

# NOTES

## INTRODUCTION

1. Anticipating the location, magnitude, or timing of earthquakes with any accuracy (as defined by the National Academy of Science Panel on Earthquake Prediction in 1976) is not considered scientifically possible at the time of this writing. There remains substantial work to understand the earth's geophysical systems sufficiently for such an operation. See R. J. Geller, "Earthquake Prediction: A Critical Review," *Geophysical Journal International* 131, no. 1 (1997): 425–450; Susan E. Hough, *Predicting the Unpredictable: The Tumultuous Science of Earthquake Prediction* (Princeton, NJ: Princeton University Press, 2010); Richard Stuart Olson, Bruno Podesta, and Joanne M. Nigg, *The Politics of Earthquake Prediction* (Princeton, NJ: Princeton University Press, 1989). Some probabilistic long-term and short-term forecasting is possible, however; see James D. Goltz and Evelyn Roeloffs, "Imminent Warning Communication: Earthquake Early Warning and Short-Term Forecasting in Japan and the US," in *Disaster Risk Communication and Communities: A Challenge from a Social Psychological Perspective*, ed. Katsuya Yamori (Singapore: Springer, 2020); and E. Tapia-Hernández, E. Reddy, and L. J. Oros-Aviles, "Earthquake Predictions and Scientific Forecast: Dangers and Opportunities for a Technical and Anthropological Perspective," *Earth Sciences Research Journal* 23, no. 4 (2019).

2. Jennifer Gabrys, *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet* (Minneapolis: University of Minnesota Press, 2016); see also Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010).

3. Quote from interview. Translation by author.

4. Matthew Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*. Cambridge, MA: MIT Press, 2012.

5. See, for example, Hugh Raffles, *In Amazonia: A Natural History* (Princeton, NJ: Princeton University Press, 2002); Cori Hayden, *When Nature Goes Public: The Making and Unmaking of Bioprospecting in Mexico* (Princeton, NJ: Princeton University Press, 2003). I would be remiss if I failed to specifically address the formation of the field of anthropology here. There is a great deal to cite, but an introduction to this history can be found in George W. Stocking, *Victorian Anthropology* (New York: Collier Macmillan, 1987).
6. “Imported magic” is a phrase used among the Brazilian technical elite to refer to computers in the 1970s before it was repurposed to title a collection of essays. See Eden Medina, Ivan da Costa Marques, and Christina Holms, eds. *Beyond Imported Magic: Essays on Science, Technology, and Society in Latin America* (Cambridge, MA: MIT Press, 2014).
7. It can be useful to understand engineering as a domain of knowledge, set of practices, profession, and ideology, to crib from Ethan Blue, Michal Levine, and Dean Nieuwsma, *Engineering and War: Militarism, Ethics, Institutions, Alternatives* (Morgan and Claypool, 2013).
8. See Hiroo Kanamori, “Real-Time Seismology and Earthquake Damage Mitigation,” *Annual Review of Earth and Planetary Sciences* 33, no. 1 (2004): 195–214.
9. Marilyn Strathern, “No Nature, No Culture: The Hagen Case,” in *Nature, Culture and Gender*, ed. Carol P. McCormack and Marilyn Strathern (Cambridge: Cambridge University Press, 1989); Donna Haraway, *ModestWitness@SecondMillennium.Female-ManMeetsOncoMouse: Feminism and Technoscience* (New York: Routledge, 1997).
10. Sandra P. González-Santos, *A Portrait of Assisted Reproduction in Mexico: Scientific, Political, and Cultural Interactions* (Cham, Switzerland: Palgrave Macmillan, 2020), 8–9. See also Hebe Vessuri, “Global Social Science Discourse: A Southern Perspective on the World,” *Current Sociology* 63, no. 2 (2015): 297–313.
11. Manuel Tironi, “Atmospheres of Indagation: Disasters and the Politics of Excessiveness,” *The Sociological Review* 62, no. S1, 155.
12. See Sandrine Revet, *Disasterland: An Ethnography of the International Disaster Community* (Paris: The Sciences Po Series in International Relations and Political Economy, 2020).
13. Mexican scholars’ impact on international, interdisciplinary disaster studies agendas represented in LA RED, the Network of Social Studies in the Prevention of Disasters in Latin America, <https://www.desenredando.org/>, stands as a marker of this; see A. Lavell, A. Brenes, and P. Girot, “The Role of LA RED in Disaster Risk Management in Latin America,” in *World Social Science Report 2013: Changing Global Environments* by International Social Science Council (Paris: OECD Publishing/UNESCO Publishing, 2013).
14. See Héctor Beltrán, “Code Work: Thinking with the System in Mexico,” *American Anthropologist* 122, no. 3 (2020): 487–500.

15. Leandro Rodríguez Medina, "Building Periphery: A Microanalysis of Subordinating Objects as Epistemic Technologies," *Sociológica* 29, no. 83 (2014): 9–46.

16. Sara Pritchard, "Environmental History of Technology," in *The Oxford Handbook of Environmental History*, ed. Andrew C. Isenberg (Oxford: Oxford University Press 2014), 227–258; and Sara B. Pritchard, *Confluence: The Nature of Technology and the Remaking of the Rhone* (Cambridge, MA: Harvard University Press, 2011). See also Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard, eds., *New Natures: Joining Environmental History with Science and Technology Studies* (Pittsburgh, PA: University of Pittsburgh Press, 2013).

17. See, for example Ashley Carse, *Beyond the Big Ditch: Politics, Ecology, and Infrastructure at the Panama Canal* (Cambridge, MA: MIT Press, 2014); Chandra Mukerji, *Impossible Engineering: Technology and Territoriality on the Canal Du Midi* (Princeton, NJ: Princeton University Press, 2012).

18. Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton, NJ: Princeton University Press, 2015); Valerie Olson, *Into the Extreme: US Environmental Systems and Politics Beyond Earth* (Minneapolis: University of Minnesota Press, 2018).

19. Janet Vertesi, *Seeing like a Rover: How Robots, Teams, and Images Craft Knowledge of Mars* (Chicago: University of Chicago Press, 2015); Antonia Walford, "Raw Data: Making Relations Matter," *Social Analysis* 61, no. 2 (2017): 65–80.

20. Gwen Ottinger and B. R. Cohen, *Technoscience and Environmental Justice* (Cambridge, MA: MIT Press, 2011); Mara Goldman, Paul Nadasdy, and Matthew Turner, eds., *Knowing Nature: Conversations at the Intersection of Political Ecology and Science Studies* (Chicago: University of Chicago Press, 2011).

21. Matthew Vitz, *A City on a Lake: Urban Political Ecology and the Growth of Mexico City* (Durham, NC: Duke University Press, 2018).

22. Gary Lee Downey, *The Machine in Me: An Anthropologist Sits Among Computer Engineers* (New York: Routledge, 1998); Jessica M. Smith, *Extracting Accountability: Engineers and Corporate Social Responsibility* (Cambridge, MA: MIT Press, 2021).

23. Ethan Blue, Michal Levine, and Dean Nieuwsma, *Engineering and War: Militarism, Ethics, Institutions, Alternatives* (Williston, VT : Morgan and Claypool, 2013); Atsushi Akera, *Calculating a Natural World* (Cambridge, MA: MIT Press, 2007); Matthew H. Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America* (Cambridge, MA: MIT Press, 2012); Matthew Wisnioski, Eric S. Hintz, and Marie Stettler Kleine, eds. *Does America Need More Innovators?* (Cambridge, MA: MIT Press, 2019); Amy E. Slaton, *Reinforced Concrete and the Modernization of American Building, 1900–1930* (Baltimore, MD: Johns Hopkins University Press, 2001); Amy E. Slaton, *Race, Rigor, and Selectivity in US Engineering: The History of an Occupational Color Line* (Cambridge, MA: Harvard University Press, 2010); Cyrus

C. M. Mody, *The Squares: US Physical and Engineering Scientists in the Long 1970s* (Cambridge, MA: MIT Press, 2022).

24. Åsa Boholm, "The Cultural Nature of Risk: Can There Be an Anthropology of Uncertainty?" *Ethnos* 68, no. 2 (2003): 175 puts this well, noting that "risk" is not really treated as a phenomenon but instead works as "a cognitive frame that produces contexts that link an object of risk (a source of potential harm), an object at risk (a potential target of harm) and an evaluation (implicit or explicit) of human consequences."

25. Lorraine Daston, *Classical Probability in the Enlightenment* (Princeton, NJ: Princeton University Press, 1988); Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990); Mary Douglas, "Risk as a Forensic Resource," *Daedalus* 119, no. 4 (1990): 1–16; Mary Douglas and Aaron Wildavsky, *Risk and Culture* (Berkeley: University of California Press, 1983).

26. Niklas Luhmann, *Risk: A Sociological Theory* (Berlin: Walter de Gruyter, 1993).

27. Michael Power, *Organized Uncertainty: Designing a World of Risk Management* (Oxford: Oxford University Press, 2007)

28. Adriana Petryna, *Life Exposed: Biological Citizens after Chernobyl* (Princeton, NJ: Princeton University Press, 2006); Manuel Tironi, I Rodriguez-Giralt, and M Guggenheim, eds., *Disasters and Politics: Materials, Experiments, Preparedness* (West Sussex, UK: Wiley Blackwell/The Sociological Review, 2014); Scott Gabriel Knowles, *The Disaster Experts: Mastering Risk in Modern America* (Philadelphia: University of Pennsylvania Press, 2012); Vivian Choi, *Disaster Nationalism: Tsunami and Civil War in Sri Lanka* (Durham: Duke University Press, forthcoming).

29. Emily Wanderer has demonstrated how coordinated efforts around a national "vivir mejor," or "live better," strategy come to frame a variety of efforts to improve ordinary life in the relation to ongoing threats to state legitimacy. See Emily Wanderer, *The Life of a Pest: An Ethnography of Biological Invasion in Mexico* (Berkeley: University of California Press, 2020).

30. Anthony Oliver-Smith and Suzanne Hoffman, eds., *The Angry Earth: Disaster in Anthropological Perspective* (New York: Routledge, 1999); *Catastrophe and Culture: The Anthropology of Disaster* (Santa Fe, NM: School of American Research Press, 2002); Michele Ruth Gamburd, *The Golden Wave: Culture and Politics after Sri Lanka's Tsunami Disaster* (Bloomington: Indiana University Press, 2013); Kathleen Tierney, *The Social Roots of Risk: Producing Disasters, Promoting Resilience* (Palo Alto, CA: Stanford University Press, 2014.); Roberto E. Barrios, *Governing Affect: Neoliberalism and Disaster Reconstruction* (Lincoln: University of Nebraska Press, 2017).

31. Elizabeth Povinelli, *Geontologies: A Requiem to Late Liberalism* (Durham, NC: Duke University Press, 2016).

32. Wendy Lesser, *The Life Below the Ground: A Study of the Subterranean in Literature and History* (Boston, MA: Faber and Faber, 1987); Rosalind H. Williams, *Notes on the*

*Underground: An Essay on Technology, Society, and the Imagination* (Cambridge, MA: MIT Press, 2008).

33. Abby Kinchy, Roopali Phadke, and Jessica Smith, "Engaging the Underground: An STS Field in Formation" *Engaging Science, Technology, and Society* 4 (2018): 22–42; Anthony Bebbington, "Underground Political Ecologies: The Second Annual Lecture of the Cultural and Political Ecology Specialty Group of the Association of American Geographers," *Geoforum* 43, no. 6 (2012): 1152–1162.

34. Kristina Lyons, "Decomposition as Life Politics: Soils, Selva, and Small Farmers under the Gun of the U.S.–Colombia War on Drugs," *Cultural Anthropology* 31, no. 1 (2016): 56–81; Maria Puig de la Bellacasa, "Making Time for Soil: Technoscientific Futurity and the Pace of Care," *Social Studies of Science*, 2015.

35. Andrea Ballesterio, "Touching with Light, or, How Texture Recasts the Sensing of Underground Water," *Science, Technology, & Human Values* 44, no. 5 (2019): 762–785.

36. Deborah R. Coen, *The Earthquake Observers: Disaster Science from Lisbon to Richter* (Chicago: University of Chicago Press, 2013); Conevery Bolton Valencius, *The Lost History of the New Madrid Earthquakes* (Chicago: University of Chicago Press, 2013); G. K. Clancey, *Earthquake Nation: The Cultural Politics of Japanese Seismicity, 1868–1930* (Berkeley: University of California Press, 2006).

37. Virginia García Acosta, "Historical Disaster Research," in *Catastrophe and Culture: The Anthropology of Disaster*, ed. Anthony Oliver-Smith and Susannah M. Hoffman (Santa Fe, NM: School of American Research Press, 2002); Sergio Puente, "Social Vulnerability to Disaster in Mexico City," in *Crucibles of Hazard: Mega-Cities and Disasters in Transition*, ed. James K. Mitchell, (Tokyo: United Nations Press, 1999); Diane E. Davis "Reverberations: Mexico City's 1985 Earthquake and the Transformation of the Capital," in *Cities of the Global South Reader*, ed. Farnak Miraftab and Neema Kudva (New York: Routledge, 2014).

38. On navigating respectful and responsible expert communication, see for example, A. Bostrom, C. J. Atman, B. Fischhoff, and M. G. Morgan, "Evaluating Risk Communications: Completing and Correcting Mental Models of Hazardous Processes, Part II," *Risk Analysis* 14, no. 5 (1994): 789–798; and Karina Landeros-Mugica, Javier Urbina-Soria, and Irasema Alcántara-Ayala, "The Good, the Bad and the Ugly: On the Interactions among Experience, Exposure and Commitment with Reference to Landslide Risk Perception in México," *Natural Hazards* 80, no. 3 (2016): 1515–1537.

## CHAPTER 1

1. Giacomo Parrinello, *Fault Lines: Earthquakes and Urbanism in Modern Italy* (New York: Berghahn Books, 2015), 6.

2. See, for example, Marina Franco and Daniel Melchor, "A Year after Mexico Earthquake, Parents Demand Justice," *New York Times*, September 19, 2018.

3. Substantial research does exist on this front, and I direct curious readers to reports such as Mario Ordaz Schroeder, Eduardo Reinoso, Miguel A. Jaimes, Leonardo Alcántara, and Citlali Pérez, “High-Resolution Early Earthquake Damage Assessment System for Mexico City Based on a Single-Station,” *Geofísica Internacional* 56, no. 1 (2017): 117–113; and Edgar Tapia-Hernández and J. Salvador García-Carrera, “Damage Assessment and Seismic Behavior of Steel Buildings during the Mexico Earthquake of 19 September 2017,” *Earthquake Spectra* 36, no. 1 (2020): 250–270.

4. Based on the territory claimed by pre-Colombian civilizations, a strict definition of Mesoamerica would only include southern and central Mexico along with other regions in Central America. However, Wolf’s way of framing the region is significant for my work, and the region incorporates most of modern-day Mexico, so the jump from Mesoamerica to Mexico here is not unwarranted.

5. Eric Wolf, *Sons of the Shaking Earth: The People of Mexico and Guatemala—Their Land, History, and Culture* (Chicago: University of Chicago Press, 1959).

6. While earthquake effects are not directly determined by magnitude, quakes over magnitude 4 are often considered moderate. Near their epicenters, they may have an intensity on the modified Mercalli scale of IV, which means they are perceptible but may not cause damage. Quakes over magnitude 7 are usually considered large. See USGS Earthquake Catalogue, December 23, 2019, <https://earthquake.usgs.gov/earthquakes/search>.

7. Centro Nacional de Prevención de Desastres (CENAPRED), *Atlas Nacional de Riesgos*, accessed March 5, 2018, <http://www.atlasnacionalderiesgos.gob.mx/>.

8. Ashley Carse, *Beyond the Big Ditch: Politics, Ecology, and Infrastructure at the Panama Canal* (Cambridge, MA: MIT Press, 2014).

9. Sara Pritchard, *Confluence: The Nature of Technology and the Remaking of the Rhone* (Cambridge, MA: Harvard University Press, 2011).

10. I make this case in the context of critical scholarship on the non-innocent production of the very concept of nature. See, for example Donna Haraway, *Simians, Cyborgs and Women: The Reinvention of Nature* (New York: Routledge, 1999). However, I describe the anthropogenic construction of physical conditions much more literally.

11. Cf. Dyl, who argues for greater attention to the ways that nonhuman nature and the built environment structure cities, even when those forces may be concealed in rebuilding and recovery efforts. Joanna L. Dyl, *Seismic City: An Environmental History of San Francisco’s 1906 Earthquake* (Seattle: University of Washington Press, 2017).

12. The Nahuatl names of these translate to Smoking Mountain and White Woman, characters in a tragic love story.

13. Geophysicist Cinna Lomnitz’s research and writing provides excellent examples (e.g., Cinna Lomnitz, “A Vanishing Island: A Tentative Reconstruction of Earthquake Hazard in Mexico City,” in *International Symposium on Earthquake Disaster Prevention Vol 1*, ed. Sergio Alcocer (Mexico City: CENAPRED and JICA, 2000).

14. The name itself being a European gloss for a confederation of three Nahuatl-speaking city-states.

15. Candiani writes that the Mexica lived in a “fluid landscape.” She suggests that, despite elaborate hydroengineering, the communities who lived in the Valley of Mexico at the height of Mexica power struggled with and made use of flooding in different ways. Vera Candiani, *Dreaming of Dry Land: Environmental Transformation in Colonial Mexico City* (Palo Alto, CA: Stanford University Press, 2014), 24.

