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JRC TECHNICAL REPORT

M7.8 and M7.5 Earthquakes in Türkiye and Syria

Update of the EC-JRC Scientific Analysis – Report #5 as of 17 February 2023 at 14:00 UTC

GDACS RED ALERT
M7.8 in Türkiye on 06 Feb 2023 01:17 UTC – 04:17 local time

GDACS ORANGE ALERT
M7.5 in Türkiye 06 Feb 2023 10:24 UTC – 13:24 local time

De Groeve T., Santini M., Necmioglu O., Abad Perez J., Proietti C., Caravaggi I., Ceccato P., de Girolamo L., Dimova S., Duta A-M., Gkoktsi K., Joubert-Boitat I., Kamberaj J., Kotseva B., Linge J., Lorini V., Mari Rivero I., Mastronunzio M., Minora U., Rosales Sanchez C., Salvitti V., Spagnolo L., Spruyt P., Tarchi D.

2023

Joint Research Centre

EUR XXXXX XX

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Contents

Abstract

This the fifth JRC emergency report on the ongoing earthquake crisis in Türkiye and Syria, which started 06 Feb 2023 at 01:17 UTC – 04:17 local time (previous reports published on 06, 07, 08 and 10 February, respectively). Please note that this report is complementary to the previous ones, i.e., it does not necessarily include information already shared, but only new information. Previous reports are available here.

This update provides additional information related to seismic analysis, based on the recorded events and measured displacements. In addition, it also focuses on the earthquake impact on built environment (buildings, critical infrastructure) and the status/outcomes of the satellite mapping activations for both Countries.

From the ongoing social media monitoring and analyses, elements about observed signals of population displacement changes, mis/disinformation (limited distribution within the Union Civil Protection Mechanism only) and health-related news are also shared.

Finally, methodologies and preliminary data for a possible scientific support to Rapid Assessment for early rehabilitation and reconstruction are also outlined.

Acknowledgements

The authors wish to thank the many colleagues who contributed to this report in record time and the European Space Agency (ESA) for providing deformation maps and interferograms of the affected areas.

Authors

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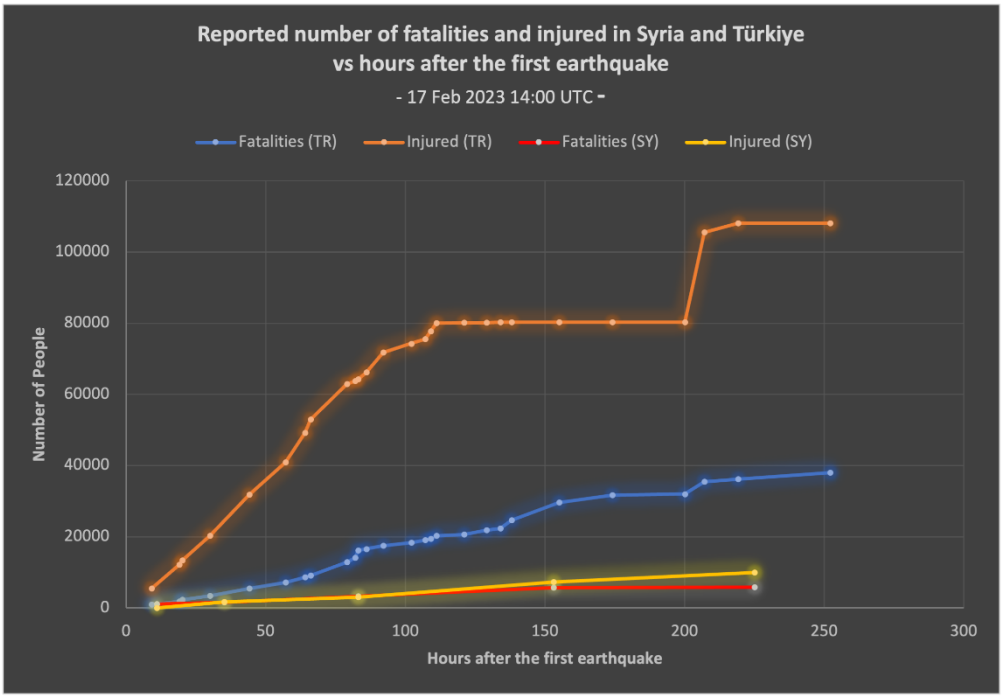
Executive summary

- Following the main shocks, as of 16 February 2023, 17:30 UTC, 4 965 aftershocks occurred along both fault systems, with 368 aftershocks of M>4. The possibility of aftershocks with M>6 cannot be excluded.
- The Disaster and Emergency Management Presidency of Türkiye (AFAD) reported that, as of 16 February at 20:30 UTC, **38 044 fatalities** across 11 Provinces (Kahramanmaras, Gaziantep, Sanliurfa, Diyarbakir, Adana, Adiyaman, Osmaniye, Hatay, Kilis, Malatya, and Elazig) in southern Türkiye. In the previous report of 16 February at 06:00 UTC, AFAD reported also 108 068 injured people across the aforementioned Provinces and **216 347 evacuated people** to other Provinces. Additionally, in a previous press conference of 07 February, AFAD reported **6 444 confirmed collapsed buildings** and **11 302 buildings reported as collapsed.**
- The republic of Türkiye requested international support soon after the first earthquake. A **three-month State of Emergency** (please refer to Annex I for further details) **has been declared in Kahramanmaraş, Kilis, Diyarbakır, Adana, Osmaniye, Gaziantep, Şanlıurfa, Adıyaman, Malatya and Hatay, a total of 10 provinces**. On 15 February 2023, a spokesman of the ruling part AKP announced that Elazığ will also be included among the earthquake impacted region as the 11th province ([1]). By the time of the release of this report, there was no presidential decree yet on this in Türkiye.
- On 6 February the UCPM was activated by Türkiye and the Emergency Response Coordination Centre (ERCC) is coordinating the mobilization. Updated details on this are provided in the Joint ECHO/ERCC – JRC Analytical Briefs and ECHO Civil Protection Messages.
- The Turkish Reinsurance and Catastrophe Insurance Pool (DASK) announced that more than 30,000 damage reports have been received so far. DASK also declared that they have the ability of approximately **EUR 1 billion direct and EUR 6 billion indirect payment capability through reinsurance protection**. On 14 February, Turkish Enterprise and Business Confederation (TURKONFED) announced that 72 663 fatalities and USD 84.1 billion damage expected in Türkiye by the earthquakes.A waste management specialist in Türkiye estimated the amount of debris at 230 million tons, which requires around 11 million truck trips.
- In Syria, more than **5 800 people died and 14 500 sustained injuries.**
- On 08 February, **the Syrian government requested assistance through the EU civil protection mechanism** for search and rescue teams and equipment, shelter items and medicines. An additional request arrived on 09 February from the World Food Programme (WFP) for search and rescue equipment, shelter and non-food items, medical equipment and medicines.
- In areas controlled by the government of Syria, more than 300 buildings have collapsed. As of 15 February, the rapid structural assessment undertaken in Aleppo classified 169 buildings as 'high risk of collapse' and 644 as 'medium risk of collapse.' In north-west Syria more than 8 900 buildings have been completely or partially destroyed leaving at least 11 00 people homeless.
- A cursory check of the pre-disaster situation in built-up environment in Syria shows that most small settlements fall inside the "informal settlement" typology and therefore presenting a number of structural vulnerability factors that exacerbate earthquake damage.
- Many buildings in Syria have been also exposed to impacts from the conflict, reducing their ability to withstand the shock of an earthquake, which may be the decisive factor.
- While several cultural sites including the Old Citadel in Aleppo have seen significant damage, UNOSAT remote sensing analysis published on 13 February showed no visible damage to the Citadel of the Crusaders in Tartous.

[1] https://t24.com.tr/haber/elazig-da-afet-bolgesi-ilan-edildi,1092565

- A scientific discussion on the overall crustal stress change resulting from both earthquakes is provided in this report, together with information about possible earthquake-related floods both in Türkiye and in Syria.
- Since 06 February both satellite mapping systems, Copernicus EMS Rapid Mapping AND International Charter for Space and Major Disasters, were activated over complementary areas of interest in the two Countries. Since then, several products have been made available, with preliminary damage assessment information and light loss assessment. All links to available products and a summary of the relevant outcomes are provided in this report.
- Copernicus Risk and Recovery Mapping has been activated to simulate a potential dam break of the Maydanki (Afrin) Dam. The results of this activation are considered sensitive and will not be publicly available.
- JRC developed an artificial intelligence deep learning model (SMDRM – Social Media for Disaster Risk Management) for the automated multilingual classification of messages and images from social media. For this disaster, the SMDRM Platform processed more than 1 million user-generated messages. An effort to identify messages requesting for help has been done: those including specific location information were filtered out, georeferenced and quickly shared to support search and rescue operations.
- In this report we updated our analysis of mis/disinformation about the ongoing event, extracting and summarizing the main narratives from unverified sources (i.e. sources that have been indicated by fact-checkers as often spreading mis/disinformation). This analysis is for limited distribution within the Union Civil Protection Mechanism only.
- The JRC continues to monitor the situation with a specific filter defined in the Epidemic Intelligence from Open Sources (EIOS) system. At the time of writing, no information is available related to new or worsened outbreaks of cholera in the affected areas, besides the known epidemic situation in Syria, pre-existing to the earthquake emergency.
- This report provides some proposals to approach in the area of quantification of damaged buildings and rubble detection.

Figure 1. Number of fatalities and injured in Syria and Türkiye vs hours after the first earthquake as of 17 February 2023 08:00 UTC (sources: media and AFAD bulletins for Türkiye, media and ECHO Daily Flash for Syria: the figures reflect the latest situation as at 17 February at 09:00 UTC.



1 Earthquake impact

1.1 Seismic analysis and assessment

A series of earthquakes started on 06 February 2023 with a strong earthquake of M7.8 (M7.7 as reported by Disaster and Emergency Management Presidency of Türkiye-AFAD) at a depth of 18 km occurred at 1:17 UTC (4:17 local time) in southern Türkiye (epicentral coordinates: 37.174°N 37.032°E), close to the border with northern Syria. The epicenter was located in Atalar town (Gaziantep Province, Southeastern Anatolia Region), and about 45 km north of the northern border of Aleppo Governorate in Syria.

