Global Rapid Post-Disaster Damage Estimation (GRADE) Report

Myanmar Earthquake - March 28, 2025

(report as of April 18, 2025)

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Abbreviations, Glossary and Key statistics

Abbreviations

ADRC	Asian Disaster Reduction Center
AHA	ASEAN Coordinating Centre for Humanitarian Assistance on disaster management
D-RAS	Disaster-Resilience Analytics & Solutions, World Bank Group
GBV	Gender-Based Violence
GFDRR	Global Facility for Disaster Reduction and Recovery
GPURL	Urban, Disaster Risk Management, Resilience and Land Global Practice
GRADE	Global Rapid Post-Disaster Damage Estimation
ICT	Information and Communication Technology
MMI	Modified Mercalli Index
MMT	Myanmar Standard Time
M_w	Moment Magnitude
OSM	Open Street Map
PDNA	Post-Disaster Needs Assessment
SAC	State Administration Council
TEV	Total Exposure Value
UCC	Unit Cost of Construction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNOPS	United Nations Office for Project Services
USD	United States Dollars
USGS	United States Geological Survey
WASH	Water, sanitation and hygiene
WFP	World Food Programme
WHO	World Health Organization

Glossary

Building typology	The classification of buildings based on their characteristics, such as their function, structure, style, age or other defined characteristics.
Damage	The destruction of physical assets.
Exposure	The people, property, and systems that could be affected by a disaster including the value of these assets.
Losses	The value of lost production or income.
Needs	The short, medium, and long-term needs for reconstruction and recovery.
Replacement cost	The cost to construct or replace an asset with equal quality and construction to its pre-disaster state.
Reconstruction cost	The cost to replicate the asset, at current construction prices, to current construction standards and quality.

Key Statistics for Myanmar

Statistic	Value	Source
Gross Domestic Product (GDP)	US$77.02 billion	World Bank (financial year 2024/25 value)
Population	51,316,756	Provision results – Census 2024[1]

[1] https://dop.gov.mm/sites/dop.gov.mm/files/publication_docs/2024_provisional_result_eng.pdf

Table of Contents

Executive Summary

This Global Rapid Post-Disaster Damage Estimation (GRADE) report summarizes the direct economic damage[2] to buildings and infrastructure caused by the March 28, 2025, magnitude 7.7 earthquake in Myanmar. This report provides critical insights to support response, recovery planning, and strategic discussions on risk reduction. The assessment does not consider the losses[3] or needs[4] of the event.

The earthquake caused significant destruction to buildings and infrastructure across central Myanmar, impacting over 17 million people. As of April 14, 2025, the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA) reported 3,655 fatalities, although these numbers are expected to increase[5]. The earthquake is one of Myanmar's most impactful seismic events since 1912, or maybe even 1839. It occurred in the context of internal conflict and a recent history of natural hazard-related disasters, including Tropical Cyclone Mocha in 2023 and Typhoon Yagi in September 2024.

The GRADE methodology[6] is a well-established rapid, remote damage estimation approach that estimates direct economic damage to physical assets through a mix of earthquake damage modelling, catastrophe risk modelling, and an assessment of capital stock value of different assets and sectors. It draws on catastrophe modelling techniques and publicly available data – in the case of this earthquake, this includes local seismic data, preliminary satellite damage assessments, building exposure models and information, and available reports from humanitarian agencies and development partners. Overall, the availability of quality data has been limited. The analysis was completed as of April 18, 2025.

Key findings of the GRADE assessment include the following:

- **Total direct economic damage is estimated at US$10.97 billion, equivalent to about 14 percent of Myanmar's GDP** for financial year (FY) 2024/25[7] (see Table ES1). This is the best estimate. However, due to considerable uncertainty as explained in the report, damage can range between US$6.24 billion and US$15.82 billion.
- **Residential buildings suffered the highest damage**, accounting for US$4.97 billion (45 percent of total damage). Non-residential buildings incurred damage valued at of US$2.63 billion (24 percent), and infrastructure damage totaled US$3.36 billion (31 percent).
- **Mandalay, Sagaing, and Bago were the most severely impacted regions in terms of total damage**, accounting for 82 percent of total damage (US$5.27 billion, US$2.26 billion, and

[2] Economic damage is defined as the physical damage caused to building and infrastructure assets in US$ terms.
[3] The value of lost production or income.
[4] The short, medium, and long-term needs for reconstruction and recovery.
[5] https://reliefweb.int/report/myanmar/situation-update-no-9-m77-mandalay-earthquake-monday-14-april-2025-2000-hrs-utc7
[6] World Bank. (2018). Methodology Note on the Global Rapid Post-Disaster Damage Estimation (GRADE) approach. Washington D.C. Available at: https://www.gfdrr.org/en/publication/global-rapid-post-disaster-damage-estimation-grade-approach
[7] The financial year in Myanmar runs from April to March.

US$1.27 billion, respectively). Substantial damage also occurred in the Nay Pyi Taw Union Territory and Magway Region. Infrastructure systems, including roads, bridges, and dams, faced extensive damage, severely disrupting essential services such as water, sanitation, electricity, and telecoms. The earthquake also heavily impacted Myanmar's cultural heritage, damaging many historical and religious sites. These are included in the non-residential damage estimates.

- **Affected households in the most impacted administrative divisions could experience consumption losses of up to 25 percent,** as suggested by a preliminary household microsimulation impact analysis based on the GRADE assessment results. Households experience differential impacts, with those that are more socioeconomically vulnerable (such as those without access to improved sanitation or water supply, and in the bottom expenditure quintile) expected to be adversely impacted compared to average households.
- **Recovery and reconstruction costs are expected to significantly exceed direct damage estimates.** Recovery strategies need to be well targeted and sensitive to the context given additional humanitarian needs, conflict dynamics, gender considerations, and socioeconomic disruptions.

Administrative Divisions (State, Regions, Union Territory)	Residential Damage (US$ mn)	Non-Residential Damage (US$ mn)	Infrastructure Damage (US$ mn)	Total Damage (US$ mn)
Mandalay	2,430	1,256	1,784	**5,470**
Sagaing	1,078	619	567	**2,264**
Bago	600	318	354	**1,271**
Nay Pyi Taw	395	236	413	**1,044**
Magway	198	108	95	**401**
Shan	118	38	84	**241**
Ayeyarwady	71	21	30	**121**
Yangon	46	23	17	**86**
Kayin	15	5	9	**30**
Mon	15	5	5	**25**
Kayah	8	4	5	**17**
Total	**4,973**	**2,633**	**3,363**	**10,969**

Table ES1: Damage estimated by GRADE by sector and by administrative division, in US$ millions.

1.0 Introduction

This Global Rapid Post-Disaster Damage Estimation (GRADE) report presents a rapid estimate of the direct economic damage to physical assets (building and infrastructure) from the moment magnitude (M_w)[8] 7.7 earthquake that struck central Myanmar on March 28, 2025. The assessment does not consider the losses[9] or needs[10] of the event. It is intended to support response planning, inform recovery strategies, and guide future risk reduction interventions.

This event is Myanmar's most impactful earthquake since the 1912 Maymyo earthquake, or even the 1839 Ava earthquake, which had a magnitude[11] estimated between 7.9 to 8.3. It is also likely to be the deadliest in the country's recorded history. The earthquake caused intense ground shaking across the densely populated central corridor, resulting in building failures, widespread fatalities, destruction of critical infrastructure, and major disruptions to social and economic systems. The situation is further complicated by the country's political instability.

This report includes (i) a characterization of the seismic event, (ii) the development of an updated exposure model of Myanmar's built environment, (iii) an estimation of economic damage to buildings and infrastructure, and (iv) a high-level discussion on the potential socio-economic and recovery implications of the disaster. It draws on seismic data, preliminary satellite damage assessments, building exposure models and information, and available reports from humanitarian agencies and development partners.

1.1. Context

Myanmar's Ministry of Immigration and Population reports that the population in 2023 was just over 54 million[12] and that most of the population (approximately 69 percent) lived in rural areas[13,14]. The area impacted by the March 28, 2025, earthquake includes Nay Pyi Taw, the administrative capital city of Myanmar; the major transport corridor between Yangon and Mandalay; and Mandalay Region[15] including its capital Mandalay city which is Myanmar's second biggest city and a major economic hub.

The earthquake struck during a period of ongoing internal conflict and humanitarian crisis. Since the 2021 military takeover, Myanmar has experienced political instability, economic disruption, widespread displacement, and strained public service delivery, exacerbated by the significant

[8] https://www.usgs.gov/faqs/moment-magnitude-richter-scale-what-are-different-magnitude-scales-and-why-are-there-so-many
[9] The value of lost production or income.
[10] The short, medium, and long-term needs for reconstruction and recovery.
[11] All references to the magnitude of an earthquake can be assumed to be moment magnitude. The magnitude of earthquakes prior to the development of the moment magnitude (M_w) scale are estimated, given available data.
[12] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=MM
[13] Although the counting or non-counting of internally displaced persons may skew results.
[14] Ministry of Immigration and Population. (2024) The Republic of the Union of Myanmar, 2024 Population and Housing Census – Preliminary Results. https://dop.gov.mm/sites/dop.gov.mm/files/publication_docs/2024_provisional_result_eng.pdf
[15] For the purposes of this report, we have assumed that Myanmar is comprised of 15 administrative divisions, including states, regions, and a union territory.

impacts of Tropical Cyclone Mocha in May 2023 and Typhoon Yagi in 2024. These conditions are likely to have significantly weakened the country's capacity to prepare for and respond to large-scale disaster events. Myanmar's vulnerability to seismic events is compounded by urban growth, informal construction practices, and varying enforcement of building codes. This section provides a synopsis of past impactful seismic events, describes the event characteristics, and presents a summary of the reported impacts.

1.2. Summary of Historical Damaging Earthquakes on the Sagaing Fault

Myanmar has a long history of seismic activity, due to its position at the complex convergence of tectonic plates. Myanmar sits between the Indian, Eurasian, Sunda and Burma tectonic plates. The Sagaing Fault, from which the March 28, 2025 earthquake was generated, is a transform fault at the boundary of the Sunda and Burma plates, that runs 1,400 km north to south between 15°N and 27°N, bisecting Myanmar. It is a very active fault divided into several segments that have previously produced several destructive earthquakes of magnitudes between M_w 7.0 and 8.0 (Table 1). Historical records and assessments of past earthquakes reveal recurring destructive events with significant impacts on lives, heritage structures, and the built environment*Table 1*. Annex B has a more detailed summary of past earthquake events that have struck throughout Myanmar, including the 1912 Maymyo earthquake that occurred on a different fault from Sagaing fault but was one of the most significant events of the 20th century.

The March 28 earthquake triggered a rupture that propagated over a total length of approximately 460 km, extending from Singu in the Mandalay Region to Pyu in the Bago Region. Satellite imagery and remote sensing analysis confirmed a continuous surface rupture of approximately 500 km, making it one of the longest strike-slip[16] ruptures recorded globally in recent decades (see Figure 1). Horizontal displacements of up to 6 meters were observed along certain segments of the fault. The rupture primarily affected the Meiktila and Sagaing fault segments, which had previously been identified as part of a seismic gap[17].

More than 390 aftershocks were recorded by April 8, 2025, including a notable M_w 6.7 event just 12 minutes after the mainshock, with an epicenter located near Mandalay International Airport. Like the main event, this aftershock displayed a strike-slip mechanism and contributed to further damage in already affected areas.

Given the length of the rupture, the earthquake produced ground shaking in a widespread area (see Figure 1). Ground shaking was categorized as violent to extreme, or intensity level IX to X on the Modified Mercalli Intensity (MMI) scale[18] in Mandalay and Sagaing. The earthquake was felt throughout Myanmar and caused significant damage in Bangkok, over 1000 km away.

[16] Strike-slip faults are characterized by lateral (horizontal) movements within the earthquake crust. For more information see: https://www.usgs.gov/faqs/what-a-fault-and-what-are-different-types

[17] A seismic gap is a length of a known fault line that has not moved in an unusually long time, compared with other segments along the same fault. Available at: https://link.springer.com/referenceworkentry/10.1007/978-1-4020-4399-4_315

[18] https://www.usgs.gov/programs/earthquake-hazards/modified-mercalli-intensity-scale

Table 1: Earthquakes on the Sagaing Fault since 1839. Each color represents the rupture of different segments of the fault.