16. Edward B. Tylor, *Anahuac; Or, Mexico and the Mexicans, Ancient and Modern* (London: Longman, Green, Longman and Roberts, 1861), 41. Spanish soldier Bernal Díaz described the waterways and settled lakes as “wonderous sights”; see Bernal Díaz del Castillo, *The Conquest of New Spain*, trans. with an introduction by J. M. Cohen (London: Penguin Books, [1632] 1963). This kind of wonder was not unusual. As historian María M. Portuondo demonstrates, Spanish encounters with the Americas in the sixteenth century were structured by biblical and classical narratives and by a drive to develop new frameworks to understand what they found. While her research emphasizes the epistemic and methodological work done by cosmographers, the basic insight is still useful to understand why Spaniards might see Venice or “wonderful sights” in Mexico. See María M. Portuondo, *Secret Science: Spanish Cosmography and the New World* (Chicago: University of Chicago Press, 2009).

17. See Candiani, *Dreaming of Dry Land*. There are certain echoes here to other colonial efforts to regulate water and rewrite landscapes, such as those described in Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (Berkeley: University of California Press, 2002). On the particular logics of Spanish expertise, see Portuondo, *Secret Science*.

18. These data can be found in Shri Krishna Singh, Enrique Mena, and Raúl R. Castro, “Some Aspects of Source Characteristics of the 19 September 1985 Michoacán Earthquake and Ground Motion Amplification in and Near Mexico City from Strong Motion Data,” *Bulletin of the Seismological Society of America* 78, no. 2 (1988): 451–477. Describing the severity of the lake zone’s effects has inspired more than quantitative language. In 1936, for example, at the first international meeting on soil mechanics, José A. Cuervas offered Mexico City’s soil up as a rare case. It was “hyper reactive,” and he wrote that it offered “a field exceptionally rare to study Soil Mechanics and Foundation Engineering at large.” See José A. Cuervas, “The Floating Foundation of the New Building for the National Lottery of Mexico: An Actual Size Study of the Deformations of a Flocculent-Structured Deep Soil,” in *Proceedings of the International Conference on Soil Mechanics and Foundation Engineering* (Cambridge, MA, June 22–26, 1936), 301, document in the collection of Harvard University Archive). It held a great deal of promise for him and his new science, so much so that in a discipline that was pushing to systematize and make scientific the evaluation of soils, he resorted to not only descriptions of material structure and water in the subsoil but also evocative language about the “marvelous twilights” that the fine volcanic particulate would have created before it had settled to the earth.

19. Mario Ordaz, Roberto Meli, Carlos Montoya-Dulché, Lorenzo Sánchez, and Luis Eduardo Pérez-Rocha, "Data Base for Seismic Risk Assessment in Mexico City," in *Recent Research in Japan and Mexico on Earthquake Risk Mitigation* (Mexico City: CENAPRED and JICA, 1993); Hortencia Flores-Estrella, Sergio Yussim, and Cinna Lomnitz, "Seismic Response of the Mexico City Basin: A Review of Twenty Years of Research," *Natural Hazards* 40 (2007), 357–372.

20. Earthquakes signal shifts in history and violent transition in many Prehispanic Mesoamerican traditions (see Wayne Elzey, "The Nahua Myth of the Suns: History and Cosmology in Pre-Hispanic Mexican Religions," *Numen* 23, no. 2 (1976): 114–135; and Robert L. Kovach, *Early Earthquakes of the Americas* (Cambridge: Cambridge University Press, 2004). Perhaps the most famous belongs to Nahua-speaking Mixtec peoples (often called Aztecs) who, in the Late Postclassic period (1300–1519) defined movement through time in terms of creation and destruction of worlds or "Suns." While the principle of "motion" (*ollin*) created the present Fifth Sun, the motion of the Earth (*tlalollin*) would destroy it. This is described in postcolonial "Legends of the Suns" and in precontact documents. See, for example, Anne S. Dowd and Susan Milbrath, eds., *Cosmology, Calendars, and Horizon-Based Astronomy in Ancient Mesoamerica* (Boulder: University of Colorado Press, 2015).

21. Garduño-Munroy has proposed a way of understanding how earthquakes are represented in the Codex Telleriano Remensis according to a scale of seismic intensity. He argues that Mexicas assessed earthquake effects quantitatively. V. H. Garduño-Monroy, "A Proposal of a Seismic Intensity Scale Obtained from the Nahuatl Codex Telleriano Remensis," *Arqueología Iberoamericana* no. 31 (2016): 9–19. Whether or not this interpretation proves well founded, contemporary researchers find it very likely that Mexica people, among others, systematically documented earthquake qualities. Virginia García Acosta, Rocío Hernández, Irene Márquez, América Molina, Juan Manuel Pérez, Teresa Rojas, and Cristina Sacristán, "Cronología de los sismos en la Cuenca Del Valle de Mexico," in *Estudios sobre sismicidad en el Valle de Mexico*, ed. Sergio Alcocer (Mexico City: Departamento Del Distrito Federal Secretaria General de Obras, 1988); T. Rojas-Rabiela, J. M. Pérez-Zavallos, and V. García-Acosta, *Y volvió a temblar* (Mexico City: Centro de Investigaciones y Estudios Superiores de Antropología Social, Cuadernos de La Casa Chata, 1987), 201.

22. García Acosta and Suárez Reynoso show records indicating damage to the pre-colonial built environment related to quakes, Virginia García Acosta and Gerardo Suárez Rayunoso, *Los sismos en la historia de México vol. 1* (Mexico City: Universidad Nacional Autónoma de México Press, 1996). The quake in 1475 was referenced in Codex Mexicanus and Codex Aubin, in Torquemada's writings, and elsewhere. They note that important records are available in Joaquín Vélazquez de León, *Joaquín Vélazquez de León y sus trabajos científicos sobre el Valle de Mexico* (Mexico City: Prensa de Universidad Nacional Autónoma de México, 1977), 262.



23. García Acosta et al., *Cronología de Los Sismos* has shown how time became incorporated into eighteenth-century colonial seismic reports as public clocks appeared and how earthquakes were systematically compared to each other to assess the degree of a Catholic god's anger.

24. Carlos María de Bustamante, *Temblores de México y justas causas por que se hacen rogaciones públicas* (Mexico City: J. M. Gallegos, 1837), 5; and Juan Orozco y Berra, "Efermídes sísmicas Mexicanas," in *Memorias de la Sociedad Científica Antonio Alzante vol 1* (Mexico City: Imprenta del Gobierno en el Ex-Arzobispado, 1887), 322–324 note these bibliographic sources. There may be some doubt regarding the true length of time the earthquake lasted, but the fact that its duration was worthy of note is important. These records are widely available because of a substantial collaborative project undertaken by historians and geophysicists in Mexico to collect diverse qualitative and quantitative records of seismic activity and make them, to the extent possible, transparent and even useful to contemporary technoscientists. See García Acosta and Suárez Rayunoso, *Los sismos en la historia de México*; on the work of making 450 years of Mexican seismological history available for research, see García Acosta 2004. Virginia García Acosta, "Historical Earthquakes in Mexico. Past Efforts and New Multidisciplinary Achievements," *Annals of Geophysics* 47, no. 2–3 (2004): 487–496.

25. Juan Manuel Espinosa-Aranda, Armando Cuellar, Armando García, Gerardo Ibarrola, Roberto Islas, Samuel Maldonado, and F. H. Rodríguez, "Evolution of the Mexican Seismic Alert System (SASMEX)," *Seismological Research Letters* 80, no. 5 (2009): 694–706.

26. According to J. Velázquez de León, this was bigger and stronger than any the city had experienced in the century (see Joaquín Velázquez de León y sus trabajos científicos, 273, cited in García Acosta and Suárez Rayunoso, *Los sismos en la historia de México*).

27. Gómez de la Cortina (1840, 16–17) among others, cited in García Acosta and Suárez Rayunoso, *Los sismos en la historia de México*.

28. José Gómez de la Cortina, *Terremotos: Carta escrita a una señora por el Coronel D. . .* (Mexico: Impresa por Ignacio Cumplido, 1840), 16–17, cited in García Acosta and Suárez Rayunoso, *Los sismos en la historia de México*.

29. Population and Housing Census, INEGI, Mexico, 1970 and 1980 cited in Sergio Puente Aguilar, "Social Vulnerability to Disaster in Mexico City," in *Social Vulnerability to Disaster in Mexico City. Crucibles of Hazard: Mega-Cities and Disasters in Transition*, ed. James K. Mitchell (Tokyo: United Nations University Press, 1999).

30. Here I have skipped many years in Mexico City's history. I recommend Matthew Vitz's book for careful attention to other ways that environmental forces, particularly water, shaped the city during this time. Matthew Vitz, *A City on a Lake: Urban Political Ecology and the Growth of Mexico City* (Durham, NC: Duke University Press, 2018).

31. S. Robinson, Y. F. H. Franco, R. M. Catrejon, and H. Bernard, "It Shook Again—The Mexico City Earthquake of 1985," *Studies in Third World Societies* 36 (1986): 87.

32. Jacobo Zabłudovsky, "Bucareli." *Por Esto! Quintana Roo*, September 13, 2010.
33. Information from the Mexican Servicio Sismológico Nacional. It was significantly smaller, as magnitude is an exponential measurement. However, after the damage of the first earthquake, its effects were still nasty.
34. It was felt in the states of Jalisco, Colima, Michoacán, Guerrero, Oaxaca, Chiapas, Mexico, Puebla, Hidalgo, and Veracruz.
35. Report by Dr. Mete Sozen, professor of civil engineering at the University of Illinois to a US Senate Commerce Sub-Committee on October 3, 1985. See S. A. Lefomex, *A Report on Mexico City's Earthquakes of September 19th and 20th, 1985* (Mexico City: Lefomex, 1985).
36. State agencies and their affiliates give a range of numbers. Six thousand is one number circulated by the Mexican state. See Rubem Hofliger, Olivier Mahul, Francis Ghesquiere, and Salvador Perez, *FONDEN, el fondo de desastres naturales de México—Una reseña* (Washington, DC: World Bank Global Facility for Disaster Reduction and Recovery, 2012). Cruz Roja Mexicano has estimated fifteen thousand (reported by Mónica Achundia, "A 26 años del sismo, cifra oficial: 3 mil 692 muertes," *El universal*, September 19, 2011). For its part, CIRES offers a number of twenty thousand, following the news outlet *Diario Amanecer* (see CIRES, "The Earthquake of September 19, 1985," accessed December 23, 2019, [cires.mx/1985\\_in.php](http://cires.mx/1985_in.php)).
37. Elena Poniatowska, *Nada, Nadie: Las voces del temblor* (Mexico City: Ediciones Era, 1988); and Russell R. Dynes, Enrico L. Quarantelli, and Dennis Wenger, *Individual and Organizational Response to the 1985 Earthquake in Mexico City, Mexico* (Newark, DE: Disaster Research Center, 1990).
38. Quote from interview with the author.
39. Mexican journalist Carlos Monsiváis communicates about this cogently. See Carlos Monsiváis, "No sin Nosotros:" *Los días del terremoto 1985–2005* (Mexico City: Ediciones Era, 2005). So do the voices recorded in testimonios such as Poniatowska, *Nada, Nadie*; Guadalupe Loeza, *Terremoto: Ausentes/presentes 20 años despues* (Mexico City: Editorial Planeta, 2005); Adolfo Montiel Talonia, Juan Manuel Juárez Cortes, Luis Muñoz Fuentes, Victor Hugo Islas, Ricardo Blanco Velazquez, Jose Santos Navarro, and Evaristo Corona Chavez, *Septiembre 19/18, 7:20: Terremoto!* (Mexico City: La Prensa, nd); and Leslie Serna, *Aquí nos quedaremos . . . !: Testimonios de la coordinadora unica de damnificados* (Mexico City: Universidad Iberoamericana Press, 1995). In their assessment, disaster researchers Dynes, Quarantelli, and Wenger suggest in *Individual and Organizational Response* that this is a product of ad hoc organization rather than the complete chaos or absence of response that some write about.
40. A detailed event timeline compiled in Dynes, Quarantelli, and Wenger, *Individual and Organizational Response* indicates that the president was quite active during these hours, but his absence from the public eye during this time was a serious gaffe. Many parts of the city did, after all, have electricity.

41. Two multidepartmental commissions were created by the president the day after the quake: the National Emergency Commission (CNE) to coordinate response outside of Mexico City, and the Metropolitan Emergency Commission (CME) to deal with the issues within it. These did not start operating until September 22, three days after the first earthquake. Dynes, Quarantelli, and Wenger report in *Individual and Organizational Response* that CME headquarters were not staffed around the clock, even then.

42. Researchers describe the complex relationship between military and civil authorities in twentieth-century Mexico. Between the 1940s and 1960s, the military and civil leadership of Mexico had been tightly integrated—with military acting in service to civilian authority. See Nora Hamilton, *The Limits of State Autonomy: Post Revolutionary Mexico* (Princeton, NJ: Princeton University Press, 1982); Judith Hellman, *Mexico in Crises* (New York: Holmes and Meier, 1983); and Roderic A. Camp, *Politics in Mexico: The Decline of Authoritarianism* (Oxford: Oxford University Press, 1999). At the time of the earthquake, there was some concern that the military might use this opportunity to accumulate power. See Adolfo Zinser, Cesareo Morales, and Rodolfo Pena, eds., *Aun tiembla: Sociedad política y cambio social: El terremoto del 19 Septiembre de 1985* (Mexico City: Grijallo, 1986).

43. Though elsewhere they did more; see Raymundo R. Palacio, “Y de repente entre escombros,” in *Aun tiembla: Sociedad política y cambio social: El terremoto del 19 Septiembre de 1985*, ed. A. Zinser, C. Morales and R. Pena (Mexico City: Grijallo, 1986), 23–37.

44. It is worth noting that this is not an unusual response in times of disaster; as in A. H. Barton, *Communities in Disaster: A Sociological Analysis of Collective Stress Situations* (New York: Doubleday, 1969); Russell R. Dynes, *Organized Behavior in Disaster* (Lexington, MA: Heath Lexington Books, 1970); and Thomas Drabek, *Human System Responses to Disasters: An Inventory of Sociological Findings* (New York: Springer-Verlag, 1986). Researchers theorize that people suspend conflicts in time of natural disasters—for a time, at least. See Tierney, “From the Margins to the Mainstream?”

45. Following a period of stability and nationalization in the middle of the twentieth century—the “Mexican Miracle” national development strategy is often periodized in relation to import substitution policies and economic growth between the 1940s and 1970s—Mexico’s economic situation had degraded dramatically in the 1970s. Troubled industries, subsidized by foreign loans, had been further subsidized by the IMF. The lenders assumed that the loans would be repaid with profits generated from newly discovered Mexican oil reserves. Then the price of oil crashed.

46. For an account of IMF refinancing and state response, see Diane E. Davis, “Failed Democratic Reform in Contemporary Mexico: From Social Movements to the State and Back Again,” *Journal of Latin American Studies* 26, no. 2 (1994): 375–408.

47. Dynes, Quarantelli, and Wenger, *Individual and Organizational Response*.

48. Quote from an interview.

49. Sometimes to the frustration of organizers, who had to manage this wave of assistance. S. A. Lefomex, *A Report on Mexico City's Earthquakes*; and Emilio Díaz Cervantes, *Brigada Plácido Domingo* (Monterrey, MX: Ediciones Castillo, 1995).

50. Díaz Cervantes, *Brigada Plácido Domingo*, 20. The Topos, or Moles, first organized in 1985. The group has subsequently become involved in international emergency response work.

51. These testimonios, true to their genre, are always political. A testimonio is a tricky genre in Latin America. As Anne McClintock defines the genre, it is a story "told to a journalist or anthropologist for political reasons," with "an implied and often explicit plural subject," making it a story with a speaker rather than a story about the speaker, incorporating into a personal narrative things that might not have happened, precisely, to the author but which are nonetheless essential to their subject position and the story they write. See Anne McClintock, "'The Very House of Difference': Race, Gender and the Politics of South African Women's Narrative in Poppie Nongena," *Social Text* 26, no. 25/26 (1990): 218. A testimonio can render experiences as at once both narratives of personal experience and representative of shared trauma. See Diane Nelson, *Reckoning: The Ends of War in Guatemala* (Durham, NC: Duke University Press, 2009).

52. Carlos Monsiváis, *No sin nosotros*, 9.

53. Corruption itself was not as vulnerable as individual politicians. Clientelist relations, so often a component of the practices indicted as corruption, are no less essential to the functioning of power, and have hardly been replaced by transparent democratic processes (see Jonathan Fox, "Governance and Rural Development in Mexico: State Intervention and Public Accountability," *Journal of Development Studies* 32, no. 1 (1995): 1–30 and Tina Hilgers, "Clientelism and Conceptual Stretching: Differentiating among Concepts and among Analytical Levels," *Theory and Society* 40, no. 5 (2011): 567–588.

54. Observers of the 1988 election find it very likely that the PRI engaged in fraudulent practices. Some believe that Cárdenas actually won, though others simply suspect that Salinas's win was by a much smaller margin than official numbers indicate. See Camp, *Politics in Mexico*.

55. Before, the PRI party had nominated leaders of the Federal District of Mexico City directly. Heather Levi recounts this transition as part of her ethnography on the political and social life of Mexican wrestling. See *The World of Lucha Libre: Secrets, Revelations, and Mexican National Identity* (Durham, NC: Duke University Press, 2008).

