European Commission

The 2023 COPERNICUS Emergency Management Service On-Demand Mapping

Earthquake Workshop
15-16 November, 2023

Ceccato, P., Pekel, J.-F., Joubert-Boitat, I., Rosales Sanchez, C., Sapino, E., Di Carlo, G., Steel, A., Dalmasso, S., Pasquali, P., Emberson, R., Rao, A., Spruyt, P., Clandillon, S., Escalante, J., Florio, P., Akgün, A., Pratola, C., Crowley, H., Proietti, C., Santini, M.

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Joint Research Centre

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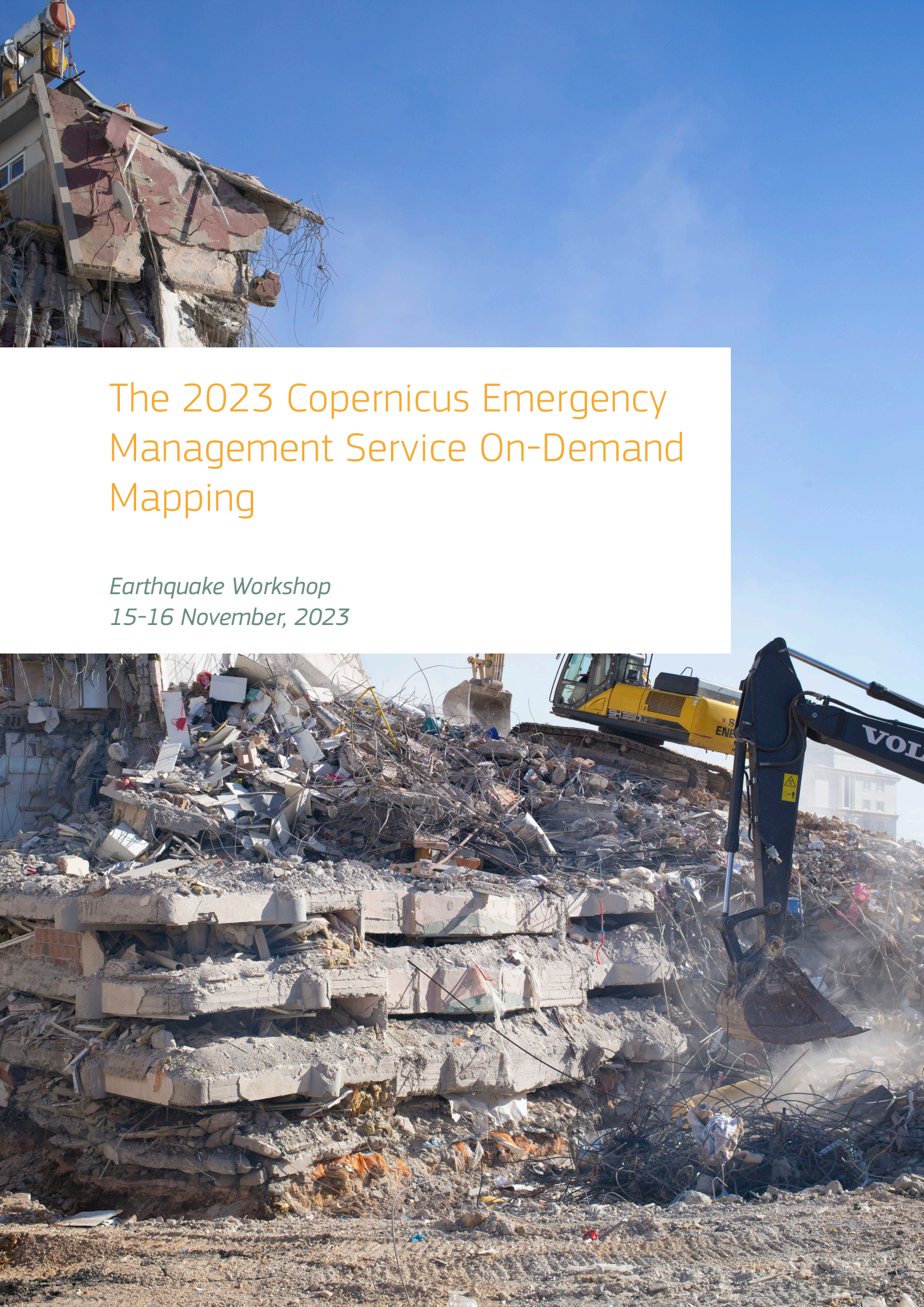

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ABSTRACT

This report presents the discussions and outputs of the CEMS On-Demand Mapping Earthquake Workshop which was held on 15-16 November 2023.

This report highlights the main points discussed at the event and actions taken to improve the earthquake products delivered to the users.

The outcomes underline the commitment and dedication of the user community that CEMS both supports and relies upon. As for the participants, it was a good opportunity to discuss and share ideas on how to best move forward, towards new successes and innovations related to earthquake products delivered by CEMS on-demand mapping.

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1 INTRODUCTION

Figure 1 presents the agenda of the Earthquake Workshop, 15-16 November 2023 and Table 1 list the participants.

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Emergency Management Service

Copernicus Emergency Management Services

On-Demand Mapping Earthquake Workshop

Agenda **DAY 1 – 15 November 2023**

09:15 – 09:30	**Welcome and Round-Table** Objectives of the workshop Presentation of Participants	*Speakers:* • Tom De Groeve *Head of Unit (JRC)* • Jean-François Pekel *(JRC)*
09:30 – 11:30	**Review the experience of user community about Earthquake in Türkiye with the CEMS "On-Demand Mapping"**	*Moderator:* Pietro Ceccato, CEMS *(JRC)* *Speakers:* • Aykut Akgun. Civil Protection AFAD *(Türkiye)* • Juan Escalante, ERCC • Chiara Proietti, ECML *(JRC)*
11:30 – 11:50	**Coffee Break**	
11:50 – 13:00	**On-Demand Mapping products: Current situation and new developments to fill in gaps and improve service**	*Moderator:* Jean-François Pekel CEMS *(JRC)* *Speakers:* • Stephen Clandillon SERTIT • Kristin Fleischer IABG
13:00 – 14:30	**Lunch**	
14:30 – 15:10	**On-Demand Mapping products: Current situation and new developments to fill in gaps and improve service**	*Moderator:* Jean-François Pekel CEMS *(JRC)* *Speakers:* • Miguel A. Belenguer-Plomer, INDRA • Chiara Pratola, e-Geos
15:10 – 16:00	**Presentation and discussion** 1) Use of CEMS products by other rapid information and assessment providers 2) Experiences in rapid loss assessment and future developments.	*Moderator:* Luca Dell'Oro *(UNOSAT)* *Speakers:* • Luca Dell'Oro, UNOSAT • Helen Crowley, GEM
16:00 – 16:15	**Coffee Break**	
16:15 – 16:50	**Discussion about the use of CEMS products by other rapid information and assessment providers**	*Moderator:* Marcus Elten *(UNDRR)* *Speaker:* • Marcus Elten, UNDRR
16:50 – 17:00	**Conclusion and Actions of the Day**	*Moderator:* Jean-François Pekel *(JRC)*

PROGRAMME OF THE EUROPEAN UNION

Copernicus

Implemented by European Commission

Figure 1. Agenda of the CEMS on-demand mapping earthquake workshop.

Table 1. List of participants.

Last name	First name	Organisation
Users		
Akgün	Aykut	Ministry of Interior, Disaster and Emergency Management Presidency (AFAD), Türkiye
Bramerini	Fabrizio	Civil Protection Department (Prime Minister Office), Italy
Morgillo	Antonella	Protezione Civile, Italy
Escalante	Juan	European Commission DG ECHO (ERCC)
Cornaglia	Giuseppe	Autoridade Nacional de Emergência e Proteção Civil, Portugal
Ilieva	Nina	DGFSCP, Bulgaria
Kautz	Marie-Luise	Federal Office of Civil Protection and Disaster Assistance, Germany
Kautny	Nieves	Ministry of Interior, General Directorate, Department for Disaster Management and Civil Protection. responsible for science and research in this area, Austria
Lalechos	Spyros	EARTHQUAKE PLANNING AND PROTECTION ORGANISATION, Greece
MCC	Cyprus Civil Defence	CYPRUS CIVIL DEFENCE, Cyprus
Nistorescu	Adrian Mihai	IGSU, Romania
Oancea	Alexandra	General Inspectorate for Emergency Situations (GIES), Romania
Ofúkaný	Miloslav	Ministry of interior of the Slovak Republic, Slovakia
Predovnik	Vesna	Administration for Civil protection and disaster relief of the Republic of Slovenia
Experts		
Crowley	Helen	Global Earthquake Model Foundation, Italy
Dell'Oro	Luca	United Nations Institute for Training and Research (UNITAR), Switzerland
Dolce	Mauro	University of Naples Federico II, Italy
Elten	Marcus	Programme Management Officer at United Nations - UNISDR, Switzerland
Emberson	Robert	JRC E1. GHSL
Li	Xi	Wuhan University, China
Prota	Andrea	UNIMA
Rao	Anirudh	Global Earthquake Model Foundation, Italy
Ripepe	Maurizio	University of Florence, Italy
Tsionis	Georgios	JRC E3
JRC		
Pekel	Jean-François	JRC E1
Ceccato	Pietro	JRC E1

Last name	First name	Organisation
Rosales Sanchez	Cristina	JRC E1
Joubert-Boitat	Inès	JRC E1
Sapino	Emanuele	JRC E1
Di Carlo	Guido	JRC E1
Steel	Alan	JRC E1
Pasquali	Paolo	JRC E1
Dalmasso	Simone	JRC E1
De Groeve	Tom	JRC E1
Santini	Marzia	JRC E1
Proietti	Chiara	JRC E1
Service Providers		
Fleischer	Kirstin	IABG
Belenguer-Plomer	Miguel Angel	INDRA
Clandillon	Stephen	SERTIT
Luzietti	Lucia	eGeos
Pratola	Chiara	eGeos

Figure 2. Participants of the CEMS on-demand mapping earthquake workshop.