Year	Location	Ruptured segment	Magnitude	Max. MMI	Deaths	Remarks
1839	Inwa, Mandalay	Meiktila & Sagaing	7.9 to 8.3	XI	500+	It is possible that part or all of the combined 400 km long Meiktila and Sagaing segments of the Sagaing Fault ruptured.
1906	Kachin State	Kamaing	6.4	-	-	
1908	Kachin State	Kamaing	7.2	VII	-	
1929	Taungoo district (Nay Pyi Taw)	Nay Pyi Taw	6.5	VII	-	The 1929 event could have contributed to triggering the 1930 earthquake series.
May 1930	Pegu, Rangoon	Bago	7.4	IX	558+	Ruptured 100 to 130 km of the Bago segment. Reoccurrence of the 1930 event along the Bago segment is likely to be >160 years, but recurrence of any earthquake close to Bago (i.e. including both the Pyu and Bago segments) is likely to between 90 and 115 years.
Dec. 1930	Pyu	Pyu	7.3	VII-IX	36	Propagated northward from the proposed northern termination of the 1930 Bago rupture and ruptured a further 120 km of the Sagaing Fault. Stress changes in the fault resulting from the 1930 Bago event may have triggered the 1930 Pyu event.
1931	Kachin State (Myitkyina, Karming)	Kamaing	7.6	IX	-	Ruptured ~180 km of the Kamaing segment.
1946	Tagaung	Ban Mauk	7.1	VII	-	Ruptured at least 80 km of the Indaw segment to the north and possibly up to 155 km, towards the southern tip of the 1931 Kachin rupture.
1946	Tagaung	Sagaing	7.6	-	-	Near complete rupture of the Sagaing segment. May have propagated 185 km northwards towards Thabeikkyin and Tagaung.
1956	Sagaing, Mandalay	Sagaing	6.8	VIII	38	May have re-ruptured a ~60 km long segment of the Sagaing Fault immediately south of the 1946 M_w 7.7 rupture.
1991	Thabeikkyin, Mandalay	Ban Mauk	7.0	VII+	2	May have re-ruptured 49 km of the 1946 slip segments, up to the location of the June 1992 M_w 6.3 aftershock near Indaw.
2012	Shwebo, Thabeikkyin	Sagaing	6.8	VII	26+	Ruptured a ~45 km long part of the Sagaing segment between Singu and Sabeanago.
2025	Mandalay, Sagain, Nay Pyi, Taw	Meiktila & Nay Pyi Taw	7.7	IX	3,500+	The rupture propagated over a total length of ~460 km, extending from Singu (Mandalay Region) to Pyu (Bago Region).

In the 19th century there were several devastating earthquakes. In 1839, a magnitude ~7.9-8.3 earthquake destroyed the capital city Inwa (Ava), which led to the relocation of the capital city to

Amarapura near Mandalay. In the 20th century, destructive events continued, with some large earthquakes occurring in close succession.

Starting in August 1929, a sequence of four earthquakes struck along the Sagaing Fault including a magnitude 7.4 earthquake in Pegu (Bago) in May 1930 that caused at least 550 fatalities and significant destruction; and a magnitude 7.6 event in January 1931. Each event ruptured different parts of the Sagaing Fault. A decade later, in September 1946, two earthquakes of magnitudes 7.1 and 7.6 occurred within minutes of each other, rupturing remaining parts of the Sagaing Fault.

Thabeikkyin, a town in the Mandalay Region, was struck by a magnitude 7.0 earthquake in 1991 which ruptured the Ban Mauk segment of the fault again (last ruptured in 1946).

The 21st century showed continued seismic activity, with 12 earthquakes of magnitude 6 and higher impacting Myanmar overall. On the Sagaing Fault, a damaging event occurred in 2012 when 45 km of the Sagaing segment ruptured causing a magnitude 6.8 earthquake. Beyond the Sagaing Fault, Myanmar has faced many major earthquakes, including the destructive 2011 Tarlay earthquake in Shan State, causing up to 150 deaths and extensive damage, and the magnitude 6.8 Chauk earthquake in 2016, severely impacting historical sites in Bagan.

For a detailed record of large earthquakes to impact Myanmar since 1839, see Annex B.

1.3. Earthquake Characteristics and Description

On March 28, 2025, at 12:50:54 Myanmar Standard Time (MMT), a powerful M_w 7.7 earthquake struck the Sagaing Region of central Myanmar, with the epicenter located between Sagaing city and Mandalay city. The earthquake occurred at a shallow depth of 10 km and is estimated to be the strongest recorded seismic event to affect Myanmar since the 1912 or even 1839 earthquake**.**

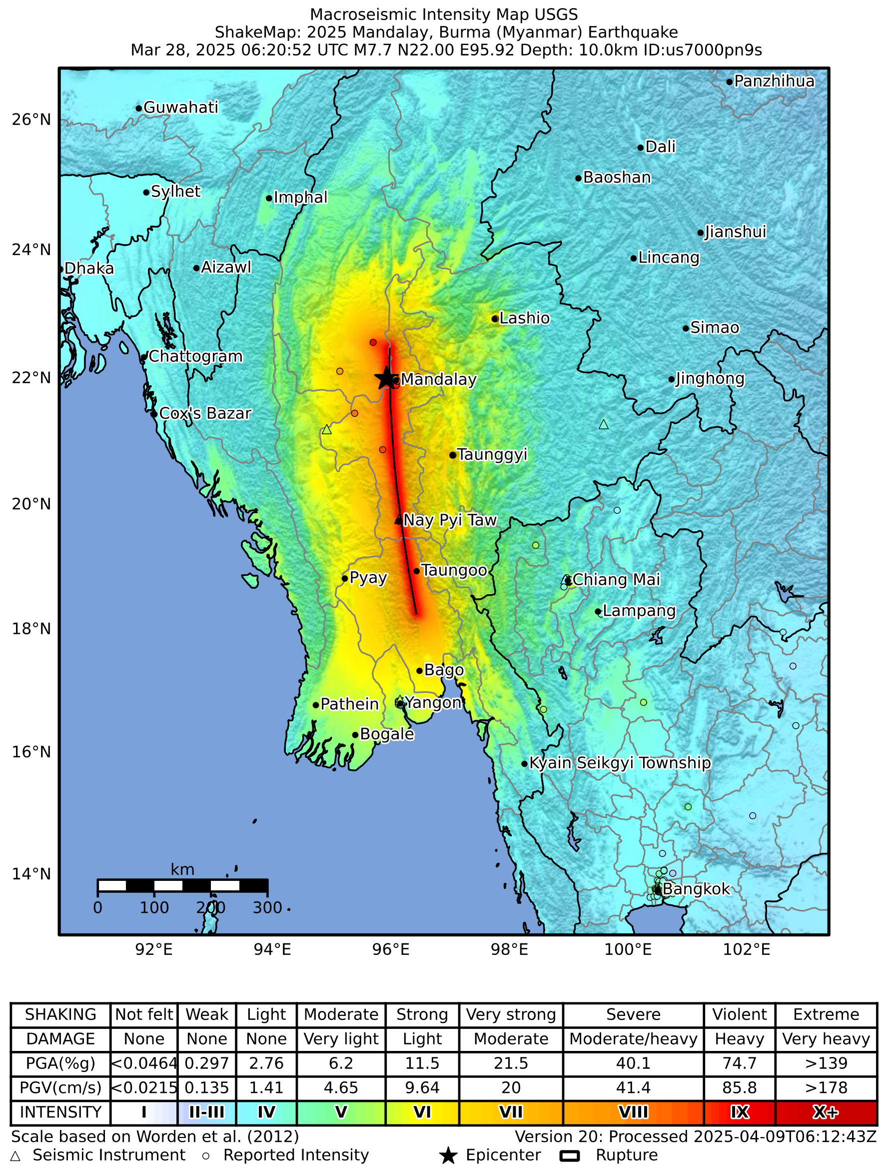

Figure 1: United States Geological Society ShakeMap. Version 20 (last updated: 2025-04-09 06:16:11 (UTC)). Accessed from: https://earthquake.usgs.gov/earthquakes/eventpage/us7000pn9s/shakemap/intensity on April 9, 2024.

1.4. Reported Impacts of the Earthquake

Reported impacts are a critical element of the GRADE approach, enabling the modelled estimations to be calibrated and validated against ground data. This section gives a summary of the reported impacts from Myanmar as of April 18, 2025. Overall, the reported impact information and official, comprehensive damage datasets have been limited.

The earthquake had a major impact across five administrative divisions of Myanmar, with reported damage and impacts in Mandalay Region, Sagaing Region, Bago Region, Nay Pyi Taw Union Territory and Magway Region. These areas are facing widespread damage to infrastructure, houses, and essential services[19]. In response to the widespread damage and destruction, the State Administration Council (SAC)— Myanmar military authorities —declared a state of emergency in all affected areas[20]. The damage and impact reports below only provide a partial overview of the effects of the earthquake, with many areas still inaccessible due to damaged infrastructure and disrupted telecommunications, making it difficult to fully assess the full extent of the devastation.

Millions of people are affected by the earthquake. The United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) estimates that the earthquake has impacted over 17 million people across 57 of Myanmar's 330 townships, with more than nine million severely affected by the strongest tremors[21]. These figures are largely consistent with, though slightly lower than, earlier estimates from the Pacific Disaster Center's Joint Analysis of Disaster Exposure, which reported 19.5 million people living in affected areas, including 10.4 million in the most severely impacted zones[22]. As of April 14, the AHA Centre had reported 3,655 fatalities, with 134 missing, and over 198,000 displaced, although these figures are expected to continue to rise[23]. UNICEF reports that the final toll is likely significantly higher, as preliminary findings from over 700 Rapid Needs Assessments conducted across 40 townships indicate a much greater number of injuries and people reported missing[24].

Buildings and infrastructure have been severely impacted throughout the areas of strong seismic shaking. As of April 14, the AHA center reported that over 13,000 buildings are totally damaged (or destroyed), and nearly 40,000 partially damaged. Media reports suggest that more houses (over 52,000) are damaged to some degree[25]. The Microsoft AI for Good Lab damage assessments for buildings in key urban centers, including Mandalay[26] and Nay Pyi Taw[27], found that the vast majority of buildings (over 98 percent) have a damage level of 0-20 percent. The number of buildings reported to have a damage fraction of over 80 percent is reported as 515 in Mandalay, and 70 in Nay Pyi Taw. The AHA Centre also reported that 2,661 schools and 640 health facilities are impacted (as of April 14) while the World Health Organization (WHO) reported a much lower number of damaged health facilities from satellite analysis, at just 190[28]. Verified health cluster

[19] https://cdn.who.int/media/docs/default-source/searo/whe/him/phsa-mmr-eq0325.pdf?sfvrsn=75144f42_3
[20] https://cincds.gov.mm/node/28710
[21] https://reliefweb.int/report/myanmar/myanmar-earthquake-flash-update-3-3-april-2025
[22] https://x.com/PDC_Global/status/1905729510626254992
[23] https://reliefweb.int/report/myanmar/situation-update-no-9-m77-mandalay-earthquake-monday-14-april-2025-2000-hrs-utc7
[24] https://reliefweb.int/report/myanmar/unicef-myanmar-flash-update-no-8-earthquake-16-april-2025
[25] https://www.ludunwayoo.com/news-mm/2025/04/17/118200/
[26] https://data.humdata.org/dataset/myanmar-earthquake-building-damage-assessment-from-3-28-2025
[27] https://data.humdata.org/dataset/myanmar-earthquake-naypyidaw-building-damage-assessment-from-03-31-2025
[28] https://reliefweb.int/report/myanmar/myanmar-health-cluster-sagaing-earthquake-situation-report-4-11-april-2025?_gl=1*2bub02*_ga*MTg3MTU4NDg1OS4xNzMyODY4MjQ2*_ga_E60ZNX2F68*MTc0NDc4NjY3MS4xMDkuMS4xNzQ0Nzg3OTQwLjE3LjAuMA

data as of April 6[29], shows five fully damaged health facilities (two in Bago, one each in Nay Pyi Taw, Sagaing, and Southern Shan) and 61 partially damaged (35 in Southern Shan, 20 in Bago, and six in Nay Pyi Taw). Data for Mandalay is not yet available.

The earthquake in Myanmar has caused extensive damage to the nation's cultural and religious heritage. As reported on April 13 by the Ministry of Religion and Culture, 9,643 religious structures have been affected across seven administrative divisions. Among the damaged sites are a reported 5,402 pagodas, 3,841 monasteries, 187 nunneries, 50 Christian churches, 136 mosques, 26 Hindu temples, and 1 Chinese temple. The destruction spans culturally rich areas including Nay Pyi Taw, Mandalay, Sagaing, Bago, Magway, Shan, and Kayin, posing a significant loss to Myanmar's historical architecture.[30]

Many forms of infrastructure are badly affected. Situation updates from the United Nations Office for Project Services (UNOPS) 10 days after the event stated that electricity and water services have not been restored in the worst hit areas, with telecommunications networks remaining severely disrupted. [31] The Myanmar Red Cross reported challenges with blocked transport routes and damaged bridges, particularly impacting transportation to rural and remote areas.[32,33] There have been a number of critical bridge failures hampering access, including the Old Inwa Bridge over the Ayeyarwaddy River[34] and the Dokhtawaddy Bridge crossing the Myitnge River on the Yangon–Mandalay Expressway near Inwa[35]. The Sinthay River Dam was damaged, along with 198 irrigation dams, including minor damage to four of the 12 dams in Nay Pyi Taw[36,37]. The earthquake caused extensive damage to water, sanitation and hygiene (WASH) infrastructure including the destruction of boreholes and disruption of piped networks, leaving many without access to clean water. Additionally, over 76,000 latrines collapsed, creating serious sanitation and public health risks in affected communities.[38]

[29] https://reliefweb.int/report/myanmar/myanmar-health-cluster-sagaing-earthquake-situation-report-3-6-april-2025
[30] https://bur.mizzima.com/2025/04/13/53010
[31] Situation report #2: Earthquake in Central Myanmar 2025. UNOPS. https://themimu.info/sites/themimu.info/files/documents/Situation_Report_2_Earthquake_in_Central_Myanmar_UNOPS_04Apr2025.pdf
[32] Myanmar Red Cross Society (MRCS) Emergency Operation Centre: 2025-Earthquake Situation Report, 7th April, 2025 https://reliefweb.int/report/myanmar/myanmar-red-cross-society-mrcs-emergency-operation-centre-2025-earthquake-situation-report-7th-april-2025
[33] WFP, Logistics Cluster. Situation update, 08 April 2025: Myanmar Earthquake Response. https://reliefweb.int/report/myanmar/myanmar-earthquake-response-situation-update-08-april-2025
[34] https://www.irrawaddy.com/news/colonial-era-ava-bridge-over-irrawaddy-river-collapses-during-earthquake.html
[35] https://yktnews.com/2025/03/209262/
[36] https://bur.mizzima.com/2025/04/13/53050, https://news-eleven.com/article/302027
[37] https://www.myanmaritv.com/news/inspecting-damages-dams-moali-um-inspected-damages-dams
[38] https://reliefweb.int/report/myanmar/unicef-myanmar-flash-update-no-8-earthquake-16-april-2025

2.0 Rapid Post-Disaster Damage Estimation Methodology

The assessment follows the World Bank (2018) GRADE methodology. It provides a fast first-order approximation of the direct economic impact and so provides a rapid high-level estimate of damage to physical assets which can be used to inform decisions in a timely fashion. Damage to residential and non-residential buildings and their contents, and infrastructure, are estimated. Losses and needs are not estimated.

