2025 March 25 Mw 7.7 Mandalay, Myanmar Earthquake

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BRIEFING NOTE 513 **April 23, 2025**

Tectonic Setting

The 2025 March 25 Mw 7.7 Mandalay earthquake occurred on the Sagaing fault, shown by the red lines in the left panel of Figure 1. It occurred as a result of steady plate motions indicated by the arrows on the left panel of Figure 1, showing northward movement of the India-Australia plate with respect to the Eurasia plate. The most recent great earthquake in this region was the Mw 9.1 2004 Sumatra – Andaman Island earthquake, in which the India-Australia plate subducted beneath the Eurasia plate in Sumatra and the Andaman Islands along the Sunda Trench, shown by the black line and teeth marks. The rupture zone of that earthquake, shown on the right panel of Figure 1, had a length of 1,250 km, a downdip width of about 200 km, and average slip of about 3 metres. It resulted in the deaths of approximately 230,000 people. The USGS PAGER report indicates that the fatalities of the 2025 Mandalay earthquake are more likely to be in the tens of thousands and hundreds of thousands than in the 5,350 identified so far, and the most likely estimated losses lie in the range of tens to hundreds of billions of US dollars.

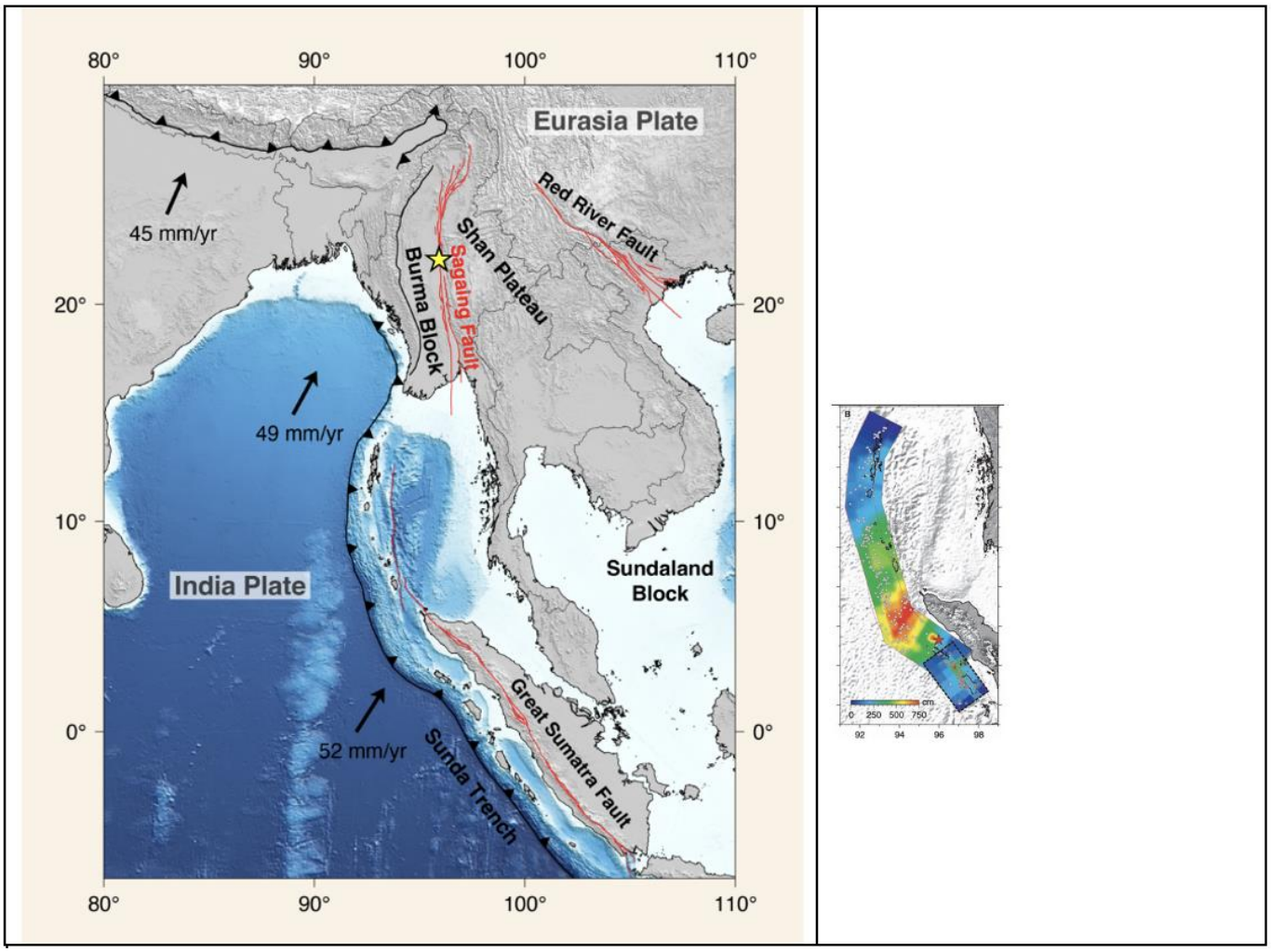


