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Research Article

SEISMIC EVENT IN MURSHIDABAD DISTRICT: FOCUSING THROUGH GEO-ENVIRONMENTAL-HISTORICAL VIEWS

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ABSTRACT
Events in nature are chance occurrences, like earthquake or tornado, which could be happened with violence and more than once but without any regular interval. These are called natural hazard. When this meets the unprepared societies play havoc with the lives of millions of people and the geo-environment around the globe. The impact of earthquake is mainly time and location dependent. While vulnerability is dependent on exposure to the hazard, the magnitude of risk is directly proportional to vulnerability, duration and intensity of the earthquake. Although Murshidabad district, West Bengal, is fallen under the fourth earthquake-prone zone or safe zone of India and extend from 24°50' 20''N to 23°43'30''N and 88° 46' E to 87° 49'17''E, covering an area about 5324 sq.km. This study seeks to focus past history of seismic event with impact assessment based and the prediction is made on future possibility of earthquake and its impact. This present study mainly based on secondary data sources and the additional information is gathered from most senior citizens of this district. All the data and information are thereafter treated scientifically. It is observed that in near twenty year there would be a massive earthquake in this district due to tectonic activities along the lower Gangetic fault line, located on upper part of this district, so the administration should implement active and strong initiative for applying modern technology for new constructional works and for sustaining geo-environment.

Key Word: *Earthquake-Prone Zone, Earthquake Hazard Assessment, Vulnerability and Seismic Event*

INTRODUCTION
Earthquake is one of the significant causes of natural hazards throughout the world. The Indian sub-continent is beset with considerable seismicity. A composite representation of anticipated losses in terms of facilities, property, damage to the environment, and the economic activity in a region on account of earthquakes is defined as seismic risk. The seismic risk, therefore, is function of seismic hazard, exposure-time and seismic vulnerability. It may vary as a function of time, according to whether a region develops or decay in terms of population and economic activity; or as a seismic hazard changes (Khattri, 2004). On the other hand seismic hazard monitoring and seismic hazard zoning are carried out earthquake hazard assessment. The earthquake hazard assessment is carried out on the basis of past history of seismic activity in the region and tectonic features like shear zones and faults. The seismic hazard monitoring is based on micro-earthquake studies (Paul, 2004). According to K.N. Khattri, the Himalaya and the contiguous Ganga plains are prone to the impact of future great earthquakes. The probability of occurrence of a great earthquake in the central seismic gap spanning Garhwal, Kumaun and western Nepal Himalaya in the next one hundred years is 52 percent. The probability of occurrence of a least one such earthquake somewhere in the Himalaya in the same time interval is 89 percent (Khattri, 2004). On basis of these predictions this present study is carried out in Murshidabad district, which is pre-identified by R. L. Singh as 'Murshidabad Plain Region' (a micro region), situated under broad physiographical section—Lower Ganga Plain Region.

Objectives
This study has some objectives which are as follows:
To find out the real time earthquake scenario of Murshidabad district,
To find out the intensity and time sequence through time series analysis,

To predict the future pattern and possibility of seismic event as well as future disaster in this district and its surroundings.

MATERIALS AND METHODS

Basically before doing this research work various kinds of literatures, journals, books and reports are surveyed for methodological preparation. Afterwards, numerous secondary data are collected from the offices like District Irrigation Office, Murshidabad, District Agricultural Development Office, Murshidabad, District Meteorological Department, Murshidabad, District Collectorate Office, Murshidabad. Moreover additional information regarding earthquake and its impact are collected through interviewing the most senior citizens of 'Rarh', 'Bagri' and Bhagirathi river bank region of this district. Geological map and geomorphic map were collected from District Geological Office and District Irrigation Office respectively. All the data are tabulated and calculated by applying simple statistical tools and then based on the data and information this paper has written systematically and sequentially.

Study Area

This present study is carried on Murshidabad District, West Bengal which situated on upper central part of the state and extend from 24°50' 20''N to 23°43'30''N and 88° 46' E to 87° 49'17''E , covering an area of about 5324 sq.km.(District Census Handbook, 2001). The district has 26 tehsils or police stations. The map of the study area is shown on Figure 1.

