National Seismic Hazard Model Project (NSHMP) 2023 50-State NSHM Update Kickoff Meeting
Teams Live Event Q&A

These questions were submitted to the Teams Live Event via the Q&A function that all meeting participants had access to during the live meeting. Questions were received and approved by the moderators (NSHMP Team), and if relevant to the general discussion, posted for all meeting participants to view throughout the meeting. If there was time after a presentation, relevant questions were read out loud to the presenters, in which case they answered the question(s) live. Other questions were answered live during the General Q&A session at the end of the meeting. NSHMP Team members also had the ability to answer questions by writing responses into the Q&A function. Answers to questions not answered live are also shown here, by listing the NSHMP Team member who answered the question and their response.

Note: Questions and answers have been lightly edited for grammar and punctuation. Participants had the option to identify themselves when asking questions and these names are included here. Timestamps noted below correspond with the meeting recording.

Overview – Mark Petersen and Peter Powers (Presenters)
- James Bela: Could you state Problems Solutions Benefits to just the model. How is an update vetted?
- Jason Altekruse: In general, we will be addressing questions at the end of each presentation. Thank you.
  - Jason Altekruse: If there isn't time at the end of each presentation, we have time scheduled at the end of the meeting for Q&A.
- Anonymous: You said this meeting recording would be available online. Are recordings of the meetings from last fall available?
  - Allison Shumway: I do not think there are recordings from these meetings. There are slides from the Hawaii Workshop on our website and contact information for Alex Hatem from the Geology meetings.
    - Allison Shumway: https://www.usgs.gov/natural-hazards/earthquake-hazards/nshmp-workshops.
- Frank Gonzales: Will presentations be available online?
  - Allison Shumway: The recording will be available online. We can also put up the slides, if people are interested in those.
    - Frank Gonzales: Hello. Yes! It would be great if the presentation is made available after the meeting. Thanks!
- Michael Hamburger: How (or whether) will secondary effects (e.g., landslides, liquefaction) be incorporated or added to the hazard mapping process?
  - Mark Petersen and Nico Luco responded live during General Q&A section (see 1:45:47 in meeting recording).
- Emel Seyhan: Peter, are you planning to include basin site period or sediment depth (or Zxx) data layers under Site Data (assuming either will be used in basin modeling)? That would be very helpful.

- o Peter Powers: Hi Emel. Yes, currently the basin data used in the 2018 model is available via web service, but not broadly advertised. We plan to expand public support/access for all site parameters in the coming year.

Earthquake Rupture Forecast - Ned Field (Presenter)

- James Bela: What is improved (more uniform) representation of epistemic uncertainty? How do you evaluate if it achieved?
    - o Ned Field responded live (see 00:40:15 in meeting recording).
- James Bela: If it's uncertain, isn't it still uncertain?
- James Bela: Every time you add complexity to a model, aren't you necessarily increasing uncertainty?
    - o Ned Field responded live (see 00:41:08 in meeting recording).
- James Bela: What is the "problem" addressed by Earthquake Rupture Forecasts?
- James Bela: How long is long-term? Is it wedded to GR Law?
    - o Ned Field responded live (see 00:42:57 in meeting recording).
- John Anderson: Are all the names on your slides USGS employees?
    - o Allison Shumway: Hi John, most of them are but we do work with external people as well. When I post the slides, I will try to put full names and affiliations.
- Frank Gonzalez: Probabilistic tsunami generation modeling is making progress, but there are still fundamental seismic modeling issues that need attention. In the general context of the GMMs being discussed here, these would be offshore, lower frequency GMM. What part of the 2023 plan might address this ?
    - o Morgan Moschetti responded live during General Q&A section (see 01:48:10 in meeting recording).
    - o Morgan Moschetti: Are you referring to tsunami earthquakes, with distinct rupture processes? The NSHM seismic source models only include sources that have the potential to cause strong ground shaking. I do not know if ground motions from tsunami earthquakes are included in recent (NGA-Sub) GMMs. Certainly earthquakes that have caused strong ground shaking and tsunamis, such as Tohoku, are included. Peter Powers may be able to address these events for Alaska.
- Norm Sleep: It would help to state explicitly what is NOT in the models. There does not seem to be flexural earthquakes in the basement of the Central Valley. The E-W thrust north of Redding is included. Is the Coast Range thrust included? How? It is somewhat blind but a Redding to Buttonwillow break would be a low 9. These are all long recurrence but very large events. Interesting for critical structures. Will Canadian physicis based model be applied to deglaciated margin in New England?
    - o Mark Petersen responded live during General Q&A section (see 01:56:41 in meeting recording).

Ground Motion – Morgan Moschetti (Presenter)

- Anonymous: Will you please also save and share the chat comments from the meeting. Thank you.
    - o Allison Shumway: We can do that, yes.
- James Bela: Do you have pictures of who the presenters are? It's pretty unusual in a virtual meeting not to have any visual connection to the presenter.

