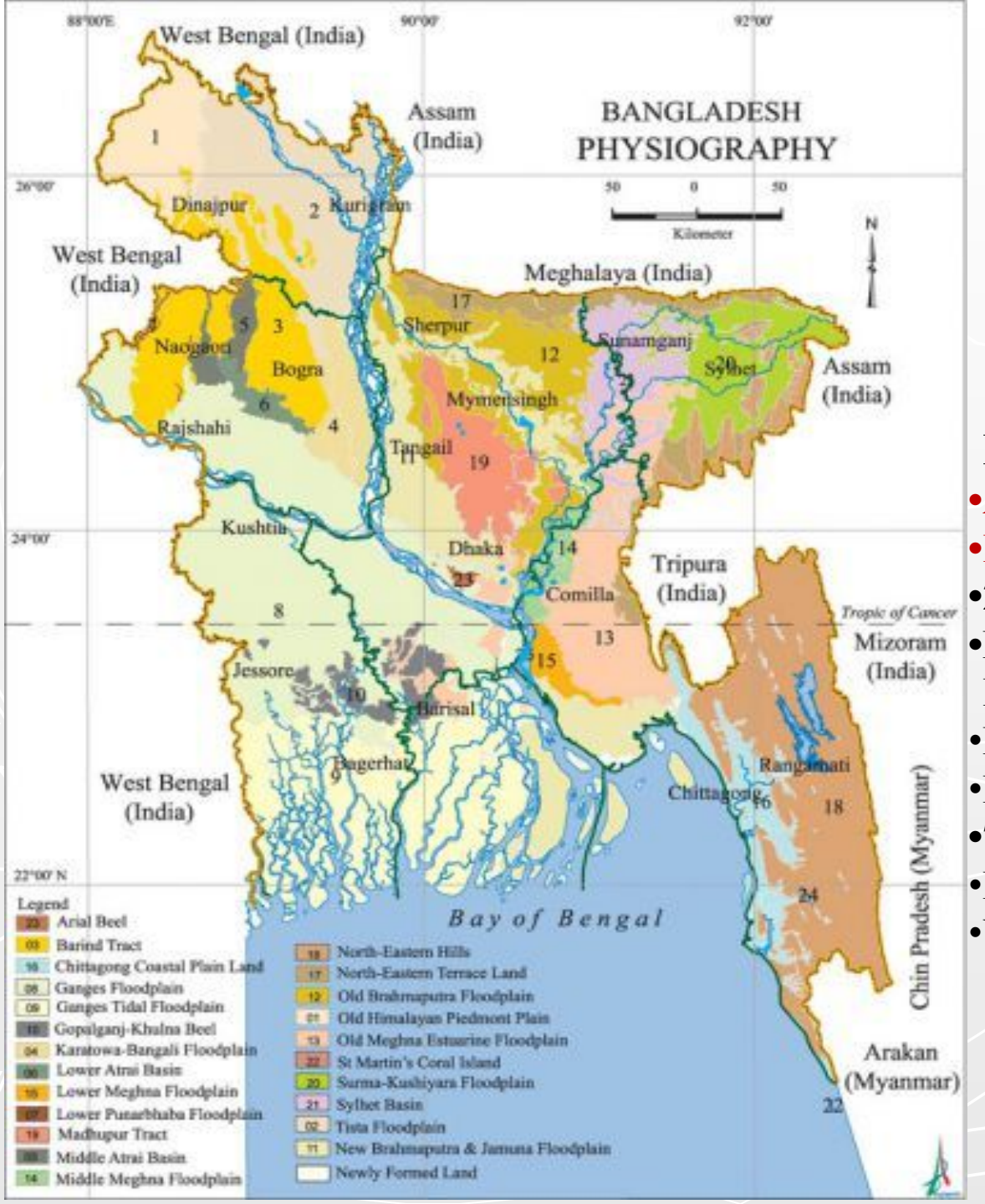
ECWE 203

Geology and Geomorphology

Seismicity in Bangladesh

Bangladesh Landform:

- **Area:** 1,47,570 sq.km
- **Population:** 180 million
- **230 x Rivers**: 2,140 km
- **Deltaic plain of the Ganges, the Brahmaputra & the Meghna**
- Flat and low topography
- Hills in SE and NE
- 700 km long coastline



Bangladesh Landform:

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- Hills in SE and NE
- **700 km** long coastline
- Border with India=**4,096** km
- With Myanmar=**271km**

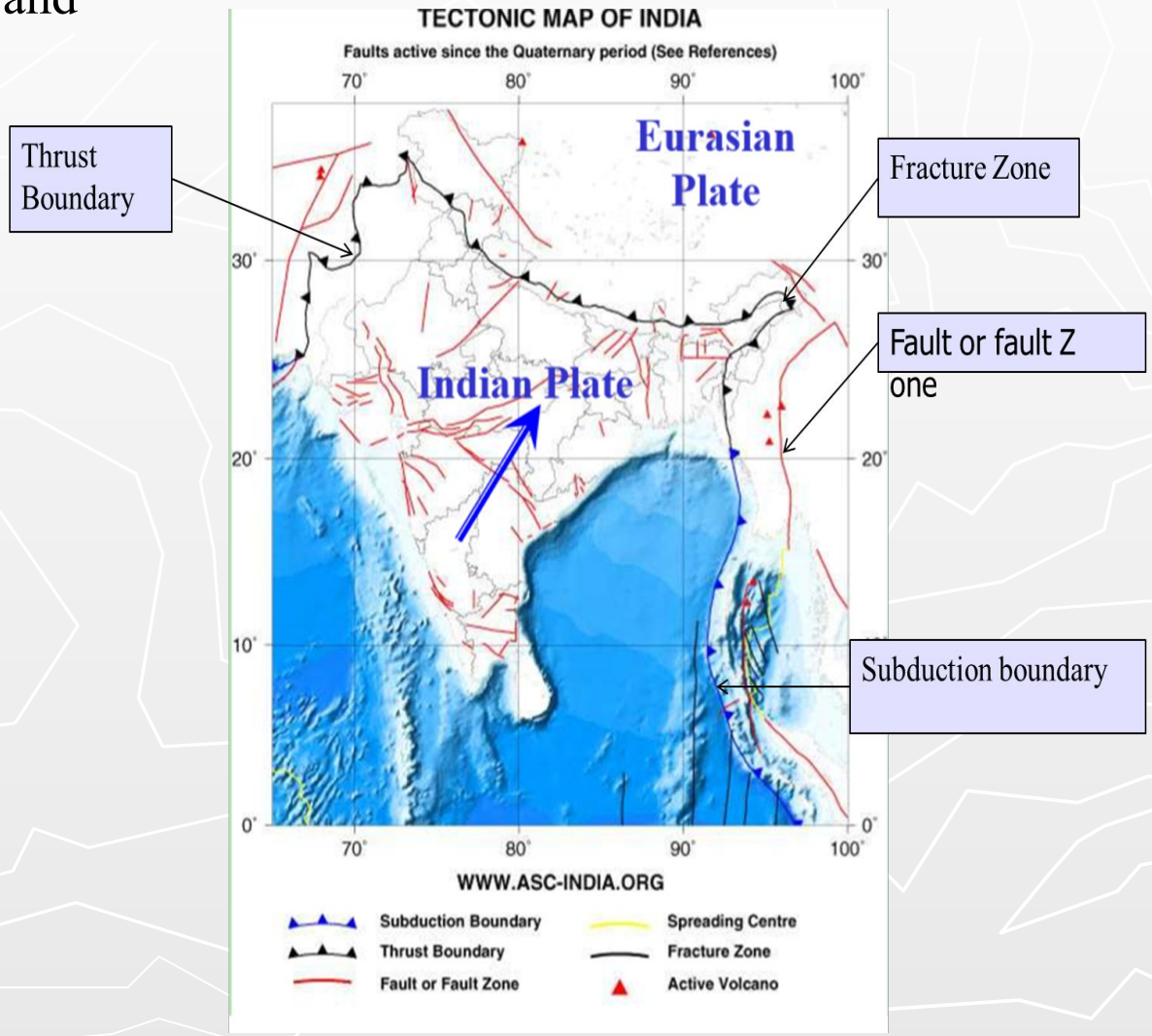
Earthquake

•Bangladeshis located in a **tectonically active region** close to the plate boundaries of the north moving **Indian plate** and the **Eurasian plate** to its **north and east**.

