2 EARTHQUAKES AND WARNINGS

My visit to Mexico City in the wake of 2017 might have been my first experience with a community in recovery after a serious quake, but my introduction to earthquake early warning systems had come years before. When loudspeakers issued an earthquake warning at 11:44 p.m. on September 29, 2015, I was on an inflatable mattress in Beca and Enrique González's home writing emails. I had two of their deep red embroidered throw pillows propping up my head so that I could make out the screen without glasses. Their living room, loaned to me for the duration of a short visit, was lit entirely by the streetlights out on Plaza Popocatepetl and my laptop monitor's glow.

It was quiet. And then it was not quiet at all. A loud digitized voice repeated the words *¡alerta sísmica!*, and a siren I had only heard before in demonstrations warbled from somewhere outside. Enrique called to me from the bedroom down the hall: "Was there a scheduled drill?" He was yelling to be heard. "No, it couldn't be," I replied at volume, grabbing a coat and the smartphone charging beside it. The laptop was still on the mattress, and I would leave that, too. Where was my wallet? I found two left shoes, a heel and a flat, and searched out the match for the flat one. These had laces. Laces had to be loosened for the shoes to go on. I put my feet in them but did not tie them, and thought again about my laptop, the last time I had backed it up, and if I could afford to lose all the work saved on it if the building came down. I could not quite recall which pocket of my wheeled luggage I had put my passport in, and I was unsure if I should commit to searching all of them. Maybe I had put it in the backpack with the week's dirty laundry. The siren continued.

At the door, I met Enrique, who was fully dressed and ready to go. A moment later, Beca appeared in a bathrobe and slippers, holding their two small dogs in her arms. I was wondering about the wisdom of going back to see if I could grab my wallet when the siren stopped.

The quiet was jarring. We waited there, in the landing of their building's wide marble stairs. I counted seconds in my head. I knew that the siren should have continued to sound until the quake was over, but the loudspeakers were newly integrated into the public earthquake early warning system, and it was possible that they would not follow the same rules as the radio broadcasts I was more familiar with. Regardless, the early warning could give us, at the absolute most, a bit over a minute's advantage before an earthquake could travel from the most distant of SASMEX's sensory field stations all the way to Plaza Popocatepetl in the center of Mexico City. We were approaching that outside time limit if we had not already passed it, slow as we were to assemble at the door, but I had felt nothing.

There was indeed an earthquake on the evening of the 29th. According to the report that the Servicio Sismológico Nacional issued the next day, an event of magnitude 4.6 originated about forty-nine kilometers northeast of the city of Ometepec, Guerrero (see figure 2.1). Though it was not quite large enough to shake the second floor of Enrique and Beca's building over the La Condesa neighborhood's sensitive soil, it still triggered SASMEX. The quake was real, but the alert was inaccurate.[1] A different sort of automated analysis might have distinguished this quake from one that would actually be felt throughout Mexico City. The techniques used by the engineers running SASMEX, however, prioritized speed over accuracy, so they sometimes produced warnings about this sort of earthquake. The engineers at CIRES had explained publicly and repeatedly that these sorts of things simply happen. They had made choices for SASMEX that reflected their priorities. These priorities did not include devoting time for very nuanced assessments of earthquake magnitude or developing lengthy alert communication about the size an earthquake was likely to be or how long listeners might have before it hit them. Because of these choices, when the sirens sounded into the night on Plaza Popocatépetl, we could not know what sort of experience to anticipate. The earthquake might have been a little bigger, and we might have felt it. If we had, it might have been begun shaking us as we stood at the top of the building's stairs or even as we collected our things and prepared to leave the apartment.

