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LEARNING MORE FROM EARTHQUAKES: AN ATTEMPT TO COLLECT MACROSEISMIC, CASUALTY, AND EARLY RECOVERY DATA

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Abstract: *After a major earthquake, there is a period when the earthquake research committee comes together not only in solidarity with the affected communities, and our colleagues in the local area but also to gather as much information from the field as possible. We must learn from the real responses of the natural and built environments to strong ground motions, to improve our imperfect knowledge and calibrate our assumptions. Traditionally, building and infrastructure damage data is collected by local governments, civil protection groups, and professional engineering bodies to assess the extent of damage to aid decisions on reoccupation, repair, or demolition. International reconnaissance missions are mobilised concurrently to bring valuable lessons from the events to their own countries and beyond. Most are in the form of observations, but some detailed damage surveys are also carried out. However, other types of perishable data are important to capture. In this paper, the authors recount their efforts and challenges to design and conduct surveys to capture qualitative data from the affected communities of the February 6th, 2023 Kahramanmaraş earthquake sequence to help assign macroseismic intensities, understand causes and types of injuries, and early recovery. It is their hope that the systematic collection of data of this kind will become standard in the future.*

1 Introduction

All post-disaster reconnaissance missions aim to accelerate and increase learning from disasters worldwide, disseminate lessons, and identify opportunities for reducing disaster losses and increasing community resilience in the future. For the past four decades, the UK Earthquake Engineering Field Investigations Team EEFIT, together with UK and international seismology and earthquake engineering professionals have strived to collect as much perishable empirical data as possible from the field, immediately after significant events around the world. For these relatively young disciplines, the ability to observe and learn lessons from real events has been vital to improve our earth science knowledge, understanding of the geotechnical consequences of earthquakes, recovery sequences, urban planning issues, the development and implementation of building code, and communication of risks. We and others focussed on geophysical and climatic hazards have been instrumental in opening dialogues with the stakeholders of built environments and disaster risk resilience globally, provided recommendations, been involved in professional reviews, and been part of implementation projects with local governments, NGOs, and academics days to complete. However, these field missions have become increasingly condensed in time, scale, and discipline. The main international reconnaissance groups like EERI, GEER, NZEE, EEFIT have traditionally focused on reporting on observations of:

- Seismology
- Geotechnical features and failures including secondary hazards like earthquake-induced landslides
- Infrastructure damage
- Impact on critical facilities
- Building damage (engineered and non-engineered)

- Emergency response and relief effort

Some teams have extended their work to compare scientific assumptions and analyses with empirical data and observations such as Figure 1, which shows a comparison between current building code requirements to seismic recordings from a nearby station (3135), and the exceedance of these design values at this location after the February 6th, 2023, earthquake sequence in Türkiye. To the right of this figure is an observed building damage in Arsuz of the Hatay province in Türkiye, suggesting strong vertical accelerations.

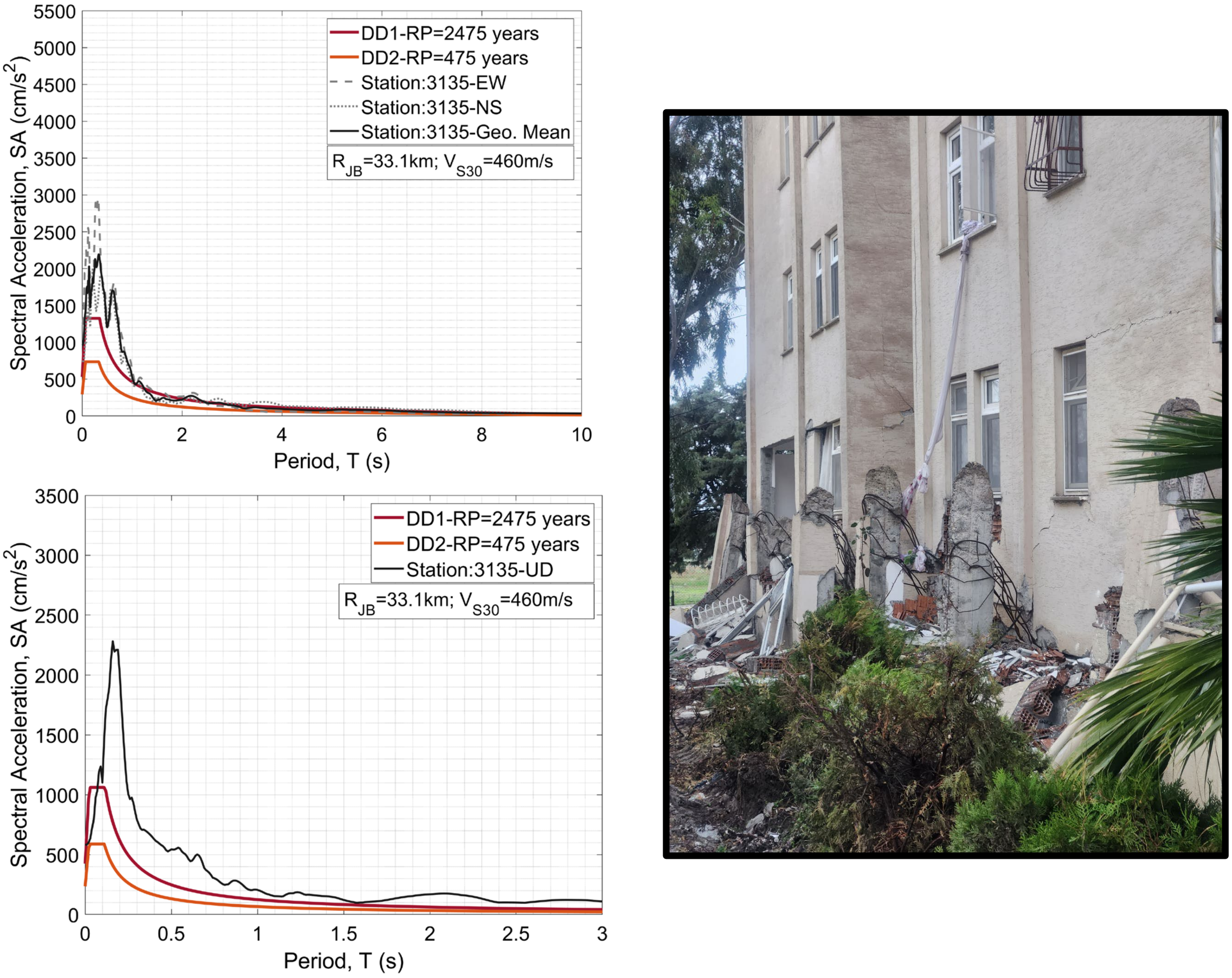


Figure 1: Graphs showing the recorded ground motions at station 3135 compared with Turkish design code; and the observed building damage near the seismic station (EEFIT,2023)

However, there is an opportunity, with the level of engagement and support that is already established to organise and deploy the missions from local academics and professional bodies, to do more. We hypothesise that if we work collaboratively and take advantage of these connections, we can develop innovative approaches and instruments to capture important empirical data from these rare events. One area of interest is macroseismic intensity.