2 CEMS ON-DEMAND MAPPING EARTHQUAKE WORKSHOP DISCUSSIONS

This chapter presents the discussions during the different presentations. The presentations are available for download at *https://emergency.copernicus.eu/mapping/ems/cems-demand-mapping-earthquake-workshop-2023*.

2.1 Presentations: review the experience of user community about the earthquake in Türkiye with the CEMS "on-demand mapping" – Civil Protection experience

▸▸ Speaker: Aykut Akgün, Ministry of Interior, Disaster and Emergency Management Presidency (AFAD), Türkiye

Prof. Aykut Akgün, an engineer geologist and member of AFAD, provided insights into various studies conducted regarding the catastrophic earthquake that occurred in February 2023. The seismic hazard in Türkiye, known for its high seismic activity, was discussed, with the country having the highest number of active faults in the world. The importance of preparedness was emphasised, and the existence of a large seismic network of stations for real-time monitoring and automated data transfer and evaluation was highlighted. The Earthquake Damage and Loss Estimation System (AFAD-RED) was also introduced as a valuable tool for estimating damage and loss of life after an earthquake, integrating data from monitoring stations and the Disaster Management Decision Support System (AYDES).

The speaker then summarised the events of the earthquake that took place on 6 February 2023, including two main shocks and four significant aftershocks. Since then, there have been seven major earthquakes and 55,000 aftershocks. The magnitude of the catastrophe was emphasised by comparing the size and population of the affected area to entire countries, surpassing Bulgaria's extension or Tunisia's population. It was noted that previous historical earthquakes in the same area had similar magnitudes, but the unexpected magnitude of the earthquake and the occurrence of the second shock were highlighted.

The relevance of mapping rural areas and suburbs was also mentioned. Rural areas and suburbs were also affected by the disaster (with rock falls, landslides) with many deaths. AFAD teams conducted studies in nine cities (see Figure 3). Over 3,700 buildings were affected by rock falls and landslides, resulting in over 100 deaths in suburban areas. The largest co-seismic landslide event in Türkiye was identified, with various types of landslides and other effects such as liquefaction and displacement. Remote sensing activities, including UAV and LiDAR data collection by private companies like Fugro, were highlighted as crucial in understanding the widespread impact and secondary disasters. While initially restricted, the data would eventually be made public for research purposes.

The initial shock and lack of awareness regarding available resources within AFAD and the availability of services, such as CEMS RM were acknowledged. The remote sensing team was overwhelmed with analysing the collected data, which would be used for planning purposes. More trainings are needed to address this, specifically on data and/or analysis based on remote sensing. A clearing house was established to facilitate the organisation for the study of the event, with around 500 researchers that gathered information in the affected area, supported by the Scientific and Technological Research Council of Türkiye (TUBİTAK).

The speaker also mentioned the involvement of 11,488 people from international rescue teams, including AFAD-trained volunteers, in search and rescue activities. Assistance provided by sea and aircraft, as well as the provision of food services and shelters by the government and other countries, were highlighted. Plans for temporary container cities and permanent housing were also discussed.

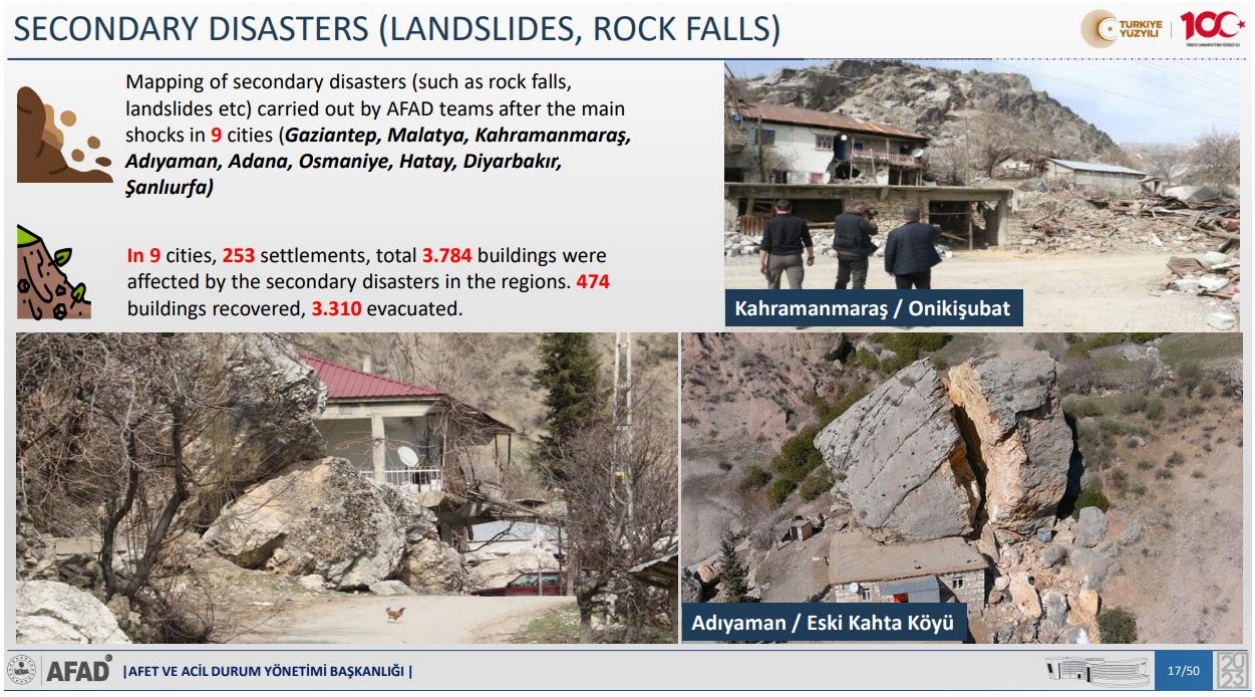

Figure 3. Secondary disasters (landslide, rosk falls) monitored by AFAD during the earthquake.

Disaster risk management plans from 2012 to the present were reviewed, acknowledging both successful and insufficient steps. The need to review and extend all plans based on the lessons learned from the event was emphasised. The Disaster Risk Reduction (DRR) plan, consisting of eight sectors and eleven hazards, was mentioned, along with the importance of renewing and extending the Integrated Risk Assessment and Planning (IRAP) plan, which had considered an earthquake of magnitude 7.2 Mw as an example.

The importance of collaboration and working together was emphasised, with AFAD collaborating with organisations such as NATO for training and support. The need for training in various areas, such as remote sensing, was highlighted, and the recent NATO workshop was mentioned as a step towards addressing this challenge. While the gathering of data was acknowledged as feasible, the expertise of professionals was stressed as vital in processing and making the information accessible for effective disaster management. The speaker also expressed a strong willingness to enhance collaboration with European countries.

Questions and comments

→ During the question and answer session of the talk, it was mentioned the challenge of analysing the vast amount of information that arrives during a catastrophic event. While AFAD had access to the Copernicus products, the question remained how to effectively utilise this information. There is a lack of trained personnel in AFAD to hinder the processing of this data. As a solution, it was suggested to provide training to individuals in various areas such as remote sensing and seek support from NATO. Recently, a NATO workshop was held to further explore this issue. Data gathering was deemed possible, but increased expertise of professionals is required to process and make it accessible for disaster management.

2.2 Presentations: review the experience of user community about the earthquake in Türkiye with the CEMS “on-demand mapping” – ERCC experience

⏩ Speaker: Juan Escalante, Emergency Response Coordination Centre (ERCC)

The presenter provided an introduction to the Situational Awareness Team of the ERCC. The mandate of the team includes ensuring situational awareness, maintaining and enhancing transnational early warning systems, bridging the scientific and operational communities, and coordinating DG ECHO's contribution to the Integrated Situational Awareness report (ISAA report).

The speaker emphasised the significant need for information at the early stages of an event, when there is a scarcity of available information in order to understand the scale of the event (see Figure 4). This is when the Copernicus service becomes crucial, as it has the capability to provide fast and accurate information based on the first available satellite images.

The speaker highlighted an important delay in the delivery of Copernicus Emergency Management Service (CEMS) products. Recent delays between 44 to 92 hours were raised, and potential solutions to overcome delays were explored. It was noted that Disaster and Emergency Management Authority (AFAD) activated the service only 4 hours after the event occurred.

The earthquake in Türkiye was cited as an example of successful mapping, while in Morocco, image analysis was more challenging due to certain factors. The difficulty in identifying affected buildings in Afghanistan due to the type of constructions was acknowledged as a major issue. The Global Earthquake Model (GEM) was presented as a possible source to identify types of building constructions prior to activations.

