What should we be rethinking?

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The title of this session, "Rethinking PSHA," appears to suggest that there may well be significant problems in PSHA. However, we think that this title understates the true extent of the problems. In a recently published paper (F. Mulargia, P.B. Stark & R.J. Geller, "Why is Probabilistic Seismic Hazard Analysis—PSHA—still used?," PEPI, 2016, http://dx.doi.org/10.1016/j.pepi.2016.12.002, cited as MSG16 below) we argue that, because its basic assumptions disagree fundamentally with the observed phenomenology of earthquake occurrence, PSHA should be abandoned, rather than just "rethought."

The case made by MSG16 rests on the following three main points. (1) PSHA makes assumptions that contradict what is known about seismicity. (2) PSHA fundamentally misuses the concept of "probability." (3) In practice PSHA does not work; many recent destructive earthquakes occurred in regions that PSHA identified as low risk. We hope that researchers who disagree with MSG16 will present detailed arguments, based on physics and observed seismic data, to explain why they disagree.

PSHA allows all of the information provided by geologists and seismologists to be aggregated and used as the input to a "black box" procedure for providing curves that give the relation between ground motion parameters and "return periods" at a particular site. Engineers can then use these curves as the basis for choosing the design parameters of structures without having to get involved in the details of the Earth-science related issues. PSHA thus serves as a seemingly objective "due diligence" procedure, which neatly separates the roles of Earth scientists and engineers. As long as engineers design their structures to meet the specified "return periods" they are regarded as having fulfilled their obligations, as are the various stakeholders (owners, operators, government regulators, etc.). The fly in the ointment, of course, is that even though PSHA has been used for about 50 years its scientific validity has not been established, and, furthermore, as noted by MSG16, it is highly questionable.

In our opinion, what we as a community should be rethinking is not PSHA, but rather the much broader question of how, in view of the great uncertainties, society should be choosing design standards for earthquake-resistant structures. We think the answer does not lie in making minor (or even major) adjustments to PSHA as now practiced and relaunching it, as the problems go far deeper. What has to happen instead is that rather than leaving the choice of earthquake design criteria up to only geoscience and engineering consultants, all participants—including project developers and owners, risk managers, engineers, and architects—have to "take ownership" of the inherent uncertainties of earthquake hazards, rather than simply tasking everything to geoscience and engineering consultants. In recent years administrative procedures in the European Union have adopted what is called the "precautionary principle." The implementation of this principle in individual cases is still evolving, but it may provide some guidance.

In the past 50 years PSHA has grown into a minor industry, and we recognize that there may be strong resistance to our call for its abandonment. However, the facts must be squarely faced: PSHA is based on flawed physical models, and its hazard forecasts do not agree with subsequent seismicity. That being the case, a new way forward must be sought, starting anew from square one. Given the present inability to

reliably predict which regions are particularly at risk, perhaps we should start by identifying seismically weak structures everywhere and then making systematic efforts to replace or reinforce them.

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