The macroseismic intensity scale is used to assess the intensity of an earthquake's effects on the ground surface and the built environment. Macroseismic datasets are extremely valuable for an overview that couples the level of shaking with the responses of the natural and built environment to the ground motions. The intensity felt can vary greatly depending on the distance from the earthquake's epicentre, local geology, building construction, and other factors. The macroseismic intensity scale relies on observations, reports from the public, and damage assessments to assign an intensity value to a particular location affected by an earthquake. This scale helps in understanding the distribution and severity of ground shaking and its impact on communities and infrastructure. Though we have instrumental data, the coverage of these accelerometers is unfortunately often not at a high enough spatial resolution to help with understanding specific damage levels to specified structure types. The popular USGS Shakemaps are used to help with humanitarian responses and in practice for many global earthquake loss estimation models, depict macroseismic intensity values Though there are platforms like DYFI (described in section 2.1) to capture these macroseismic intensity values from citizen science, there are limitations, and much more can be done from the field.

The Sendai Framework for Disaster Risk Reduction has charged governments to conduct extensive quantitative assessments of future extreme events to understand community risks. To reduce casualty risks and enhance preparedness effectively, these quantitative assessments must be based on a thorough understanding of earthquakes' impact on their population. However, our understanding of these impacts has lagged due to a lack of appropriate casualty data and models. Current earthquake casualty models, like the widely used HAZUS in the US (and adapted abroad) are based at present on a set of ill-defined metrics for medical support. The models also lack proper integration with high-resolution structural analysis to capture critical contributing factors to casualties (Spence and So 2021). These fundamental gaps hinder our ability to understand and model health impacts and healthcare needs following earthquakes, including localised and detailed casualty descriptions and distributions. Without empirical data from the field, it will be near impossible to improve these models and our ability to plan for future events based on analytical assessment alone.

On 6 February 2023 at 4:17 am local time, a large area in southeastern Türkiye and northern Syria was hit by an Mw 7.8 earthquake, which was followed by an Mw 7.5 earthquake at 1:24 pm local time, causing the loss of more than 50,000 lives, some 100,000 injuries and significant damage to buildings and infrastructure, estimated to be in the range of 84.1 billion USD for Türkiye alone. The largest earthquake in Türkiye since the deadly 1939 Erzincan earthquake with however much larger losses, the sequence immediately attracted the attention of the global post-disaster reconnaissance/engineering communities.

The societal impact of earthquakes in Türkiye since 1900 is depicted in Figure 2 (database: EM-BAT, 2023). Although the effects of the 1939 Erzincan and 1999 Kocaeli earthquakes on individuals are notable in this chart, the seismic events in Türkiye in 2023 have left a profound mark on collective memory. Following the 2023 earthquakes, the overall death toll in Türkiye due to seismic activity reached 144,118, with 209,057 reported injuries. Another significant noteworthy statistic is that the total number of individuals affected by earthquakes, which stood at 7.7 million until the 2023 earthquakes, has surged to 17 million level, marking a 220% increase.

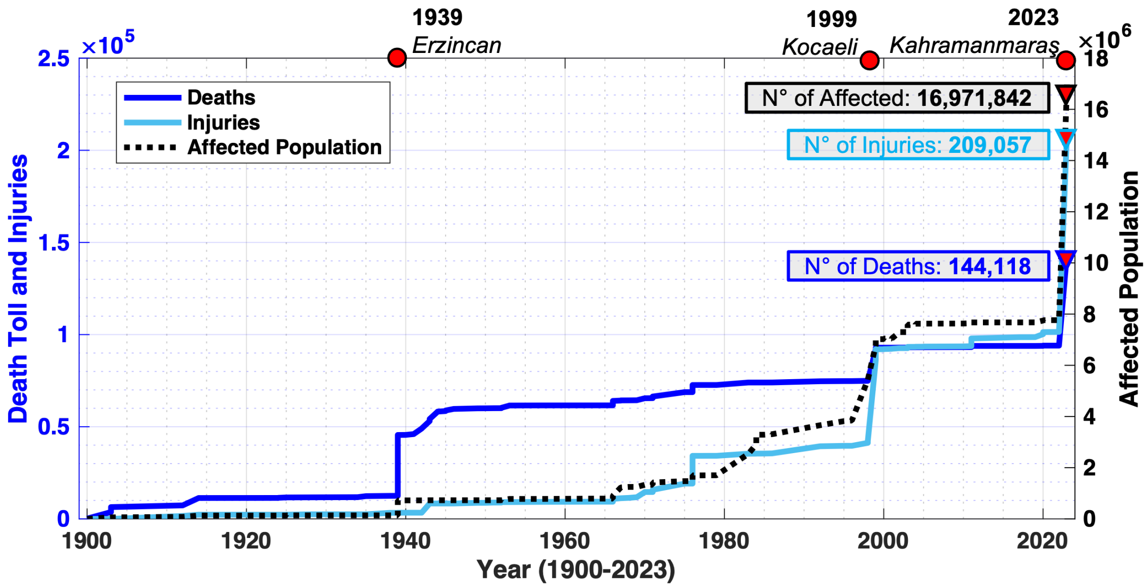


Figure 2: Summary of the societal impact of earthquakes on people in Türkiye from 1900 to the present: Cumulative loss of life, injuries, and the number of affected individuals.