The feasibility of utilising remote sensing (RS) in different countries was discussed, with some countries being more suitable for RS analysis and others presenting difficulties. Estimates of damages and affected population are crucial for decision-making and a user-friendly visualisation of these estimates can be very helpful. A proposal was made to visualise the table of consequences using a dashboard. A Derna (Libya) dashboard was presented as an example of actionable information to understanding events, making funding decisions, and deploying teams.

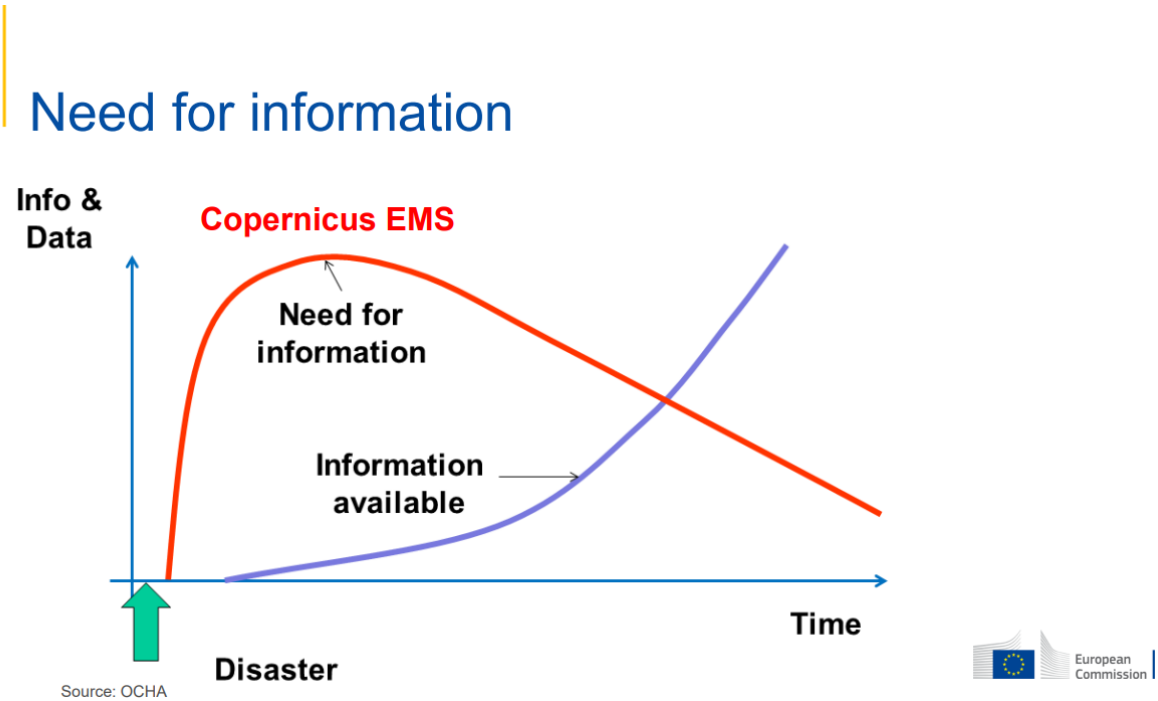

Figure 4. Timeliness of information required by DG ECHO, ERCC.

Questions and comments

→ During the Q&A session, addressing the issue of delayed deliveries, it was emphasised that certain factors beyond the analysts control contribute to these delays. Specifically, in the case of Afghanistan, the type of building materials and the need for 30 cm satellite images resulted in a wait of several days to obtain the necessary imagery. This delay was identified as a critical issue due to the unavailability of data providers. Additionally, it was acknowledged that adverse weather conditions, such as clouds and snow, posed further challenges in Türkiye, making the situation even more complex. In that sense, better information to understand the real availability of potential acquisitions is needed, and efforts with ESA to address the problem are ongoing. The aerial component for earthquakes in the EU was also noted as highly useful.

→ Participants raised the usefulness of products considering the type of buildings before the event. Maps from GEM were shown at a national level but data are available at a much higher resolution. It was suggested that having a pre-understanding of the type of buildings could help define clearer expectations, which is critical communication for ERCC.

→ Regarding the limitations of satellite images to analyse building damages after the earthquake, pancake collapses were mentioned as an example, where buildings appear intact from remote sensing but are actually damaged. Stephen Clandillon highlighted that oblique 0.3 m data (CNES/Airbus Pléiades NEO study) showed pancake collapses but obviously only on visible buildings.

→ The discussion concluded with the need to make decisions regarding whether to analyse individual buildings or building blocks, and the importance of understanding user needs.

2.3 Presentation: review the experience of user community about the earthquake in Türkiye with the CEMS “on-demand mapping” – ECML experience

⏩ Speaker: Chiara Proietti, JRC's European Crisis Management Laboratory (ECML)

The presenter introduced the European Crisis Management Laboratory (ECML), and what the role of the European Commission’s Joint Research Centre (JRC) had in supporting Türkiye and Syria in the earthquakes events on 6 February 2023.

The ECML creates enhanced situational awareness for crisis management, by forecasting disasters, analysing and predicting impacts. The main users of ECML are the Emergency Response Coordination Centre (ERCC) coordinating the Union Civil Protection Mechanism, the international Humanitarian community, colleagues in the field, and key actors for the PDNA process (see Figure 5).

Figure 5. Main users of JRC scientific analyses.

The presenter discussed JRC activities in Türkiye and Syria, emphasizing the need to consider various components such as seismic activity, affected critical infrastructures, like hospitals, impact on cultural heritage, and conflicts. Coordination was highlighted as crucial in these efforts, as there was a clear need to analyse the different aspects of the emergency, considering also the pre-existing crisis and conflict situation.

ECML has conducted several impact and scenario analyses, including supporting Turkish authorities and Syrian authorities for dam breaches. ECHO and JRC Daily maps were created on a daily basis to disseminate data and analysis helpful for the humanitarian community. The Post Disaster Needs Assessment (PDNA) process, conducted in collaboration with World Bank, UNDP and EU institutions was described as an arduous and challenging process, which could benefit from the post-disaster satellite damage assessment.

The role of satellite images was discussed, with a mention of the underestimation of the post-earthquake assessment of building damage using satellite images and the presence of scientific articles on this topic.

The products provided for Morocco were highlighted as important, as they provided damage information for inaccessible areas. The heat map was identified as a necessary input for data analysis.

Conclusions:

→ The underestimation of satellite-based building damage is well known, but it could be the only available information in the first hours/days after the event.
→ Over the first hours, a quick and dirty information could be helpful (e.g. heat-map with damage ratio).
→ All emergencies are different, and the information needed from remote sensing products could evolve over time.
→ The following question was raised: would it be possible to apply "under-estimation damage factors" to the number of destroyed buildings from literature?

2.4 Presentation: rapid mapping products: current situation and new developments to fill in gaps and improve service

⏩ Speaker: Stephen Clandillon, SERTIT

Part of the reason for Copernicus Emergency Management Service (CEMS) rapid mapping initiative being initiated was due to the ERCC being overwhelmed by requests and needs during the Port au Prince earthquake in 2010. In earthquake scenarios, the current methods are precise when mapping at a building point level but lack timeliness and scalability. On the other hand, building blocks, while not as precise, prove to be timely and more scalable, despite the absence of automation.

Data resolution poses a significant challenge, with satellites providing good resolution but facing limitations in availability, while aerial and drone options offer good resolution but struggle with availability and production readiness.

At the single-building level, it becomes evident that for destroyed structures, the resolution is adequate, but to confidently assess potentially damaged buildings, a resolution of 30 cm or below is required. An example from Croatia demonstrated the significant improvement achieved with aerial images compared to a 70 cm satellite image, reducing guesswork.

The focus on building blocks facilitates easier mapping for 2-3 classes, leading to faster and more straightforward map creation. Over Türkiye the service povider faced challenging conditions, such as post-disaster snow, but successfully utilised building blocks for efficient mapping.

Regardless of the cause, the primary focus remains on buildings. Pleiades NEO, with enhanced resolution, proved effective in identifying more destroyed and damaged buildings, including details like partially damaged roofs. Detection of debris on roads, although hindered by angles, could be enhanced with two high-resolution images featuring different incidence angles.

The followings were proposed to improve the accuracy of damage assessment:
1. Transition to building blocks.
2. Embrace higher spatial resolution.

Additional ideas were proposed for developing further the service:
1. Ground movement seismic product with InSAR; Sentinel-1 reception seven hours post-data reception.
2. Evolution: population counting for grading maps, integrating building heights.
3. Lidar for very high precision damage assessment, indicating mass movement and debris. The propositions need to be tested before to ascertain technical limitations and other specifications such as timing. Mandatory: pre and post layers, recent pre-data, at least 4 points per sqm, delivered as DSM to production sites.
4. Damage estimation based on Lidar, acknowledging potential delays in receiving data for rapid mapping.
5. Multimedia: Information complementing existing products, including geotagged elements. Resolution, availability, delivery, and automation considered on a case-by-case basis.

Questions and comments from the public included discussions on the effectiveness of satellites versus drones, social media's role in verification, and potential partnerships for utilising social media data. The use of data from sources like the Global Human Settlement Layer (GHSL) and census data was also explored, suggesting potential combined use with building blocks for enhanced results.