•Presence of major faults in and around Bangladesh.

•Lack of earthquake awareness and preparedness may lead to **massive disaster** if **major earthquake (M= 7 to 7.9) strikes**.

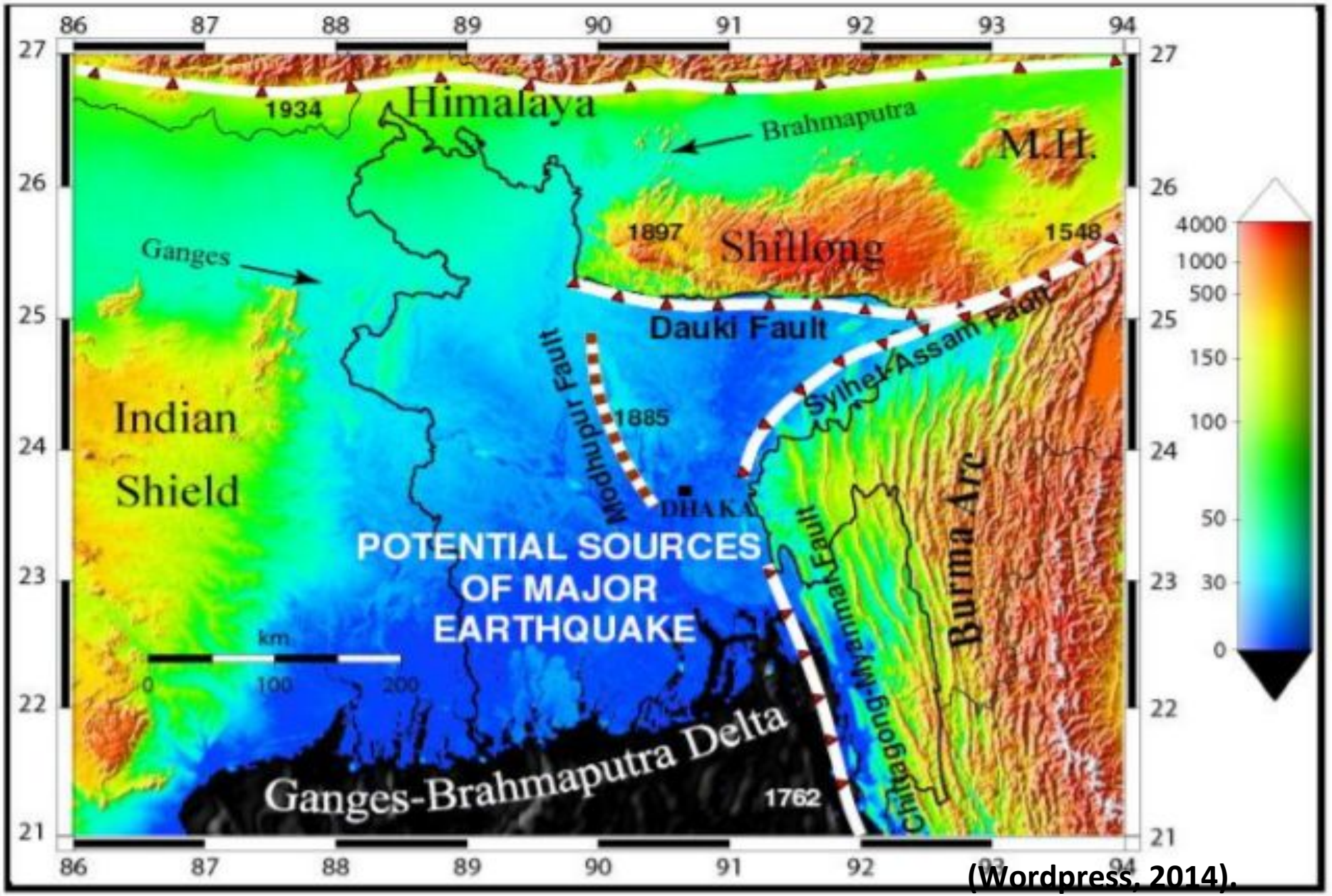
•Recent tremors have frequently shaken the country indicates how the country is vulnerability of EQ



Strong Earthquakes affecting Bangladesh

Date	Earthquake	Magnitude	Distance (km) from Dhaka
10 Jan, 1869	Cachar Earthquake	7.5	250
14 July, 1885	Bengal Earthquake	7.0	170
12 June, 1897	Great Indian Earthquake	8.7	230
8 July, 1918	Srimongal Earthquake	7.6	150
3 July, 1930	Dhubri Earthquake	7.1	250