56. The PRI reasserted its hold in 1991 congressional elections, but in 2000 the nation's second-ranking party, the Partido Acción Nacional (PAN), gained the presidency with support from migrants living outside of Mexico's borders. See Luin Goldring, "The Mexican State and Transmigrant Organizations: Negotiating the Boundaries of Membership and Participation," *Latin American Research Review* 37, no. 3 (2002): 55–99.

57. This is the estimate published by Dynes, Quarantelli, and Wenger, *Individual and Organizational Response*, 3; though as Diane Davis points out, a great deal of reconstruction money should be understood to have been diverted to other uses, especially given Mexico's troubled economy at the time. See Diane Davis, "Reverberations: Mexico City's 1985 Earthquake and the Transformation of the Capital," In Faranak MirafTAB and Neema Kudva, eds., *Cities of the Global South Reader* (New York: Routledge, 2015), 203.

58. Quote from an interview.

59. Comisión Nacional de Reconstrucción, *Bases para el establecimiento del sistema nacional de protección civil* (Mexico City, 1986).

60. It had sister organizations, Centro de Investigaciones Sísmicas (CIS) and Centro de Estudios Prospectivos (CEPRO). All were built up under the auspices of the NGO Fundación Javier Barros Sierra. The Foundation itself was named after a well-known civil engineer with a powerful influence on Mexican policy and education, and the safety-related missions of these research organizations resonated strongly with this legacy. However, of all of them, only CIRES remains; CIS, CEPRO, and even the Fundación Javier Barros Sierra were dissolved.

61. Union Geofísica Mexicana, "Declaration of Morelia," *Excelsior*, November 27, 1986.

62. Geophysicists are no longer sure that the Guerrero Gap will produce a big temblor. It was much discussed in the 1980s and 1990s but might well have released its energy in a so-called slow or "silent" earthquake in which pressures are released over hours or even months and are not necessarily detectable as the kind of motion we generally identify as an earthquake. Herb Dragert, Kelin Wang, and Thomas S. James, "A Silent Slip Event on the Deeper Cascadia Subduction Interface," *Science* 292, no. 5521 (2001): 1525–1528. Further, the idea that seismic pressure builds up and must be regularly released (the basis of the "gap" theory) has since lost some credibility, as Hough (2010) described.

63. CIRES's Espinosa Aranda and a Japanese engineer named Nakamura seem to have arrived at this unique application as solutions to their particular problems independently in the late 1980s. See Yutaka Nakamura, "On the Urgent Earthquake Detection and Alarm System (UrEDAS)," in *Proceedings of the 9th World Conference on Earthquake Engineering VII* (1988), 673–678., Juan Manuel Espinosa-Aranda, Alejandro Jimenez, O. Contreras, Gerardo Ibarrola, and R Ortega, "Mexico City Seismic Alert System," in *Simpósio Internacional Sobre Prevención de Desastres Sísmicos* (Mexico City: CENAPRED, 1992).

64. Mexico City's executive is often referred to as a "governor," largely because the powers of the office are more like those of the executive offices of states than like those of the executive offices of other cities.

65. Quoted from presentation at Avances y Retos en Sismología, Ingeniería y Gestión de Riesgos a 30 Años del Sismo de 1985 (Mexico City, September 17–19, 2015).

66. See Juan Manuel Espinosa-Aranda, Armando Cuellar, Armando Garcia, Gerardo Ibarrola, Roberto Islas, Samuel Maldonado, and F. H. Rodriguez, "Evolution of the Mexican Seismic Alert System (SASMEX)," *Seismological Research Letters* 80, no. 5 (2009): 694–709.

67. Fundación Javier Barros Sierra, *Seminario Aprovechamiento del Sistema de Alerta Sísmica*, 8.

68. Gerardo Rico, Víctor Ruiz, Topiltzin Ochoa, and Carlos Camacho, "Sismo de 6.5 grados; Un muerto en el DF," *La Jornada*, July 16, 1996; Mirna Servín, "Alerta Sísmica," *La Jornada*, June 1, 1998. Angel Bolaños, "Restringida, la señal de alerta; se activó parcialmente (primera plana)," *La Jornada*, June 16, 1999; "Temblor de 5.3 Richter sacude la ciudad; no hubo víctimas ni daños," *La Crónica de Hoy*, September 26, 2002.

69. Elia Arjonilla Cuenca, "Evaluación de la alerta sísmica para la ciudad de México desde una perspectiva sociológica: Resultados en poblaciones escolares con y sin alerta," paper presented at Conference on Early Warning Systems for Reduction of Natural Disasters (Chile, April 27–30, 1998).

70. These were recorded in news articles from the period. Roger Díaz de Cossío and Antonio Alonso Concheiro, "Desgracias: Olvido y recordatorio," *Este País*, May 1, 2002. Miguel Bárcena, "El fangoso suelo del DF amplifica los sismos," *Epoca*, September 26, 1994; Elisa Robledo, Carolina Ballesteros Niño, Noé Cruz Serrano, Rebeca Hernández Marín, Miguel Bárcena, and Ernesto Zavaleta, "Sigue abierta la herida que dejó el sismo del 85," September 26, 1994.

71. Sistema (Agregado 1-SO17) XXX Costas, *Servicio Universal de Noticias*, September 19, 2000.

72. Complaints regarding this theme can be found in popular news articles from the time, which also describe a brief suspension of service. "Servicio alerta sísmica," *Servicio Universal de Noticias*, September 3, 2000; "Escuelas alarma pública," *Servicio Universal de Noticias*, October 13, 2001; Sergio Morales, "Critican diputados suspensión del SAS," *El Economista*, March 13, 2003.

73. It is worth noting that this is not the dense network that Japan boasts. While ubiquitous sensing can structure our imagination of environmental monitoring, this kind of minimal but highly strategized spread is the reality of much knowledge production.

74. "Ciudad de México se mantiene alerta 25 años después de su peor terremoto," *Agencia EFE*, September 18, 2010; Ariette Gutiérrez, "Delegación Cuauhtémoc contrastará con su alerta sísmica," *El Sol de México*, April 9, 2010.

75. Norma Técnica Complementaria al Reglamento de la Ley de Protección Civil del Distrito Federal 2010 (Government of Mexico City).

76. AlertaDF and SkyAlert were the main drivers here. I've written about these partially integrated infrastructures elsewhere. See Elizabeth Reddy, "Crying 'Crying

Wolf: How Misfires and Mexican Engineering Expertise Are Made Meaningful,” *Ethnos* (2019): 1–16.

77. The company Grillo began to do this but soon opted to develop its own sensory network.

78. An unpublished market research survey by company MDreieck presented to CIRES while I was visiting also showed evidence of general ignorance of SASMEX.

79. In a useful typology of warning in alerting developed by McBride et al, this might be considered a “Late Alert.” See S. K. McBride, A. Bostrom, J. Sutton, R. M. de Groot, A. S. Baltay, B. Terbush, P. Bodin, P. M. Dixon, E. Holland, R. Arba, P. Laustsen, S. Liu, and M. Vinci, “Developing Post-Alert Messaging for ShakeAlert, the Earthquake Early Warning System for the West Coast of the United States of America,” *International Journal of Disaster Risk Reduction* 50 (2020).

80. Because there had been an earthquake in southern Mexico earlier in the month, several states canceled plans to participate in the drill. See: “Megasimulacros were cancelled in the states of Mexico, Michoacán, Guerrero, Oaxaca and Puebla.” See “Secretaría de Gobernación Boletín No. 304,” accessed December 27, 2019, <https://www.gob.mx/segob/prensa/suspenden-os-estado>.

81. Reports in Mexican popular media include: Sara Hidalgo and Andrés Lajous, “11 segundos vitales: ¿por qué no sonó a tiempo la alerta sísmica el 19 de Septiembre?” *Animal Político*, November 1, 2017, <https://www.animalpolitico.com/2017/11/alerta-sismica-sensores-cdmx>; Gabriela Romero Sánchez, “Un minuto de silencio y luego el simulacro, piden damnificados,” *La Jornada*, August 31, 2018, <https://www.jornada.com.mx/2018/08/31/capital/032n2cap>.

82. Twelve seconds was the final official time given by CIRES, though early reports on how much of a warning the earthquake early warning system had given were contradictory—some saying twenty seconds and others none whatever. Reports suggest that the quake was detected and analyzed by a first SASMEX station at 1:14:57 and confirmed by another 13:15:04. This was reported in Hidalgo and Lajous, “11 segundos vitales.”

83. In 2018, authorities reported trouble with 12 percent of the loudspeakers meant to sound the earthquake early warning; there is reason to understand that this problem existed before the 2017 quake, as the popular media outlet *Animal Político* reported. “Autoridades de CDMX reconocen que cientos de altavoces no emitieron alerta sísmica por ser obsoletos,” *Redacción Animal Político*, June 29, 2018, <https://www.animalpolitico.com/2018/07/altavoces-alerta-sismica-cdmx>.

## CHAPTER 2

1. See typology of problematic alerts in S. K. McBride, A. Bostrom, J. Sutton, R. M. de Groot, A. S. Baltay, B. Terbush, P. Bodin, P. M. Dixon, E. Holland, R. Arba, P. Laustsen,

S. Liu, and M. Vinci, "Developing Post-Alert Messaging for ShakeAlert, the Earthquake Early Warning System for the West Coast of the United States of America," *International Journal of Disaster Risk Reduction* 50 (2020).

2. Early warning experts Dennis Mileti and John H. Sorensen have recommended that members of the public take advantage of warnings in this way for years. Dennis Mileti, *Communication of Emergency Public Warnings: A Social Science Perspective and State-of-the-Art Assessment* (Washington, DC: Federal Emergency Management Agency, 1990); John H. Sorensen, "Hazard Warning Systems: Review of 20 Years of Progress," *Natural Hazards Review* 1, no. 2 (2000): 119–125. Drilling, rehearsals, or practices of this sort can have political as well as practical effects. See Tracy C. Davis, *Stages of Emergency: Cold War Nuclear Civil Defense* (Durham, NC: Duke University Press, 2007); Ben Anderson and Peter Adey, "Affect and Security: Exercising Emergency in 'UK Civil Contingencies,'" *Environment and Planning D: Society and Space* 29, no. 6 (2011): 1092–1109.

3. See S. K. McBride, A. Bostrom, J. Sutton, R. M. de Groot, A. S. Baltay, B. Terbush, P. Bodin, P. M. Dixon, E. Holland, R. Arba, P. Laustsen, S. Liu, and M. Vinci, "Developing Post-Alert Messaging for ShakeAlert, the Earthquake Early Warning System for the West Coast of the United States of America," *International Journal of Disaster Risk Reduction* 50 (2020).

4. The amount of information that can be communicated by sirens makes this more of an "alert" than a "warning," as the latter can be understood to contain more information. I use "warning" here because it is in keeping with accepted language about what this type of system does. See Jeanette Sutton, Brett Hansard, and Paul Hewett, "Changing Channels: Communicating Tsunami Warning Information in Hawaii," *Proceedings of the 3rd International Joint Topical Meeting on Emergency Preparedness and Response, Robotics, and Remote Systems* (2011): 1–14. I do not parse this difference here because I did not observe the distinction used among either residents of Mexican City or the engineers at CIRES. I note it for curious readers.

5. "One moment" are the words of Dr. Sergio Puente Aguilar, voiced in an interview I conducted in 2014. Puente is a researcher and professor at the Centro de Estudios Demográficos, Urbanos y Ambientales at El Colegio de Mexico, and the author of a number of works on risk in urban Mexico. See Sergio Puente Aguilar, "Social Vulnerability to Disasters in Mexico City: An Assessment," in *Crucibles of Hazard: Mega-Cities and Disasters in Transition*, ed. J. K. Mitchell (Tokyo: The United Nations University Press, 1999); and "Un megalopolis en riesgo: La ciudad de Mexico," in *Los Grandes Problemas de Mexico: Medio Ambiente*, ed. B. Graizbord and J. L. Lezama (Mexico City: El Colegio de Mexico, 2013). He was also on the scientific advisory committee of CIRES, and though he hosted long meetings about SASMEX, he considered earthquake early warning to be one mode among many for intervening on earthquake risk management.



6. With this term I reference two movements in science and technology studies. First, I point to work like that of sociologist John Law that accounts for technological systems in ways that take social and technical forces, logics, and agents seriously, as in "Technology, Closure and Heterogeneous Engineering: The Case of the Portuguese Expansion," in *The Social Construction of Technological Systems*, ed. W. Bijker, T. Hughes, and T. Pinch (Cambridge, MA: MIT Press, 1987): 111–134. Second, I also reference efforts like anthropologist Helen Verran's that address forces, ideas, and conditions more broadly as "heterogenous material-symbolic assemblages" that, as she writes, are active in "making and remaking our world." Helen Verran, "Re-Imagining Land Ownership in Australia," *Postcolonial Studies: Culture, Politics, Economy* 1, no. 2 (1998): 250. I use this word, in short, to signal my attention to multiplicity within and around this system.

7. I use the term "embeddedness" to resonate with an analogous scholarly conversation around formal economic systems and their sociocultural contexts. See Karl Polanyi, *The Great Transformation: The Political and Economic Origins of Our Time* (New York: Farrar & Rinehart, 1944); Clifford Geertz, *Peddlers and Princes: Social Change and Economic Modernization in Two Indonesian Towns* (Chicago: University of Chicago Press, 1963); Mark Granovetter, "Economic Action and Social Structure: The Problem of Embeddedness," *American Journal of Sociology* 91 (1985): 481–510. In much the same way that scholars have engaged with the challenge of how best to understand convergences and contradictions related to the global rise of the market economy, the question of how an early warning can (or cannot) be made part of ordinary life is a site of ongoing trouble for emergency managers and technoscientists.

8. Craig Calhoun, "The Idea of Emergency: Humanitarian Action and Global (Dis) Order," in *Contemporary States of Emergency: The Politics of Military and Humanitarian Interventions*, ed. D. Fassin and M. Pandolfi (New York: Zone Books, 2010), 30. It is worth making clear that this is a critical social scientific analysis of emergency that I am using to help me historicize and reflect on the category of emergency. Professionals in fields related to disaster response and recovery also draw on a sizeable body of research literature, or *literatures*, related to risk reduction, preparedness for, and recovery from emergencies. See George Haddow, Jane Bullock, and Damon P. Coppola, *Introduction to Emergency Management* (Newton, MA: Butterworth-Heinemann, 2013).

9. As Sara McBride shows, while emergency management and emergency communication are related in important and practical ways, the research that informs these practices has significant divergences as well as relations. Although communications research often highlights complex emergent relations, she notes that many "current civil defence public education campaigns still maintain . . . the 'tell people what to do and they will do it' ideology." Sara K. McBride, *The Canterbury Tales: An Insider's Lessons and Reflections from the Canterbury Earthquake Sequence to Inform Better Communication Models* (PhD diss., Massey University, 2017), 65.

10. Mileti and Sorensen, *Communication of Emergency Public Warnings*, 2–10. These warnings are, at times, more directive [see Ann Bostrom, Cynthia J. Atman, Baruch Fischhoff, and M. Granger Morgan, “Evaluating Risk Communications: Completing and Correcting Mental Models of Hazardous Processes, Part II,” *Risk Analysis* 14, no. 5 (1994): 789–798] and at others, more processual, as in Julia Becker, Sally H. Potter, Sara K. McBride, Anne Wein, E. E. H. Doyle, and D. Paton, “When the Earth Doesn’t Stop Shaking: How Experiences over Time Influenced Information Needs, Communication, and Interpretation of Aftershock Information during the Canterbury Earthquake Sequence, New Zealand,” *International Journal of Disaster Risk Reduction* 34 (2019): 397–411.

11. See Jeannette Sutton, Sarah C. Vos, Michele M. Wood, and Monique Turner, “Designing Effective Tsunami Messages: Examining the Role of Short Messages and Fear in Warning Response,” *Weather, Climate, and Society* 10, no. 1 (2018): 75–87; Hamilton Bean, Brooke F. Liu, Stephanie Madden, Jeannette Sutton, Michele M. Wood, and Dennis S. Mileti, “Disaster Warnings in Your Pocket: How Audiences Interpret Mobile Alerts for an Unfamiliar Hazard,” *Journal of Contingencies and Crisis Management* 24, no. 3 (2016): 136–147.

12. On the use of social media and other short-form modes of emergency communication, see Jeannette Sutton, E. S. Spiro, B. Johnson, S. Fitzhugh, B. Gibson, and C. T. Butts, “Warning Tweets: Serial Transmission of Messages during the Warning Phase of a Disaster Event,” *Information, Communication & Society* 17, no. 6 (2014): 765–787; and Jeannette Sutton and Erica D. Kuligowski, “Alerts and Warnings on Short Messaging Channels: Guidance from an Expert Panel Process,” *Natural Hazards Review* 20, no. 2 (2019).

13. There is a substantial body of literature that parses these understandings and actions. They are reviewed admirably in Ann Bostrom, Adam L. Hayes, and Katherine M. Crosman, “Efficacy, Action, and Support for Reducing Climate Change Risks,” *Risk Analysis* 39, no. 4 (2019): 805–828.

14. While I note that personal orientation toward surprises may matter, I want to be clear: there is consensus among researchers that stories about widespread public panic upon receiving warnings, much like those about post-disaster lawlessness and shock responses, are largely myths. For a serious discussion of how ideas about panic have surfaced and circulated, see Scott Knowles, *The Disaster Experts: Mastering Risk in Modern America* (Philadelphia: University of Pennsylvania Press, 2012).

