OPINION

PREDICTABLE DEBATE

We scientists often make the philosophical argument that technically informed debate on socially relevant issues is in the public interest. Left unsaid is how disagreement is resolved under the glare of public scrutiny, and in what venue. It will surely not have escaped the notice of the SRL readership that "earthquake prediction" is being debated in the peer-reviewed as well as the public press, not to mention professional meetings and workshops, and that the debate has become polarized, at least from the lay point of view. Can earthquakes be predicted? This is what society wants to know, yet most of us think that this question is not properly posed. But declaring earthquakes to be "unpredictable" does a disservice to the state of our science and, quite frankly, doesn't do the public any good. However, do we structure our answer by hedging, or do we try to reformulate the question? And how do we put boundaries around our uncertainty so that society can act in the near term?

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The immediate precursor to the current level of debate appears to be the spotlighted focus on a particular methodology for predicting earthquakes, but more general meetings, symposia, and workshops have been held within the last several years to address a host of issues in earthquake science. The latter have occurred because there now seems to be an undercurrent of acknowledgment within the community that advances in non-linear physics, phenomenological observation, and laboratory experiments have accelerated in recent years. Our colleagues practicing "earthquake physics" may not agree that a unified event model is in sight, or even plausible, but I would argue that awareness of the potential for advance is at its highest point in two decades. The Committee on Seismology's upcoming report on earthquake science is one product trying to focus this awareness. Moreover, there has been remarkable recent progress in characterizing multi-decadal scale processes of plate boundary deformation, particularly in Southern California. Underlying all of this has been a steady flow of work studying spatial and temporal characteristics of seismicity. This burgeoning awareness, coupled with new seismological and geodetic instrumentation initiatives, smells like a mini-revolution in the making. It's an exciting time, and collectively we should be proud of the work.

But is it time to debate these scientific issues to their resolution with respect to the occurrence of earthquakes? No, the field is not ready. We should not be arguing over predictions (except to validate those that work and those that don't) but rather allow the most basic nature of predictability to unfold. Watching public pronouncements of predictability has itself been a predictable exercise. We must be wary of the trap of the extrapolated null hypothesis, which can be deadly when arguing a societal issue in a lay forum. The falsification of a particular methodology does not indict an entire field, particularly one in which the set of observations is incomplete. Personally, I am not ready to declare earthquakes inherently unpredictable. But by that I mean that the events, quaking and otherwise, associated with plate boundary deformation seem to be yielding their secrets to our increased scrutiny. The dilemma we share is how to bring this knowledge to a public fearful of the impact of the next "big" event and demanding imminent, but not necessarily eminent, warning.

First, we have to structure the discussion of predictability. We must broaden the public discussion of earthquake prediction to accommodate determinism at longer time scales and for loci of activity, not singular events. To put it simply, the public discussion should be about risk. Our society is used to this type of analysis when it purchases life, auto, or homeowners' liability insurance. We are willing to acknowledge, financially and otherwise, our own risk factors, and we seem as a society to have accepted the dictum that risk has a market value in the aggregate. We therefore should be communicating our abilities to predict earthquakes in the aggregate. The USGS probabilistic hazard maps are one step. As the aggregate forecasting abilities of seismology increase, that is, as "best practice" shifts from probabilistic to quasi-deterministic forecasting, we should develop forums to publicize the (peer-reviewed) results.

Second, and as a corollary, we must deconstruct the notion that to be useful, a prediction must be imminent. I was recently at a Beijing meeting of selected public administrators and geophysicists, sponsored by the UN, where the interaction between public policy and prediction science was explored. The collision between the need for imminent action and scientific validity was apparent at this symposium. Under the right circumstances (which earthquake

impacts easily provide), this collision is destructive both to scientific integrity and to cogent public policy. We must find the means to engage the other sectors of our society in the need for hierarchical planning based on the best science. Remediation when the near-term risk is high is one solution. But the world is more complex, and more interesting, than that. (As an aside, there should be a strong international component of this discussion.)

I believe we have something to learn from our colleagues in physical oceanography and atmospheric science, who have successfully made the public aware of the distinction between weather prediction and climate forecasting. The focus on longer-term trends and cycles rather than individual events has been an intellectual gold mine at the intersection of science and society. The predictability of El Niño and other air-sea patterns based on simple observable indices was (and is) a valid and viable scientific target for that community, despite the incomplete physics and computational limitations. When it was discovered that social impacts correlated with the physical phenomena in a predictable way, the discussion developed an approach that has the potential for providing mature and reasoned boundary conditions on public policy and the commercial sector. Despite the best efforts of many, we are a long way from that level of discussion in earthquake prediction. ▨

Arthur L. Lerner-Lam
Lamont-Doherty Earth Observatory
Columbia University
Palisades, NY 10964