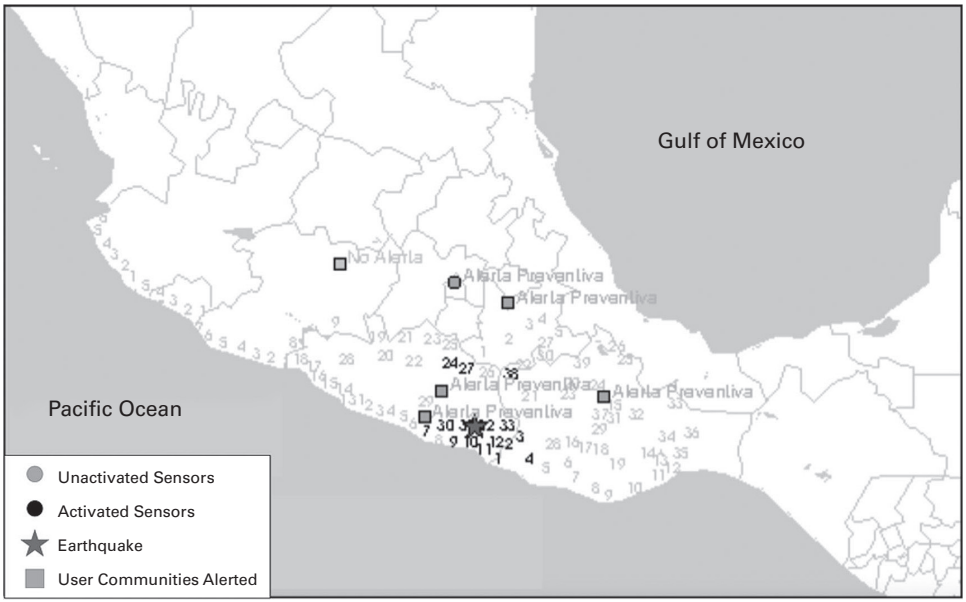

FIGURE 2.1
Map of September 29, 2015 earthquake detection and warnings. Mexico City is one of the places marked with a square, and the epicenter of the earthquake is marked with a star. Activated stations that detected motion are indicated by black numbers, while unactivated stations that did not are pale gray. *Source*: CIRES (2015)

When people live with both earthquakes and warning systems, they live with many possible configurations of the two. They experience alerts for earthquakes they feel and warnings for those they cannot without knowing for sure which any given howl of *¡alerta sísmica!* might foretell. Although emergency management professionals have shown quite convincingly that warnings for events that never happen can be considered drills or opportunities for training,[2] and that post-alert messaging can support public confidence in a system even after trouble,[3] there is a substantial difference between such a suggestion, in theory, and how people experience and respond to warnings and earthquakes in practice.

In the days that followed the late-night alarm in 2015, the siren that sounded from the loudspeakers was a topic of significant interest among people I spoke to in Mexico City. It was covered in news reports, and CIRES and other organizations associated with the system were tagged in diverse

social media responses. Some people accepted this kind of warning-without-event as the price they paid for an earthquake early warning system, but many expressed frustration and confusion about how the system worked, as well as worry about the real physical harm that the shock of this warning might cause or habituation that might result from false alarms.[4]

An earthquake early warning system is a tool built to intervene in users' experiences in just one moment, to allow certain opportunities for diminishing risk.[5] In this moment, we can have dogs and shoes ready to go, laptops and wallets either at hand or left behind. Such technologies are easy to break down into components or subsystems, making a unified whole into separate processes with different responsible parties. This is very much how Mexico's earthquake early warning system has been treated. CIRES was responsible for seismic instrumentation and registry, for generating alerts to the specifications of the cities and private businesses who contracted with them. Civil Protection was in charge of distributing alerts, and local authorities were responsible for maintaining loudspeakers. General education and outreach was largely theirs, too. However, the integrated experiences of people who live with earthquakes and early warning on a day-to-day basis are harder to partition. We respond to our experiences, our knowledge, and encounter every new warning as a single intervention: a siren in the night rather than a variety of subsystems performing to different standards.

In this chapter, I put my early warning experience in the context of life with both earthquakes and warnings, treating earthquake early warning as a heterogenous system.[6] I choose to describe this case precisely because it is so far from ideal but nonetheless absolutely ordinary. Starting from here allows me to show how people live with earthquakes and technologies in ways that include earth-shaking of many different intensities, emergency education, and, of course, the particular technical tools and decisions that comprise SASMEX.[7] For all that many might consider this an imperfect orchestration of environment, technology, and social action, alerts like this are just as crucial to risk mitigation as cases in which a sizeable earthquake triggers a warning. Here, I interrogate Mexico City's current normal: ordinary experiences of life with ongoing earthquakes and various kinds of earthquake early warnings. It is not as different as the most optimistic of early warning advocates might wish. However, it does entail particular tangles of collaboration and confusion. Considering these can help us better understand the kinds of

collaborations required to grapple with and change the way people live with earthquakes in Mexico.

I first consider what it means to address earthquake early warnings and earthquakes on the same terms—as emergencies for Mexico City residents. I go on to describe how technoscientists have worked to make warnings part of Mexican life, with particular attention to the limitations and opportunities that they found in doing so. I end by returning to the story that opens this chapter to consider life with both earthquakes and technoscientific efforts to change the way people experience earthquakes. There will be no disasters in this chapter, no massive earthquakes, and no destruction. Instead, I foreground what happens as we prepare for and attempt to mitigate the worst effects such events might have.

NOT ONLY THE BIG ONES

A substantial portion of my research on this project involved intensive ethnographic participant observation with CIRES, the NGO that developed and maintains Mexico's earthquake early warning system from a pair of busy buttery-yellow buildings on a residential street in Mexico City. Over ten months of visits and interviews with the engineers, technicians, and administrators whose work made earthquake early warning possible, I learned about the complex collaborations undergirding alerts.

Even in my first formal meetings with CIRES director Juan Manuel Espinosa Aranda and his colleagues, in a room given over to maps and blinking system servers or at massive desks in the building's biggest and least-cluttered offices, I learned that very little about earthquakes, or early warning, was as obvious as it may seem. Conducting interviews, sitting in on meetings, and working at a computer terminal while activity swirled around me in the following months only served to support this initial impression. Earthquakes are complicated events, and even CIRES's efforts to focus only on the instrumentation of early warning—siting and maintaining field stations, developing and refining algorithms for seismic analysis, and delivering alerts to a handful of cities across Mexico—was undermined by the complex entailments of system function. Perhaps in ideal cases, where alerts sound and people take cover before massive earthquakes roll in, CIRES's efforts to focus on technology and leave alerting and education to others would be sufficient. The diverse forms of seismicity and experiences with alerts made this impossible, though.