15. Although they may not be ideal, our slow responses may be far from an unusual way to interact with this technology. Two recent surveys of Japanese earthquake early warning users found that many respondents simply used the warning to mentally brace themselves and took no significant physical actions. See Kazuya Nakayachi, Julia S. Becker, Sally H. Potter, and Maximilian Dixon, “Residents’ Reactions to Earthquake Early Warnings in Japan,” *Risk Analysis* 39, no. 8 (2019).

16. On the tension between descriptive and brief messages, see Michele M. Wood, Dennis S. Mileti, Hamilton Bean, Brooke F. Liu, Jeannette Sutton, and Stephanie Madde, “Milling and Public Warnings,” *Environment and Behavior* 50, no. 5 (2018): 535–566.

17. Sara K. McBride, Anne Bostrom, Jeanette Sutton, Robert M. de Groot, A. S. Baltay, Brian Terbush, Paul Bodin, Maximilian Dixon, E. Holland, R. Arba, P. Laustsen, S. Liu, and M. Vinci, “Developing Post-Alert Messaging for ShakeAlert, the Earthquake Early Warning System for the West Coast of the United States of America,” *International Journal of Disaster Risk Reduction* 50 (2020): 101713; Jeanette Sutton, Laura Fischer, Lori E. James, and Sarah E. Sheff, “Earthquake Early Warning Message Testing: Visual Attention, Behavioral Responses, and Message Perceptions,” *International Journal of Disaster Risk Reduction* 49 (2020): 101664. Jeanette Sutton and Erica D. Kuligowski, “Alerts and Warnings on Short Messaging Channels: Guidance from an Expert Panel Process,” *Natural Hazards Review* 20, no. 2 (2019): 04019002.

18. Quote from interview. Translation by author.

19. This term, which refers to the practice of characterizing “micro zones” of soil within geographic area according to their response to seismicity, is described in greater detail in chapter 1.

20. That is not to say that these distinctions do not still matter when Mexico City is only a fraction of the Mexico City Metro Area, and when regional Civil Protection agencies are clients who choose to pay for earthquake early warning services or not.

21. CONACYT-INEGI, *Encuesta sobre la percepción pública de la ciencia y la tecnología (ENPECYT)* (Mexico City: INEGI, 2014).

22. CIRES engineers continued to maintain SASPERs, but they hoped schools would begin to adopt less expensive emergency radios instead.

23. The Spanish word they use, “gabinete,” can also refer to the tower that holds the CPU of a desktop computer. This means that in Spanish, the word has a stronger association with digital technology than it does when it is translated to English.

24. In this case, as in a great deal of emergency management practice, “education” refers to an activity by which experts inform publics about hazards before they happen. See Dennis Mileti, S. Nathe, P. Gori, M. Greene, and E. Lemersal, *Public Hazards Communication and Education: The State of the Art* (Boulder, CO: Natural Hazards Center University of Colorado, 2004). This type of “education” may rely, as McBride notes, on a model more concerned with transferring information to learners than supporting their acquisition of new critical skills. See *The Canterbury Tales*, 60.

25. The outreach team comprised primarily women. While most CIRES departments are mixed-gender, women are usually in the minority in technical spaces. This was an exception.

26. Norma Técnica Complementaria al Reglamento de la Ley de Protección Civil del Distrito Federal, 2010, Mexico City's Law of Civil Protection.

27. Gerardo Suárez, David Novelo, and Elizabeth Mansilla, "Performance Evaluation of the Seismic Alert and a Social Perspective," *Seismological Research Letters* 80, no. 5 (2009): 707–716.

28. Revet notes that children are often key to efforts to illustrate disasters. She notes the symbolic power of their presence and writes that they "play a role that fluctuates artfully between innocence, vulnerability, and resilience." Sandrine Revet, *Disasterland: An Ethnography of the International Disaster Community* (Paris: The Sciences Po Series in International Relations and Political Economy, 2020), 59.

29. It should be noted that communicating in terms of magnitude at source is a debated practice. While broadly used by publics, experts find that the measure does not communicate the key concern of risk management, which is less about the magnitude at source than the intensity of shaking in communities at risk. For that reason, CIRES engineers use magnitude as a resource for public communication related to the system only sometimes, when it is useful. Like many earthquake experts, they prefer to avoid doing so. In this way, magnitude language is only one way to talk earthquakes, a resource to be used when necessary. See chapter 1 for a more in-depth explanation of how the system is arranged in Mexican territory and how it came to be so.

30. Given a multiple-choice question about expectations, 58.3 percent of 2,400 people in Mexico City and the surrounding region who were surveyed indicated that they expected sixty seconds of warning time. Only 22.8 percent indicated the correct answer: the time varies. On a 5-point Likert scale, 77.5 percent of respondents considered themselves knowledgeable or very knowledgeable about response—but the study did not inquire about what response they thought would be appropriate. See Jaime Santos-Reyes, "How Useful Are Earthquake Early Warnings? The Case of the 2017 Earthquakes in Mexico City," *International Journal of Disaster Risk Reduction*, 2019. Earthquake early warnings can be hard to parse, though; see surveys on Japanese understanding of earthquake early warning systems reviewed in James D. Goltz and Evelyn Roeloffs, "Imminent Warning Communication: Earthquake Early Warning and Short-Term Forecasting in Japan and the US James," in *Disaster Risk Communication and Communities: A Challenge from a Social Psychological Perspective*, ed. Katsuya Yamori (Singapore: Springer, 2020).

31. For an earthquake originating in Oaxaca on September 7, 2017, when the Mexico City region had significant warning time, respondents were asked to rank how useful they thought the warning was on a five-point Likert scale. Only 50.2 percent of respondents indicated they found it useful or very useful. For an earthquake originating in Puebla on September 19 (discussed in chapter 1), only 14.3 percent indicated that they found it useful or very useful. See Santos-Reyes, "How Useful Are Earthquake Early Warnings?"

32. Use of SASMEX in schools was never universal, even in areas that the system nominally protected. Nevertheless, CIRES rallied attention around their work in schools.

33. Direct quote from interview. Translated by the author.

34. Direct quote from interview. Translated by the author.

35. Vivian G. Gratton, Herbert D. Thier, Elia Arjonilla, and Rosa Melgar, "The Recovery of Schools from Earthquake Effects: Lessons from Mexico City," *Disasters* 11, no. 4 (1987): 310–316.

36. "Sólida planeación y preparación por parte de la comunidad." See Elia Arjonilla, "Evaluación de la alerta sísmica para la ciudad de México desde una perspectiva sociológica: Resultados en poblaciones escolares con y sin alerta," *International IDNDR: Conference on Early Warning Systems for Reduction of Natural Disasters*, 1998, 3.

37. Arjonilla, "Evaluación de la alerta sísmica," 2–3.

38. Suárez, Novelo, and Mansilla, "Performance Evaluation."

39. The business that supplied these, MDreieck, was founded by former CIRES engineers.

40. Data on radios distributed received from CIRES internal document: "Historico de instalaciones de equipos receptores por parte del CIRES," accessed August 13, 2014. On trouble with distribution, see: Paris Martínez, "El gobierno compra alertas sísmicas, pero éstas desaparecen o se quedan en bodegas," *Animal Político*, September 12, 2017, <http://www.animalpolitico.com/2017/09/gobierno-compraalertas-sismicas-desaparecen-bodegas/>.

41. Direccion de Emergencia Escolar, *Informacion Relativa al Sistema de Alerta Sismica* (Mexico City: Secretaría de Educación Pública, 1995), from CIRES collection.

42. Direct quotes from conversation in public space. Translated by the author.

43. Direct quotes from Twitter. Translated by the author.

44. That is, "for the fear," the implication being that they wanted to eat comforting food to calm themselves after the shock.

45. As reported in Arturo Páramo, "Sismo de 4.6 grados a medianoche alertó al D. F.," *Excelsior*, September 30, 2015, <http://www.excelsior.com.mx/comunidad/2015/09/30/1048507#view-1>.

46. Arthur J. Rubel is well known for his extensive work exploring maladies related to *susto* or "fright" in Latin America. See A. J. Rubel, "Concepts of Disease in Mexican-American Culture," *American Anthropologist* 62, no. 5 (1960): 795–814; and A. J. Rubel, "The Epidemiology of a Folk Illness: Susto in Hispanic America," *Ethnology* 3, no. 3 (1964): 268–283. For a more contemporary overview, see S. C. Weller, R. D. Baer, J. Garcia de Alba Garcia, M. Glazer, R. Trotter, L. Pachter, and R. E. Klein, "Regional Variation in Latino Descriptions of Susto," *Culture, Medicine and Psychiatry* 26 (2002): 449–472.

47. Direct quotes from Twitter. Translated by the author.
48. I have written about “crying wolf” as a way for people to voice concern about early warning elsewhere. See Elizabeth Reddy, “Crying ‘Crying Wolf’ How Misfires and Mexican Engineering Expertise Are Made Meaningful,” *Ethnos* 85, no. 2 (2020): 335–350.
49. Priscila Navarrete, “Alerta sísmica en México por dos temblores en 12 horas,” *El País*, September 30, 2015, [http://internacional.elpais.com/internacional/2015/09/30/actualidad/1443635879\\_427581.html](http://internacional.elpais.com/internacional/2015/09/30/actualidad/1443635879_427581.html).
50. See K. Landeros-Mugica, J. Urbina-Soria, and I. Alcántara-Ayala, “The Good, the Bad and the Ugly: On the Interactions among Experience, Exposure and Commitment with Reference to Landslide Risk Perception in México,” *Natural Hazards* 80, no. 3 (2016): 1515–1537.
51. Arturo Páramo, “Alerta Sísmica busca advertir, no asustar,” *Excelsior*, October 1, 2015, <https://www.excelsior.com.mx/comunidad/2015/10/01/1048733>.
52. A magnitude 4.9 quake, which happened at 6:29 p.m.
53. Direct quote from conversation. Reprinted with permission.

### CHAPTER 3

1. Richard Allen, “Welcome and Opening Remarks,” *Third International Conference on Earthquake Early Warning*, September 3, 2014.
2. Japan, China, Italy, Switzerland, Mexico, the Caribbean, Canada, and, of course, the United States were all very well represented.
3. Attendees included future California secretary of state and US senator Alex Padilla, at the time a state senator; future California governor Gavin Newsom, then serving as lieutenant governor; and San Francisco mayor Ed Lee.
4. Japan’s system is the only exception. Although a number of articles about how earthquake early warning were published by Californian scientists in the late 1980s, their early experimental system had a long way to go before it became the basis for ShakeAlert. See T. H. Heaton, “A Model for a Seismic Computerized Alert Network,” *Science* 228 (1985): 987–990; and R. Holden, M. Reichle, and R. Lee, *Technical and Economic Feasibility of an Earthquake Warning System in California* (Special Publication 101: California Division of Mines and Geology 1989). A longer history is detailed in James D. Goltz and Evelyn Roeloffs, “Imminent Warning Communication: Earthquake Early Warning and Short-Term Forecasting in Japan and the US,” in *Disaster Risk Communication and Communities: A Challenge from a Social Psychological Perspective*, ed. Katsuya Yamori (Singapore: Springer, 2020).
5. The observation that early warning systems are often designed to meet technological requirements and may neglect issues related to use emerges from my research

and has been noted in related studies. See Jeannette Sutton and Erica D. Kuligowski, "Alerts and Warnings on Short Messaging Channels: Guidance from an Expert Panel Process," *Natural Hazards Review* 20, no. 2 (2019): 1–10.

6. Anthropogenic earth motions are also, technically, earthquakes. When stadiums full of sports fans make the ground shake, it is not necessarily interesting from a seismological or emergency management perspective. However, the same cannot be said of other kinds of seismicity that humans produce. Emerging research suggests, for instance, that the seismic effects of hydraulic fracturing practices may take on importance for both in the coming years. See Elizabeth Reddy, "Stability," in *Anthropocene Unseen: A Lexicon*, ed. C. Howe and A. Pandian (Goleta, CA: Punctum Press, 2019). Seismological knowledge has also been crucial to facilitating and documenting global nuclear arms testing. See Kai Henrik Barth, "The Politics of Seismology: Nuclear Testing, Arms Control, and the Transformation of a Discipline," *Social Studies of Science* 33, no. 5 (2003): 743–781. Indeed, military funding for this research has had powerful effects for the twentieth-century disciplinary formation of geophysics, as described in Ronald E. Doel, "Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA after 1945," *Social Studies of Science* 33, no. 5 (2003): 635–666. It has for scientific modes of understanding earth systems more broadly, too, as in Joseph Masco, "Bad Weather: On Planetary Crisis," *Social Studies of Science* 40, no. 1 (2010): 7–40.

7. This mostly happens at or near the edges of tectonic plates—hence the "Ring of Fire" around the Pacific Ocean. Intraplate faulting systems are also significant, though: these produced the New Madrid earthquakes in 1811 and 1812, the significance of which for political and scientific knowledge has been well documented by Conevery Bolton Valencius, *The Lost History of the New Madrid Earthquakes* (Chicago: University of Chicago Press, 2013). Another intraplate rupture produced the 2017 Puebla earthquake discussed in chapter 1 of this book.

8. For excellent detailed and accessible overviews of contemporary mainstream scientific ways of understanding seismicity, see Susan E. Hough, *Earthshaking Science: What We Know (and Don't Know) about Earthquakes* (Princeton, NJ: Princeton University Press, 2002).

9. A careful overview of contemporary work in the histories of scientific knowledge related to seismicity far beyond the scope of this chapter, but for a more thorough engagement, see Deborah R. Coen, *The Earthquake Observers: Disaster Science from Lisbon to Richter* (Chicago: University of Chicago Press, 2013). Seismological research in China and Japan was ongoing and represented less significant breaks with folk traditions than those cultivated in Europe. While Mexico was not a site of innovation, it was nonetheless an important location for seismic instrumentation; see Fa-ti Fan, "'Collective Monitoring, Collective Defense': Science, Earthquakes, and Politics in Communist China." *Science in Context* 25, no. 1 (2007): 127–154; and G. K. Clancey, *Earthquake Nation: The Cultural Politics of Japanese Seismicity, 1868–1930*

(Berkeley: University of California Press, 2006). Mexico's first seismographs—massive Wiechert devices weighing between twelve and seventeen tons each—were installed just to the southwest of Mexico City's historic center in 1910, only thirteen years after the first seismograph in North America was positioned in San Jose, California, as Roberto Quaa Weppen describes in “Breve Historia de La Instrumentacion Sismica En Mexico,” in *Instrumentación sísmica de temblores fuertes* (Mexico City: CENAPRED and JICA, 1992), 35–40. At that time, this kind of state investment in science was explicitly political: “algo para daría lustre al país y le permitiría superar el atraso, para formar parte de los países modernos,” that is, “Something that to give luster to the country and enable it to overcome its backwardness and gain a place among the modern countries of the world.” Natalia Priego, *Ciencia, historia y modernidad: La microbiología en México durante el porfiriato* (Madrid: Editorial CSIC-CSIC Press, 2009), 21.

10. Magnitude is often referred to as the “Richter scale,” in reference to Charles Richter. California seismologist Richter and his colleague Beno Gutenberg developed a logarithmic method for describing the magnitude of seismicity in the 1930s based on the kinds of data that a particular type of seismometer could produce. This type of seismometer was not, as later researchers discovered, as useful for registering bigger earthquakes as it was for smaller ones, and consequently a new scale called “moment magnitude” has since come into more popular use (see Coen, *The Earthquake Observers*). On Richter's life and twentieth-century seismology, see Susan Hough, *Richter's Scale: Measure of an Earthquake, Measure of a Man* (Princeton, NJ: Princeton University Press, 2007).

11. See, for example, Virginia Garcia Acosta, Rocío Hernández, Irene Márquez, América Molina, Juan Manuel Pérez, Teresa Rojas, and Cristina Sacristán, “Cronología de los sismos en la Cuenca del Valle de Mexico,” in *Estudios sobre sismicidad en el Valle de Mexico*, ed. Sergio Alcocer (Mexico City: Departamento Del Distrito Federal Secretaria General de Obras, 1988) on the slow incorporation of time into eighteenth-century colonial seismic reports as public clocks appeared and in relation to concerns that earthquakes might be an indication of the degree of a Catholic god's anger; Coen, *The Earthquake Observers* on how expertise and power were at play in the development and policing of earthquake knowledge between the eighteenth and twentieth centuries; Valencius, *The Lost History of the New Madrid Earthquakes* on how evidence of earthquakes in the central United States has been used in various political and scientific projects; and Finn, *Documenting Aftermath* on how communication in crisis shapes how we understand events like earthquakes. See also Megan Finn, “Information Infrastructure and Descriptions of the 1857 Fort Tejon Earthquake,” *Information and Culture: A Journal of History* 48, no. 2 (2013): 194–221.

12. For a more detailed historical account of these movements, see Sandrine Revet, *Disasterland: An Ethnography of the International Disaster Community* (Paris: The Sciences Po Series in International Relations and Political Economy, 2020), 164–168.

13. This does not include tsunamis. See Centre for Research on the Epidemiology of Disasters and UN Office for Disaster Risk Reduction, “Poverty & Death: Disaster Mortality 1996–2015” (2016), 1–20.