This paper describes efforts to further our knowledge of earthquakes by exploring the possibility of collecting macroseismic and building component-level casualty data from the February 6th, 2023, Kahramanmaraş earthquake sequence. Our approach is interdisciplinary and made only possible by existing partnerships and those built during the EEFIT 2023 missions to the affected areas in March and June 2023, in Türkiye.

2 Post-earthquake data collection

2.1 "Did you feel it?"

The U.S. Geological Survey (USGS) "Did You Feel It?" (DYFI) collects felt reports directly from people in the earthquake-affected area through an online platform. USGS' DYFI has for the past two decades become a popular and standard way for members of the public to contribute to earthquake science and earthquake response and this has since been replicated in other countries, like Italy, Japan, New Zealand, and in the Mediterranean through EMSC (Figure 3).

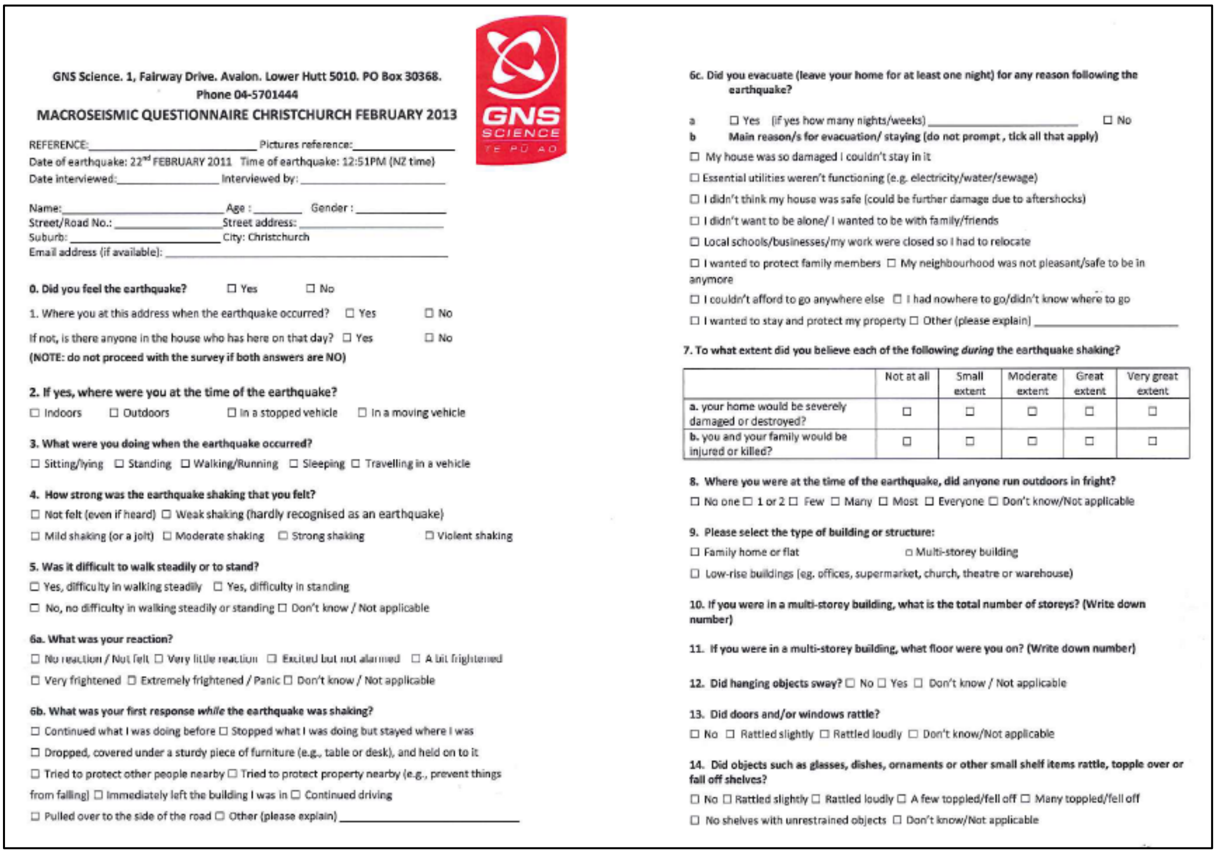
The majority of macroseismic observations around the world are collected by DYFI and its counterparts are for the lower range of intensities, up to VII which accounts for more than 95% of all observations. For these lower intensity values, human perceptions can be used solely for intensity assignments but for higher intensities, as the impact on different types of buildings is needed, evaluation by professionals is needed. DYFI data has been used and deemed helpful for constraining higher intensities in practice (Worden et al.,2018). For destructive earthquakes in some countries in Europe and Japan, dedicated teams have visited the affected areas (e.g. Italy, Greece, Romania, etc) to collect this perishable data with the Japanese Macroseismic Scale and European Macroseismic Scale, but elsewhere not many countries have committed resources to capture of this valuable data. This remains an unresolved issue for many countries where the online platforms are working well but the evaluation and assignment of higher shaking intensities are difficult to attain.

Figure 3: EMSC's online portal to report 'I felt an earthquake' amongst its citizen-science network

2.2 Ground survey

In New Zealand, the macroseismic data collection practices are the same as in the US with the *Felt Basic/ Felt Detailed* system where they rely on crowd-sourced observation assignments for mid-to-lower intensities but require expertise to assign higher intensity values. In 2013 a group at GNS conducted a ground survey to capture building damage from the M6.2 2011 Christchurch earthquake near the strong-motion stations. The questions shown in Figure 4 are based on their online *Felt Detailed* survey. This information, supplemented with other input, became the basis for an update of the New Zealand Ground Motion to Intensity Conversion equation.

The same group at GNS, led by Goded et al., (2019) explored how building inspectors can make use of post-earthquake inspection surveys to capture data required for intensity assignments in the high-intensity range, based on their rapid assessment forms shown in Figure 5.


