M 7.7 Myanmar Earthquake

March 28, 2025

Global RApid Post-Disaster Damage Estimation (GRADE)

Source:
Zaw Winn Naing/World Bank

May 9, 2025

The assessment received financing support from GFDRR and the Ministry of Finance, Japan

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GFDRR
Global Facility for Disaster Reduction and Recovery

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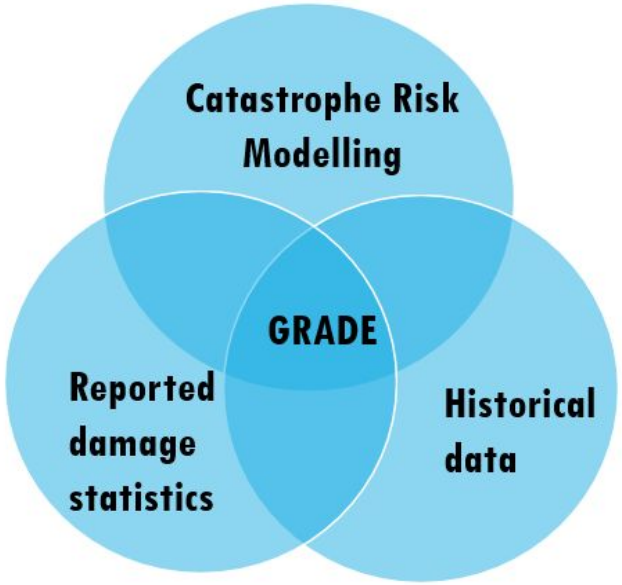
Many urgent questions arise following a disaster:

- **How** do we assess damages?
- **Where** are the damages distributed?
- **What** is the socio-economic impact?



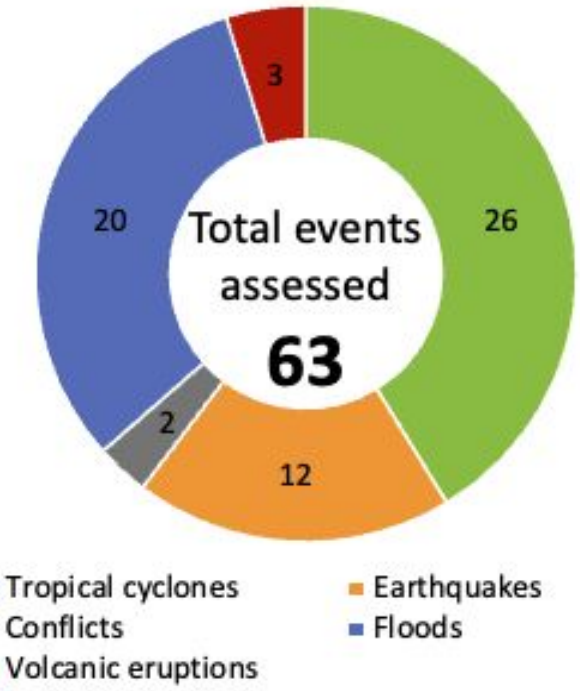
Global RApid Post-Disaster Damage Estimation (GRADE)