In the past 10 years, the World Bank's Disaster-Resilience Analytics and Solutions (D-RAS) team has produced 14 earthquake-related GRADE assessments (World Bank, 2025a). The most recent was for the December 2024 Port Vila, Vanuatu Earthquake (World Bank, 2025b). The GRADE methodology estimates damage in three stages:

1. Data collection, monitoring, and checking.
2. Comparison with damage estimates for historical events.
3. Calibration, modelling, cross-checking, and validation.

This GRADE assessment provides an estimation of the direct damage caused by the 2025 Myanmar Earthquake, through an approach that utilizes a mix of earthquake damage modelling, catastrophe risk modelling, and an assessment of capital stock value of different assets and sectors. This rapid and remote assessment used a range of datasets to assess damage, including historical data, scientific data such as ground motion, information on the built environment and population, engineering information on vulnerability, as well as available data through local sources, and reports on the ground (Figure 2). A full list of data sources used is given in Annex A. Overall, data for this event has been limited, particularly as it relates to comprehensive official estimates of damage.

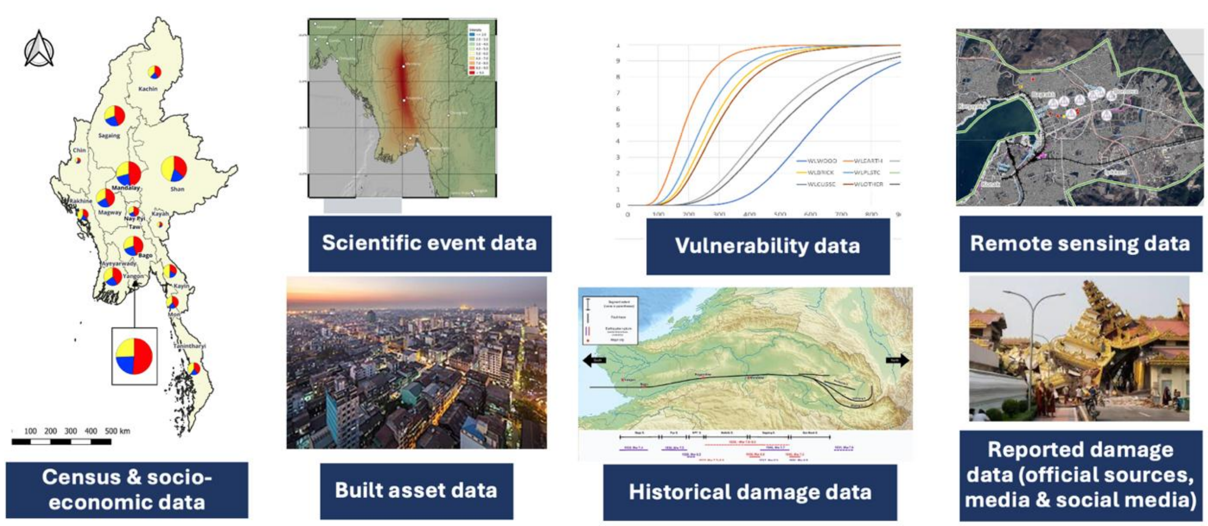

Figure 2: Example of some of the methods and datasets used for the analysis.

2.1. Hazard analysis

The GRADE team developed a hazard model of the earthquake event using ground shaking datasets, damage patterns, scientific research on the Sagaing Fault line, seismic hazard models for Myanmar, and other hazard assessments (e.g. United States Geological Survey (USGS) ShakeMap in Figure 1). The resulting GRADE ShakeMap is given in Figure 3. More detail is given on the hazard analysis in Annex C.

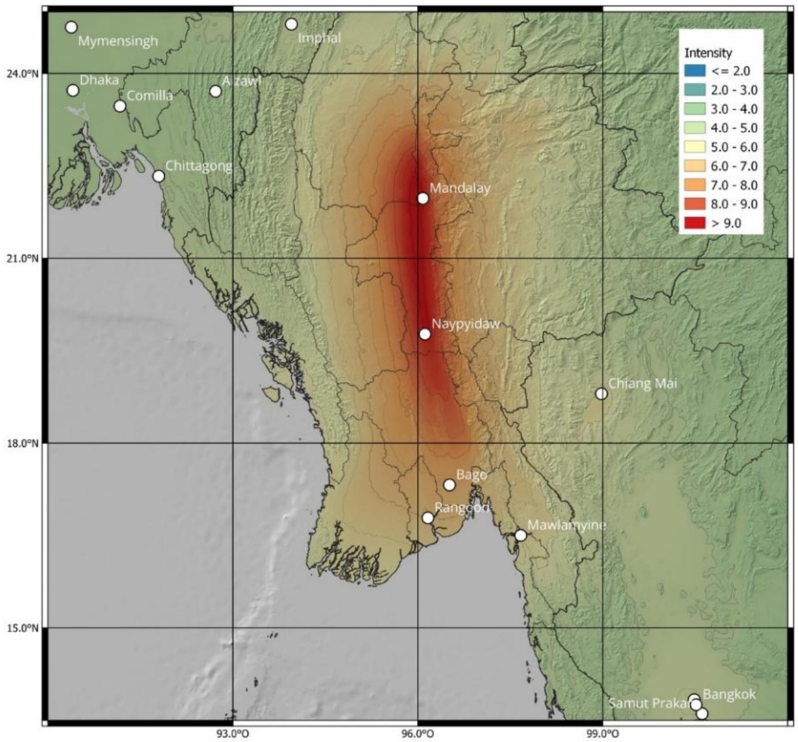

Figure 3: GRADE ShakeMap for the 2025 Myanmar Earthquake

2.2. Exposure modeling

The analysis included updating Myanmar's building and contents exposure model, building upon previous GRADE assessments. The most recent model used was initially developed in 2019, based on data from the 2014 Myanmar census and additional township profiles. This model was subsequently updated in June 2023 for the Tropical Cyclone Mocha GRADE assessment.

The exposure model distinguishes between residential and non-residential buildings—the latter including industrial, commercial, public, religious, and other structures, and infrastructure. Financial valuations of these buildings were determined using unit costs of construction (UCCs) tailored to specific building typologies, accounting for factors such as (but not limited to) construction materials and number of stories.

The exposure model developed for this assessment integrates the latest building footprint datasets derived from Open Street Map (OSM) and Microsoft AI. These were validated against data from the Ministry of Immigration and Population (Ministry of Immigration and Population, 2024). Building footprints, along with township census data, provided detailed insights into building sizes and heights, crucial for accurate exposure characterization. Building typologies were mapped using the Global Earthquake Model's classification system[39] to consistently categorize residential and non-residential structures. Infrastructure modelling was undertaken using, among others, OSM and local data on roads, bridges, electricity, water, sanitation, information and communication technology (ICT) and other infrastructure. In addition, for current infrastructure exposure, the 2023 model was updated and expanded to include more assets, such as irrigation infrastructure.

The total exposure for Myanmar is estimated to be US$248.4 billion, including US$110 billion in residential buildings and contents (44 percent), US$54.6 billion in non-residential buildings and contents (23 percent), and US$83.4 billion in infrastructure assets (34 percent). The full exposure model results by sector and state are presented in Table 2 and Figure 4. Yangon Region represents the highest concentration of assets with 26 percent of the gross capital stock. US$32.6 billion of the country's exposure is estimated in Shan State, while Mandalay and Sagaing contain US$30.4 billion and US$20.9 billion, respectively.

Table 2: Exposure for Myanmar by sector and administrative division. Economic exposure refers to the sum of the buildings and infrastructure exposure.

Administrative Divisions (State, Regions, Union Territory)	Total Residential Buildings & Contents Exposure (US$ mn)	Total Non-Residential Buildings & Contents Exposure (US$ mn)	Total Infrastructure Exposure (US$ mn)	Total Economic Exposure (US$ mn)
Yangon	33,542	14,741	16,692	**64,975**
Shan	11,827	5,926	14,875	**32,629**
Mandalay	14,654	6,884	8,858	**30,396**
Sagaing	9,213	5,272	6,431	**20,917**
Bago	8,568	4,680	5,840	**19,087**
Magway	7,447	4,016	5,736	**17,199**
Ayeyarwady	6,820	3,814	5,684	**16,318**
Kayin	2,888	1,595	4,350	**8,833**
Kachin	3,521	1,729	3,312	**8,561**
Tanintharyi	3,025	1,519	3,105	**7,650**
Mon	3,057	1,501	2,871	**7,429**
Rakhine	2,207	1,146	2,605	**5,958**
Nay Pyi Taw	2,518	1,169	1,736	**5,423**
Chin	603	334	648	**1,585**
Kayah	529	277	671	**1,476**
Total	**110,419**	**54,604**	**83,415**	**248,437**

[39] https://cloud-storage.globalquakemodel.org/public/wix-new-website/pdf-collections-wix/publications/GEM%20Building%20Taxonomy%20Version%202.0.pdf

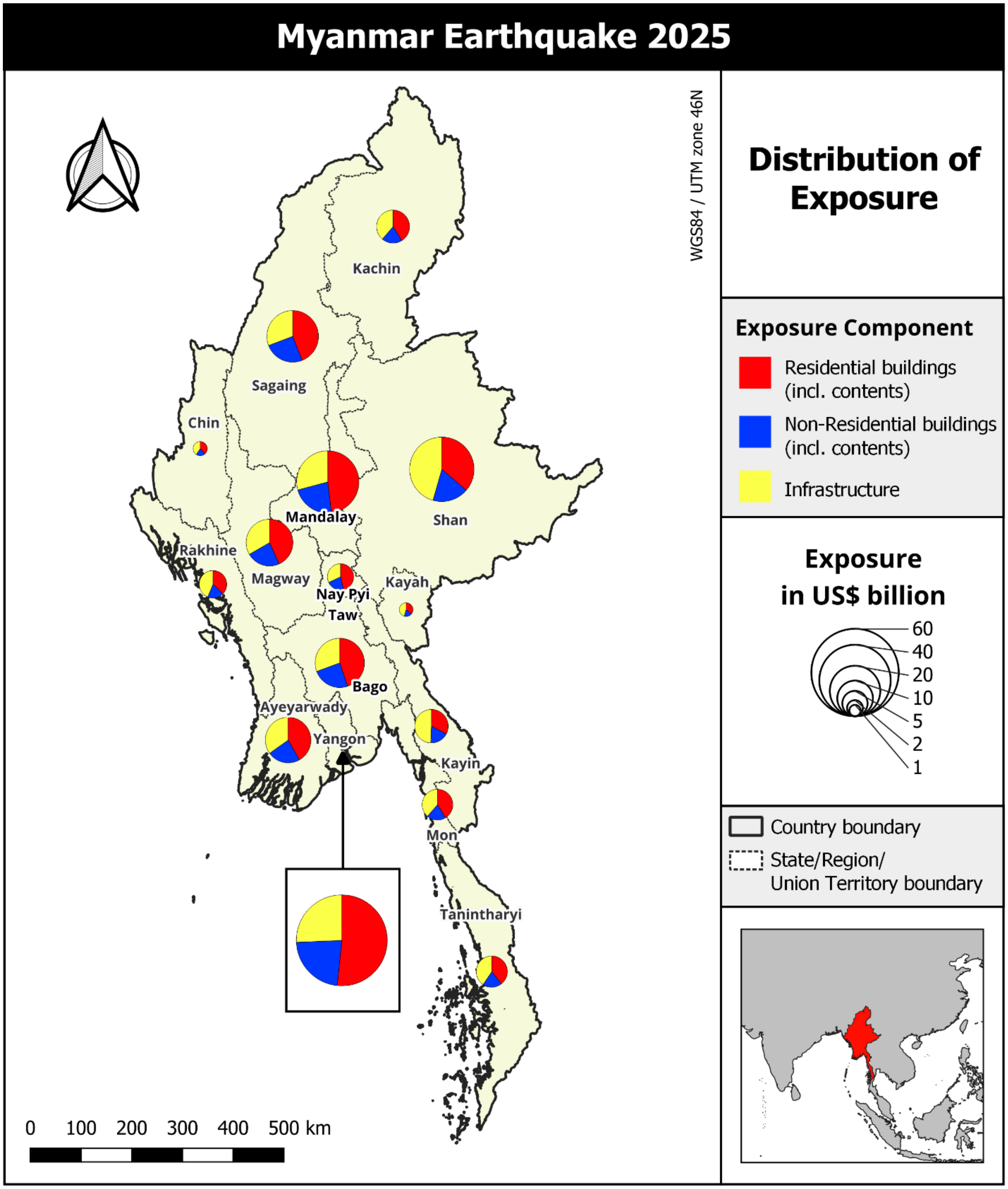

Figure 4: Exposure map for Myanmar by administrative division and exposure component/sector.