Physiography

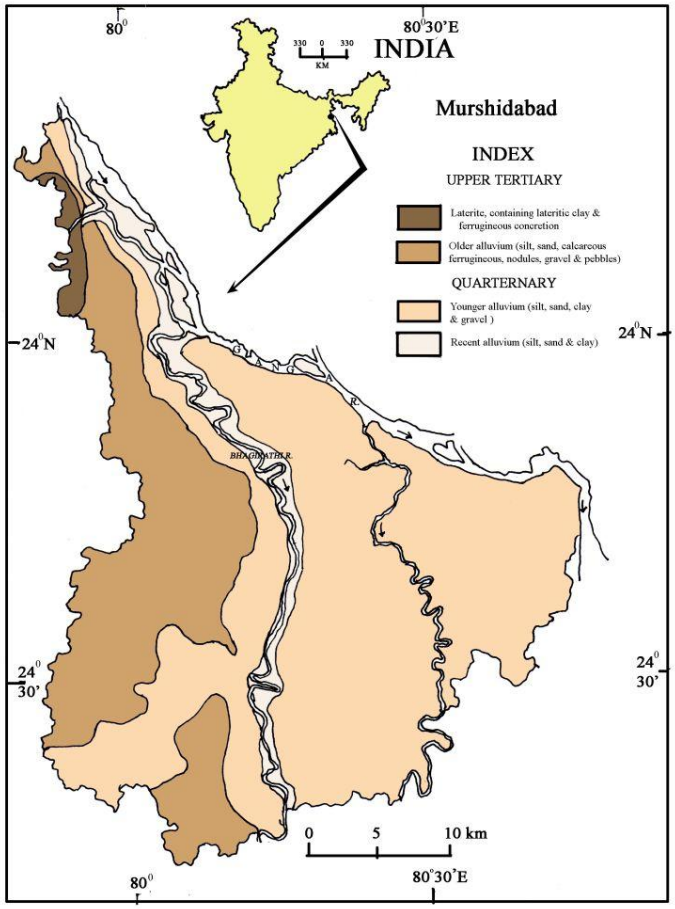
Physiographically the entire district is belonging to plain region. The average height of the district is 300 metre. The river Bhagirathi, flowing from north to south through the district, which divides it into two equal portions form a striking contrast to each other in their geology, their physical characteristic, their agriculture, and even the religion of their inhabitants. The tract to the west of the river is locally known as 'Rarh' and tract to the east as 'Bagri'. Rarh is to the south of the Ganges and west of the Bhagirathi. Barendra is lying in the north of the Ganges between the Mahananda and Karatoya rivers, whereas 'Bagri' is positioned in between the South Bengal and Banga or Eastern Bengal. East of the Bhagirathi the country is low-lying and alluvial, with a humid climate and a fertile soil, which is liable to be flooded by the spill of the Bhagirathi and other rivers. On the western side the surface is high and undulating; the soil is hard clay, on which winter rice alone grows well and the climate is drier than the eastern tract (O`Malley, 1997).

Geological History

Geologically Murshidabad district situated amidst Rajmahal-Meghalaya gaps. This gap actually extended from northwestern Rajmahal hill to eastern Meghalaya plateau and it is 200 km. in width. And along this vast extended plain region all the rain fed water and melted ice water are passed to this newly formed delta of Bengal. The earthquake and other tectonic activities were started from the beginning of the period of origin of the Himalaya, in the tertiary era which is 70 million years ago. The foothill region of Himalaya was a synclinal older stratum, called as Bengal Basin. The Ganga delta was formed after enormous deposition of alluvial sediment over Bengal Basin and took about seven million years and eastern part of this district belongs to this region. On the other hand the rock strata of Rajmahal trap are found in the northwestern part of Murshidabad district.

District Murshidabad is recognized as an important part of Bengal Basin. Some fundamental geological units of Bengal Basin are observed in this district, i.e. shield region and continental shelf region. The shield region was formed by Arcian Shield. This region is buried under thicker alluvial deposition which is located at northwestern part of this district or Farakka tehsil. The stable continental shelf located at Jalangi tehsil. Tectonically Murshidabad district may be divided into three categories: (i) bared shield region is observed in some part of this district, (ii) buried shield region, underneath thicker alluvial sediment, located at some part of Farakka tehsil and Suti I & II tehsils, (iii) remaining part of this district is known as shield and geosynclinals subsided region (Figure 1).

