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Global Rapid Post-Disaster Damage Estimation (GRADE) Report

M_w 7.8 Türkiye-Syria Earthquake – Assessment of the Impact on Syria: (Results as of February 20, 2023)

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Abbreviations

AANES:	Autonomous Administration of North and East Syria
ACU:	Assistance Coordination Unit
DaLA:	Damage and Loss Assessment
D-RAS:	Disaster-Resilience Analytics and Solutions Team, World Bank Group
ECHO:	European Civil Protection and Humanitarian Aid Operations
GFDRR:	Global Facility for Disaster Reduction and Recovery
GPSS:	Global Program for Safer Schools
GPURL:	Urban, Disaster Risk Management, Resilience and Land Global Practice
GRADE:	Global RApid post-disaster Damage Estimation
HOTOSM:	Humanitarian OpenStreetMap Team
IDP:	Internally Displaced Persons
OSM:	Open Street Map
PDNA:	Post-Disaster Needs Assessments
RDNA:	Rapid Damage and Needs Assessment
TEV:	Total Exposure Value
UNESCO	The United Nations Educational, Scientific and Cultural Organization
UNOCHA:	United Nations Office for the Coordination of Humanitarian Affairs
UNOSAT:	United Nations Satellite Centre
USGS:	United States Geological Survey
US$:	United States Dollars
WASH:	Water, Sanitation and Hygiene
WHO:	World Health Organization

Exchange Rates

US$ 1 = Syrian Pound (SYP) – Official 4,522 (as of March 2, 2023)

Contents

1.0 Executive Summary

Following the magnitude (M_w) 7.8 Türkiye-Syria Earthquake on February 6, 2023 and the M_w 6.3 earthquake on February 20, 2023, the World Bank carried out a remote, desk-based assessment of the physical damages in Syria using the Global RApid post-disaster Damage Estimation (GRADE) methodology[1]. The objective of the assessment is to develop a model-based estimate of the direct physical damages[2] to residential buildings (houses) and non-residential buildings[3] caused by the event, and to evaluate the spatial distribution of damages. The analysis does not evaluate the impact on loss in terms of economic flows (e.g. production or business interruption, as might be included in a Rapid Damage and Needs Assessment - RDNA); it only assesses direct damage to capital stock. It is expected that an RDNA will follow this analysis.

The objective of this report is to provide an estimate of the direct damage costs caused by these earthquakes. The report is based on a rapid and remote post-disaster damage assessment that follows the established GRADE methodology, which benefited from a range of data including: government damage data and reports; simulation of earthquake ground motion through hazard modelling that was verified against instrumental strong ground motion recordings; buildings and infrastructure exposure database and capital stock information; analysis of current unit costs of construction in Syria; and structural vulnerability analysis. GRADE is intended as a rapid remote estimate in a short timeframe to inform early decision-making, and is not intended as a substitute for detailed, on-the-ground analysis which may be additionally conducted in the weeks/months to come. The GRADE assessment should be interpreted as a first-order direct damages estimation, albeit with a significant degree of reliability. However, GRADE's outputs are still estimates; remote-based calculations that are influenced and updated from available ground-based data. While there is confidence in the overall economic estimates and distribution of damage, the confidence level at the individual asset level is very low. Furthermore, GRADE results do not include the losses and needs that are also crucial for the comprehensive understanding of the impact of the disaster.

In this report, direct physical damage is quantified using the gross capital stock, which is the replacement cost of an asset newly rebuilt based on current unit costs[4] and construction practice, and although it does

[1] Global RApid post-disaster Damage Estimation (GRADE) approach developed at the World Bank and conducted by the Global Practice for Urban, Disaster Risk Management, Resilience and Land (GPURL) Disaster-Resilience Analytics & Solutions (D-RAS) Knowledge Silo Breaker (KSB). The methodology aims to address specific damage information needs in the first few weeks after a major disaster. For details of the methodology see: https://www.gfdrr.org/sites/default/files/publication/DRAS_web_04172018.pdf.

[2] The gross capital stock represents the replacement costs of all evaluated residential, non-residential and infrastructure assets in Syria at their pre-earthquake conditions.

[3] Non-residential buildings include every type of building which is not a residence. This includes: education, health, commercial, public, industrial assets and infrastructure (transport, power, water, telecommunications infrastructure).

[4] Unit costs are as of September 2022. Unit costs are in US$ and estimated at around 80% of respective unit costs in Türkiye. Unit costs do not account for the recent depreciation of the Syrian Pound nor the increase in inflation.

include fixed/mobile industry capital, it does not take into account transport equipment, or technological changes etc. However, reconstruction costs could be higher by a factor of 1.1 to 2.0 depending on the impact of the protracted conflict on the availability and pricing of material and labor, as well as the security premium. Another factor, though unlikely,[5] is the extent of new construction codes and guidelines being used. Reconstruction costs are expected to be proportionately higher for non-residential than residential buildings, due to the possibility of upgrades and "build back better" practices (because a large share of its capital stock and production technologies are outdated). Estimates of direct damages, presented in this report, do not include costs associated with humanitarian and emergency response, or the losses associated with economic flows (e.g., business interruption). Moreover, assessments of damage are still ongoing across many sectors.

The total damages presented here are broadly consistent with the only other assessment found to date which estimated reported damages at US$5 billion (accessed on Feb 22)[6], including over US$2 billion in Aleppo, Hama and Latakia, and over US$2 billion in Idlib.

Key Highlights:

- **In Syria, which is the focus of this report, these earthquakes have resulted in widespread damage across 4 governorates, where around 10 million of Syria's population resides. This includes Aleppo (population of 4.2 million), Idlib (population of 2.8 million), Hama, and Lattakia governorates (joint population around 2.6 million). As of February 20, 2023, the confirmed death toll across Türkiye and Syria reached 47,489 deaths.** Of this, 6,469 fatalities are in Syria with at least 14,500 injuries in total. In northwest Syria, this includes 4,525 reported deaths and 8,424 reported injuries, with many still trapped under the rubble (Assistance Coordination Unit - ACU). In addition, another 2,068 fatalities have been reported in government-controlled areas, with an additional six fatalities reported from the Autonomous Administration of North and East Syria (AANES). These human casualty figures are expected to underrepresent the true scale of the earthquake's impact, which will become clearer as further assessments are concluded.
- **The total direct damages are estimated at US$5.1 billion (with a range from US$2.7 billion to US$7.9 billion given the inherent uncertainties).** Given the uncertainty surrounding previously damaged buildings due to conflict, triggered earthquake damage, demolition rates, lack of information on the response of the building stock in Syria to earthquakes, and coverage of damage reporting due to the ongoing conflict, there is a significant spread in the lower and upper bound of the direct damage estimations from US$2.7 to US$7.9 billion. Further discussed in Annex C.
- **The median value of US$5.1 billion is based on the replacement value of capital stock damaged or destroyed.** The current value of this destroyed capital stock is estimated at about 10 percent of GDP. Due to the longstanding conflict, the Syria's current capital stock has declined significantly

Depreciation is expected to lower unit costs in local currency, while inflation will increase rebuilding costs; their combined impact on unit costs is difficult to assess without comprehensive and up-to-date inflation data. This provides a caveat for the estimated replacement costs (See also Point 4 in Annex C).

[5] Urban and construction policies updates and implementation have been in decline in the country since the beginning of the war. CF: https://www.rosalux.de/en/publication/id/39119

[6] Ali Kanaan, head of the Banking and Insurance Department at the University of Damascus, Faculty of Economics, https://almashhadonline.com/article/63e9df634d023.

(e.g. due conflict related damages, lack of adequate maintenance and dis-saving). As such, a significant gap in valuation between the current capital stock and its replacement value is to be expected. This generates some uncertainty when estimating the impact of damages in terms of GDP.

- **Damage to the residential building stock of US$2.5 billion accounts for approximately half of the total damages (48.5 percent),** followed by US$1.7 billion (33.5 percent) to non-residential buildings (including commercial, industrial, and public buildings) and US$0.9 billion (18 percent) in infrastructure damages.
- **The earthquake impacted 38 districts and 174 sub-districts across 8 out of Syria's 14 governorates.** The governorates with the highest total median estimated damage were Aleppo (US$2.3 billion) and Idlib (US$1.9 billion). Governorates suffering total damages in excess of US$100 million include Lattakia (US$549 million) and Hama (US$167 million). However, considering upper bound estimates, Idlib may have had up to US$3.1 billion in damages, and Aleppo up to US$3.2 billion.
- **The median estimated damage from the earthquakes is approximately 58 percent of the lower-limit damages (US$8.7 billion) caused by the war to 14 cities[7] until end of 2021.** Actual estimated damage by the World Bank was between US$8.7 – US$11.4 billion.
- ACU reported that, as of February 18, more than 1,796 buildings in northwest Syria were completely destroyed, with another 8,093 partially destroyed. This is likely an underestimate. In the government-controlled areas, 41,000 buildings have so far been identified as being either completely damaged, heavily damaged, moderately damaged or with very minor damage or needing checks. The government expects many of these will just need simple maintenance or no remediation. 22,000 have been inspected in Lattakia governorate, 12,600 in Aleppo and 7,200 in Hama. More than 1,000 buildings in Al-Tloul and in the surrounding villages were flooded as a result of the Al-Talul packwall dam rupture in Idlib governorate.
- **The M_W 6.3 earthquake of February 20, 2023, added additional damage to the border regions in Lattakia, Idlib, Hama and Aleppo, with Idlib and Lattakia being the worst hit.** Often, moderately damaged buildings unfortunately become irreparable after big aftershocks/triggered earthquakes such as this. Additional slight damage, as well as disruption is also seen. The economic impact of the aftershock is estimated to be less than US$1 billion. The analysis does not always account for structural weaknesses caused by previous conflict, which like incremental damage is an additional source of damage.
- The mainshock on February 6, and subsequent earthquakes in and near northern Syria including that of February 20, affected populations that had already been substantially impacted by the ongoing armed conflict since March 2011. The fragility and protracted crisis context are now further exacerbated in the earthquake affected region. The earthquakes have also exacerbated the ongoing camp and informal settlement crisis in north-western Syria. Overcrowded, informal, and unmanaged, IDP sites are particularly vulnerable to disasters, including flood, extended drought, and winter storms. Such risks, if left unaddressed, may further increase the compounded risk for disasters-related conflicts (including hazards exacerbated by climate variability and change) and displacements.