3.0 Estimation of Direct Damage to Physical Assets

Direct damage from the earthquakes is estimated at US$10.97 billion, equivalent to 14 percent of Myanmar's 2024/5 GDP. The direct damage is dominated by damage to residential buildings (US$4.97 billion or 45 percent of total), followed by non-residential buildings (US$2.63 billion or 24 percent of total), while effects on infrastructure account for the remaining 31 percent (US$3.36 billion). The GRADE report only considers direct damage, however, there will also be significant losses[40] due to the event.

The most extensive damage to buildings and infrastructure occurred in Mandalay, Sagaing, and Bago, which are home to around 16.8 million people (around 33 percent of the population). Of the total damage, 50 percent occurred in Mandalay, followed by 21 percent in Sagaing, and 12 percent in Bago (see Table 3 and Figure 5). There is negligible damage in Kachin, Chin, Tanintharyi, and Rakhine (the latter severely affected by Tropical Cyclone Mocha in 2023). See Annex D for maps of sectoral damage.

Table 3: Damage estimated by GRADE by sector and by administrative region, in US$ millions.

Administrative Divisions (State, Regions, Union Territory)	Residential Damage (US$ mn)	Non-Residential Damage (US$ mn)	Infrastructure Damage (US$ mn)	Total Damage (US$ mn)
Mandalay	2,430	1,256	1,784	**5,470**
Sagaing	1,078	619	567	**2,264**
Bago	600	318	354	**1,271**
Nay Pyi Taw	395	236	413	**1,044**
Magway	198	108	95	**401**
Shan	118	38	84	**241**
Ayeyarwady	71	21	30	**121**
Yangon	46	23	17	**86**
Kayin	15	5	9	**30**
Mon	15	5	5	**25**
Kayah	8	4	5	**17**
Total	**4,973**	**2,633**	**3,363**	**10,969**

[40] The value of lost production or income.

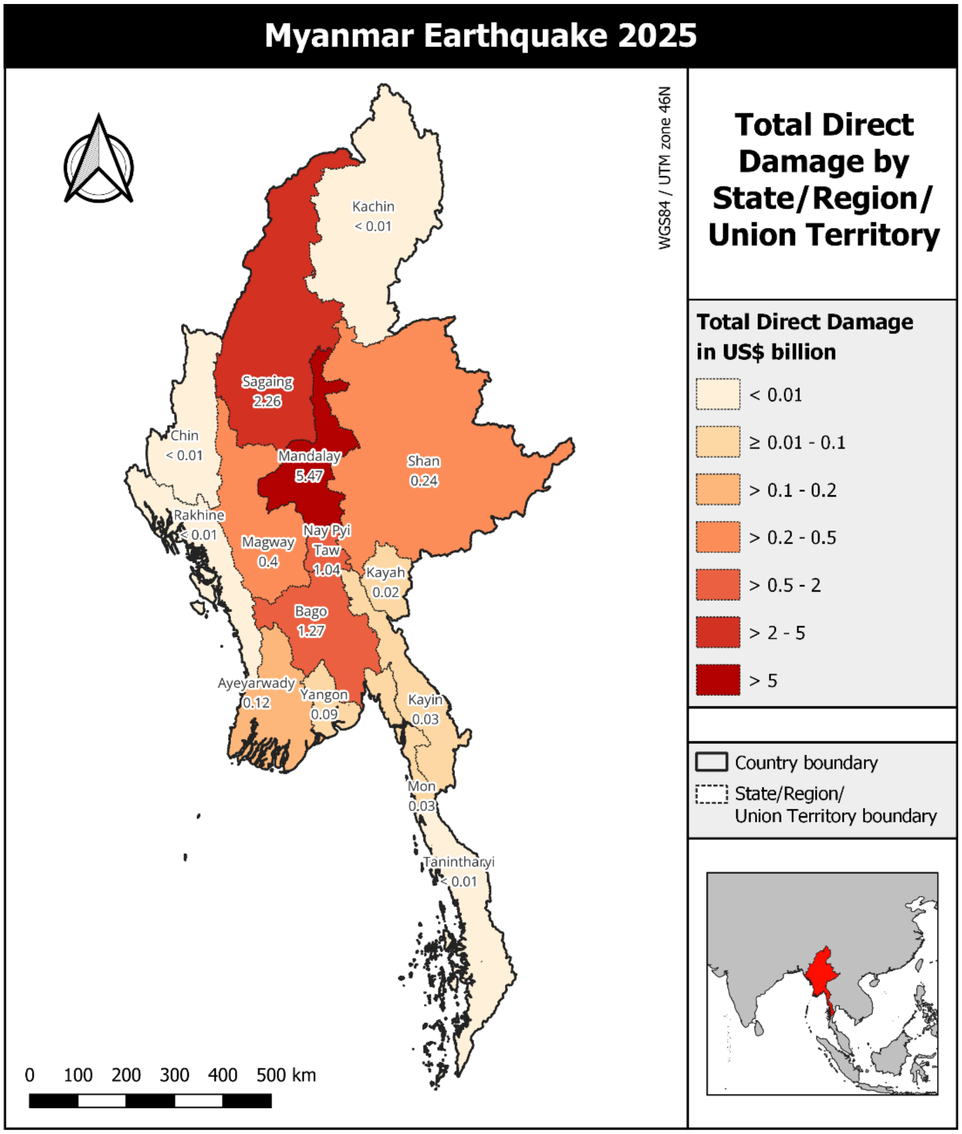

Figure 5: Map of the estimated damage by administrative division in absolute values (in US$ billions).

Damage as a proportion of total exposure is highest in Nay Pyi Taw, Mandalay, and Sagaing, as shown in Table 4 and Figure 6**.** In Nay Pyi Taw, damage is estimated at 15.7 percent of the residential exposure value, 20.2 percent of non-residential exposure value, and almost 23.8 percent of infrastructure exposure. In Mandalay, damage is estimated at 16.6 percent of residential buildings exposure, 18.2 percent of non-residential buildings exposure, and 20.1 percent of the infrastructure exposure value. In Sagaing, damage is estimated to be 11.7 percent of residential building's exposure value, 11.7 percent of non-residential building's exposure, and 8.8 percent of infrastructure exposure value.

Table 4: Damage estimated by GRADE by sector and by administrative division, as a proportion of total exposed value (TEV).

Administrative Divisions (State, Regions, Union Territory)	Residential Damage (as % of Res TEV)	Non-Residential Damage (as % of Non-Res TEV)	Infrastructure Damage (as % of Infra TEV)	Total Damage (as % of Total Exposed Value)
Nay Pyi Taw	15.7%	20.2%	23.8%	**19.3%**
Mandalay	16.6%	18.2%	20.1%	**18.0%**
Sagaing	11.7%	11.7%	8.8%	**10.8%**
Bago	7.0%	6.8%	6.1%	**6.7%**
Magway	2.7%	2.7%	1.7%	**2.3%**
Kayah	1.5%	1.3%	0.7%	**1.1%**
Ayeyarwady	1.0%	0.6%	0.5%	**0.7%**
Shan	1.0%	0.6%	0.6%	**0.7%**
Mon	0.5%	0.3%	0.2%	**0.3%**
Kayin	0.5%	0.3%	0.2%	**0.3%**
Yangon	0.1%	0.2%	0.1%	**0.1%**
Total	**4.5%**	**4.8%**	**4.0%**	**4.4%**

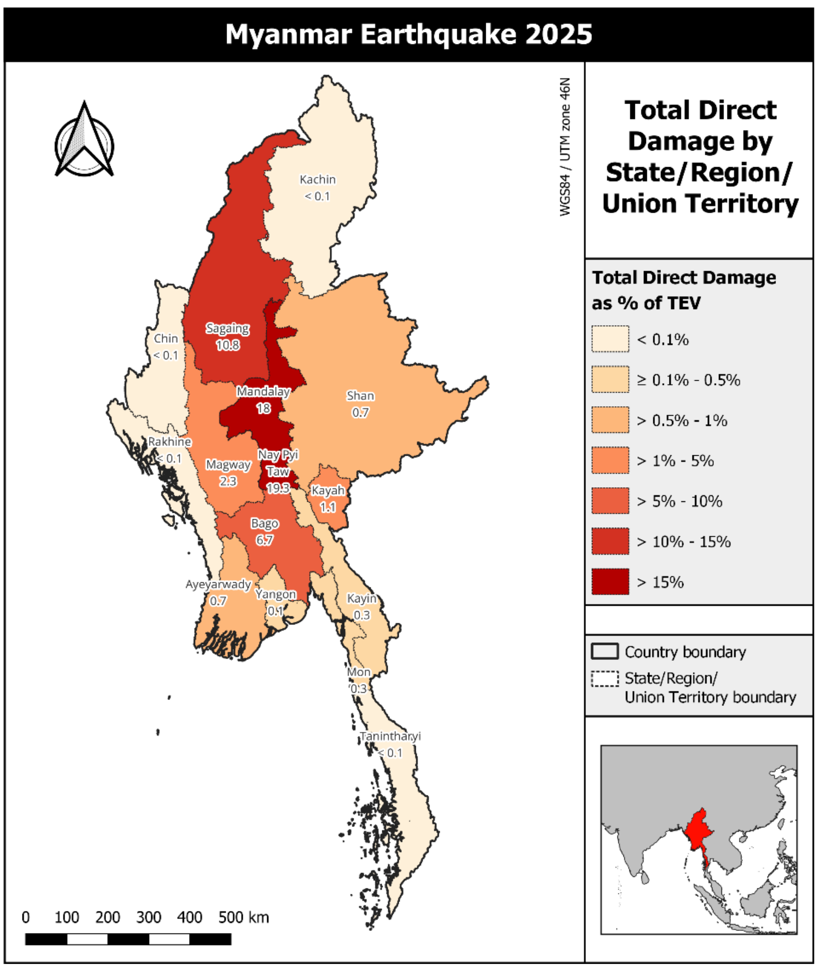

Figure 6: Map of the estimated damage by administrative division as a proportion of exposed asset.

4.0 Interpretation of results

4.1. Comparison of the results

Validation and checking of results are a critical part of the GRADE process. To highlight a key example for this event, the GRADE results are **similar to the Global Earthquake Model** which estimates US$6.4 billion in damage (for buildings and contents only) (Crowley and Silva, 2025) vs. US$7.61 billion from the GRADE assessment (buildings and contents only).

The Ghorka Earthquake in Nepal in 2015 was a similar order of magnitude event (M_W 7.8) to the 2025 Myanmar Earthquake, with both affecting some densely populated areas. The GRADE damage estimates for Myanmar are over double the damage from the 2015 Ghorka Earthquake, Nepal (which was US$4.66 billion[41,42])[43]; however, this difference reduces when inflation is accounted for[44]. The damage-to-GDP ratios are 14 percent for Myanmar, compared to 23 percent for the Ghorka Earthquake.

Although GRADE does not calculate losses or needs, they could be between 50 to 200 percent of the damage in such earthquakes (Daniell et al., 2012). For Nepal, the losses were estimated at US$1.89 billion (or 36.5 percent of the damage estimate). However, the estimate for needs after the earthquake in Nepal was US$6.695 billion (or 129 percent of damage).

4.2. Uncertainty

The GRADE best estimate of damage, given all uncertainty considerations, is US$10.97 billion. The uncertainty range for this event is estimated to span from about US$6.24 billion to US$15.82 billion. Uncertainty in GRADE assessments and risk modeling always exists, however, in this assessment, it is amplified due to the significant:

- amount of religious cultural heritage assets damage, for which their vulnerability is difficult to assess as they cannot be grouped in with other masonry structures (such as housing) and their replacement value is difficult to estimate; and
- uncertainty in seismic intensity estimated and modelled by USGS and other institutions, which resulted in the team developing its own seismic intensity maps (see section 2).

4.3. Social Vulnerability

Disasters do not impact people equally; marginalized and vulnerable populations often suffer disproportionately. Vulnerable groups lack the resources necessary to prepare for, respond to, and

[41] https://www.worldbank.org/content/dam/Worldbank/document/SAR/nepalPDNA%20Volume%20A%20Final.pdf
[42] On a like for like basis 2015 Nepal PDNA results are US$4.66 bn (when excl. US$0.52 bn in the cross-cutting sectors, not considered by this GRADE)
[43] This difference is due to a combination of factors, including the extensive scale of shaking in Myanmar due to the long fault rupture, and differences in the assets that were impacted.
[44] Adjusted to 2025 US$, the Ghorka Earthquake in 2015 results in estimated damage of US$7.3 billion.

recover from disasters, exacerbating pre-existing inequalities. To better understand the potential distributional impacts of the earthquake on households with different demographic and socioeconomic profiles in Myanmar, a data-driven and model-based approach was used as part of this assessment, utilizing the microsimulation model "Unbreakable" (Hallegatte et al. 2016). The model integrates household-level data with national household survey from the global micro database[45] with exposure models and disaster damage data.

The microsimulation model converts physical asset damage to household-level consumption losses[46]. Two complementary indicators of annual consumption loss per capita for each administrative division (State/Region/Union Territory) in Myanmar were computed. These include:

1. **Consumption losses across all population**

- ***Definition***: Total annual consumption losses by disaster-affected households divided by the total annual consumption of all households in each province, expressed as a percentage.
- ***Interpretation***: Captures how much the total household consumption in each administrative division is dragged down by disaster impacts, smoothing the effect over the entire population. This indicates the breadth of the disaster impacts. This indicator is correlated with the total direct asset damage (Section 3) and number of households exposed. The larger the total direct asset damage, the higher the consumption losses across all population.