Completed GRADE assessments to date

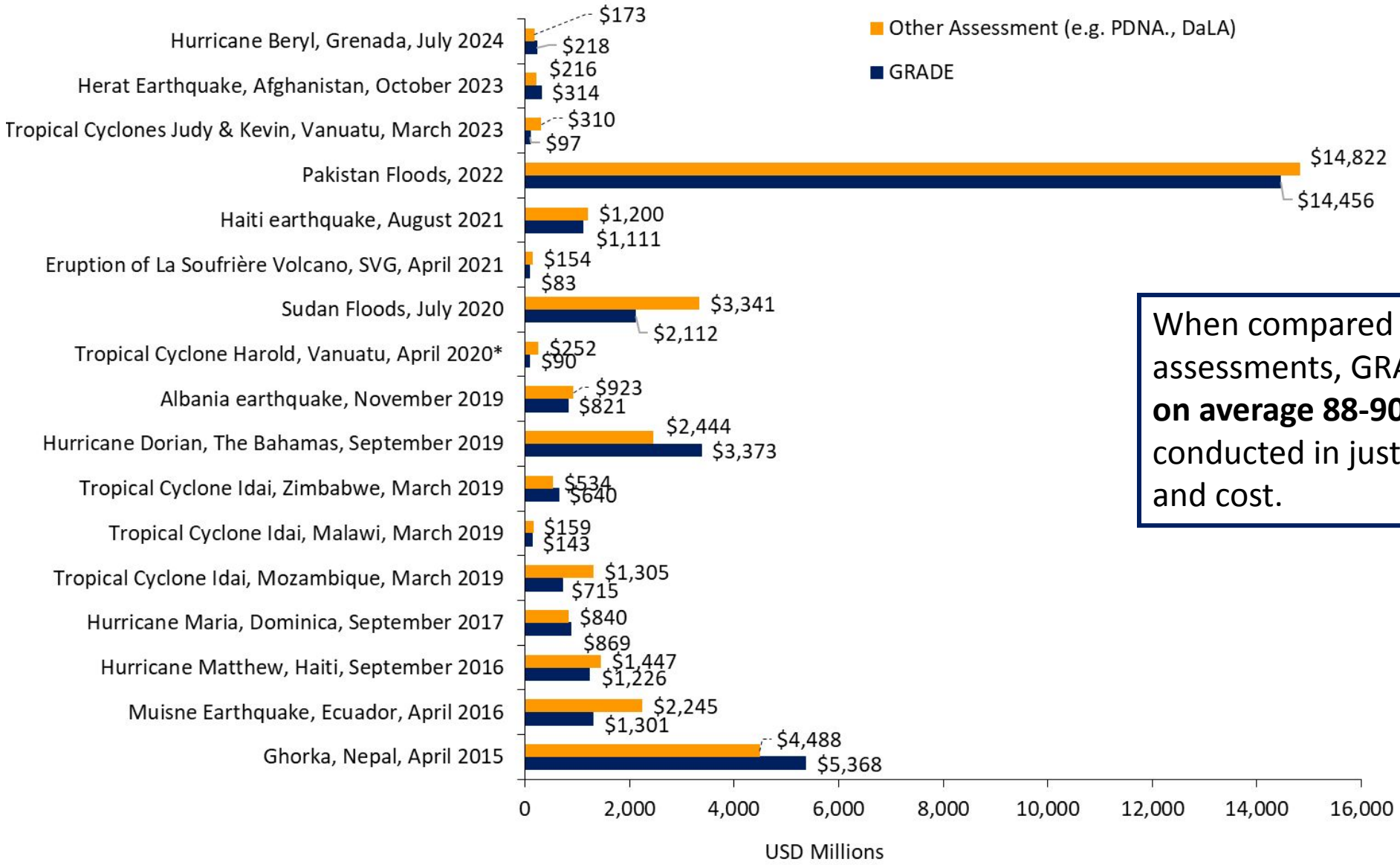
Total of **67** GRADEs completed

Number of countries for which at least one GRADE has been completed

54



How does GRADE perform vs. other assessments? Accurate and fast

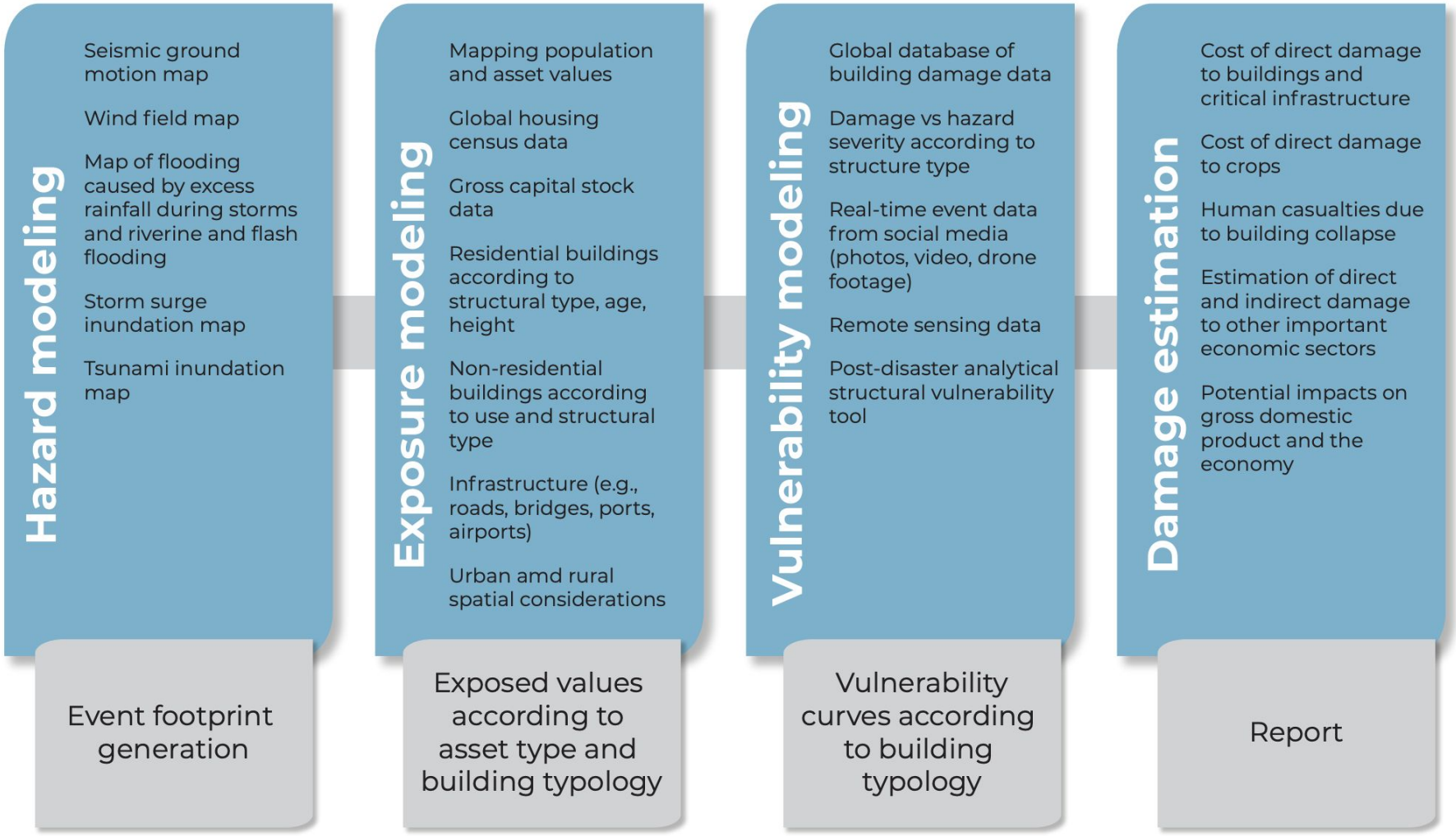


When compared with other assessments, GRADE results are **on average 88-90% accurate** but conducted in just **10% of time** and cost.

Key findings: GRADE Results by Sector

Sector	Definition	Estimated damages US$ billion
Residential	Houses and contents, Some mixed-use	$ 4.97
Non-Residential	Commercial, industrial, public, religious and mixed-use buildings and contents	$ 2.63
Infrastructure	Power networks, water networks, telecoms, airports, roads + bridges, agriculture, irrigation, dams	$ 3.36
Total		**$10.97** (equivalent to 14 percent of Myanmar's GDP for 2024/25)

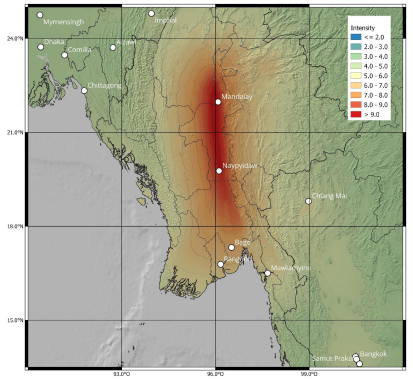
Overview - GRADE methodology



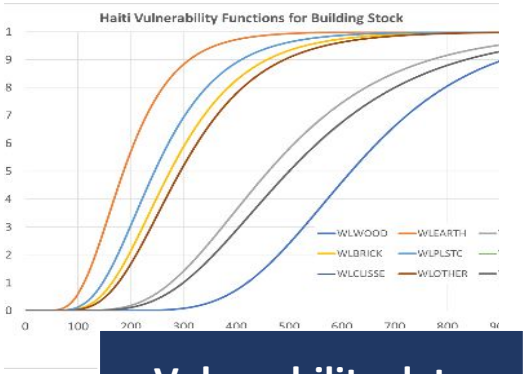
What data is needed to calibrate these?

- Comparison of past risk studies
- Collection of damage data statistics
- Comparison with past events
- Comparison with asset values