[7] The World Bank conducted a remote-based damage assessment of 14 selected cities: Afrin, Aleppo, Dar'a, Daraya, Deir-ez-Zor, Al Hasakah, Homs, Idlib, Manbij, Palmyra, Ar-Raqqa, Rastan, Tell Abiad, and Zabadani—from 2014 to 2022 (World Bank, 2022)

- **Overall, this is the worst earthquake event in Syria since the M_W 7.4, 1822 Afrin earthquake.** Given the size of the earthquakes, aftershocks may take place for many months before seismicity returns to background levels and, during this time, large aftershocks such as the February 20 earthquakes are possible.

Table 1 shows the estimated direct physical damages (in US$ millions) for three sectors: residential, non-residential, and infrastructure, across the entire affected region (eight governorates) including the three governorates closest to the area most impacted by the earthquake (i.e. the meizoseismal area). The analysis does not evaluate impacts in terms of economic flows, such as production or business interruption, loss of income, costs for temporary housing/relocation, and demolition costs. Agricultural impacts are also not included in the calculation of direct physical damages as they are largely due to loss of economic flows (which are omitted from the GRADE calculation).

Table 1: Direct damage by sector and governorate in absolute values (in US$ millions) including a lower and upper bound.

Governorates	Residential	Non-Residential	Infrastructure	Total		
				Median	Lower	Upper
Aleppo	1,108	790	413	**2,311**	**1,324**	**3,176**
Idleb	923	640	331	**1,894**	**1,062**	**3,082**
Lattakia	267	174	108	**549**	**176**	**947**
Hama	86	51	29	**167**	**84**	**272**
Homs	34	21	13	**69**	**14**	**144**
Tartous	26	18	10	**55**	**15**	**105**
Al-Hasakeh	5	2	1	**9**	**1**	**119**
Ar-Raqqa	17	8	5	**30**	**9**	**58**
Other	<1	<1	<1	**<1**	**<1**	**5**
Total	**2,466**	**1,705**	**912**	**5,083**	**2,685**	**7,903**

Table 1 shows that the direct impacts are dominated by damages to Aleppo (45 percent), Idlib (37 percent), Lattakia (11 percent) and Hama (3 percent) governorates.

Table 2 shows the estimated direct damages expressed as percentage values relative to the baseline exposure of each of the three sectors in each of the affected governorates.

Table 2: Direct damage by sector and governorate in relative terms (in % of the exposure in each sector) for the median estimate.

Governorate	Residential	Non-Residential	Infrastructure	Total
Aleppo	4.8%	3.9%	3.3%	**4.1%**
Idleb	14.8%	13.1%	10.0%	**13.1%**
Lattakia	3.8%	2.9%	2.8%	**3.3%**
Hama	1.2%	0.9%	0.7%	**1.0%**
Other	0.1%	0.1%	0.1%	**0.1%**
Total	**2.4%**	**2.0%**	**1.6%**	**2.1%**

The results in Table 2 show that direct damage in Idlib amounts to nearly 13 percent of the joint residential, non-residential and infrastructure capital stock in this governorate. Similarly, Aleppo also experienced relatively high damage ratios, with damages amounting to about 4 percent of the joint residential, non-residential and infrastructure capital stock in this governorate. Lattakia governorate has damages amounting to around 3 percent of the joint residential, non-residential and infrastructure capital stock. The damage ratios in Hama governorate are around 1 percent of the joint capital stock. The average damage ratio across all sectors and governorates of the country is 2.1 percent, indicating significant damage on top of the existing conflict-related damage within the country.

2.0 Introduction

2.1 Event Characteristics and Description

A moment magnitude (M_W) 7.8 Türkiye-Syria earthquake occurred on February 6, 2023, at 04:17 Syria local time, at a depth of approximately 18 km, with an epicenter 34 kilometers west of Gaziantep, near the Türkiye-Syria border. The earthquake ruptured a large segment of the East Anatolian Fault (EAF) in Türkiye between Elazığ and Gaziantep and the complete Karasu fault in Hatay, causing devastation in 11 provinces of Türkiye and four governorates of northwest Syria. It was one of the strongest earthquakes recorded in Türkiye, equalling the magnitude of the 1939 Erzincan earthquake.

On the same day, a second major earthquake (M_w 7.5) at 13:45 Syria time, occurred on a fault branch off the EAF, rupturing the Çardak and Sürgü faults around Elbistan in Kahramanmaraş province of Türkiye, along a length of about 150 km. Both earthquakes occurred on known faults. The second earthquake did not have significant impacts on Syria.

On February 20, 2023, at 20:04 Syria time, an aftershock of M_w 6.3, at a depth of 16 km, occurred near Defne in Hatay province of Türkiye. This was followed by one more aftershock of M_w 5.8 soon afterwards. Early reports from Syria of this aftershock are of deaths, additional damage, and a significant number of buildings changing from moderately damaged to being irreparable. Some buildings have collapsed in this aftershock, trapping people under the rubble in Syria.

For the purposes of this GRADE assessment note for Syria, various seismic intensity maps were created to determine the reported shaking impacts in Syria. An example is shown in Figure 1, including a color scale for the severity of shaking falling within each of the 12-degree (I to XII) Modified Mercalli Intensity (MMI) scale zones (“severe/very damaging” ground motion corresponds to macroseismic intensity VIII on the Modified Mercalli scale, while “violent/devastating” corresponds to macroseismic intensity IX). Significant

adjustments were made for ground observations in terms of felt intensities. The various shakemaps produced were used as part of the range of modelled results for the damage estimates.