2.5 Presentation: risk and recovery mapping Flex products – IABG service provider: current situation and new developments to fill in gaps and improve service

▸▸ Speaker: Kristin Fleischer, IABG

The distinctive advantage of the Copernicus Risk and Recovery Mapping (RRM) lies in the ample time available, meaning the service can wait for higher quality images, apply a more thorough analysis, and strategically plan for the activation's purpose and data utility.

The earthquake in Zagreb, magnitude 5.4 was presented as an example. The objective was to conduct damage assessment on building footprints, particularly roofs and chimneys. The social media data proved crucial in understanding the real-life impact. Input data quality and resolution are pivotal. Post-event Pleiades images, though lacking sufficient resolution, were later complemented with drone data for the city centre. The timely availability of drone data significantly enhances the analysis's accuracy. Comparisons between drone and satellite images revealed the potential guesswork involved in satellite-based damage assessment. For instance, a roof appeared extensively damaged in drone images, but a satellite image captured three days later, after debris removal and repairs, showed a different scenario. Indeed, the timely acquisition of imagery is essential as most relatively minor damage is repaired rapidly.

Conclusion: Optimal results require the highest resolution images being taken as close as possible time wise to the event's occurrence.

As a second example, the activation in Beirut was presented. It focused on damage assessment and reconstruction monitoring, pushing the limits of satellite data. Except for the port area, where buildings were destroyed, satellite imagery could not capture damages to windows and facades. Ground data were invaluable. The request for small nadir images was accompanied by the need for 30-45 degree imagery (see Figure 6).

While Pleiades proved suboptimal due to its 70 cm resolution (resampled to 50 cm), WorldView (WV) provided clearer results. Sole reliance on satellite imagery led to overlooking damages even where ground data confirmed them, particularly in densely populated areas with narrow streets, where debris had been cleared.

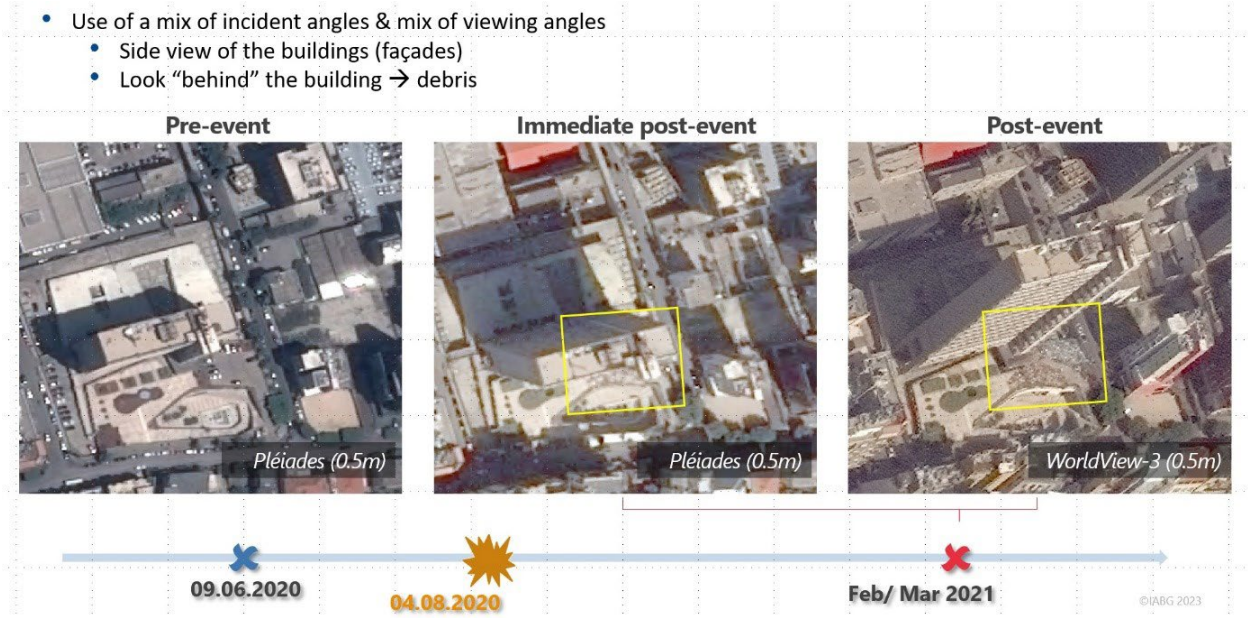

Figure 6. Satellite images taken with different viewing angles to better assess damages during the explosion in Beirut, Lebanon.

Conclusion: The following elements are necessary for improving damage assessment: define the analysis purpose early to anticipate limitations; consider acquisition mode, involving different satellites, viewing angles, and stereo acquisition for improved results.

Essential considerations:

1. Use 30 cm aerial imagery.
2. Prioritise timeliness, ensuring data is as close to the event as possible, even if the analysis occurs later.

RRM aims to establish a workflow that immediately tasks satellites and aerial resources when an earthquake activation request is received, particularly for European events. The acknowledgment is that at the building footprint level, extraction becomes challenging, especially in high-rise, narrow-road areas.

2.6 Presentation: damage assessment and recovery support after the 2023 earthquake in Syrian affected areas

▸▸ Speaker: Miguel Belenguer-Plomer, INDRA

The focus of the presentation was on the earthquake in Syria and subsequent reconstruction monitoring, aiming to facilitate early recovery response and support post-event activities, despite the challenges posed by damages from previous conflicts.

Strict image specifications were mandated, demanding Very High-Resolution (VHR) imagery with a resolution of less than 1 meter and an incidence angle below 30 degrees.

The delivered products included damage assessment, volume of debris, landfill locations, IDP (Internally Displaced Persons), camp locations, and estimations of direct and indirect economic losses. Assessing the destroyed class was relatively straightforward, but difficulties arose in evaluating damaged, possibly damaged, and, most challenging, uninhabitable buildings.

Debris estimation involved calculating 1/3 of the building volume for destroyed structures and using area estimates for those not completely destroyed. Waste storage locations were easily derived from VHR images, while identifying IDP camps posed no significant challenges.

Estimating direct and indirect economic losses proved complex, with direct losses derived from financial value maps intersected with damage assessment

results. Quantifying elements like education and health service interruptions was particularly challenging.

Main limitations highlighted included the difficulty of interpreting images at around 1-meter resolution, lack of ground truth, challenges in cross-checking with media sources, and the impact of shadows. Obtaining data from sensitive areas post-event was the most challenging, as government orders restricted image access.

Future steps involve the integration of AI for automatic damage assessment to enhance processing speed, efficiency, and consistency. Cloud computing is expected to reduce data download times, and there is an emphasis on fusing data from various sources, including satellites, UAVs, and Lidar.

During the Q&A session, the question of handling situations without ground truth was discussed. In cases where data were lacking, the speaker emphasised the importance of working to obtain them as frequently as possible. The number of photo interpreters was highlighted as crucial for timely product delivery.

2.7 Presentation: Damage Proxy Map in support of post-disaster damage assessment analysis

▸▸ Speaker: Chiara Pratola, eGeos

The presentation focused on the application of Damage Proxy Maps to support post-disaster damage assessment analysis, using the Indonesia earthquake case study with a magnitude of 5.1 on 21 November 2022. Rapid mapping was initiated by DG ECHO one day after the event, with the areas defined through the GDACS system. Despite suboptimal post-event satellite imagery due to clouds and haze, the product was delivered on time. However, the media reported damage not reflected in the satellite maps, prompting a re-evaluation.

To enhance the analysis, a new approach was proposed: the use of a Damage Proxy Map. Synthetic Aperture Radar (SAR) imagery, while not directly providing damage assessment, can offer information on the potential magnitude of the damage through the analysis of pre and co-seismic interferometric coherence. Specific requirements and limitations included acquiring SAR image pairs with the same geometry, suitability for urbanised areas, and a pre-seismic interferometric pair of less than one month, ideally with a co-seismic pair acquisition of less than three days. A drawback is the lack of information regarding the severity of the damage.

Examples of suitable SAR missions were mentioned, such as Sentinel-1A (with a 12-day revisit time), Cosmo Skymed (revisit time ranging from 1 to 16 days, potentially achieving co-seismic pair acquisition), and others like ICEYE and Capella.

This approach helped identify a new area to concentrate the analysis, demonstrating its utility in challenging scenarios.

2.8 Presentation: use of CEMS products by other rapid information and assessment

⏩ Speaker: Luca Dell'Oro, Disaster Risk Management and Climate Resilience Section, United Nations Satellite Centre (UNOSAT)

1. UNOSAT Humanitarian Rapid Mapping Service Overview
    - Division: Satellite Analysis and Applied Research, United Nations Institute for Training and Research (UNITAR)
    - Operational since: 2001, recognised as the United Nations Satellite Centre in June 2021

2. UNOSAT: Mandate
    - UNOSAT's mandate is to provide United Nations' funds, programmes, and specialised agencies with satellite analysis, training, and capacity development. This includes support to Member States with satellite imagery analysis and geospatial information technologies.
    - UNOSAT operates globally, with main offices in New York, Bangkok, Nairobi, and Geneva, and has an in-country presence in countries like Bangladesh, Bhutan, Nigeria, and Uganda.

3. Services:
    - Emergency Support: Satellite image analysis during humanitarian emergencies, including natural disasters and conflicts.
    - 24/7 Operational Service: A team in Geneva and Bangkok ensures timely delivery of satellite imagery-derived analysis.
    - Activations can be automatically triggered by Charter for UNOSAT Charter Products.

