Engineering Attributes of Ground Motions from February 2023 Türkiye Earthquake Sequence

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Outline

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- Available Ground Motion Data
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- Spatial Analysis of Ground Motion Intensity Measures
- Summary & Conclusions

Events Considered for Ground Motion Analyses



February 20, 2023 (17:04 UTC) – M6.3 (17:04 UTC)

Hundreds of M4.0+ aftershocks (not considered)





Available Ground Motion Data

Unprocessed data provided by:

- Disaster and Emergency Management Authority (AFAD)
 - TK: Turkish National Strong Motion Network (TNSMN)
 - TU: National Seismic Network of Türkiye (DDA)
 - KO: Kandilli Observatory (KO) Regional Seismic Network
- Incorporated Research Institutions for Seismology (IRIS)
 - Other networks: CQ, GE, GO, IM, IU, and MP







Comparisons of Data to Ground Motion Models

Global model:

- Boore et al (2014; BSSA14)
- Regional adjustments for anelastic attenuation:
 - Global average
 - Türkiye slower attenuation / shallower rate-of-change
 - Italy faster attenuation / steeper rate of-change

Türkiye-specific model:

- Kale et al. (2015; KAAH15)
- Regional adjustments for anelastic attenuation:
 - Türkiye faster attenuation / steeper rate-of-change
 - Iran slower attenuation / shallower rate of-change



Comparisons of Data to Ground Motion Models



Spatial Correlation Models

Account for the effect of Euclidean (d_E) and azimuthal distance (d_A) between two given locations ($\rho_{EA} = \rho_E \cdot \rho_A$)



(courtesy of Renmin Pretell)

Within-Event Residual Maps: $\delta W_{ijk} = R_{ijk} - \eta_{E,jk}$

Comparison to Boore et al. (2014; BSSA14)

weaker-than-average

average

stronger-than-average



Summary & Conclusions

- The 2023 Türkiye Earthquake Sequence was a catastrophic event, however the data recovered from it have proved to be insightful
- Observations from these events suggest event-specific effects and complex path effects in these regions, uncaptured by existing GMMs
- Within-event residual maps provide a useful way to look at spatial variability of ground motions, and can be used to provide reliable estimates at sites-ofinterest without recorded observations:

$$\ln(\hat{y}_{ij}) = \ln(y_{ij}) + \eta_{E,i} + \delta W_{ij}$$

prediction = GMM-estimate + event-bias + within-event-residual (map)

Thank You

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Assembled ground motion data/metadata available at:

Buckreis T, B Güryuva, A İçen, O Okcu, A Altindal, M Aydin, R Pretell, A Sandikkaya, Ö Kale, A Askan, S Brandenberg, T Kishida, S Akkar, Y Bozorgnia, and J Stewart (2023) "Ground Motion Data from the 2023 Türkiye-Syria Earthquake Sequence." DesignSafe-CI. https://doi.org/10.17603/ds2-t115-bk16

Much of the technical content shown in this presentation will be available in:

Buckreis TE, R Pretell, MA Sandikkaya, Ö Kale, A Askan, SJ Brandenberg, and JP Stewart (accepted) Engineering attributes of ground motions from February 2023 Türkiye Earthquake Sequence, Earthquake Spectra (Turkey Special Issue)

Spatial correlation models and Python tools available at:

Pretell, R, T Buckreis, S Brandenberg, and J Stewart (2024) "Spatial correlation models for ground motion intensity measures of the 2023 Türkiye-Syria Earthquakes." DesignSafe-CI. <u>https://doi.org/10.17603/ds2-27yr-5m86</u>