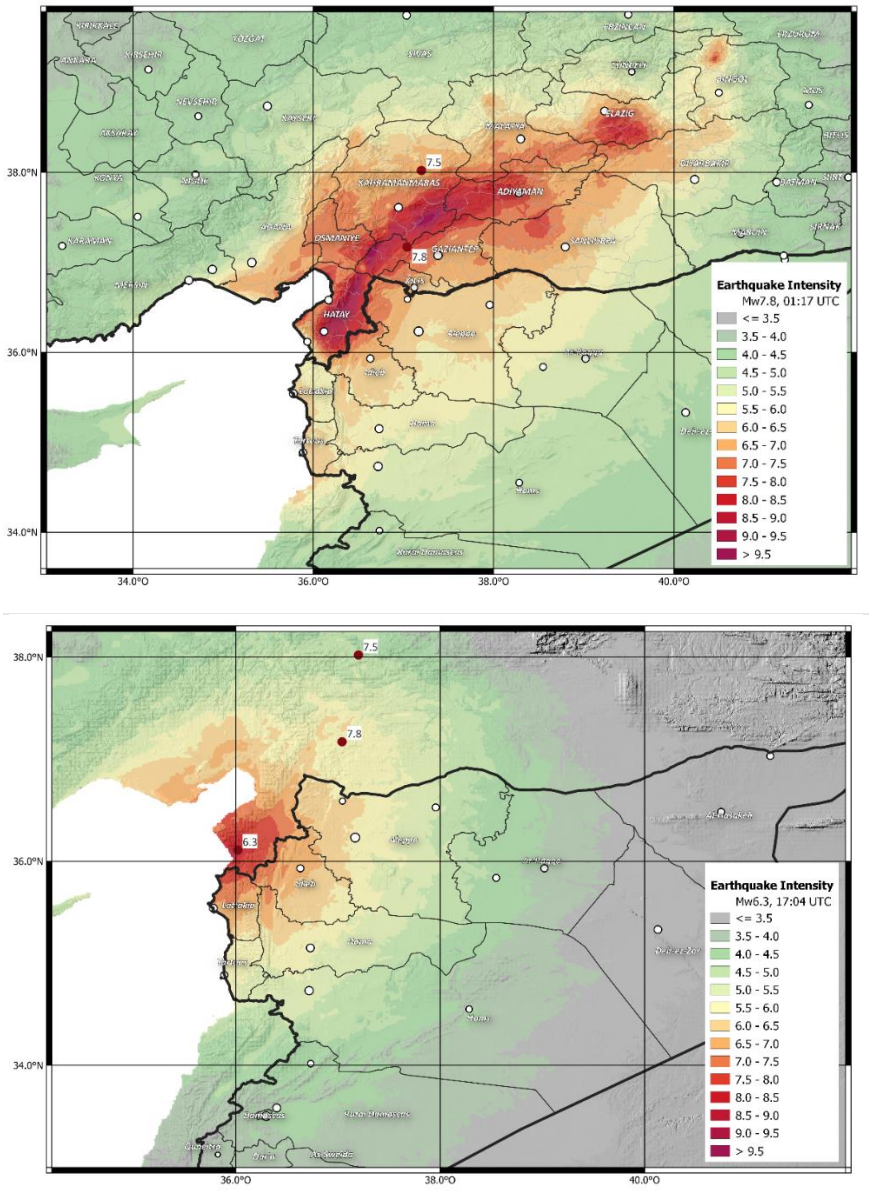

Figure 1: Recreated median MMI (Modified Mercalli Intensity) Shakemap of the M_W 7.8 earthquake of February 6, 2023 (top) and M_W 6.3 earthquake of February 20, 2023 (bottom), in Northwestern Syria. It shows seismic shaking distribution of the earthquake. The dark brown shaded locations along the border with Hatay province in Türkiye correspond to very strong and severe ground shaking intensities VII and VIII.

2.2 Seismo-tectonic Background and Earthquake History

While it is certain that records of many small earthquakes must be missing for many reasons in Syria's historic earthquake catalogue, it is estimated that the total number of the historical earthquakes in and around Syria for the period between the 14th century B.C. and the 19th century A.D. amounts to 181

events (Sbeinati et al., 2015). The 1365 B.C. earthquake in Ugharit was the first documented earthquake to be mentioned in the catalogue. The most extensive and disastrous events appear to have been those of 53 A.D., 494, 502, 551, 747, 849, 859-860, 1114, 1157, 1170, 1202, 1404, 1408, 1705, 1759, 1796, 1822, 1837 and 1872. These events caused considerable damage and killed a large number of people in Syria (Ambraseys, 2009).

Table 3 shows several large earthquakes ($M_w > 7$) that have been recorded in the East Anatolian and Dead Sea Transform Faults between 1100 A.D. and 1899. Due to the uncertainties associated with historic earthquake data, their magnitudes are only estimates. The 1170 and 1202 earthquakes on the Dead Sea Transform Fault have been classified between M_w 7.2 and 7.7 depending on the historical analysis done. At least six earthquakes with estimated $M_w > 7.5$ occurred between 1100 A.D. and 1899, while no event of $M_w \geq 7$ occurred in these two major fault structures between 1900 and 2022. Closer in time period to the mainshock earthquake of February 6, 2023, the August 13, 1822 Afrin-Aleppo earthquake was estimated to have been of M_w 7.4 (Ambraseys, 1989), causing severe damage in Aleppo, leaving most of the old city center in disrepair. Such large magnitude earthquakes are not uncommon in Syria's historical record of earthquakes, but the February 6, 2023 earthquake was the most damaging to Syria since the estimated M_w 7.4 1822 Afrin-Aleppo earthquake.

Table 3: Large historic earthquakes in the East Anatolian and Dead Sea Transform Faults since the 12th century

Date / Local Time	Nearest Place	Location	Magnitude (M_W)	Source
1114-11-29	Kahramanmaraş	37.6°N 37.2°E	7.4 - 7.8	GHEA
1157-08-12	El-Ghab	35.4°N 36.6°E	7.2 - 7.8	GHEA
1170-06-29	Missyaf / Homs	34.8°N 36.4°E	7.3 - 7.7	GHEA
1202-05-20	Syria	34.1°N 36.1°E	7.2 - 7.6	GHEA
1344-01-02	Aleppo / Gaziantep	36.7°N 37.4°E	6.8 - 7.6	GHEA
1408-12-29	Lattakia	35.8°N 36.1°E	7.4	GHEA
1513	Kahramanmaraş	37.8°N 37.5°E	7.4	GHEA
1626-01-21	Aleppo	36.5°N 37.1°E	7.3	GHEA
1759	Damascus	33.7°N 35.9°E	7.4 – 7.5	GHEA
1822-08-13	Afrin	36.7°N 36.9°E	7.4	GHEA
1872-04-03	Hatay	36.4°N 36.5°E	7.2	GHEA
1874-05-03	Elazığ	38.5°N 39.5°E	7.1	GHEA
1893-03-02	Malatya	38°N 38.3°E	7.1	GHEA

3.0 Reported Earthquake Impacts in Syria

Syria's pre-existing social, economic, logistical and political conflict-challenges are now conflated with the effects and impact of the February 6, 2023 earthquake sequence, exacerbating the difficulties of response and recovery efforts and leading to additional and intersecting hardships for the affected population. Buildings and infrastructure in northwestern Syria were already weakened by years of bombardment during the 12-year civil war, leaving many structures unable to withstand the earthquake and the ensuing aftershocks. More details on the fragility and crisis dynamics and how these amplified the earthquakes' impacts are discussed in the Annex B of this GRADE report.

3.1 Human Casualties, Affected and Displaced Population

As of February 20, 2023, the confirmed death toll across Türkiye and Syria surpassed 47,000 deaths, with 6,599 fatalities and 14,500 injuries in Syria. In northwest Syria, this includes 4,525 reported deaths and 8,424 reported injuries, with many still trapped under the rubble (ACU, 2023, Feb 20). The Syrian Ministry of Health reported 2,068 earthquake-related deaths and 2,950 injuries in government-held areas, mostly in Aleppo and Lattakia. An additional six fatalities were reported from the AANES. In the government-held governorate of Lattakia, the end of the search for survivors was signalled on February 13, 2023, with 805 dead and 1,131 injured. More details are included in the Annex.

The M_w 7.8 Türkiye-Syria earthquake on February 6, 2023, widely affected approximately 10 million people in Syria, which accounts for more than half of Syria's population. The strongest shaking and damage have been reported primarily in the governorates of Idlib and Aleppo. Worst affected was the Idlib governorate, (particularly communities near the border with Türkiye), with the (2021) population estimated at nearly 1.2 million. In the Aleppo governorate, worst hit was the Afrin district in northwestern Aleppo with a population of 172,000 during the 2004 Syria census. Hama, Lattakia and other governorates were less affected.

According to reports from Syria, 900,000 people are in urgent need of shelter assistance across the country. More than 298,000 people left their homes in the Government-controlled areas, at least 30,000 were displaced in the northwest, and approximately 30,000 were reportedly housed in shelters in Aleppo alone (Al Araby Jadid, 2023, Feb. 9). In addition, 18,500 families are currently sheltered in collective centers, but more temporary shelters are being set up as the need keeps growing. REACH's assessments with community leaders in 604 earthquake-affected communities in Greater Idlib and Northern Aleppo between February 9 and 11 showed that the earthquake displaced 55,000 households and left 50,000 households in need of tents or emergency shelter (REACH, 2023, Feb 15).

3.2 Building Damage

In Syria, building damage was reported in nine districts and 34 subdistricts in the Aleppo and Idlib governorates. As of February 19, 2023, 1,796 buildings in northwest Syria were reported to have been completely destroyed, with another 8,093 partially destroyed (ACU, 2023, Feb. 19), not including the government held areas. In Aleppo, 56 buildings reportedly collapsed. In the small town of Sarmada, in the Idlib governorate, buildings were reduced to rubble. In the northwest, the Violet organization estimated that 100 percent of buildings were damaged to some extent in Besnaya-Bseineh and Atma (Idlib

governorate), 90 percent in Armanaz (Idlib) and Atareb (Aleppo), 80 percent in Sarmada, Dana, Termanin and Milis (Idlib) and 75 percent in Jandairis (Aleppo).

Table 4 shows a breakdown of totally and partially destroyed buildings across different districts of Aleppo and Idlib governorates as part of the ACU data.

The following damage observation statistics are valid as of February 19 (prior to the February 20 earthquake). In the government-controlled areas, 41,000 buildings have so far been inspected (22,000 inspected in Lattakia governorate; 12,600 in Aleppo; and 7,200 in Hama) and identified as being either completely damaged, heavily damaged, moderately damaged, or with very minor damage or needing checks. In the Lattakia governorate, 103 buildings were destroyed and another 247 were to be pulled down, while 47 shelter centers were provided across the governorate.

Table 4: Number of totally destroyed and partially destroyed buildings across different districts of Aleppo and Idlib governorates (Data Source: ACU Data updated February 19, 2023).