***Figure 1**. Left: Mandalay earthquake epicentre on the Sagaing fault connecting the Sunda Trench and Himalaya plate convergence zones. Source: USGS (2025a). Right: Rupture model of the 2004 Sumatra – Andaman Islands subduction earthquake on the same scale. Source: Ammon et al. (2005).*

Convergence between the India-Australia plate and the Eurasia plate in northern India, shown by the black line and teeth marks in the left panel of Figure 1, is generating the Himalaya Mountains. The 2025 Mandalay earthquake occurred on the Sagaing fault, which is a strike-slip transform fault about 1,400 km long that connects the Sunda Trench and Himalaya plate convergence zones.

Earthquake Rupture Model

The earthquake propagated bilaterally, about 100 km north and about 400 km south of the epicentre (Figures 2 and 3). The distribution of slip on the fault in the depth range of 0–15 km from the inversion of seismograms is shown on the left Figure 3, and the fault-parallel ground displacement from satellite observations is shown on the right panel. Both sets of observations indicate an average slip of about 3 metres on the fault. The west side of the fault moved north and the east side of the fault moved south.

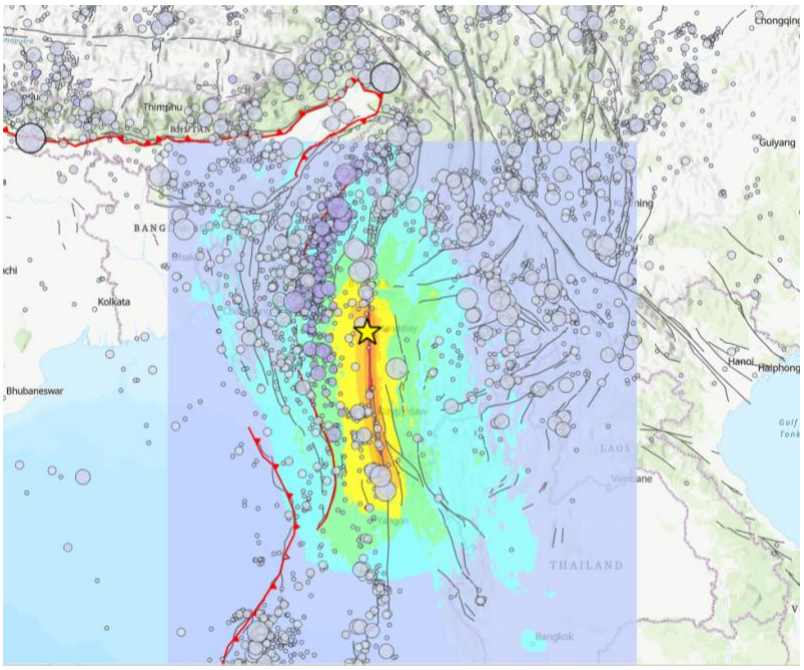


***Figure 2**. Earthquake epicentre (yellow star), rupture zone, intensity, historical earthquakes, and locations of stations Naypyitaw and Ngaung U (red and green triangles)*