Research Article



(Source: State water investigation directorate)

Figure 1: Geological set of Murshidabad

From the geological point of view there are evidences of three eras Jurassic, Pliestocene and Recent which is discussed below. In Murshidabad district Rajmahal Trap of Jurassic period observed at northwestern part. In the era of Jurassic there was a basaltic lava flow due to volcanic activity and after that the recent topography was formed after numerous depositional works in different era. This Rajmahal Trap was constituted by shale and basaltic clay. The remnants of Pliestocene era is observed along the eastern bank of Bhagirathi River. This part is formed by older alluvial and lateritic clay. According to some eminent geologists the eastern bank of river Bhagirathi is an extended part of Sub-Vindhayan era. Apart from the northwestern part and eastern bank of river Bhagirathi the remaining part of this district belongs to recent era. All these major parts were formed, which are mainly recent alluvial depositions, due to depositional work of regional rivers and streams. The lithological composition is mainly sand and clay dominated.

Rivers and Streams

The river system composed of the Ganges and its distributaries, of which the most important are Bhagirathi, Jalangi, and Bhairab. Formerly large rivers with an active current, they are now merely spill channels of the great river, which during the rains carry off a portion of flood water but the remainder of the year have a very sluggish current (O`Malley, 1997). In1974 due to the introduction of feeder cannel from Farakka Barrage was connected with river Bhagirathi and thereafter the river became navigable (Murshidabad Zilla Gazetteer, 2003). The rivers in the east of the district are fed to a certain extent during the dry season by infiltration from the Ganges (O`Malley,1997) but after the water agreement with

Bangladesh the river Bhagirathi get 4000 m^{-s} and in dry season Padma also get sufficient water and maintain its navigability (Murshidabad Zilla Gazetteer, 2003). The other important streams are Bhramani, Mayurakshi, Dwarka, Sialmari, Gobra Nullah, Bansloi and Babla.

Climate

District Murshidabad belongs to humid tropical monsoon climatic region. According to District Meteorological Department there are very minor variation of temperature, rainfall and relative humidity in all over the district viz. north to south and west to east. In winter season the mean maximum temperature is 25^0 C and means minimum temperature is 11.9^0 C. Whereas in summer season the mean maximum temperature is 39.86 degree C and mean minimum temperature is 22.43^0 C. The average annual rainfall of the district is 11.68 cm. Although the relative humidity remained high throughout the year but in the months of March-April it becomes lower (60-65% morning, 35-40% afternoon). The detailed climatic statistic is given on Table 1.

Table 1: Average annual statistics of climate of Murshidabad district

Months	Mean Temp.(0 C)	Mean Max. Temp.(0 C)	Mean Min. Temp.(0 C)	DailyRange Temp.(0 C)	MonthlyRange Temp.(0C)	Humidity (%)	Cloud (%)	Rainfall (cm.)	No.of RanyDays
January	18.33	25.0	11.6	-4.4	-3.8	87	1.5	1.19	1
February	21.1	27.7	13.8	-3.8	1.1	80	2.2	2.33	2
March	26.6	33.8	18.8	-2.7	3.3	71	2.7	2.67	2
April	31.1	37.7	23.8	-3.8	-1.6	76	3.8	4.44	3
May	30.5	36.1	25.0	-6.6	-5.0	82	5.6	12.39	8
June	30.0	33.3	26.1	-10.5	-8.3	88	8.1	25.06	12
July	28.8	31.6	26.1	-12.2	-11.1	92	8.7	26.18	16
August	28.8	31.6	26.1	-12.2	-12.2	92	8.9	27.88	16
September	28.8	31.6	26.1	-12.2	-11.6	90	7.2	24.86	12
October	27.2	31.1	23.3	-10.0	-6.6	85	3.6	11.93	5
November	22.7	27.7	17.7	-7.7	-3.8	85	1.9	1.01	1
December	18.8	25.0	12.7	-5.5	-3.3	85	1.4	0.25	-