It is common to talk about earthquakes as if they are obvious, focusing on incidents of significant shaking that require people to act to protect themselves. Such events are, after all, what most charismatic earthquake risk mitigation technologies and policies are designed to address. Early warning systems are no different; experts and popular accounts alike often describe how these technologies can detect and then communicate about significant shaking to trigger human or automated action, rather than the kind of alert that I experienced on September 29. Everyday life with and work on early warnings, however, requires considering more than massive quakes and the dangers they pose to human lives. Thinking only about big events means denying empirical complexity, focusing instead on those few cases that fit into a single narrow category. Severe earthquakes are important and dangerous, but understanding life with moving earth and technoscientific intervention requires something more. It is important, instead, to seriously consider the diverse experiences that people may have with the hazard as well as the technology, not just to account for ideal use cases but to understand real ones.

Considering how this technology contributes to contemporary Mexican experiences of seismicity means addressing what it is like to live with an early warning system, which, in turn, requires accounting for the fact that experiences with the warning constitute emergencies regardless of whether any earthquake follows. By emergency, I mean a sudden disruption, something that requires an urgent response and has potentially serious consequences. "'Emergency' is now the primary term for referring to catastrophes, conflicts, and settings for human suffering," sociologist and political theorist Craig Calhoun explains. He understands it to have "rough cognates such as 'disaster' and 'crisis,'" but, as he points out: "Use of the word focuses attention on the immediate event, and not on its causes."[8] The "immediate event," when it comes to early warnings, need not be an earthquake itself. As I felt viscerally in the apartment on Plaza Popocatepetl on September 29, the warning itself is an emergency: Beca, Enrique, and I were surprised. We made decisions—moderately quick ones, although we were still in the building by the time the siren stopped sounding—about what to take with us and what to leave behind.

Although the nature of emergencies varies significantly, scholars and professionals in disaster response and recovery alike have developed certain principles for communicating about hazards and dangerous conditions.[9]

The best modes of dissemination take users into account. The early warning experts I worked with in Mexico often referred to guidelines established by Denis Mileti and John H. Sorensen's extensive review of early warning systems for all manner of phenomena. Good warning messaging should contain "consistent, accurate, and clear information; guidance on what to do; risk locations; and confidence or certainty in tone," and should come from sources that the groups targeted for messaging consider credible.[10] The production of that trustworthy information and guidance should, they stipulate, be calibrated to users and their needs, and offered by multiple sources with as much detail as possible.[11]

In emergencies, it is essential that authorities communicate key information. It is also important for people to be able to find more information about what is happening and why as they need it.[12] People involved in earthquake early warning, including engineers and their client governments, have pursued a variety of strategies for authoritative communication and making further resources available. Early warnings that once went to dedicated receivers and broadcast only on public radio and television now echo from sirens mounted on telephone poles and buzz from smartphone apps. Nonetheless, some issues related to effective rapid broadcast emergency communication remain constant.

Public ability to respond effectively in an emergency is related to the context of the warning—the second crucial element of living with early warning. When we experience warnings, we understand and act on them in the context of how we see the world.[13] Everything, from how we understood the content of warnings themselves to the way we felt about the agencies that circulated them to our preparation for hazards and the way each of us reacts to surprises, had implications for how Beca, Enrique, and I responded to the warning we heard on September 29.[14] After many years of living in Mexico City and a few years of hearing my research stories, Beca and Enrique understood as well as I did that the system could indicate an earthquake but might not be entirely accurate. We took the warning seriously. However, we could have been faster at getting ready and getting out the door. We were not as prepared as we might have been, though for different reasons—Beca was asleep, and she and Enrique were just getting used to the city's new system of loudspeaker-aided warnings. I was out of my element and disoriented by travel.[15]

Even those early warning system administrators who assured me that their responsibilities are confined to instrumentation alone also told me that getting users—even willing ones like me and my friends—to take advantage of alerts was both crucial and challenging in the extreme. Although there is a wealth of investigations on effective strategies for emergency communication available to earthquake early warning system designers, these suggestions are only sometimes useful. Earthquakes happen much more quickly than hazards like floods, hurricanes, or droughts. Insights related to other hazards may simply not be helpful in the case of earthquakes, for which warning time is so tightly constrained. With only seconds to spare even in a best-case scenario, it may be impractical to include the kind of information that Mileti and Sorensen recommend.[16] Communication must happen rapidly enough that people can use the information, and alerts must be brief and clear. Short and easy-to-understand messages are especially important for earthquake early warning, as the window of opportunity to act is so small. Research has also highlighted the advantages of including directions and images, but there is strong evidence that emergency communication should not be considered in isolation. Follow-up messaging and familiarity with protective actions are also crucial.[17]

Communicating earthquake early warnings is one thing, and a difficult one at that. Communicating *about* earthquake early warnings presents its own additional challenges. Mounting a large-scale public education campaign has been beyond the scope of the engineers at CIRES. As engineers would tell me, they were technically trained and their responsibilities were related to their areas of expertise. Nonetheless, it is essential for users to understand how early warning works and how they can use it. CIRES engineers strategically navigated the tension between the needs of their project; the social, financial, and technological resources available to it; and the scope of their expertise.