A second event with a M7.5 and 10 km depth occurred at 10:24 UTC at a distance of about 100 km from the first event (epicentral coordinates: 38.024°N 37.203°E), likely worsening the impact and the ongoing Search & Rescue operations.

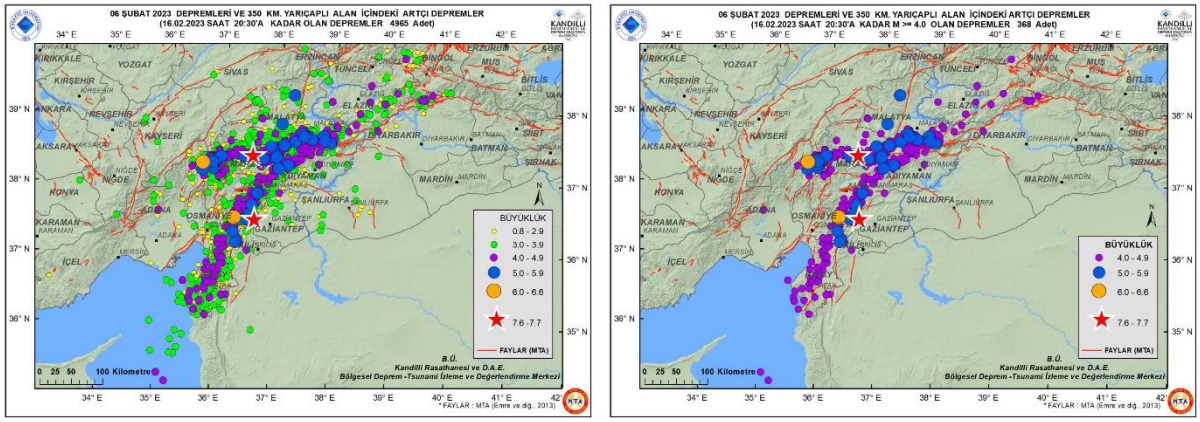
Figure 2. Surface ruptures in Türkiye generated from the 1st earthquake with M7.8 and 2nd earthquake with M7.5. (top-left) Kahramanmaraş-Şekeroba (top-left 2 and top-centre 3), Hatay (top-right 4), Kahramanmaraş-Tevekkeli (bottom-left 5), Kahramanmaraş-Türkoğlu (bottom-centre 6) and along Sürgü-Çardak fault (second earthquake) (bottom-right 7).

Following the main shocks, as of 16 February 2023, 17:30 UTC, 4 965 aftershocks occurred along both fault systems, with 368 aftershocks of M>4. The possibility of aftershocks with M>6 cannot be excluded.

During a press conference on 15 February, the Director of AFAD's Earthquake and Risk Reduction section stated that “according to the observations obtained so far in the earth's crust as a result of these two earthquakes, we know that a surface rupture over 400 km has occurred... This earthquake is the biggest earthquake that Anatolia has experienced in the past 2 000 years." ([8])

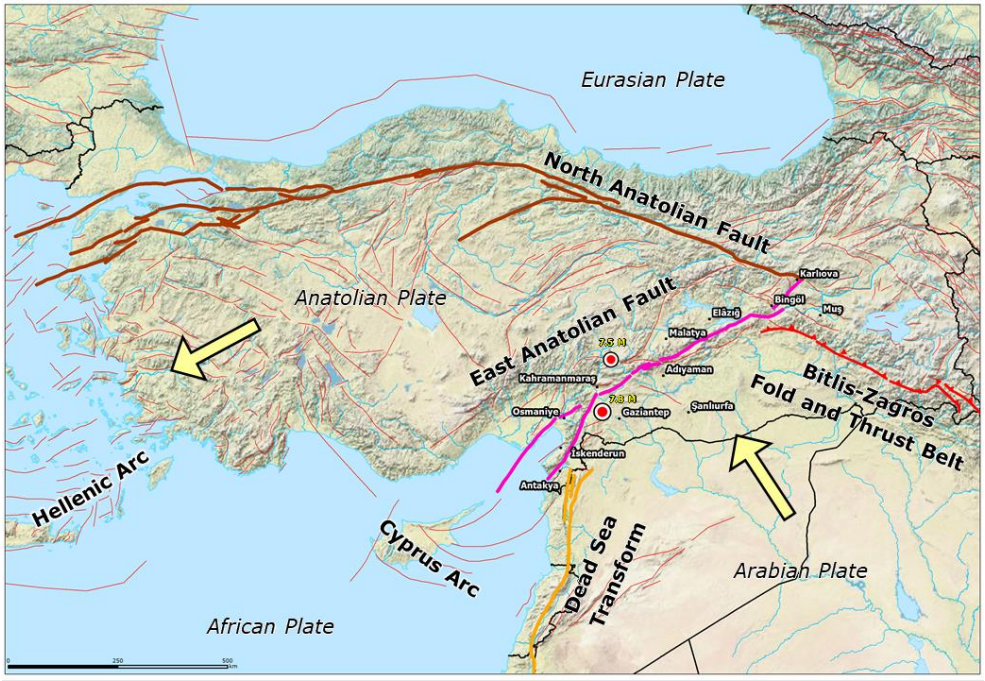
[2] https://twitter.com/CengizZabci/status/1623236454926229504/photo/1
[3] https://twitter.com/akyuz24/status/1623455630676860928/photo/1
[4] https://twitter.com/onediocom/status/1624075046430842881/photo/1
[5] https://www.hurriyet.com.tr/gundem/depremin-buyuklugunu-gozler-onune-seren-goruntu-kahramanmarastaki-fay-kirigi-goruntulendi-kilometrelerce-uzaniyor-42217908
[6] https://twitter.com/CengizZabci/status/1623236487687929857/photo/1
[7] https://twitter.com/tsancar/status/1623698495730339840/photo/1
[8] https://t24.com.tr/haber/afad-bu-deprem-anadolu-cografyasinin-son-2-bin-yilda-yasadigi-en-buyuk-deprem,1092505

Figure 3. Main shock and aftershocks (left-all aftershocks, right aftershocks with M>4) of 06 February 2023 earthquakes in Türkiye as of 16 February 2023 17:30 UTC (source: KOERI).



The earthquakes in Türkiye on 06 February 2023 occurred on the East Anatolian Fault (EAF), which is a major transform type tectonic boundary between the Anatolian Plate and the northward-moving Arabian Plate accommodated mainly by strike-slip faults, starting from the Maras Triple Junction (MTJ) at the northern end of the Dead Sea Transform (DST) and ending at the Karlıova Triple Junction (KTJ) where it meets the North Anatolian Fault (NAF) (Figure below). Aftershocks of the first earthquake with M7.8 extended also into the northern section of the DSF to the southern parts of Antakya region. While M>7 earthquakes on the EAF are extremely rare, both NAF and DSF experienced catastrophic events with M>7 in their past, such as 1939 M7.7 Erzincan, 1943 M7.6 Ladik-Tosya, 1999 M7.6 Izmit on the NAFZ and 525-528 M7 and 1872 M7.3 earthquakes in Antakya, 1202 M7.6 in Damascus.

Figure 4. Main tectonic structures of Anatolia and Middle East. North Anatolian Fault (NAF), East Anatolian Fault (EAF), Dead Sea Transform (DST), Bitlis-Zagros Fold and Thrust Belt (BZFTB), together with the two main earthquakes and the administrative regions along the DAF and EAF in Türkiye.



The 1st earthquake with M7.8 is composed of two ruptures with approximately 230 km rupture on the EAF and approximately 60 km rupture on its southern branch that runs parallel to DSF (Figure 4 – left).

Figure 5. (left) USGS finite fault model for the 1st earthquake with M7.8 (9). (right) Instrumental intensity as recorded by the KOERI and AFAD networks in Türkiye (10).

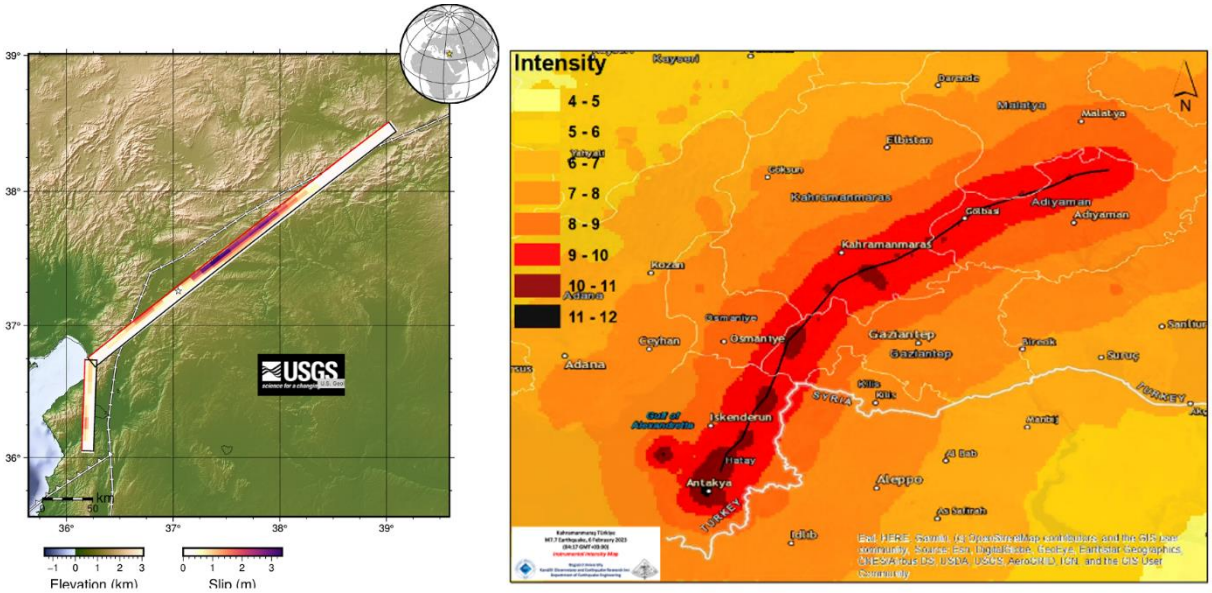
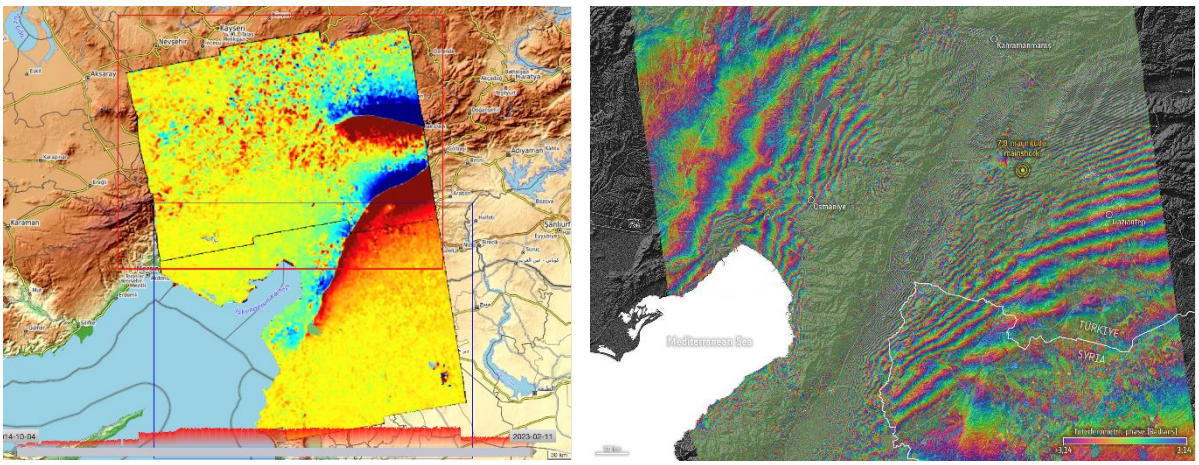