District	Governorate	Totally Destroyed	Partially Destroyed
Harim	Idlib	669	2602
Afrin	Aleppo	483	2427
Jisr-Ash-Shugur	Idlib	435	1295
Idlib	Idlib	79	536
A'zaz	Aleppo	61	215
Jebel Saman	Aleppo	51	125
Al Bab	Aleppo	7	825
Ariha	Idlib	6	52
Jarablus	Aleppo	5	16

3.3 Dam Failures and Associated Flooding

Several dams were exposed to ground shaking following the earthquakes. The Al-Tloul packwall dam in the Idlib governorate near the Syria-Türkiye border developed fractures, and on February 9 at 04:00 local Syria time, the dam ruptured and inundated the village of Al-Tloul, situated in the Salqin subdistrict of Harem district, Idlib governorate. Heavy rain and water from the dam caused the Orontes (Al Assi) River to surge and flood an area of 18 square kilometers (Figure 3). The annual water potential of the Orontes river is 1,200 hm^3 and its flow rate is 67 m^3/s. When used for irrigation purposes, it can dry out completely in summer. Almost all of the buildings in Al-Tloul were inundated, displacing around 500 people. According to Reuters, which cited locals, between 35 and 40 people died in the earthquake, and many buildings in Al-Tloul were already damaged or destroyed from the earthquake. Furthermore, about 1,000 dwellings in the villages of Hardana, Delbiya, Jakara, and Hamziyeh were also flooded, causing nearly 7,000 people to evacuate (ACU, 2023, Feb. 9).

The Maydanki dam, also known as the Afrin dam, is located 12 km from the northern city of Afrin and 70 km from Aleppo. Similar to the Al-Tloul dam, the sites where this dam was located experienced Macroseismic Intensities of VII (very strong) and it developed massive longitudinal and transverse cracks on the asphalt road on the top of the dam, based on an inspection report by the Free Engineers Syndicate (Enabbaladi, 2023, Feb 19).

Other dams, such as the Duwaysat, Mare, Sajur and Tishreen dams, which were exposed to Macroseismic Intensity VI (strong) or higher, were not affected.

Note that dams were not expressly modelled in the GRADE analysis.

3.4 Reported Damages to Critical Facilities and Infrastructure

The following are reported by ACU, for opposition-controlled areas. The earthquake damaged many buildings in the health and education sector. Damage to the energy and water supply networks was also reported. A brief summary on damages to these sectors follows below:

- **Hospitals** - Prior to the earthquake, hospitals were running low on medical supplies and were forced to operate at capacity. Following the earthquakes, 55 health facilities, including four hospitals, were damaged (ACU, 2023, Feb 19) and hospitals became overcrowded due to the large number of earthquake related casualties and trauma cases. In the Annex A (Additional information on casualties and injuries in Syria), Table 8 depicts the distribution of health-care facility damage, casualties and injuries across nine different districts.

- **Schools** - As of February 13th, there were 599 schools reportedly damaged (this could be as high as 900 schools, as reported by UNICEF, when including Lattakia, Hama, and Aleppo). Another 126 were being used as shelters, hosting displaced people who fled the earthquake because their homes were considered dangerous (ACU, Feb 17).

- **Energy** - A major power outage caused problems in hospitals, leading to calls for electricity companies to ensure a constant supply. Dozens of power transmissions, around 200 electricity poles and seven tonnes of cables in Aleppo sustained damage. In addition, the Rastan substation in Lattakia, and other substations in Hama and Tartous were damaged. According to the Ministry of Electricity, the losses in the electrical sector, due to the earthquake, exceed approximately US$ 4 million, and it is likely that this number will double.

- **Water Supply** - The majority of the affected areas have central water tanks (cement water storage tanks) that have collapsed, necessitating the installation of temporary tanks until the damaged tanks can be repaired. Water networks have reportedly sustained significant damage, with 12 high water tanks damaged or affected in Government-held areas. In Lattakia, the 200 cubic meter Ghaniri reservoir threatens to burst in a residential area. There was also structural damage to the Al Bahloulieh, Al Rastan, Al-Zoubar and Karkit water stations; the high-water reservoir in Dahr Al-Syriani village collapsed; and cracks were reported on the Al Fawar ground tank (Jableh city), the Cemet high reservoir of Wadi Qandil station, and the Dam station reservoir (UN OCHA, 2023, Feb 19).

4.0 Post-Disaster Rapid Damage Estimation Methodology

To derive the direct damage estimates for this event, the World Bank's GPURL D-RAS team adapted the GRADE approach (Figure 2). For this analysis, hazard footprint datasets and shaking intensity maps were developed based on recorded ground shaking and remote sensing damage assessments[4]. These estimates were checked against ground truthing of the shaking and modified where needed. It was discovered that a pure Shakemap-style methodology could not be used due to the nature and uncertainty of the fault rupture, and thus various felt reports, response spectra from TADAS via AFAD, and damage observations were used to change the map beyond normal internet-based reporting. No station data from NEC Syria beyond that transmitted to USGS was used in the analysis. Modified seismic intensity maps were produced based on response spectra-based intensity. Both ground-based and satellite images and social media feeds were used to derive a composite spatial damage distribution analysis.

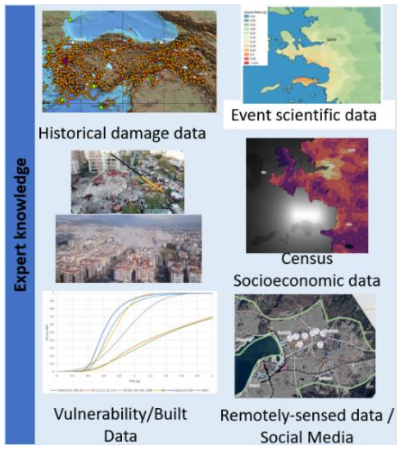

Figure 2: Example of some of methods/datasets used for the analysis.

Due to the large number of products available globally, a selection process was needed to choose the baseline information to be used for the final exposure model. The GlobalML dataset of building footprints was combined with GHS BUILT-C MSZ to characterize the building heights and sizes. The typologies were split into residential and non-residential (where mixes of industrial, commercial, public and other stock are contained).

In the Syria model, the work of Dabbeek et al. (2020) provided a good baseline for the Syrian residential building typologies. In addition to the datasets of the Syrian census, other reports during the conflict were able to give an insight into the typologies used within Syria, such as Damage Assessment reports.

For non-residential building stock, the work of the Global Earthquake Model (GEM) on their global exposure database, existing work of the Global Assessment Report (GAR) and risk assessments for Syria, as well as the work of Daniell (2014) were used. Capital stock values for non-residential assets were compared to the existing building footprints and distributed across Syria using the distributions from the GlobalML and Dabbeek et al. (2020).

For infrastructure, the databases of Open Street Map (OSM), United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA), government data and global datasets were used to create a roads, energy, water and ICT database to be distributed. In addition, yearbook and conflict information databases were used.

This analysis also assessed and rectified damage distributions produced by local and international agencies (e.g. UNOSAT) to account for already derelict buildings before the earthquake, and offset the potential miscalculation of damage where possible. This was especially an issue for the existing damage due to war, where assumptions had to be made for the level of damage before the event.

For the education sector, detailed data from the Syrian schools database and bespoke analysis for the World Bank under the Global Program for Safer Schools (GPSS) risk study was used to determine spatial distribution of schools (both public and private). However, the complex nature of the building typologies and unknown damage statistics mean an estimate was not derived specifically for this sector at this point.

The team evaluated replacement cost as opposed to reconstruction cost of buildings in the affected region. Unit costs of construction appropriate for the area were derived from local information, but use was also made of media feeds on the costs of existing housing projects in the area, construction statistics, as well as on the costs proposed after the earthquake. Unit costs of construction for the replacement of destroyed, or the repair of damaged buildings (depending on the damage level), were thus obtained. To verify the economic exposure values, disaggregated macro-economic (capital stock) information was also used and corroborated with detailed estimates. Data (including county data) on capital investment was also used to differentiate capital stock building and non-building proportions. These exposure values were also checked against other independent data sources such as industry, EMME and CATDAT data. The exposure values can be seen in Table 5.

Table 5: Exposure per sector (including building contents) in the four worst affected governorates and the rest of Syria as a whole (bottom row) due to the February 6, 2023 earthquake sequence, in US$ millions.

Governorates	Total Residential	Total Non-Residential	Total Infrastructure	Total Value
Aleppo	22,964	20,288	12,613	**55,864**
Idleb	6,223	4,888	3,311	**14,422**
Hama	7,414	5,714	3,907	**17,035**
Lattakia	7,088	5,931	3,828	**16,847**
Other	59,967	49,785	32,392	**142,145**
Total	**103,656**	**86,606**	**56,051**	**246,314**

For validation of the direct damage estimates, comparison of past Post Disaster Needs Assessments (PDNAs) with similar characteristics and past risk studies were conducted. Several other cross-validation tasks were also performed to enhance corroboration of direct damage estimation.

The distribution of exposure in buildings, contents, and infrastructure is shown in Figure 3.