+ spatio-temporal scale + much calibration

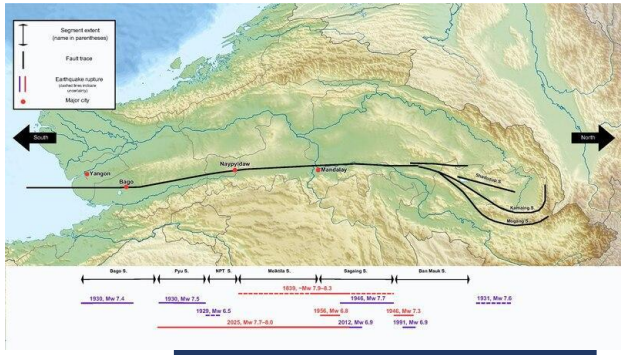


Scientific event data



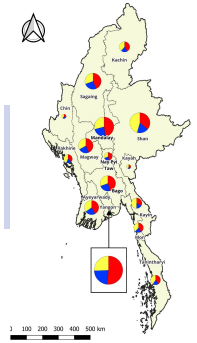
Vulnerability data

Remote sensing data



Historical damage data

Built asset data



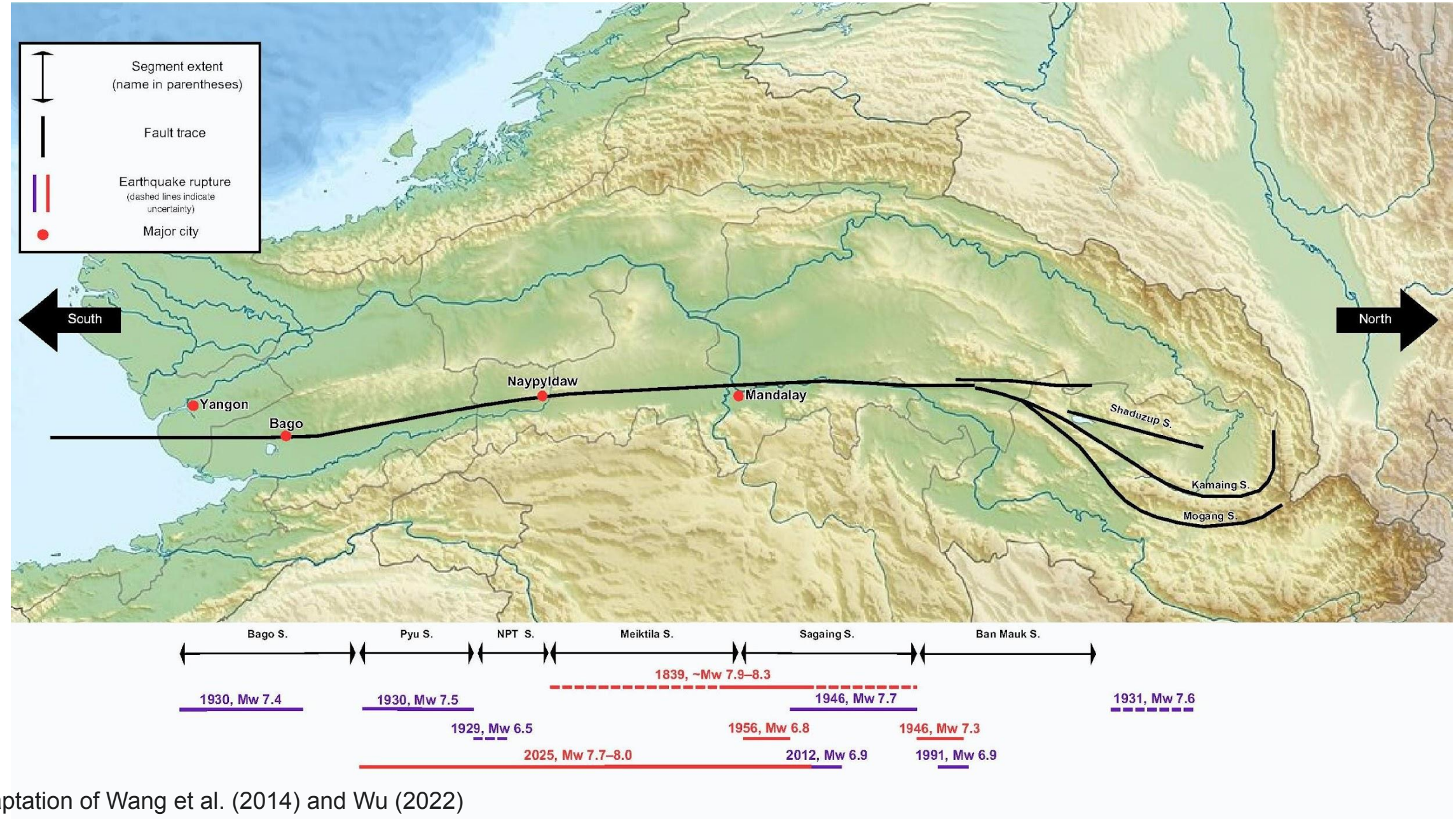
Census & socio-economic data

Reported damage data (official sources, media & social media)

Historical impacts – Sagaing Fault

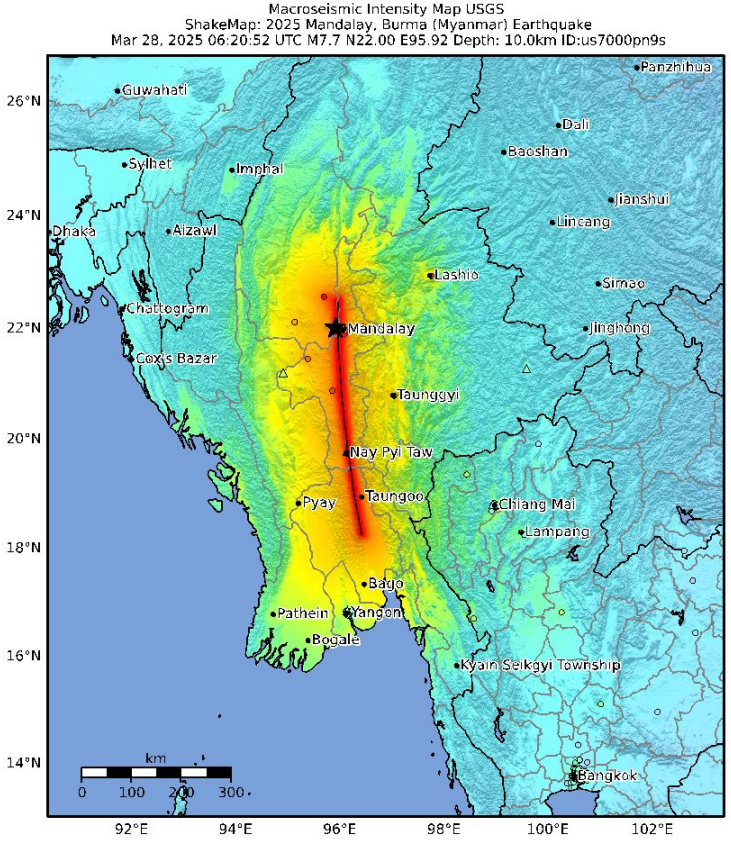
Year	Location	Ruptured segment	Magnitude	Max. MMI	Deaths	Remarks
1839	Inwa, Mandalay	Meiktila & Sagaing	7.9 to 8.3	XI	500+	It is possible that part or all of the combined 400 km long Meiktila and Sagaing segments of the Sagaing Fault ruptured.
1906	Kachin State	Kamaing	6.4	-	-	
1908	Kachin State	Kamaing	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	3500+	The rupture propagated over a total length of ~460 km, extending from Singu (Mandalay Region) to Pyu (Bago Region).

Historical impacts



an adaptation of Wang et al. (2014) and Wu (2022)
https://en.wikipedia.org/wiki/File:Sagaing_Fault_mapv2.pdf

This Earthquake is the strongest earthquake to hit Myanmar since 1912



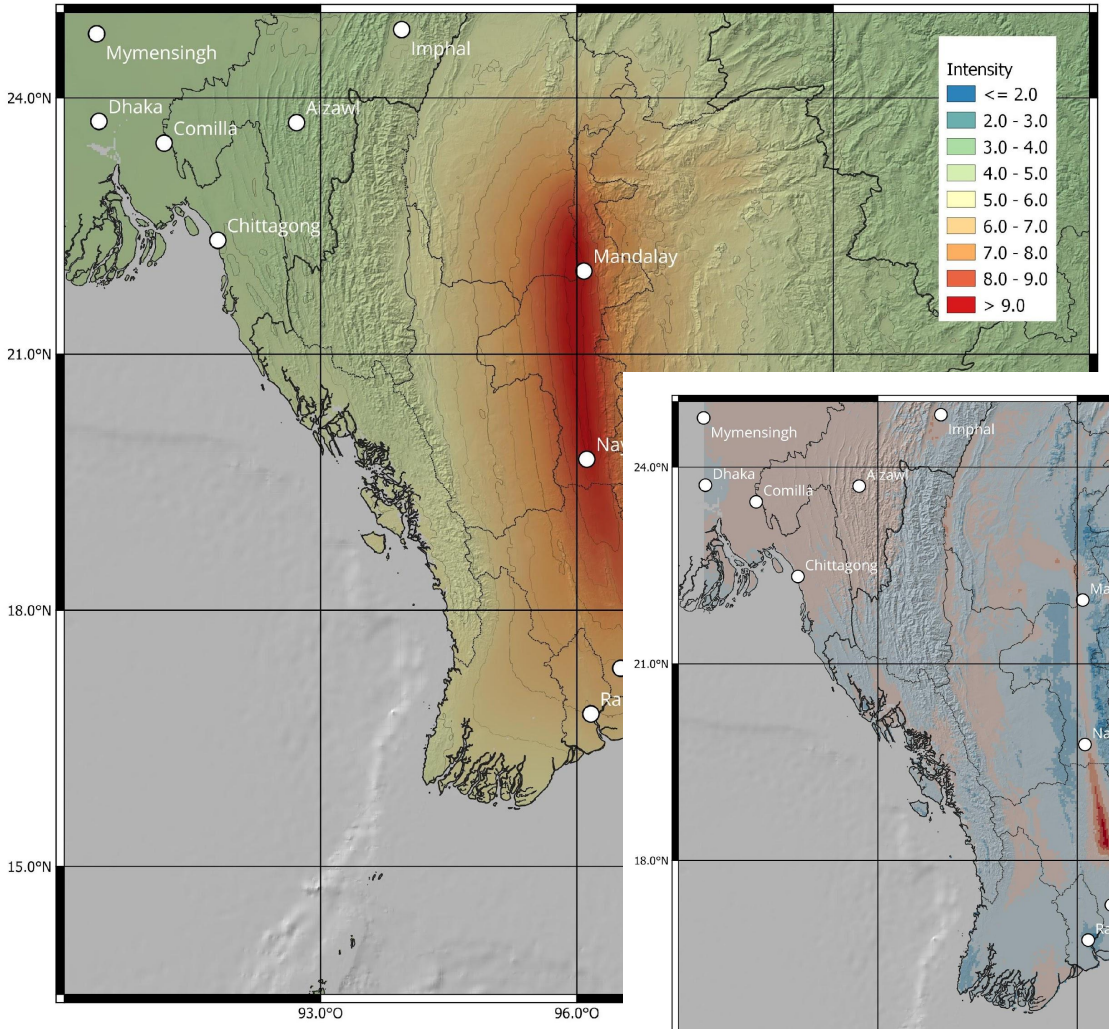
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012) Version 20: Processed 2025-04-09T06:12:43Z
△ Seismic Instrument ○ Reported Intensity ★ Epicenter ▭ Rupture