Figure 6. (left) InSAR analysis by the German Aeronautics and Space Research Centre (DLR). (right) Interferogram showing the co-seismic surface displacement in the area near Gaziantep, generated from multiple Copernicus Sentinel-1 scans – before and after the earthquakes (modified Copernicus Sentinel data (2023), processed by ESA, CC BY-SA 3.0 IGO.



Figures above (left) represents the range shift measured using Sentinel-1 acquisitions from 09 February and 28 January. The image was processed using the InSAR processing service integrated by the German Aeronautics and Space Research Centre (DLR) on the Geohazard Exploitation Platform (GEP). The range shift is an estimate of the terrain deformation using the radar signal correlation between the two images called pixel offset tracking.

Figure above (right) is an interferogram showing the co-seismic surface displacement in the area near Gaziantep, generated from multiple Copernicus Sentinel-1 scans – before and after the earthquakes.

[9] https://earthquake.usgs.gov/earthquakes/eventpage/us6000jllz/finite-fault

[10] Hancılar, U., Şeşetyan, K., Çaktı, E., Yenihayat, N., Süleyman, H., Açıkgöz, N., Dede, Ş., Acar, Ş. (2023) Kahramanmaraş - Gaziantep Türkiye M7.7 Earthquake, 6 February 2023 (04:17 GMT+03:00) Strong Ground Motion and Building Damage Estimations Preliminary Report (v6), Boğaziçi University - Kandilli Observatory and Earthquake Research Institute - Department of Earthquake Engineering

By combining data from the Copernicus Sentinel-1 mission, acquired before and after the earthquake, changes on the ground that occurred between the two acquisition dates lead to the colourful interference patterns in the images, known as an 'interferogram', enabling scientists to quantify the ground movement (contains modified Copernicus Sentinel data (2023), processed by ESA, CC BY-SA 3.0 IGO (communication from Maria Pilar Milagro Perez – ESA).

Figure 7. Results (as of 13 February 2023 12:00 UTC) of ground deformation estimated with sub-pixel image correlation applied to several Sentinel-2 tiles.

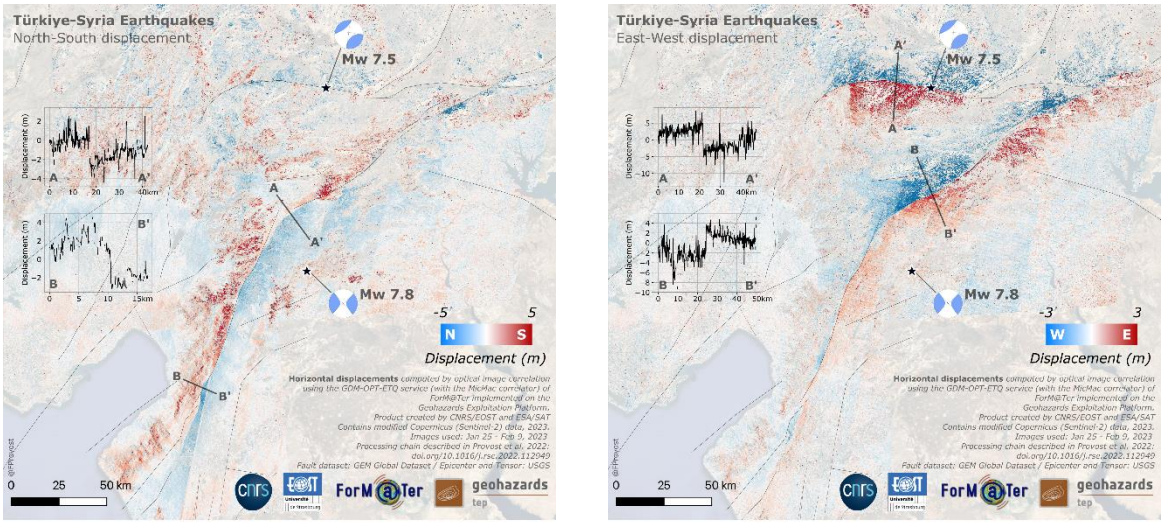
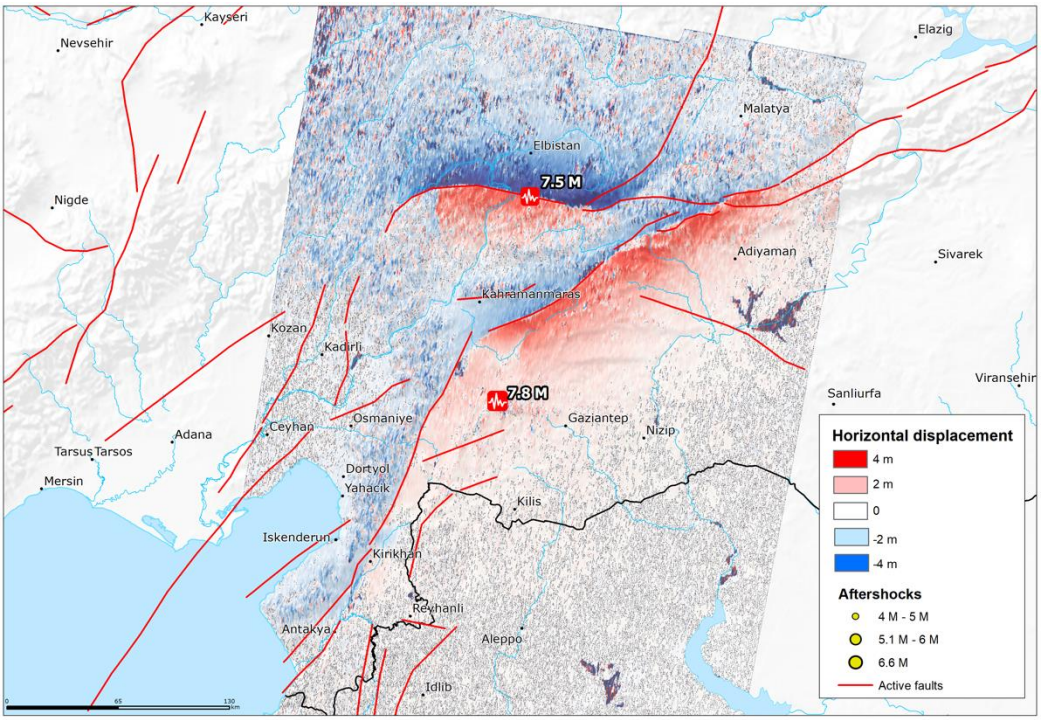


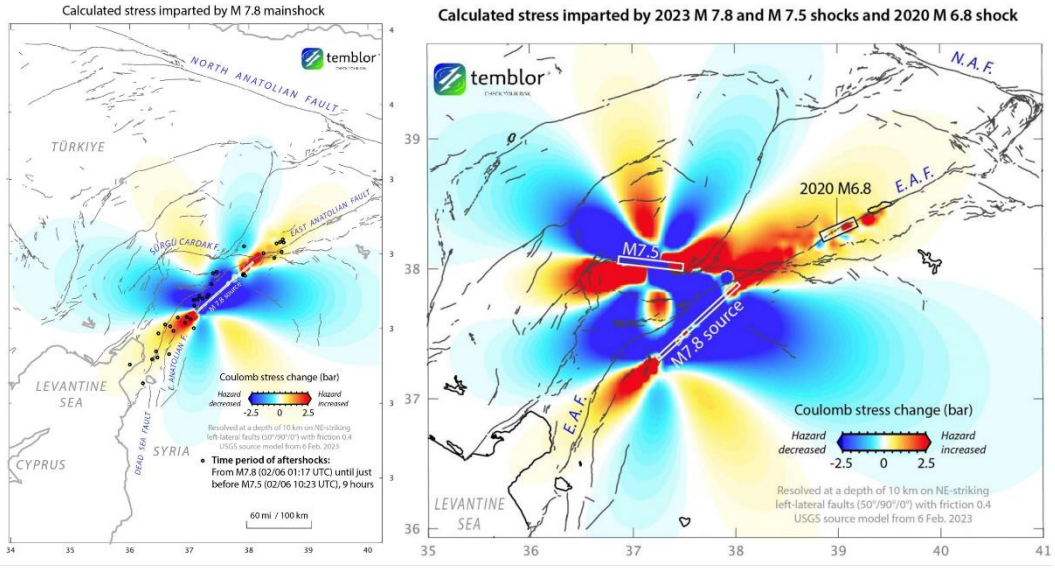
Figure 7 shows the latest results (as of 13 February 2023 12:00 UTC) of ground deformation estimated with sub-pixel image correlation applied to several Sentinel-2 tiles. The processing has been carried out with the ForM@Ter GDM-OPT-ETQ service implemented by CNRS/EOST. A massive calculation was performed on the Geohazards Exploitation Platform / GEP. Cross-sections indicate offsets of nearly 3 m in the E-W component, and 5 m in the N-S component (Communication by Floriane Provost and Jean-Philippe Malet).