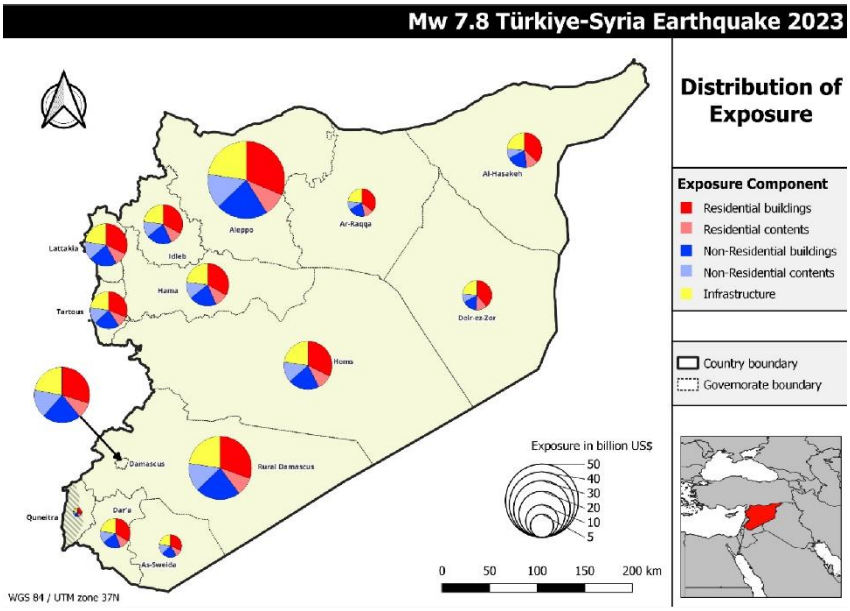

Figure 3: Map of the buildings and infrastructure exposure by governorate in absolute values (in US$ billions)

In summary, the GRADE assessment provides an estimation of the direct damage caused by the earthquake in Syria, through a remote-based methodology that utilized a mix of earthquake damage modelling, secondary hazard modelling with flooding, etc. and assessment of capital stock value of different assets and sectors. As part of this assessment, several tasks were undertaken to estimate the physical damages caused by the earthquake. These include:

a) Rapid collection and analysis of satellite imagery, damage data, government damage assessment reports, public sources such as newspaper articles from the government and rebel-held press offices, local newspapers, 13 situation reports of the ACU in northwest Syria, the Syrian Ministry of Health updates, Syrian Civil Defence, UNOCHA and World Health Organization (WHO) Situation Reports, United Nations Satellite Centre's (UNOSAT) Satellite Derived Damage Assessments and information from local NGO's. Further information is detailed in Annex A.
b) Recreation of earthquake ground motion through hazard modelling and close examination of the strong ground motion recordings, including directivity, across the affected region, in addition to intensity and damage data across Syria. The intensities were calibrated, and multiple maps created. In addition, the earthquake of February 20, 2023, was modelled and added to the damage analysis.
c) Development of a full buildings and infrastructure exposure database via capital stock and construction typology information for all 14 governorates; analysis of current unit costs of construction in Syria and projected to 2022.
d) Vulnerability and Fragility Modelling of Syrian Building and Infrastructure typologies.

5.0 Results – Economic Damage Estimates

The results show that the median estimate of total direct damage of the earthquakes on the residential, non-residential, and infrastructure sectors is US$5.1 billion Damage to residential buildings and contents accounts for nearly half or 48.5 percent of the total in the affected districts. Residential building and contents damage is estimated to be US$2.47 billion. This damage equates to approximately 2.5 percent of Syria's total exposure value of residential building stock (replacement cost of buildings and contents), which has been calculated to be a value of US$103 billion.

Damage to non-residential buildings and contents accounts for a third of total damages. Non-residential (commercial and public buildings) damages in earthquake-affected districts total **US$1.7 billion,** accounting for about 2 percent of the total exposed value of commercial and public buildings (estimated at US$87 billion). This includes private, public and commercial buildings, schools and other education facilities, hospitals and clinics/health centers, public administration, mosques, agricultural warehouses and industrial buildings or warehouses.

Damage to infrastructure accounts for nearly 18 percent of total damages. This includes transport infrastructure (e.g. roads, railways, bridges, etc.), critical power and water infrastructure (power plants, pipelines, power networks, transmission, water structures), and Information and Communications Technology (ICT) infrastructure (communications, cables, towers, TV, radio, etc.). Infrastructure damages total **US$912 million,** accounting for about 1.6 percent of the total exposed value of infrastructure estimated at US$56,050 million).

The governorates that were affected the most were **Aleppo (45 percent)** and **Idlib (37 percent**), which together endured just over 82 percent of the total damages. The governorates of **Lattakia (11 percent) and Hama (3 percent)** were moderately impacted by the earthquake, and to a lesser extent the governorates of **Homs (1.4 percent), Tartous (1.1 percent), Ar-Raqqa (0.6 percent) and Al-Hasakeh (0.17 percent).**

The earthquake impacted 38 districts and 174 sub-districts across Syria's 14 governorates. The governorates with the highest total damage were Aleppo (US$2.311 billion) and Idlib (US$1.894 billion). Governorates suffering total damages in excess of US$100 million include Lattakia (US$549 million) and Hama (US$167 million). Following the methodology described in Section 4, Table 6 and Table 7 show the breakdown of the best estimate of direct damages in Syria by sector and by governorate in absolute numbers (US$ millions), and relative to baseline capital stock exposure (percentage) respectively. Table 6 and Table 7 show the estimated direct damages for three sectors: residential (housing), non-residential buildings, and infrastructure. The damage estimates cover buildings and contents. The analysis does not evaluate the impact on loss in terms of economic flow (e.g., business interruption); it only assesses economic damage to capital stock.

Table 6: Direct physical economic damage by sector and governorate in absolute values (in US$ millions).

Governorates	Residential	Non-Residential	Infrastructure	Total		
				Median	Lower	Upper
Aleppo	1,108	790	413	**2,311**	**1,324**	**3,176**
Idleb	923	640	331	**1,894**	**1,062**	**3,082**
Lattakia	267	174	108	**549**	**176**	**947**
Hama	86	51	29	**167**	**84**	**272**
Homs	34	21	13	**69**	**14**	**144**
Tartous	26	18	10	**55**	**15**	**105**
Al-Hasakeh	5	2	1	**9**	**1**	**119**
Ar-Raqqa	17	8	5	**30**	**9**	**58**
Other	<1	<1	<1	**<1**	**<1**	**5**
Total	**2,466**	**1,705**	**912**	**5,083**	**2,685**	**7,903**

Table 7 shows the estimated direct physical economic damages expressed as percentage value relative to the baseline exposure of each of the three sectors in each of the governorates.

Table 7: Direct physical economic damage by sector and governorate in relative terms (in % of the exposure).

Governorate	Residential	Non-Residential	Infrastructure	Total
Aleppo	4.8%	3.9%	3.3%	**4.1%**
Idleb	14.8%	13.1%	10.0%	**13.1%**
Lattakia	3.8%	2.9%	2.8%	**3.3%**
Hama	1.2%	0.9%	0.7%	**1.0%**
Other	0.1%	0.1%	0.1%	**0.1%**
Total	**2.4%**	**2.0%**	**1.6%**	**2.1%**

The results in Table 7 show that damage ratios (i.e. physical economic damage as a percentage of capital stock) for the housing sector were high in Idlib, Aleppo and Lattakia governorates, at 14.8 percent, 4.8 percent and 3.8 percent of the baseline residential exposure in these two governorates respectively. The damage ratio for non-residential buildings was nearly as high as the residential sector, amounting to around 13.1 percent, 3.9 percent and 2.9 percent of the baseline non-residential exposure in Idlib, Aleppo and Lattakia governorates respectively. The estimated damages to infrastructure amounted to around 10 percent of the total infrastructure value in Idlib governorate, 3.3 percent of the total infrastructure value in Aleppo governorate and 2.8 percent for Lattakia governorate. It can also be seen that the damage ratios outside of these three governorates are less than around 1 percent for non-residential and infrastructure in Hama governorate, and slightly above 1 percent for the residential sector. The damage ratio in all other governorates outside of the four most affected ones are around 0.1 percent. The average damage ratio across all sectors and governorates is 2.1 percent.

Figure 4 and Figure 5 show the spatial breakdown of damages. The total damages per governorate are shown in Figure 4 and damages split by sector are shown in Figure 5.