GNS Science. 1, Fairway Drive. Avalon. Lower Hutt 5010. PO Box 30368.
Phone 04-5701444

MACROSEISMIC QUESTIONNAIRE CHRISTCHURCH FEBRUARY 2013

GNS SCIENCE TE PŪ AO

REFERENCE:________ Pictures reference:________
Date of earthquake: 22nd FEBRUARY 2011 Time of earthquake: 12:51PM (NZ time)
Date interviewed:________ Interviewed by:________

Name:________ Age :________ Gender :________
Street/Road No.:________ Street address:________
Suburb:________ City: Christchurch
Email address (if available):________

0. Did you feel the earthquake? ☐ Yes ☐ No

1. Where you at this address when the earthquake occurred? ☐ Yes ☐ No

If not, is there anyone in the house who has here on that day? ☐ Yes ☐ No

(NOTE: do not proceed with the survey if both answers are NO)

2. If yes, where were you at the time of the earthquake?
☐ Indoors ☐ Outdoors ☐ In a stopped vehicle ☐ In a moving vehicle

3. What were you doing when the earthquake occurred?
☐ Sitting/lying ☐ Standing ☐ Walking/Running ☐ Sleeping ☐ Travelling in a vehicle

4. How strong was the earthquake shaking that you felt?
☐ Not felt (even if heard) ☐ Weak shaking (hardly recognised as an earthquake)
☐ Mild shaking (or a jolt) ☐ Moderate shaking ☐ Strong shaking ☐ Violent shaking

5. Was it difficult to walk steadily or to stand?
☐ Yes, difficulty in walking steadily ☐ Yes, difficulty in standing
☐ No, no difficulty in walking steadily or standing ☐ Don't know / Not applicable

6a. What was your reaction?
☐ No reaction / Not felt ☐ Very little reaction ☐ Excited but not alarmed ☐ A bit frightened
☐ Very frightened ☐ Extremely frightened / Panic ☐ Don't know / Not applicable

6b. What was your first response *while* the earthquake was shaking?
☐ Continued what I was doing before ☐ Stopped what I was doing but stayed where I was
☐ Dropped, covered under a sturdy piece of furniture (e.g., table or desk), and held on to it
☐ Tried to protect other people nearby ☐ Tried to protect property nearby (e.g., prevent things from falling) ☐ Immediately left the building I was in ☐ Continued driving
☐ Pulled over to the side of the road ☐ Other (please explain) ________

6c. Did you evacuate (leave your home for at least one night) for any reason following the earthquake?

a ☐ Yes (If yes how many nights/weeks) ________ ☐ No
b **Main reason/s for evacuation/ staying (do not prompt , tick all that apply)**
☐ My house was so damaged I couldn't stay in it
☐ Essential utilities weren't functioning (e.g. electricity/water/sewage)
☐ I didn't think my house was safe (could be further damage due to aftershocks)
☐ I didn't want to be alone/ I wanted to be with family/friends
☐ Local schools/businesses/my work were closed so I had to relocate
☐ I wanted to protect family members ☐ My neighbourhood was not pleasant/safe to be in anymore
☐ I couldn't afford to go anywhere else ☐ I had nowhere to go/didn't know where to go
☐ I wanted to stay and protect my property ☐ Other (please explain) ________

7. To what extent did you believe each of the following *during* the earthquake shaking?

	Not at all	Small extent	Moderate extent	Great extent	Very great extent
a. your home would be severely damaged or destroyed?	☐	☐	☐	☐	☐
b. you and your family would be injured or killed?	☐	☐	☐	☐	☐

8. Where you were at the time of the earthquake, did anyone run outdoors in fright?
☐ No one ☐ 1 or 2 ☐ Few ☐ Many ☐ Most ☐ Everyone ☐ Don't know/Not applicable

9. Please select the type of building or structure:
☐ Family home or flat ☐ Multi-storey building
☐ Low-rise buildings (eg. offices, supermarket, church, theatre or warehouse)

10. If you were in a multi-storey building, what is the total number of storeys? (Write down number)

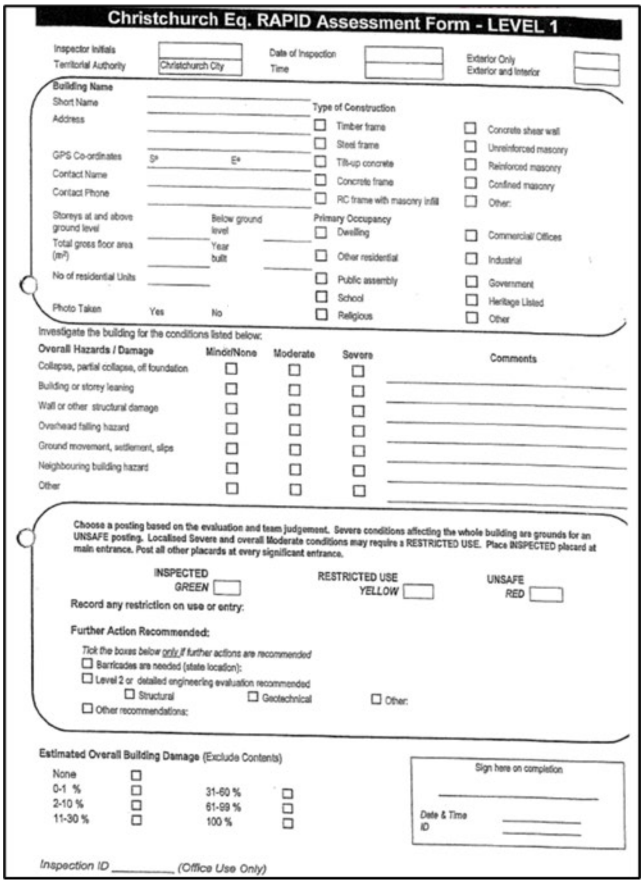
11. If you were in a multi-storey building, what floor were you on? (Write down number)

12. Did hanging objects sway? ☐ No ☐ Yes ☐ Don't know / Not applicable

13. Did doors and/or windows rattle?
☐ No ☐ Rattled slightly ☐ Rattled loudly ☐ Don't know/Not applicable

14. Did objects such as glasses, dishes, ornaments or other small shelf items rattle, topple over or fall off shelves?
☐ No ☐ Rattled slightly ☐ Rattled loudly ☐ A few toppled/fell off ☐ Many toppled/fell off
☐ No shelves with unrestrained objects ☐ Don't know/Not applicable

Figure 4: A ground survey to capture budling damage data after the M6.2 2011 Christchurch earthquake


Christchurch Eq. RAPID Assessment Form - LEVEL 1

Inspector Initials ________ Date of Inspection ________ Exterior Only ☐
Territorial Authority Christchurch City Time ________ Exterior and Interior ☐

