48
22 Dec	5:52 AM	<u>Gafargaon, Dhaka, Bangladesh</u>	4.0	14
30 Oct	4:15 AM	<u>Hailakandi, Assam, India</u>	4.8	36
29 Oct	5:54 AM	<u>Darlawm, Mizoram, India</u>	4.3	38
10 Oct	7:48 AM	<u>Gangtok, Sikkim, India</u>	4.3	48
02 Oct	5:29 PM	<u>Hakha, Chin, Myanmar</u>	4.6	42
25 Sep	10:57 PM	<u>Rangia, Assam, India</u>	4.4	48
12 Sep	5:56 AM	<u>Dinhata, West Bengal, India</u>	4.0	18
05 Sep	11:39 AM	<u>Hojaj, Assam, India</u>	4.2	47
29 Aug	1:21 AM	<u>Chilmari, Rangpur Division, Bangladesh</u>	4.2	13
21 Aug	1:21 AM	<u>Lakhipur, Assam, India</u>	3.9	42
10 Jul	6:53 PM	<u>Bongaigaon, Assam, India</u>	4.3	19
30 Jun	7:15 PM	<u>Goalpara, Assam, India</u>	4.0	42
28 Jun	7:05 PM	<u>Basugaon, Assam, India</u>	5.1	26
25 May	9:59 PM	<u>Saiha, Mizoram, India</u>	4.5	53
16 May	5:34 PM	<u>Kothari, Nepal</u>	5.5	7
12 May	1:05 PM	<u>Kothari, Nepal</u>	7.3	15
12 May	1:36 PM	<u>Kothari, Nepal</u>	6.3	15
12 May	1:17 PM	<u>Kothari, Nepal</u>	5.5	13
08 Apr	7:43 AM	<u>Sarankhola, Khulna, Bangladesh</u>	4.6	17
27 Apr	6:35 PM	<u>Ilam, Eastern Region, Nepal</u>	5.1	31
26 Apr	1:09 PM	<u>Kothari, Nepal</u>	6.7	22
25 Apr	3:17 PM	<u>Lobuche, Eastern Region, Nepal</u>	5.7	10
25 Apr	12:56 PM	<u>Kothari, Nepal</u>	5.5	10
25 Apr	12:18 PM	<u>Kothari, Nepal</u>	5.6	10
25 Apr	12:11 PM	<u>Bharatpur, Central Region, Nepal</u>	7.8	8
15 Jan	7:33 AM	<u>Lunglei, Mizoram, India</u>	4.3	50
05 Jan	9:39 PM	<u>Churachandpur, Manipur, India</u>	4.2	61

3.2 Graphical Representation Of Earthquake Record According To Magnitude And Year

From the earthquake records of five years shown above, two maps were prepared according to magnitude and earthquake occurrence year. They are shown in figure 4 and figure 5. From the magnitude graph, it was seen that earthquake with a magnitude of 5 to 7.9 and 3 to 4.9 occurred at Nepal and northern side of Bangladesh (the area between Bangladesh and Bhutan) respectively. At the eastern side of Bangladesh (the

portion between Bangladesh and Myanmar), the values were within 4 to 5.9. From the year wise graph, it was seen that considerable earthquake records were at the northern outside of Bangladesh in the last year 2019 that indicates a major earthquake may happen here from the stored energy and can make a devastating effect.