14. Maura R. O'Connor, "Two Years Later, Haitian Earthquake Death Toll in Dispute," *Colombia Journalism Review*, January 12, 2012, [https://archives.cjr.org/behind\\_the\\_news/one\\_year\\_later\\_haitian\\_earthqu.php](https://archives.cjr.org/behind_the_news/one_year_later_haitian_earthqu.php). The Interamerican Development Bank estimated it could cost as much as \$13.9 billion to rebuild Haiti over time, a fraction of the impact to New Zealand. Eduardo Cavallo, Andrew Powell, and Oscar Becerra, "Estimating the Direct Economic Damage of the Earthquake in Haiti," IDB Working Paper No. IDB-WP-163 (2010). Real impacts are notoriously hard to assess, however.

15. The cost of this event, coupled with a second earthquake the next year, totaled \$28 billion USD—the equivalent of almost 20 percent of the country's current gross domestic product. See Canterbury Earthquake Recovery Authority, "Funding the Recovery: The CERA Perspective," *EQ Recovery Learning*, April 18, 2016.

16. Port-au-Prince's population was 900,000 in 2010, a little less than three times Christchurch's 377,000. The difference in fatalities is not even close to proportional.

17. Mary Comerio, "Disaster Recovery and Community Renewal: Housing Approaches," *Cityscape: A Journal of Policy Development and Research* 16, no. 2 (2014): 51–68.

18. See overviews in Revet, *Disasterland*; Malcom Spector and John I. Kitsuse, *Constructing Social Problems* (New York: Routledge, 1987); Anthony Oliver-Smith, "Anthropological Research on Hazards and Disasters," *Annual Review of Anthropology* 25 (1996); Anthony Oliver-Smith and Susannah Hoffman, eds., *Catastrophe and Culture: The Anthropology of Disaster* (Santa Fe: School of American Research Press, 2002); Anthony Oliver-Smith and Susannah Hoffman, eds., *The Angry Earth: Disaster in Anthropological Perspective* (New York: Routledge, 1999); Kathleen J. Tierney "From the Margins to the Mainstream? Disaster Research at the Crossroads," *Annual Review of Sociology* 33, (2007): 503–525. A. J. Faas and Roberto Barrios, "Applied Anthropology of Risks, Hazards, and Disasters," *Human Organization* 74, no. 4 (2015): 287–295. This research has particularly benefited from the insights of cultural and political ecologists. See Aletta Biersack, "Reimagining Political Ecology: Culture/Power/History/Nature," in *Reimagining Political Ecology*, ed. Aletta Biersack and James B. Greenberg (Durham, NC: Duke University Press, 2006), 16–53.

19. See James Kendra and Joanne Nigg, "Engineering and the Social Sciences: Historical Evolution of Interdisciplinary Approaches to Hazard and Disaster," *Engineering Studies* 6, no. 3 (2014): 134–58. This has happened alongside what Kathleen Tierney has called the "mainstreaming" of attention to disaster in social sciences in her article "From the Margins to the Mainstream? Disaster Research at the Crossroads."

20. As UN Disaster policy official Andrew Maskrey put it in 2015, disaster is "endogenous" to the material and social organization of life. Maskrey went so far as to title an influential book *Los desastres no son naturales* [Disasters Are Not Natural] (1993) to emphasize the degree to which human decisions, not earthquakes themselves, make the destruction of the built environment and loss of life possible. Maskrey notes what he calls "a sea change" in the way disaster prevention was conceptualized and done throughout the late-twentieth century. See Andrew Maskrey, "Gestion de

riesgos: Cuenta historico,” paper presented at Sismo 85 Conference (Mexico City, September 18, 2015); and *Los desastres no son naturales* (Panama City, PN: Red de Estudios Sociales en Prevención de Desastres en América Latina, 1993). See also Scott Knowles, *The Disaster Experts: Mastering Risk in Modern America* (Philadelphia: University of Pennsylvania Press, 2013); and Joseph Masco, *The Theater of Operations: National Security Affect from the Cold War to the War on Terror* (Durham, NC: Duke University Press, 2014) on simultaneous shifts in risk and security logics.

21. In Mexico, such insights are written into state-sponsored research and emergency management institutions such as CENAPRED, the National Center for Disaster Prevention.

22. A correspondence between Rousseau and Voltaire is often cited as the first evidence of a “modern” perspective on human agency in the production of disasters. Russell R. Dynes, “The Dialogue between Voltaire and Rousseau on the Lisbon Earthquake: The Emergence of a Social Science View,” *International Journal of Mass Emergencies and Disasters* 18 (2000): 97–115.

23. Wescoat offers an expanded genealogy of some of these concepts in policy and academic research in James L. Wescoat Jr., “Political Ecology of Risk, Hazards, Vulnerability, and Capacities,” in *The Routledge Handbook of Political Ecology*, ed. Tom Perreault, Gavin Bridge, and James McCarthy (London: Routledge, 2015), 293–302.

24. The sociologist and educator Elia Arjonilla’s short book on this topic, originally written for Mexican educators to help them communicate with their students, articulates the utility of this heuristic nicely: “En un mundo que ya no se basa en certezas tradicionales, lo más riesosos . . . puede ser que no sean capaces de tomar decisions”; that is, “In a world no longer based on traditional certainties, the riskiest thing . . . could be not having the capacity to make decisions.” *Como hablar de riesgo: Consideraciones teóricas y unidas, temáticas con ejercicios para la escuela* (Mexico City: Fundación Mexicana para la Salud, n.d.), 10.

25. This kind of exercise in defining variables and relationships is not limited to disaster professionals in fields related to disaster response and recovery. Andrea Ballesterio considers how a similar formula enfolds issues of morality in flexible decision-making. See Andrea Ballesterio, *A Future History of Water* (Durham, NC: Duke University Press, 2019), 37–74

26. The Office of the United Nations Disaster Relief Coordinator, “Natural Disasters and Vulnerability Analysis.” *Report of Expert Group Meeting* (Geneva: United Nations, 1979), iv and 6.

27. “Natural Disasters and Vulnerability Analysis,” 5.

28. “Natural Disasters and Vulnerability Analysis,” 5. In Mexico, I have not seen this operationalization taken up significantly as more than a useful way of illustrating the relationship proposed by the equation itself.

29. Some have called this a “physicalist” approach to mitigating risk. See Christine Gibb, “A Critical Analysis of Vulnerability,” *International Journal of Disaster Risk Reduction* 28 (2018): 327–334; and Kathleen Tierney, “From the Margins to the Mainstream? Disaster Research at the Crossroads.”

30. The shift was hardly universal, and, when he wrote his influential book in the early 1990s, Andrew Maskrey described approaches to vulnerability characterized by what he called a spectrum of approaches, which included as its poles the idea that “disasters were characteristic of natural hazards” and the idea that they might be a matter of “socioeconomic and political structures and practices,” concerning “construction and settlement patterns” somewhere the middle of the two. See Andrew Maskrey, *Los desastres no son naturales*, 2.

31. The recent UN-sponsored Sendai Framework on Disaster Risk Reduction (2015) addresses social and structural issues as part of a single problem: systemically and structurally vulnerable people are disproportionately affected by disaster. This is a significant change even from the focus of the 2005 Hyogo framework that predated it, which focused more on disasters themselves rather than the factors that contribute to them. See United Nations International Strategy for Disaster Reduction, *Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters* (Hyogo, Japan: United Nations, January 22, 2005); and United Nations International Strategy for Disaster Reduction, *Sendai Framework for Disaster Risk Reduction 2015–2030* (Sendai, Japan: United Nations, March 18, 2015).

32. Anthony Oliver-Smith and Susanna Hoffman write that “disaster becomes unavoidable in the context of a historically produced pattern of ‘vulnerability’” (*Catastrophe and Culture*, 3). However, as historian Gregory Clancey reminds us, we would do well to beware of reducing natural events to social ones. See Gregory Clancey, “The Meiji Earthquake: Nature, Nation, and the Ambiguities of Catastrophe,” *Modern Asian Studies* 40, no. 4 (2006): 818.

33. Though ideas about physical vulnerability due to urbanization continue to motivate disaster studies scholarship, Tierney notes that the vast majority of new university programs on risk and disaster are housed in public administration, engineering, geography, and urban planning units, rather than in social science departments (“From the Margins to the Mainstream? Disaster Research at the Crossroads,” 517).

34. For example, Sabine Loos, David Lallemand, Feroz Khan, Jamie McCaughey, Robert Banick, Nama Budhathoki, and Jack Baker, “Beyond Building Damage: Estimating and understanding non-recovery following disasters,” *Preprint through Research Square* (2021).

35. See Roberto E. Barrios, “Resilience: A Commentary from the Vantage Point of Anthropology,” *Annals of Anthropological Practice* 40, no. 1 (2016): 28–38; Jeremy Walker and Melinda Cooper, “Genealogies of Resilience from Systems Ecology to the Political Economy of Crisis Adaptation,” *Security Dialogue* 42, no. 2 (2011): 143–160; J. C. Gaillard, “Vulnerability, Capacity, and Resilience: Perspectives for Climate and Development Policy,” *Journal of International Development* 22 (2010); and John

Hausdoerffer, "What Anything Is For," in *Pragmatist and American Philosophical Perspectives on Resilience*, ed. Kelly A. Parker and Heather E. Keith (Lanham, MD: Lexington Books, 2019).

36. Indeed, the UN Office for Disaster Risk Reduction has recommended early warning systems particularly for places subject to such conditions, suggesting that they are "far more cost-effective in strengthening coping mechanisms than is primary reliance on post-disaster recovery" (*Hyogo Framework*, 5).

37. Other kinds of warning of interest might include those documented in C. Garcia and C. J. Fearnley, "Evaluating Critical Links in Early Warning Systems for Natural Hazards," *Environmental Hazards* 11, no. 2 (2012): 123–137; J. H. Sorensen, "Hazard Warning Systems: Review of 20 Years of Progress," *Natural Hazards Review* 1, no. 2 (2000): 119–125; J. S. Becker, G. S. Leonard, S. H. Potter, M. A. Coomer, D. Paton, K. C. Wright, and D. M. Johnston, "Organisational Response to the 2007 Ruapehu Crater Lake Dam-Break Lahar in New Zealand: Use of Communication in Creating an Effective Response," in *Observing the Volcano World. Advances in Volcanology*, ed. C. J. Fearnley, D. K. Bird, K. Haynes, W. J. McGuire, and G. Jolly (Barcelona, Spain: Springer, 2017); J. Brotzge and W. Donner, "The Tornado Warning Process: A Review of Current Research, Challenges, and Opportunities," *Bulletin of the American Meteorological Society* 94, no. 11 (2013): 1715–1733.

38. On the ways that this community distinguishes between forecasting and prediction, see Revet, *Disasterland*. Some probabilistic long- and short-term forecasting is possible, however; see James D. Goltz and Evelyn Roeloffs, "Imminent Warning Communication: Earthquake Early Warning and Short-Term Forecasting in Japan and the US," in *Disaster Risk Communication and Communities: A Challenge from a Social Psychological Perspective*, ed. Katsuya Yamori (Singapore: Springer, 2020); and E. Tapia-Hernández, E. Reddy, and L. J. Oros-Aviles, "Earthquake Predictions and Scientific Forecast: Dangers and Opportunities for a Technical and Anthropological Perspective," *Earth Sciences Research Journal* 23, no. 4 (2019).

39. Ignacio Farías, for example, writes about the troubles of recognizing such hazards and the obligation to do so. See "Misrecognizing Tsunamis: Ontological Politics and Cosmopolitical Challenges in Early Warning Systems," in *Disasters and Politics: Materials, Experiments, Preparedness*, 62 (2014): 61–87. In her book on weather prediction, Phaedra Daipha suggests that, while the way experts grapple with uncertainty can be concealed in decision-making, it nevertheless remains essential to understand. See *Masters of Uncertainty: Weather Forecasters and the Quest for Ground Truth* (Chicago: University of Chicago Press, 2015).

40. On the state of prediction in earthquake science, see Susan Hough, *Predicting the Unpredictable: The Tumultuous Science of Earthquake Prediction*. (Princeton, NJ: Princeton University Press, 2010).

41. This nineteenth-century plan was even used to help settle a legal battle in Mexico. A group of geophysicists patented the idea of an early alert system in 1986.

In 1993, they brought a legal suit against both the government of Mexico City and the nonprofit through which the earthquake early warning was being run, asking for payment of damages and fees to the tune of \$20 million pesos (the equivalent of a little less than \$6 million USD). The suit lasted nearly a decade. The patent was finally nullified in 1999, in light of pre-existing work on earthquake early warning.

42. Richard M. Allen, Paolo Gasparini, O. Kamigaichi, and M. Bose, "The Status of Earthquake Early Warning around the World: An Introductory Overview," *Seismological Research Letters* 80, no. 5 (2009): 682–693; W. H. K. Lee and J. M. Espinosa-Aranda, "Earthquake Early-Warning Systems: Current Status and Perspectives," in *Early Warning Systems for Natural Disaster Reduction*, edited by J. Zschau and A. N. Küpper (New York: Springer Publishing, 2003).

43. See Valencius, *The Lost History of the New Madrid Earthquakes*; and Coen, *The Earthquake Observers*.

44. See Peter U. Rodda and Alan E. Leviton, "Nineteenth Century Earthquake Investigations in California," *Earth Sciences History* 2, no. 1 (1983): 48–56.

45. While Finn focuses on how information circulates after a disaster, her insight that the flow of information related to a crisis can have consequences for how the event, and future events, are experienced and understood is also important here. See Megan Finn, *Documenting Aftermath: Information Infrastructures in the Wake of Disasters* (Cambridge, MA: MIT Press, 2018).

46. Pursuit of knowledge of the underground has not only been important for geoscientists' ongoing disciplinary work but has become key to the territorialization of sovereignty. See Bruce Braun, "Producing Vertical Territory: Geology and Governmentality in Late Victorian Canada," *Ecumene* 7, no. 1 (2000): 7–46; Anthony Bebbington, "Underground Political Ecologies: The Second Annual Lecture of the Cultural and Political Ecology Specialty Group of the Association of American Geographers," *Geoforum* 43, no. 6 (2012): 1152–1162. Stuart Elden, "Secure the Volume: Vertical Geopolitics and the Depth of Power," *Political Geography* 34 (2013): 35–51.

47. On mechanical objectivity, see Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007). On the ways that human and mechanized senses were both used in earthquake research in the nineteenth and twentieth centuries, see Coen, *The Earthquake Observers*.

48. See Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010); and "Entangled Histories: Climate Science and Nuclear Weapons Research," *Bulletin of the Atomic Scientists* 68, no. 4 (2012): 28–40.

49. See Tahani Nadim, "Blind Regards: Troubling Data and Their Sentinels," *Big Data & Society* 3, no. 2 (2016): 1–6; Jennifer Gabrys, *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet* (Minneapolis: University of Minnesota Press, 2016).

50. Key projects related to quickly identifying earthquakes and defining them from background noise are documented in W. H. K. Lee, R. E. Bennett, and K. L. Meagher, *A Method of Estimating Magnitude of Local Earthquakes from Signal Duration* (US Department of the Interior, Geological Survey, 1972); Rex V. Allen, "Automatic Earthquake Recognition and Timing from Single Traces," *Bulletin of the Seismological Society of America* 68, no. 5 (1978): 1521–1532. T. V. McEvilly and E. L. Majer, "ASP: An Automated Seismic Processor for Microearthquake Networks," *Bulletin of the Seismological Society of America* 72, no. 1 (1982): 303–325.

51. The development of the first techniques to estimate a quake's eventual magnitude with data collected at the moment it commences are recorded in Yutaka Nakamura, "On the Urgent Earthquake Detection and Alarm System (UrEDAS)," in *Proceedings of the 9th World Conference on Earthquake Engineering VII* (1988), 673–678; Juan Manuel Espinosa-Aranda, Arturo Uribe, Gerardo Ibarrola, Victor Toledo, and Cecelio Rebollar, "Evaluación de un algoritmo para detectar sismos de subducción," in *Memorias VIII Congreso Nacional de Ingeniería Sísmica* (1989): A199–A211; and Juan Manuel Espinosa-Aranda, Alejandro Jimenez, O. Contreras, Gerardo Ibarrola, and R. Ortega, "Mexico City Seismic Alert System," in *Simpósio Internacional Sobre Prevenção de Desastres Sísmicos* (Mexico City: CENAPRED, 1992).

52. No European system is public.

53. See, for example, Sarah E. Minson, Annemarie S. Baltay, Elizabeth S. Cochran, Thomas C. Hanks, Morgan T. Page, Sara K. McBride, Kevin R. Milner, and Men Andrin Meier, "The Limits of Earthquake Early Warning Accuracy and Best Alerting Strategy," *Scientific Reports* 9, no. 1 (2019): 1–13; and David Wald, "Practical Limitations of Earthquake Early Warning," *Earthquake Spectra* 36, no. 3 (2020): 1412–1447.

54. Comisión Nacional de Reconstrucción, *Bases para el establecimiento de una sistema nacional de protección civil* (Mexico City: CNR, 1986), 16. See also Organisation for Economic Co-operation and Development. "Mexico 2013: Review of the Mexican National Civil Protection System." *OECD Reviews of Risk Management Policies* (Paris: OECD, 2013). Civil Protection has been institutionalized differently across Mexico. There are Ayuntamientos, Coordinaciones, Direcciones, Unidades, Institutos, Subsecretarías, and Secretarías in various states' governments. Each of these implies different levels of access to leaders and of influence in decision-making. They are listed in roughly ascending order here. Funding and personnel also vary, though not necessarily in accordance with the status of Civil Protection offices or with respect to with the risk related to the hazards that the populations of these states might live with.