Building Name
Short Name ________
Address ________
GPS Co-ordinates S° ________ E° ________
Contact Name ________
Contact Phone ________
Storeys at and above ground level ________ Below ground level ________
Total gross floor area (m²) ________ Year built ________
No of residential Units ________
Photo Taken Yes No

Type of Construction
☐ Timber frame ☐ Concrete shear wall
☐ Steel frame ☐ Unreinforced masonry
☐ Tilt-up concrete ☐ Reinforced masonry
☐ Concrete frame ☐ Confined masonry
☐ RC frame with masonry infill ☐ Other:

Primary Occupancy
☐ Dwelling ☐ Commercial/ Offices
☐ Other residential ☐ Industrial
☐ Public assembly ☐ Government
☐ School ☐ Heritage Listed
☐ Religious ☐ Other

Investigate the building for the conditions listed below:

Overall Hazards / Damage	Minor/None	Moderate	Severe	Comments
Collapse, partial collapse, off foundation	☐	☐	☐	
Building or storey leaning	☐	☐	☐	
Wall or other structural damage	☐	☐	☐	
Overhead falling hazard	☐	☐	☐	
Ground movement, settlement, slips	☐	☐	☐	
Neighbouring building hazard	☐	☐	☐	
Other	☐	☐	☐	

Choose a posting based on the evaluation and team judgement. Severe conditions affecting the whole building are grounds for an UNSAFE posting. Localised Severe and overall Moderate conditions may require a RESTRICTED USE. Place INSPECTED placard at main entrance. Post all other placards at every significant entrance.

INSPECTED *GREEN* ☐ RESTRICTED USE *YELLOW* ☐ UNSAFE *RED* ☐

Record any restriction on use or entry:

Further Action Recommended:
Tick the boxes below only if further actions are recommended
☐ Barricades are needed (state location):
☐ Level 2 or detailed engineering evaluation recommended
☐ Structural ☐ Geotechnical ☐ Other:
☐ Other recommendations:

Estimated Overall Building Damage (Exclude Contents)

None	☐		
0-1 %	☐	31-60 %	☐
2-10 %	☐	61-99 %	☐
11-30 %	☐	100 %	☐

Sign here on completion ________
Date & Time ________
ID ________

Inspection ID ________ (Office Use Only)

Figure 5: A sample RAPID assessment form used for post-earthquake building damage inspections in NZ

Like in the US, seismologists and engineers are not tasked with assigning macro intensity values in New Zealand, whereas there are many mandatory post-earthquake building inspections. It is the hope of the group working on developing an International Macroseismic Scale that this valuable resource can be expanded to capture this important information (Wald et al., 2023) if equipped with the right protocols and tools.

2.2.1 Casualties from earthquakes

Understanding why and how injuries and deaths are caused by earthquakes is essential for mitigating and preparing for future human losses. The best way to gain a holistic view of the causes of injuries, capturing information on a survivor's experiences leading to different severities and types of injuries, is by surveying the survivors of an earthquake. However, like attaining macroseismic intensity data, efforts to capture information on the modes and causes of casualties from earthquakes are rare. This is because collecting representative samples is not straightforward and there is currently no standard procedure or sufficient funding in this research area to ensure data is collected after each event.

An opportunity arose during the EEFIT mission to the affected area of the February 6th, 2023, Kahramanmaraş earthquake sequence in June 2023 for the team to work with the local university in Antakya to survey survivors of the earthquake. Initially, the aim was to carry out a casualty survey, like that designed by So (2011) covering the old river basins where most deaths, injuries, and heavily damaged buildings happened in and around Gaziantep, Antakya, Iskenderun and Adiyaman. The team had planned to survey the affected population in two ways, through NGOs in temporary camps and the mukhtars responsible for each local neighbourhood. We would provide the mukhtars with a list of buildings we would like to sample and the mukhtars will then be asked to provide household-level contact information for residents of those buildings at the time of the earthquake. If the mukhtar did not have up-to-date contact information, a proxy for the household would be sought. We proposed to provide mukhtars with in-kind incentives that can be used for preparedness for their community, e.g., small generators or community response supplies.

The interviewers would connect with the household-level contact provided by the mukhtar to invite them to participate in the survey. The interview would then be conducted where the participants live or if that is not possible, at a location convenient to the interviewee. These interviews would be conducted in pairs so one interviewer could focus on the conversation while the other notes down the responses on their online survey form. As part of the questionnaire, the interviewer would guide the interviewee through a series of questions relating to the actions and circumstances that led to the injury or death of a household member. The interviewer would also gather detailed descriptions of the injuries and the resulting health care. Questions about actions would include intentionally protective ones (for oneself or others) and those taken without the protection intent. The interview would be repeated for each household member who was in the home at the time of the earthquake. The interviewer would take detailed notes and record all interviews that were expected to last between 30 – 60 minutes.

Ground surveys have the advantage of bypassing any language and cultural barriers and can be more targeted in terms of spatial and demographic reach. However, the team was unable to secure sufficient funding for the work[1] and thus we decided to change tact and trial an online survey.

In reviewing the previous questionnaires used on and offline to capture macroseismic data, it became clear that there were overlaps in the questions posed in a macroseismic intensity survey and those used to establish the context leading to injuries and deaths investigated in a casualty survey. The pilot public survey would capture both sets of data and test whether the quantity and quality of the data would be sufficient for macroseismic intensity assignments and further our understanding of the causes and modes of casualties.

2.3 Online surveys

Online surveys can be a valuable tool for collecting data after earthquakes and can help address some of the challenges associated with traditional survey methods related to accessibility, consistency, cost-effectiveness, and scalability, and enable long-term engagements. After the Aegean Sea event in 2019 (Aktas et al., 2022), a local EEFIT team was deployed on the ground to collect building damage data. Concurrently, there was an opportunity to roll out an online survey to supplement the on-site observations. The public survey was used to gauge people's responses to and perceptions of the event. Since the earthquake was felt in Turkey and

[1] funding is currently being sought through NSF with PIs Ceferino and Shoaf

Greece, the surveys were translated into Greek and Turkish and distributed through local newspapers and social media networks. Within 72 hours, 270 and 860 respondents completed the surveys in Samos and the Izmir region, respectively. The surveys addressed the perceptions and behaviour towards seismic and tsunami risk; actual responses of the affected population and buildings to the events; their capacity to respond; and impact and sustained losses. The types and ages of the residential building stock, their occupancy rates, and damage incurred during the earthquake were also attained.