Figure 8. Map produced by the JRC showing the ground displacement caused by the two earthquakes. The red gradient colours describe the movement of the land towards the satellite while the blue colours represent the movement away from the satellite since it last flew over the area.



The horizontal displacement in Figure above has been processed and created by the Advanced Rapid Imaging and Analysis (ARIA) team at NASA's Jet Propulsion Laboratory and California Institute of Technology. The interferogram (available at this link), has been produced from synthetic aperture radar (SAR) images from the Copernicus Sentinel-1 satellites, operated by the European Space Agency (ESA). It derives from the interferometric difference between the post-event image acquired on 10 February 2023, with a pre-event image acquired on 29 January 2023. The interferogram provides information on the rupture length and variations in the amount of slip along the faults, which helps to estimate the slip at depth and the change in stress on nearby faults, providing information on the areas where aftershocks are more likely. This map also helped to confirm assumptions from initial seismic readings that the earthquakes originated from ruptures in both the East Anatolian Fault and the Dead Sea Fault systems. The rupture of these two faults may have greatly increased the area impacted by these earthquakes. (*Jacob Reed and Gabriella Lewis, NASA Disasters*).

Figure 9. (left) Coulomb stress calculations for the main segment of the 1st earthquake. (right) Overall stress change resulting from both earthquakes (11).



Coulomb stress calculations show that the 2nd earthquake with M7.5 is triggered by the stress change resulted from the main segment of the 1st earthquake with M7.8 on the East Anatolian Fault (Figure 5 – left) ([5]). The same calculations also indicate a stress change on the DSF component of the total rupture zone (Hatay region), which provides a plausible explanation on the activation of this segment during the 1st earthquake. Overall stress change resulting from both earthquakes (Figure 5 – right) show stress loading in the north-eastern section of the EAF between Malatya and Bingöl, where in 2020 an earthquake with M6.7 occurred ([12]). Some prominent experts argue that the region between Bingöl and Karlıova is a source of "concern" for possible "future" earthquakes ([13]), without making any reference to its possible magnitude or occurrence time. A relatively lower level of aftershock activity in this section (Figure 1) of the EAF further contributes to this concern. Similar concerns are expressed by some scientist for the north-eastern section of the Cyprus Arc offshore İskenderun/Syria ([14]).

It is worth noting that less than 3 months after the M7.6 Izmit earthquake in Türkiye in 1999 with more than 18 000 fatalities ([15]), an earthquake in the same fault system in Düzce with M7.2 ([16]) caused around 1000 fatalities. Several scientific studies argued that the M7.2 Duzce earthquake was triggered because of the stress change resulted by the M7.6 Izmit earthquake ([17,18]).

1.2 Impact on buildings

Situation in Türkiye

In a press conference of 07 February, AFAD reported 6 444 confirmed collapsed buildings and 11 302 buildings reported as collapsed in Türkiye.

Turkish Reinsurance and Catastrophe Insurance Pool (DASK) announced that more than 30 000 damage reports have been received so far. DASK also declared that they have the ability of

[11] https://temblor.net/earthquake-insights/stress-calculation-clues-aftershocks-turkey-earthquakes-2023-14952/
[12] https://earthquake.usgs.gov/earthquakes/eventpage/us60007ewc/executive
[13] https://tr.euronews.com/2023/02/09/prof-naci-gorur-iki-fay-enerjisini-bosaltti-endise-ettigimiz-yer-bingol-ile-karliova-arasi
[14] https://twitter.com/Paleosismolog/status/1626317482561503233/photo/1
[15] https://en.wikipedia.org/wiki/1999_%C4%B0zmit_earthquake
[16] https://en.wikipedia.org/wiki/1999_D%C3%BCzce_earthquake
[17] https://www.sciencedirect.com/science/article/abs/pii/S1251805001016767
[18] https://academic.oup.com/gji/article/153/1/229/621117

approximately EUR 1 billion direct and EUR 6 billion indirect payment capability through reinsurance protection ([19]).

On 14 February, the Turkish Enterprise and Business Confederation (TURKONFED)([20]) announced that 72 663 fatalities and USD 84.1 billion damage were expected in Türkiye due to the earthquakes ([21]).

On 14 February, media reported ([22]) the number of buildings to be demolished urgently/heavily damaged/collapsed in Türkiye as follows: Adiyaman 5 000; Diyarbakir: 434; Gaziantep: 10 777; Hatay: 8 268; Kahramanmaraş: 8 633; Malatya: 5 578; Osmaniye: 1 739; Sanliurfa: 338.

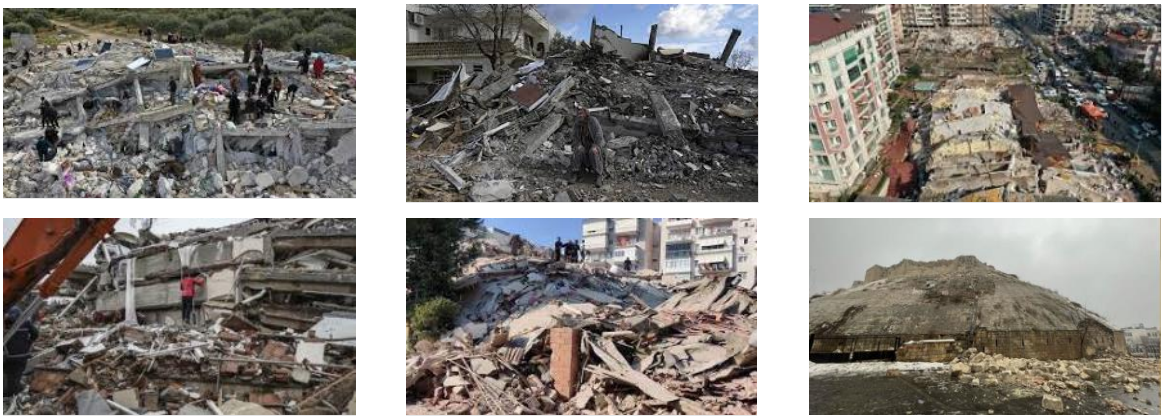
During a press conference on 15 February, the Minister of Interior of Türkiye announced that half of the buildings in Antakya (Türkiye) are either collapsed or heavily damaged or classified as to be demolished ([23]).
The Ministry of Environment, Urbanization and Climate Change of Türkiye ([24]) carried out damage assessments in 2 196 088 independent units, in 481 865 buildings in the earthquake affected regions. As at 16 February 2023 the resulted were the following:

- immediate demolition required: 263 800 individual units in 61 722 buildings
- moderately damaged: 86 673 individual units in 13 917 buildings
- slightly damaged: 749 654 individual units in 121 515 buildings with minor damage
- undamaged: 915 723 individual units in 229 023 buildings.

A waste management specialist in Türkiye estimated the amount of debris at 230 million tons, which requires around 11 million truck trips ([25]).

The Gaziantep castle was heavily damaged. Turkish media report as well extended damages to other religious and cultural heritage properties.

Figure 10. Images from the structural impact of the earthquakes in Türkiye on 6 February 2023.



Situation in Syria

In government of Syria controlled areas, more than 300 buildings have collapsed. As of 15 February, the rapid structural assessment undertaken in Aleppo classified 169 buildings as 'high risk of collapse' and 644 as 'medium risk of collapse.' In north-west Syria more than 8 900 buildings have been completely or partially destroyed leaving at least 11 000 people homeless.

[19] https://t24.com.tr/haber/dask-genel-muduru-eren-30-bini-askin-hasar-ihbari-isleme-alindi,1091217
[20] https://turkonfed.org/en
[21] https://www.cumhuriyet.com.tr/turkiye/turkonfedden-carpici-rapor-kahramanmaras-depremleri-72-bin-663-can-kaybina-neden-olacak-2051241?utm_medium=ilgili%20Haberler&utm_source=Haber%20Detay&utm_campaign=ilgili%20Haberler
[22] https://t24.com.tr/haber/kahramanmaras-merkezli-depremlerden-etkilenen-ilcelerdeki-ilk-hasar-tespit-verileri-aciklandi,1092283
[23] https://www.cumhuriyet.com.tr/turkiye/soyludan-deprem-aciklamasi-delil-toplamadan-enkaz-kaldirilmiyor-2051989?utm_medium=Slider%20Haber&utm_source=Cumhuriyet%20Anasayfa&utm_campaign=Slider%20Haber
[24] https://www.csb.gov.tr/hasar-tespit-calismasi-kapsaminda-263-bin-800-bagimsiz-birimin-acil-yikilmasi-gereken-agir-hasarli-ve-yikik-oldugu-tespit-edildi-bakanlik-faaliyetleri-38431
[25] https://www.hurriyet.com.tr/gundem/enkazin-agirligi-erciyes-dagini-asti-230-milyon-ton-tasinacak-42219974

A cursory check of the pre-disaster situation shows that most small settlements fall inside the "informal settlement" typology, having been built without professional input, let alone earthquake-resistant design, and presenting a number of structural vulnerability factors that exacerbate earthquake damage, such as irregular shapes (likely to generate weak points that would accelerate collapse) and clustering of several buildings with different floor heights (making buildings pound into each, delivering shocks that structures are not prepared to receive).

Even in the urban areas with formal settlements, code-uptake is expected to be low, even if the code foresees designing for a PGA of 0.4 m/s2, which is below what was experienced.

Finally, many of these buildings have been exposed to impacts from the conflict, reducing their ability to withstand the shock of an earthquake, which may be the decisive factor.

While several cultural sites including the Old Citadel in Aleppo have seen significant damage, UNOSAT remote sensing analysis published on 13 February showed no visible damage to the Citadel of the Crusaders in Tartous.