4. Cartographic Services
    - Phases: Includes Preliminary Situation Awareness, Exposure, and Impact Assessment (Phase 1) and Damage Assessment (Phase 2).
    - Products: Analytical outputs, static maps, preliminary assessment reports, statistics, AI dashboard.

5. Satellite Imagery Acquisitions
   - Range: From very high resolution (32 cm) to low resolution (1 km), using Optical and Radar satellite imagery from commercial and scientific sensors.
   - Sources: Free and open data platforms, commercial vendors, International Charter Space and Major Disasters, and contributing missions from Governments and space agencies.

6. GDACS Satellite Mapping Coordination System (SMCS)
   - Function: A web-based tool facilitating coordination between satellite mapping organisations during major disaster events.
   - Usage: Allows GDACS users to access information about satellite-derived products and analysis plans.
   - Operational Since: 2013-2014, UNOSAT is fully integrated into the GDACS website since 2021.

7. Hazard and subsequent Analyses
   - Hazard Extent: Sourced from GDACS.
   - Map Products: Accessible by users with information about the satellite images collected and the organisations involved.

8. Presented Case Studies in relation to Earthquakes
   - Türkiye / Syria Earthquake (February 2023): resulting in various reports and damage assessment maps.
   - Morocco Earthquake (September 2023): Supported IFRC, involving activation of International Charter and CEMS, leading to a comprehensive damage report.
   - Afghanistan Earthquakes (October 2023): Example case demonstrating UNOSAT's capabilities.

9. Integration of CEMS Products into UNOSAT activations
   - Benefits: Wider coverage, summary statistics and comprehensive geodatabase for e.g. damage assessment, utilisation for decision-making.
   - Coverage: UNOSAT covered 50% of Charter activations in 2023.
   - UNOSAT has a high regard for CEMS RM products and any contribution is welcome.

10. Use of AI-Generated Building Footprints in UNOSAT analyses
    - Challenges: Discrepancies in building counts and delineation issues.
    - Approach: Combining AI-generated data with UNOSAT's visual building count.
    - Focus Areas: Predictability, accuracy, completeness, timeliness, and human oversight.

11. Final Remarks
    - Trends: Increase in the frequency and magnitude of major disaster events and complex emergencies.

- Collaboration: Essential for ensuring efficient and timely support to humanitarian actors.
- Future Directions: Improvement in coordination with CEMS and careful assessment of analysis quality to avoid discrepancies and confusion among end-users.

2.9 Presentation: GEM's experiences with rapid loss assessment and future developments

▸▸ Speaker: Helen Crowley, Global Earthquake Model (GEM)

GEM, a non-profit organisation founded in 2009 in Pavia, shared their experiences with rapid loss assessment based on modelling and outlined future developments.

Key points:

1. Organisation overview:
   - GEM's mission is to develop open software for earthquake hazard and risk assessment.
   - They collaborate with various entities, including public and private sectors, and work globally.

2. Methodology:
   - GEM's methodology combines hazard, exposure, and vulnerability.
   - They collect global datasets to create six flagship products (see Figure 7), including hazard models (see Figure 8), exposure data (see Figure 9), and seismic risk maps (see Figure 10).
   - The OpenQuake model is the open-source software used.

3. Global Mosaic of Exposure:
   - For each administrative region, GEM collects data on construction materials, number of stories, seismic design level, replacement cost, number of buildings, total built area, and occupancy (day and night).

4. Use Case: Event Response - Aristotle:
   - GEM utilises OpenQuake to create scenario damage calculators, providing damage statistics, maps, consequence models, and loss statistics after an event.
   - They shared experiences from events in Türkiye and Syria, estimating not only damage but also economic loss, fatalities, injuries, and other correlated factors.

Figure 7. Six flagship products available through www.globalquakemodel.org/products.

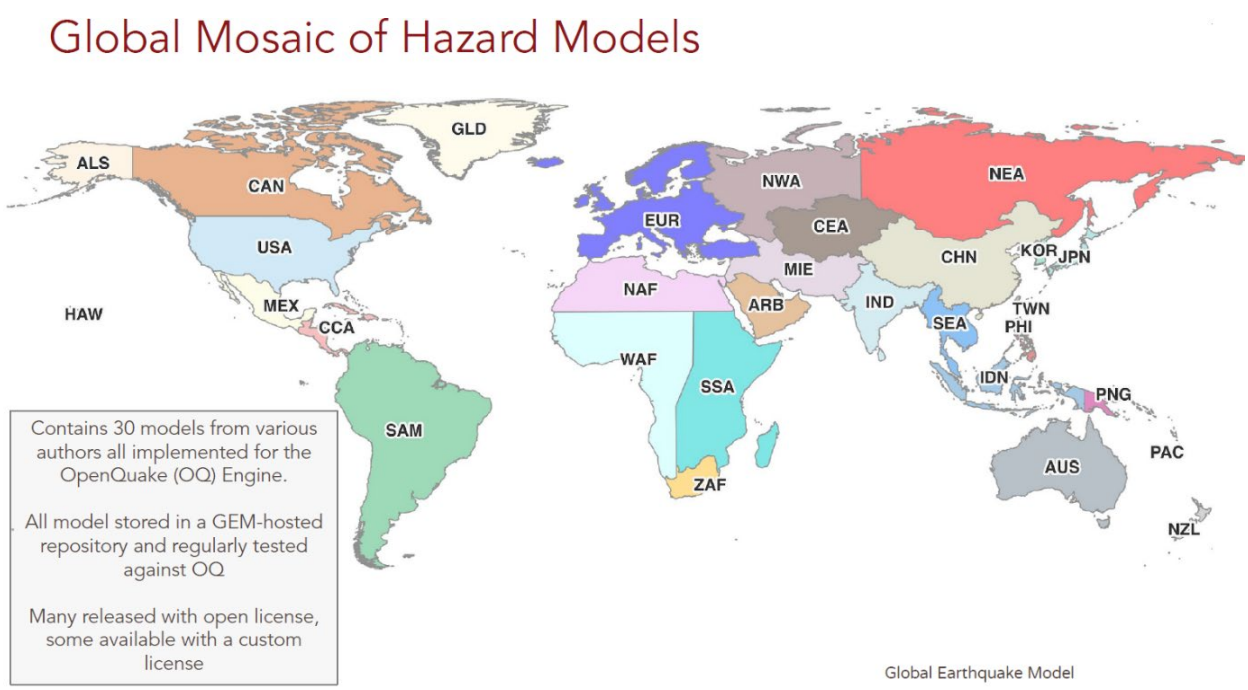

Figure 8. Global mosaic of hazard models available through www.globalquakemodel.org.

Global Exposure Maps

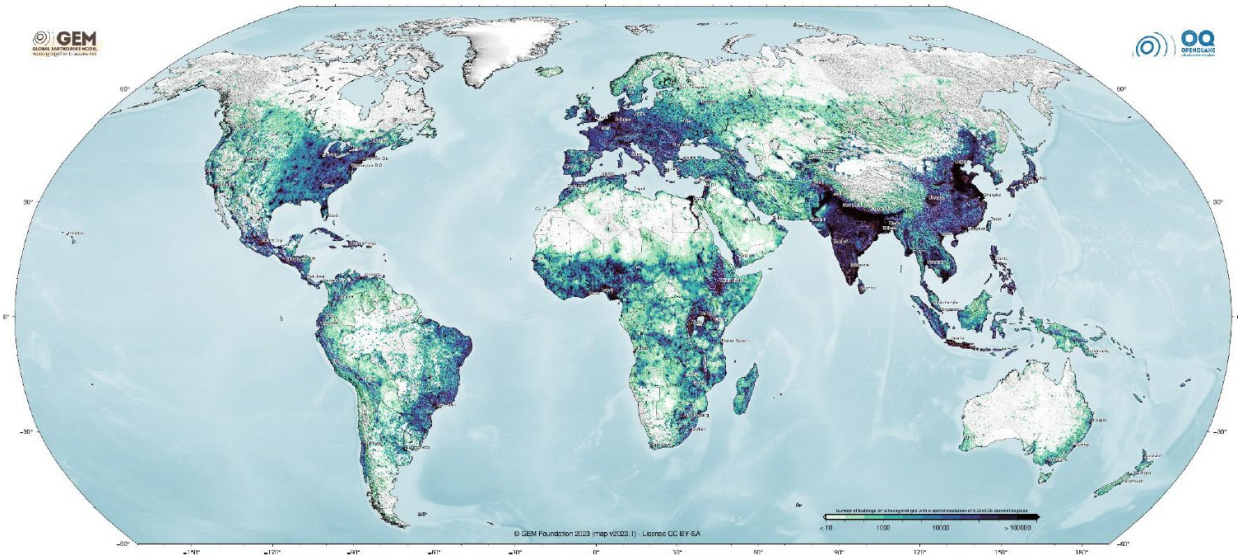

Figure 9. Global seismic risk maps available through www.globalquakemodel.org.