Though the survey was mainly focused on post-earthquake response (roughly half of the respondents reported calling family or friends) and their understanding of the event (most understood the damage was due to badly constructed buildings on poor soils), the quality of the answers gave the team confidence that an online survey has the potential of helping the team determine the severity of shaking and calibrate intensity distribution in the affected area, as well as provide insights into how and why people were injured.

At the time of writing, a team of Japanese seismologists and engineers have also released an online survey in collaboration with Boğaziçi University and supported by the JRapid grant in Japan. The survey is largely based on a pioneering approach by Murakami since the 1990s to apply high precision questionnaire intensity survey method to the Modified Mercalli Intensity Scale (Murakami et al., 1991 and 2015, Koyama et al., 2024).

The Japanese team described the survey to the public as a way of using data statistically to estimate the magnitude of the earthquake locally. The purpose of the survey is to clarify the intensity distribution factors and determine the severity of shaking in each region and neighbourhood. In the preamble to the survey, they state that their ambition was to use these results to develop a new seismic intensity calculation method from a combination of seismic records, structural damage analyses in the strong ground motion zone, and microtremor measurements.Their team was successful in gaining permission from the chiefs of each affected prefecture to complete the survey through their school networks. The questionnaire link was distributed to residents on 9 October 2023, eight months after the earthquakes and data is still being collected, but as of 27/10/2023 more than 10,000 responses have been collected through the ArcGIS123 platform. The number of responses was as follows:

1. Gaziantep province:5651
2. Hatay province:2298
3. Osmaniye province:1380
4. Kahramanmaras province:628
5. Malatya: province:3536
6. Adiyanman province:954
7. Sanliufa province:246

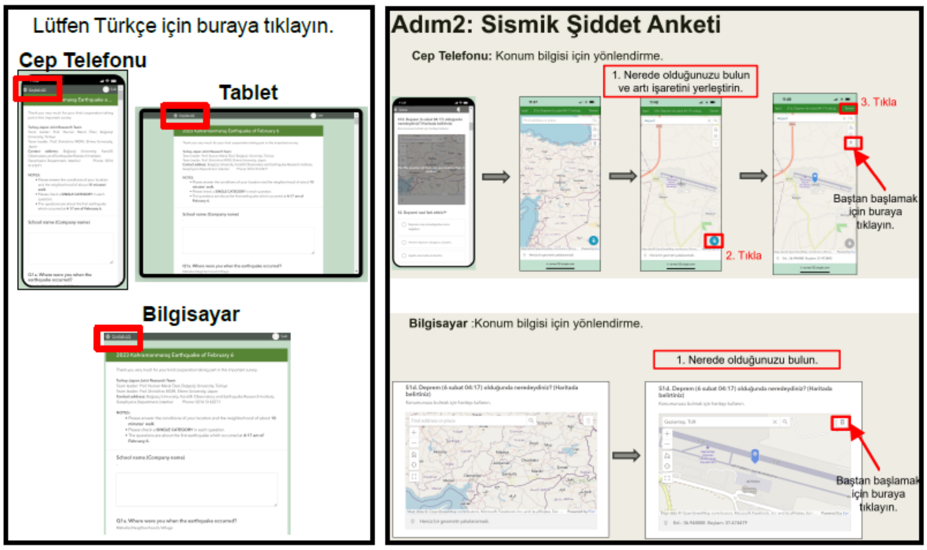


Figure 6: Survey instrument designed in ArcGIS Survey123 by the JRapid team to capture macroseismic intensity data in the affected area of the February 6th 2023 © Saki Yotsui

3 Survey Design

Our final survey design was a compilation of key questions for macroseismic intensity assignments, taken from GNS, USGS, EMS, and JMA intensity work and the casualty survey instrument developed by So (2011). The team decided to solicit data and community feedback on recovery as well, an area of research that lacks empirical data. Information on early recovery can help us gauge if any of the policies and actions in post-disaster management have been led by lessons learned from this or previous events. In addition, comparisons on quality and speed of recovery may be possible if sufficient data is acquired across geographies and demographics. Figure 7 shows the sections and number of questions in the survey.

The team was wary of the lack of appetite and ability to answer such a lengthy questionnaire, so we reached out to a network of psychiatrists in Turkiye who were working in the affected area at the time of the events. Their valuable input enabled us to provide explanations to the questions asked, include more multiple-choice or sliding scale questions, and improve the sequencing of questions. Google Forms was used and a link to the survey was sent by email to a network of local professionals on the 23rd of October 2023, and within a few hours, over thirty responses had been collated.