Source: District Meteorological Department, Murshidabad, 2001

RESULTS AND DISCUSSION

Historical evidence of seismic hazard reveals the fact that starting from the seventh century there were enormous earthquake strike on Murshidabad District. According to previous record in 1762 there was a devastating earthquake. This earthquake cast its effect all over the independent West Bengal, as well as in Murshidabad, and its magnitude was not merely moderate. But the effect of this earthquake was not recorded. In the year 1766 another earthquake was occurred but its shock wave was realized in north-eastern part of this district or along the Ganga river tract. A devastating earthquake has been occurred on 1st September, 1803, whose epicenter was Mathura and Kumaun region, and 300 people were died all over India. But this district did not have any record of affected or died population or any other monetary loss due to this earthquake. According to Asiatic Annual Register, in Murshidabad district there was two earthquakes occurred in the year 1810 and 1811 (1st April). Among the two, the earthquake of 1811 was more vulnerable but like previous seismic hazard there was no writing evidence of humanitarian or monetary loss. In 1822 an earthquake has been realized all over West Bengal, including Murshidabad district, and the epicenter was Assam-Himalayan region. The motion of shock wave was north, north-east

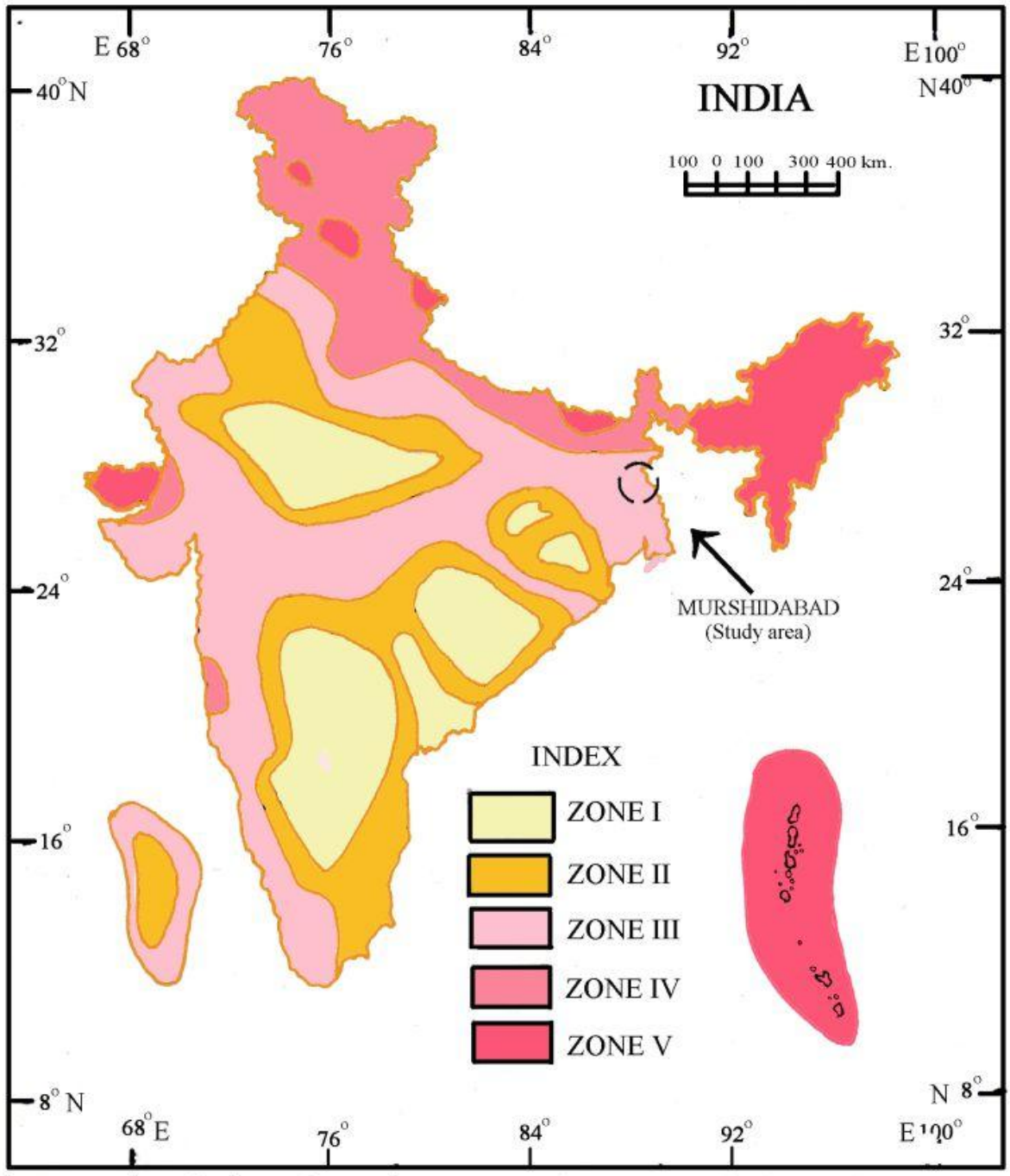


Fig. 2, Earthquake hazard zonation map, *After, K.N. Kathari,2004 (IS: 1983-1984)*
(Modified by- Author, according to true scale)