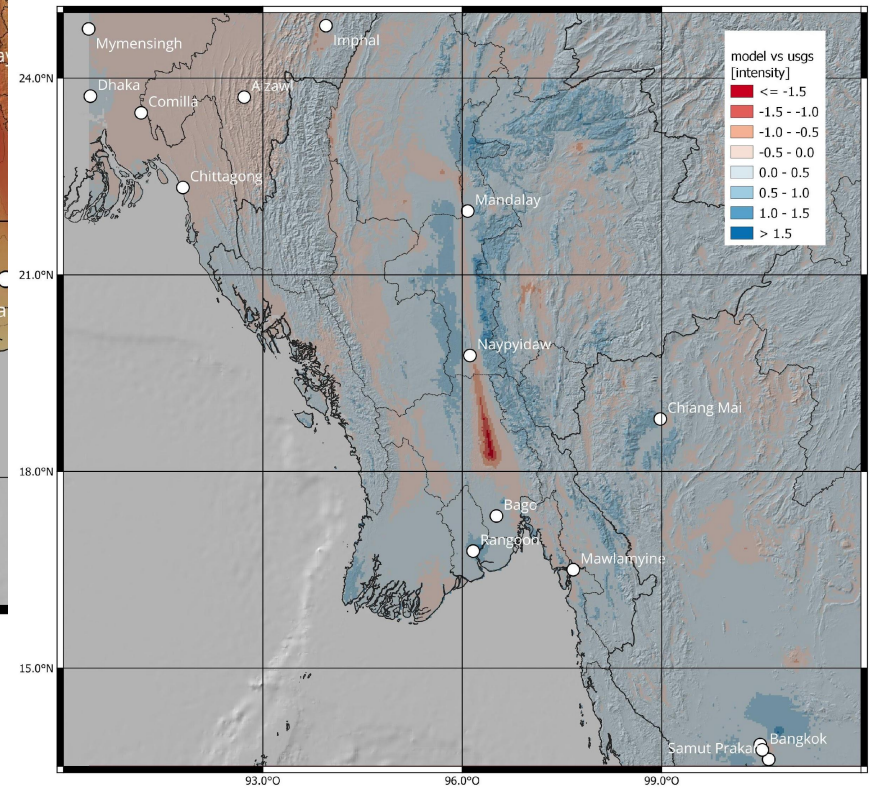
Source: USGS

- M_w 7.7 earthquake with an extensive rupture of the Sagaing Fault.
- Intense shaking in highly populated central region.

Hazard analysis: Limitations with the USGS map



Map A



Map B

- GRADE team **developed own ShakeMap** using recorded ground shaking, remote sensing, damage assessments, and other relevant data (Map A)
- **GRADE custom ShakeMap fits better to observed damage** distribution:
  - along fault line(N-S Direction) & blue areas (E-W Direction)
  - **Difference in GRADE and USGS maps**: blue areas shows more GRADE estimated shaking intensity than USGS Shakemap) (Map B)

Widespread catastrophic impacts in the Central Corridor

- 17 million people affected (UNOCHA)
- Current reported fatalities are at 3645 (As of April 17th). However, modeled estimated fatalities are expected to be greater than 7K.
- Buildings, infrastructure and cultural heritage sites damaged and destroyed.

The aftermath of the Mandalay Earthquake
Source: Zaw Winn Naing/World Bank

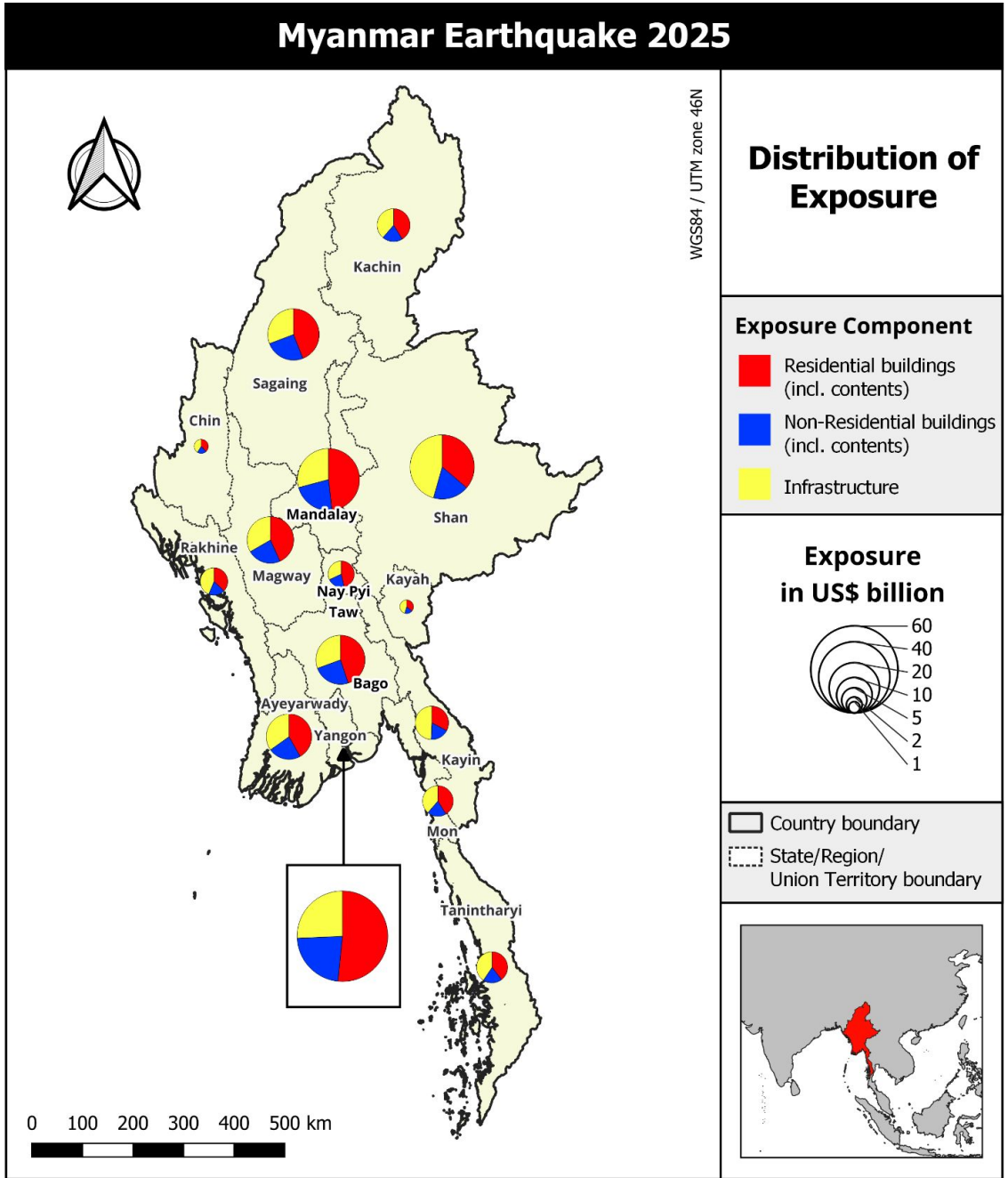
- *<u>Reported stats</u>: 48,834 houses, 3,094 monasteries and nunneries, 2,045 schools, 2,171 offices and buildings, 148 bridges, and 5,275 pagodas, were destroyed (as of April 16th).*

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**

- **Total exposure** of buildings (and contents) and infrastructure: **USD 248 billion**
- Majority of assets in Yangon and Shan, Mandalay and Sagaing Provinces.