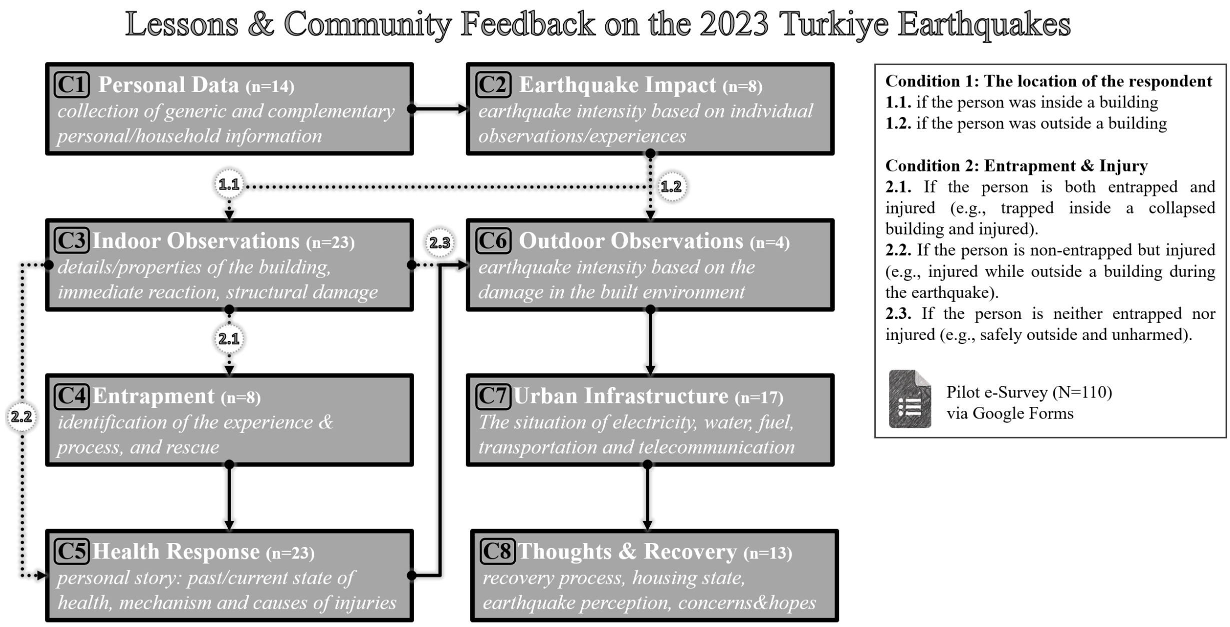


Figure 7: The team's survey design

4 Preliminary results and analyses

In total, 35 respondents completed the survey in our pilot. There was one respondent from Cyprus who responded, but the rest were all from the locally affected area, especially Hatay (n=13) and Gaziantep (n=10) provinces. We were able to obtain good qualitative information on the following from the survey:

- Their location (whether inside or outside a building and the floor they are on).
- The building type, material, number of storeys, and age.
- Damage to non-structural and structural elements of the building.
- Damage in terms of cracking on walls, to severity of overall damage to the buildings %
- Official damage assignment by the Ministry of Environment and Urbanisation
- Construction types in their neighbourhood and levels of damage to different construction material types.
- Whether the respondents self-evacuated, were trapped and who helped them get out.
- Any injury sustained and the number of people injured within their family (%).
- Types of injuries, treatment sought, and current condition.
- Infrastructure damage and service interruptions (impact and duration)
- Current status

Two of the respondents are earthquake survivors and inhabitants of Antakya, where the river basin resulted in extensive levels of horizontal and vertical shaking, they were both trapped and injured due to the Mw 7.8 event. Some prominent points from their responses are given in Table 1. Both indicated vertical shaking was distinguishable, which is evident in accelerometer recordings gathered from the field (Figure 1). While their households were of similar sizes, Respondent 2's household reported more injuries. Notably, Respondent 2's building had illegal removal of columns, contributing to its collapse. Both respondents were trapped in their collapsed buildings, with variations in their entrapment locations. Rescue operations differed, with Respondent 1 being rescued by neighbours after 6 hours, while Respondent 2 was rescued by relatives within 3-5 hours. Injuries ranged from superficial abrasions (e.g., Respondent 2, who reported collapsed structural elements as “all”, including columns, beams, and walls, but they were entrapped in a relatively larger volume and consider the collapse pattern as a factor that helped them to survive) to severe fractures and dehydration (e.g., Respondent 1, who experienced the earthquake on the top floor of a 5-storey building with no known structural interventions. Respondent 1 identified the structural elements causing the injury as “roof” and “walls” and was injured more seriously and hospitalised for a longer period).

In the last section of the survey, two questions were included to examine the post-event hopes and concerns: (1) “*What are your concerns for the future?*” and (2) “*What are your hopes for the future?*”. Text data collected from 35 respondents for these two items were analysed using sentiment and frequency-based word cloud analyses. While the sentiment analysis provides a qualitative understanding of the experiences of participants, the frequency-based word cloud analysis is complementary to this sentiment examination. In conducting the sentiment analyses for both items, it is important to note that ChatGPT (Chat Generative Pre-trained Transformer of OpenAI), an advanced language model, was employed to classify the responses as “positive”, “negative” and “neutral”. This examination of hopes and concerns regarding the future offers valuable insights into the thoughts of individuals in the aftermath of the earthquake sequence.

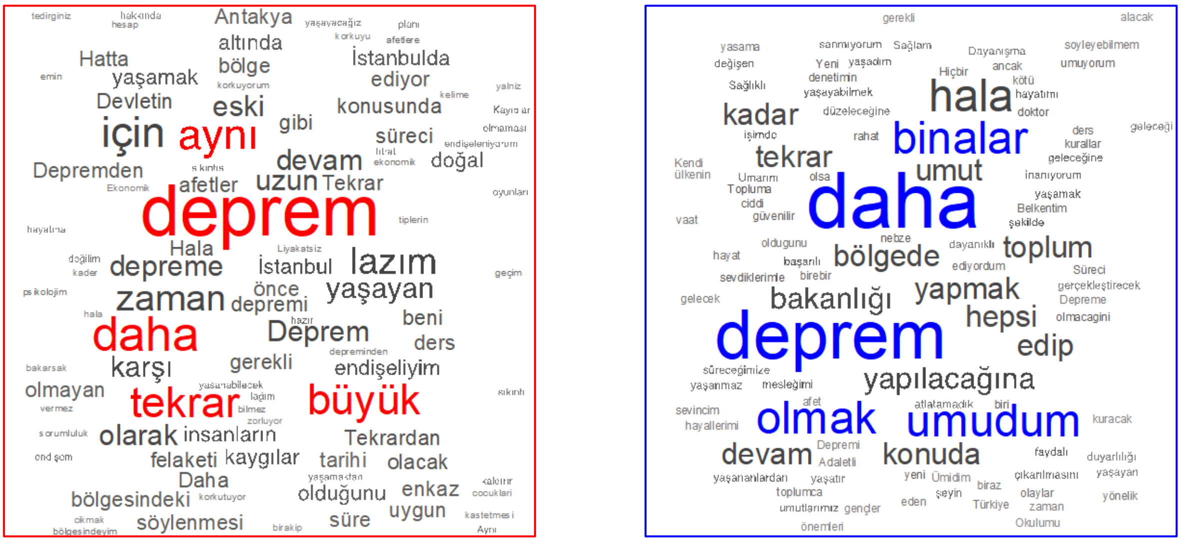
In item (1), sentiment analyses underscore the prevalence of concerns, with a statistically significant number of respondents expressing discomfort about the continued lack of preparedness for such disasters, the psychological consequences of living in an earthquake-prone region, economic hardship, and fears about possible future earthquakes. There is also a significant sense of perceived neglect in learning from past earthquakes, raising concerns that similar or more significant challenges will reoccur. On the other hand, answers that were collected in item (2) for future hopes show a discrete pattern with a variation as exemplified below:

- Positive Sentiments: A statistically notable number of participants express positive sentiments about personal aspirations, such as contributing to society as a doctor (e.g., "*Topluma faydalı bir doktor olmak*").
- Negative Sentiments: There is a statistically significant group with negative sentiments, expressing a lack of hope and unchanged circumstances post-earthquake (e.g., "*Hiç umudum yok. Belkentim de yok. Süreci birebir yaşadım. Hiçbir değişen hala yok*").
- Neutral Sentiments: Some participants express neutral sentiments, indicating a sense of uncertainty or lack of conviction about the future (e.g., "*Umarım bir daha bu kadar kötü olaylar yaşanmaz hala atlatamadık.*").