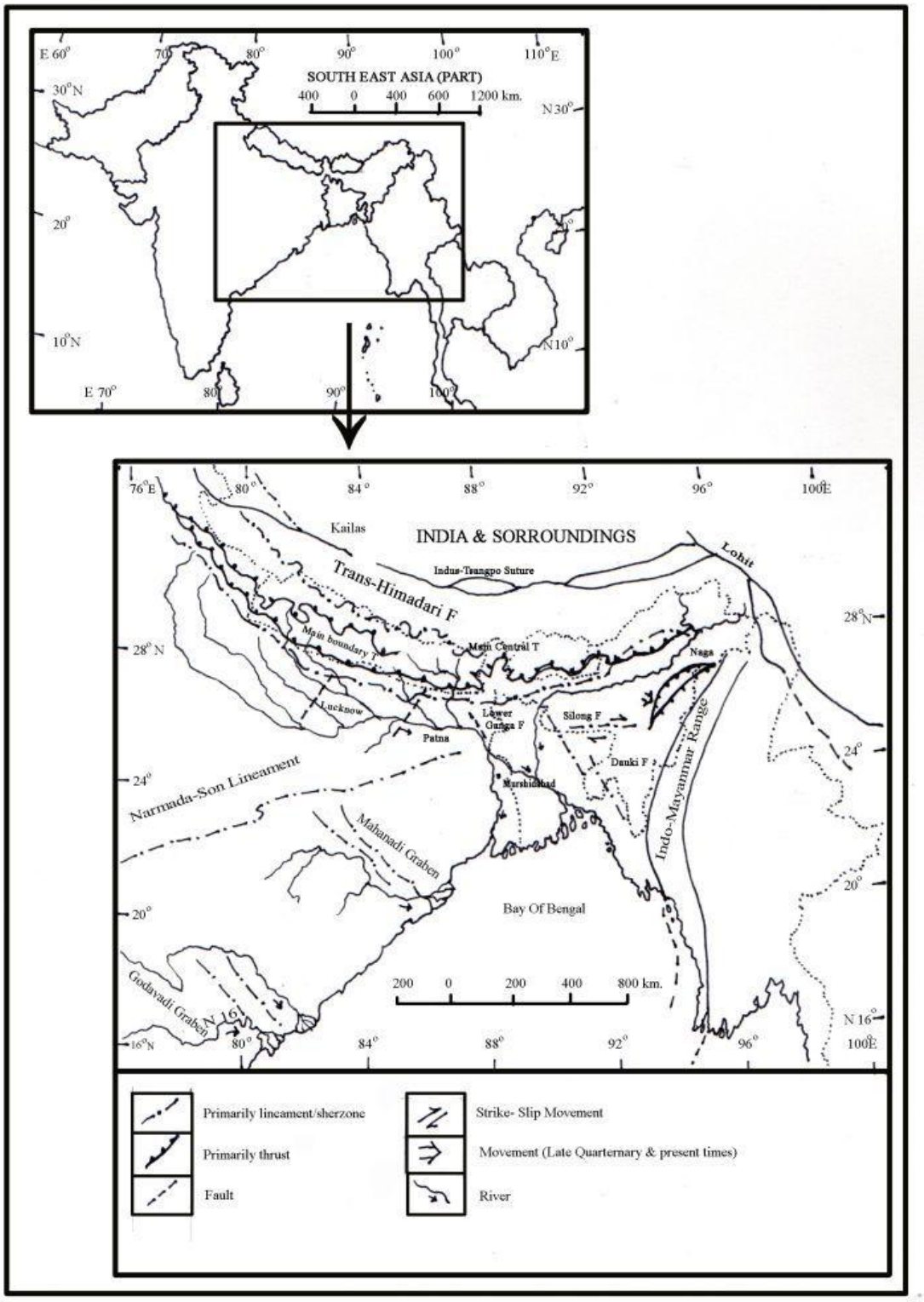


Fig 2.1, Modified generalized techtonic map.*(After, K. S. Valdiya, 2004)*

to south, south-west direction. In Berhampur town the stability was recorded two minutes but its devastating effect and impact was not traced.

In spite of all these, in Murshidabad District as well as in West Bengal earthquake occurred eleven times in various years with irregular interval, i.e. in 1834, 1835, 1839, 1842, 1843, 1845, 1846, 1847, 1849, 1852 and 1858. But all these earthquakes having lesser intensity, did not affect too much on its civilization on district level. On 10th January, 1869 a more vulnerable earthquake occurred on 15:10 PM and the epicenter was Kachaar in Assam. And on Richter scale the magnitude was recorded as 7.5 Richter. But Murshidabad district did not affected too much through this seismic event. After that in the year of 1885 on 14th July an earthquake had shaken the entire West Bengal. As per record, the total affected area was around 2, 30,400 square mile of Lower Ganga Plain. And it was evident that the eastern part of Murshidabad district was highly affected, especially densely settled area and agricultural field, but no death reports were observed.

On 12th June, 1897 almost a violent earthquake occurred at about 17:00 PM the like of which have never before been seen. The epicenter of this earthquake was Shilong, Maghalaya and adjacent Goalpara region. The intensity of this seismic hazard as recorded through Richter scale was 8.7 Richter or in other words it was the highest massive earthquake in India till 1897. According to some eminent geologists the cause of this earthquake was tectonic activity on the fault line of Assam-Meghalaya Hill, which is 360 km. long stay at 8 km depth from ground surface. The total area of Indian sub-continent affected badly by this earthquake was around 2, 00,000 sq. km. As this earthquake in Murshidabad did not occurred all of a sudden but still though with a moderate magnitude and it is also mention worthy that, after 