Communicating about earthquake early warnings has required significant interagency coordination, as I learned in the CIRES offices. There, a great deal of higher-ranking engineers' time was devoted to strategizing about and managing these collaborations. Although this earthquake early warning tool is designed to change the way people experience earthquakes, engineers often discussed how vexing the challenges of public communication could be. As CIRES engineer Antonio Duran reflected candidly to me

during one of our long meetings, "The human factor always puts us in our place."[18]

Communication is crucial to the success of risk mitigation projects but was beyond the scope of what the engineers at CIRES could bring to bear on the project. To me, it seemed that this did more than put the engineers "in their place," or keep them humble, but rather caught them in pernicious trap. As SASMEX's only real consistent advocates, they had taken responsibility for the system. However, the system was always failing to meet expectations—in part because its success depended on kinds of social science work that they were neither trained in nor funded to do and required influence in policy and popular culture that they could not access.

DISTRIBUTING ALERTS

While engineers at CIRES were by no means trained in social science, SASMEX has been developed in ways that show some consideration of social dynamics. Take, for example, the problem of spatial warning distribution. In Mexico City, the ground in one place may respond differently to seismic effects than that in another, a phenomenon that has been documented with many seismic microzonification studies.[19] It might seem sensible to some of us to customize early warning systems to each different area, at least before mobile phones began to travel everywhere with people. Sirens could warn those in the sensitive lake regions to earthquakes of lower magnitude than those living on hard rock. But Mexico City is also known for its inequality and rampant clientelism, and many of the wealthy areas of the city are on sensitive soils. This could conceivably lead to a situation where the rich benefited from sirens and the poor did not.[20] For this reason, earthquake warnings have never been disseminated only to certain sites. They have instead been circulated throughout Mexico City and, later, other user communities who contracted with CIRES to use the system primarily by means of broadcast. The CIRES team has asserted that they are primarily responsible for instrumentation and the technical operation of the earthquake early warning system, and that others should take on decisions like where and how to spread alerts. However, while Civil Protection authorities may be involved in making choices like setting alerting thresholds or designating areas to receive alerts, their efforts to educate people about the

alert have been limited. Thus, despite their insistence that they focus on technologies rather than the social aspects of alerting, CIRES engineers are nonetheless in a position where they must grapple with how people relate to the technology they develop and maintain.

Before loudspeakers throughout Mexico City first began to howl out *alerta sísmica* in 2015, earthquake early warnings were primarily propagated by television and radio stations. It was a good strategy, and the CIRES team told me that they were happy to have professional communicators passing on the warnings their technology produced, but it fell short in several ways. First, media watchers were simply limited. In 2013, before the sirens, a survey of over thirty-three million Mexicans indicated that most (77.32 percent) watched between one and eight hours of television per week.[21] Second, broadcasters only rarely described how early warning works, leaving people with limited context to understand what an alert might mean for them.

Partnerships with television and radio stations were, in short, not working as well as they might have. CIRES developed other tools to integrate alerting into peoples' lives and do careful outreach in the process. As an alternative to the broadcasting system, wealthy companies, government offices, and schools contracted directly with CIRES to have on-site radio receivers installed in their buildings dedicated to detecting signals from the earthquake early warning system. CIRES complied, developing and maintaining large radio equipment for these clients, often with rooftop antennae carefully arranged to receive signals in dense urban spaces where a line of sight could not be guaranteed. Of the available options, this method offered the most controlled, reliable way for CIRES engineers to get an early warning to people at risk. As of 2014, 403 Personalized Seismic Alert Systems (or SASPERs) receivers had been installed in Mexico City. Schools have these devices, along with banks, government offices, and courtrooms. Though CIRES does not plan to install any new ones,[22] the "cabinets," as they are called around CIRES offices, are still maintained through ongoing cycles of personalized and time-consuming technical attention.[23] Technicians have to visit each one three or four times a year to prevent problems, to ensure that the backup batteries are not slowly draining from electrical interference, and that the technical tools have been cared for.

By interviewing personnel and observing work in CIRES offices, I learned that these visits presented opportunities not only for tune-ups but also for

conversation and education.[24] Technicians, primarily young men, would go out daily on maintenance visits or even to set up tests and drills for users. I saw them leave CIRES headquarters with tools in the early morning in cars emblazoned with the NGO's logo, or, if they got in too late to requisition a car for themselves or were headed somewhere without parking, on one of Mexico City's many public transit options. They worked in pairs to fix or relocate parts of the receivers: the loudspeaker, antenna, or the "cabinet" itself. Teams of three or more would go out for each installation. Back at the offices in their workrooms, they explained to me that they moved from one user to another, circulating, testing, connecting, and writing reports. Meanwhile, they would also answer questions and train users, helping them understand the system and how to use early warning technologies. The work that technicians do is, in this way, a key (though often less obvious) part of CIRES's education strategy.