Exposure



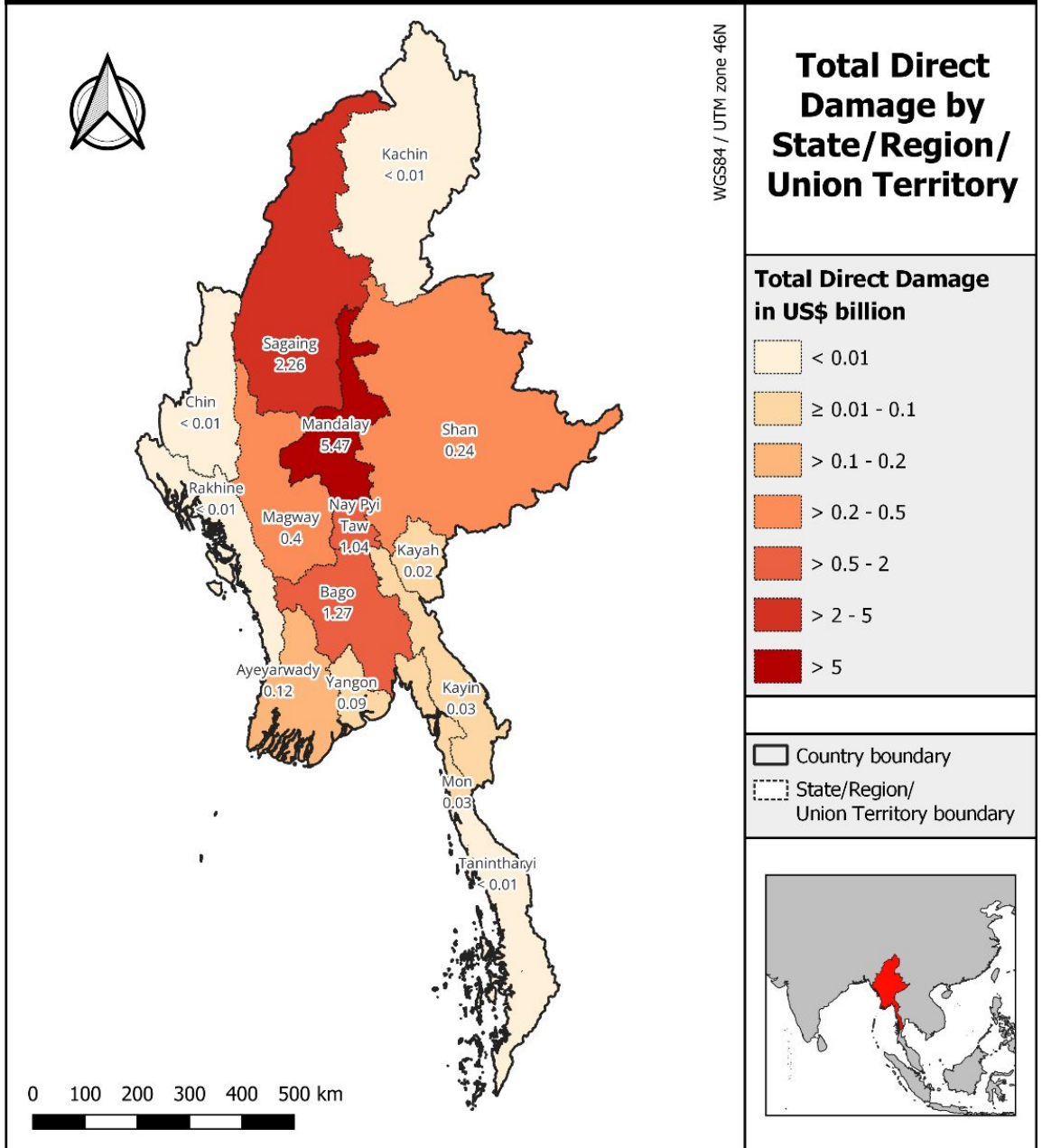
GRADE: Damage Results by States

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**

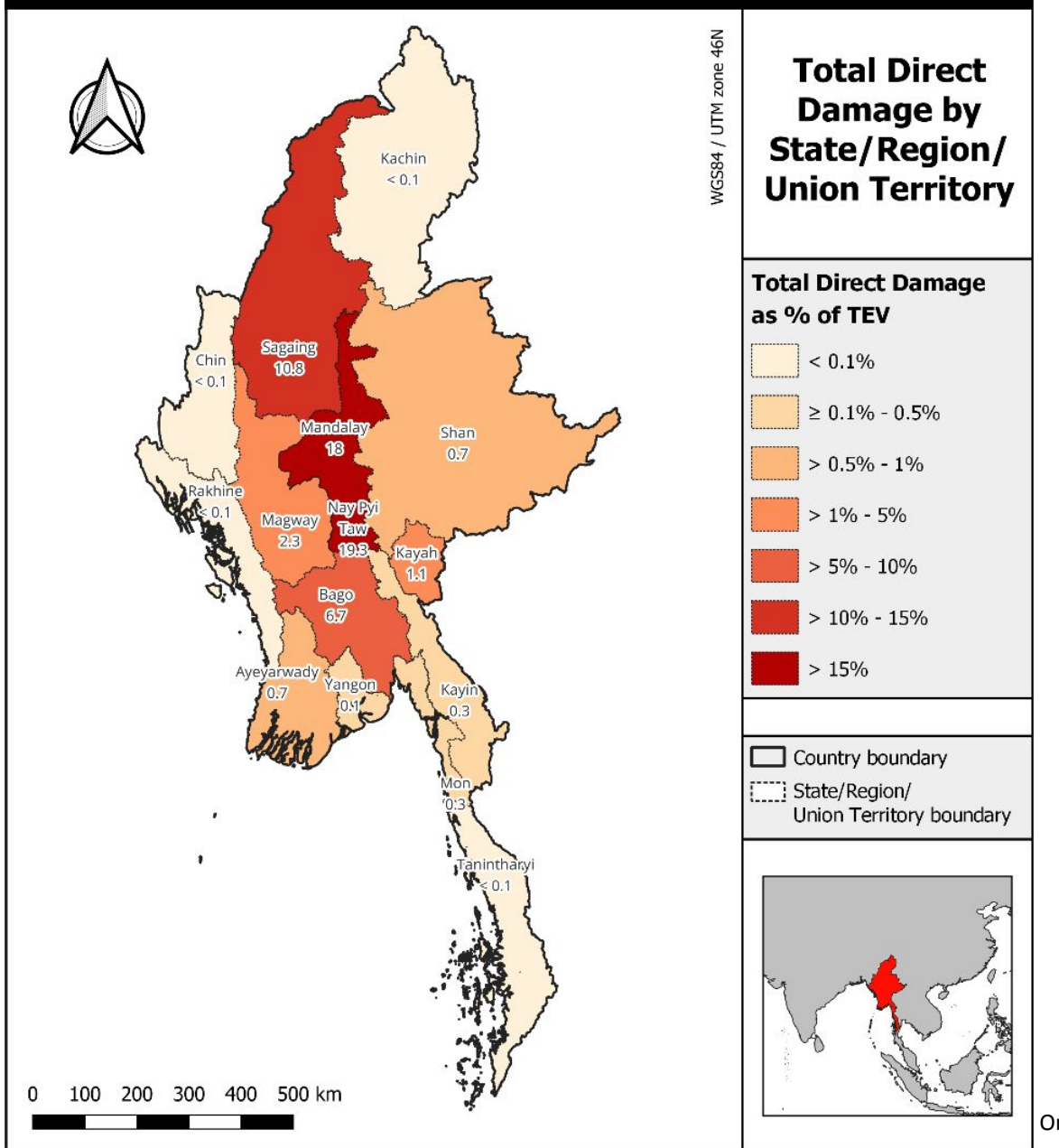
GRADE Results by States by % of Exposed Assets