12th June next two days after shock was also realized, the number of deaths were very minor in this regard. But the new and old houses, the new and old palaces like the Imamwara, the Stables, the Mubarak Munzil, Garden House, the Katra Masjid as also other buildings of former Murshidabad (Lalbag town), have together with their furniture been most seriously damaged. The Assistant Superintendent of Geological Survey of India E. Vredenberg came in Murshidabad for field observation on 15th June, 1897. According to Vredenberg, the most hazardous condition was observed mainly in four areas like Berhampur Town, former Murshidabad (Lalbag town), former Baluchar (Jiaganj) and Azimganj. In above said densely settled areas most of the houses were destroyed and those were not completely destroyed damaged seriously. Apart from these, at Berhampur town few prominent concrete buildings like Dakbanglow, Church, Post-Office, Colonial Barak Quarters were badly damaged and in few cases concrete roofs and big walls were collapsed. At Berhampur town soil cracks were observed here and there. According to former price level (1897) the total monetary losses were 60,000 rupees. It is worthwhile to mention that in spite of these entire community based hazard, some geomorphic hazards were also observed, due to this violent earthquake. In Jalangi tehsil and Goase village nine cracks were observed. Among observed cracks the biggest soil cracks, which is 2 miles in length and 2 feet in width, was found at Bhumitola village of Jalangi tehsil. In Kandi sub-division almost at 25 places liquid black-mud eruption were occurred through soil cracks. While at Chandipur village, Gokarno sandy ground level water erupted at higher speed through some soil cracks, which are 200-600 feet long and 0.5-3.0 feet wide. The number of death recorded as 11 in Azimganj, 6 in former Murshidabad (Lalbag town), 5 in Jangipur, 2 in Kasimbazar, 10 in Berhampur town. The total death occurred due to this vulnerable earthquake in district Murshidabad was 34.