Others working at the NGO use different methods to educate people about how to interpret and respond to warnings. CIRES director Juan Manuel Espinosa Aranda appears regularly in news and print media, explaining warnings and the organization's work. For lower-stakes and less visible work, there is an entire department at CIRES tasked with maintaining outreach efforts. When I visited, this team sat at computers a floor below the technicians.[25] There, they used their skills in computer science, law, and design to make sure that data produced by seismic field stations were accessible to users. They developed blog posts, tweeted, posted on Facebook, and generally monitored SASMEX's media presence. They designed outreach and education materials and sometimes operated programs appropriate for changing messaging strategies. Through these varied mechanisms, the CIRES team advocates for earthquake early warning in public spaces, attempting to make it manageable and comprehensible. They engage with topics of seismic risk mitigation generally and help people make sense of the earthquake early warning system and its uses.

Even though the CIRES team's labor is significant, the technology has not garnered easy acceptance in Mexico City. New support from agencies and collaborations with private alerting firms (discussed further in chapter 4) have brought new users and technologies into relation with SASMEX and its signal. New regulations that require businesses of a certain capacity in Mexico City's high-risk zones to purchase and install some form of radio receiver have caused an increase in the absolute number of users,

while the means by which they receive warnings have diversified.[26] Users may encounter an earthquake or warning in different contexts, such as different times of day or in different built environments. Those who hear the warning may be visitors or simply unfamiliar with how to interpret it and what actions they should take. When sirens were first activated in 2015, there were similar misunderstandings. While CIRES technicians try to have face-to-face interactions with the majority of those who own dedicated radio receivers, they can hardly reach all possible users. As different ways of encountering the alerts become more common, CIRES technicians have little say in potentially crucial questions of equipment operation or emergency action. Subscribers to the increasing number of smartphone app notification services may not know how to interpret the messages they receive or respond to them. SASMEX's infrastructure is decentralized, but no organization besides CIRES seems to prioritize supporting new ways to live with earthquakes and earthquake early warning. Despite all the CIRES team's efforts, their work alone has not been sufficient to help people understand and use earthquake early warning.

A study of users of dedicated, CIRES-maintained radios in 2009—before the sirens and smartphone apps—indicated that even for these users, education about the warnings might be lacking, or at least partial.[27] Among the users surveyed, researchers found that people did not accurately understand how earthquakes worked or, more worryingly, how SASMEX worked and the standards against which it should be assessed. Of those who responded, 91 percent regarded the earthquake early warning system as helpful. However, most could not explain the differences between the two forms of warnings they might receive—that preventative sirens might sound for high-risk populations, like school children, at any earth motion above magnitude 5.5 at the source, while the public at large would receive warnings for all earthquakes at magnitudes above 6 that might shake them.[28] Many did not understand that the territorial arrangement of the system's seismic stations would mean that they would get warnings about only some earthquakes, particularly those originating on the west coast of the country.[29] Further, there was the question of what to do with warnings. For all the counsel that CIRES technicians provided, many users claimed they had received no support for developing or implementing evacuation plans. A more recent study has demonstrated that some of these issues are ongoing. In the wake of two 2017 earthquakes, Jaime Santos-Reyes, a systems engineering

researcher in Mexico City, showed substantial inconsistency in how people understand the capabilities of SASMEX. More than half of those surveyed indicated that they expected a standard sixty-second warning time for any earth motion.[30] While most respondents reported they were confident that they knew what to do when the warning sounded, many had not found it helpful in a recent earthquake when the system had given them substantial warning before shaking began.[31]

Given that campaigns to help people understand and use the warning have been so limited, it is perhaps not surprising that most people are not quite sure what to do when they hear the simple earthquake warning sound. The general tasks of sharing information related to early warning and advocating for its use require help from people with different connections and training than most of CIRES's staff have.

INSTRUMENTATION AND ITS ADVOCATES

In ordinary conversations around their offices, CIRES engineers and technicians told me that their focus was on instrumentation, not the complex relationships between social practices and environmental conditions that SASMEX was designed to fundamentally change. For all they understood how important it was to their project to consider how people might really live with both warnings and earthquakes, engaging with these issues fully was outside of their capabilities. They were trained in electrical engineering and computer science, and specialized in seismological technology. They could develop equipment to register, analyze, and broadcast warnings about quakes, and advocate for it. They could stray from their commitment to instrumentation to train those few users who had their own dedicated in-building SASMEX receiver and alarm systems, or advocate for the system in popular media. But the system the CIRES team operated would never work on their efforts alone.