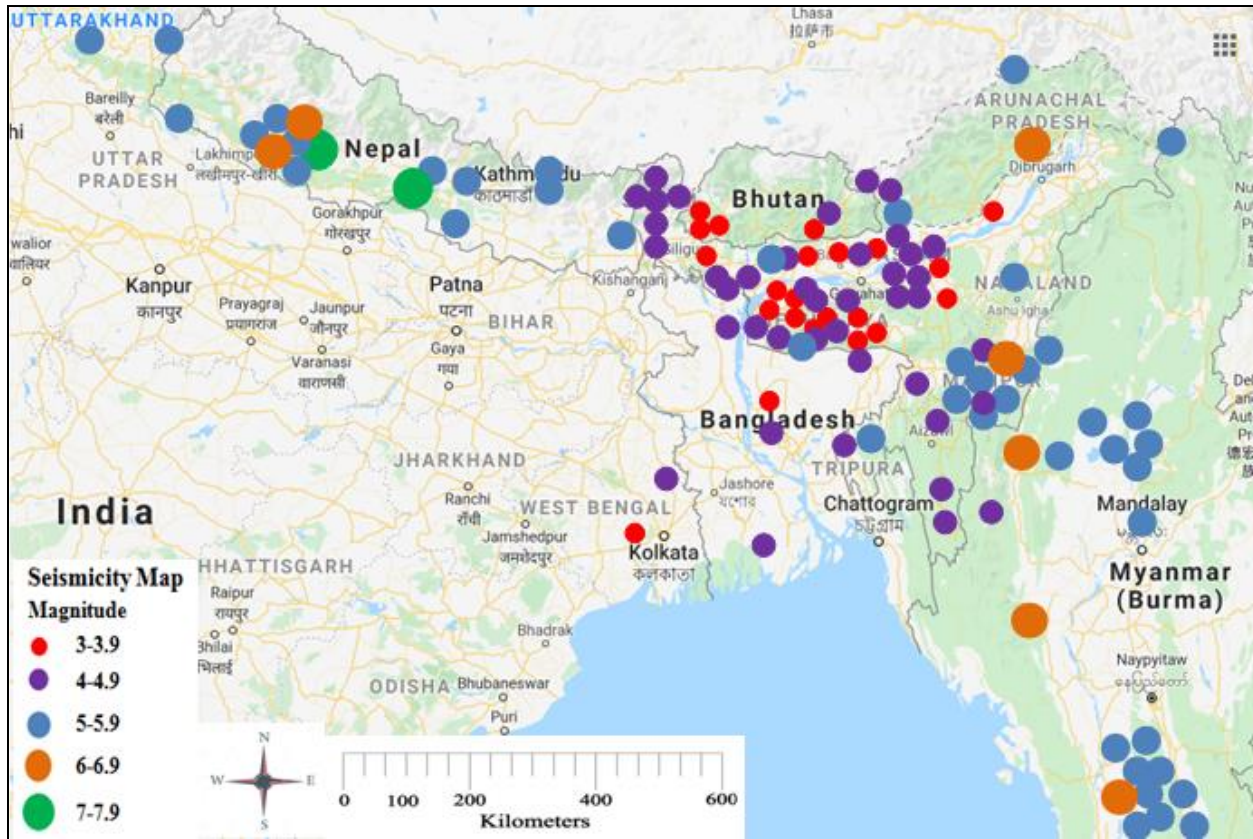


Figure 4: Earthquake Magnitude in and around Bangladesh from 2015 to 2019

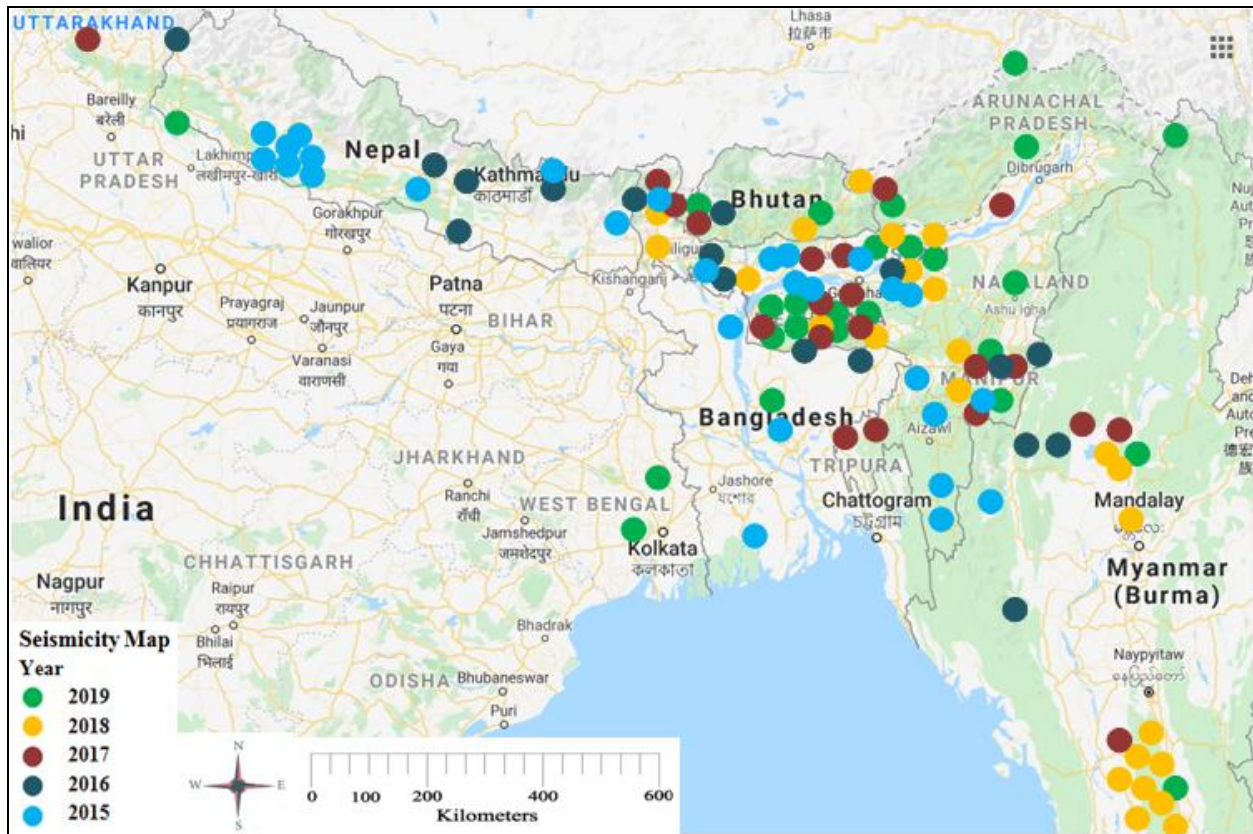


Figure 5: Earthquake occurrence in and around Bangladesh from 2015 to 2019

3.3 Comparison between Magnitude and Focal Depth of Different Earthquake in Various Dates:

A comparison between magnitude and focal depth of different earthquake in 2019 (up to October), 2018, 2017, 2016, and 2015 are shown in figure 6 and figure 7. It was seen that