2. **Consumption losses for affected households only**

- ***Definition***: The same aggregate consumption losses of affected households, divided by the annual consumption of only those households who were affected, expressed as a percentage.
- ***Interpretation***: Measures the severity of the shock of the directly impacted households only. This indicates the depth of the disaster impacts, i.e., the severity of the impacts to those who were impacted. This indicator is not necessarily related to the total direct asset damage, but more related to the socioeconomic resilience of the population. An administrative division can be only marginally impacted, but if the population in that area

[45] The main household survey dataset used was the 2017 harmonized survey from the World Bank's Global Monitoring Database portal. The World Bank Myanmar Phone Survey 2022 to infer information about dwelling ownership and wall materials. Since the dataset does not allow to pinpoint exactly which households are affected, all households in each administrative division are assumed to be equally affected.

[46] Consumption losses are derived from the reconstruction cost of the effective capital stock (including dwellings, productive assets, etc) that households need to spend as well as foregone income due to damaged productive assets. The analysis assumes that households would reconstruct their effective capital stock to the pre-earthquake conditions (i.e., not upgrading the assets). Foregone income is assumed to be linearly correlated with the progress of the effective capital stock's reconstruction. For detailed methodology, see https://unbreakable.gfdrr.org/, https://doi.org/10.1007/s41885-019-00047-x, or https://hdl.handle.net/10986/31227

is relatively worse-off to cope with disaster impacts, then the consumption losses for affected households only may be high. This is the case, for instance, for Magway and Ayeyarwady (see below).

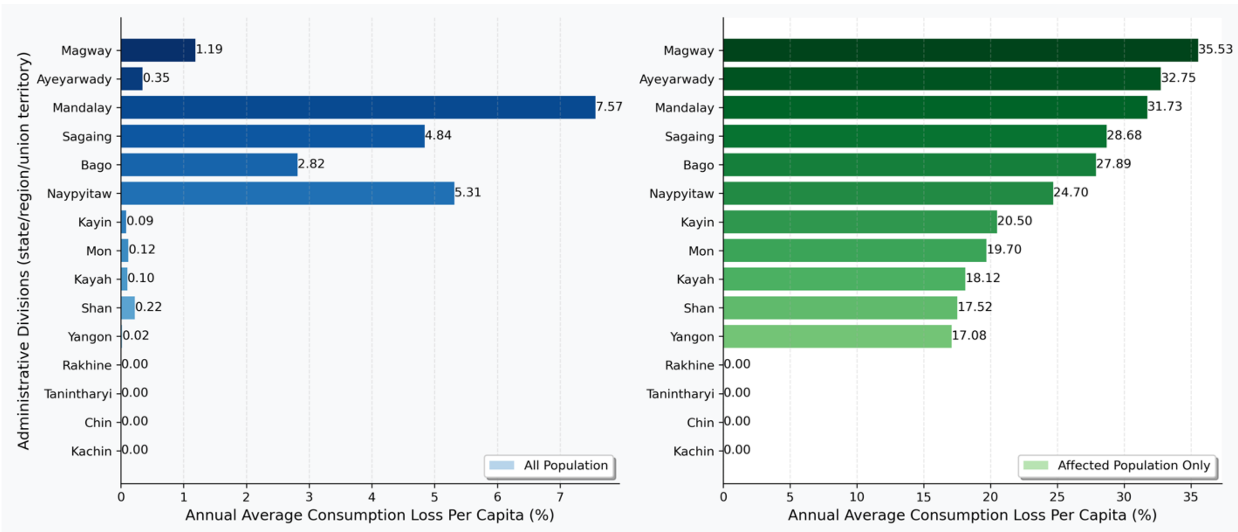

Figure 7: Left panel: Percentage loss in annual household consumption, computed as the total consumption foregone by disaster-affected households divided by the aggregate consumption of all households in each province. Right panel: Percentage loss for affected households only, computed as the same foregone consumption divided by the total consumption of just the affected households.

Across the 15 administrative divisions, per capita annual consumption loss averaged 1 – 8 percent[47] (Figure 7, left panel). Losses were modest in Yangon, Kayin, Mon, Kayah and Shan (less than 0.5 percent), but rose sharply in the central regions. For instance, Mandalay's overall household consumption was reduced by roughly 7.6 percent. **When focusing exclusively on households directly hit by disasters (Figure 7, right), consumption losses rise to 17 – 36 percent.** The consumption losses for affected populations in lower-impact provinces (e.g. Kayin, Mon, Kayah, Shan) still exceed 17% (Figure 7, right). This implies that, even though only a small fraction of these administrative divisions' population in those provinces was affected, the depth of the impacts to those affected is still significant. Affected households in the most severely hit provinces, i.e., Mandalay, Nay Pyi Taw, and Sagaing, experience consumption losses of 31.7 percent, 24.7 percent, and 28.7 percent, respectively.

Some households with certain socio-economic-demographic characteristics are more adversely impacted, compared to an average population. To uncover which types of households experience disproportionate impacts, this assessment extended the analysis to population subgroups with different characteristics, defined by access to sanitation, access to water, education, expenditure quintile and industry of the primary occupation (Figure 8). For each population subgroup, we then

[47] Note that this is the annual average consumption loss. In the microsimulation model, consumption losses are calculated over a 10-year recovery period, though some households would be able to recover much faster.

compared the relative difference (percent) and the absolute gap (percentage point difference) of their consumption losses with an average household, to understand whether they are more (or less) severely impacted compared to the average.

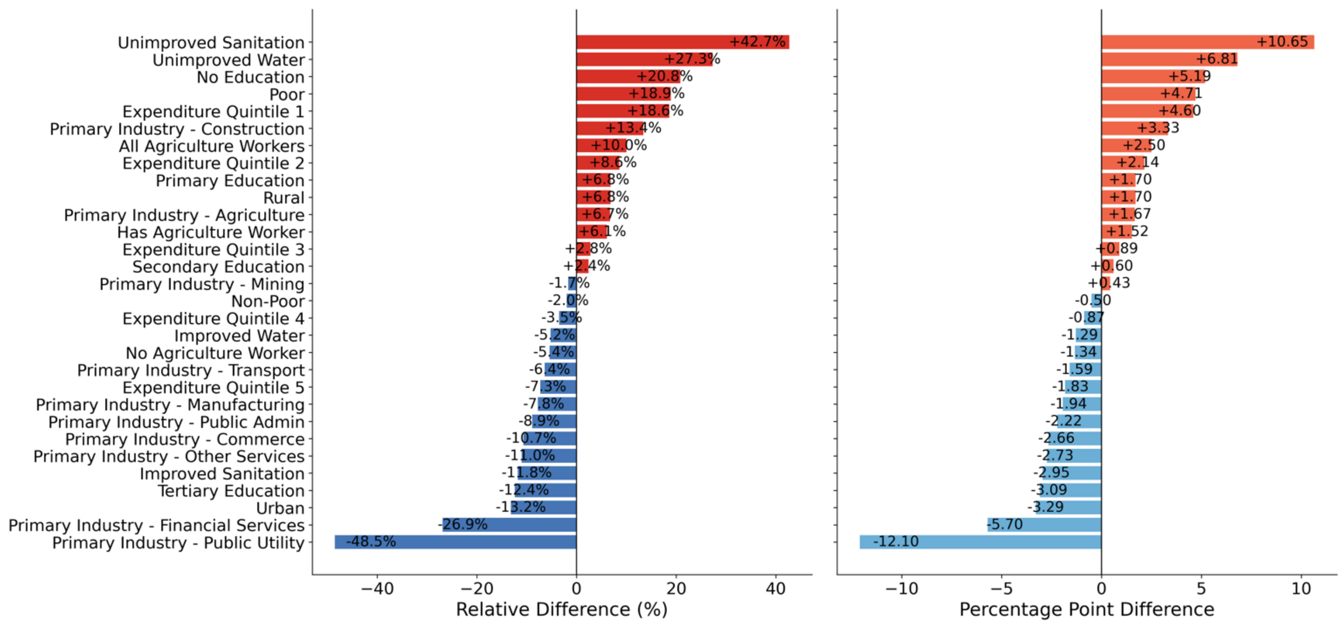

Figure 8: Left panel: Relative difference in group-specific loss rates versus the average household. Right panel: Absolute gap in percentage points between each group's loss rate and the overall average.

Households without access to improved basic water and sanitation services, no formal education, and in the poorest expenditure quintiles, suffer 18–43 percent higher losses than average, equivalent to an extra 5–11 percentage points of consumption lost. In contrast, households whose members are employed in public utilities and financial services, those living in urban areas, and tertiary-educated households incur **13–49 percent** lower losses (around **3–12 percentage points** less) than the average population. This distributional analysis highlights the disproportional burdens experienced across the population, showing that households who are less well-off socioeconomically experience higher impacts. The findings could also help design recovery or support programs, so that such programs can be better targeted towards the most vulnerable segments of the population.

These results highlight the devastating impact of the earthquake. However, the results should be considered as preliminary. They are also conducted at the administrative division of State/Region/Union Territory and not at township level where household impacts could be more heterogeneous. Further information and analysis are needed to include the other social vulnerability variables and different factors into the microsimulation utilized here.

4.4. The Disaster-Fragility, Conflict, Violence Nexus

The interaction of the earthquake damage with the impact of ongoing conflict in the country may disproportionately impact the population, further amplifying needs and losses. Prior to the March 2025 earthquake, southern Sagaing, Magway, and Mandalay were significantly affected by armed conflict. Sagaing alone has experienced nearly 5,000 military incidents[48] since the 2021 military takeover, severely impacting social cohesion and humanitarian conditions. The conflict contributed to Sagaing region having the highest internally displaced populations (IDPs) in the country, numbering approximately 1.25 million.[49] Hence, the 2025 Myanmar Earthquake has exacerbated an already severe humanitarian crisis, affecting approximately 1.6 million people who were previously displaced by conflict.[50]

Infrastructure essential for effective disaster response, including healthcare[51] and information systems, were compromised due to ongoing hostilities. Conflict-induced damage to healthcare infrastructure, health workers leaving the profession, and targeted violence against health workers prior to the earthquake[52] severely weakened health sector capabilities, impacting the immediate earthquake response. This, coupled with disruption of medical supply chains, exacerbate public health risks and contribute to outbreaks of previously controlled diseases such as measles and diphtheria,[53] particularly under the extreme heat in the region at the time of the earthquake. Additionally, extensive internet censorship and conflict-induced digital infrastructure damage have impeded timely information collection and dissemination, further complicating relief efforts.[54] The compounded impacts of prolonged conflict, existing humanitarian vulnerabilities, and new disaster challenges lead to a complex set of requirements for effective comprehensive disaster response, including shelter, healthcare, WASH, and livelihoods restoration.

4.5. Impacts on women

Women are often disproportionately more affected by the impacts of disasters than men, especially those who live in vulnerable situations. In Myanmar, women and girls, already

[48] Based on ACLED data, as cited in ACAPS (2025), Myanmar Earthquake: Sagaing pre-crisis profile, Thematic Report, April 1, 2025. https://www.acaps.org/en/countries/archives/detail/myanmar-earthquake-sagaing-pre-crisis-profile

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[50] Finn Church Aid. 'More than a week after the earthquake, the needs are enormous – FCA expands its aid operation in Myannar.' April 9, 2025. https://reliefweb.int/report/myanmar/more-week-after-earthquake-needs-are-enormous-fca-expands-its-aid-operation-myanmar

[51] https://healthpolicy-watch.news/myanmars-collapsing-health-system-crushed-beneath-earthquake-and-civil-war

[52] World Bank. 2024. Analysis of Access to Essential Health Services in Myanmar 2021-2023.

[53] Jonathon Foster and Thinn Thinn Hlaing. 'Earthquake pushes Myanmar's health system to verge of collapse.' Think Global Health, April 8. 2025. https://www.thinkglobalhealth.org/article/earthquake-pushes-myanmars-health-system-verge-collapse

[54] https://reliefweb.int/report/myanmar/myanmar-earthquake-flash-update-3-3-april-2025

vulnerable due to years of conflict, displacement, and economic instability, face heightened risks and unique challenges in the aftermath of the 2025 Myanmar Earthquake[55].

Even before the earthquake, more than a third of Myanmar's people— including 10.4 million women and girls—needed urgent humanitarian aid[56]. The multi-layered crisis in the country has led to a notable backslide in progress on gender equality and women's empowerment, with Myanmar ranking 123 out of 146 countries with a score of 0.65 in the Global Gender Gap Index 2023[57], revealing the substantial challenges the nation faces in achieving gender parity.

The earthquake has intensified the challenges for Myanmar's women living in poverty, with women-headed households struggling to access emergency relief and financial assistance and needing income sources to cope with the disaster[58]. Data on attitudes indicate the presence of prevailing discriminatory social norms that confine women to the household in Myanmar [59]. During disasters, women's caregiving responsibilities for children, the ill, and the elderly, can make it difficult for them to promptly seek safety, access shelter and adequate sanitation facilities and or obtain necessary healthcare, including sexual and reproductive health services. In addition, violence against women and child marriage, primarily affecting girls, remain a concern.[60] Data on gender violence severely underreports sexual violence due to lack of primary reporting.[61] Following the earthquake, women and girls are facing even greater risks of gender-based violence and exploitation, especially girls separated from their families[62].

Recognizing these differentiated impacts in the context of disasters enables the design and implementation of post-disaster policies and interventions, specifically tailored to ensuring that the needs of women and other vulnerable groups are considered in recovery and rebuilding efforts.