Instead, CIRES relied on partnerships, which could be challenging and inconsistent. Their nature could change with the political winds and the agendas of leaders who rotated through agencies, but they could also benefit from shared interests. For example, the CIRES team's work to reduce risk among vulnerable populations could bring their project in alignment with other organizations. The way that CIRES focused on school safety provides an example, allowing them not only to take on public education and

outreach by other means but also to enroll motivated allies with crucial expertise to consider what life with warnings could be like. Schools provided an opportunity to protect high-priority and vulnerable populations and make educational interventions with potentially broad effects. For this reason, schoolchildren became an important target user population for the warning as the system developed in the 1990s.[32]

Protecting children was a shared value for collaborators in CIRES and Mexican government agencies. The stakes of protecting children are high, and keeping them safe was an important goal for risk management. More than that, though, children represented a particularly excellent focal population for efforts to change how people living with earthquakes used new alerting technology. Children could learn, and classrooms could provide an environment where they could be drilled and that knowledge reinforced. They could then serve as vectors, bringing what they learned home from school and teaching it to their families, and could grow up to teach their own children.

The decision to focus on protecting children made it possible to mobilize collaborators with different kinds of expertise. Elia Arjonilla Cuenca, a sociologist who began to study and design earthquake safety in Mexican schools after the 1985 earthquake, was one such collaborator. Her presence in the earthquake risk-mitigation community and her work studying and advocating for earthquake early warning from an early stage shows just how critical external support has been for SASMEX.

It was CIRES engineers who first introduced me to Arjonilla. Now retired, she is still active and thoughtful about her work on earthquake safety. Over coffee in the beautiful Museo Dolores Olmedo, the small, elegant woman spoke about her work frankly. Arjonilla explained how her social background as well as her education facilitated her work on earthquake risk and risk mitigation. With family members and friends who studied earthquake monitoring, she was part of the seismic community by association. Arjonilla herself had received training in sociology and public health, a combination that made her ready to organize studies and advocate for public safety. This background positioned her well to participate in technical and political talk, from conversations over meals to community events in the wake of the 1985 quake and the reevaluation of safety procedures that followed.

Arjonilla described to me how she began to enter scientific gatherings. After the earthquake, there were visitors from around the world. Concepts and people circulating through Mexico City from Japan were particularly

exciting. She went to all the seminars. "I wrote and wrote and wrote," she told me, "and I asked questions."[33] It was important to her to be involved, but she knew she would seem out of place in a highly technical and male-dominated space.

She described how deliberately she went about introducing herself in such gatherings. "I'm overjoyed to be here with you today. I work in seismic education," she recited for me. That was her line. She knew that she was not like the other people present. She could not hide it, so she did not try. Instead, she made sure to tell people about the parts of her work she knew they would care about.

> It was like opening doors! Once you identify yourself as a nontechnical person with a very important job . . . well, they were very interested in building seismic education at that time. I would say "I work in seismic education, and I'd like to know . . ." well, whatever I wanted to know. Their responses would be better, their attitudes better, so much better. And if your question wasn't answered by the speaker, maybe someone from the audience would catch up with you at the exit and say, "That's fascinating. Where are you based? What are you doing? I'll give you my card."[34]

In 1985, when the disastrous quake struck, Arjonilla had children enrolled at Colegio Madrid, a private school that children attend from kindergarten until they are old enough to attend university. The Colegio is in Mexico City near Xochimilco and on seismically sensitive soil. Her extended family was soon deeply involved in the seismic community working busily at the National Autonomous University of Mexico and within Mexico City's government to understand the seismic territory on which they lived in new ways. The quakes had damaged her children's school quite badly, and some parents of the Colegio's three thousand students decided to take part in a project called the Parents' Volunteer Safety Commission. She used the contacts she made to advocate for new safety procedures.

Arjonilla left her position in medical sociology to take that post-earthquake volunteer job along with other parents. Over time, she took on more responsibility. Part of her work involved looking at the earthquake procedures in places elsewhere and developing plans to implement the best of them as a safety program for the school. In 1986, Arjonilla and another parent worked with US-based disaster researchers on an English-language report on the Colegio's recovery.[35] She remembers picking up the technical language of seismicity quickly from conversations with family and friends,

and the meetings she attended. She paired it with the professional knowledge of risk prevention that she already had and brought both to bear on her interest in school safety.

When other parents scaled down their involvement, Arjonilla kept working. What she had been doing as a volunteer became paying work. "You know what they called me?" she laughed. "The Earthquake Girl." Her gender and her youth made her stand out, but she slowly gained influence. She continued her work at Colegio Madrid, contributing to safety assessment and training teachers, students, and staff. Then she became a consultant with other schools, the education ministry, Mexico City's government, and then eventually with CENAPRED, the National Center for Disaster Prevention.

Another sizeable earthquake struck the city in 1995, and Arjonilla was able to compare responses in a school that used SASMEX with one that did not. When she interviewed students who had experienced the same degree of shaking in similar structures, she found that, overall, SASMEX had helped. The school that had an early warning followed safety procedures without difficulties; the earthquake emergency produced less tension and disruption than at the school that lacked the system.