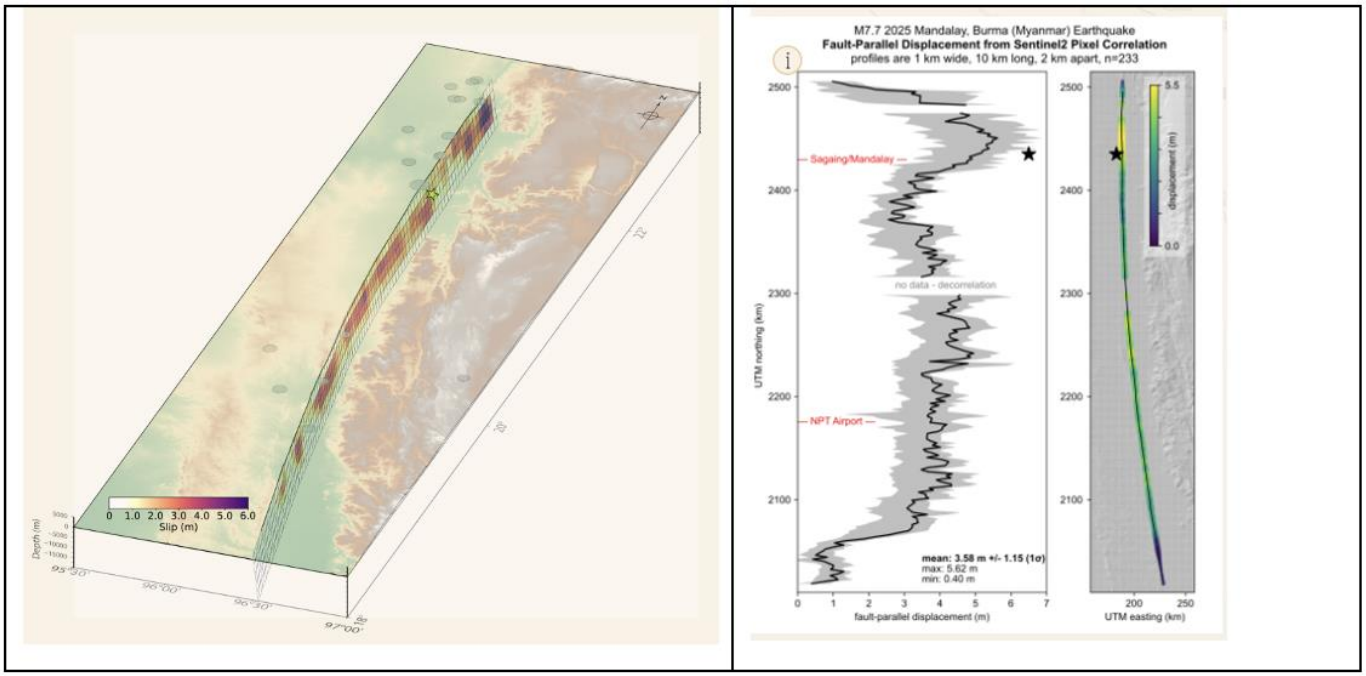


***Figure 3. Left**: Slip distribution on the fault from inversion of seismograms. Source: USGS (2025a). Right: Horizontal fault-parallel ground displacement from satellite observations. The hypocentre is shown by a star in each panel. Source: Reitman et al. (2025).*

Strong Ground Motion

The propagation of rupture at speeds close to the shear wave velocity in rock causes large pulses of long period ground motion due to the superposition of seismic waves arriving at almost the same time from all parts of the fault, creating a seismic shock wave (Somerville et al., 1997). This can be seen in the seismograms recorded at Naypyitaw (left panel of Figure 4), whose location on the fault about 250 km south of the epicentre is shown by the red triangle in Figure 2. The strong ground motion there only lasts about 5 seconds and is very large. In contrast, the ground motion recorded off to the side of the fault at Ngaung U, shown on the right panel, lasts about 50 seconds, ten times longer, and is much weaker; it has a much better view of the actual duration of the rupture of 80 seconds as observed around the world (USGS, 2025b).

