EVENT BRIEFING

Event:	22 June 2022, Afghanistan, Mw 5.9 Earthquake
Region:	Asia

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Key Lessons

- ❏ Although ground motion data from recording stations was not available, USGS ShakeMap and DYFI (Did You Feel It) estimates indicated significant levels of ground shaking. However, these estimations should be used with caution due to the methods used in these predictions, involving equations that relate the human responses to ground shaking.
- ❏ Estimated large shaking in this modest magnitude earthquake can provide a case study for physics-based ground motion simulations.
- ❏ There is a need to establish ground motion recording stations in this region for better characterization of ground shaking in future earthquakes.
- ❏ Many of the traditional houses in the area are made of earthen materials including mud, making them vulnerable to damage. The earthquake coincided with heavy monsoon rain in the region, with rain reducing the strength of these houses and increasing their vulnerability, most of which collapsed or experienced major damage.
- ❏ This is an example of a multi-hazard event and is an indication that climate change-related hazards, the frequency of which increased in the past years, can increase the negative consequences of earthquakes on the built environment.
- ❏ There were a large number of casualties in this earthquake. Reasons for the large number of casualties are: (a) poor quality of structures in the area, (b) estimated shaking at significantly large levels, and (c) time of the earthquake, which is 1:24 am, when most were at home sleeping.
- ❏ This earthquake had a major impact on the community and will adversely affect its recovery, compounding the negative consequences of a year-long drought, recent monsoon rains, and ongoing political and economic instability.

Event Description

On June 22, 2022, at approximately 1:24 am local time, a moment magnitude (Mw) 5.9 earthquake, with a depth of 10.0 km, struck eastern Afghanistan (33.092°N 69.514°E), near the Pakistan-Afghanistan border (Fig. 1a). The nearest city to the epicenter is the Afghan city of Khōst, located 46 km SW of the epicenter (Fig. 1b). The earthquake was followed by several aftershocks, including one with 4.2 magnitude that led to 5 more casualties (CBSNews, 2022). The earthquake resulted in a large number of casualties and injuries. Objectives of this earthquake briefing are: (1) to provide details of the 22 June 2022 Mw 5.9 Afghanistan Earthquake, (2) to describe damage to buildings and disruption to the community in terms of fatalities, downtime, and economic losses, and (3) to list key lessons learned from this international event.

(a) (b)

Figure 1. Epicenter of the 22 June 2022, Mw 5.9 earthquake: (a) per USGS (2022a) and (b) per Popalzai et al. (2022).

Hazard Description

Earthquakes and active faults in eastern Afghanistan and western and northern Pakistan are mainly due to the India plate moving northward at a rate of about 40 mm/yr (1.6 inches/yr) and colliding with the Eurasia plate (USGS, 2022a, Fig. 2). This plate boundary is a good example of a continental-continental boundary and occurred as a result of the collision between the Indian and Eurasian plates, which has pushed up the Himalayas and the Tibetan Plateau. As plate movement has caused these two large landmasses (India and Eurasia) to collide, one plate could not be subducted under the other due to the comparable rock density of these continental landmasses. Instead, the crust tends to buckle and be pushed upward or sideways, leading to the formation of the Himalayas (USGS, 2022b). At the west and south of the Himalayan front, the relative motion between the Indian and Eurasian plates is oblique, which results in strike-slip, reverse-slip, and oblique-slip earthquakes. The pattern of elastic waves that were radiated by the 22 June 2022 earthquake indeed indicates that the event was predominantly strike-slip, either left-lateral slip on a northeast-striking fault or right-lateral slip on a northwest-striking fault (USGS, 2022a).

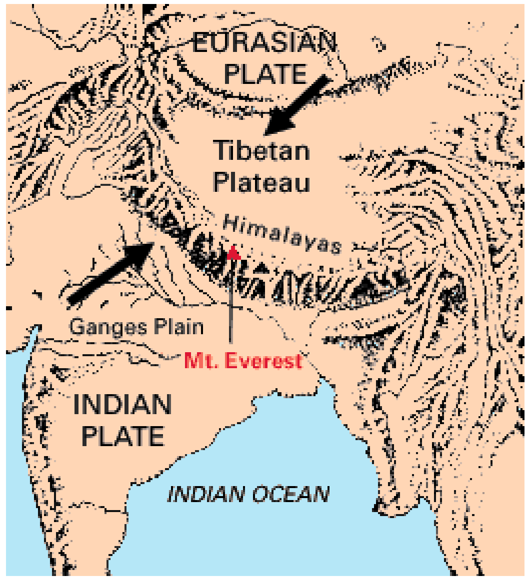

Figure 2. Plate boundaries near the epicenter of the earthquake (USGS, 2022b).