While Arjonilla broadly supported expanding earthquake early warning systems, she also argued that, from her observations, integrating earthquake early warning into practice in a sensible way would require "solid planning and preparation on the part of the community."[36] She was, in other words, an engaged collaborator and critical of the lack of thoughtful public communication involved in earthquake early warning rollout. She wrote that CIRES was "expert in questions of monitoring, detection, and warning, in merely technical terms," but it did not have "the perspective of other disciplines necessary to promote an optimal collective response."[37] Her vision of an "optimal collective response" would include large-scale education and outreach, and better emergency training for all.

Despite Arjonilla's advocacy and that of many others, not all schools were able to use earthquake early warnings. It is difficult to tell how many did. Out of 5,500 schools in Mexico City in 2009, only seventy-six had their own SASPER cabinets and associated contracts with CIRES.[38] It is likely that many more had less expensive emergency radios tuned to the service. As today, with increasing options for early warning transmission, it is challenging to document and evaluate warning use, even with the reporting

required by Civil Protection. In an effort to overcome this limited use, in 2010 and 2011, Mexico City and federal governments purchased 88,000 small emergency radios for distribution to users around the nation.[39] Nearly forty thousand were destined for primary and secondary schools in Mexico City alone. Although there are records of the city and national governments purchasing this equipment, journalists have suggested that many of these devices did not make it to their designated recipients.[40] Those schools that were unable to buy SASPERs, to purchase their own small emergency radios or to receive government-sponsored dedicated radios may have found other ways to access the warnings. While this policy was outlined in a memo for public schools in 1995, its rate of implementation is unclear.[41]

Arjonilla's experience was unique, animated by her passion for safety reform. Gracefully yet insistently, she made a space for herself and her insights in a field dominated by physical scientists and engineers. She became a volunteer, an educator, and an "Earthquake Girl" to bring sociological insights to risk mitigation work. She was able to help identify the challenges that would plague SASMEX, but this kind of attention and support combined with the CIRES team's creative commitment alone could not mobilize the kinds of large-scale resources that integrating the earthquake early warning system into Mexican awareness required.

AN EARTHQUAKE EMERGENCY IN 2015

In 2015, it took only seconds after the siren stopped for my friend Beca to grow tired of holding her squirming dogs outside her door. She knew there would be people outside, talking through their shared experience. "Take the keys and tell us what you find out," she told me, and, sensibly, went back into her apartment with Enrique and the dogs. They shut the door behind them.

Down on the plaza in front of their house, I found a handful of people talking. They were gathered near the central fountain in little groups, away from buildings and bathed in the green glow of streetlights filtering through the canopy of trees (see figure 2.2). Against the white of the fountain's arches, their outlines were visible, even blind as I was without my contact lenses.

"I suppose there has been an earthquake," a young woman in pajamas told me. "When we came down, the water in the fountain was rippling." Another was more skeptical. "It's rippling," she said, adjusting her short blue dress, "from the wind."[42] A magnitude 4.8 earthquake originating in

FIGURE 2.2
The author and Beca Gonzalez walk past the fountain in the middle of Plaza Popocatepetl at a more leisurely moment. *Source*: Stephen C. Rea (2018).

Guerrero might just have made the water in the fountain on top of one of the most sensitive soils in the city ripple. But there was also a light breeze that night.

When I returned to the apartment, I scanned Twitter and Facebook messages for more responses, reading about how people had become caught up in SASMEX. No single hashtag surfaced that evening as a locus for commentary, but I found many messages in response to tweets from official business and NGO accounts affiliated with earthquake early warning, visible to anyone watching the lively feeds. I saw frustration, commiseration,

and confusion. Many referenced the scare of the warning and the bodily responses it had engendered in them. "Fuckin' fright!!!" one wrote, appending a photo of an adorably horrified-looking child. "I just about died of a heart attack in my baby's arms," another posted.[43] The tweets may have been hyperbolic, but they reflected a community dealing with stress. Others posted pictures of bloodshot eyes, frightened cartoon characters in bed, or of bread rolls they would eat ("*pa'l susto*").[44]

People were frightened of seismicity and understood encounters with this fear to have consequences, even without any physical shaking. According to the Ministry of Civil Protection in Mexico City, there were no injuries or damages that could be attributed to the quake, but some residents took the experience itself seriously.[45] Commenters understood that a warning might remind some of old earthquake trauma, or could itself cause new emotional and physical harm.[46] Although social media commentary is not necessarily an indication of earnest response to an event, these posts demonstrate that the warning was broadly an unpleasant experience, and a matter of serious concern for Mexicans.

Even on the night of the alert, those who had received the warning debated the long-term effects of "false alarms." There was some discussion of preparation and training on Twitter. "It can work like a drill," wrote one person. "Every false warning should be an opportunity to practice a successful evacuation in case an earthquake happens. I don't know why they just complain!"[47] The sentiment was not uncommon. The warning, here, could be considered part of a training regimen for speed and organization in evacuation, an opportunity to rehearse for a more dangerous earthquake. Recipients of a warning run through the physical steps and experience the tension of an unexpected experience so that, in the future, they are more likely to know what to do and, moreover, confident in their actions. Drills, rehearsals, or practices of this sort have become ways that people make themselves ready for an otherwise unpredictable emergency, and ready to avoid the worst of its potential effects. Risk mitigation experts like Arjonilla have, for years, urged the public to use false alarms as opportunities to train for the real thing. In practice, however, the issue of the earthquake-yet-to-come surfaced in other ways.