When the rupture reached Naypyitaw, there is evidence from worldwide observations (Tilmann and Vera, 2025) that its rupture velocity had increased from about 3 km/s, which is normal in shallow crustal earthquakes, to a value of about 5 km/sec, which is faster than the shear wave velocity and therefore "supershear" for shear waves (analogous to supersonic speeds in air). Contrary to widespread media statements, which imply that this rupture directivity effect produces even stronger ground motions than subshear rupture speeds, the supershear rupture breaks up the coherence of the arriving shear waves and reduces their amplitudes. This may have caused the North (fault parallel) component ground velocity at Naypyitaw, 1.64 m/s, to be larger than the 1.0 m/s on the East (fault normal) component; the fault normal component is usually larger (Somerville et al., 1997). The fault parallel component was also larger than the fault normal component in the Pump Station 10 recording of the Mw 7.9 Denali, Alaska strike-slip earthquake, and attributed to transient supershear rupture (Dunham and Archuleta, 2004).

The near fault ground motions were very large. Imagine the ground under your feet moving 1.64 m and then reversing in the other direction for a similar distance in the space of a few seconds. This is the kind of ground motion that occurred along the entire 500 km length of the fault rupture, causing disastrous levels of destruction to buildings. The supershear rupture velocity may explain why the rupture length of this earthquake is more than twice the average of 200 km for a magnitude Mw 7.7 strike-slip earthquake.