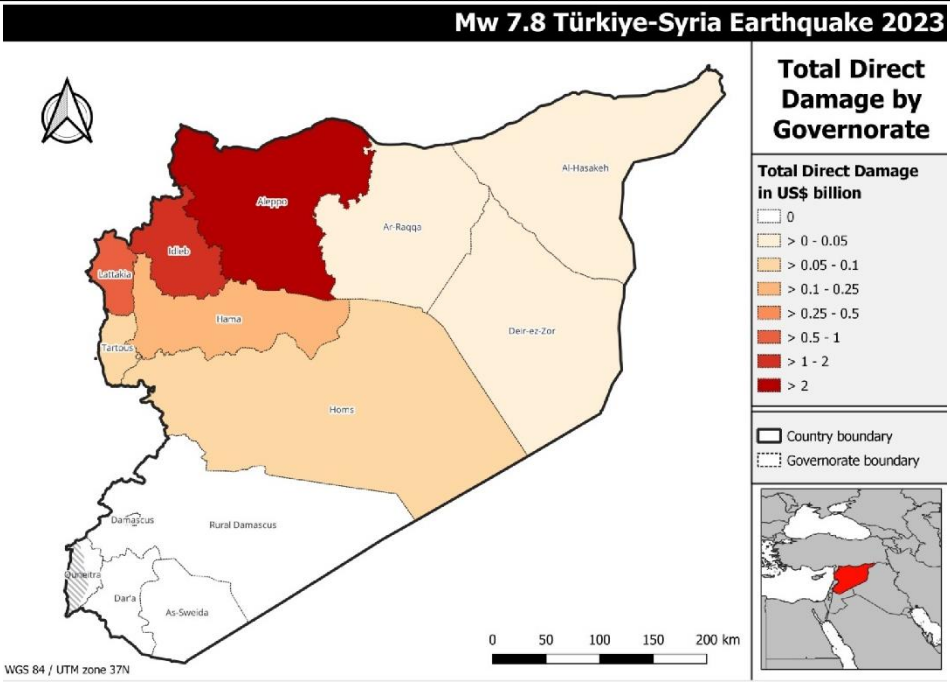

Figure 4: Spatial distribution of total damages at governorate level in Syria. It can be seen that, as expected, Aleppo and Idlib are hardest hit by the earthquake.

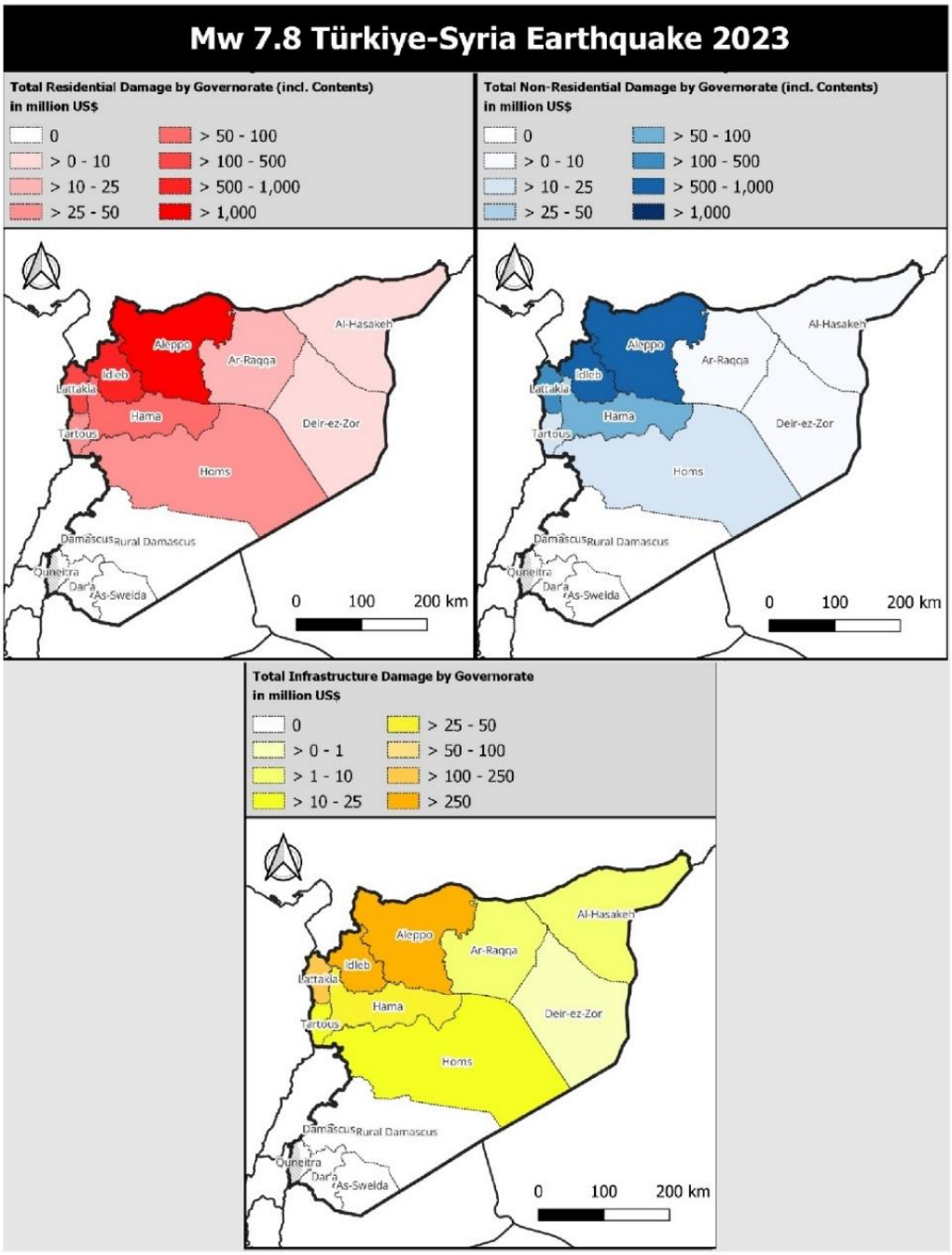

Figure 5: Spatial distribution of total damages at governorate level in Syria for each sector affected: Upper Left: Residential; Upper Right: Non-Residential; Lower Center: Infrastructure.

6.0 Conclusions

Following the M_w 7.8 Türkiye-Syria Earthquake on February 6, 2023, the World Bank carried out a remote, desk-based assessment of the physical damages using the Global RApid post-disaster Damage Estimation (GRADE) methodology[8] in Syria. The objective of the assessment is to develop a model-based estimate of the direct physical (economic) damages[9] to residential buildings (houses), non-residential buildings (e.g. education, health, commercial, industrial assets) and infrastructure (e.g. transport, power, water, telecommunications infrastructure) caused by the event, and to evaluate the spatial distribution of damages.

Key findings of the GRADE assessment:

- The February 6, 2023, M_W 7.8 Türkiye-Syria earthquake affected approximately ten million people in Syria with the strongest shaking and damage reported mainly in the **Aleppo, Idlib, Hama, and Lattakia Governorates**. Overall, this is the worst earthquake event in Syria since the M_W 7.4, 1822 Afrin earthquake.
- **The overall best estimate of direct physical damages to buildings (residential and non-residential) and infrastructure is US$5.1 billion (with a range from US$2.7 billion to US$7.9 billion given the inherent uncertainties)**.
- **Damage to the residential building stock of US$2.5 billion accounts for approximately half of the total damages (48.5 percent),** followed by US$1.7 billion (33.5 percent) to non-residential buildings (including commercial, industrial, and public buildings) and US$0.91 billion (18 percent) in infrastructure damages.
- The damage estimates to the residential and non-residential sector include direct damages to all buildings and structures including cultural heritage sites. However, it significantly underestimates the damage, as cultural heritage sites are classed as non-residential stone, masonry or other structures and the additional (priceless) value is not included that is associated with loss of cultural heritage such as damage to Aleppo's ancient citadel, classified as a world heritage monument by the United Nations Educational, Scientific and Cultural Organization (UNESCO); the Crusader-built fortress of Margat; the Grand Mosque in Kobani; and other cultural heritage sites with immeasurable cultural and historical significance. The financial value of cultural heritage is complex and challenging to quantify, as the value of cultural heritage cannot be determined by market forces alone.

[8] Global RApid post-disaster Damage Estimation (GRADE) approach developed at the World Bank and conducted by the Global Practice for Urban, Disaster Risk Management, Resilience and Land (GPURL) Disaster-Resilience Analytics & Solutions (D-RAS) Knowledge Silo Breaker (KSB). The methodology aims to address specific damage information needs in the first few weeks after a major disaster Seehttps://www.gfdrr.org/sites/default/files/publication/DRAS_web_04172018.pdf for details of the methodology.

[9] Using capital replacement costs which is the actual cost to replace an asset at its pre-damage condition. This may not be the "market value" of the asset, and is typically distinguished from the "actual cash value" payment which includes a deduction for depreciation etc.

- **The median estimated damage from the earthquakes is approximately 58 percent of the lower-limit damages (US$8.7 billion) caused by the war to 14 cities (as defined in Annex B.2) until end of 2021.** Actual estimated damage by the World Bank was between US$8.7 – US$11.4 billion.
- **The governorates with the highest total damage were Aleppo and Idlib.** Aleppo governorate (4.11 million estimated population, mid-2021) contains numerous cities, including Syria's most populous metropolis, Aleppo, which has significant residential and non-residential capital stock. Because of the stronger shaking in Idlib governorate (1.17 million estimated population, mid-2021), the damage ratio in Idlib governorate (13.1 percent) is three times larger than Aleppo (4.1 percent); however, the absolute damage value in Idlib governorate (US$1.9 billion) is only 82 percent that of Aleppo governorate (US$2.3 billion) due to a much lower capital stock.
- Significant non-residential damage is also present with many health and education facilities damaged.
- The earthquake also further damaged an already weakened infrastructure that included 12 high water tanks as well as impacting the transportation and electricity networks as of February 17, 2023. Overall, the direct infrastructure damage from the earthquake in Syria was **US$912 million,** accounting for about 18 percent of the total direct damage of the earthquake.