Again in 15th January, 1934 another earthquake occurred and the magnitude of this earthquake was 8.4 Richter. The epicenter was the border area of India-Nepal boundary or foothills of Siwalik Himalaya. In India the total number of death recorded, due to this earthquake, were 10,700. But according to the death record of Murshidabad District 105 people were died. In 15th August, 1950 a vulnerable earthquake was realized first in Assam Plain Region and district Murshidabad was also affected by this seismic hazard. The magnitude of this was 8.5 Richter. Almost 65 people were died all over the district and the total monetary loss was 50,000 rupees at former price level. After 1950 again on 6th August, 1988 an

Table 2: Detail report of earthquake in Murshidabad district

Year	Frequency in a year	Epicentre	Magnitude	Effect
1772	1	UA	UA	UA
1776	1	UA	UA	UA
1803	1	Mathura, Kumaun Region	UA	300 people were died in India
1810	1	UA	Moderate	UA
1811	1	UA	Moderate	UA
1822	1	Assam Himalaya	UA	UA
1834	1	UA	Low	UA
1835	1	UA	Low	UA
1839	1	UA	Low	UA
1842	1	UA	Low	UA
1843	1	UA	Low	UA
1845	1	UA	Low	UA
1846	1	UA	Low	UA
1847	1	UA	Low	UA
1849	1	UA	Low	UA
1852	1	UA	Low	UA
1858	1	UA	UA	UA
1869	1	Kachaar, Assam	7.5 richter	Eastern part of the district; densely settled area; agricultural field
1885	1	UA	UA	Total affected area were 2,30,400 sq. mile (India)
1897	1	Shilong	8.7 richter	Total affected area were 2,00,000 sq. km. (India); Loss of 60,000 Rs.; Buildings were destroyed & damaged; soil cracks; 34 people were died in this district
1934	1	Assam Plain Region	8.4 richter	10,700 died in India and 65 in Murshidabad; Monetary loss were almost 50,000 Rs.
1988	2	UA	6.5 richter	32 people died and 77 were injured
2011	1	Sikkim	3.9-4.3 richter	71 people died in India, 12 in North Bengal; 100 mud houses were destroyed in this district

Source: Various secondary data and report and selective field interview (Tabulated by author).
N.B. UA- Unavailable/Unknown

earthquake with lesser intensity were realized, although there was no evidence of big disaster but few cracks found on the big walls of Krishnanath Collegiate School, Berhampur. In the same year, on 21st August an earthquake was realized, although the epicenter was unknown and the magnitude was 6.5 Richter. According to the record of local journal 'Murshidabad Sandesh' all over the district 32 people were died 77 were injured and on that special day a longest swimming competition on Bhagirathi river was organized at Jangipur. Very recently on 18th September, 2011 at 18:32 PM an earthquake was realized all over the district, as well as, in West Bengal. The magnitude of this earthquake was recorded as 3.9-4.3 Richter and the epicenter was Sikkim. The total number of death occurred 71 in India including 12 in North Bengal. Whereas there was no death reported (Murshidabad) due to earthquake in spite of minor monetary loss. According to daily newspapers two people were injured and more than 100 'kaccha' houses were destroyed all over Murshidabad. The trend and magnitude of earthquake in Murshidabad District since 1700 is shown in Figure 3.