- o Jason Altekruse: We understand. During our tests of the platform, we found that including the presenter's web cams caused some issues. We plan to share web cams during the Q&A session at the end of the meeting.
- Jim Flournoy: Are we considering hillside and hilltop amplification? Thanks.
  - o Morgan Moschetti responded live during General G&A section (see 01:49:18 in meeting recording).
- Emel Seyhan: Hi Morgan, will you be able to include directivity models in WUS in this cycle?
  - o Morgan Moschetti responded live (see 01:10:58 in meeting recording).
  - o Morgan Moschetti: We can't currently commit to whether these will be included or not. We plan to compute seismic hazard sensitivity test with simple directivity effects for consideration and discussion with the community at future webinars/workshops.
- Jim Flournoy: Is a site sitting on top of a basin edge subject to increased hazard especially increased vertical hazard when waves reflect back (or up)?
  - o Brad Aagaard: As Morgan just mentioned, basin edge effects and shallow basins will be considered for inclusion in the 2023 update.
- Alireza Soltani: Will the vertical component of ground motions be considered in new updates?
  - o Peter Powers: Possibly; vertical ground motion is not a target product for 2023, but given support for vertical component in GMMs or reasonable horizontal to vertical conversions we will consider adding support in our codes (in the same way that we are currently working on adding support for PGV)
- Anonymous: The 2018 version of the NSHMs set a minimum threshold for Z1.0 and Z2.5 as the default values in the NGA relationship. According to developers this is not intended to be the minimum, will shallower Z1.0 and Z2.5 values be considered in places such as the San Francisco Bay Area?
  - o Brad Aagaard: Yes, in places where we are using non-default values for Z1.0 and Z2.5, such as the San Francisco Bay region, we want to address what to do when Z2.5 is less than 3 km.
- Emel Seyhan: Morgan, sorry if I missed. Are you going to revise WUS-CEUS boundary?
  - o Allison Shumway: Hi Emel, we are planning to update it, yes.

Alaska and Hawaii NSHMs - Peter Powers and Mark Petersen (Presenters)
- James Bela: Since site effects are, as a rule, dependent upon source properties that are a consequence of the tensor nature of the motion equation, won't the uncertainty be large in trying to include site effects into a probabilistic model?
- Dave Jackson, UCLA: In Alaska, what fraction of large earthquakes (6.5+,say) can be clearly associated with previously known faults. Where there are surface ruptures or geophysically identifiable rupture geometries, do those agree with the faults section boundaries?
  - o Peter Powers: Hi Dave, yes, for most but I don't know if all do; I will add it to our fault model verification; to date, updates to the fault model has focused primarily on adding data/faults from recent publications and the work of Koehler and Carver (AK misc. pub).
- Anonymous: Can support be added for Arias intensity in a similar manner as PGV?
  - o Brad Aagaard: Most, if not all, of the ground-motion models used, such as those from NGA-West2, include ground-motion metrics PGA, PGV, and spectral acceleration at various periods, but not Arias intensity. Model developers are starting to look at

additional ground-motion metrics, such as Fourier amplitude spectra. If they start including Arias intensity, then it could be included in the NSHM.

- o Peter Powers responded live during the General Q&A section (see 02:02:32 in meeting recording).
- James Bela: Doesn't slip-rate transfer to "earthquake cycle" and "elastic-rebound" postulated models - but which are scientifically discredited in the literature, as well as by occurrence of actual earthquake seismicity?
- James Bela: Why are NSHMs imposing GMMs on subduction zone megathrust event, given that ground motions (from experience) are variable . . from huge to not-so-bad?
  - o Morgan Moschetti: The NSHM uses subduction GMMS that account for the ground-motion variability that has been observed in recordings. For 2023, this will include NGA-Sub GMMs developed from recent recordings of the M9 Tohoku-oki, M8.8 Maule, and many other earthquakes. Is there a feature of subduction megathrust earthquakes that you consider not well modeled by these GMMs?
- Alireza Shahjouei: Do the Alaska and Hawaii seismic update are going to be in B/C boundary condition or the site amp factors are included?
  - o Peter Powers: Starting with the 2018 CONUS model and for all models going forward, we support all NEHRP Site classes and boundaries (Vs30 150-1500 m/s) and 22 spectral periods. Additional intensity measures are also being worked on.
- James Bela: What are the Magnitudes of historical Hawaii earthquakes, and what is the maximum potential magnitude?
  - o Mark Petersen responded live during the General Q&A session (see 01:50:16 in meeting recording).
  - o Brian Shiro: The Klein and Wright catalog is used for pre-1959, and HVO catalog for post-1959. Magnitudes are mostly Ml and Md, but larger events use Mw, Ms, or Mb. Max potential magnitude was discussed in detail in the Hawaii workshop. Based on decollement fault area, M8.0 is the rule of thumb, and I think that was going to be padded up to M8.2, but others can correct if I'm wrong on that detail.