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%**

Myanmar Earthquake 2025

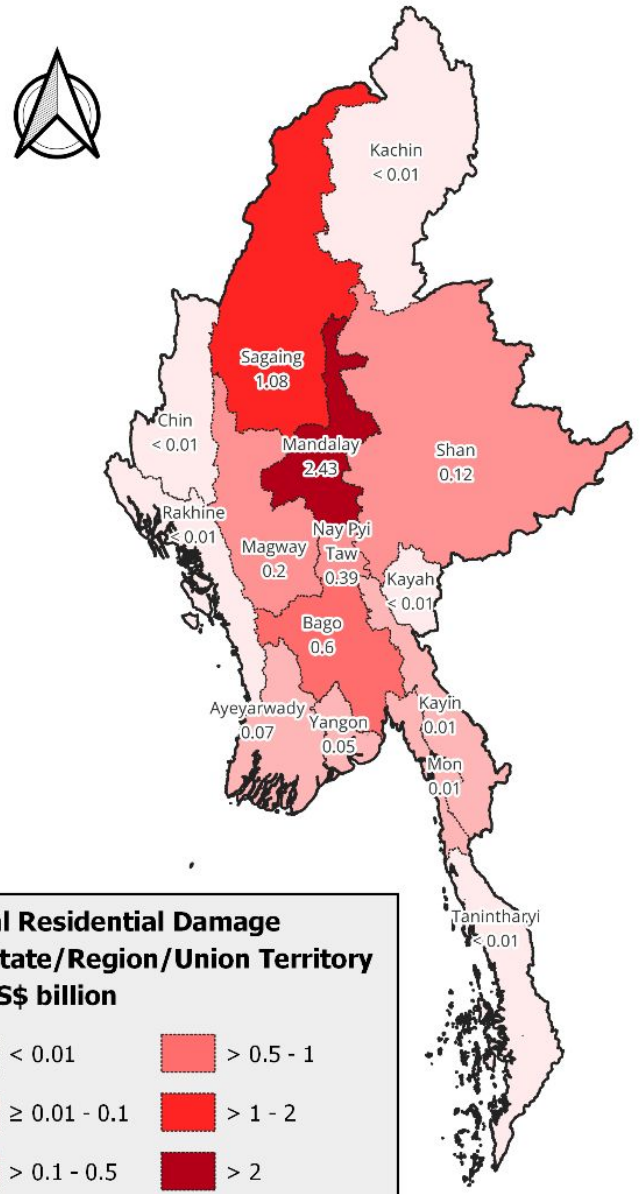


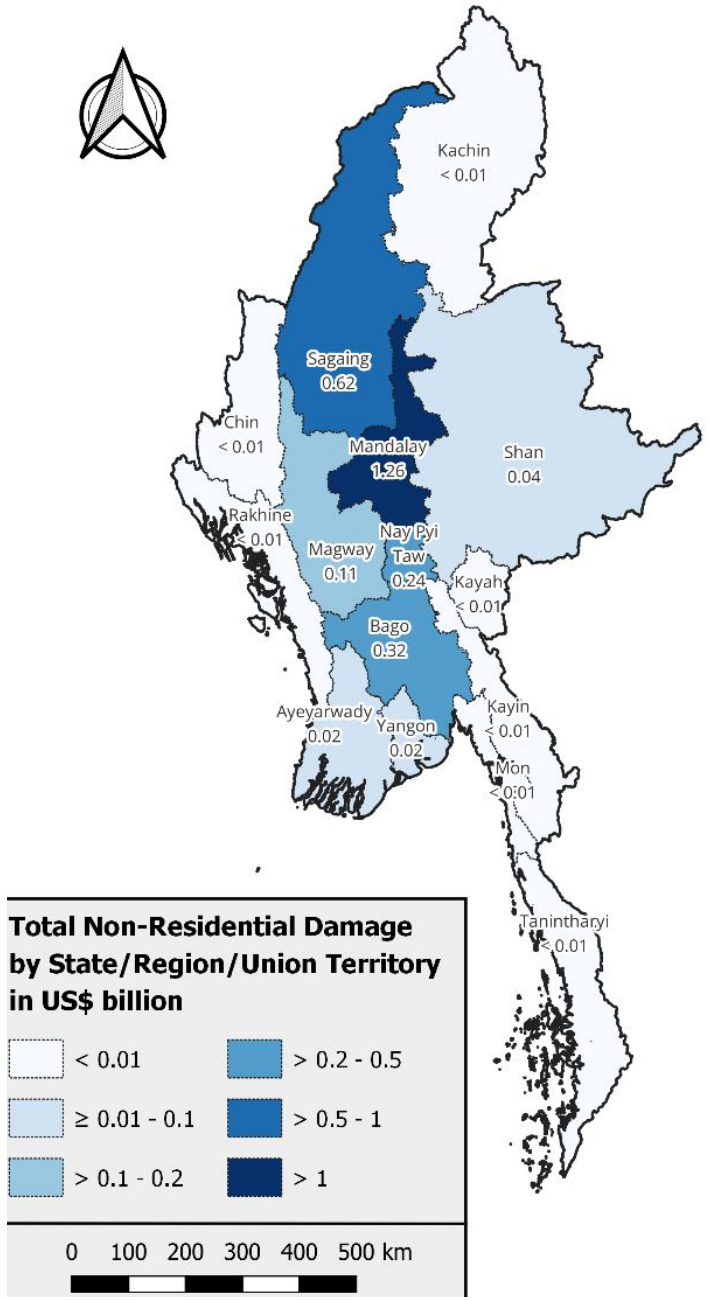
Myanmar Earthquake 2025

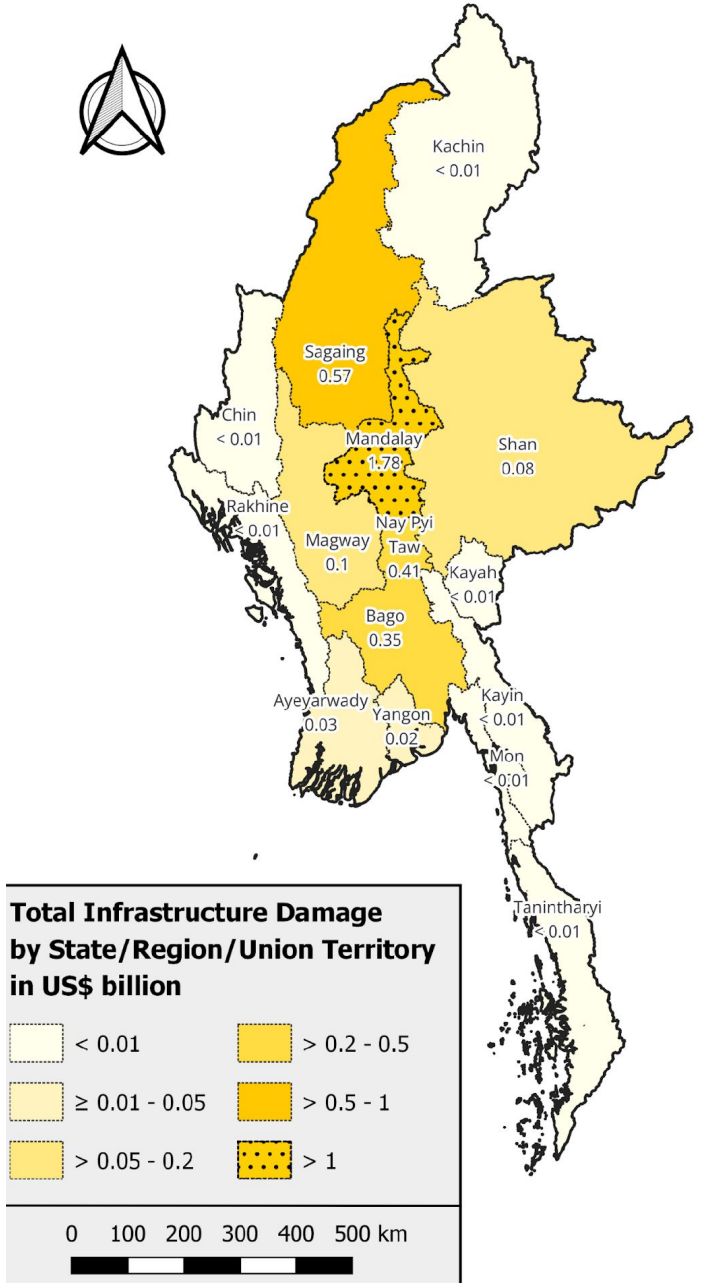


Only

Sectoral Damage







Interpreting the Results – page 1

- **Residential buildings (and contents) dominate the damage estimates** (45%), followed by infrastructure (31%) and the non-residential (24%).
- GRADE results are **similar to the Global Earthquake Model** which estimates US$ 6.4 billion (*unpublished & not detailed*) in damage (for buildings only) vs. US$ 7.61 billion from GRADE (buildings and contents).
- There is **significant uncertainty** in the results. While GRADE 'best estimate' is US$10.97 billion there is an uncertainty range of US$ 6.2 billion to US$ 15.8 billion.
- A substantial amount of this uncertainty is **driven by a) under reporting of damages; b) the significant number of cultural heritage sites that incurred damage** which are difficult to value accurately; and c) differences in shakeMap calculations.
- **Shaking intensities greater than VI (damaging intensities), show over 20 million people** affected. This also implies many million households affected.
- **Capital stock of $122.4 billion also exposed to damaging shaking** which puts in context the large financial impact ($11 billion in damages) of the earthquake.

Interpreting the Results – page 2