Major Faults Existing in/around Bangladesh

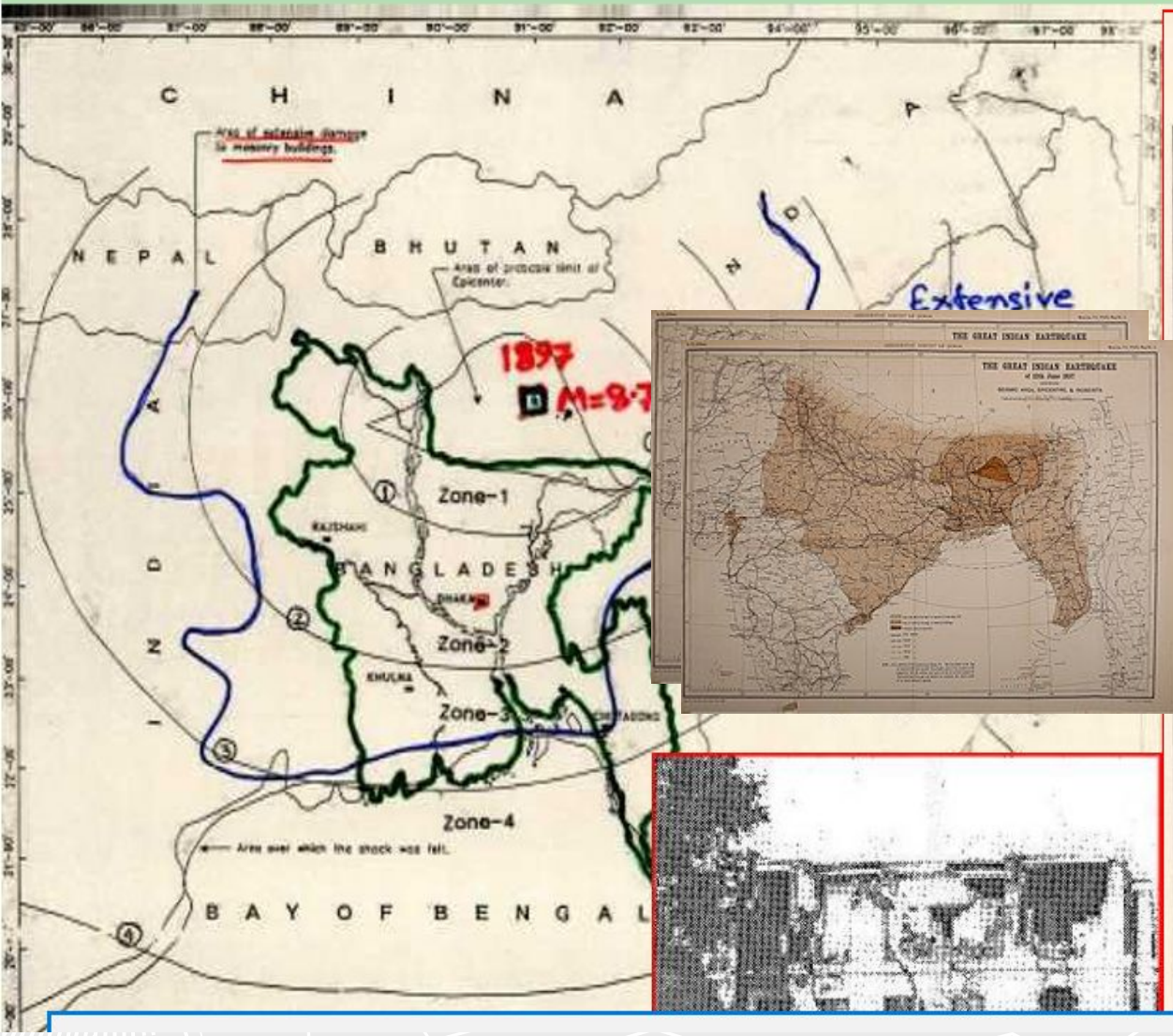


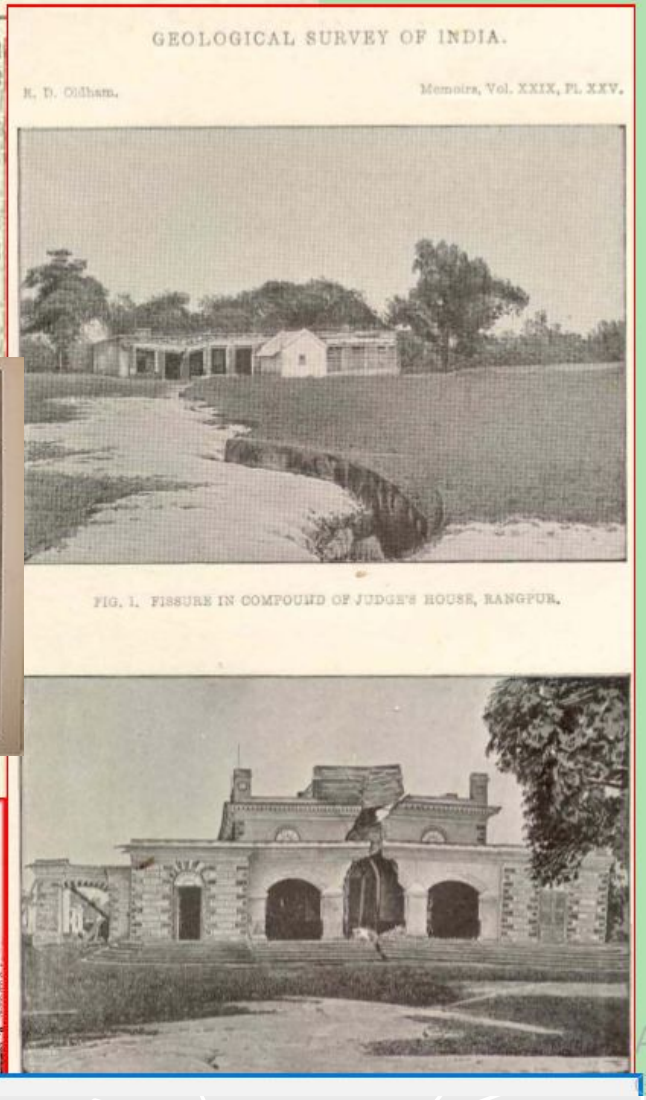
(Wordpress, 2014).

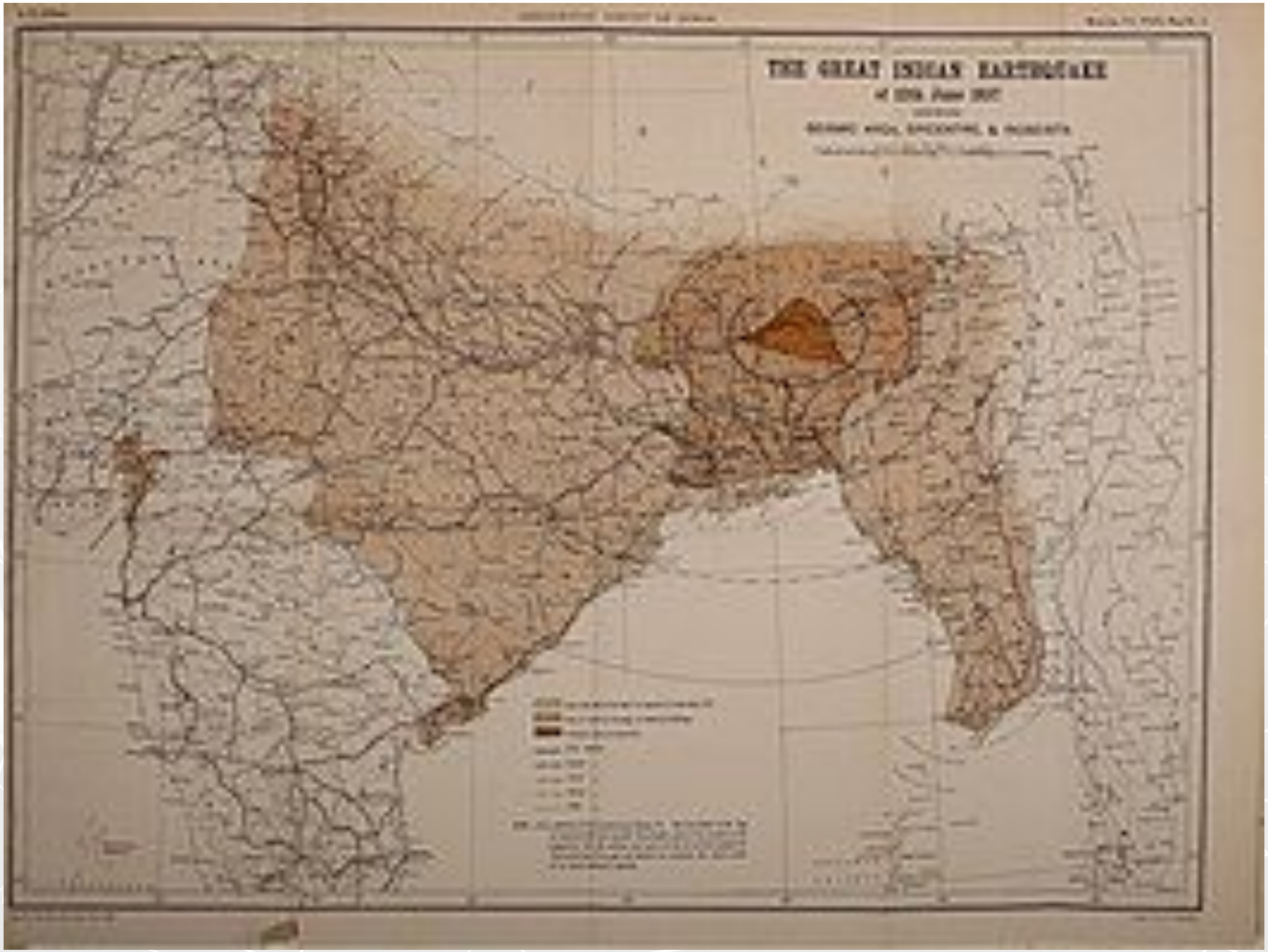
Five Tectonic Blocks/Zones

- Considering **geology and tectonics of Bangladesh and neighborhood** **five tectonic** blocks can be identified which have been **active in producing damaging earthquakes.**
- Tectonic block and maximum predicted magnitude of earthquake:
- **Bogura fault zone : M=7.0**
- Tripura fault zone: **M=7.0**
- Sub Dauki fault zone: **M= 7.3**
- Shillong fault zone: **M= 7.0**
- Assam fault zone: **M=8.5**

1897 Great Indian Earthquake (M=8.7)






THE GREAT INDIAN EARTHQUAKE

The Great Indian Earthquake:

- Also called the **Assam earthquake of 1897** occurred on 12 June in Assam at **17:15 local time**, India, and had an estimated moment **Magnitude of 8.0** and **Intensity X.**

- Mortality rate was about **1,542 casualties**, but ***property damage*** was very heavy.