Earthquake with more than 3 Richter magnitudes occurred in all five years in February, April, August, and September. January and December have comparatively less earthquake records. Focal depth was higher in 2016 related to others in April of August.

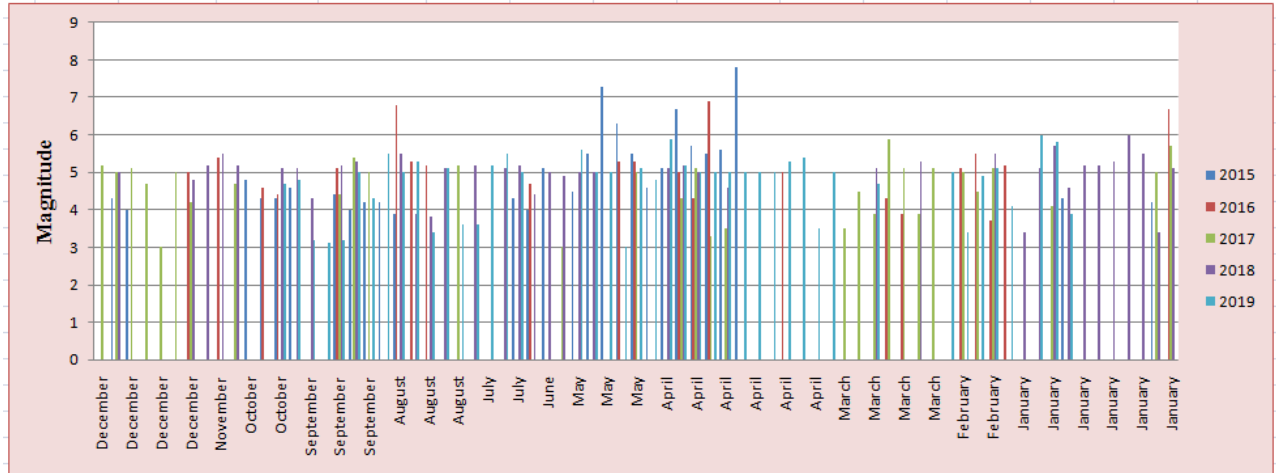


Figure 6: Comparison between magnitudes of different earthquake from 2015 to 2019