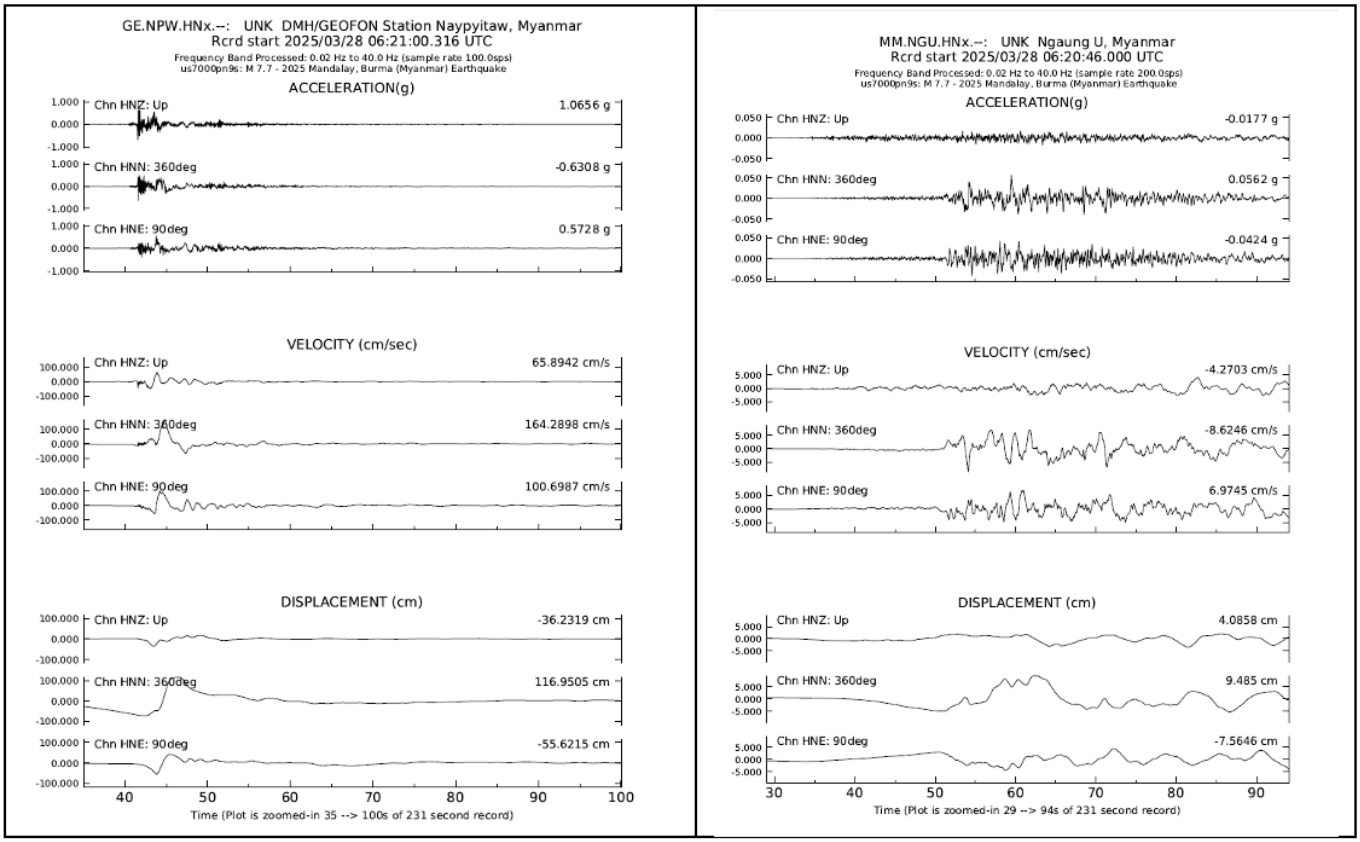


***Figure 4**. Three-component recordings of ground acceleration, velocity and displacment at Naypyitaw, which was subjected to forward rupture directivity effects (left panel), and Ngaung U, which was subjected to neutral rupture directivity effects. Source: CESMD (2025).*

Maps of peak ground acceleration and peak ground velocity throughout the affected region are shown in Figure 5. The ground motions recorded in Bangkok, shown by the coloured dots, are higher than the contour values, reflecting the local strong amplification of ground motions in the Bangkok basin at periods of several seconds that has been measured there by Poovarodom and Jirasakjamroonsri (2015) and Ornthammarath et al. (2023). This amplification was evidently sufficient to cause the collapse of a 33 storey building in Bangkok that was under construction, resulting in 35 confirmed worker deaths and nine injuries, while 59 remained unaccounted for.