[55] UN Women 2025. Myanmar Earthquake 2025. What it means for women and girls. https://www.unwomen.org/en/articles/explainer/myanmar-earthquake-2025-what-it-means-for-women-and-girls
[56] Ibid.
[57] World Economic Forum. (2023). Global Gender Gap Report 2023. https://www.weforum.org/reports/global-gender-gap-report-2023
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[60] OECD. SIGI Country Profile Myanmar. https://webfs.oecd.org/devsigi/SIGI%202023%20Country%20Profiles/country_profile_MMR_Myanmar.pdf
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[62] Gender in Humanitarian Action Working Group (GiHa WG) Myanmar, April 2nd 2025. "Gender-impact flash update: Myanmar Earthquake". https://asiapacific.unwomen.org/en/digital-library/publications/2025/04/gender-impact-flash-update-myanmar-earthquake-01

5.0 Conclusions

This GRADE assessment provides a synopsis of direct economic damage to physical assets from the March 28, 2025, M7.7 earthquake in Myanmar. Damage was most severe in the central corridor where ground shaking was the most intense, causing damage to buildings and infrastructure. This was the most impactful earthquake in Myanmar in at least over 100 years.

The direct economic damage to physical assets is estimated to be US$10.97 billion or approximately equivalent to 14 percent of Myanmar's 2024/25 GDP, including residential buildings and their contents, non-residential buildings and their contents, and infrastructure.

In total, damage to buildings and their contents accounts for over 69 percent of the total damage. The residential sector is estimated to have sustained US$4.97 billion in damage, non-residential buildings sustained US$2.63 billion in damage and Infrastructure estimated at US$3.63 billion in damage. This highlights the large impact on the buildings sector, particularly residential buildings and contents. This will likely have a lasting impact on those who have lost their homes.

There is notable uncertainty in the results given several factors, including the limited reported damage data from the ground and the extensive damage to cultural heritage sites. The uncertainty range in the total damage estimations is about US$6.24 billion to US$15.82 billion for this event; however, the best estimate of damage is assessed with confidence.

This is a very significant disaster for Myanmar and the region, in both scale and reach. The damage estimate for this earthquake is almost five times larger than for Cyclone Mocha in Myanmar in 2023 and the impact is the same order of magnitude as the Ghorka Earthquake in Nepal in 2015.

The reconstruction costs associated with this disaster are likely to be greater than the estimated damage. The damage estimate also does not consider significant negative impact on economic activity, the constraints of rebuilding in a conflict setting, and additional costs for repairing or rebuilding damaged or destroyed cultural heritage assets.

The wider social and gender impacts of the event are concerning. Meanwhile, poor and vulnerable households are disproportionally impacted, which could exacerbate existing poverty. Households with unimproved water sources and no education, for instance, may experience 27.3 percent and 20.8 percent higher impacts, respectively, compared to the average population. Earthquake-affected households in the most severely hit administrative divisions, Mandalay, Nay Pyi Taw, and Sagaing, could experience average per capita consumption losses of 31.7 percent, 24.7 percent, and 28.7 percent, respectively, with the vulnerable population in these administrative divisions experiencing even larger impacts.

Future conflict-sensitive interventions focused on increasing resilience to earthquakes are needed in Myanmar which has a long history of damaging seismic events. This could include strengthening the resilience of assets and communities to future disasters including capacity building.

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Annex A. Datasets Used

The main data sources used in the GRADE assessment are summarized below:

Damage Data

- Agency and development partner reports
- Social media reports from X, Facebook and other sources to corroborate damage data.
- Global Earthquake Model data and reports
- ReliefWeb Updates
- MSR
- AHA
- OCHA
- NUG-MOHADM
- IFRC
- MRCS
- DIEM
- MOSWRR
- Tokyo University damage statistics

Exposure Data

1. Admin data
    - MIMU admin boundaries for the purposes of analysis (Township, Village etc.)
    - geoBoundaries
2. Population data
    - The General Administration Department (GAD), and Ministry of Home Affairs townships survey (2017 and 2019)
    - Department of Population (DoP), Ministry of Labor, Immigration and Population 2014 census + 2019 Intercensal Survey + 2024 census
    - WorldPop
    - GHS-POP
    - HRSL checks
3. Building Exposure
    - Myanmar Statistical Yearbooks
    - 2014 Census + 2019 Intercensal Survey
    - General Administration Department 2017 data
    - CATDAT
    - METEOR OED database for Myanmar
    - GEM database

- Microsoft AI Driven Building Footprints
- GHS BUILT-C, BUILT-V, BUILT-H, BUILT-S products
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- Myanmar Post-Disaster Needs Assessment of Floods and Landslides, July–September 2015, December 2015
- GRADE 2019 Floods Assessment.
- GRADE 2023 Cyclone Assessment

4. Infrastructure
    - Myanmar National Accounts
    - State accounts and other datasets from IMF and World Bank
    - OSM roads, waterways and other datasets
    - MIMU airport data, railway and road data
    - CATDAT
    - Various OpenData portals (OpenDevelopment, OSM, OpenInfraMap, Gridfinder, etc.)
    - MIMU Baseline datasets
5. Agriculture
    - State and District Agriculture sections of local Websites
    - Myanmar Statistical Yearbook quoting Agricultural censuses
    - MOALI
    - Myanmar: Analysis of Farm Production Economics - World Bank
    - Agricultural Census 2010
    - FAO
    - ESA 10m WorldCover Product

Hazard Data

1. Ground Motion Data and Shakemaps
    - USGS
    - GEOFON
    - IRIS
    - EMSC
    - CEDIM
2. Fault data and InSAR through Zixin Lee:
   Bradley, K., Hubbard, J., 2025. Surface ruptures of the Myanmar M7.7 earthquake mapped from space. Earthquake Insights, https://doi.org/10.62481/51b7df8c
3. Satellite Imagery (Flood and Storm Surge)

- COPERNICUS
- UNOSAT
- WFP-ADAM
- GDACS
- MAXAR

4. Historic Myanmar Earthquake DATA
    - GHEA
    - CATDAT
    - USAID
    - Utsu

Microsimulation modelling data

1. Myanmar 2017 harmonized household survey from the World Bank's Global Monitoring Database portal.
2. World Bank Myanmar Phone Survey 2022.
3. Penn World Table version 10.

Annex B. Significant Historical Earthquakes in Myanmar

N.B. The sources used to collate this table are listed in Annex A.

Date	Location	Magnitude	MMI (Max)	Focal Depth (km)	Deaths (#)	Injuries (#)	Houses Destroyed (#)	Houses Damaged (#)	Damage (M USD)	Notes & Comments
March 23, 1839	Mandalay	~8.1	XI	15	500+	-	101 - 1,000	-	$5.0 - $25.0	- Former capital city Inwa destroyed and abandoned. - Queen Mae Nu's brick monastery in Inwa, was heavily damaged. - The 27m high Palace Watch Tower in Inwa, was tilted. - The Mingun Pagoda was severely damaged.
January 3, 1848	Kyaukpyu	7.0	-	-	-	-	-	-	-	- Buildings damaged - Houses and of the tops of pagodas at Pyay, Henzada and Thayetmyo collapsed
August 24, 1858	Pyay	7.7	-	-	-	-	-	-	-	- Some damage in Inna, Sittway, Kyaukpyu and Yangon
June 24, 1906	Coco Islands	7.3	-	60	-	-	-	-	-	- Near the Sunda megathrust
June 24, 1906	Magway Region	6.7	-	35	-	-	-	-	-	- 36 km northeast of Magway
August 31, 1906	Kachin	6.4	-	15	-	-	-	-	-	- On the northern extremities of the Sagaing fault
December 12, 1908	Kachin	7.2	VII	15	-	-	-	-	-	- On the northern section of the Sagaing fault
May 23, 1912	Mandalay, Mogok, Maymyo	7.9	IX	25	1 - 50	-	-	-	$5.0 - $25.0	- Epicenter near Taunggyi and Pyin Oo Lwin in Shan State; it was felt over 375,000 square miles in Myanmar and adjoining Thailand, Yunnan (China), and northeastern India. - Pyin Oo Lwin: brick masonry buildings suffered serious structural damage; many bungalows were damaged and some were unsafe for people; wooden beams, bricks, and plaster fell from the Governor's House; two chimneys fell off a station hospital and the roof of a family hospital collapsed; Burma Railway between Nawnghkio and Hsum-hsai disrupted by major rockslide.; every pagoda in the city was obliterated. - Mandalay: 75 percent of brick buildings and nearly all pagodas and monasteries were damaged; the cathedral suffered extensive cracking; the Wesleyan School's masonry building suffered major damage; five buildings suffered total collapse, 31 were severely damaged and 75 more or less cracked. - Taunggyi: nearly all chimneys fell, and military buildings were in

										critical condition. - Mogok: cracks in brick buildings and several pagodas collapsed; water pipelines damaged, and power cut off by landslides for two nights. - Hsipaw: several masonry buildings suffered heavy damage, and several chimneys collapsed. - Toungoo: old pagodas have had part of their tops carried away; cracks inside several buildings and a few fallen brick panels.
March 6, 1913	Bago	-	-	-	-	-	-	-	-	- Sbwemawdaw Pagoda lost its finial
July 5, 1917	Bago	-	-	-	-	-	-	-	-	- Shwemawdaw Pagoda fell
May 2, 1922	Shan	6.7	VII	35	-	-	-	-	-	- Near the Myanmar-Thailand border
June 22, 1923	Shan	7.3	VII	25	-	-	-	-	-	- 25 km southwest of Mongmao
December 17, 1927	Yangon	7.0	-	-	-	-	-	-	-	- Epicenter would have been somewhere west and northwest of Yangon. Damage in Yangon. Felt in Dedaye.
January 19, 1929	Htawgaw	5.5	IX	-	-	-	-	-	$1.0 - $5.0	- Severest shock ever felt in Htawgaw. No reports of damage in Myanmar - All stone masonry buildings at Htawgaw were considered no longer fit for human habitation
June 4, 1929	Myitkyina	-	-	-	-	-	-	-	-	-
August 8, 1929	Swa (Toungoo district), Nay Pyi Taw	6.5	VII	15	-	-	-	-	-	- A meter-gauge railway was severely damaged; - In places the track twisted and bent, fishplates and bolts snapped, bridges and culverts collapsed, the sides of cuttings fell in - Loaded trucks were turned upside down and cooly huts were shaken to pieces. - This event was reported from Yamethin, Pyinmana, Yenangyaung and Tharrawaddy.

May 5, 1930	Pegu, Yangon	7.4	IX	35	558+	2,500	101 - 1,000	101 - 1,000	$5.0 - $25.0	- The southern part of the country was affected, i.e. Bago (formerly Pegu) and Yangon; Pegu was almost completely destroyed. A tsunami and fires followed. Cracks in the ground appeared in several places. Subsidence occurred. - All types of structures were damaged or destroyed including almost all pucca buildings, concrete residences and large shops and commercial buildings. The Pegu Co-operative Central Bank, a court and police buildings were destroyed; municipal buildings and schools suffered severe damage. - Many pagodas were destroyed. The remains of the Thonpaya Buddhist temple including the Buddha image suffered considerable damage; mosques and minarets collapsed; a Roman Catholic Church was also heavily damaged. - The pipe that brought water into the town running along the Moulmein bridge collapsed and stopped the water supply; the reservoir and power plant were damaged; railway and telegraphic communication were disrupted.
July 18, 1930	Tharrawaddy, Yangon	-	-	-	50		-	-	$1.0 - $5.0	- A severe earthquake in Tharrawaddy District was reported to have caused much damage to property. Fifty persons were reported killed or injured.
September 21, 1930	China: Yunnan Province and affected Myanmar	6.7	VIII	15	3	-	51 - 100	-	$1.0 - $5.0	- Epicenter in Tengchong, China just East of the border with Myanmar, where damage was significant. - Impacts in Myanmar unknown.
December 3, 1930	Pyu	7.3	VIII-IX	10	36	101 - 1,000	51 - 100	51 - 100	$1.0 - $5.0	- Destroyed the town of Pyu; the earthquake's epicenter lies a few miles to its west. - Most of the buildings were destroyed; they were of flimsy construction. - Local railway line severely damaged
January 27, 1931	Myitkyina (Kamaing) earthquake	7.6	IX	35	-	-	-	-	-	- Numerous fissures, cracks and sand blows. Damage caused in Karming
August 14, 1932	Myanmar; India: Assam	7.0	-	120	-	-	-	-	$1.0 - $5.0	- Semi-destructive near the epicentral region and some damage over eastern part of northern Assam
August 16, 1938	31 km southeast of Falam	7.0	VII	75						- No reports about damage in Myanmar
December 26, 1941	Myanmar (Shan state) - China border region	7.2	VIII	10	15	-	-	-	-	- Impacts in Nanqiao, Dongluan, Mengman (China). No reports about damage in Myanmar.