Global Seismic Risk Maps

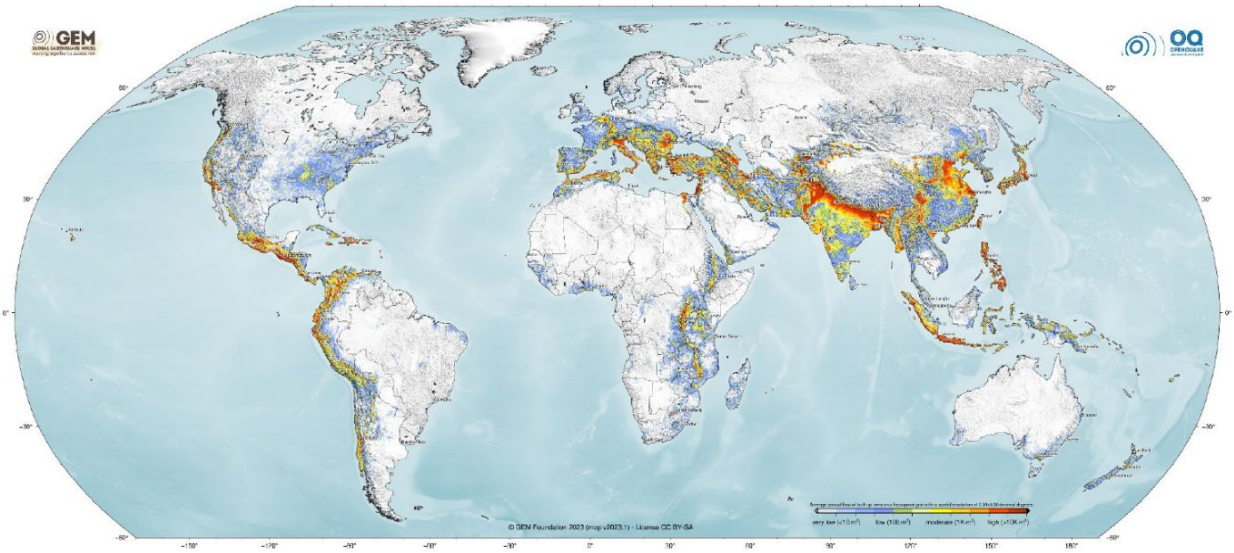

Figure 10. Global seismic risk maps available through www.globalquakemodel.org.

5. Future Developments:
   - GEM aims to focus on demographic aspects of victims in future assessments.
   - They acknowledge uncertainties in ground motion, exposure locations, and consequence models.
   - Currently operating in manual mode, GEM is transitioning to an automated and on-demand workflow.

6. Integration with CEMS Products:
   - GEM explores the direct use of satellite imagery from CEMS for rapid damage assessment.

- They emphasise the potential indirect use of CEMS data to constrain models, reduce uncertainties, and facilitate a comprehensive assessment.

7. Macroseismic Intensity:
   - GEM discussed the assignment of intensity based on earthquake effects and introduced the European Macroseismic Intensity Scale (EMS-98) and the update to an International Macroseismic intensity Scale (IMS-24).
   - Proposals were made to define macroseismic intensity from satellite imagery, which can then be used to better constrain the ground shaking in the models.

Questions and Answers:

→ Latency: GEM is not able to perform calculations until the magnitude, location and depth are known; this typically takes minutes to get a first estimate. Using ShakeMaps, this could take up to 30-60 minutes.

→ Reliability related to informal settlements: GEM produces exposure models by collecting census data country by country, and by working with local experts and engineers to account for code compliance, informal dwellings etc.

2.10 Discussion about the use of CEMS products by other rapid information and assessment providers

⏩ Speaker: Marcus Elten, United Nations Office for Disaster Risk Reduction (UNDRR)

Marcus Elten introduced the Assessment and Analysis Cell (A&A) that focuses on providing reliable and evidence-based information to support operational and strategic decision-making. The primary objective of the A&A Cell is to develop a shared understanding of the humanitarian situation by building an evidence-based foundation. By doing so, the A&A supports partners in creating comprehensive operational pictures and informing decision-making processes. One of the key responsibilities of the A&A Cell is to coordinate assessments and facilitate joint analysis, thereby ensuring a cohesive approach towards understanding the needs on the ground.

The speaker highlighted the importance of making information easily digestible and understandable for teams operating in the field, especially in chaotic scenarios. He emphasised the need to bridge the initial days of an emergency by activating remote collaboration upon request. By agreeing on an initial plan of action the A&A

Cell is able to swiftly provide assistance and support during critical times.

It was stressed the significance of engaging with focal actors and partners on the ground. By actively involving these stakeholders, the impact of the work carried out by the A&A Cell can be greatly enhanced. Additionally, main tasks of the A&A Cell include digesting new information daily, managing external coordination of assessments and analysis, consolidating information and analysis within the wider Operations and Coordination Centre (OSOCC) functions, producing regular situation reports and briefings, leading secondary data analysis, coordinating field assessments, and taking the lead in multi-cluster rapid assessments (MIRA) when necessary.

Questions and comments

→ Participants emphasised the importance of effective communication and collaboration. There was a suggestion to establish a protocol of communication to streamline efforts. UNDAC is coordinating the efforts through the A&A cell. The ECML highlighted the need for active participation in the A&A cell, involving in the trainings, and information exchange. It was mentioned that DG ECHO and ERCC are responsible for coordinating efforts in Europe and will reach out to the necessary individuals. Different levels of coordination were acknowledged. It was noted that coordination meetings might not always be possible, and immediate action is required upon receiving a request. Machine-to-machine exchange and the use of APIs were suggested for faster information sharing.

→ It was suggested that CEMS could provide building block information for faster and rough data, while leaving the building footprint for recovery. In that regard, it was highlighted the potential for collaboration between GEM and CEMS. The Global Earthquake Model has a focus on global information but covers also local needs. By providing magnitude and depth information, GEM has the capability to deliver results within minutes, with a maximum of 15 minutes. It was suggested that GEM's data could be provided at the beginning of an activation. Regarding GEM's methodology, it was mentioned that they do not require individual building data but instead rely on aggregated data. They start with the number of dwellings from national census data, estimate the number of buildings based on assumptions about the number of dwellings per building, and compute their results per pixels at several kilometres, rather than per building.

2.11 Presentation: night-light assessment during the earthquake in Türkiye

▸▸ Speaker: Xi Li, Wuhan University

The presentation highlighted the use of night-light assessment during the earthquake in Türkiye, conducted by Prof Xi Li from Wuhan University. Prof Li presented the work carried out by his team monitoring the disaster impact and recovery by monitoring power loss in cities, using time series of night time satellite images over Türkiye and Syria. This was a collaboration between Wuhan University and UNOSAT on Humanitarian Mapping using Night Light.

Key Points:

1. Night-Light Assessment:
   - Initially designed to detect clouds at night, the assessment utilised Jilin-1, a Chinese satellite with resolutions ranging from 1m to 1000m.
   - Night-light data have applications in various fields, including urban mapping, economics, light pollution, energy use, carbon emissions, and humanitarian crises.
   - Time series of night-light images can reflect humanitarian disasters and are valuable for change detection, particularly during crises.

2. Challenges in Night-Light Assessment:
   - Challenges include comparing images from different sensors, accounting for various factors like clouds, atmosphere, moonlight, and viewing angles.
   - NASA developed a dataset to address these challenges, including models to remove angular effects, gap filling, and intercalibration.

3. Use during the Earthquake in Türkiye:
   - Chinese satellites were employed during the earthquake in Türkiye, utilizing images with the same viewing angles.
   - Calculations enabled the creation of area maps depicting reductions in light, offering insights into the impact of the earthquake.

4. Monitoring Reconstruction:
   - Night-light monitoring allows tracking the progress of reconstruction.
   - Time series data can visualise crisis moments and recovery phases.

5. Applications in Syria:
   - In Syria, night-light patterns were less affected by the earthquake but were more closely linked to the economic situation. The earthquake had a limited impact on the already low level of light output.

6. Conclusions and Limitations:
    - Night-light images can cover large areas, but professional pre-processing is essential.
    - Limitations include challenges in timely obtaining night-time light data, the expense of high-resolution nightlight data, and difficulty tracking poor regions without power supply.

Questions and comments

→ Pietro Ceccato – highlighted the importance of sensor calibration.
→ Chiara Proietti said that this work provides critical information on service disruptions. Can we be certain if/when the products will be released? Will there be a monitoring?
→ Professor Li replied to say that such work would require funding. Commercial companies can produce much more quickly.
→ Stephen Clandillon said that VIIRS is good for an overview, with daily acquisitions at relatively low resolution. However, data availability is currently limited due to the conflict in Ukraine.
→ Jean-Francois Pekel highlighted that this information would be best disseminated automatically, through a notification/API approach.
→ Luca Dell'Oro highlighted the importance of this collaboration. The analysis should be packaged into a report, in order to explain product and its context and limitations.

2.12 Presentation: European and global exposure modelling using Census and Satellite products

⏩ Speaker: Helen Crowley, GEM

Models and maps of exposure at global and European scales were presented. GEM is developing a building taxonomy throughout the world, focussing on the minimum fundamental building descriptors – (design codes) material, height, and lateral force coefficient. These are connected with vulnerability functions. Such descriptors are critical for estimating the cost for reconstruction.

Exposure is modelled at national, regional building scales. However, data are available at varying spatial resolution. Global Human Settlement Layer (GHSL) offers a very useful global data set.

As part of project funded by the World Bank in 2020, GEM produced forecasted European exposure models for 2030, 2040 and 2050, using GHSL time series

correlated with GDP data from World Bank. Temporal movements of population – daily, seasonal – make exposure dynamic.

For seismic performance attributes, we also need to think about changes in design practices and evolution of seismic design codes into the future.