55. A security apparatus is a matter of epistemological, material, and administrative elements and agents working in coordination. Large-scale coordinated systems can make possible vast integrated configurations of power and sometimes violence in the intimate life of ordinary people. As Stephen Collier points out, Foucault gives us the tools to think through disaster prevention in terms of a "system of correlations"

and “heterogenous ensembles.” See Stephen J. Collier, “Enacting Catastrophe: Preparedness, Insurance, Budgetary Rationalization,” *Economy and Society* 37, no. 2 (2008): 224–250. See also Masco, *The Theater of Operations*; Tracy C. Davis, *Stages of Emergency: Cold War Nuclear Civil Defense* (Durham, NC: Duke University Press, 2007); Ben Anderson, “Preemption, Precaution, Preparedness: Anticipatory Action and Future Geographies,” *Progress in Human Geography* 34, no. 6 (2010): 777–798; Didier Fassin and Mariella Pandolfi, eds., *Contemporary States of Emergency: The Politics of Military and Humanitarian Interventions* (New York: Zone Books, 2010); and Brian Massumi, “Fear (The Spectrum Said),” *Positions* 13, no. 1 (2005): 31–48.

56. The Mexico City authority is, in the schema of Mexico’s three-level system of government, a city with the power of a state (and its leader is, consequently, referred to as a “governor”) while its various boroughs are classed as municipal governments with the attendant powers and regulatory responsibilities. There are, then, thirty-two entities treated like “states” in Mexico but only thirty-one states.

57. Each of these implies different levels of access to leaders and of influence in decision-making; they are listed in roughly ascending order here. Funding and personnel also vary, though not necessarily in accordance with the status of Civil Protection offices or with respect to with the risk of “perturbatory phenomena” or disastrous fallout from encounters with such hazards that the populations of these states might live with.

58. Guerrero’s annual state budget: \$5 billion pesos in 2014 when I visited, or approximately \$400 million USD. Oaxaca’s was \$8 billion pesos or \$600 million USD. A rich state like Nuevo León might have a budget of around twice that of these two.

59. Quote from interview. Translation by author.

60. Michael Fischer, “Culture and Cultural Analysis as Experimental Systems,” *Cultural Anthropology* 22, no. 1 (2007): 3.

61. Stefan Helmreich has discussed this issue thoughtfully in “After Culture: Reflections on the Apparition of Anthropology in Artificial Life, a Science of Simulation,” *Cultural Anthropology* 16, no. 4 (2001): 612–627. After spending time in Mexico, I developed a sense that even outside of the social sciences I could expect the term to carry different kinds of meanings there: to describe how people lived and how they made sense of the world or perhaps their traditions, stories, and craftwork. The “cultures” that have been the topic of academic and popular interest are often indigenous; for a critical account of this movement in national mythmaking, see Claudio Lomnitz Adler, *Exits from the Labyrinth: Culture and Ideology in the Mexican National Space* (Berkeley: University of California Press, 1992); and Roger Bartra, *The Cage of Melancholy: Identity and Metamorphosis in the Mexican Character* (New Brunswick, NJ: Rutgers University Press, 1992).

62. This is evident in a number of official statements from this time period, including a public talk by the general coordinator of Mexico City’s Program for the Prevention

of Risks and Civil Protection. See José Antonio Carranza Palacios, “La prevención y la cultura sísmica,” First National Conference on Civil Protection, December 8–10, (Mexico City: Sistema Nacional de Protección Civil, 1993), 92. See also Elia Arjónilla and Virginia García Acosta, “Cultura sísmica,” in *Seminario aprovechamiento del sistema de alerta sísmica* (Mexico City: Fundación Javier Barros Sierra, 1992).

63. Comisión Nacional de Reconstrucción, *Bases para el establecimiento de una sistema nacional de protección civil*, 101.

64. Ley de Protección Civil 2012.

65. Some suggested that the Japanese had such a culture, when I asked. In the wake of the disaster related to Hurricane Katrina, at least one Civil Protection official was skeptical of the culture of prevention in the United States.

66. See Comisión Nacional de Reconstrucción, *Bases para el establecimiento*.

67. On the effects that such models can have for policy, see Sheila Jasanoff, “A Mirror for Science,” *Public Understanding of Science* 23, no. 1 (2014): 21–26.

68. There are many resonances here with recrimination about the so-called “culture of poverty.” This model associates certain ways of being with failures to thrive in the world and tends to ignore the forms of dominance that produce structural inequality and affect material conditions of life. See Michele Lamont, Mario Luis Small, and David J. Harding, “Reconsidering Culture and Poverty,” *The Annals of the American Academy of Political and Social Science* 629, no. 1 (2010): 6–27. I thank Elizabeth F. S. Roberts for pointing out this relation to me in conversation, and for her work on the topic.

69. Julie Koppel Maldonado, “Considering Culture in Disaster Practice,” *Annals of Anthropological Practice* 40, no. 1 (2016): 52–60 uses the term “scapegoating,” as do Faas and Barrios, “Applied Anthropology of Risks, Hazards, and Disasters.”

70. Jesus Manuel Macías Medrano, *Desastres y protección civil: Problemas sociales, políticos y organizacionales* (Mexico City: CIESAS, 1999), 7. Doing so would articulate a kind of personalization of responsibility that resonates with the security rationalities documented in Davis, *Stages of Emergency*, and Masco, *The Theater of Operations*, with respect to the Cold War and the War on Terror, respectively.

71. Quote from interview. Translation by author.

72. Alex Padilla, “Opening Remarks on Bringing EEW to the US,” *Third International Conference on Earthquake Early Warning*, September 3, 2014.

## CHAPTER 4

1. Mirna Servín Vega, “Falsa alarma de sismo provoca estampida en inmuebles de la capital,” *La Jornada*, July 28, 2014, <https://www.jornada.com.mx/2014/07/29/capital/030n1cap>.

2. This has since changed as other technoscientists have developed networks of small sensors and even smartphones to use for this purpose. Additionally, note that



I am not referring to on-site devices that can register P-waves of earthquakes and produce alerts before slower and stronger S-waves arrive. While some refer to those as early warning systems too, the CIRES team just calls them “pendulums.” They do not rely on complex environmental monitoring networks in the same way that the systems under discussion here do.

3. This is, of course, not always the case. The tragic earthquake of September 19, 2017, originated very near to Mexico City, so the system was only able to give city residents between five and ten seconds of warning. In cases where an earthquake originates on the western coast of Mexico, however, a minute is a conservative estimate of the lead-time that an earthquake early warning system can offer.

4. It was ASCII, or American Standard Code for Information Interchange.

5. Astute readers will note that “crying wolf” was a concern with the alert described in chapter 2 as well. See Elizabeth Reddy, “Crying ‘Crying Wolf’ How Misfires and Mexican Engineering Expertise are Made Meaningful,” *Ethnos* 85, no. 2 (2020): 335–350. J. L. Austin considered misfires as only one ordinary kind of “infelicity” that might interfere with the performative efficacy of a speech act. *How to Do Things with Words* (Oxford: Oxford University Press, 1961).

6. For a more extended and nuanced consideration of engineers and professional dynamics around responsibility, see Jessica M. Smith, *Extracting Accountability: Engineers and Corporate Social Responsibility* (Cambridge, MA: MIT Press, 2021).

7. Dennis S. Mileti and John H. Sorensen, *Communication of Emergency Public Warnings: A Social Science Perspective and State-of-the-Art Assessment* (Washington, DC: Federal Emergency Management Agency, 1990). See also Jeannette Sutton and Erica D. Kuligowski, “Alerts and Warnings on Short Messaging Channels: Guidance from an Expert Panel Process,” *Natural Hazards Review* 20, no. 2 (2019): 1–10; and Michele M. Wood, Dennis S. Mileti, Hamilton Bean, Brooke F. Liu, Jeannette Sutton, and Stephanie Madden, “Milling and Public Warnings,” *Environment and Behavior* 50, no. 5 (2018): 535–566.

8. See Jeannette Sutton, Sarah C. Vos, Michele M. Wood, and Monique Turner, “Designing Effective Tsunami Messages: Examining the Role of Short Messages and Fear in Warning Response,” *Weather, Climate, and Society* 10, no. 1 (2018): 75–87; Jeannette Sutton, Laura Fischer, Lori E. James, and Sarah E. Sheff, “Earthquake Early Warning Message Testing: Visual Attention, Behavioral Responses, and Message Perceptions,” *International Journal of Disaster Risk Reduction* 49 (2020); S. K. McBride, A. Bostrom, J. Sutton, R. M. de Groot, A. S. Baltay, B. Terbush, P. Bodin, M. Dixon, E. Holland, R. Arba, P. Laustsen, S. Liu, and M. Vinci, “Developing Post-Alert Messaging for ShakeAlert, the Earthquake Early Warning System for the West Coast of the United States of America,” *International Journal of Disaster Risk Reduction* 50 (2020): 101713.

9. See Alissa Walker, “Earthquake-Prone LA Needs a Better Early Warning Alert,” *Curbed Los Angeles*, July 10, 2019, <https://la.curbed.com/2019/7/10/20688797/earthquake-early-warning-los-angeles-app>.

10. See, for example, “Chinese Researchers Build World-Leading Earthquake Early Warning System,” *Sputnik*, June 27, 2019, <https://sputniknews.com/analysis/201906271076062345-chinese-researchers-world-leading-earthquake-early-warning-system>.

11. Mexico had roughly 33.3 million smartphone users at this time according to the Groupe Speciale Mobile Association. *Mobile Economy: Latin America* (London: GSMA, 2013) <http://www.gsma.com/latinamerica>.

12. Sixty-three percent of Mexicans had access to smartphones in 2018. Groupe Speciale Mobile Association, *The Mobile Economy: Latin America 2019* (London: GSMA, 2019) <http://www.gsma.com/latinamerica>.

13. As of this writing, these are options for subscribers who pay \$7.49 USD per year.

14. Quote from interview. Translation by author.

15. On Mexico’s digital frontier, see Héctor Beltrán, “Code Work: Thinking with the System in Mexico,” *American Anthropologist* 122, no. 3 (2020): 487–500. This description of the SkyAlert app is very much in keeping with the scholar Lilly Irani’s insights about how entrepreneurial ventures are often described. Irani shows that entrepreneurialism is often vaguely defined and understood to be pluripotent. It is expected to “construct markets, produce value, and do nation building” all at once. Lilly Irani, *Chasing Innovation: Making Entrepreneurial Citizens in Modern India* (Princeton, NJ: Princeton University Press, 2019), 2.

16. Quote from interview. Translation by author.

17. Those who are not served by an infrastructure never rely on its function, either. See Susan Leigh Star, “The Ethnography of Infrastructure,” *American Behavioral Scientist* no. 3 (1999): 377–391.

18. Infrastructural changes and failures are, of course, never out of the ordinary (see, for example, Nikhil Anand’s excellent infrastructural scholarship in *Hydraulic City: Water and the Infrastructures of Citizenship in Mumbai* (Durham, NC: Duke University Press, 2017), or the overview in Casper Bruun Jensen and Atsuro Morita, “Introduction: Infrastructures as Ontological Experiments,” *Ethnos* 82, no. 4 (2017): 615–626. Systems break down all the time, and breakdowns must be part of any analysis related to them.

19. Brian Larkin, “The Politics and Poetics of Infrastructure,” *Annual Review of Anthropology* 42, no. 1 (2013): 329.

20. Mirna Servín Vega, “Falsa alarma de sismo provoca estampida en inmuebles de la capital.”

21. One tweet summarized various interactions after Mexico’s July 2014 misfire in rude text transposed over a popular image of a bellicose anteater with its claws spread wide and aggressive: “Ven puto/vente a pelear cabron” it read: “Come at me, pussy/you bastard, come and fight.” It was not clear to me which of the organizations

was meant to be the violent mammal with its claws stretched wide and which the taunted audience. It seemed significant, though, that this gloss of the organizations' interaction is brimming with energy and anticipating action, responding to one event and preparing for a new one.

22. Quote from Twitter. Translated by author.

23. Tom Boellstorff, *Coming of Age in Second Life: An Anthropologist Explores the Virtually Human* (Princeton, NJ: Princeton University Press, 2008).

24. See Denise Maerker, "App SkyAlert 'replicó' falsa alerta sísmica," *Grupo Formula*, July 28, 2014, <https://www.radioformula.com.mx/noticias/20140728/app-skyalert-replico-falsa-alerta-sismica-con-denise-maerker/#sthash.s17KNgpW.dpuf>.

25. A smartphone app was limited by Mexico's telephone infrastructure, which didn't facilitate broadcast texts but might still warn more people of an impending earthquake than a radio or television message that they had no way of receiving. This is a "Late Alert" in the typology developed by S. K. McBride, A. Bostrom, J. Sutton, R. M. de Groot, A. S. Baltay, B. Terbush, P. Bodin, P. M. Dixon, E. Holland, R. Arba, P. Laustsen, S. Liu, and M. Vinci, "Developing Post-Alert Messaging for ShakeAlert, the Earthquake Early Warning System for the West Coast of the United States of America," *International Journal of Disaster Risk Reduction* 50 (2020).

26. These are sold at ever-more-affordable but still prohibitive costs (as of June 2015, the price might range from \$1,300 for a new radio and installation to \$100 USD for a used off-brand receiver, though a home receiver to be priced at about \$25 is currently in the works).

27. As Stephanie C. Kane, Eden Medina, and Daniel M. Michler note in the course of their reflections on communication failures in Chile following the 2010 Maule earthquake, "Disaster preparation has not guided the development of digital communication infrastructure to the extent required for effective disaster response." Stephanie C. Kane, Eden Medina, and Daniel M. Michler, "Infrastructural Drift in Seismic Cities," *Social Text* 33, no. 1 (2015): 71

28. Narratives that relate technical efforts to the common good of Mexico and its people have powerful implications for how experts consider their social roles and the subjectivities they embody today. Mexican technical experts have a unique position of obligation and ability for public safety. Many feminist science and technology studies scholars have explored the relationship between having the capacity to take some action and feeling an obligation to do so using the term "response-ability." The concept of response-ability directs attention to how ways of knowing the self and the world can constitute the conditions of possibility for action, and vice versa. As Donna Haraway puts it, response-ability is the "praxis of care and response." See Donna Haraway, "Awash in Urine: DES and Premarin® in Multispecies Response-Ability," *WSQ: Women's Studies Quarterly* 40, no. 1 (2012): 301–316. See also Eva Hayward, "Fingeryeyes: Impressions of Cup Corals," *Cultural Anthropology* 25, no. 4 (2010): 577–599;

Astrid Schrader, "Responding to *Pfiesteria piscicida* (the Fish Killer): Phantomatic Ontologies, Indeterminacy, and Responsibility in Toxic Microbiology," *Social Studies of Science* 40, no. 2 (2010): 275–306; Aryn Martin, Natasha Myers, and Ana Viseu, "The Politics of Care in Technoscience," *Social Studies of Science* 45, no. 5 (2015): 625–641.

29. Quotes from interview. Translation by author.

30. Mirna Servín Vega, "Falsa alarma de sismo provoca estampida en inmuebles de la capital."

31. *El Economista*, "SkyAlert acepta error tras alerta sísmica," *El Economista*, July 28, 2014, <https://www.eleconomista.com.mx/politica/SkyAlert-acepta-error-tras-alerta-sismica-20140728-0012.html>. The news story was picked up by international media too—see *BBC News*, "Mexico quake app firm SkyAlert sorry for false alarm," July 29, 2014, <http://www.bbc.com/news/world-latin-america-28543663>.

32. Quote from interview. Translation by author.

33. This should not be understood to be a paradox. As Michelle Murphy wrote, "the exercise of power operates through care." Michelle Murphy, "Unsettling Care: Troubling Transnational Itineraries of Care in Feminist Health Practices," *Social Studies of Science* 45, no. 5 (2015): 719; see also Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: Minnesota University Press, 2017). Care is not simple and must be interrogated with respect to its material and symbolic attributes and effects.

34. Claudio Lomnitz, "Ritual, Rumor and Corruption in the Constitution of Polity in Modern Mexico," *Journal of Latin American Anthropology* 1, no. 1 (1995): 38. The social work of conspiracy theories is a topic of some interest to anthropologists outside of Mexican contexts. While Lomnitz sees chisme as an important form of national discourse and crucial to the national public, Charles Briggs has documented the conspiracy theories that such gossip may contain as political epistemological practices of marginalized communities. Charles Briggs, "Theorizing Modernity Conspiratorially: Science, Scale, and the Political Economy of Public Discourse in Explanations of a Cholera Epidemic," *American Ethnologist* 31, no. 2 (2004): 164–187. Hoon Song points out how such theories, and our theorizing about them, might trouble our understandings of knowledge. Hoon Song, "Cogito, Mimesis, and Conspiracy Theory," *Culture, Theory and Critique* 53, no. 1 (2012): 1–18.

35. See John Gledhill, *Power and its Disguises: Anthropological Perspectives on Politics* (Boulder, CO: Pluto Press, 1994); Pieter De Vries, "Vanishing Mediators: Enjoyment as a Political Factor in Western Mexico," *American Ethnologist* 29, no. 4 (2002): 901–927.

36. In her recent ethnography of Guatemalan conservation work, Micha Rahder describes similar theory work as a "paranoid epistemology," a "mode of thought borne of social contexts in which suspicion of hidden dealings is a perfectly

reasonable response." *An Ecology of Knowledges: Fear, Love and Technoscience in Guatemalan Forest Conservation* (Durham, NC: Duke University Press, 2020): 27.