September 12, 1946	Tagaung	7.1	VII	15	-	-	-	-	-	- Epicentre in Tagaung town, Thabeikkyin township (North of Mandalay). - Rupture length of approximately 80 km, and possibly as long as 155 km along the Indaw segment of the Sagaing fault.
September 12, 1946	Tagaung	7.6		15	-	-	-	-	-	- Doublet earthquake three minutes later; ruptured south of the first event for a length of 185 kilometers, through the villages of Tagaung and Thabeikkyin.
July 16, 1956	Myanmar (Sagaing Region)	6.8	VIII	34	38	50	-	> 10,000	$1.0 - $5.0	- Destructive earthquake in upper Burma; it ruptured a 60 km segment south of the 1946 rupture - 80 percent of houses damaged; several pagodas including the Mingun Pagoda and several masonry buildings ruined.
July 8, 1975	Mandalay, Bagan	7.0	VIII	107	2	15	-	-	$0.5	- Caused by reverse faulting within the Indian plate, subducting underneath the Burma plate, at a depth of 107 km - The strongest earthquake to have been felt in this area in the last 900 years. - Severe damage was done to many large temples and pagodas of great archaeological interest, on the eastern bank of the Irrawady (the archaeological area extends for 16 square miles). - Among the 500 principal monuments in Bagan, more than half were damaged or destroyed.
August 6, 1988	Myanmar (Sagaing); India: Gauhati, Sibsagar, Imphal; Bangladesh	7.3	VIII	98	35	42	-	-	$1.0 - $5.0	- Epicenter location in a remote and sparsely populated area of Myanmar - Minor damage in Myanmar in small settlements that were in proximity: Homalin, Maungkan, Hta Man Thi and Kawya - Widespread damage at Jorhat, Golaghat, Dirugarh & Manipur, India. Considerable damage and landslides in the Gauhati-Sibsagar-Imphal area, India. - About 30 people injured and some damage in Bangladesh.
January 5, 1991	Thabeikkyin, Mandalay	7.0	VII+	20	2	-	-	32	< $1.0	- 32 Buildings and 380 hectares of farmland damaged in the Thabeikkyin area - Some landslides were also reported
April 23, 1992	Panhsang (Shan State)	6.2	VII	10	4	48	-	-	-	- Two earthquakes of M 6.1 and M 6.2 within 78 minutes - Slight damage in Yunnan Province. No reports about damage in Myanmar. - Felt in northern Thailand and by people in tall buildings in Bangkok.
July 11, 1995	60 km S of Panhsang (Shan State)	7.2	VIII	13	11	147	100,000	42,000	$36.1	- Earthquake prediction in China mitigated loss of life: 11 people died in a town with a population of 600,000 - Some buildings also damaged in Chiang Mai and Chiang Rai Provinces, Thailand; no reports of damage in Myanmar

June 7, 2000	Kachin State	6.3	-	15	-	-	51 - 100	51 - 100	< $1.0	- Many buildings damaged at Liuku, China. - Felt in northern Myanmar.
September 21, 2003	Taungdwingyi (Magway Region)	6.6	VII	37	10	43	-	180	< $1.0	- Two houses, two monasteries, one school and one bridge were destroyed in Taungdwingyi. - Three ancient pagodas and over 180 ritual houses destroyed.
December 26, 2004	Kawthoung, Pyapon, Pathein districts (Ayeyawaddy province), Kawthoung district (Taninthayi province), Sittwe district (Rakhine province)	9.1	-	21.5	71	-	-	-	$500.0	- 2004 Indian Ocean Earthquake and Tsunami. - In Kawthoung, 12 villages were affected, where 8 died, 44 fishing boats destroyed, 83 houses damaged, and 2 wooden bridges about 650 m long were broken. - In the southern part of the Ayeyarwaddy Delta, Pyinsalu in Labutta township was reportedly the most severely affected area in the delta. 15 villages were affected, with 32 deaths, 50 injuries, 550 damaged houses, and 130 destroyed boats. - Along the Rakhine coastal area, reportedly, 21 people died on a newly exposed beach.
December 26, 2004	Namzang (Shan State)	5.8	-	33	13	-	-	-	-	- Moderate earthquake in Shan State 30 minutes after the great Sumatra-Andaman earthquake (2004 Indian Ocean tsunami). - Several buildings collapsed and a pagoda near the Namzang Airfield was also damaged. - Damage to buildings was also reported from Langkhur to the south of Namzang. - Strong tremors were experienced at Loilem and Panglong; the shock was also felt in the surrounding region including at Kunhing, Mongnai, Langkher, Mawkmai and Mongpan; tremors were also perceptible as far as Chiang Mai in northern Thailand.
August 21, 2008	Myanmar-China border in Kachin State	6.0	VII	10	5	130				- A series of earthquakes struck on the Myanmar-China border affecting Yingjiang county, Yunnan province (China), between Aug. 20 and Sept. 3. The strongest was on Aug. 21 (M 6). - No reports about damage in Myanmar.
August 10, 2009	Andaman Islands	7.5	VII	24						- A tsunami warning was issued that was later lifted.
February 4, 2011	Monywa	6.4	VI	89	1	-	51 - 100	-	< $1.0	- One person was killed, and several buildings and bridges were damaged in Monywa. - Slight damage in Assam, Manipur and Nagaland, India.

March 24, 2011	Tarlay area (Tachileik district, Shan State); Thailand; China	6.9	VIII	8	75+	123+		10,393	$475.0	- Occurred northwest of the border between Myanmar, Thailand and Laos; strike-slip faulting along the Nan Ma Fault was identified as the cause (rupture on a 30 km segment at the west end of the fault). - 74 or up to 150 killed in Myanmar and 1 in Thailand. - Houses, schools, religious buildings were damaged or destroyed in Myanmar. - The Tarlay Sub-Township Relief Committee estimated the cost of damage to be approximately MMK 3 billion (approx. USD 475 million) - The Tarlay bridge linking Tachileik and Keng Tung collapsed. The 16-bed Tarlay hospital was damaged. The collapse of a church caused the loss of 20 lives, at least 17 soldiers and family members were killed in Tachilek when a barracks building collapsed. - In China's Yunnan province, 9,691 houses, 136 reservoirs and 35 roads damaged
November 11, 2012	North of Shwebo on the Sagaing Fault	6.8	VII	14	26+	231	251	207	$1.17	- Many buildings including monasteries, pagodas, a hospital, a school, a bridge as well as a gold mine collapsed. - The most serious damage occurred in Male and neighboring villages, Kyaukmyaung, Thabeikyin, Sintku township. - Damage was also reported in Schwebo and Mogok.
September 20, 2013	North of Shwebo on the Sagaing Fault	5.7	VII	4	-	-	-	-	-	-
April 13, 2016	India: Assam; Bangladesh; Myanmar (Sagaing)	6.9	VI	136	2	247	-	4	$1.0 - $5.0	- No reports of major damage or loss of life in Myanmar - 70 injured in Assam (India), 100 in Chittagong, Dhaka and Sylhet (Bangladesh)
August 24, 2016	Magway, Mandalay, Rakhine, Sagaing provinces	6.8	V	82	4	20	-	230	$10.0	- Out of 425 listed pagodas in the Bagan Ancient Cultural Area, 414 were damaged of which 89 severely damaged as of Sept. 22 - Damage to houses, other buildings, pagodas and some casualties were reported in Yenangyaung Township (2 deaths), Pwint Phyu Township, Saku Township, Salin Township, Pakokku Township (1 death), Min Hla Township, Nga Phe Township, Chauk Township, Mrauk U Township, Sittwe Township and Kyaukphyu Township.

March 13, 2017	Taikkyi township (Yangon region); Tharrawaddy	5.1	VI	10	2	36	1 - 50	1 - 50	< $1.0	- The epicenter was 35.4 km northwest of Yangon and 8.04 km southwest of Taikkyi township. The earthquake was also felt in Insein, Hlaingtharyar, South Dagon and Bahan of Yangon region and in Maubin township of Ayeyawaddy region - Some religious buildings in Taikkyi were damaged and some residential quarters of township police station and civilian houses collapsed.
January 11, 2018	Bago region	6.0	VII	10	-	-	-	-	-	- Epicentre between Taungoo and Pyay west of the Sagaing fault; no reported impacts
June 21, 2020	Ri Khor Dar, Chin State	5.6	VII	11	-	-	-	-	-	- Minor damage to some houses and public buildings.
November 26, 2021	Hakha (Chin State)	6.2	VIII	43	-	1	-	-	-	- A temple damaged at Hakha
July 21, 2022	Keng Tung	5.9	VII	5	-	-	-	-	-	- Damage in Keng Tung - Also felt in China, Thailand, and Laos.
May 31, 2023	Inn Taw Gyi Area, Mohnyin Township, Kachin State	5.8	VIII	10	-	-	-	-	-	- It occurred 35 km northwest of Hopin Township, Moehnyin District, Kachin State. - Damaged some houses, walkways and donated property inside the Indawgyi River Pagoda in Hopin. - Ground cracks and liquefaction occurred at Indawgyi area of Mohnyin Township; cracks in some parts of the Hopin-Whelong road, causing water to flow out; the ground on Hepu Beach cracked. - In Nantmaukkan village, the crematorium chimney and the ceiling and walls of a middle school collapsed. The brick wall of Lep Phon Lay Monastery collapsed. The floor tiles of the Shwe Maungzhu Pagoda in the Indawgyi Lake area cracked, as did the ceiling and windows of the monastery. The ceiling and walls of the Nant Maokkan Village Middle School collapsed.
June 7, 2023	Maubin, Ayeyarwady	4.8	VI	19	3	1	-	1 - 50	< $1.0	- Deaths produced by the collapse of stucco of a wall of the Shwe Boon Myint Pagoda; some buildings destroyed and several more buildings damaged (incl. Maupin University of Technology) including a school and a pagoda.

Annex C: Hazard analysis

The latest USGS ShakeMap (v20) (see Figure 1) considered a 460 km long fault model, which describes the earthquake rupture starting about north of Mandalay and ending just south of Pyu. This ShakeMap was modeled after satellite imagery became available along the whole rupture area and included data from USGS' Did-you-Felt-It reports and scarce seismic station data. The GRADE team had some concerns with the initial USGS ShakeMap related to the modelling techniques used and the correlation between mapped intensities and the initial reports of damage, so decided to develop their own hazard model, drawing directly on seismic datasets, historical events, remote sensing imagery and data, damage patterns, and complex seismological modelling techniques.

The GRADE ShakeMap (see Figure 3) shares a lot of similarities with the v20 USGS ShakeMap but the biggest differences are an increase in intensities in some locations away from the fault rupture, including in the mountainous regions to the east of the earthquake; and calibration of the seismic intensities along the rupture based on the assumed slip which acted to reduce the GRADE ShakeMap's near-fault intensities in places of less slip, i.e. to the south. In addition, to better account for damage reports in some places, intensities are slightly higher, for example in parts of Yangon.

The GRADE ShakeMap is presented in Figure 3 and the differences between the GRADE ShakeMap and the v20 USGS ShakeMap (seen in Figure 1) are given in Figure 9 where blue indicates areas where the GRADE ShakeMap gives higher intensities than the USGS ShakeMap; while red indicates the opposite.