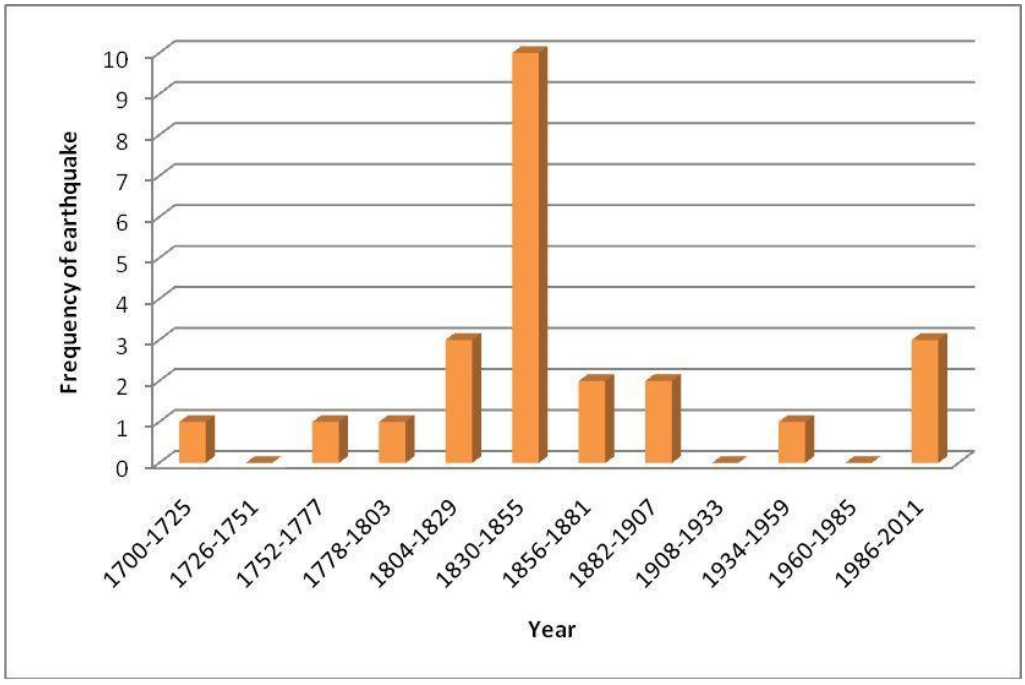


Figure 3: Trend of earthquake in Murshidabad (1700-2011)

The probability of occurrence of future characteristic earthquake over the fault segment can be based on the time-predictable model of earthquakes. The probability of occurrence of the next greater earthquake on a particular segment of fault is proportional to time elapsed since the last event. The time occurrence, T, between successive great earthquakes in the same section of plate boundary thrust (PBT), is related as a random variable having a log normal distribution. The most probable recurrence time $< T >$, of the next earthquake is given by-

$< T > = D/V.$

Where, D is the based (median) estimate of displacement in the previous great earthquake and V is the based (median) estimate of the long-term slip rate. The conditional probability of the next great earthquake in a time window ΔT is given by (WGOCEP, 1990).

$P (T_e < T < T_e + \Delta T \mid T > T_e) = P (T_e < T < T_e + \Delta T) / \{1-P (0 < T < T_e)\}$

Where, T_e is the time elapsed since the last earthquake P is the log normal distribution.

After computation it is revealed that the probability is moderate in fault zone in the lower Gangetic plain (Fig. 2.1) adjacent to Murshidabad District and the probability of earthquake in 25-year window, 50-year window, 100-year window are <0.098, 0.101 and 0.165 respectively.

CONCLUSION

Whether India is divided into earthquake-prone zones, there are five zones and the fifth zone is the safest zone. And Murshidabad district is fallen under third zone (Fig. 2), although few area of West Bengal fallen under fourth and fifth zone. Moreover it can be said that temporarily district Murshidabad is fallen under safe earthquake–prone zone and previous records and historical evidence also support this comment but no one can ignore the future possibility of a vulnerable and disastrous earthquake because the neighbor district—Malda is the most earthquake-prone district and the Lower Ganga Fault line just touched the northern portion of this district. Narmada-Son lineament also located at northwestern portion of this study area (Fig. 2.1). It can be also added that the most dangerous earthquake–prone zone, Assam and Northeastern Himalayan states are not too far from Murshidabad. So there may be a devastating

earthquake within almost near twenty years, so the local Government and NGOs should give adequate preparedness measures, the loss of lives and property was considerably lower. If they are well aware of the preventive measures to be taken, the community can substantially reduce the damage caused by disasters. Community awareness and training are particularly useful in areas that are prone to disasters. Thereafter, building codes have to be drawn up, which defines the minimum requirements of urban structural design (rural and urban) essential to public safety. Design norms and material standards both are necessary for new constructions. These codes should apply to new as well as existing buildings, and should take care of the changes that are likely to take place in terms of increase of population density, changes in building usage and so on.

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