37. Lomnitz, "Ritual, Rumor and Corruption in the Constitution of Polity in Modern Mexico," 36.

38. SkyAlert 4, *System Information* (Accessed July 1, 2020).

## CHAPTER 5

1. Quote from interview. Translation by author.

2. Quote from interview. Translation by author.

3. See Ethan Blue, Michal Levine, and Dean Nieuwsma, *Engineering and War: Militarism, Ethics, Institutions, Alternatives* (Williston, VT: Morgan and Claypool, 2013) for a discussion of engineering as a domain of knowledge, a set of practices, a profession, and an ideology.

4. See Wendy Faulkner, "'Nuts and Bolts and People': Gender-Troubled Engineering Identities," *Social Studies of Science* 37, no. 3 (2007): 331–356.

5. Quote from interview. Translation by author.

6. For an extended and thoughtful historical meditation on interplay of materials, engineering knowledge, and broad social trends, see Amy E. Slaton, *Reinforced Concrete and the Modernization of American Building, 1900–1930* (Baltimore, MD: Johns Hopkins University Press, 2001).

7. On measurement practices and their social worlds as objects of anthropological inquiry, see also Antonia Walford, "Double Standards: Examples and Exceptions in Scientific Metrological Practices in Brazil," *Journal of the Royal Anthropological Institute* 21, no. S1 (2015): 64–77.

8. Atsushi Akera, *Calculating a Natural World* (Cambridge, MA: MIT Press, 2007).

9. Although one should not assume that one epistemology alone informs the technical development of a system simply because those directing design and construction were trained in it. See Chandra Mukerji, *Impossible Engineering: Technology and Territoriality on the Canal Du Midi* (Princeton, NJ: Princeton University Press, 2012).

10. In a survey of thirty-two of the seventy-four CIRES employees at the time of my fieldwork, only six identified themselves as engineers—that is, people who had completed the education necessary to attain the title of engineer and were employed in that role. Others were still contributing to engineering projects, even without the title and position.

11. On the topic of engineering identities, see Karen L. Tonso, *On the Outskirts of Engineering: Learning Identity, Gender, and Power via Engineering Practice* (Rotterdam: Sense Publishers, 2007). She and other scholars of engineering have emphasized

questions about who can be an engineer that I do not go into here, but interested readers should also see Amy E. Slaton, *Race, Rigor, and Selectivity in U.S. Engineering: The History of an Occupational Color Line* (Cambridge, MA: Harvard University Press, 2010). Some researchers now describe knowledge traditions of marginalized and non-Western communities as engineering to better respect the expert technical practice that they involve. See, for example, the decolonial work of Joel A. Mejia and Alberto López Pulido, “Fregados Pero no Jodidos: A Case Study of Latinx Rasquachismo,” in *American Society for Engineering Education Annual Conference Proceedings* (2018); and Gordon D. Hoople, Joel A. Mejia, Diana A. Chen, and Susan M. Lord, “Reimagining Energy: Deconstructing Traditional Engineering Silos Using Culturally Sustaining Pedagogies,” in *American Society for Engineering Education Annual Conference Proceedings* (2018).

12. See Gary Lee Downey and Juan C. Lucena, “National Identities in Multinational Worlds: Engineers and ‘Engineering Cultures,’” *International Journal of Continuing Engineering Education and Life-Long Learning* 15 (2005).

13. Blue, Levine, and Nieuwsma, *Engineering and War*; Juan C. Lucena, *Defending the Nation: US Policymaking to Create Scientists and Engineers from Sputnik to the “War Against Terrorism”* (Lanham: University Press of America, 2005); David Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism* (Oxford: Oxford University Press, 1979) details a history of engineering, capitalism, and the armed forces. See Scott Knowles, *The Disaster Experts: Mastering Risk in Modern America* (Philadelphia: University of Pennsylvania Press, 2012) for a consideration of how urbanization and different forms of life as well as capital have driven movements of professionalization and standardization of engineers in the United States. These projects, of course, have been far from the only visions structuring the field: see Matthew Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America* (Cambridge, MA: MIT Press, 2012).

14. Luz Fernanda Azuela and Rafael Guevara Fefer offer an account of how writing about of these movements in science and technology has been strongly motivated by modernist, developmentalist narratives. See L. Azuela and R. Guevara Fefer, “La ciencia en México en el siglo XIX: Una aproximación historográfica,” *Asclepio* 2 (1998).

15. These “arts” meant “scientific and technical instruction for mine owners, metallurgists, engravers, draftsmen, engineers, architects, farmers, druggists, seamen, artists, and other artisans,” and schools often drew on financial support of interested parties, including mine owners and merchants who might employ graduates. Juan José Saldaña, *Science in Latin America* (Austin: University of Texas Press, 2006), 53. See also J. J. Izquierdo, “La primera casa de la ciencias en México: El Real Seminario de Minería 1792–1811” (México: Ediciones Ciencia, 1958); Luz Fernanda Azuela, “La geología en la formación de los ingenieros Mexicanos del siglo XIX,” in *Formación de ingenieros en el México del siglo XIX*, ed. M. Ramos Lara and R. Rodríguez Benítez

(Mexico City: Universidad Nacional Autónoma de México Press, 2007), 91–108; Dogan and Parhe, *Las nuevas ciencias sociales: La marginalidad creadora*, (México: Grijalbo, 1991); and P. Arias, *Industria y estado en la vida de México* (Zamora: El Colegio de Michoacán, 1990). This focus on useful arts should be understood in the frame of Mexico's position on the "periphery" of European imperial power and science.

16. On the history of Mexican engineering and science education during its time as a Spanish colony, much has been written. Scholars concerned with the sweeping history of Mexican science and technology interests offer good accounts, including E. Gortari, *La ciencia en la historia de México* (Mexico City: FCE, 1963) J. J. Saldaña, *Science in Latin America* (Austin: University of Texas Press, 2006). For detailed investigations of key moments and communities, the following may be of use: W. Howe, *The Mining Guild of New Spain and Its Tribunal General, 1770–1821* (Greenwood Press, 1968); K. Brown, *A History of Mining in Latin America from the Colonial Era to the Present* (Albuquerque: University of New Mexico Press, 2012); D. A. Brading, "Miners and Merchants in Bourbon Mexico 1763–1810" (Cambridge: Cambridge University Press, 1971).

17. On the history of Mexican engineering in the nineteenth century, see M. Ramos Lara and R. Rodríguez Benítez, eds., *Formación de ingenieros en el México del siglo XIX* (Mexico City: Universidad Nacional Autónoma de México Press, 2007); M. Ramos Lara, *Vicisitudes de la ingeniería en México (Siglo XIX)* (Mexico City: Universidad Nacional Autónoma de México Press, 2013); M. Bazant, *Historia de la educación durante El Porfiriato* (Mexico City: El Colegio de México, 2014). As Juan Lucena points out, Mexican engineering has been institutionalized around ideas of public well-being that are particularly related to state projects. See Juan C. Lucena, "De Criollos a Mexicanos: Engineers' Identity and the Construction of Mexico," *History and Technology* 23, no. 3 (2007): 275–288.

18. Jacqueline Fortes and Larissa Adler Lomnitz, *Becoming a Scientist in Mexico: The Challenge of Creating a Scientific Community in an Underdeveloped Country* (University Park: University of Pennsylvania Press, 1994).

19. The son of a composer and brother of a high-ranking career Institutional Revolutionary Party (commonly called the PRI) functionary who served as minister of foreign affairs and minister of finance, Carrillo Flores (1911–1967) was a mid-century soil mechanics and atomic energy researcher. He earned degrees from UNAM and then MIT in the United States before serving as Mexico's representative at Bikini Atoll and, eventually, rector at UNAM. Historians Gisela Mateos and Edna Suárez-Díaz argue that his international circulations were crucial for Mexico's emergent nuclear research program. For more on Carrillo Flores's international circulations, see Gisela Mateos and Edna Suárez-Díaz, "Peaceful Atoms in Mexico," *Beyond Imported Magic* (Cambridge, MA: MIT Press, 2014).

20. Rosenblueth (1926–1994) was a civil engineer who specialized in seismic safety in the mid- and late-twentieth century. Trained at UNAM and then at the University

of Illinois, at various times he served as a subminister of public education, consulted for UNESCO, and played a leadership role in many engineering organizations. His work was not limited to engineering, though; his published work refers to continental philosophy and art as well as Mexican intellectual traditions, and explicitly engages with issues related to race and culture. His father was a well-recognized artist, and his cousin, a medical doctor, coauthored work on cybernetics with Norbert Wiener and participated in the Macy Conferences.

21. Still, only 51 percent of Mexican adults have graduated from secondary school, and only 22 percent have any form of higher degree at all. These figures refer to adults between the ages of twenty-five and sixty-four, as reported in the Secretaria de Educación Pública, *Principales cifras del sistema educativo nacional 2015–2016* (Mexico City: Dirección General de Planeación, Programación y Estadística Educativa, 2016).

22. More than 700,000 students enrolled in engineering programs in 2011, almost double the number who enrolled in 2000. There was significant growth in education related to technology during this time, but in each of these years, engineering students comprised over 70 percent of the total population of students matriculating. See Academia de Ingeniería, *Menú educación-general. Recuperado el 5 de 2014, de Observatorio de la Ingeniería Mexicana* (Mexico City: Academia de Ingeniería, 2012); and Academia de Ingeniería, *Coloquio Sobre Formación de Ingenieros en México* (Mexico City: Academia de Ingeniería, 2016), 8.

23. Academia de Ingeniería, *Coloquio sobre formación de ingenieros en México*.

24. Roderic A. Camp, *Politics in Mexico: The Decline of Authoritarianism* (Oxford: Oxford University Press, 1999).

25. While “technoscience” is a fairly common term in the fields of STS and cultural anthropology, I use it here in light of the work of two key thinkers. Bruno Latour suggests that it allows us to critically consider what is understood to be “inside” and “outside” of the scope of science and engineering and query boundaries between science and society. See Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987), 174 and 176. Donna Haraway builds on this work to consider the messy and unexpected ways that human and nonhuman actors are brought into relation around the topic. She is particularly interested in how power is enacted in these contexts. See Donna Haraway, *ModestWitness@SecondMillennium.FemaleManMeetsOncoMous: Feminism and Technoscience* (New York: Routledge, 1997), 50–51. While technoscience is, in their hands, somewhat all-encompassing, other thinkers argue that it is still useful to attend to technoscience’s alternatives and margins. For example, Arun Agrawal has written powerfully about the ways that indigenous environmental knowledge is contrasted to scientific or Western environmental knowledge in scholarship and development practice. See Arun Agrawal, “Dismantling the Divide Between Indigenous and Scientific Knowledge,” *Development and Change* 26, no. 3 (1995): 413–439. Distinguishing these forms of knowledge from each other can, as Povinelli points



out, be crucial to distributing power and authority in late liberalism. See Elizabeth Povinelli, *Geontologies: A Requiem to Late Liberalism* (Durham, NC: Duke University Press, 2016).

26. Historian Amy Slaton notes that this narrative can be misleading and historically inaccurate but is nonetheless indicative of powerful narratives in the field Amy E. Slaton, *Reinforced Concrete and the Modernization of American Building, 1900–1930* (Baltimore, MD: The Johns Hopkins University Press, 2001), 21.

27. Fortes and Lomnitz, *Becoming a Scientist in Mexico*, 2.

28. On engineering jokes and how they can be understood to highlight values and practices related to disciplinary identities, see Donna Riley, *Engineering and Social Justice* (Williston, VT: Morgan and Claypool, 2008).

29. Downey writes about this as a matter of *agencies of construction and response*. This language particularly comes from studies of US engineering students who were engaged in identity work around their chosen field, but I find it appropriate for this application too. See Gary Lee Downey, “What Is Engineering Studies for? Dominant Practices and Scalable Scholarship,” *Engineering Studies* 1, no. 1 (2009): 55–76.

30. Helen Verran, “Number as an Inventive Frontier in Knowing and Working Australia’s Water Resources,” *Anthropological Theory* 10, no. 1–2 (2010): 171.

31. As Star and Lampland put it, attention to “boring things” like measurement can allow us insight into important social relations and structures that inform and are shaped by “their historical development, their political consequences, and the . . . decisions made about them.” Martha Lampland and Susan Leigh Star, *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life* (Ithaca, NY: Cornell University Press, 2009), 13. See also Theodore Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (Princeton, NJ: Princeton University Press, 1995); Jane I. Guyer, Naveeda Khan, and Juan Obarrio, “Number as an Inventive Frontier,” *Anthropological Theory* 10, no. 1 (2010): 63–86.

32. Diana Forsythe found a similar description of epistemic work in a computer science lab in the late 1990s. There, Forsythe observed an engineering ethos marked by what she calls “a tendency to approach things practically rather than theoretically.” She quotes an informant: “if you waited to figure out what you were doing, you’d never get anything done. There just isn’t time to do that.” Diana Forsythe, *Studying Those Who Study Us: An Anthropologist in the World of Artificial Intelligence* (Stanford, CA: Stanford University Press, 2001), 44.

33. For curious readers, the particular operations that they performed involved taking derivatives of readings and performing comparative topographical analyses. Duran noted a resonance between this analysis and super vector theory, books about which were packed onto the shelves in his overcrowded office, but also explained that this was coincidental and that this form of mathematical analytic was not available to Espinosa Aranda in the 1980s.

34. J. M. Espinosa-Aranda, A. Jiménez, O. Contreras, G. Ibarrola, and R. Ortega, "Mexico City Seismic Alert System," *International Symposium on Earthquake Disaster Prevention* (Mexico City: CENAPRED, JICA, IDNDR, 2000).

35. This is, of course, an explanation for a general audience, written to draw attention to particular features of data analysis. A more technical one can be found in Juan Manuel Espinosa-Aranda, Armando Cuellar, Armando Garcia, Gerardo Ibarrola, Roberto Islas, Samuel Maldonado, and F. H. Rodriguez, "Evolution of the Mexican Seismic Alert System (SASMEX)," *Seismological Research Letters* 80, no. 5 (2009): 694–709; or A. Cuéllar, J. M. Espinosa-Aranda, G. Suárez, G. Ibarrola, A. Uribe, F. H. Rodríguez, R. Islas, G. M. Rodríguez, A. Garcia, and B. Frontana, "The Mexican Seismic Alert System (SASMEX): Its Alert Signals, Broadcast Results and Performance During the M7.4 Punta Maldonado Earthquake of March 20 2012," in *Early Warning for Geological Disasters*, ed. F. Wenzel and J. Zschau (Berlin, Heidelberg: Springer-Verlag, 2014), 307–331.

36. While other innovations made this possible, CIRES's Espinosa Aranda and a Japanese engineer named Nakamura seem to have arrived at this unique application independently in the late 1980s as solutions to their particular problems, as described in chapter 3.

37. For more on engineering as a pragmatics, see Penelope Harvey and Hannah Knox, *Roads: An Anthropology of Infrastructure and Expertise* (Ithaca, NY: Cornell University Press, 2015).

38. Showing these off was a frequent occurrence. Many engineers and technicians at CIRES had pet projects that could be used to change how the system worked in some small way. Senior management retained power to decide whether to move forward with a project or nix it.

39. See for example, Dominique Vinck, Eric Blanco, Michel Bovy, Pascal Laureillard, Oliver Lavoisy, Stéphane Mer, Nathalie Ravaille, and Thomas Reverdy, *Everyday Engineering: An Ethnography of Design and Innovation* (Cambridge, MA: MIT Press, 2003); and Louis L. Bucciarelli, *Designing Engineers* (Cambridge, MA: MIT Press, 1994).

40. Fortes and Lomnitz, *Becoming a Scientist in Mexico*.

41. A. Iglesias, S. K. Singh, M. Ordaz, M. A. Santoyo, and J. Pacheco, "The Seismic Alert System for Mexico City: An Evaluation of Its Performance and a Strategy for Its Improvement," *Bulletin of the Seismological Society of America* 97, no. 5 (2007): 1727.

42. About twenty-eight seconds for events occurring at epicentral distances of up to 270 kilometers away, as opposed to around sixty seconds offered by the current Sistema de Alerta Sísmica Mexicano. See Iglesias et al., "The Seismic Alert System for Mexico City," 1727.

43. Iglesias et al., "The Seismic Alert System for Mexico City," 1720.

44. Iglesias et al., "The Seismic Alert System for Mexico City," 1728. These would be categorized as "inaccurate" alerts in a recent typography of alerting. See S. K. McBride, A. Bostrom, J. Sutton, R. M. de Groot, A. S. Baltay, B. Terbush, P. Bodin, P. M. Dixon, E. Holland, R. Arba, P. Laustsen, S. Liu, and M. Vinci, "Developing Post-Alert Messaging for ShakeAlert, the Earthquake Early Warning System for the West Coast of the United States of America," *International Journal of Disaster Risk Reduction* 50 (2020).
45. See Espinosa-Aranda et al., "Evolution of the Mexican Seismic Alert System (SASMEX)."
46. This is the very issue that framed the development of a typology of kinds of alerting trouble by McBride, et al., "Developing Post-Alert Messaging for ShakeAlert."
47. Quotes from a public event.