- Damage from the earthquake **extended into Calcutta** where dozens of buildings were badly damaged or partially collapsed.

- Shaking from the event was felt across India, as far as **Ahmedabad and Peshawar.**



Rail Track at Rangpur



Collapse of building in Armanitola Dhaka



Damage at Rangpur, 1897 earthquake



Court – Kachari Building Collapsed at Mymensingh



Damage at Sirajganj 1897 Earthquake (http://www.world-housing.net)

: Effect of 1997 Earthquake, Bangladesh (Al-Hussaini , 2005)

1918 Srimangal Earthquake (M=7.6)

GEOLOGICAL SURVEY OF INDIA.

Memoirs, Vol. XLVI, Pt. 1.



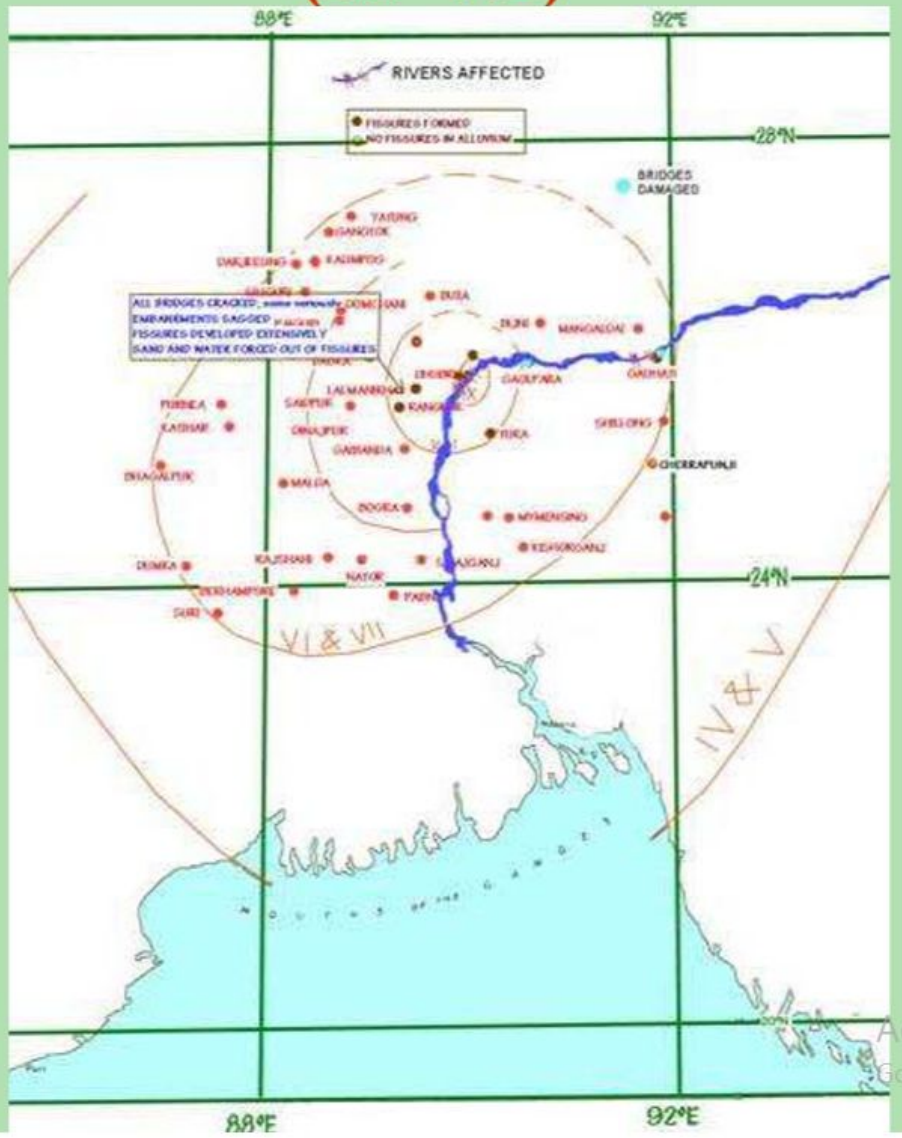
FIG. 1. THE CLUB AT KALIGHAT.



Photographs by Murray Stuart. *G. S. I. Calcutta*

FIG. 2. Dr. MUMFORD'S BUNGALOW AT KALIGHAT.

1930 Dhubri Earthquake (M=7.1)



1918 Srimangal Earthquake

- In the Sylhet Region of Bangladesh, the **8th July 1918 Srimangal Earthquake** is one of the most destructive earthquakes that have taken place in this century.

- Focus of the earthquake was **12–14 km beneath**.

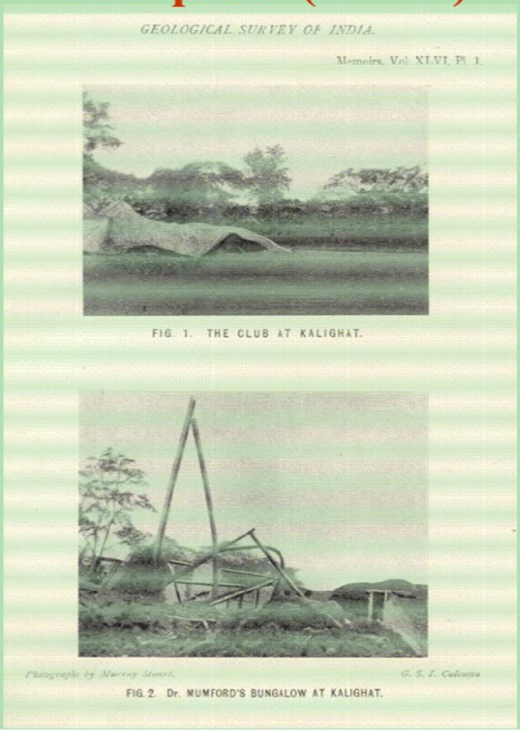
- Shock was felt over **eastern Bengal and Assam**, throughout most of **Burma**, and felt over north-east India as far west as **Lahore**.

- Srimangal is situated in the tea-garden area, and whole valleys of **tea-factories and bungalows were reported to be destroyed**.

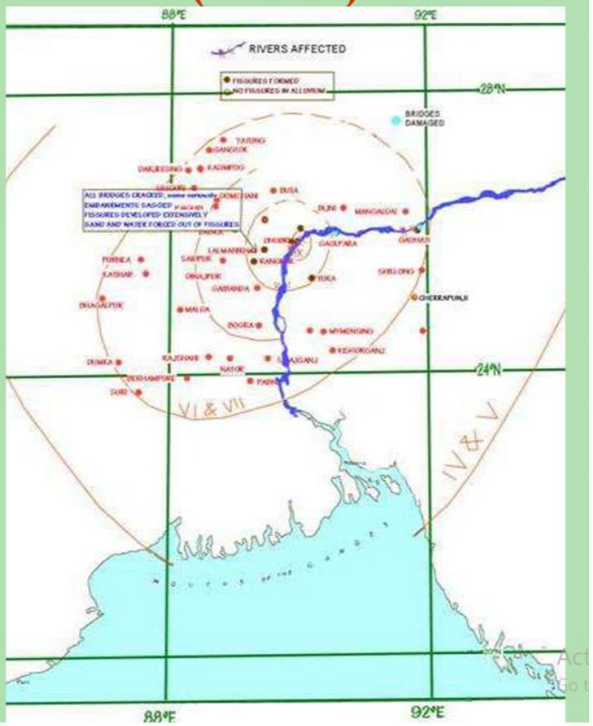
1930 Dhubri Earthquake

- **Earthquake** occurred on July 3 at 03:23 local time near Dhubri, India.
- It had a magnitude of **Mw =7.1**.
- Most of the buildings were damaged in Dhubri and the surrounding areas.