1.3 Impact on critical infrastructures

1.3.1 Situation of the dams

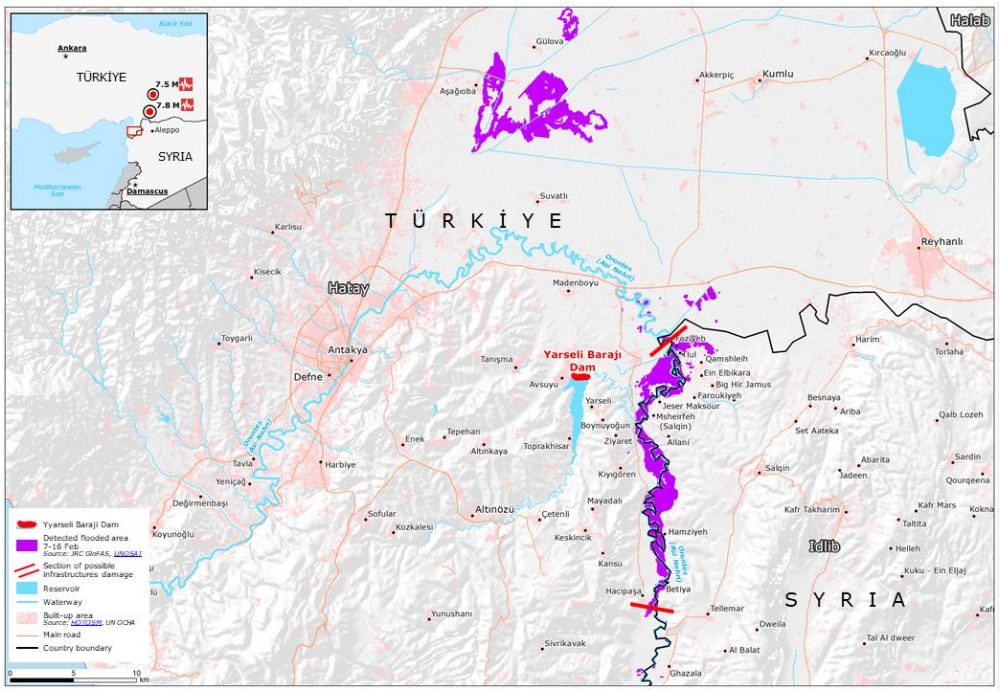
Additional information about possible earthquake-related floods both in Türkiye and in Syria are emerging from the affected areas. Details regarding the previously reported possible earthquake-affected dams (Sultansuyu Dam in Türkiye and Maydanki-Afrin Dam in Syria) are in the previous JRC Technical Report of 10 February.

Regarding the Yarseli Dam (located in southern Türkiye near the border with Syria, very close to the Avsuyu village, eastern Hatay Province), UN OCHA reports as of 12 February (source: https://reliefweb.int/report/syrian-arab-republic/north-west-syria-situation-report-11-february-2023-enar), that the water level of the Orontes/Asi River has reportedly risen and submerged a number of houses in the aftermath of the earthquakes of 06 February. The dam generates a tributary of the mentioned Orontes/Asi River.

The flooding occurred on both side of the border area between the Hatay Province (southern Türkiye) and Idlib Governorate (north-west Syria). In this latter, due to the presence of more settlements along the river valley, the floods led to population displacements (around 7 000 people) from several villages, in particular: Al-Talul, Dergoush, Al-Jameiyah, Hardana, Delbiya, Jakara, and Hamziyeh. The flooding affected approximately 1 000 houses across the aforementioned villages.

Figure 11. Image of the flooded area in the along Al-Taloul village, along the Orontes/Asi River, in Syria. (source:@HussamHamoud)

Figure 12. Map produced by the JRC with the location of the Yarseli Dam in Türkiye and detected flooded areas in Syria and Türkiye.



This map illustrates satellite-detected flooded area from the JRC GloFAS Global Flood Monitoring (GFM) over the period 07-16 February and from UNOSAT-UNITAR on 09 February on 13 February[26]. Currently, no clear hypotheses can be formulated regarding a collapse of the Yarseli Dam. The floods may have been likely triggered by the controlled opening of the dam for the water discharge through the tributary that flows from the dam to the Orontes/Asi River and the damage also induced to certain water infrastructures along this river by the shaking due to the earthquakes and the large number of aftershocks.

[26] https://data.humdata.org/dataset/flood-impact-analysis-along-the-orontes-river-al-assi-syrian-turkyie-boarder-as-of-9-febru

This is a preliminary analysis and has not yet been validated in the field.

1.3.1.1 CEMS Risk and Recovery mapping activation for the dam breach

Copernicus Risk and Recovery Mapping has been activated to simulate a potential dam break of the Maydanki (Afrin) Dam. Severe damages in form of significant cracks have been reported for this dam, that is located in northwest Syria, 12 km north of the town of Afrin, and 70 km from the city of Aleppo.

The results of this activation are considered sensitive and will not be publicly available.

2 Overview of satellite mapping activations

2.1 Outcomes of satellite activations

2.1.1 Copernicus EMS Rapid Mapping activation in Türkiye (EMSR648)

The European Commission's Copernicus emergency satellite mapping system was activated by the ERCC on 06 February at 04:43 UTC to support damage assessment (less than 4 hours after the M7.8. earthquake). The JRC Copernicus Mapping Team is providing technical support to the activity. All information and maps related to this activation are available here:

https://emergency.copernicus.eu/mapping/list-of-components/EMSR648

Optical satellite images of very high resolution (less than 1 meter) were acquired on 07, 08 and 09 February over 20 areas of interest (AOIs) located near the epicentres of the earthquakes. These areas, with a total area of 664 km^2, are home to an estimated population of 4 279 646 people.

Due to cloud coverage, it was necessary to order numerous satellite images in order to cover all areas. As of 09 February, 100% of the area covered by the 20 AOIs have been analysed (32% on 08 February). In total 64 maps (in 37 products) were published showing a total of 1 161 building blocks, 3 361 buildings and 84 km of roads as possibly damaged, damaged or destroyed. In addition, 644 temporary or spontaneous camps and 46 ha for larger camps were identified on the satellite images.

Figure 15. Results of the damage assessments as performed by the Copernicus EMS Rapid Mapping team in the context of the EMSR648 activation. Situation as of 12 February at 10:00 CET.

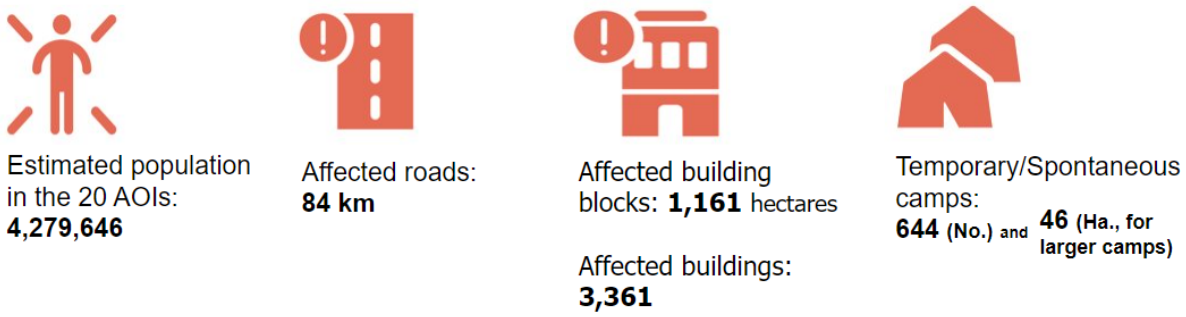
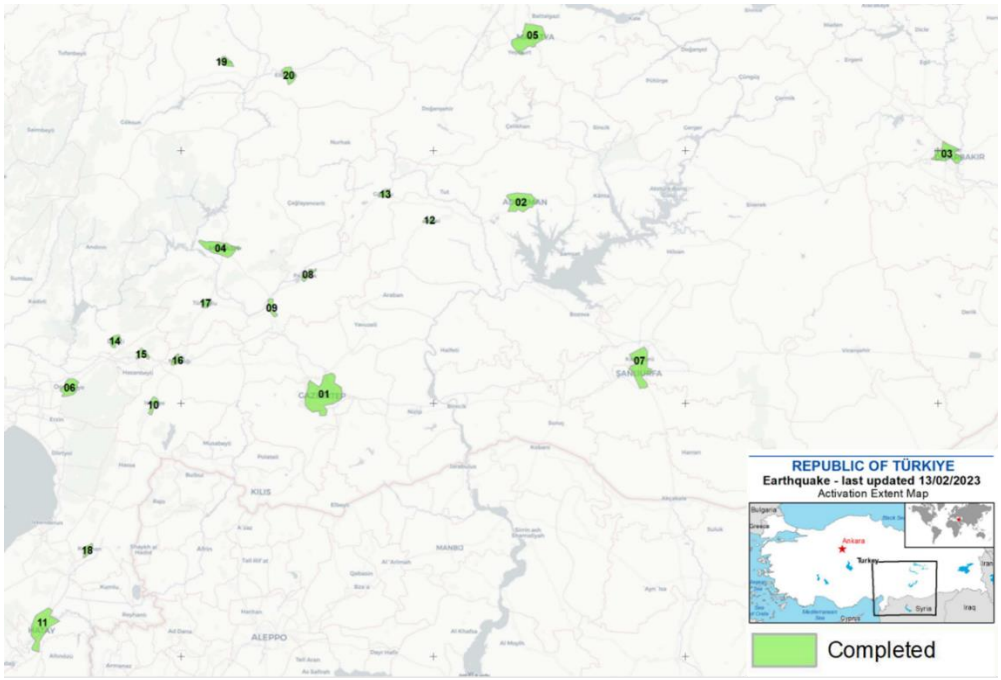


Figure 16. Activation Extent Map: overview of the areas of interest and map production for EMSR648. Latest update here.



All the results of the damage assessments can be visualised on the Activation Viewer. The latest activation report presenting also satellite images is available for download on the activation webpage.

No other assessment is planned to be conducted over these areas. However, the activation remains open in case analysis over new areas or consolidations of previous assessments are requested.

Figure 17. Detailed list of the areas of interest, production status and results for EMSR648.

									Temporary/Spontaneous camps *	
AOI n.	AOI name	Area (km²)	Estimated population **	Production status	Affected roads (km) *			Affected building blocks	No.	Ha (for larger
1	Gaziantep	126	1,191,034	Completed	0	72	118			
2	Adiyaman	62	209,256	Completed	12	83	27	6.6		
3	Diyarbakir	52	562,481	Completed	-	64	14			
4	Kahramanmaras	56	384,404	Completed	21	927	4			
5	Malatya	87	423,295	Completed	6	229			10.3	
6	Osmaniye	34	231,122	Completed	9	116	115			
7	Sanliurfa	60	501,655	Completed	-	3				
8	Pazarcik	7	25,477	Completed	-	79	6			
9	Cumhuriyet	12	16,653	Completed	0	8				
10	Islahiye	7	16,036	Completed	15	33	24		4.9	
11	Antiochia	85	385,430	Completed	14	502	93		12.1	
12	Erdemoglu	6	12,077	Completed	-	166	3			
13	Golbasi	6	31,431	Completed	1	172	161			
14	Duzici	10	33,556	Completed	0	5	2		0.2	
15	Bahce	4	12,467	Completed	-	2			0.8	
16	Nurdagi	4	12,258	Completed	2	64	44		11.1	
17	Turkoglu	4	36,094	Completed	-	60				
18	Kirikhan	12	63,537	Completed	1	1,593	22			
19	Afsin	13	33,725	Completed	0	56				
20	Elbistan	18	97,658	Completed	2	289	11			
TOTAL		**664**	**4,279,646**		**84**	**4,522**	**644**		**46**	

* Source: Copernicus activation EMSR648. Sum of assets identified as Destroyed, Damaged and Possibly damaged

** The population density grids that were used to estimate the potentially affected population is based on the Turkish census 2011 and has been adjusted based on the 2019 version of the World Population Prospect (WPP2019).

