CONCLUSION

Throughout this book, I make the case we should think about efforts to design new risk mitigation technologies like earthquake early warning systems as attempts to transform relationships between people and the dangerous environments we live in. I develop this case as I make three arguments: that the development and use of SASMEX is more than a sociotechnical project, and has to be understood in terms of environment, society, and technology; that the system has been unfortunately marked by techno-solutionist models for risk mitigation and a lack of reliable institutional support; and that its logics are shaped by disciplinary approaches distinctive of engineering in Mexico. Considering these aspects of SASMEX allows us to understand environmental monitoring for risk mitigation holistically.

With its ethnographic approach, this book has been able to explore environmental monitoring and risk mitigation in ways that other accounts (especially those focused on multiple systems, those that evaluate isolated incidents, or those concerned with only certain technology performance) cannot. Systems like SASMEX are never simple technical tools that either succeed or fail at warning users before earthquakes. The more we approach such technologies as part of life for users and operators alike, the more we may understand what these tools do and how they do it. In this book, a close examination of SASMEX is an opportunity to understand earthquake risk mitigation as an international preoccupation and a Mexican phenomenon; as part of global trends in technoscience emerging from particular communities and environmental conditions.

That specificity is important. I have shown how this novel risk-mitigation technology developed in light of ongoing environmental conditions and

disastrous events: informed by technical, conceptual, and political trends, and shaped by decisions made by specific people. This approach allows me to showcase the complex interplay of social and material worlds that include and exceed "sociotechnical" models of technology, and oppose simple environmental determinist logics for risk mitigation and disengaged, apolitical narratives of technoscientific development. We need to do better if we want to understand—and maybe even succeed at developing—environmental monitoring and risk-mitigation technologies.

While I remain guardedly optimistic about earthquake early warning's potential, fulfilling its promises is no small undertaking. Technocentric approaches to risk-mitigation technology are an impediment. When technoscientists are made wholly responsible for outcomes that require more kinds of expertise than those in which they are trained, when potential user communities are not meaningfully involved in alert decision-making (or even consistently taught about alert utility), when the infrastructures that support early warning dissemination are not well-integrated, and when funding for earthquake early warning is unreliable at best, it can be no surprise if earthquake early warning falters. If, on the other hand, experts in communication and social research are brought in from the very beginning, education and community involvement are made high priorities, efforts at warning are controlled and coordinated, and funding is reliable—well, earthquake early warning might help protect people and property in the ways that advocates want it to.

These suggestions are borne out of close study of SASMEX, but they are applicable for different projects. At the very least, any earthquake early warning system can benefit from these insights. These systems vary tremendously, too, whatever their parameters. Some systems are robust, offering wide coverage and multichannel communication optimized for a variety of functions both automated and social; this is certainly true of the growing US system.[1] Similarly, Japan's earthquake early warning system transmits messages to emergency management organizations, media, and the public in a number of ways. It is designed to have many different effects, from prompting protective actions, to controlling automated functions in factories, to slowing down elevators.[2] These are far from the only other examples of earthquake early warning systems for which a book like this might be pertinent. In South Korea, public earthquake alerts are broadcast to all cell phones simultaneously across the country.[3] In northern India, a

network of eighty-four accelerometers produces an alert that sounds sirens in student dormitories and for emergency managers.[4] Turkey has a small warning system that provides alerts specifically to a gas utility and the Marmaray Tube Tunnel.[5] In Romania, warnings are used primarily by a nuclear research facility and the Basarab Bridge.[6] These systems are only the beginning. I am aware of other systems that are operational or in development in China, Taiwan, Italy, Switzerland, Hungary, Israel, New Zealand, Chile, Costa Rica, El Salvador, Nicaragua, Nepal, and Canada. There are doubtless more.[7] Despite the differences in each system's particular environmental, social, and technical conditions and configurations, they all need to put nature, humans, and technology "on the map" together, as a CIRES engineer named Antonio Duran said.[8]

The practical insights I developed owe a great deal to highly academic scholarly work. It is true, as critics say, that research that focuses exclusively on developing theory may miss opportunities to lay out the real-world implications of its findings. On the other hand, studies that center narrow, practical concerns often neglect theoretical engagements that would help make their interventions more robust and thoughtful. Writing this book for multiple purposes, in light of both kinds of work, has been no small thing.

While we may often write for academics like ourselves, we do not always do so. For example, anthropology has substantial traditions to draw on for meaningful engagement with the communities we study and for whom we write.[9] STS has its own histories of engagement. Gary Downey and collaborators have used the term "critical participation" to refer to the kinds of things we produce when we take these challenges on to "make and do" outside of STS scholarly spaces.[10] STS scholar Annie Patrick points out that this kind of research on and practice with technoscientific communities is at its best when it refuses to adopt the goals and perspectives of the topics under examination—these are, after all, often part of dominant political narratives that exclude and undermine critical ideas, marginalized groups, and important alternatives.[11] Producing usable insights with and for members of these technoscientific communities under these circumstances is challenging, requiring labor above and beyond what scholars are typically trained to do.

In my efforts at critical participation, I have been particularly inspired by some feminist science studies scholarship, which theorizes moving across the boundaries of discipline and practice. In particular, Emily Martin's thoughts on "irenic"—that is, peaceful or conciliatory—kinds of engagement help

me think about my research and writing as "a motivated positionality . . . in which diverse kinds of alliances could be forged with others (even natural scientists) over a variety of (changing) common interests."[12] Martin's work and the conversations that have emerged around it[13] offer me models to grapple with the perspectives and alliances that we take on when we experiment with the many vibrant modes of engagement available to us.[14] Thinking with Martin's irenics helps me resist the pernicious and seductive purity politics that often lead people in my position to consider research and writing for one professional purpose—whether that be applied or highly academic—to be by definition superior to work done for different audiences and goals. These purity politics have marked too many discussions about what makes good scholarship and practice. We must find ways to value and evaluate research within and across fields without leaning so hard upon narrow normative imaginaries. This book is, in the end, only one contribution to diverse, excellent efforts to understand environmental monitoring and risk mitigation. I researched and wrote in light of particular opportunities (described in more detail in the appendix). I could have made different choices, and, indeed, many wonderful researchers have and will in the future.

Whatever else my contribution may be to various projects and conversations, I have sought to guide all readers to understand SASMEX as a kind of experiment unfolding over decades. I have highlighted the creativity of the people who designed, maintain, and advocate for it. Their ingenuity means that SASMEX continues to develop. SASMEX, once only broadcast to radio and television stations, scattered dedicated receivers, and privately operated smartphone apps, now triggers sirens. It has been enrolled in state-sponsored apps, too. A series of dangerous earthquakes in 2017 promoted new kinds of awareness about earthquake risk mitigation and earthquake early warning in many parts of Mexico. Now, producing notification in advance of dangerous quakes is increasingly a project for publicly and privately funded systems. History shows that memory is often short and political support may dwindle, but for now they are growing. I am invested intellectually and intimately in these new configurations of environment, society, and technology. I know I am not alone in that. Whatever form your investments take, I hope this book supports your thoughtful engagement with them.

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¡Alerta!

Engineering on Shaky Ground

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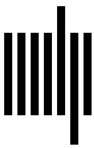

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