1918 Srimangal Earthquake (M=7.6)



1930 Dhubri Earthquake (M=7.1)



Moderate damaging EQ in Bangladesh:

- **May 1997 EQ in Sylhet (M=5.6):** Wall cracks.

- **November 1997 EQ at Myanmar Border (M=6.8):** Collapse of a building in Chottogram (18 Death).

- **July 1999, EQ in Moheshkhali Island (M=5.1):** Serious damage and collapse of mad-walled houses. Serious damage to cyclone center.
- **December 2001 EQ near Dhaka City (M=4.3 – 4.8):** Panic and injuries.
- **July 2003 EQ in Rangamati (M=5.6):** Serious damage to brick masonry building and mud-walled houses. Major cracks in Building in Chottogram.

Past EQ Affecting Bangladesh:

- Bangladesh has not experienced a major earthquake in over a century, since the **8.1 magnitude Great Indian Earthquake in 1897**.

- At the time, **545 buildings collapsed** in Sylhet district **and a large number of people died,** even though the population density and number of concrete structures were far less back then.

Recent EQ Activities:

- An **escalation i**n seismic activity has been observed recently.

- A **magnitude 6** earthquake was felt on April 28, 2021.

- **Three earthquakes were felt in 2020**—a magnitude 4.4 on November 3, 5.8 on June 22 and a magnitude 5.1 earthquake on June 21.

Concrete Frame Building is common in urban areas.



1997 collapse of this reinforced concrete frame building in Chittagong city was trigerred by M=6.0 earthquake more than 100 km away.



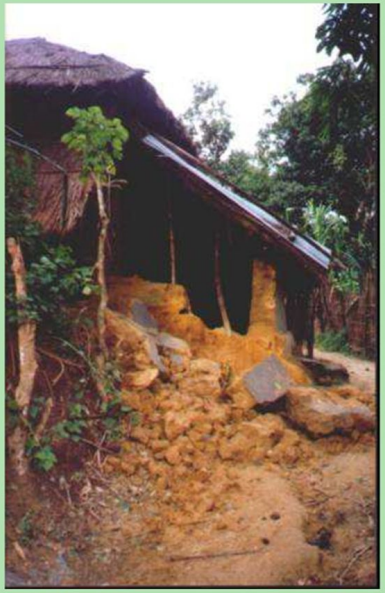


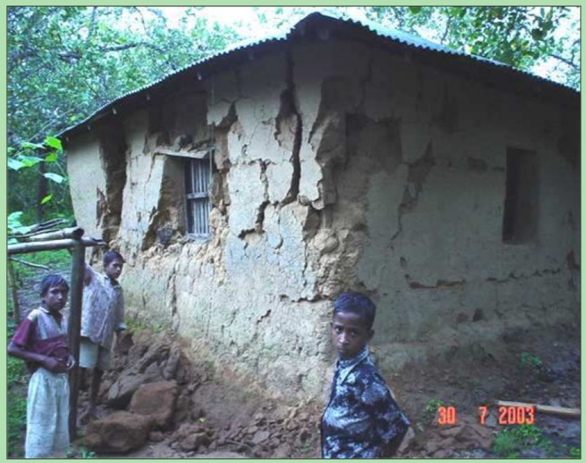
Cyclone Shelter

Column damage during 1999 Moheshkhali earthquake (M=5.1)