The following additional conclusions are drawn relating to reported earthquake impacts:

- **As of February 19, more than 1,796 buildings in opposition-controlled areas of Syria had been completely destroyed, with another 8,093 partially destroyed (ACU).** 41,000 buildings in the government-held area either have significant damage, minor damage or require checks. More than 1,000 buildings in Al-Tloul and in the surrounding villages have been flooded as a result of a dam rupture in the Idlib governorate.
- Pre-existing large-scale humanitarian needs, structural damage to many buildings and infrastructures prior to the earthquake, logistical and access constraints to certain areas, harsh winter conditions, an ongoing cholera outbreak, and flooding of settlements due to dam failure in the Idlib governorate are all influencing and exacerbating the severity of humanitarian needs following this event. Prior to the earthquake, it was estimated that 15.3 million Syrians (67 percent of the national population) would require humanitarian assistance in 2023 (UNHCR, 2023, Feb 16), an all-time high for the country, which is entering its 12th year of conflict.
- The mainshock on February 6, and subsequent earthquakes in northern Syria, affected populations that had already been substantially impacted by the ongoing armed conflict since March 2011, which was accompanied by human rights violations, security and protection threats, and a lack of access to secure livelihoods, food, and water.
- In order to avoid selective reconstruction blueprints, exacerbating pre-existing tensions or igniting new ones, it is crucial that any efforts on Syria's post-disaster recovery should take into consideration the intersection between conflict and fragility dynamics and disaster response and recovery.
- The GRADE assessment of economic damages provides an initial diagnosis of the widespread impact of the earthquake in terms of direct damage to the residential, non-residential and infrastructure assets; however, more detailed studies will have to be carried out in the coming weeks to determine the true scale of impact and needs, including priorities for providing housing and shelter to the over half million targeted population in Syria in need of immediate assistance. It is expected that an RDNA will follow this analysis.

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8.0 Datasets Used

Hazard Data:

- Local Station Data (AFAD TADAS database)
- TDTH portal for hazard data
- Social media sourced data on intensities
- CATDAT (historical info)
- NEC Syria (necsyria.sy)
- KOERI USGS, EMSC, CATNews, EarthquakeReport data on intensities, and evaluation of Shakemap results
- COPERNICUS, Maxar, UNOSAT satellite analysis
- Fault Rupture data from Sentinel-2, Sentinel-1, InSAR.
- Bogaziçi University Reports v1-v5

Exposure Data:

- Basis of Daniell (2014) and Dabbeek et al. (2020) adjusted with updated unit costs of construction and capital estimates.
- IRAP Master Plans and Earthquake Scenarios including infrastructure and non-residential datasets close to Syria
- Statistical datasets in Syria including Provincial GDP, and checks against CATDAT data, Investment Data
- OSM and HOTOSM additions across Syria for infrastructure and reanalysis
- GlobalML Footprints for all footprints across Syria
- GHS BUILT Products
- EMME models for building stock
- Capital Stock Modelling (Daniell, 2014; GAR; IMF WEO; World Bank)
- Subnational Crime Database (Brand et al., 2021)
- Official Building/Construction Costs data via news reports and project data
- GPSS Schools study, Planopolis, Ministry data, Health statistics
- UN OCHA administrative zones

Vulnerability and Damage Data:

- Historical event data (DaLA, PDNA, CATDAT)
- SANA.sy reports as well as data from White Helmets.
- Global Seismic Code Index and Building Practice Factor
- Empirical vulnerability functions, semi-analytical fragility functions, Syrian risk studies
- Social media and ground photo analysis and loss adjusting
- Situation Reports (Reliefweb, ACU etc.)
- Daily Ground Briefs

- MoEUCC Damage Survey (Hasar Tespit) checking data in the border region of Syria
- VOSOCC, Humanitarian Response Data

Annex A: Additional Damage Statistics

A.1 Additional information on casualties and injuries in Syria

Impact on casualties and injuries in Syria were also considered as part of the assessment. However, there are discrepancies as published numbers are of the ACU reporting only part of the fatalities outside of government-held areas. While some of the higher estimates include double counting of fatalities, according to ACU in some of the earlier reports, the reported numbers still likely underrepresent the true scale of needs which will become clearer as further assessments are concluded. As can be seen in Table 8, the highest number of casualties was recorded in the Harim and Afrin districts, which also had the highest number of damaged or partially damaged health facilities. These are just for the ACU portion.

Table 8: Number of casualties, injuries and number of partially damaged health facilities (HF) in the northwest Syria part excluding the government held areas (WHO, 2023, Feb 19). Data Source: ACU and Health Cluster Partners, Data updated Feb 19, 2023.

District	Casualties	Injuries	Number of HFs partially damaged
Harim	2,507	5,687	14
Afrin	1,107	1,010	12
Jisr-Ash-Shugur	242	343	3
Jebel Saman	235	370	3
Ariha	211	284	1
A'zaz	62	288	8
Idlib	61	228	7
Al Bab	12	142	3
Jarablus	10	30	1

A.2 Additional information on post-earthquake IDP arrivals in Syria

Sixty-eight percent of 265 communities assessed in Greater Idlib and Norther Aleppo reported that the main community of origin for new IDPs was outside of their sub-districts. Across the 251 communities assessed in the earthquake-affected areas, 69 percent were hosted for free by friends and families; 13 percent resided in functioning tents and 1 percent in makeshift shelters; 4 percent stayed in vehicles; 2 percent resided in unfinished or damaged buildings; 6 percent in collective centers outside of education or health facilities; 4 percent inside educational facilities and 1 percent inside health facilities. Table 5 shows the sub-districts with the highest number of post-earthquake IDP household arrivals, as reported by Key Informants (KIs) who were able to estimate the number of IDP household (HH) arrivals in the communities assessed by REACH. These can be seen in Table 9.

Table 9: Estimated post-earthquake IDP household (HH) arrivals to assessed communities (as reported by KIs who were able to estimate the number of IDP HH arrivals; 579 communities) Source: REACH, Feb 15, 2023.

Sub-district	**Number of IDP HH arrivals**	**Coverage of communities in sub-district (by % assessed)**
Darkosh	1,400	78%
Salqin	1,400	94%
Maaret Tamsrin	1,300	94%
Afrin	1,300	71%
Raju	1,300	55%
Idlib	1,300	91%
Jandairis	1,300	89%
Al Bab	1,200	65%
Dana	600	91%

Annex B: Pre-earthquake Fragility and Impacts on Response

B.1 Conflict and fragility dynamics in Syria

The mainshock on February 6, as well as subsequent aftershocks in northern Syria, impacted populations that had already been significantly impacted by the ongoing armed conflict since March 2011, which was accompanied by human rights violations, security and protection threats, and a lack of access to secure livelihoods, food, and water. This, combined with a deep socioeconomic crisis and severely deteriorating living conditions, as well as being governed by opposing factions and subject to international sanctions and embargoes since April 2011, will result in a protracted crisis context.

Overall, the consequences of the earthquake response and recovery efforts in Syria are deeply interconnected with a number of pre-existing social, economic, geopolitical and logistical challenges leading to further hardship on the affected population. The following is a brief discussion of the pre-existing conflict and fragility dynamics in Syria, and how these can exacerbate the direct impact, both in the immediate aftermath of the earthquake and long-term recovery and reconstruction efforts. In order to avoid selective reconstruction blueprints, aggravating pre-existing tensions or igniting new ones, it is crucial that any efforts on Syria's post-disaster recovery should take into consideration the intersection between conflict and fragility dynamics and disaster response and recovery.

- **Informal Settlement Crisis:** The earthquakes have also exacerbated the camp and informal settlement crisis in northwestern Syria, with over 5.3 million people in need of shelter assistance, according to the UNHCR (2023, Feb 10). Over 2.8 million Syrians in the earthquake-affected region are internally displaced, with 1.7 million living in IDP camps (Brookings, 2023, Feb 8). Overcrowded, informal, and unmanaged IDP sites are particularly vulnerable to disasters, including flood, extended drought and winter storms. Such risks, if left unaddressed, may further increase the compounded risk for disaster-related conflicts (including hazards exacerbated by climate variability and change) and displacements.

- **Political Fragmentation:** The earthquake-affected northern border area between Syria and Türkiye is a politically fragmented territory: a) the Lattakia governorate and parts of Aleppo are under government control; b) the last remaining rebel factions are located in and around Idlib, primarily controlled by Hay'at Tahrir al-Sham (HTS), a former Al-Qaeda affiliate designated terrorist organization by the United States; c) pro-Turkish armed groups manage areas around Afrin and Al-Bab; and d) Kurdish forces hold an enclave between Aleppo and Afrin (HIIC, 2021).

- **Security Issues:** In Syria, security issues linked to the ongoing armed conflict and presence of terrorist groups, lack of accessibility to regions under rebel control, but also restrictions from the Syrian government, are hindering opportunities for any form of medium or long-term recovery and reconstruction support.

- **War-Damaged Buildings and Infrastructure**: Buildings in northern Syria had been extensively damaged by years of bombardment before the earthquake, and survivors of building collapses are being forced to city streets and already overcrowded IDP camps in harsh weather conditions.