Ground motion data from recording stations is not available; however, according to USGS ShakeMap and DYFI (Did You Feel It), ground shaking due to this earthquake was very large, reaching 1.38g PGA (Peak Ground Acceleration) and 103.86 cm/s PGV (Peak Ground Velocity) in the near-fault region, 10 km away from the epicenter (USGS, 2022a, Fig. 3). These extremely large ground shaking estimates may explain the extent of observed damage and large number of casualties, as discussed shortly. While structures in the region are constructed using non-engineered earth materials, even well-engineered structures could collapse if subjected to such large ground motions.

The magnitudes of these projected ground motions are significantly above the mean + one standard deviation estimates of Ground Motion Prediction Equations (GMPEs) given the relatively moderate magnitude of this earthquake (Fig. 4). This is mainly because the USGS DYFI determines the MMI (Modified Mercalli Intensity) based on human responses and converts it to PGA and PGV, using the relationships between MMI and PGA & PGV (e.g., Worden et al., 2012). These relationships are region-specific and they are only available in certain regions, e.g., California. Therefore, the usage of these equations in other regions can be misleading, e.g., same MMI can correspond to a smaller PGA in Afghanistan compared to California because of the characteristics of the infrastructure and the felt responses. Therefore, these estimates should be used with caution. This indicates the need for establishing ground motion recording stations in this region and potentially relationships between MMI and PGA &/or PGV. Furthermore, these results can provide an important case study for physics-based ground motion simulations to evaluate these estimates, if sufficient geophysical data is available in the region.

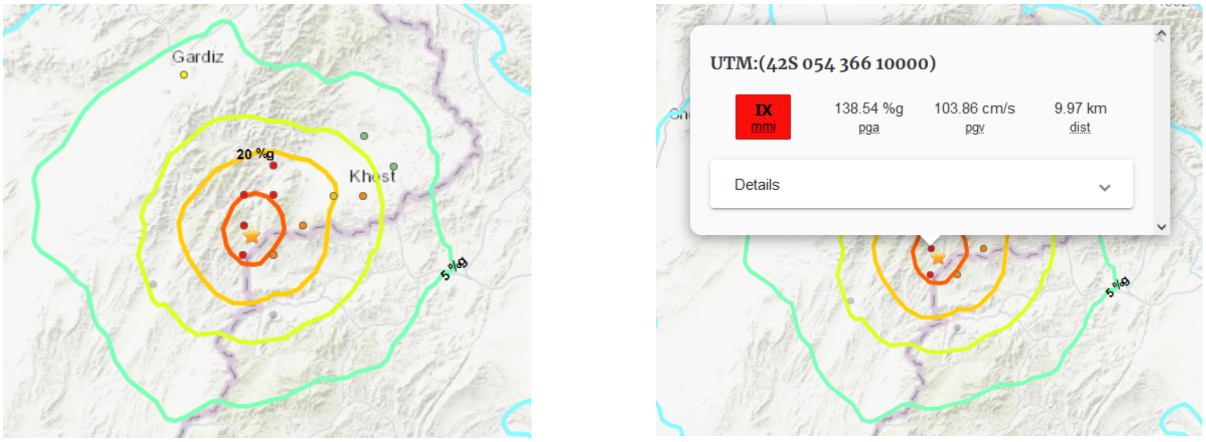

Figure 3. USGS ShakeMap (left) and DYFI (right) ground shaking estimates (USGS, 2022a).