2.1.2 Copernicus EMS Rapid Mapping activation in Syria

On 15 February, the ERCC activated the European Commission's Copernicus emergency satellite mapping system, following a request from the United Nations Development Programme. The aim is to carry damage assessments based on archive and new imagery, as new aftershocks are reported in affected areas, furthering the destruction of buildings and critical infrastructure (especially water and electricity infrastructure). The analysis is being carried out on 10 areas covering almost 1 000km^2

This activation is sensitive and not publicly available.

2.1.3 International Charter for Space and Major Disasters, and UNOSAT activations in Türkiye and Syria

On 06 February (date of the M7.8 earthquake), the International Charter for Space and Major Disasters was activated in Türkiye (activation 797), as well as in Syria (activation 798). Since then, several assessments have been conducted.

Based on Pleiades very high-resolution satellite image acquired on 07 February 2023, UNOSAT produced a preliminary damage assessment over the town of Latakia in Syria (available here). From the report, damaged and potentially damaged buildings in some sectors of the city like Raml al Janoubi and Dam Sarkho neighbourhoods located south and north of the city respectively. Some potentially damaged buildings were also identified in the sector of Tishreen University Hospital.

Based on Worldview-3 Very high-resolution satellite image acquired on 07 February 2023, a map (available here) illustrates potentially damaged structures/buildings in Zayzafun (Aykadah) village, A'zaz District in Aleppo Governorate. In Lilawa Village, Jarablus District, Aleppo Governorate, 30 damaged structures and 68 potentially damaged structures were identified (see map here).

Additional products have been created based on satellite images over Jisr al-Shughur City (Idlib Governorate) (see map here); Al Bab in Aleppo Governorate (see map here); Afrin district (Aleppo governorate) (see map here); Salqin (Idlib governorate) (see map here); and additional ones are regularly updated through https://unosat.org/products/.

UNOSAT also released a product developed by the Wuhan University in collaboration with the United Nations Satellite Centre (UNOSAT) related to light loss assessment following the Marash / Antep earthquake using Night-time Light imagery (06 February 2023, M7.8) using SDGSAT-1; Yangwang-1 and VIIRS satellite data. The report, downloadable from the URL below, shows significant observed light loss in Hatay, Kahramanmaras and Adiyaman provinces in Türkiye (https://unosat.org/products/3495).

Furthermore, the GIS centre of Médecins Sans Frontières (MSF) has released a damage analysis in Al Atarib (Aleppo Governorate) which can be downloaded from this URL: https://disasterscharter.org/image/journal/article.jpg?img_id=18768677&t=1676556763408.

UNOSAT is continuously updating its web map dedicated to this event which is available from this URL:
https://experience.arcgis.com/experience/af8529245dbb4041ba532fab46ee02d2/page/UNOSAT/?views=Home.

3 Media analysis

3.1 Monitoring of impacts detected from social media

The Social media for Disaster Risk Management (SMDRM) platform has been triggered by GDACS system for 2 data collections. The main one refers to the event with GLIDE: EQ-2023-000015-TUR.

This section shows how social media users, specifically on the Twitter platform, discussed about the event and how descriptions of impacts on people/infrastructures/services are witnessed or described over time in different administrative areas affecting the event. The JRC developed an artificial intelligence deep learning model for the automated multilingual classification of messages from social media in terms of impacts with the scope of supporting humanitarian aid. In a few hours, using an automated processing pipeline for filtering impact-related tweets, the SMDRM (Social Media for Disaster Risk Management) platform aggregates and presents relevant information and meaningful message and images that can help depict the situation among population. Information with statements from authoritative sources is favoured.

Since the activation, the SMDRM Platform processed more than 1 million user-generated messages for the event in Türkiye. A second data collection has been launched on the February the 8th for locations in Syria. The analysis and geo-location of impacts is still on-going for the 30K more messages collected.

The decrease of messages about impacts and immediate response that can be seen in the following pictures is the expression of a shift of topic related to the event. After a few days the conversation moved from immediate rescue and response needs to messages of support and empathy.

Figure 21. Number of tweets mentioning the event processed in near real time by the SMDRM platform for locations in Türkiye.

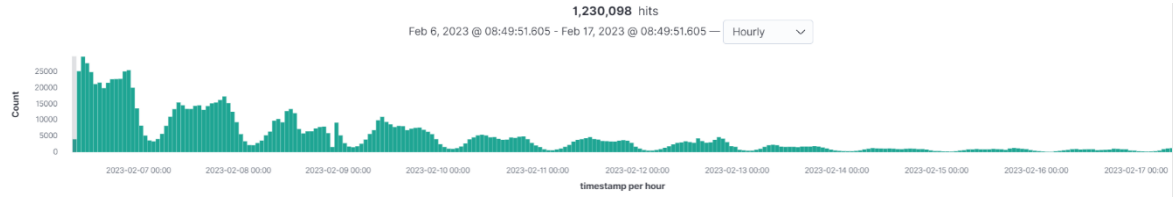


Figure 22. Number of tweets mentioning the event processed in near real time by the SMDRM platform for locations in Syria.

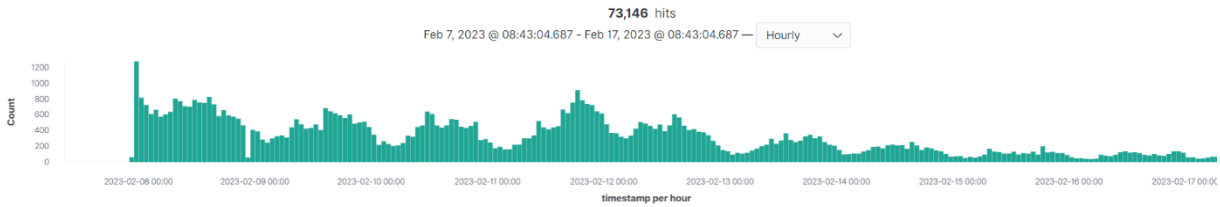
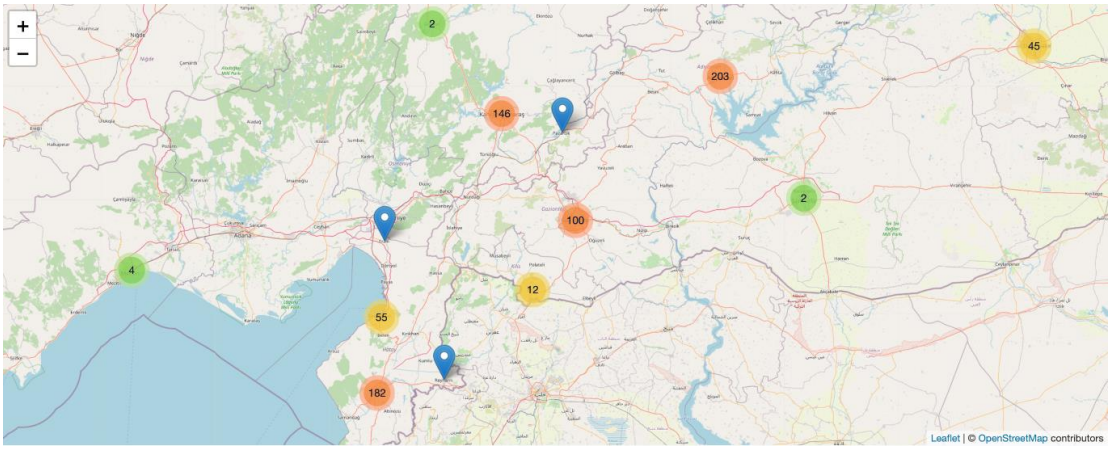


Figure 23. Türkiye - Detailed image of non-duplicated georeferenced posts relevant to impacts aggregated by administrative regions within the proximity of the epicenter.



.**Figure 24.** Syria - Detailed image of non-duplicated georeferenced posts relevant to impacts aggregated by administrative regions within the proximity of the epicentre.

An additional attempt was made to collect information about damages to buildings. The figures below show relevant messages about impacts on buildings selected by the SM4DRM platform.

Figure 25. Examples of relevant messages.