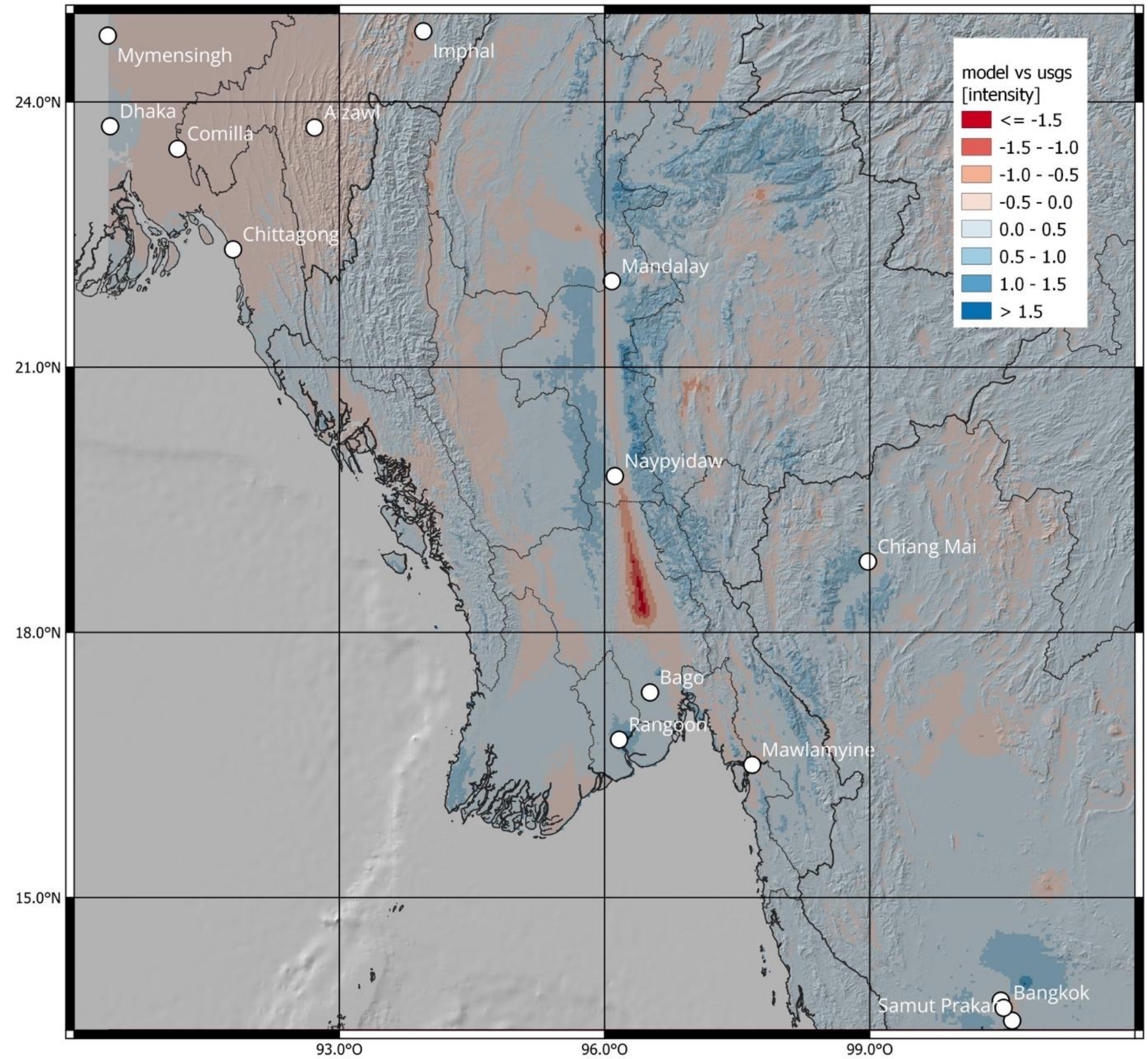
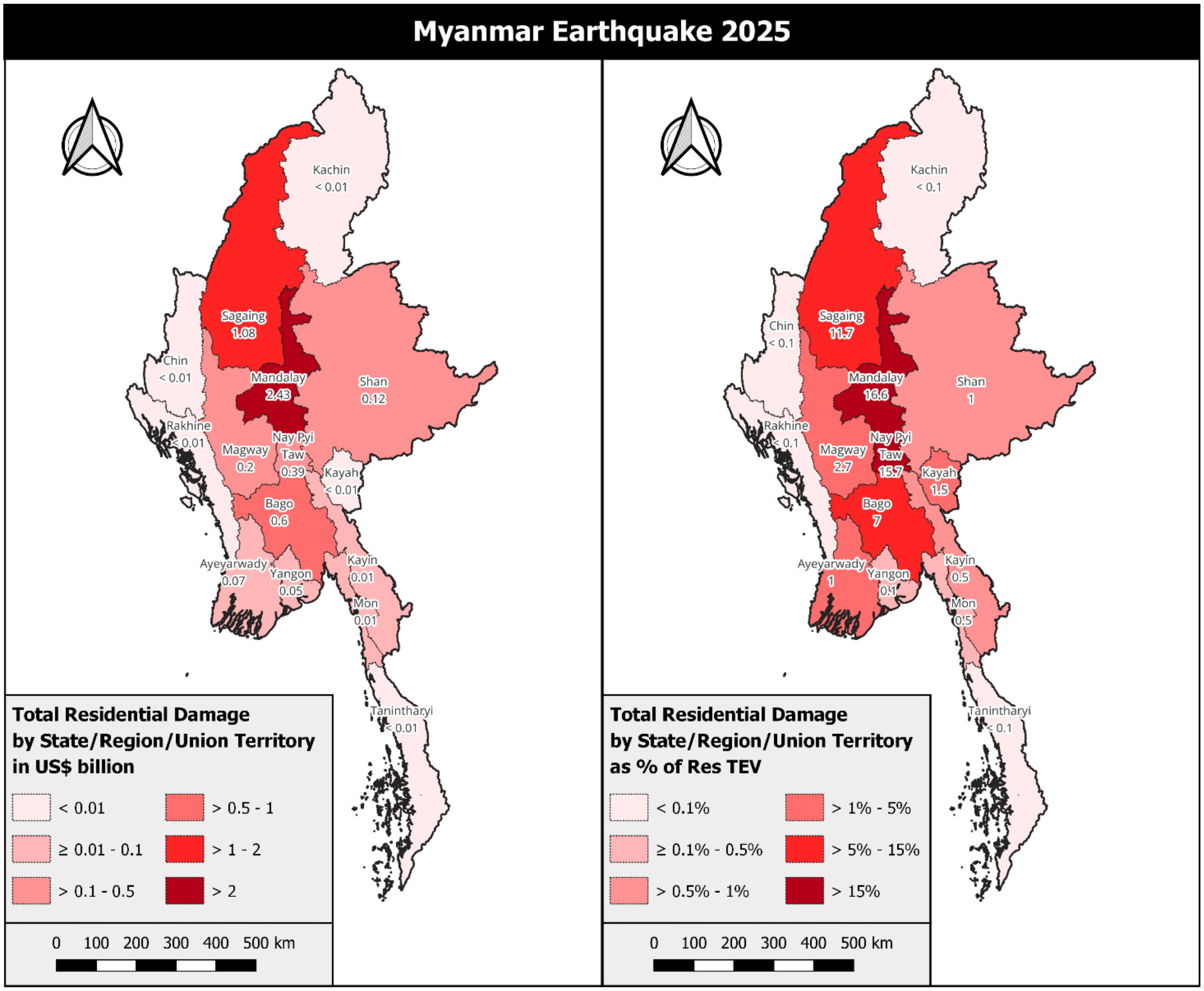
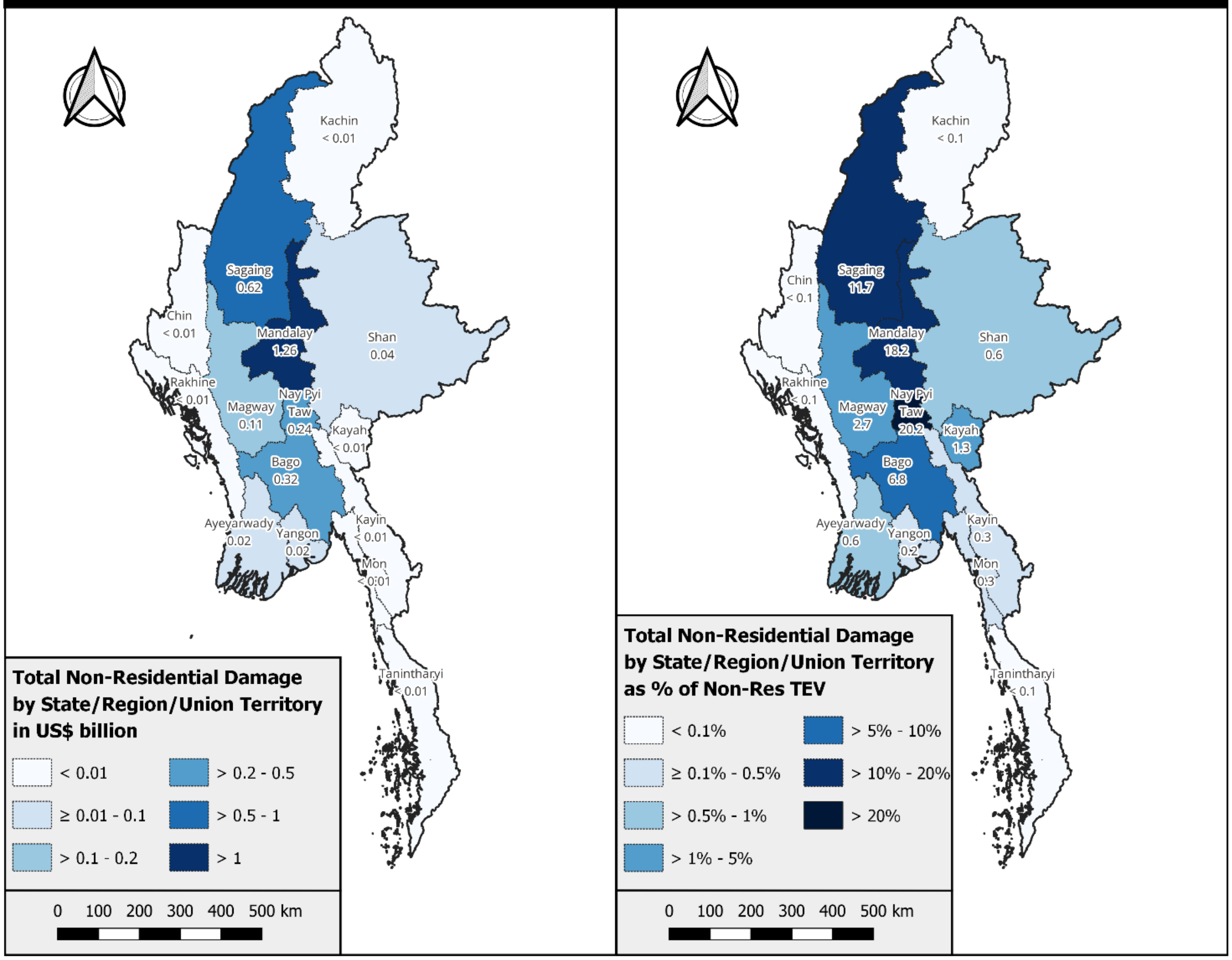


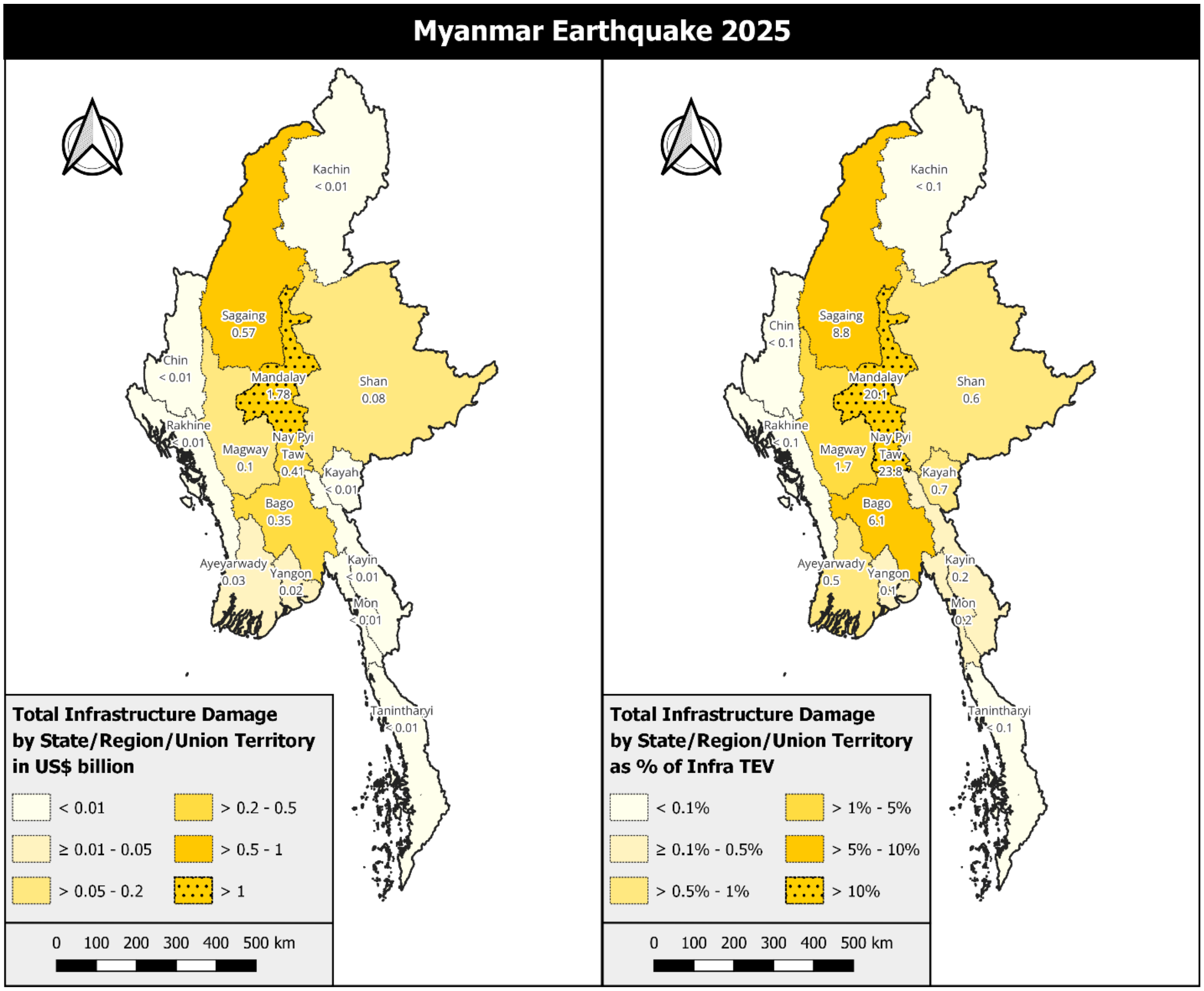
Figure 9: The differences between the GRADE ShakeMap (see Figure 3), and the USGS ShakeMap version 20 (see Figure 1). Blue indicates areas where the GRADE ShakeMap gives higher intensities than the USGS ShakeMap while red indicates the opposite.

Annex D: Sectoral damage maps



Myanmar Earthquake 2025




Myanmar Earthquake 2025
Kachin
< 0.01
Sagaing
0.57
Chin
< 0.01
Mandalay
1.78
Shan
0.08
Rakhine
< 0.01
Magway
0.1
Nay Pyi
Taw
0.41
Kayah
< 0.01
Bago
0.35
Ayeyarwady
0.03
Yangon
0.02
Kayin
< 0.01
Mon
< 0.01
Tanintharyi
< 0.01
Total Infrastructure Damage
by State/Region/Union Territory
in US$ billion
< 0.01
≥ 0.01 - 0.05
> 0.05 - 0.2
> 0.2 - 0.5
> 0.5 - 1
> 1
0 100 200 300 400 500 km
Kachin
< 0.1
Sagaing
8.8
Chin
< 0.1
Mandalay
20.1
Shan
0.6
Rakhine
< 0.1
Magway
1.7
Nay Pyi
Taw
23.8
Kayah
0.7
Bago
6.1
Ayeyarwady
0.5
Yangon
0.1
Kayin
0.2
Mon
0.2
Tanintharyi
< 0.1
Total Infrastructure Damage
by State/Region/Union Territory
as % of Infra TEV
< 0.1%
≥ 0.1% - 0.5%
> 0.5% - 1%
> 1% - 5%
> 5% - 10%
> 10%
0 100 200 300 400 500 km