Questions and comments

→ Pietro Ceccato asked where can we access the exposure model data? Helen replied that the github links in her presentation provide that access. However, currently they do not include the future projections.
→ Stephen Clandillon asked if the projections take into account the European policy to reduce of new developments that expand urban areas. Helen was not sure if those factors were included, but will consult colleagues.

2.13 Presentation: access to access to infrastructure data Cadastre from GHSL

⏩ Speaker: Pietro Florio, GHSL

Pietro Florio presented new developments of Updated GHSL release R2023A and The Digital Building Stock Model – DBSM (see Figure 11). Building attributes available and under development include height, area, volume, age, rooftop type, RES/NRES. GHSL data is available as WMS and GEE.

Figure 11. The GHSL Digital Building Stock Model.

The Digital Building Stock Model combines data from OpenStreetMap (OSM), Microsoft Global Building Footprints (MSB), European Settlement Map (ESM), and cadastral data from national agencies. The data are also available on JRC BDAP (Big Data Analytics Platform).

2.14 Presentation: Exploitation of satellite interferometric data for damage assessment of building and infrastructures

⏩ Speaker: Mauro Dolce and Andrea Prota, ReLUIS Interuniversity Consortium

The ReLUIS Guidelines for the interpretation of satellite data for structural purposes – SCOPE, were presented. ReLUIS is a large network of researchers in Italy.

Andrea Prota and Mauro Dolce presented monitoring of structural behaviour over time with interferometry. Satellite interferometry (DinSAR) can provide precise information on displacements and speeds of portions of constructions (buildings, monumental works, reservoirs, etc.) and of infrastructures (roads, railways, bridges, viaducts, etc.). This is important in assessing the health of structures and infrastructures.

ReLUIS Guidelines are published in Italian. A condensed version will be translated into English.

Questions and comments

Chiara Proietti commented that this type of monitoring fits well into the Risk and Recovery mode of CEMS Mapping – and it would be helpful to understand the data requirements to reproduce the methodology.

2.15 Presentation: Rapid Damage Assessment using remote sensing and machine learning

⏩ Speaker: Anirudh Rao, GEM

The presentation focused on the challenges of on-field damage assessment, emphasising the time-consuming nature of traditional methods and the need for rapid identification of areas requiring attention. Anirudh Rao introduced a

methodology combining available information for rapid damage assessment using remote sensing and machine learning.

Key Points:

1. Challenges in On-field Damage Assessment:
    - Traditional methods are time-consuming, taking months for large events.
    - Expert access to assess damage and fill in forms is required for traditional insurance products.

2. Rapid Identification and Deployment:
    - The goal is to rapidly identify areas for field missions and determine inaccessible regions.

3. Methodology Example - Zagreb Earthquake 2020:
    - Utilised building information from the city for exposure data.
    - Incorporated a damage proxy map, estimating ground shaking intensity from USGS.
    - Developed a building damage assessment dataset indicating expected damage at the building level.
    - Combined datasets to produce the Damage Proxy Map and Building Dataset.

4. Input Features for Machine Learning:
    - Building attributes (occupancy class, number of stories, etc.).
    - Earthquake attributes (ShakeMap intensity).
    - Remote sensing attributes (Damage Proxy Map).

5. Conclusions:
    - Detailed building inventories, including footprints and structural attributes, are crucial.
    - A common damage grading schema is essential.
    - The availability of high-resolution SAR data at 0.5 meters enhances the delineation of finer damage details.

6. Questions and Answers:
    - Operational Status: The project is currently a pilot research initiative, not yet operational, aiming to assess the state of the art and determine the progress made in this field.
    - Comparison with Satellite and Drone Data: Satellite data may not yield comparable results with field data, whereas drones provide satisfactory outcomes. The use of SAR data, especially in large or inaccessible areas, can be beneficial, and advancements in high-resolution SAR are making it increasingly valuable.

2.16 Presentation: aerial component

⏩ Speaker: Guido Di Carlo, CEMS RRM

Guido Di Carlo presented the capabilities of CEMS on-demand mapping to deploy aerial component in Europe. The aerial component encompasses:

1. Drones which can provide processed images within 48 hours after acquisition. Currently, more than 150 on-boarded pilots can acquire images in all Europe except for Malta. The FWC is currently managed on behalf of the EC by the company FairFleet.
2. Airplane which can provide optical (RGB/NIR) and LiDAR data. The FWC is currently executed on behalf of the EC by a consortia led by CGR/Eurosense.

So far, 10 unmanned missions have been accomplished in Italy, Spain, Portugal, Slovenia, Bulgaria and Croatia while 6 manned missions have been conducted in Italy, Slovenia and Romania. The aerial component will be a great asset during Earthquake operations to map building damages.

2.17 Presentation: NASA's Disasters Program – Earthquake response and research

⏩ Speaker: Robert Emberson – NASA

The presentation discussed NASA's Disasters Program, particularly focusing on earthquake response and research. Robert Emberson highlighted the Global Rapid Damage Assessment System with SAR data and efforts to quantify economic impacts.

Key Points:

1. Global Rapid Damage Assessment System:
   - Utilises Synthetic Aperture Radar (SAR) data for surface deformation to create damage proxy maps.
   - Involves semi-automatic landslide detection with manual quality control using Planet 3m data.

2. Methodologies:
   - After reviewing various methodologies, high-resolution optical and SAR data were deemed critical for effective earthquake response and research.

3. Disasters Mapping Portal:
   - Mentioned the Disasters Mapping Portal, a tool or platform for disaster-related mapping activities.

4. Questions and Answers:
   - Operational Service: The Disaster Response Coordination System will formalise the response element of NASA's Disasters program early next year, providing consistent support to response agencies and teams globally.
   - API for Production Updates: Yes, setting up an API to inform when production is starting is on the list of considerations.

2.18 Discussion about implementing new actions for CEMS "on-demand mapping"

Speaker: Inès Joubert-Boitat, CEMS RM

Inès Joubert-Boitat presented a proposal for a new workflow in Rapid Mapping to increase the probability of obtaining useable data and producing useful analysis (see Figure 12). To do so, it is suggested to carry out different tasks in parallel to gain time and eventually deliver the first estimates as fast and early as possible.

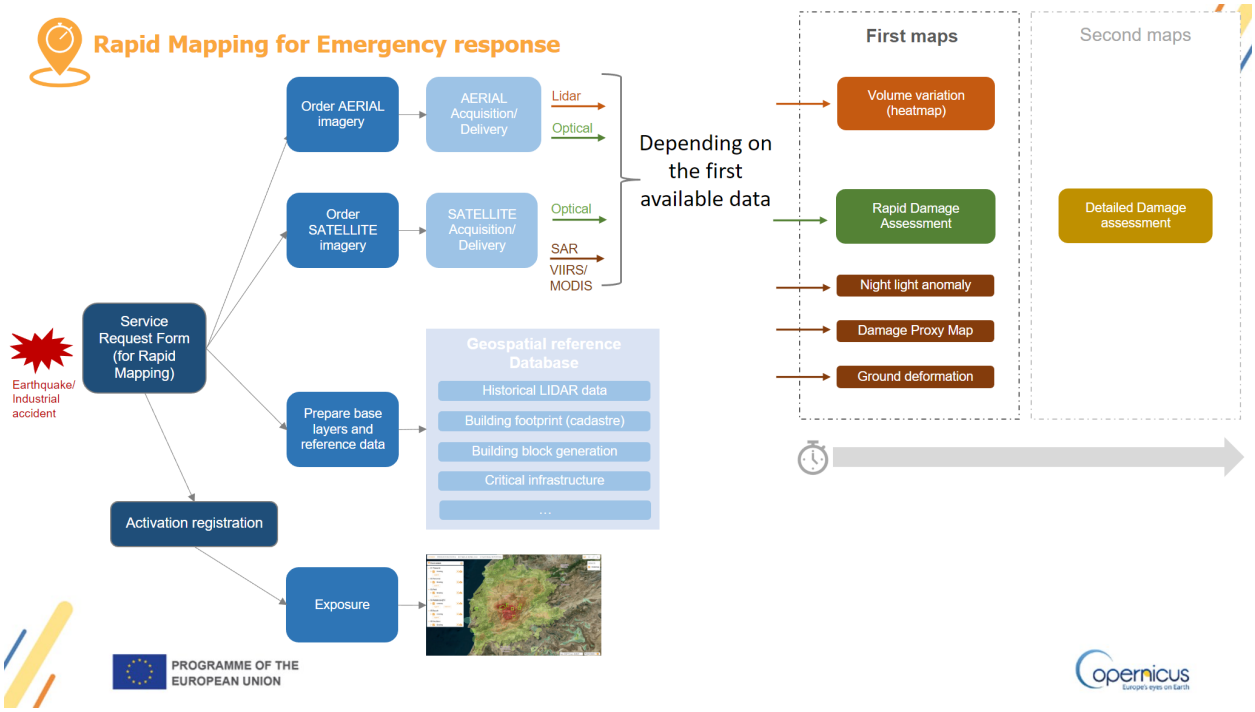

Figure 12. Proposed workflow and products for earthquake damage assessments.

First of all, information on exposure could be improved. Data on exposure can be used to generate estimates and visual it on a map. It can be processed while waiting for satellite data acquisition to gain time.