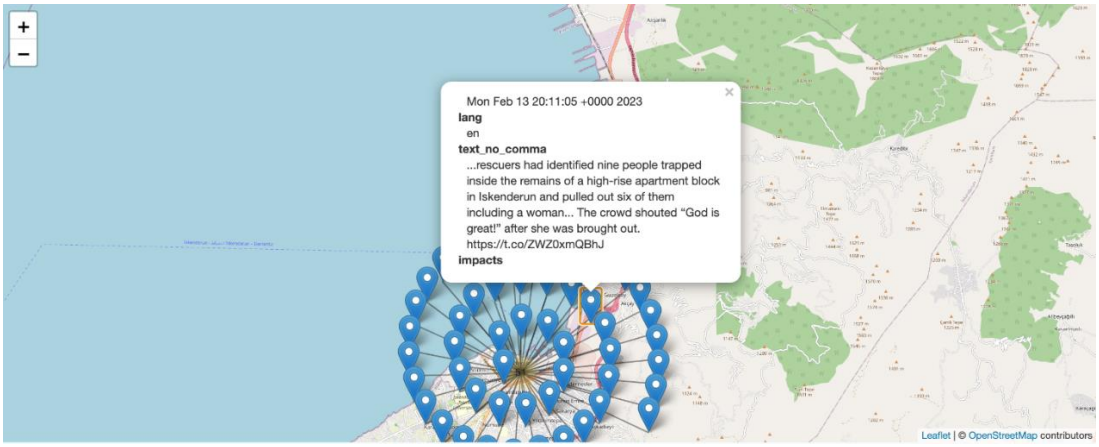
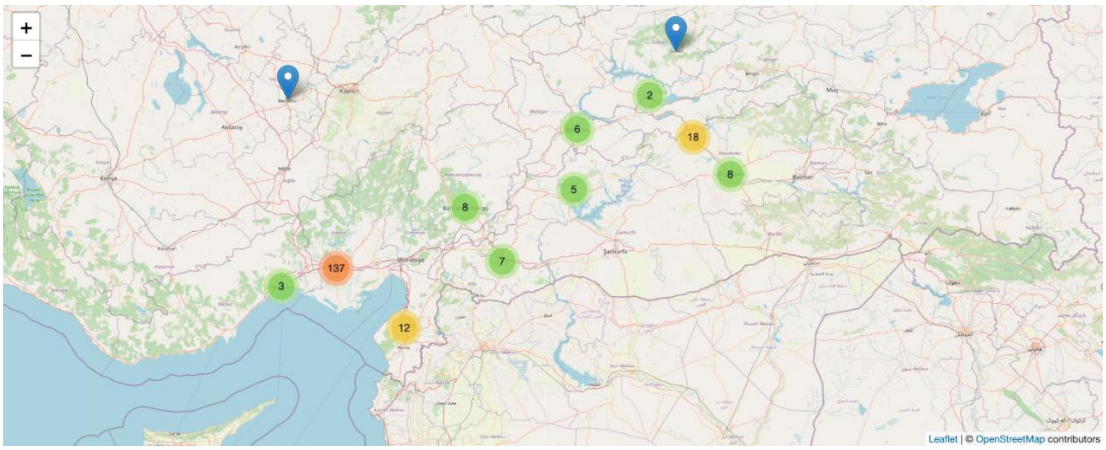


Figure 26. Türkiye – Map of geocoded messages mentioning damaged buildings.



3.2 Health-related news from the Epidemic Intelligence from Open Sources (EIOS) system

The JRC is continuing monitor the situation with a specific filter defined in the Epidemic Intelligence from Open Sources (EIOS) system. Other public health institutions using the platform such as WHO and ECDC are also doing the same.

Several media sources report warnings from public health experts and NGOs regarding a high risk of new of exacerbated outbreaks of waterborne and other communicable diseases due to water shortages and poor conditions in terms of sanitation and hygiene in both Türkiye and Syria[27, 28].

Moreover, according to media sources, public experts suggest that the shortage of cholera vaccines worldwide may have a negative impact on the earthquake crisis[29].

Local media news are reporting about scabies outbreak among adults in Adiyaman, Türkiye, according to a source[30]. Also, NGOs report children in Antakya, Türkiye, experiencing symptoms such as vomiting and diarrhoea, possibly associated with the spread of a communicable diseases[31].

However, at the time of writing, no information is available related to new or worsened outbreaks of cholera in the affected areas, besides the known epidemic situation in Syria, pre-existing to the earthquake emergency.

Finally, reports from media and NGOs still focus on the overwhelmed medical capacity, especially in Syria[32] with a likely additional need for additional medical equipment and supplies[33].

[27] https://wsau.com/2023/02/15/disease-the-new-threat-as-turkey-faces-post-quake-water-shortage/, https://reliefweb.int/report/turkiye/lack-clean-water-toilets-puts-earthquake-survivors-particularly-children-turkiye-risk-disease

[28] https://www.irishtimes.com/ireland/2023/02/15/syria-facing-a-crisis-within-a-crisis-within-a-crisis-after-earthquake-irish-aid-worker-says/

[29] https://flutrackers.com/forum/forum/emerging-diseases-other-health-threats-alphabetical-a-thru-h/cholera-incl-haiti-cholera-disaster/968708-the-cholera-vaccine-shortage-could-increase-the-toll-of-the-earthquake-in-syria-and-turkey#post968708

[30] https://www.downtoearth.org.in/news/world/lack-of-clean-water-sanitation-facilities-put-quake-survivors-in-turkey-at-risk-87692

[31] https://reliefweb.int/report/turkiye/lack-clean-water-toilets-puts-earthquake-survivors-particularly-children-turkiye-risk-disease

[32] https://www.msf.ie/article/syria-hospitals-were-full-wounded-and-dead and https://www.interndaily.com/reports/Syrias_health_workers_hit_by_double_tragedy_after_quake_999.html

[33] https://reliefweb.int/report/syrian-arab-republic/syria-earthquake-situation-indescribable-and-now-we-are-alone

4 Monitoring proposal for urban areas: quantification of damaged buildings and rubble detection

JRC has activated multiple analyses to monitor the damage in urban areas, with particular attention to the estimation of the number of damaged buildings and a feasibility assessment of rubble detection.

The extent of built-up destruction in several cities of Türkiye, including Antakya, Osmaniye, Adiyaman, Islahiye, Kahramanmaras, Nurdagi, Osmaniye, Sanliurfa, and Turkoglu was analysed. The number of destroyed buildings in each block was determined using data from the Humanitarian Open Street Map Team (HOTOSM) (downloaded on 15 February, 11:12, GMT+1)[34] and building block delineation from CEMS Rapid Mapping activation (EMSR648). A set of parameters to characterise the extent of damage, was calculated for the blocks with destroyed buildings:

- Total population based on Global Human Settlement (GHS) population grid (R2022).
- Total number of households in the building block. The average size of the households per province is provided by TURKSTAT in the Population and Housing Census, 2021[35].
- Total volume of built-up inside a building block. This data can prove useful to identify the potential amount of rubble caused by the destruction of buildings. The calculation is based on the dataset GHS built-up volume (R2022).
- Average number of floors and range of floors are also provided in order to define the average building height. The calculation is based on the dataset GHS built-up volume (R2022).

However, some limitations to this approach should be acknowledged. The GHS population data may underestimate the number of people in rural areas, and the GHS model used to estimate built-up height may have an error of ±1 floor according to Pesaresi et.al. (2021)[36]. Additionally, the number of households is calculated based on average household size per province, which may result in an over or underestimation of the total value. A detailed description of data limitations can be found in the GHSL website[37]. Despite these limitations, the data provides an estimation for the purpose of this calculation.

The use of building blocks as the spatial unit for this analysis was required by the 100 sqm grid of the GHS data package. Analysing data at the level of individual buildings would not yield significant results.

The calculated data presented in figures and tables below are aggregated at the city level, but the spatial dataset is available for analysis. All the data used in this analysis is publicly accessible.

To accurately interpret the data presented in the tables, it is important to note that the data has been calculated for all buildings in a given block, regardless of whether there is only one destroyed building or more than ten, potentially resulting in overestimations.

To replicate this analysis in other cities, building block delineations and identification of destroyed buildings are needed. The analysis was conducted at the building block level, but any administrative unit or grid could be used, keeping in mind the scale limitation. Furthermore, considering different damage characterisations could expand this analysis.

[34] https://data.humdata.org/dataset/hotosm_tur_destroyed_buildings
[35] https://data.tuik.gov.tr/Bulten/Index?p=Population-and-Housing-Census-2021-45866&dil=2
[36] Pesaresi M, Corbane C, Ren C, Edward N (2021) Generalized Vertical Components of built-up areas from global Digital Elevation Models by multi-scale linear regression modelling. PLoS ONE 16(2): e0244478. https://doi.org/10.1371/journal.pone.0244478
[37] https://ghsl.jrc.ec.europa.eu/download.php?ds=pop

This preliminary study was conducted for Türkiye but it could be also applied to Syria provided the necessary information and data is available.

This analysis may assist stakeholders in the second phase of the emergency response, by providing insights into the quantification of damaged buildings, the volume of rubble that must be cleared or the number of households and floor space that need to be rebuilt. Additionally, the spatially explicit data indicates the concentration of damage in each location.

Figure 27. Number of destroyed buildings per building block in Adiyaman (top-left), Kahramanmaras (top-right), Antakya (bottom-left) and Islahiye (bottom-right) in Türkiye determined using data from the Humanitarian Open Street Map Team (HOTOSM) (downloaded on 15 February, 11:12, GMT+1) and building block delineation from CEMS Rapid Mapping activation (EMSR648).