- **Damage estimates** are over double the damages from **the 2015 Ghorka Earthquake, Nepal (US$ 5.4 billion) however, the damage relative to GDP are less (16% for this event, vs. 24% for Nepal).**
- GRADE **does not calculate losses**, but they could **be between 50%-200% of the damages** in such earthquakes. Most lie between 70-150%, however there are outliers. For Nepal, there was US$ 8.59 billion estimated for the losses and needs which is 159% of damage.
- Given the typologies and damage patterns seen, **reconstruction costs** could be 2-3 times the damage estimates given the need for demolition, modernization, improved code compliance, and typology changes of damaged buildings and infrastructure.
- The impacts and the speed of response and recovery will likely be hampered given the **complex conflict context**. Estimated 1.6 million earthquake-affected population had already been internally displaced owning to conflict. Sagaing region alone housed 1.25 million IDPs before the event.
- On **gender**, before the event, 10.4 million women and girls needed urgent humanitarian aid. Following the earthquake, women-headed households are reported to be struggling to access emergency relief and financial assistance, and women and girls are facing even greater risks of gender-based violence and exploitation, especially girls separated from their families

From asset damage to well being impacts: poor disproportionally impacted

poor

rich

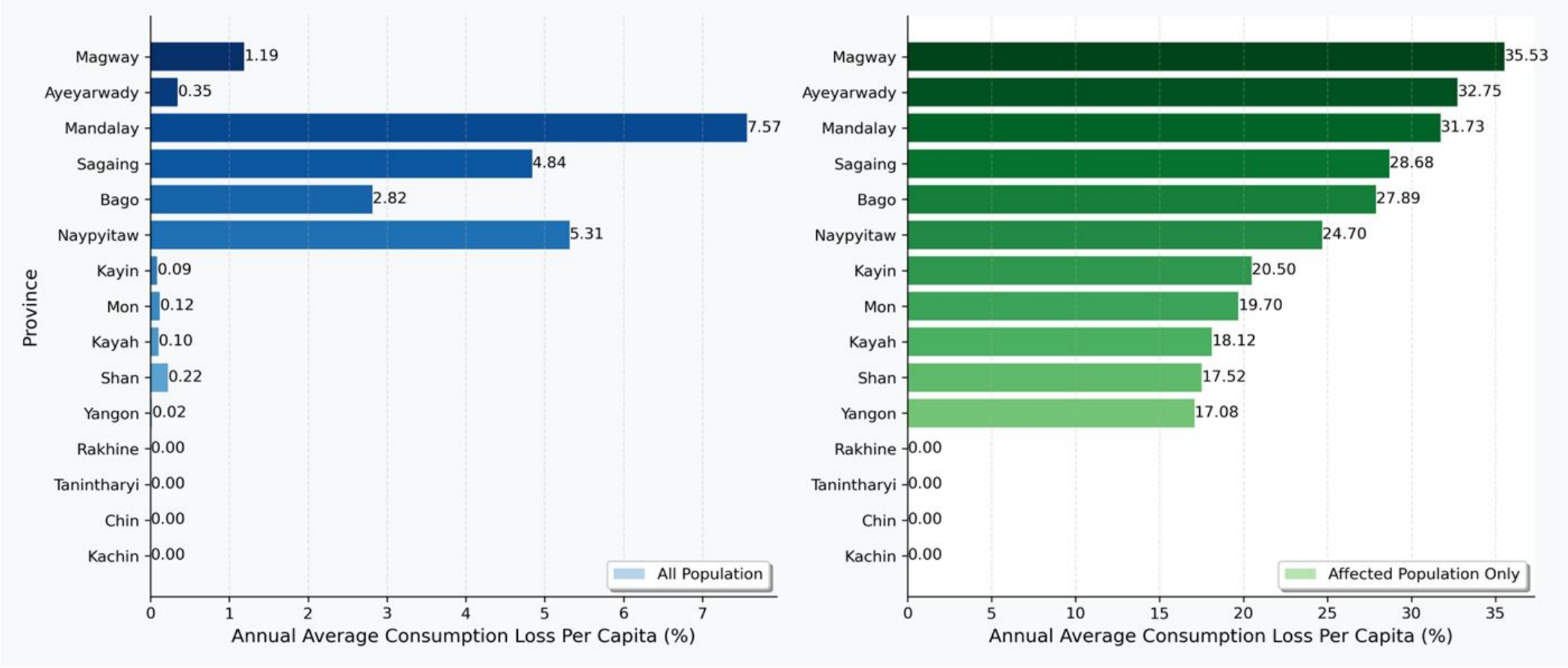
$1000 asset losses =? $1000 asset losses