Damaged in an M=5.6 earthquake





2003 M=5.6 Rangamati Earthquake



LAKER'S PUBLIC SCHOOL, RANGAMATI



HEALTH COMPLEX, KALABUNIA, RANGAMATI



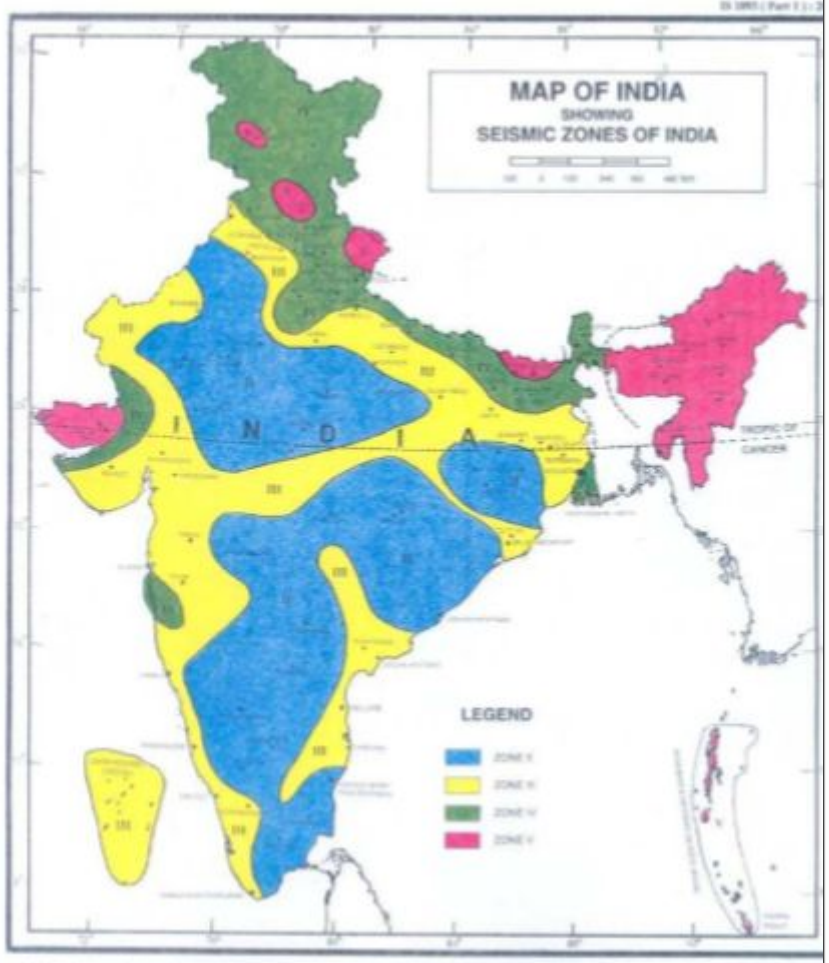
BDR CLUB, KALABUNIA, RANGAMATI



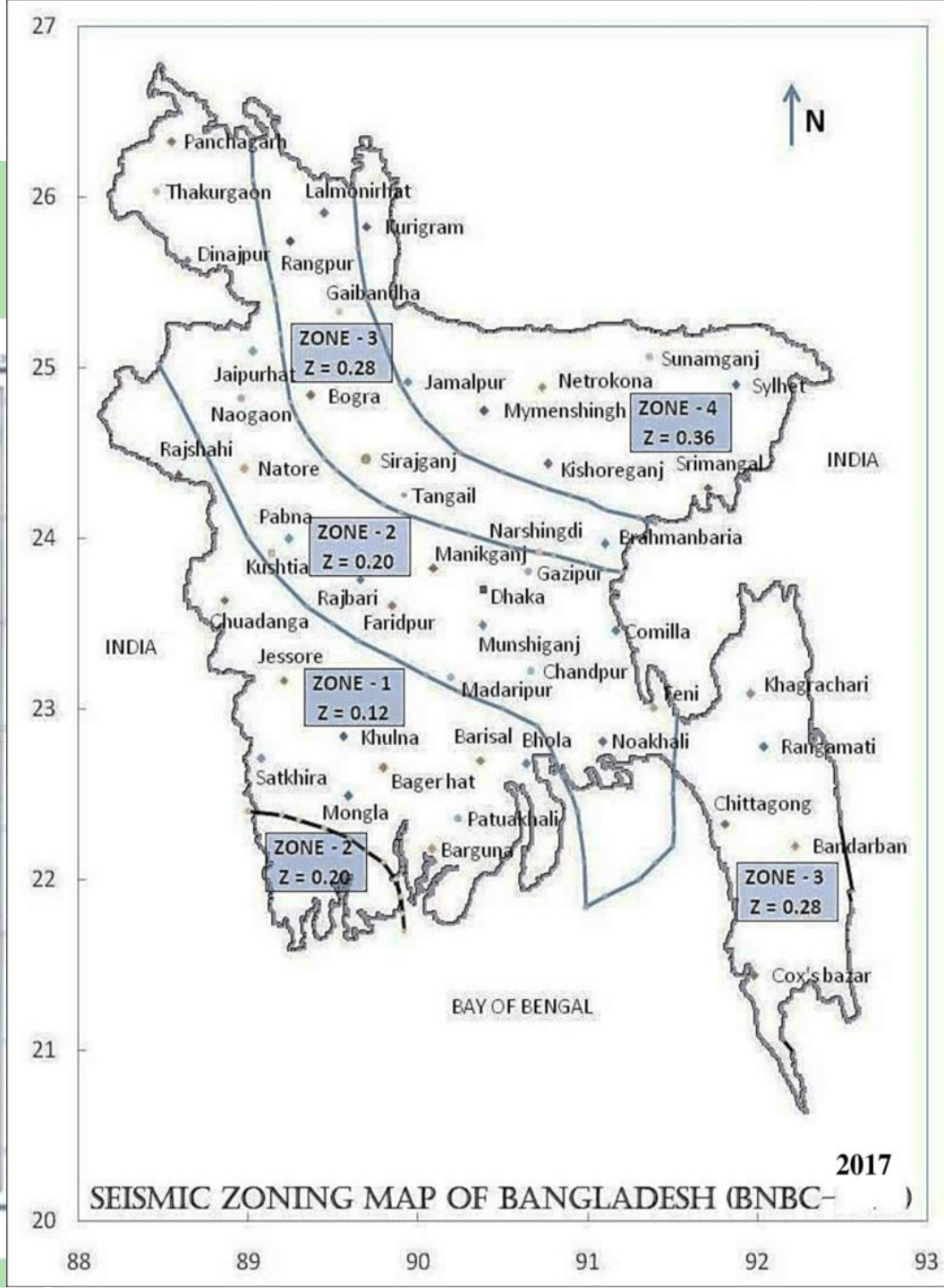
BDR CAMP, KALABUNIA, RANGAMATI

Figure 9: Effect of 2003 Rangamati Earthquake (Ansary et al. 2003)

Seismic Zoning Map of India (IS 1893, 2002)



NOTE : Towns falling at the boundary of zones demarcation line between two zones shall be considered in High Zone.



Seismic Zoning of Bangladesh

Bangladesh can be divided into three main earthquake zones:

Zone-1 (z=0.36): **Sylhet-Mymensingh** is with the possible magnitude of **7.5 or more** on the Richter scale.

Zone-2 (z=0.28): **Chittagong-Comilla-Dhaka and Tangail and CHT**are with the possible magnitude of **6.5 or more** on Richter scale.

Zone-3 (z=0.20): Natore, Pabna, Noakhali, Bhola and Monla. Shatkhira are with possible magnitude of 6 on Richter scale.

Zone-4 (z=0.12): Rajshai, Jessore, Borgunaare with possible magnitude of 5 on Richter scale.

Dhaka City









Old Brick Masonry and Roof Framing



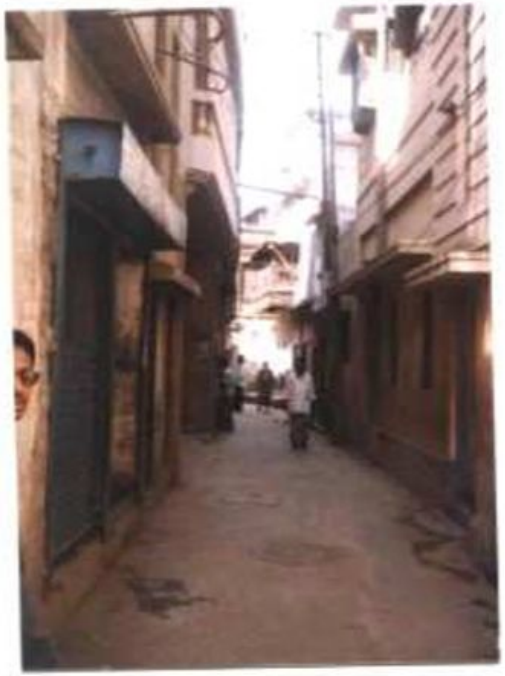








Narrow Roadway







High Rise Building



Open Ground Storey- Car parking

Possibility of Pounding



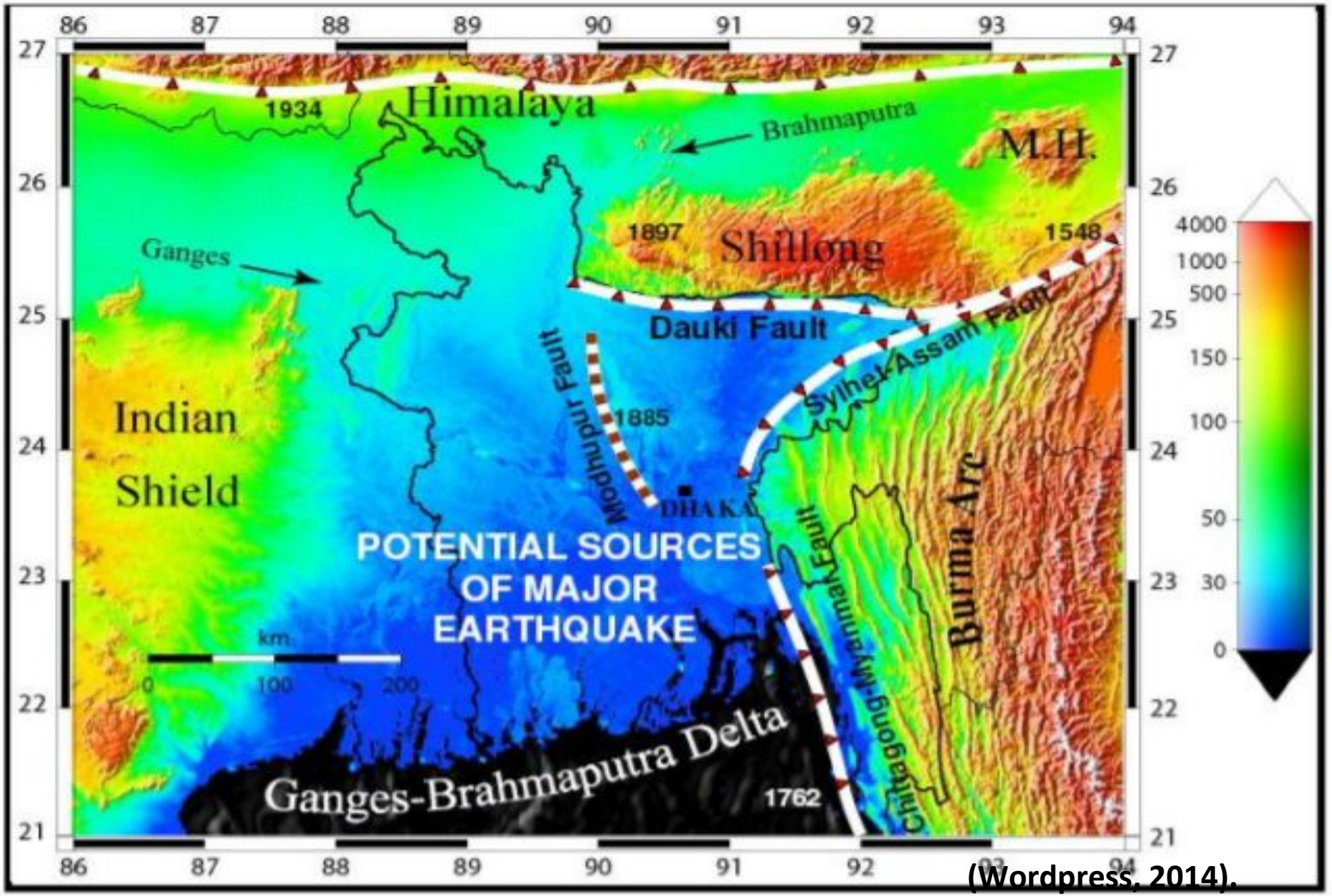
Seismicity of Bangladesh:

- **Northern and Eastern Bangladesh and the adjoining regions** lie in the **most seismically active zone** in the world.
-
- Historical records show that **at least seven large earthquakes** (three of them having M > 8) in and around Bangladesh have occurred during the last 100 years.
- Among these great earthquakes, **Bengal earthquake of 1885** and **Srimangal earthquake of 1918** having M > 7 had their **epicenters** located in Bangladesh.