Depending on the type of the first available satellite image, different analysis can be carried out to provide a first rough estimate of the damages and their location: Rapid Damage Assessment based on Optical satellite imagery of very high resolution, Damage Proxy Map based on SAR imagery, Night light anomaly based on VIIRS/MODIS data, or volume variation based on LiDAR data. More specifically for analysis based on optical EO data, it is suggested to limit the analysis at building level to critical infrastructure. For non-critical infrastructure, damage assessment would be instead performed at building block level, as first available image is almost never of ideal quality.

Aerial component in Europe was highlighted as a significant advance in the rapid coverage of affected areas with very high resolution orthophotos and LiDAR.

The development of a Geospatial Reference Database will become the source of ready-to-use information that will improve the quality of CEMS Mapping. This will include cadastre data, LiDAR-derived digital elevation models (DEM) and digital surface models (DSM). Analysis ready data can also be 'pre-cooked' from elevation data, such as the Height Above Nearest Drainage (HAND), for improving the accuracy of flood mapping.

As users can directly benefit from CEMS On-Demand Mapping based on the best available data, users are strongly encouraged to share their data– e.g. aerial survey, LiDAR archives, building blocks, etc.

Questions and comments

→ Should we only consider damaged infrastructure?
Aykut Akgün – Information on damage to roads are critical for access.

→ Jean-François – Is info at building level of importance?
Aykut Akgün – Building type is held in AFAD database. Yes, it is useful for rapid assessment.

→ Inès Joubert-Boitat – We could use Damage Proxy Map and night light products to define or redefine AOIs. Ground deformation products on the other hand are already produced by many academic institutes and NASA after an earthquake.

→ Helen Crowley – rapid assessment outputs based on modelling could be used to identify priority areas for requesting images.

→ Aykut Akgün – planning location of temporary shelters is important and needed rapidly. Also warning of adverse weather – e.g. flood risk.

→ Marzia Santini – planning for location of potential areas carried out by national authorities – image data could identify if these areas are affected or accessible.

→ Aykut Akgün – we have both national and provincial plans, based on scenarios. These assumed only one shock, but they were rendered less useful after second strong shock.

→ Stephen Clandillon – for exceptionally large events, could we produce partial coverage, based on high priority areas?
Aykut Akgün – yes, we don't expect complete coverage immediately. ADAD has data on landslide/rockfall susceptibility.

→ Jean-François – an API could provide information exchange, and download in real time. Information would need to also be communicated on the areas that are yet to be covered.

3 ACTIONS FOR CEMS ON-DEMAND MAPPING TO IMPROVE EARTHQUAKE PRODUCTS

The following Table 2 presents the list of actions discussed and to be undertaken by CEMS On-Demand Mapping.

Table 2. List of actions.

Subject	Action description	Actors
Aerial imagery	Action: - Follow-up about possibilities to develop an efficient workflow (automatic SRF, and dashboard on budget) - AOI definition: one block of x sqkm as bounding box incl. GDACS AOIs; Explore possibilities to integrate GEM data in this procedure	JRC
Integration of multi-media / social media in analysis process	Ask Service Providers (SP) for update on this integration (presentation of Hensoldt)	SP
Rapid (visible) Damage Assessment	Action with SP: Ask SP for prototype that includes: Building-block level analysis (incl. Classes definition, decision tree for point or block (depending on built-up density (and not damage extent as said in the slides) ; Critical infrastructure listing and assessment (incl. symbology) ; Ask for evaluation of time needed for such analysis. Action with ECHO: Ask for feedback to ECHO when prototypes are ready. Action with Risk and Recovery Mapping (RRM): Agree on a workflow, and suggest it to ECHO (e.g. RM makes second round of products with points or RRM takes over for point-level assessment).	SP

Subject	Action description	Actors
Requirements in terms of EO data	Action for ESA: - Requirements for EO data: o Very high resolution o Multiple viewing angle (enabled by FGD/parallel tasking) - Multiple acquisition (enabled by FGD/parallel tasking) - Ask for details on parallel tasking, and implications for EQ for example (how to ask for more than one image, or all missions?) Action to SP: - Clarify: Sequential or merged in one product, depending on when the images are delivered	JRC to ESA (at review meeting to be scheduled)
RRM products	Action: Define a catalogue of products to offer in parallel (or after) of the RM activation: - Dam break scenario o Proposal: In case of presence of dam in the AOI, activate immediately RRM => Ask ECHO and Peter RRM for feedback - Landslide risk - Investigate other option Invite an expert to discuss methodologies	JRC
Damage Proxy Map	Action: - Ask for prototype (which unit/legend? => explore possibility to develop a heat map with damage ratio based on DPM); - Define all technical specifications and integration operation (e.g. only for urban areas);	e-GEOS
Dashboard/viewer development (for any type of event)	Action: - Add information on the delivery of the first product (per activation) on the dashboard? - Better data visualisation for consequences table (similar to a dashboard), and at the activation level. Linked to AST. - Integration of data visualisation in the Situational Reporting	JRC

Subject	Action description	Actors
Data/product delivery (also relevant for other types of event)	Description: - Long-term development: NRT delivery of results. Progressive/partial delivery on the viewer, while the product per se would remain complete (not partial) - Especially in case of large AOI and/or large damage extent, explore new delivery possibilities. Action - Brainstorm internally o Discuss technical implications (e.g. transfer of data, as automatic procedure and not manual regular upload) and workflow o Discuss data visualisation (For example how to represent clearly the area on which SP is working and which are not looked at yet) o Define strict requirements - Ask SP for feasibility study, as part of a yearly evolution? - Ask ECHO for their feedback about the usefulness	JRC/SP/ ECHO
Building damage and debris estimation based on LIDAR data	Action: - Make sure it is part of the proposal for the yearly evolution - In general, explore possibilities of taking advantage of availability of pre & post LIDAR data - Review RRM product (P02) done for the activation EQ in Syria (production to be checked and feasibility for RM)	SP
Manage expectations of the user (e.g. ERCC)	Status: - ERCC mentioned need to manage expectations (building types vs. colours of the buildings/soil) - More communication needed Action JRC -> SP: - If difficulties are foreseen (while studying the area that will be analysed), include in a feasibility study descriptions of the limitations for the user (anticipation). Inform also about the conditions needed to perform the tasks - If difficulties are confirmed or discovered (when receiving the image), inform the user with few illustrations.	SP

Subject	Action description	Actors
Improvement of population count for Grading products	Action with SP: - Review the proposal for evolution - Ask for clarification and methodology, including on building heights for the estimate of population (part of the service evolution). Potential source of information: GHSL and GEM, Such investigation is also the mandate of GHSL.	SERTIT
SMCS platform and others	Document integration on SMCS platform and GDACS ; Explore possibilities for better integration, also with Charter (CEMS/Charter logo on each other's page)	JRC
GEM	Action: Explore how to integrate loss statistics and maps in our Situational Reporting; integrate it in the viewer? ; explore how GEM info can be ingested in RM analysis/product, and used for AOI definition	JRC
Ground deformation	Explore possibilities for RM/RRM: Seems to be unfeasible/not relevant as first product for RM, so we can leave it aside for the moment and keep an eye on NASA production, while RRM explores possibilities to produce it?	JRC
Night light anomaly	Explore possibilities for RM/RRM: Seems to be unfeasible as first product for RM, so we can leave it aside for the moment and keep an eye on UNOSAT production, while RRM explores possibilities to produce it? Especially relevant for critical infrastructure.	JRC

4 CONCLUSION

The Earthquake workshop has gathered together:
1) the user community from Germany, Spain, Portugal, France, Slovenia, Slovakia, Italy and Türkiye;
2) experts;
3) ECML team;
4) Service Providers and
5) CEMS On-Demand Mapping.

A series of discussions and outcomes were achieved. A list of actions were identified (see Section 3) in order to improve the current Earthquake Products delivered by CEMS On-Demand Mapping.

LIST OF ABBREVIATIONS AND DEFINITIONS

ANEPC	Autoridade Nacional de Emergência e Proteção Civil
AOI	Area of Interest
API	Application Programming Interface
BBK	Bundesamt für Bevölkerungsschutz und Katastrophenhilfe
CAMS	Copernicus Atmosphere Monitoring Service
CBI	Composite Burn Index
CEMS	Copernicus Emergency Management Services
COAU	Unified Aerial Operation Center
DEFIS	Defence Industry and Space – European Commission
dNBR	difference Normalized Burn Ratio
DSS	Decision Support System
ECHO	European Civil Protection and Humanitarian Aid
EFAS	European Flood Awareness System
EFFIS	European Forest Fire Information System
EO	Earth Observation
EQ	Earth Quake
ERCC	Emergency Response Coordination Centre
FD	Forest Department
FEP	First Estimate Product
FMC	Fuel Moisture Content
FRP	Fire Radiative Power
GDACS	Global Disaster Alert and Coordination System
GIS	Geographical Information System
GRA	Grading
IABG	Industrieanlagen-Betriebsgesellschaft mbH
JRC	Joint Research Centre
KML	Keyhole Markup Language
LULC	Land Use and Land Cover
NBR	Normalized Burn Ratio
NCPD	National Department of Civil Protection
RBR	Relativized Burn Ratio
RM	Rapid Mapping
RRM	Risk and Recovery Mapping
RTP	Ready To Print
SP	Service Provider

SPERF	Services Provider Emergency Request Form
SR	Situational Reporting
SRF	Service Request Form
SWIR	Short Wave Infra-Red
UN	United Nations
US	United States
WFS	Web Feature Service
WMS	Web Map Service

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