https://unbreakable.gfdrr.org/countrytool

Spatial Variation

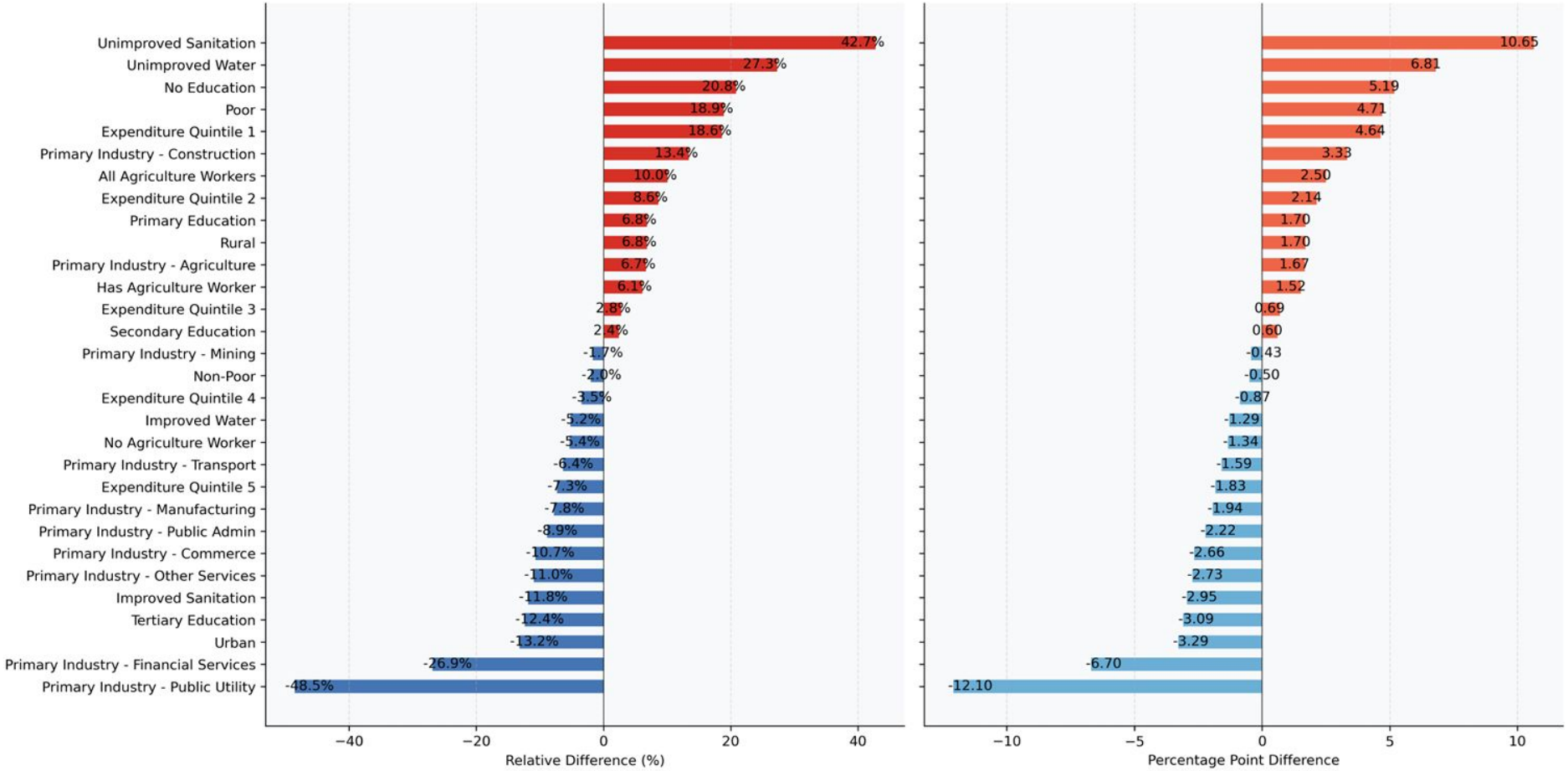
All households see modest per-capita losses (1–8%), peaking in Mandalay (7.6%), Naypyitaw (5.3%) and Sagaing (4.8%).

•Among affected households, losses rise to 28–36% in Magway, Ayeyarwady, Mandalay and Sagaing, and exceed 17% even in lower-impact provinces.



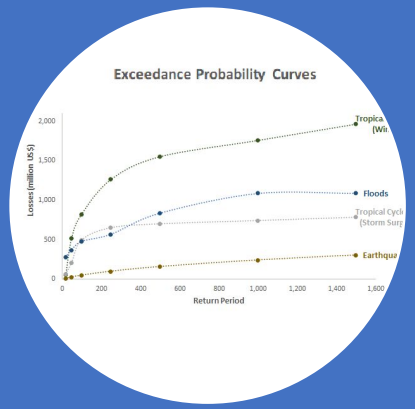
Distributional Impacts:

Households with *unimproved sanitation*, *water access* or *no education*—and the *poorest quintile*—suffer 18–43 % higher losses (≈ 5–11 pp). In contrast, *public-utility* and *financial-services workers*, as well as *urban* and *tertiary-educated* households, have 13–49% lower impacts (≈ 3–12 pp).



Integrating climate and disaster risk info

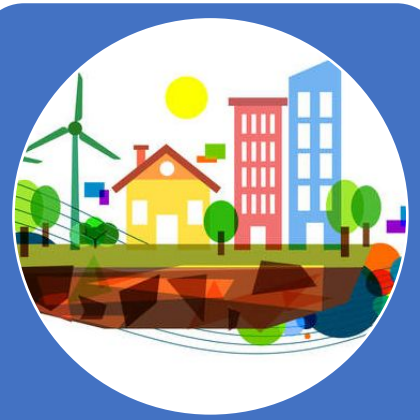
Provide an analytical framework for assessing climate and disaster impacts on macroeconomic, poverty, and welfare indicators.



Rapid Disaster Damage Assessment

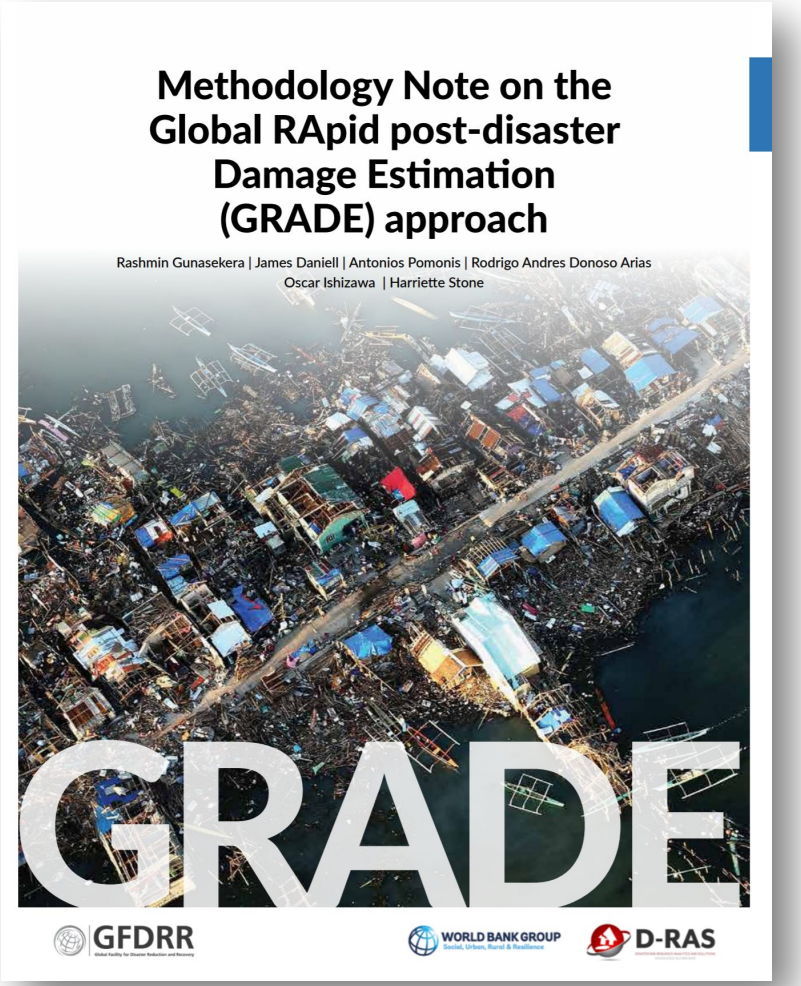
Macroeconomic Impact of Disasters

Impact of Disasters on Poverty and Inclusion



Changing Risk Picture

Thank you!



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Key data sources used in GRADE analysis

- USGS, GEOFON, IRIS, EMSC earthquake data and shakemaps
- Ground motion station data
- Population from Census data, MIMU and projections
- Settlement Information
- Physical Planning Unit data (building attributes, enumeration districts, hotels and other public buildings)
- Data from the 2023 Cyclone Mocha GRADE.
- Infrastructure data from OSM, Microsoft, Google, OpenInfraMap, Gridfinder, Myanmar Statistics reports
- UNOSAT, Copernicus, and other remote sensing imagery.
- Building typologies from census data, footprints from OSM, Microsoft, Google
- Unit Costs of Construction (UCC) from Building Permit statistics (2004 and 2012), as well as recent estimates from construction projects
- Agency and development partner reports
- Social media reports from X, Facebook and other sources to corroborate damage data.
- Sentinel imagery
- Global Earthquake Model data and reports
- ReliefWeb Updates
- MSR, AHA, OCHA, NUG-MOHADM, IFRC, MRCS, DIEM, MOSWRR, Univ Tokyo damage statistics
- Datasets from MIMU