Engineering & Risk – Nico Luco (Presenter)
- James Bela: What is statistical seismicity? What makes it statistical? Statistics is useful in guessing, when you don't know the answer, but practical only if some phenomenon has an average value - which is probably not useful in reliable seismic hazard assessment.
- Norm Sleep: General comments on nonlinearity: (1) Structural failure is highly nonlinear. That is, failure is associated with peak dynamic stresses within structure. Fourier spectra are not then eigenfunctions. Excessive concentration on the frequency domain may obscure this feature. (2) Nonlinearity of seismic waves is not local to the site. LA basin waves are basically 3-4 s Love waves. Roten models show nonlinity beneath Whittier Narrows affacets amplitude in central LA. Near-fault nonlinearity occurs in near-field velocity pulse. Energy is dissipated. The gross rupture may be affected. Again see Roten models. Site effect models will wanting.
  - o Morgan Moschetti: We only include these near-source nonlinearity to the extent that they are represented in ground motion databases and therefore empirical GMMs. Nonlinearity at sites are represented by site information (Vs30).
- James Bela: M 6.7 - M 6.9 earthquakes have Io = VIII/IX pga .5-.6g. shouldn't that eventuality be accommodated in the building code, if the NSHM values are variable?

General Q&A (see 01:44:50 in meeting recording)

- Emel Seyhan: Regarding loss modeling topic, I'm curious about your scope: 1) Are you moving away from HAZUS and develop your own fragility curves? 2) Are you going to make US based risk map layers similar to hazard maps?
    - Simon Kwong: Hi Emel, thanks for your questions. (1) No, we are not planning to develop our own fragility curves. (2) No for the time being.
- Jeff Bayless: Thanks to the presenters. To Morgan and maybe Mark: You discussed briefly rupture directivity and the alternative directivity models that will be considered. Can you go into a bit more detail on the plan for testing and implementing these models? Thanks.
    - Morgan Moschetti responded live (see 01:51:25 in meeting recording).
- Anonymous: Will it be possible to share the updated source model for Alaska prior to publishing of the SHMs?
    - Peter Powers and Ned Field responded live (see 01:52:30 in meeting recording).
- Anonymous: To Ned/Mark: To limit the complexity in multi-fault scenario model, does it make sense to define a limited number of representative faults for different regions and after all work you guys do, map the mag-rates to those representative faults.
- Alireza Shahjouei: Luco- what are the impact scenarios you are planning to potentially include on the risk assessment?
    - Nico Luco and Mark Petersen responded live (see 01:54:20 in meeting recording).
- James Bela: GAO is reviewing the acceptability of presenting USGS NSHM information in (pay to attend) professional association and society meetings, rather than independently under the Congressionally authorized NEHRP program. Similar review is occurring regarding publication in journals outside of USGS, which, so far at least, have not challenged the non-scientific aspects of the 50+ year old PSHA model. The goal should be to publish only as USGS Professional (not draft as the first NSHM was printed) .
    - NSHMP Comment: Papers authored by USGS scientists in scientific journals should be available free to the public. It seems that some older (and newer?) papers published in *Earthquake Spectra* are not freely available (requiring subscription or fee to journal). The NSHMP will look into this and get this corrected.
- Yajie Lee: For added epistemic uncertainty for GMM, one issue we often encounter in ground motion simulation for risk assessment is that, when compounding with aleatory uncertainty (up to 3 sigma), it can produce extremely large ground motions, which may be "physically impossible". Any consideration on some physical constraints in compound impact in handling these uncertainties in future updates?
    - Morgan Moschetti responded live (see 01:58:16 in meeting recording).
- Mike Tong: Question for Nico: The 2020 NEHRP Provisions and ASCE7-22 have adopted 22 period multiperiod spectra, so far MPRS data are only available for conterminous US, will USGS plan to develop MPRS data for non-conterminous US sites? If so, any timeline?
    - Nico Luco responded live (see 01:59:23 in meeting recording).
- Norm Sleep: FYI: With regard to last question there is scaling relationship. Coulomb stress ratio is dynamic acceleration in g's. This apply to frictional materials not ductile mud. Tensional P-waves above 1 g cause absolute tension. Records sometimes clip on tensional half cycle near 1 g.
- Norm Sleep: To all. Thanks. My intent is to get comments to committee.

After Meeting Concluded

- James Bela: Can site response be predicted? Boore (2004), in posing this question points out that "because the soil amplifications can be as large as a factor of ten, they are important in engineering applications that require the quantitative specifications of ground motions. What is often missing in these studies however," as he points out, "are dussions of the uncertainty of the predicted response." Observational studies of site response (site effects) have demonstrated that ground motions have both: (a) "large site-to-site variability for a single earthquake," and (b) "large earthquake-location-dependent variability for a single site." -- and that therefore (c) "this variability makes site-specific, earthquake-specific predictions of site response quite uncertain, even if detailed geotechnical and geological information is available near the site." Alternatively, however, "predictions of site response for average classes of sites exposed to the motions from many earthquakes can be made with much greater certainty if sufficient empirical observations are available." (e.g. lemente-Chavez 2014 and Poggi et al 2017). Therefore site response needs to be evaluated for scenario sources to determine if practical for general maps.