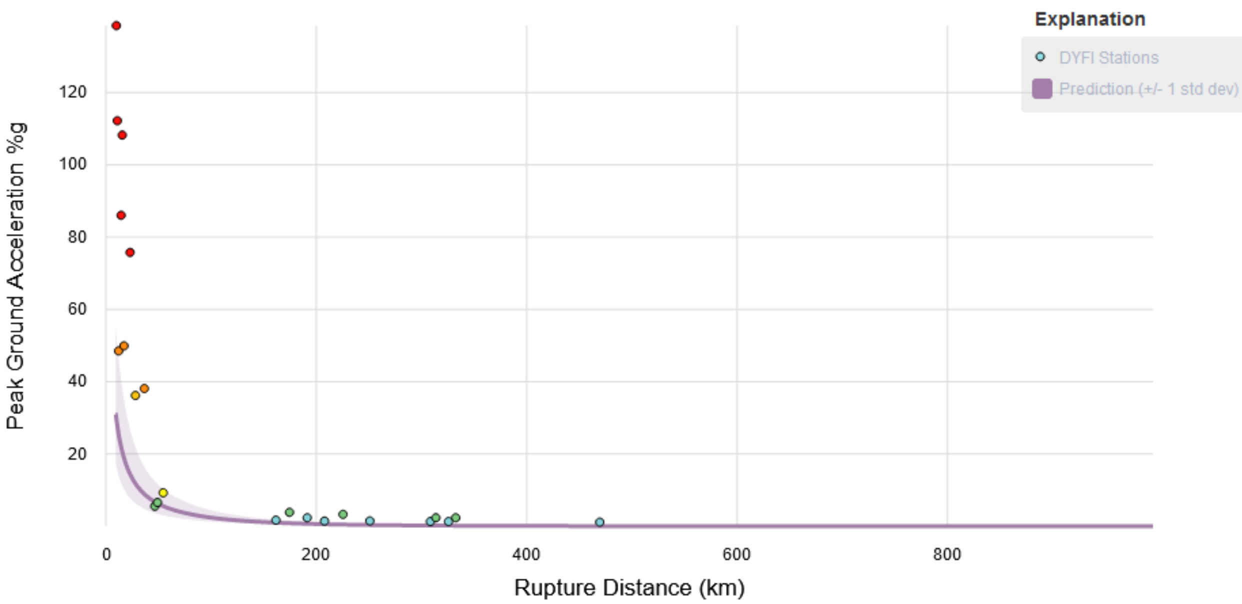

Figure 4. Comparison of DYFI ground shaking estimates with those of GMPEs (USGS, 2022a).

Damage to Structures

Photographs from Paktika and Khost provinces (Fig. 5) show completely or partially collapsed houses (CNN, 2022; Norooz, 2022). Many of the traditional houses in the area are made of masonry, mud or other earthen materials, making them vulnerable to damage. The earthquake coincided with heavy monsoon rain in the region, with rain reducing the strength of these structures and increasing their vulnerability, most of which collapsed or experienced major damage (Popalzai et al., 2022), highlighting a notable multi-hazard effect. At least 4 of 19 districts in Paktika experienced severe damage, and officials reported 1,700 homes that were in need of total rebuilding (Latifi, 2022).

Figure 5. Collapsed masonry and earthen homes in Paktika & Khost provinces (Popalzai et al., 2022; Noroozi, 2022).

Community Impacts

More than 1,000 people were killed and another 1,600 others injured in this earthquake (Padshah et al., 2022). Reasons for the large number of casualties are: (a) poor quality of structures in the area, (b) projected large levels of ground shaking, and (c) time of the earthquake, 1:24 am local time, when most were in their homes sleeping. This earthquake had a major impact on the community, adding to the negative consequences of a year-long drought followed recently by monsoon rains and ongoing political and economic instability.

USGS PAGER tool estimates of fatalities and economic losses are shown in Figure 6, with fatalities between 1,000 and 10,000 with a probability of 35%, binning the actual fatalities in excess of 1000. However, it is noted that these PAGER estimates were updated as more data became available within hours of the earthquake. PAGER similarly estimated the economic losses to be between $100 million and $1,000 million, which is likely true considering the needed reconstruction and community rebuilding activities.

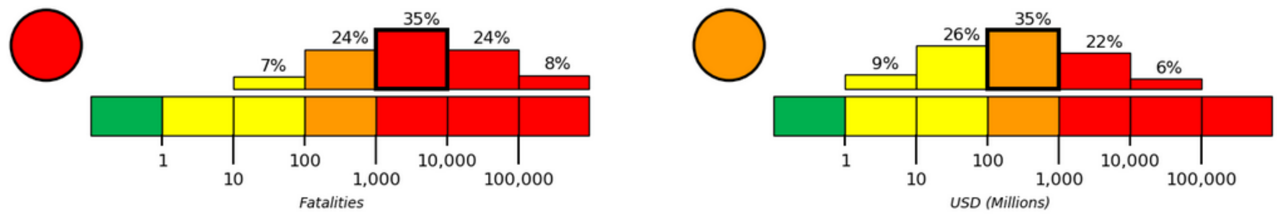

Figure 6. USGS PAGER loss estimates (USGS, 2022a).

StEER Response Strategy

At present, StEER has assigned this event a Level 1 (virtual) response; based upon the information assembled in this briefing, StEER does not deem it necessary to form a Virtual Assessment Structural Team (VAST) or Field Assessment Structural Team (FAST) in response to this event. This decision does not diminish the gravity of this event, particularly in light of the numerous lives lost and countless others who will struggle with recovery in a very challenging context. Sadly this event reinforces the persistent vulnerabilities that manifest in the building inventory across low-to-middle income countries. StEER's present response takes the form of this Event Briefing to reiterate these tragic lessons. Information provided herein is based on various websites, news channels, and USGS. It does not include detailed field investigations. StEER will continue to monitor the event and, if necessary, will activate a Virtual Assessment Structural Team (VAST) to collect and process additional public data relating to this earthquake in support of a Preliminary Virtual Reconnaissance Report (PVRR).

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