"They need to recalibrate the system," Enrique told me over coffee, the morning after the loudspeakers had sent us rushing out of the apartment, "or no one will trust the warning." A post on the Facebook wall of the

earthquake early warning mobile phone application SkyAlert offered a similar sentiment. It read: "Me, I left the house when I heard the alarm. I think it's unwise for the government and that company to make panic with a tremor of 3 degrees. It reminds me of the joke about 'crying wolf.' After all this, they'll lose credibility." The "joke" referenced a fable attributed to Aesop, sometimes titled "The Boy Who Cried Wolf." The fable involves a boy tasked with guarding sheep. The boy issues false alarms about a threatening wolf and loses credibility as a result. In some versions, the false alarms and the subsequent inability of the shepherd boy to find help when he needs it costs him his flock of sheep. In others, he pays with his own life.[48]

An article in the Spanish newspaper *El Pais* recounted similar concerns. A warning without a perceptible earthquake following—like the earthquake emergency I experienced with Beca and Enrique on September 29—might have implications for a large quake that is likely to occur sometime soon. The emergency could blossom into disaster if Mexico City experiences a large earthquake and people neglect early warnings; they could be injured or killed because they expect another misfire.[49] Previous experiences could lead to better awareness and preparation or, conversely, might result in avoidance or a naively optimistic assessment of safety.[50]

Emergency responses, especially responses to quick-moving hazards like earthquakes, generally work best when they are trained into the body and come to entail simple and unconfused physical reactions to certain stimuli. This is one of the reasons that drilling and similar exercises have become so important in emergency preparation. They provide opportunities to rehearse crisis, to condition embodied and mental responses, and encounter safety tools and techniques intimately. In this context, a warning like the one on September 29 could interfere with effective responses to future earthquake early warnings. Or, just as easily, it could facilitate them.

Public earthquake early warnings use technoscientific means to give users a chance for speedy response in case of a quake. If people are not interested in taking that action, then the advantage that early warnings provide decreases tremendously. With the loudspeaker broadcast, Mexico City provided a new way for people to use SASMEX. Juan Manuel Espinosa Aranda was interviewed about it by a journalist. He commented, "[The warning] was warranted because we do not control the phenomenon, because we have no certainty that all the structures of the city are safe."[51] Broadcasting

the warning could make a tremendous difference for Mexico City residents in dangerous places.

CIRES engineers continue to tweak the system. In an earthquake on March 23, 2016, of a similar magnitude to the one that triggered the warnings discussed here, no warning went out over the loudspeakers.[52] Refinements can only do so much, however, to control for the many ways that users experience a technoscientific intervention in their lives. Even the moderately sized earthquakes for which Mexico City has chosen to alert its population might be felt strongly in the areas of the city with the most sensitive soil, and less in those built on hard rock. Any warning will intervene in the lives of Mexico City residents; this general broadcast is particularly promising because it is available to so many. This remains true even as smartphone use rises; apps may be popular, but they face certain technical limitations. The ways the warnings relate meaningfully to the material world, however, is a matter of diverse practice rather than an automatic effect of the technology.

THE PRINCIPAL SUSPECT

Enrique messaged me soon after I left Mexico City to joke about my obvious fascination with the events that continued to unfold during and after my visit. "You are now the principal suspect of producing earthquakes! I am sure you are playing with the thingie to see how we, your lab rats, react!"[53] Enrique's comment was self-consciously absurd, but I could not deny how useful for my research it was that an alert should happen when I was around to experience and analyze it. The importance of empirical social scientific research on how these events unfold in context cannot be overstated, especially when so many accounts of early warning systems focus on isolated warnings and evaluate technical successes and failures.

In this chapter, I have suggested that we reorder and expand how we conceptualize earthquake early warning to include more diverse seismic and warning events—events that may happen more often than those who are not playing host to inquisitive anthropologists realize. People do not simply engage with earthquake early warnings as precursors to earthquakes; rather, they live with warnings as well as earthquakes. Understanding that allows us to think in greater scope than the simple techno-optimistic

approaches to seismic disaster prevention, which suggest that earthquake early warning technologies alone will save lives and transform users' experiences of seismicity simply, without causing other challenges.

Considering the different kinds of experiences that a warning might entail means addressing challenges that include: the ongoing threat of a violent earthquake; the promise of new opportunities to evacuate or take cover before the danger; the experience of a late-night shock; and the real capabilities and limitations of technical interventions into life with complex, unpredictable, ongoing seismicity. Earthquake early warning is not simply a communicative act but one part of a complex of meaningful events around seismicity in Mexico City.

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¡Alerta!

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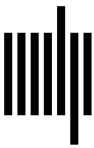

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