Great historical earthquakes in and around Bangladesh (M > 7)

Date	Name	Epicenter	Magnitude
10th Jan. 1869	Cachar earthquake	Jantia Hill, Asssam	-
14'h July 1885	**Bengal earthquake**	**Manikgonj, Bangladesh**	**7.0**
12lh July 1897	**West Assam earthquake**	**Shillong Plateau**	**8.7**
18th July 1918	**Srimangal earthquake**	**Srimangal. Sythet**	**7.6**
3rd July 1930	**Dhubri earthquake**	**Dhubri, Assam**	**7.1**
I5th Jan. 1934	**Bihar earthquake**	**Bihar, India**	**8.3**
15th Aug. 1950	**Assam earthquake**	**Asssam, India**	**8.4**

Major Faults Existing in/around Bangladesh



(Wordpress, 2014).

Earthquake vulnerability of Bangladesh

- In the eastern frontier of Bangladesh, **Eurasian and Indian Plate boundary exist** while within the country; where **three major fault lines Madhupur fault**, **Dauki fault** and **Eastern Plate boundary fault** are located.

- In the last **250 years**, Bangladesh experienced almost **7 major to strong** ground motion (magnitude over 7.0), of which, **epicenter of two earthquakes** (Srimongal Earthquake of 1918, and Bengal Earthquake of 1885) were located within the country.

- Due to the
  - **existences of geological plate boundary and fault lines,**
  - **occurrences of historical damaging earthquakes** in and around the country and
  - **long-term silences of happening potential earthquake** (seismic-gap) across the region,

possibility of **occurring strong earthquake is increasing** over the time period.

- Since it is **not possible to predict earthquake**, **awareness** (what to do) with regard to this devastating phenomena that can **save the live and livelihood** to a great extend of the dwellers living at risk.

- Taking care of the **structural and non-structural elements**, earthquake vulnerability **can be reduced a lot**.

Five Tectonic Blocks/Zones

- Considering **geology and tectonics of Bangladesh and neighborhood five tectonic** blocks can be identified which have been **active in producing damaging earthquakes.**
- Tectonic block and maximum predicted magnitude of earthquake:
- **Bogura fault zone : M=7.0**
- Tripura fault zone: **M=7.0**
- Sub Dauki fault zone: **M= 7.3**
- Shillong fault zone: **M= 7.0**
- Assam fault zone: **M=8.5**

Major causes of earthquake in Bangladesh

Location:

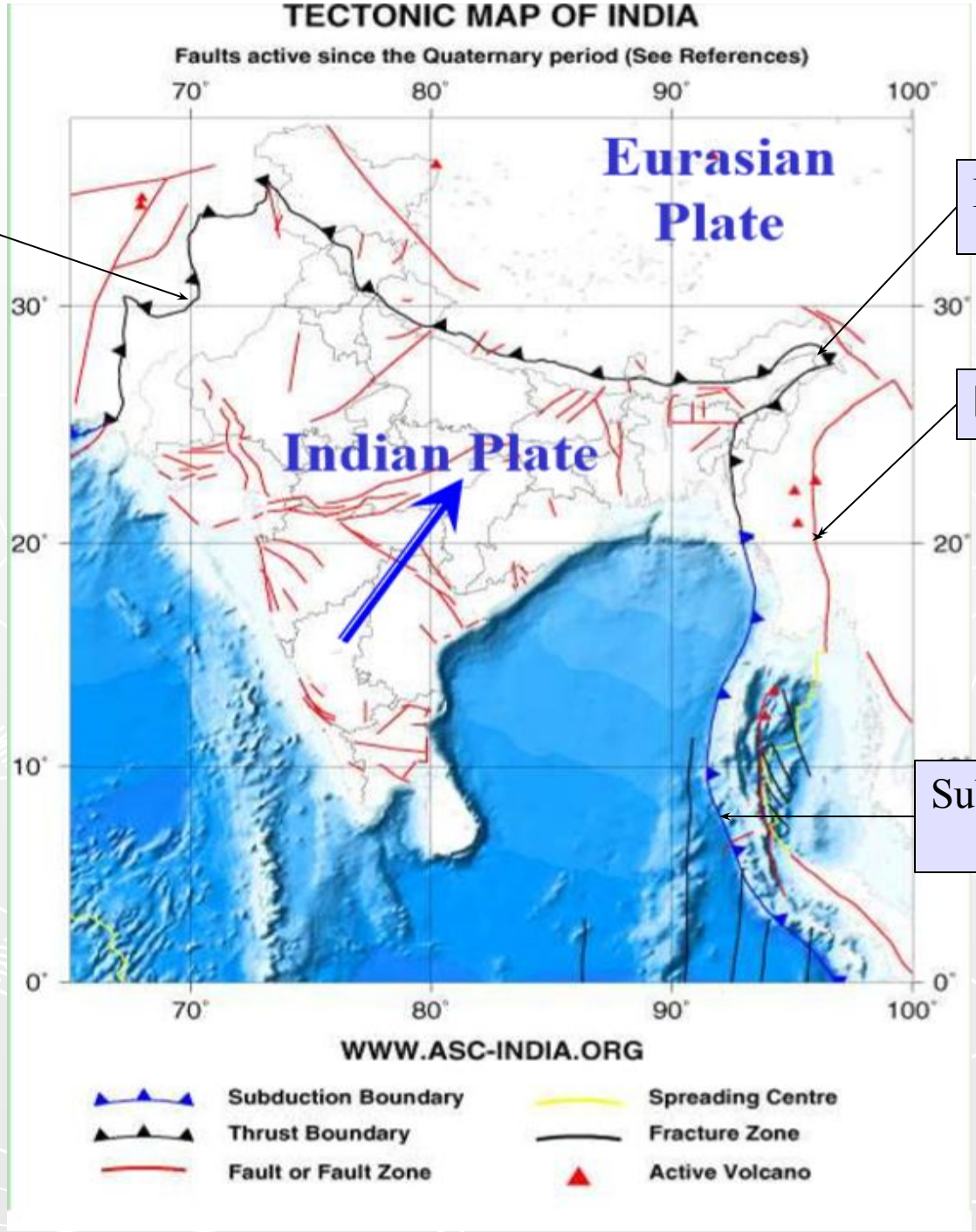
a. Bangladesh at high quake risk for its geographic location. Tectonic frame work of Bangladesh and adjoining areas indicate that **Bangladesh is situated adjacent to the plate margins of India and Eurasia** where devastating earthquake have occurred in the past and still now is seismically active.

Movement of Tectonic Plate:

b. **Indian plate is moving 6 cm each year** towards the northeast, and **subducting** under the Eurasian plate at 45 mm and the Burmese plate at 35 mm in the north and east respectively each year. This continuous motion is taken **up by active faults.**

Generation of EQ:

c. **Active faults of regional scale** capable of generating **moderate to great earthquakes** are present in and around Bangladesh.