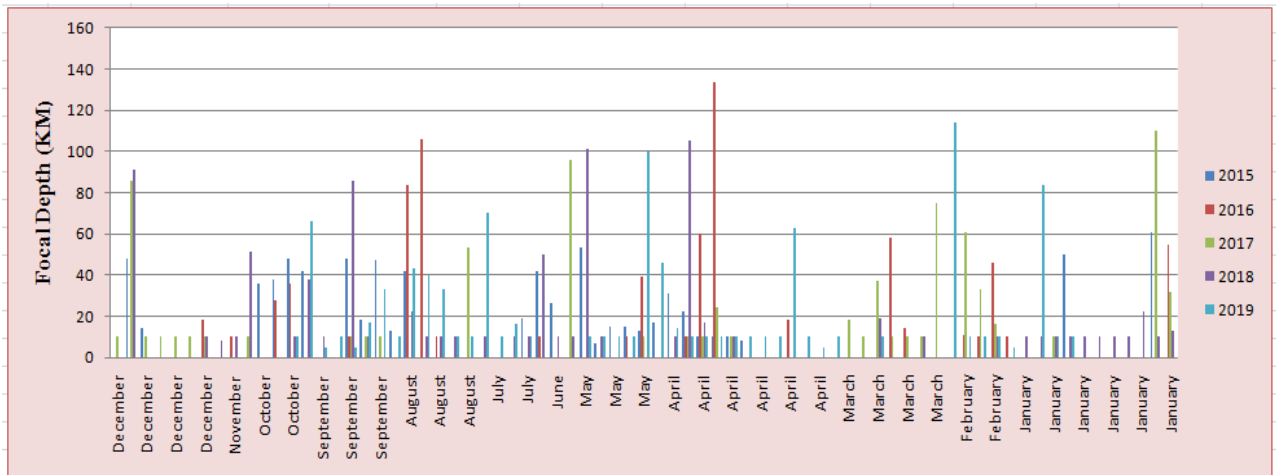


Figure 7: Comparison between focal depths of different earthquake from 2015 to 2019

All data of magnitude vs focal depth of earthquake records shown in this article were plotted in a graph and an equation

was developed from the straight-line graph. The straight-line graph is shown in figure 8 and the equation is given below.

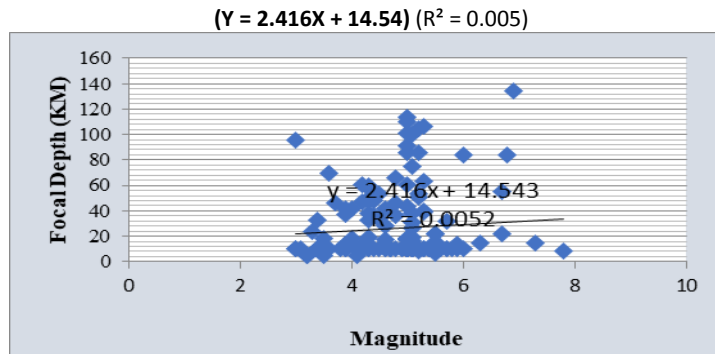


Figure 8: Focal Depth vs Magnitude of different earthquakes from 2015 to 2019

4.0 CONCLUSIONS

In this review article, only earthquake records were demonstrated and earthquake occurring zones and frequency of earthquake were simply analyzed and described. But earthquake hazard analysis of different portions of that earthquakes should be analyzed. The topographical position and the historical quakes obviously demonstrate that the administration of Bangladesh should put much stress on seismic tremors and how to limit its harm. The disaster management system of Bangladesh should be more developed to minimize the loss during the earthquake. The building codes should be followed by the citizens and the government should try to increase the awareness about the safety rules of earthquakes among the mass people.

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