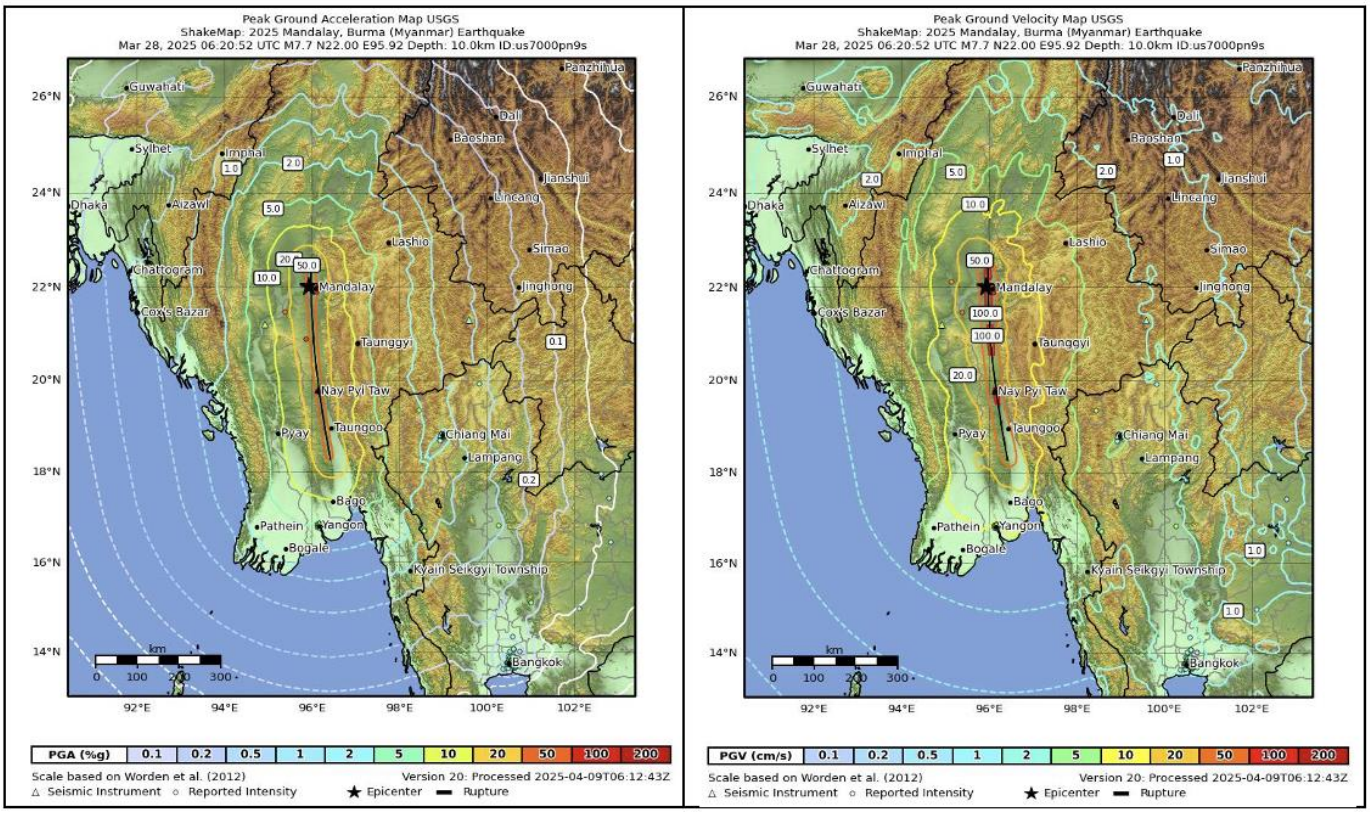


Figure 5. *Peak ground acceleration (left) and peak ground velocity (right) throughout the affected region. Source: USGS (2025b).*

Impacts

There is limited direct information available about the impacts of the earthquake. The USGS PAGER information, based primarily on modeling, is summarized in Figure 6. A summary of local newspaper reports is provided by Wikipedia (2025). They report that, as of 16 April 2025, the earthquake directly killed up to 5,350 people in Myanmar and 51 in Thailand. The PAGER report indicates that the fatalities are more likely to be in the tens of thousands and hundreds of thousands than in the thousands identified so far. The most likely estimated losses lie in the range of tens to hundreds of billions of US dollars.

Wikipedia (2025) also reports that as the earthquake struck during Friday prayer hours, collapsing mosques resulted in the deaths of hundreds of Muslims, and that more than 8,300 monasteries, nunneries and pagodas were destroyed by the earthquake. They noted that the ongoing civil war in Myanmar has exacerbated the difficulty of disaster relief and reconnaissance.

This is the deadliest earthquake in the world since the magnitude Mw 7.8 and 7.7 2023 Turkey–Syria earthquakes, which are estimated to have killed 53,537 people in Turkey and between 5,951 and 8,476 people in Syria. The damage of those earthquakes was estimated at US$148.8 billion in Turkey, which is 9% of the country's GDP, and US$9 billion in Syria. This indicates that the fatalities and economic losses from the 2025 Myanmar earthquake may be similar to those from the Mw 7.8 and 7.7 2023 Turkey–Syria earthquakes.

USGS
science for a changing world

Earthquake Shaking — Red Alert

USAID FROM THE AMERICAN PEOPLE

GSN ANSS

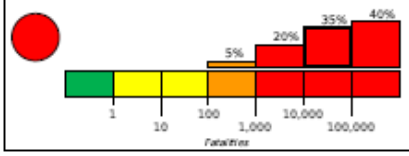
M 7.7, 2025 Mandalay, Burma (Myanmar) Earthquake

Origin Time: 2025-03-28 06:20:52 UTC (Fri 12:50:52 local)
Location: 22.0014° N 95.9247° E Depth: 10.0 km

PAGER
Version 22

Created: 1 week, 4 days after earthquake

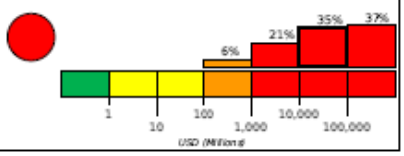
Estimated Fatalities



Red alert for shaking-related fatalities and economic losses. High casualties and extensive damage are probable and the disaster is likely widespread. Past red alerts have required a national or international response.

Estimated economic losses may exceed the GDP of Burma.