Thrust Boundary

Fracture Zone

Fault or fault Zone

Subduction boundary

Trending of Fault:

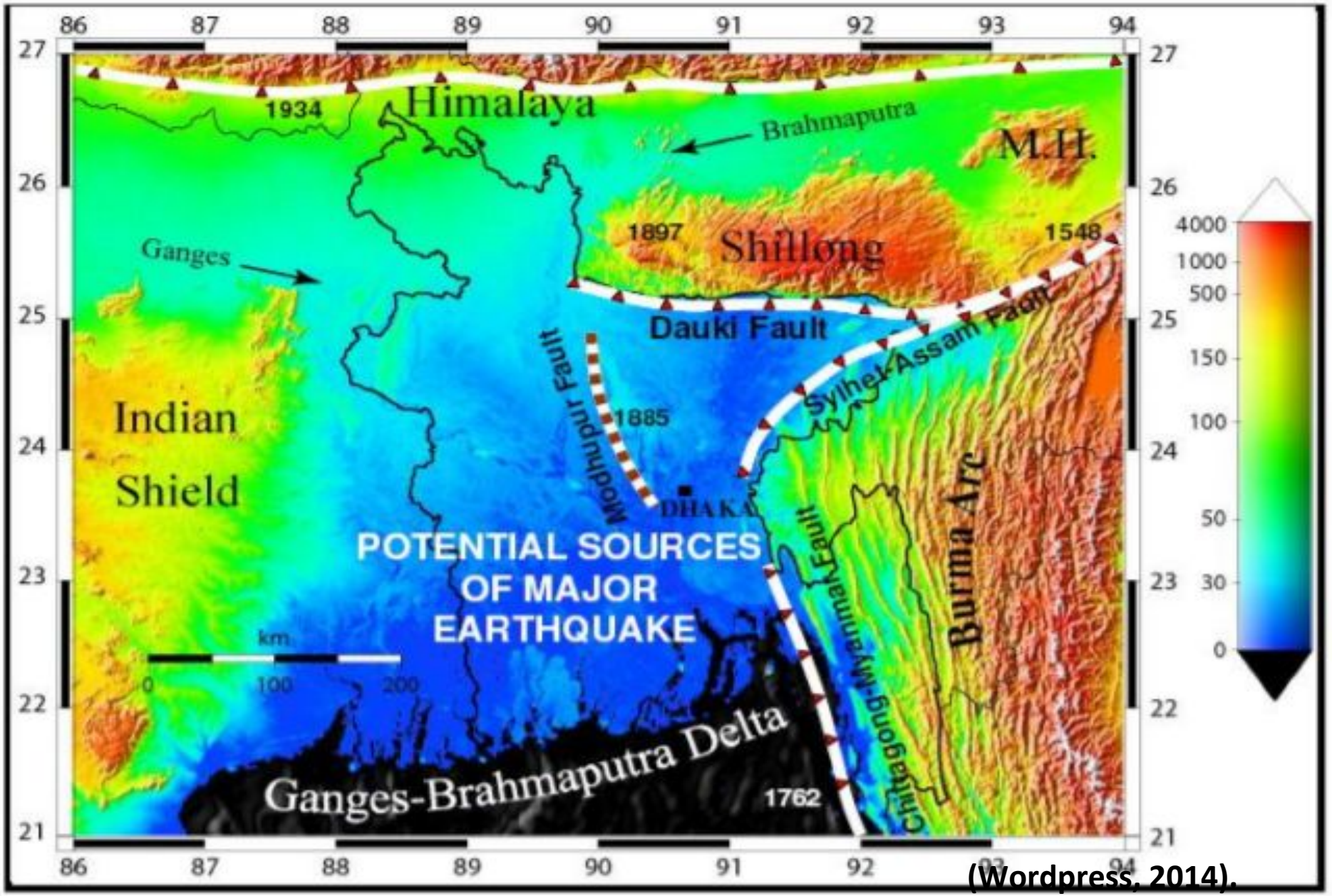
d. **Dauki fault**, trending east-west and located along the southern edge of the Shillong Plateau (Meghalaya- Bangladesh border), **Madhupur fault** trending north-south situated between Madhupur Tract and Jamuna flood plain, **Assam-Sylhet fault**, trending northeast to southwest located in the southern Surma basin, and **Chittagong-Myanmar plate boundary fault**, running parallel to the Chittagong-Myanmar coast.

Seismic Design Consideration:

e. Urban areas in Bangladesh have **developed in a fast pace** to accommodate the increasing population resulting in extensive construction of multi-storied buildings.

In the absence of **legal enforcement of the building code** in the country and **lack of earthquake awareness** in the country, **many multi-storied buildings have been constructed without proper earthquake consideration.**

Major Faults Existing in Bangladesh



(Wordpress, 2014).

Factors contributing to earthquake hazards in Bangladesh:

Various factors contributing to the earthquake hazardsin the urban and rural areas of Bangladesh may be summarized below:

- **Absence of earthquake awareness.**

- **High population density and construction lacking of legal enforcement of building code and its seismic design provisions.**

- **Poor quality of construction materials and improper construction method.**

- **Economic limitation**.

- **Possibility of fire outbreaks** due to rupture of gas pipelines or electric short-circuit during an earthquake and inadequate fire fighting facilities.

- **Inadequate road width and space** between buildings preventing rescue operations and firefighting vehicles to reach certain areas.
- **Inadequate exit** (at the same time) for the occupants of a building during an emergency.
- **Lack of facilities** (rescue equipment, trained staff, medical personnel, and medical facilities) and **preparedness** for emergency response and recovery operations following an earthquake.
- **Lack of earthquake resistant design of life line facilities** which include power plants, power stations, bridges, communication, control stations, gas and water supply stations earthquake resistant design.

What to do During the earthquake

- **Stay as safe as possible** during an earthquake. Be aware that some earthquakes are actually **fore shocks** and a **larger earthquake** might occur.

- **Minimize your movements** to a few steps to a nearby safe place and **stay indoors** until the shaking has stopped and you are sure existing is safe.

During the earthquake

If indoors

- **DROP** to the ground; take **COVER** by getting under a sturdy table or other piece of furniture; and **HOLD** on until the shaking stops. If there is no table or desk near you, **cover your face and head with your arms** and **crouch in an inside corner** of the building.

- **Stay away** from glass, windows, outside doors and walls, and anything **that could fall**, such as lighting fixtures or furniture.

- **Stay in bed** if you are there when the earthquake strikes. Hold on and protect your head with a pillow, unless you are under a heavy light fixture that could fall. In that case, move to the nearest safe place.

- **Use a doorway for shelter** only if it is in close proximity to you and if you know it is a strongly supported, load-bearing doorway.

- **Stay inside** until shaking stops and it is safe to go outside. Research has shown that **most injuries occur when people inside buildings attempt to move** to a different location inside the building or try to leave.

- **Be aware that the electricity may go out** or the sprinkler systems or fire alarms may turn on.

- **DO NOT use the elevators**.

If outdoors

- **Stay there.**

- **Move away** from buildings, streetlights, and utility wires.

- **Once in the open**, stay there until the shaking stops. The greatest danger exists **directly outside buildings, at exits, and alongside exterior walls**. **Many of the fatalities** from occurred when people ran outside of buildings only to be killed by falling debris from collapsing walls.

- Ground movement during an earthquake is seldom the direct cause of death or injury. **Most earthquake related casualties result from collapsing walls, flying glass, and falling objects.**

If in a moving vehicle

- **Stop as quickly as safety permits** and **stay in the vehicle**. Avoid stopping **near or under buildings, trees, overpasses, and utility wires**.

- **Proceed cautiously** once the earthquake has stopped. **Avoid roads, bridges, or ramps that might have been damaged by the earthquake**.

If trapped under debris

- **Do not light a match**.
- **Do not move** about or **kick up dust.**
- **Cover your mouth** with a handkerchief or clothing.
- **Tap on a pipe or wall** so rescuers can locate you. Use a **whistle** if one is available.
- **Shout only as a last resort.**
- Shouting can cause you to **inhale dangerous amounts of dust**.

Thank you