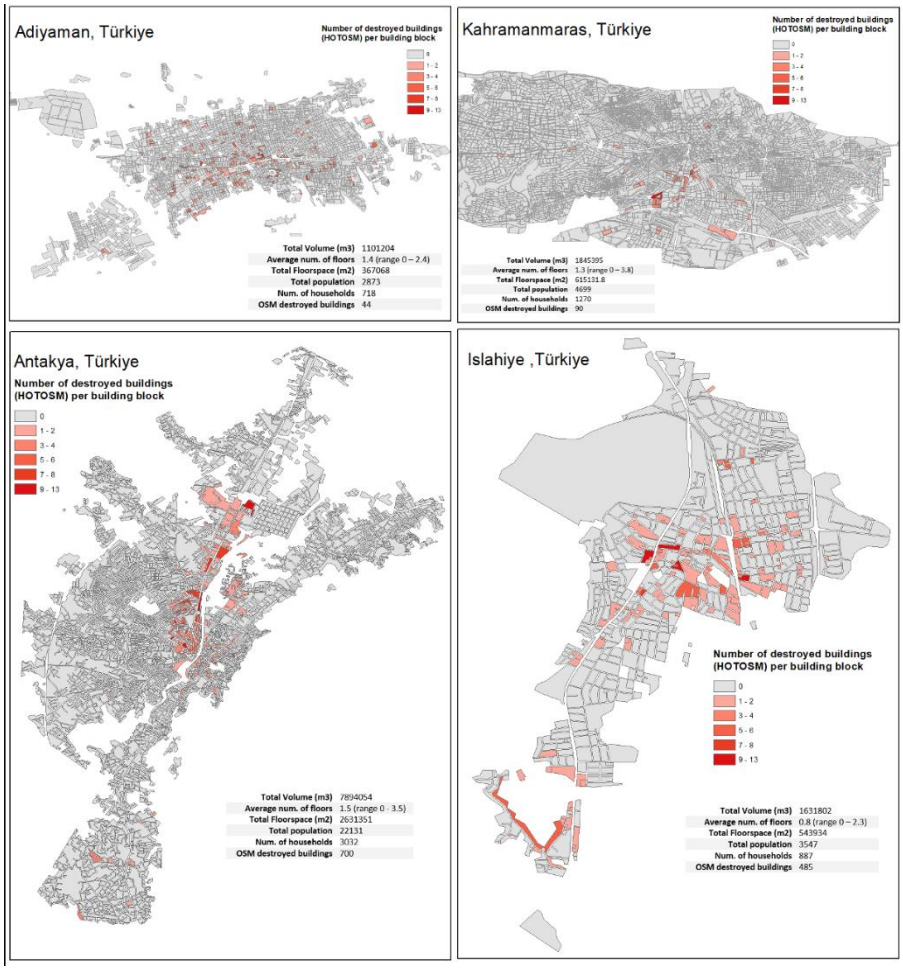
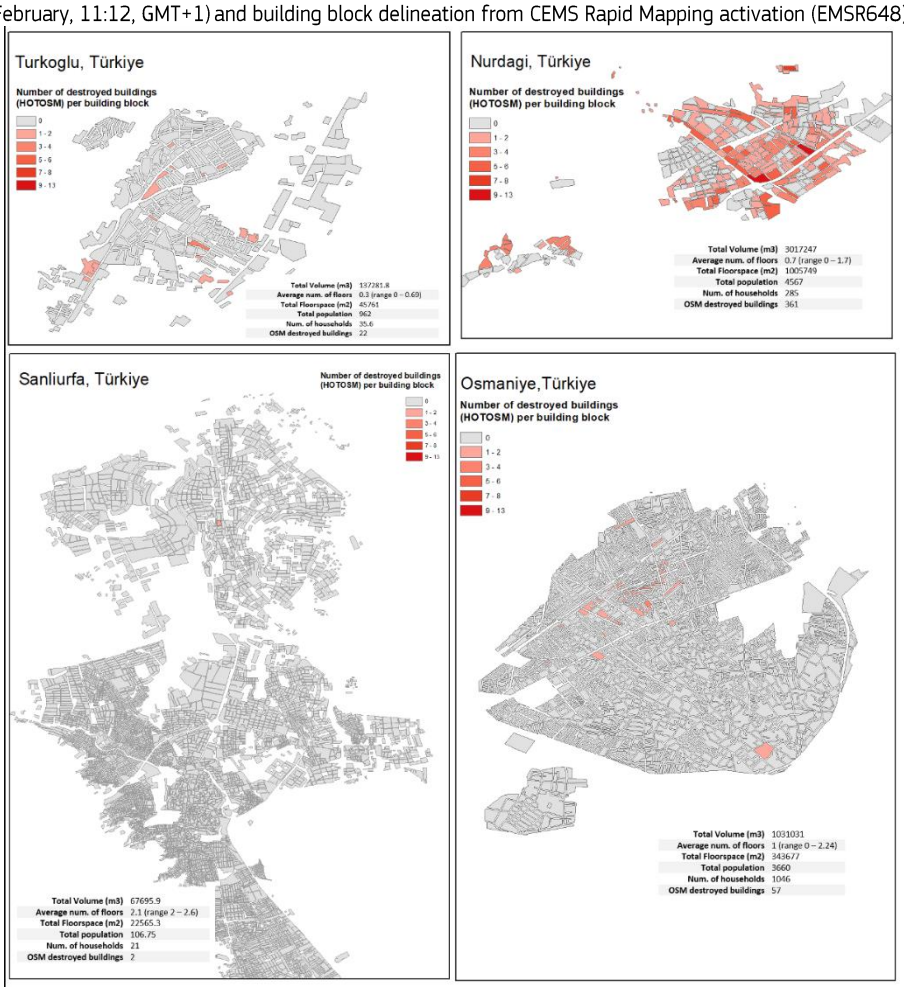


Figure 28. Number of destroyed buildings per building block in Turkoglu (top-left), Nurdagi (top-right), Sanliurfa (bottom-left) and Osmaniye (bottom-right) in Türkiye determined using data from the Humanitarian Open Street Map Team (HOTOSM) (downloaded on 15 February, 11:12, GMT+1) and building block delineation from CEMS Rapid Mapping activation (EMSR648).



5 Expected Updates

The report will be updated upon need to monitor the event and the response activities.

List of figures

Annexes

Annex 1. Information regarding State of Emergency (SoE) in Türkiye

Republic of Türkiye declared State of Emergency (SoE) on 8 February 2023 based on the Article 3a of the Law #2935 applicable in the event of one or more of the natural disasters, dangerous epidemics or severe economic depression. SoE was approved at the Turkish Parliament on 9 Feb 2023

According to Article 119 of the Constitution of Republic of Türkiye, the President is entitled to declare State of Emergency (SoE - OHAL in Turkish) in the whole or in one region of the country for a period not exceeding six months in case of the emergence of natural disasters, dangerous epidemics, or severe economic depression[38].

Declaration of SoE can be renewed as long as necessary for periods not exceeding 4 months.

The last time a SoE was declared in Türkiye was after the 2016 Turkish coup d'état attempt (based on the Article 3b of the Law #2935). It had been renewed for three months several times and was permanently lifted in July 2018.

Obligations and measures to be taken in Natural Disasters under SoE:

- Public institutions and organizations and legal and real persons within the region where a SoE have been declared are obliged to give the land, building, facility, vehicle, equipment, food, medicine and medical equipment, clothing and other items that will be requested or imposed on them.

- All citizens between the ages of 18 and 60 in regions where a SoE has been declared are obliged to perform the tasks assigned to them due to the state of emergency.

- the following additional measures can be taken:

a) Prohibiting settlement in certain parts of the region, restricting entry to and exiting certain settlements, evacuating certain settlements or transferring them to other places,

b) Suspending education in public and private education and training institutions of all degrees and closing student dormitories temporarily or indefinitely,

c) Inspecting entertainment or recreational/touristic accommodation facilities and opening and closing them, and to use these places according to the necessities of the SoE

d) Limiting or removing the annual leave of the personnel responsible for the execution of the emergency services in the region,

e) Making use of all communication tools and equipment within the boundaries of the SoE and temporarily seizing them for this purpose, when necessary,

f) Demolish dangerous buildings; destroying movable and immovable properties, which are found to threaten health, and foodstuffs and crops that are harmful to health,

g) To control, limit or, if necessary, prohibit the removal or introduction of certain foodstuffs, animal and animal feed and animal products out of the zone,

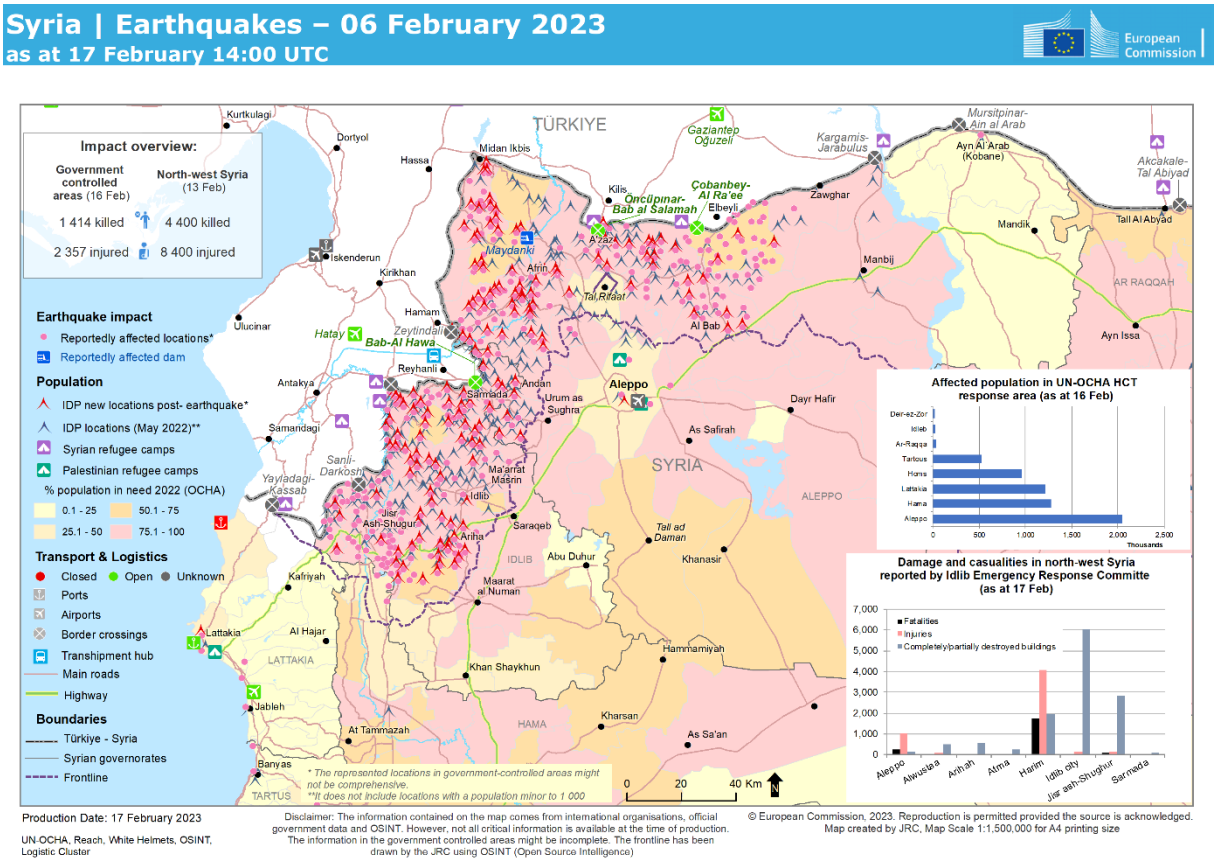
h) Arranging the distribution of essential goods deemed necessary,

i) Food items and goods and all kinds of fuels necessary for the nutrition, heating, cleaning and enlightenment of the public, drugs, chemicals, tools and other things used in the protection of health, treatment and medicine, goods and materials used in construction, industry, transportation and agriculture, to take necessary measures for the production, sale, distribution, storage and trade of other goods, tools, equipment and all kinds of materials necessary for the shutting down the workplace, if it is not vital for the place where the workplace is located, taking into account the way or nature of the act about those who stop or slow down,

j) to take measures regarding land, sea, and air traffic order, to register or prohibit the entry and exit of transportation vehicles to the region.

[38] The declaration of a SoE due to the prevalence of violence and serious disruption of public order is defined in Article 120.

Annex 2 – Syria – Earthquake impact map



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