Estimated Economic Losses



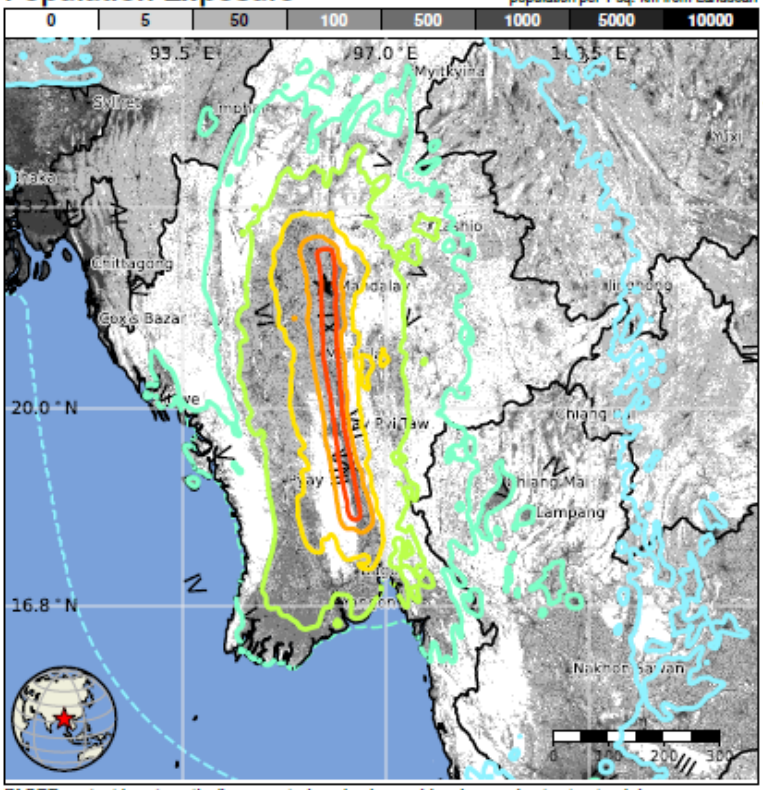
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k=x1000)		–*	43,912k*	154,945k	28,468k	17,264k	6,806k	4,138k	4,727k	12k
ESTIMATED MODIFIED MERCALLI INTENSITY		I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING		Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	None	None	None	V. Light	Light	Moderate	Mod./Heavy	Heavy	V. Heavy
	Vulnerable Structures	None	None	None	Light	Moderate	Mod./Heavy	Heavy	V. Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Population Exposure

population per 1 sq. km from Landscan



Structures

Overall, the population in this region resides in structures that are vulnerable to earthquake shaking, though resistant structures exist. The predominant vulnerable building types are informal (metal, timber, GI etc.) and unreinforced brick masonry construction.

Historical Earthquakes

Date (UTC)	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1977-05-12	310	5.9	VII(4k)	0
1995-07-11	329	6.8	IX(3k)	11
1988-11-06	386	7.0	IX(38k)	730

Recent earthquakes in this area have caused secondary hazards such as landslides that might have contributed to losses.

Selected City Exposure

from GeoNames.org

MMI	City	Population
IX	Sagaing	79k
IX	Pyu	40k
IX	Yamethin	60k
IX	Pyinmana	97k
IX	**Nay Pyi Taw**	**925k**
IX	**Mandalay**	**1,208k**
V	**Yangon**	**4,478k**
V	Bangkok	5,104k
IV	**Chittagong**	**3,920k**
IV	Kunming	3,855k
III	**Dhaka**	**10,356k**

bold cities appear on map. (k=x1000)

PAGER content is automatically generated, and only considers losses due to structural damage. Limitations of input data, shaking estimates, and loss models may add uncertainty.
https://earthquake.usgs.gov/earthquakes/eventpage/us7000pn9s#pager

Event ID: us7000pn9s

***Figure 6**. USGS PAGER Summary. Source: USGS (2025b).*

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Paul is Chief Geoscientist at Risk Frontiers. He has a PhD in Geophysics, and has 45 years experience as an engineering seismologist, including 15 years with Risk Frontiers. He has had first hand experience of damaging earthquakes in California, Japan, Taiwan and New Zealand. He works with Jacob Evans and Behnam Beheshtian in the development of QuakeAus and QuakeNZ.