- **Economic Crisis**: The conflict and COVID-19 have led to widespread poverty and deep economic crisis. The conflict has also led to high levels of inflation, making basic goods and services unaffordable for many people. Amidst a record increase in prices of more than 800 percent in the last two years alone, 90 percent of the population now lives below the poverty line (Euro-Med Monitor, 2022, Oct 18). The humanitarian situation's deterioration affects all Syrian governorates.

- **Food Insecurity**: In 2022, 12.4 million Syrians—half the population—were food insecure, and 1.3 million were severely food insecure (Euro-Med Monitor, 2022, Oct 18). This can be attributed to a combination of factors, including conflict-related disruption of agriculture and food supply chains, Ukraine war and reduction of wheat imports, reduced access to income and livelihoods, and increase in food prices. Food prices almost doubled in 2022 (WFP, 2023). Only 25 percent of the humanitarian response plan for Syria has received funding at a time when poverty and food insecurity are at record highs.

- **Unemployment and Loss of Livelihoods**: The conflict has caused significant job losses, with many businesses closing due to the conflict. This has led to high levels of unemployment and created a sense of despair and frustration, particularly among young people. (From the beginning of 2022 through August, more than 150 suicide cases were recorded in areas controlled by the Syrian government and the armed opposition).

- **Access to Basic Services**: Access to water, electricity, heating, sanitation, healthcare, and education are all under severe strain, and people's access to emergency healthcare is limited due to hospital overcrowding. Only 59 percent of hospitals, 57 percent of primary health care facilities and 63 percent of specialized centers were fully functional before the earthquake. In addition, lack of fuel, as well as heavy machinery and equipment, are major issues impeding efforts to reach those in greatest need as quickly as possible. Many hospitals and schools have been damaged or destroyed in the conflict, and many people lack access to safe drinking water and sanitation (UNOCHA, 2023, Feb 14).

- **Vulnerable Populations:** 85 percent of households were unable to meet their basic needs, with a disproportionate impact on populations with vulnerabilities compounded by age, gender, and/or disability. The conflict has also resulted in an increase in gender-based violence, such as sexual violence, forced marriage, and domestic violence. Women and girls are especially vulnerable to these forms of violence, particularly in conflict and displacement zones.

In addition to the conflict-induced drivers and social and economic vulnerabilities mentioned above, harsh weather conditions and a cholera outbreak in the earthquake-affected region of northern Syria will exacerbate the event's effects.

- **Weather Conditions:** Adverse weather conditions, including freezing temperatures, heavy snowstorms and rainfall over regions severely impacted by the earthquake, are exacerbating the situation for survivors, making it more difficult for refugees and IDPs living in tents, as well as those who have been displaced from their homes due to damage and safety concerns.

- **Cholera Outbreak:** In 2021, Syria experienced its worst water crisis in 70 years. The lack of safe water and the destruction of water infrastructure created a breeding ground for the cholera outbreak that was declared in September 2022. Eighty-four thousand, six hundred and seven (84,607) suspected cases and 101 deaths of cholera have been reported in Syria since August 2022 (WHO, 2022, Feb 5). Within the earthquake-affected areas, 16,877 suspected cases were reported in Aleppo, 21,033 cases in Idlib, 149 cases in Hama, 184 cases in Lattakia and 28 cases in Tartous. Forty-five (45) deaths in Aleppo, 14 deaths in Idlib, and one death in Idlib have been attributed to cholera.

B.2 Building damage from conflict (2014-2022)

Buildings and infrastructure in northwestern Syria were already weakened by years of bombardment during the 12-year civil war, with many structures unable to withstand the earthquake and dozens of aftershocks. The World Bank conducted a remote-based damage assessment of 14 selected cities: Afrin, Aleppo, Dar'a, Daraya, Deir-ez-Zor, Al Hasakah, Homs, Idlib, Manbij, Palmyra, Ar-Raqqa, Rastan, Tell Abiad, and Zabadani—from 2014 to 2022 (World Bank, 2022). The damage assessment shows how the crisis affected the population and infrastructure in the cities and regions impacted by the earthquake. Comparing the scenarios provides unique insights that can be applied to analyses and estimations in different cities with similar dynamics. All damage estimates shown here are based on the higher range of preliminary damage estimates from the study period. The loss values are backward-looking because they use pre-crisis unit replacement costs to replace key infrastructure.

The 2022 Syria damage assessment finds that, as of January 2022, total damage across the assessed cities and sectors was estimated at US$8.7 – US$11.4 billion. Of the total damage estimate, 68 percent of damage or US$5.80 – US$7.8 billion was attributed to the physical infrastructure sectors, 30 percent or US$2.7 – US$3.3 billion to damage in the social sectors, and 2 percent or US$175 – US$278 million to cross-cutting sectors. The functionality of agri-food value chains was the most distorted by the conflict. Syria's wholesale vegetable markets have been damaged, with 82 percent of markets assessed as either partially damaged or totally destroyed in the conflict. While the operational status of assets varies across sectors and cities, the enabling conditions play a significant role in the functionality of sectors. For example, although a large part of the physical infrastructure was undamaged in the WASH sector, 51 percent of assets suffered from reduced functionality, including 11 percent totally not functioning, which is a significant problem for the most affected cities.

B.3 Internal displacement

- Over 2.8 million Syrians in the affected region are internally displaced, with 1.7 million living in IDP camps (Brookings, 2023, Feb 8). In government-controlled areas, over 3 million people are internally displaced, and 8.2 million vulnerable people need life-saving aid. The security situation in the south remains volatile, with a risk of escalation. Over 650,000 people are displaced in the northeast, of which 135,000 are in camps and rely on aid (ECHO, 2022).

Table 10: IDPs in Syria by Governorate (Source: UNHCR, UNOCHA 31 May 2022)

Location name	Ratio of IDP	Population
Idlib	28.1%	1,899,293
Aleppo	18.8%	1,267,862
Rural Damascus	16.2%	1,097,352
Damascus	8.9%	600,097
Lattakia	6.6%	447,947
Al-Hasakeh	4.5%	305,648
Homs	4.4%	299,525
Hama	3.2%	214,036
Tartous	2.7%	180,735
Deir-ez-Zor	2.3%	153,814
Ar-Raqqa	2.1%	144,787
As-Sweida	1.1%	70,931
Dar'a	1.0%	68,792
Quneitra	0.1%	3,418

Annex C: Sources of Uncertainty in the Syrian Model

There are a number of uncertainties (due to physical, economic, structural, and social variables) related to the GRADE estimation for earthquake damage within Syria:

- **There is significant uncertainty around the shaking and damage distributions.** When damage is properly reported, we can limit the uncertainty in estimated damages for those areas. Uncertainty is especially high in Lattakia due to a lack of reported information on the intensity distribution and number of damaged buildings (there are only partial surveys from UNOSAT, and partial surveys done by the government). Although the ACU data is useful, it does not provide many details about the number of building units affected. From satellite imagery and photographs, we see the same trend as seen in damage data in Türkiye: a high number of mid-high-rise collapses, resulting in significant damage to housing units.

- **There are large uncertainties in Syria for the cost of a building.** There is a wide range of values in the literature for the value of specific types of mid-rise concrete frame or wall buildings. Labor and material costs will vary depending on what materials are available; furthermore, exchange rates can be much lower for any materials. The price of concrete in Syria has been very volatile and has increased significantly in recent years (not just to compensate for the exchange rate), because production cannot meet all demand (See footnote # 4).

- **We have significant uncertainties in the unit costs of construction**. It is true that we expect costs to be somewhere in the order of 80 percent that of Türkiye for each of the different typologies. However capital stock on a per capita basis in Syria is 34% that of Türkiye due to a significantly higher proportion of buildings with lower unit cost of construction (UCC) values, such as unreinforced masonry. Although the Syria UCCs are only a little lower than Türkiye, the total building stock is far lower, because it is a poorer mix of building typologies (no high-code buildings, all pre-code and low code, which means less simply capital stock sitting in those lower UCCs).

- **The costs of the residential building stock (including contents) can be compared to some existing literature values.** In our study, we calculated a value of US$104 billion for the residential building stock including contents. There are a few models available which can be used to compare to this: GEM (2018) = US$136 billion; and GEM (2023) = US$185 billion.

- **Contents damage is included in the assessment for residential and non-residential building types; however, there is little data in Syria on contents value.** Therefore, neighboring country surveys and other data make up the contents value; and thus contribute to the $1 billion damage in contents.

- **A major underestimation is the cultural heritage damage associated with the event.** Our estimates to the residential and non-residential sector include direct damages to all buildings and structures, including cultural heritage sites. However, this significantly underestimates the damage, as cultural heritage sites are classed as non-residential stone, masonry or other structures, and so they do not include additional (priceless) value associated with loss of cultural

heritage. Such sites include damage to Aleppo's ancient citadel, classified as a world heritage monument by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Crusader-built fortress of Margat, the Grand Mosque in Kobani and other cultural heritage sites with immeasurable cultural and historical significance. The financial value of cultural heritage is complex and challenging to quantify, as the value of cultural heritage cannot be determined by market forces alone.