The frequency-based word cloud analyses are visualised in Figure 8. For item (1), "deprem" (earthquake), "endişe" (concern), "ekonomik" (economic), and "gelecek" (future) are statistically prominent terms. Furthermore, it highlights some other specific future concerns that can be understood by the co-occurrence of words like "İstanbul depremi" (İstanbul earthquake) and "depreme uygun olmayan yapılar" (seismically non-resistant buildings). That suggests a statistical association between fears of a potential Istanbul earthquake, which is expected to take place in the main Marmara segments of North Anatolian Fault Zone, and concerns about non-resistant structures. Responses to item (2) resulted in statistically prominent words such as “deprem” (earthquake), “umut” (hope), “yaşamak” (live), and “gelecek” (future). The semantic connections revealed in terms like “güvenilir binalar” (safe buildings), “dayanıklı” (resilient), and “toplum duyarlılığı” (societal awareness) provide statistical evidence of associations between hopes for a safer built environment and increased societal consciousness.

Table 1. Key findings from two survival stories collected in the pilot e-survey.

Survey Item	**Respondent 1**	**Respondent 2**
Age & Gender	43 & Male	39 & Female
Location	Antakya, Hatay	Antakya, Hatay
Household Size	5 individuals	5 individuals
N° of injured in household	2	5
N° of deaths in household	0	0
"*Can you describe the movement during the earthquake?"*	Horizontal movement (Waving/wobbling left and right), Vertical shaking (A strong shaking up and down)	Horizontal movement (Waving/wobbling left and right), Vertical shaking (A strong shaking up and down)
Structural Typology	Reinforced Concrete	Reinforced Concrete
N° of storeys	5 storeys	8 storeys
Location in the building	5^{th} storey	6^{th} storey
Construction Date	Unknown	2011
"*Select the option that best describes the building you were in during the earthquake*"	A building **without** shop(s) on the ground floor	A building **with** shop(s) on the ground floor
Any known interventions to the structural elements	N/A	Illegal removal of some columns to expand the shopping area on the ground floor.
Damage State of the Building	Fully Collapsed	Fully collapsed
Entrapment location	Corridor	Bedroom
Entrapment position	Lying down the full length.	Lying down the full length.
Approximate size of the volume in which the survivor was trapped	Just a volume as big as me.	It's big enough for one more person to fit in, including me.
Factors that lead to injury	Structural elements, Non-structural elements	Structural elements, Non-structural elements
Which structural elements	Roof, walls	All.
Which non-structural elements	Partition wall	All.
Rescued after	6 hours	3-5 hours
Rescued by	Neighbours	Relatives
Injuries	Dehydration, Open wounds, Crush, Upper extremity fracture, Lower extremity fracture, Kidney problems or kidney failure	Superficial injury (Abrasion), Crush
Hospitalised	19 hours later	Next day
Time in hospital	30 days	21 days
Recovery time	6 months	1 month
Current location	Antakya, Hatay	Antakya, Hatay
Current situation	Living in their own house with 5 people	Living in their relative's house with 13 people
"*What factors do you think contributed to your survival*?"	Other people's help, How the building collapsed	How the building collapsed
"*How long did it take before you were/will be able to return home?"*	7 months later	At least 5 years



(a) Concerns and fears. (b) Hopes.

Figure 8: Frequency-based text analysis of word clouds in Turkish (Words with three or fewer letters were considered as noise and excluded)

5 Limitations and 'terms and conditions'

For our survey instrument, it took at least 20mins (for those who are not entrapped nor hospitalised) to complete. In our ambition to capture as many aspects of the post-earthquake situation as possible, our questionnaire had 110 questions. Though the level of detail was desired, given the insights from this pilot work, we would explore optimisation possibilities. By comparison, the JRapid survey contained only 30 questions in their survey and took around 10 mins to complete. It remains to be seen once their collection and analyses are complete in early 2024 what their results yield and what lessons can be gained from their experience.

It is also important to recognise that online surveys have their limitations. Not everyone in earthquake-affected areas has access to the internet or the necessary technology, and there may be issues with digital literacy. Additionally, online surveys may not capture the perspectives of the most vulnerable or marginalised populations. Therefore, a combination of online with other survey methods would be advocated to ensure a more comprehensive and inclusive data collection effort.

6 Conclusions

At present there is no standardisation of post-disaster data collection and management. It is hoped by drawing attention to the various types of data and trialling the efficacy of data collection methods post-earthquake, this research can serve as a useful resource to provide guidance, data standards, and protocols for post-disaster data collection, to enable data sharing and harmonisation across the international community of post-disaster reconnaissance. Though the sample was too small to assign macroseismic intensities in this pilot study, we were enthused by the level of detail that can be attained from the responses, on the exact location of the respondent, the individual dwelling information, and damage, and that of the neighbourhoods. We hope a continuation of this work will create a possibility for capturing macroseismic intensity data if implemented at a larger scale, which the team is active in seeking to do with a future funding proposal with TUBITAK. We also hope to build a renewed understanding of casualty occurrence in earthquakes, which are currently highly scarce worldwide.

Existing loss estimation models have demonstrated the imperative need for these surveys to calibrate performance-based engineering case studies on earthquake casualties (Ceferino et al., 2018a and b). While the survey will be conducted in Turkey, the resulting dataset will provide a calibration benchmark for assessing casualties in multiple regions.

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