## CHAPTER 6

1. Field stations are named with reference to their location, generally after nearby communities.
2. A deep and thoughtful exploration of the role of technicians in knowledge work can be found in Caitlin Wylie, *Preparing Dinosaurs: The Work behind the Scenes* (Cambridge, MA: MIT Press, 2021).
3. See Nicole Staroslieski, *The Undersea Network* (Durham, NC: Duke University Press, 2015).
4. This account, particularly in its focus on knowledge and ever-present threats of violence that engineers and technicians experience in the field, might well be read alongside Micha Rahder, *An Ecology of Knowledges: Fear, Love and Technoscience in Guatemalan Forest Conservation* (Durham, NC: Duke University Press, 2020).
5. On the social, technical, and material existence of infrastructures, with particular attention to when and for whom they become relevant, see Susan Leigh Star and Karen Ruhleder, "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research* 7, no. 1 (1996); Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43, no. 3 (1999); Geoffrey Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999); Arild Jansen and Petter Nielsen, "Theorizing Convergence: Co-Evolution of Information Infrastructures," *Scandinavian Journal of Information Systems* 17, no. 1 (2005): 67–100. David Ribes and Thomas A. Finholt, "The Long Now of Technology Infrastructure: Articulating Tensions in Development," *Journal of the Association for Information Systems* 10 (2009): 375–398; Geoffrey Bowker, Karen Baker, Florence Millerand, and David Ribes, "Towards Information Infrastructure Studies: Ways of Knowing in a Networked Environment," in *International Handbook of Internet Research*, ed. J. Hunsinger, Li. Klastруп, and M. Allen (New York: Springer, 2010).

6. As critical data scholars frequently remind us, data are always the result of and the occasion for relationships between humans, technologies, institutions, forces, environments, animals, plants, and so on that are absolutely necessary but will never be formally addressed in most discussions of earthquake early warning. See Antonia Walford, "Raw Data: Making Relations Matter," *Social Analysis* 61 (2017): 65–80.

7. Lucy Suchman, "Centers of Coordination: A Case and Some Themes," *Discourse, Tools and Reasoning—Essays on Situated Cognition* 47 (1997); also see also Daniel Neyland, "The Accomplishment of Spatial Adequacy: Analysing CCTV Accounts of British Town Centres," *Environment and Planning D: Society and Space* 24, no. 4 (2006): 599–613.

8. The simplicity of these maps should not let us forget that there is much more going on in earthquake early warning than can be represented here. Calling attention to both action and infrastructure, environmental data scholar Jennifer Gabrys writes: "Environmental data, monitoring practices and technologies undergo complex processes of negotiation and shaping that do not simply translate a phenomenon monitored into a data point." Jennifer Gabrys, "Practicing, Materialising and Contesting Environmental Data," *Big Data & Society* (2016): 2; see also Jennifer Gabrys, *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet*. (Minneapolis: University of Minnesota Press, 2016); and Starosielski, *The Undersea Network*.

9. While interviews indicated that some of their female colleagues had gone to the field in the past, field visits were not a mixed-gender undertaking during my time at CIRES.

10. As Walford writes of field data gathered in a remote site in the Amazon rainforest, "Without the ongoing relational work . . . data would not exist. Its uniqueness is not due to its isolation, as such, but to the very particular relational configuration from which it emerges." *Raw Data*, 73. This insight does not at first seem out of keeping with how STS scholarship, particularly that related to Actor Network Theory (ANT), understands facts to become established (see, for example, Michel Callon, "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay," in *Power, Action and Belief: A New Sociology of Knowledge?*, ed. J. Law (London: Routledge, 1986); or Bruno Latour, *Reassembling the Social. An Introduction to Actor-Network Theory* (Oxford: Oxford University Press, 2005). Walford is not, however, addressing ANT scholarship's frequent preoccupation with how data's significance is stabilized for technoscientific purposes. Instead, her work shows how more-than-technoscientific relations are always embedded in data production. She suggests that these relations can both make data collection possible and also make the data itself problematic. On ecologies of knowledge and practice, also see Geoffrey Bowker, Stefan Timmermans, Adele E. Clark, and Ellen Balka, eds., *Boundary Objects and Beyond: Working with Leigh Star* (Cambridge, MA: MIT Press, 2015).

11. Quote from interview. Translation by author.

12. Quote from interview. Translation by author.

13. Thirty-two of seventy-four CIRES employees participated in this anonymous survey in 2013; of the twelve members of the communications department that sent teams to the field, eleven indicated that they were born and had lived all their lives in Mexico City.

14. Conversations with Adriana Minor García, a historian of science, have been critical for helping me see how this language works to diminish places outside Mexico City. As Cynthia Hewitt de Alcántara's history of research in rural Mexico demonstrates, the differences that make a difference (as we anthropologists say) between rural and urban Mexican spaces are in flux. She describes the body of research devoted to rural Mexico in the twentieth century as a matter of "cumulative—and in some respects, dialectical . . . half-century-long encounter with the Mexican countryside." Cynthia Hewitt de Alcántara, *Anthropological Perspectives on Rural Mexico* (New York: Routledge and Kegan Paul, 1984), 188. Some observers have considered the differences it marks to be so extreme that it became appropriate to discuss them as two civilizations. See, for example, Guillermo Bonfil Batalla, *México Profundo: Reclaiming a Civilization* (Austin: University of Texas Press, 2004), xv. However, grounding this contrast in specific regional logics, peasant and popular movements, and shifting agrarian policies and modes of production offer more nuanced perspectives on the ways these differences are structured. See Claudio Lomnitz-Adler, "Concepts for the Study of Regional Culture," *American Ethnologist* 18 (1991): 195–214; Peter Guardino, *Peasants, Politics, and the Formation of Mexico's National State: Guerrero, 1800–1857* (Stanford, CA: Stanford University Press, 2002); Gilbert Michael Joseph and Daniel Nugent, *Everyday Forms of State Formation: Revolution and the Negotiation of Rule in Modern Mexico* (Durham, NC: Duke University Press, 1994); and Rodger Bartra, *Agrarian Structure and Political Power in Mexico* (Baltimore, MD: The Johns Hopkins University Press, 1993). Andrew S. Mathews, for example, has shown that these distinctions have significant implications for policy and knowledge projects. See Andrew S. Mathews, "Building the Town in the Country: Official Understandings of Fire, Logging and Biodiversity in Oaxaca, Mexico, 1926–2004," *Social Anthropology* 14 (2006): 335–359.

15. Armando Cuéllar, Gerardo Ibarrola Álvarez, C. Samuel Maldonado, and Juan Manuel Espinosa Aranda, "Sistema de Alerta Sísmica para la ciudad de México," *Revista Digital Universitaria* 11, no. 1 (2010): 1–10; and Juan Manuel Espinosa Aranda, Armando Cuéllar, Armando García, Gerardo Ibarrola, Roberto Islas, Samuel Maldonado, and F. H. Rodríguez, "Evolution of the Mexican Seismic Alert System (SASMEX)," *Seismological Research Letters*, 80 (2009): 694–706.

16. These dangers were of serious concern to the CIRES team whose aim was to keep the stations constantly running and ready for any earthquake. See Alejandro Jiménez, Juan Manuel Espinosa, F. Alcántara, and I. García, "Análisis de confiabilidad del Sistema de Alerta Sísmica," in *X Congreso Nacional de Ingeniería Sísmica* (Puerto

Vallarta, Jalisco: Sociedad Mexicana de Ingeniería Sísmica, October 8–11, 1993), 629–634.

17. Quote from interview. Translation by author.

18. Quote from interview. Translation by author.

19. Contrast this to what Dalakoglou and Harvey have called the “paradigmatic material infrastructure of the twenty first century.” See Dimitris Dalakoglou and Penny Harvey, “Roads and Anthropology: Ethnographic Perspectives on Space, Time and (Im)Mobility,” *Mobilities* 7 (2012): 459.

20. Quote from interview. Translation by author.

21. Quote from interview. Translation by author.

22. Quote from interview. Translation by author.

23. A one-time payment of 18,000 pesos, or nearly \$1,400 USD, for the ongoing use of the property was not uncommon (exchange rate calculated for 2014, when this interview occurred).

24. Quote from interview. Translation by author.

25. Quote from interview. Translation by author.

26. His name for them resonates with science-fictional uncertainties about identity, origin, and capacity. See Sarah Franklin, *Dolly Mixtures: The Remaking of Genealogy* (Durham, NC: Duke University Press, 2007). They are copies of CIRES field stations, certainly, but they are more than that. Where they come from cannot be precisely known, at least not safely. What kind of system they might be part of, or what kind of work they might have been developed for, is similarly impossible to get any real information about.

27. I use “organized crime” rather than “narcoviolence” here because of the diversity of dangerous and illegal projects that engineers and technicians might have encountered in rural Mexico in 2014. These are not necessarily directly drug related. For example, self-defense leagues are also extremely dangerous. See Patricio Asfura-Heim, and Ralph H. Espach, “The Rise of Mexico’s Self-Defense Forces Vigilante Justice South of the Border,” *Foreign Affairs*, 2013. However, I also acknowledge that it is difficult to refer to perpetrators of this violence as “criminals” when evidence suggests that their organizations carry out some of the roles and duties of a traditional government, even as they make heavy use of spectacular intimidation and brutality. See George W. Grayson, “La Familia Drug Cartel: Implications for U.S.-Mexican Security,” December 2010, *Strategic Studies Institute*; and Andrew Lantz, “The Performativity of Violence: Abducting Agency in Mexico’s Drug War,” *Journal of Latin American Cultural Studies* 25 (2016): 253–269. Further, observers of Mexico’s drug war inside and outside of academia have been increasingly critical of the state’s role in this violence. As Alejandro Zagato points out, the Mexican activist slogan “it was the state!” should direct our attention to how violence is enacted and enabled not just by organizations that have taken on state functions but also by the Mexican

state itself. See Alessandro Zagato, "State and Warfare in Mexico," *Social Analysis* 62 (2018): 55–75.

28. See, for example, Francisco Goldman's excellent reporting for the *New Yorker*. Francisco Goldman, "Crisis in Mexico: The Disappearance of the Forty-Three," *New Yorker*, October 2014; Francisco Goldman, "Mexico's Missing Forty-Three: One Year, Many Lies, and a Theory That Might Make Sense," *New Yorker*, September 30, 2015; Francisco Goldman, "The Missing Forty-Three: The Mexican Government Sabotages Its Own Independent Investigation," *New Yorker*, April 2016.

29. As reported in INEGI 2018. Not all can be associated with organized crime, certainly, but the incredible size of the difference between murder rates in 2014 and 2007 is significant. Further, these numbers do not include those whose remains have not been found and those who may be officially considered "missing." Instituto Nacional de Estadística y Geografía (INEGI) Mortalidad: Conjunto de datos: Defunciones por homicidios, 2018, [http://www.inegi.org.mx/lib/olap/consulta/general\\_ver4/MDXQueryDatos.asp?proy=](http://www.inegi.org.mx/lib/olap/consulta/general_ver4/MDXQueryDatos.asp?proy=).

30. Viridiana Rios, "Why Did Mexico Become So Violent? A Self-Reinforcing Violent Equilibrium Caused by Competition and Enforcement," *Trends in Organized Crime* 16 (2013): 138–155.

31. Cf. Paul Kockelman, "How to Take Up Residence in a System," *Journal of Linguistic Anthropology* 20 (2010): 406–402.

32. Quote from interview. Translation by author.

33. Quote from interview. Translation by author.

34. Indeed, this was possible on September 8, 2017, but sadly less so on September 19 when a quake emerged from a fault where CIRES had not positioned field stations.

35. When mapping projects explicitly take on politics, it often happens through the creation of what Young and Gilmore call a "politically potent map." They make the case that this approach assumes a "rational and deliberative" system in which claims simply need to be made in the right ways. See Jason Young and Michael P. Gilmore, "The Spatial Politics of Affect and Emotion in Participatory GIS," *Annals of the Association of American Geographers* 103 (2013): 814. Just as a map is not necessarily an accurate reflection of the world, nor do its political effects need to be conceptualized as direct. See also Joe Gerlach, "Editing Worlds: Participatory Mapping and a Minor Geopolitics," *Transactions of the Institute of British Geographers* 40 (2015): 273–286.

## CONCLUSION

1. M. Wood, *State-of-the-Art Knowledge of Protective Actions Appropriate for Earthquake Early Warning*, report prepared for the Cascadia Region Earthquake Workgroup (Denver, CO: Nusura, Inc., 2018); S. E. Minson, M.-A. Meier, A. S. Baltay, T. C. Hanks, and E. S. Cochran, "The Limits of Earthquake Early Warning: Timeliness of Ground Motion Estimates," *Science Advances* 4 (2018); O. Kamigaichi, M. Saito, K.

Doi, T. Matsumori, S. Tsukada, K. Takeda, T. Shimoyama, K. Nakamura, M. Kiyomoto, and Y. Watanabe, "Earthquake Early Warning in Japan: Warning the General Public and Future Prospects," *Seismological Research Letters* 80, no. 5 (2009): 717–726; K. A. Porter and J. L. Jones, "How Many Injuries Can Be Avoided in the HayWired Scenario through Earthquake Early Warning and Drop, Cover, and Hold On?," in S. T. Detweiler and A. M. Wein, eds., *The HayWired Earthquake Scenario—Engineering Implications* (U.S. Geological Survey Scientific Investigations Report, 2018).

2. Y. Horiuchi, "Earthquake Early Warning Hospital Applications," *Journal of Disaster Research* 4, no. 4 (2009): 237–241; E. Yamasaki, "What We Can Learn from Japan's Earthquake Warning System," *Momentum* 1, no. 2 (2012): 1–26; Y. Fujinawa and Y. Noda, "Japan's Earthquake Early Warning System on 11 March 2011: Performance, Shortcomings, and Changes," *Earthquake Spectra* 29, no. S1 (2013): S341–S368.

3. H. S. Kuyuk, R. M. Allen, H. Brown, M. Hellweg, I. Henson, and D. Neuhauser, "Designing a Network-Based Earthquake Early Warning Algorithm for California: ElarmS-2," *Bulletin of the Seismological Society of America* 104 (2014): 162–173; D.-H. Sheen, J.-H. Park, H.-C. Chi, E.-H. Hwang, I.-S. Lim, Y. J. Seong, and J. Pak, "The First Stage of an Earthquake Early Warning System in South Korea," *Seismological Research Letters* 88, no. 6 (2017): 1491–1498.

4. Bhanu Pratap Chamoli, Ashok Kumar, Da-Yi Chen, Ajay Gairola, Ravi S. Jukka, Bhavesh Pandey, Pankaj Kumar, and Govind Rathore, "A Prototype Earthquake Early Warning System for Northern India," *Journal of Earthquake Engineering* 25, no. 12 (2021): 2455–2473.

5. J. Clinton, A. Zollo, A. Mărmureanu C. Zulfikar, and S. Parolai, "State-of-the Art and Future of Earthquake Early Warning in the European Region," *Bulletin of Earthquake Engineering* 14, no. 9 (2016): 2441–2445.

6. C. Satriano, L. Elia, C. Martino, M. Lancieri, A. Zollo, and G. Iannaccone, "PRESto, the Earthquake Early Warning System for Southern Italy: Concepts, Capabilities and Future Perspectives," *Soil Dynamics and Earthquake Engineering* 31 (2010): 137–153; A. Mărmureanu, C. Ionescu, and C. O. Cioflan, "Advanced Real-Time Acquisition of the Vrancea Earthquake Early Warning System," *Soil Dynamics and Earthquake Engineering* 31 (2010): 163–169.

7. An excellent literature review of these and other pieces was developed by Richard M. Allen and Diego Melgar, "Earthquake Early Warning: Advances, Scientific Challenges, and Societal Needs," *Annual Review of Earth and Planetary Sciences* 47 (2019): 361–388.

8. Quote from interview. Translation by author.

9. See, for example, Charles R. Hale, "Activist Research v. Cultural Critique: Indigenous Land Rights and the Contradictions of Politically Engaged Anthropology," *Cultural Anthropology* 21, no. 1 (2006): 96–120; Louise Lamphere, "The Convergence of Applied, Practicing, and Public Anthropology in the 21st Century," *Human Organization* 63, no. 4 (2004): 431–443; Anthony Oliver-Smith, "Disaster Risk Reduction and Applied Anthropology," *Annals of Anthropological Practice* 40, no. 1 (2016): 73–85.



10. Gary Lee Downey, "What Is Engineering Studies For? Dominant Practices and Scalable Scholarship," *Engineering Studies* 1, no. 1 (2009): 55–76. See also Gary Lee Downey and Teun Zuiderent-Jerak, eds., *Making and Doing: Activating STS through Knowledge Expression and Travel* (Cambridge, MA: MIT Press, 2021). I also thank Jessica Smith, Marie Stettler Kleine, and Emily York for helping me think through the significance of such a project.

11. Annie Y. Patrick, *Engaging with the Invisible: STS Groundwork in an Electrical and Computer Engineering Department* (PhD Diss., Virginia Tech, 2021).

12. Emily Martin, "Meeting Polemics with Irenics in the Science Wars," *Social Text* 46/47 (1996): 57. See also the discussion in Stefan Helmreich, "Nonlinear Works and Lives," presented at the Annual Meeting of the American Anthropological Association, Philadelphia, PA, December 2–6, 2009.

13. This was a central topic of reflection on the past and future of anthropology of science and technology in the "20th Diana Forsythe Prize Celebration and Discussion," presented at the Annual Meeting of the American Anthropological Association, Vancouver, BC, November 20–24, 2019. Contributors included Heather Paxson, Sareeta Amrute, Eben Kirksey, Gabriella Coleman, Rayna Rapp, Lucy Suchman, Stefan Helmreich, Marcia Inhorn, Rene Almeling, Emily Martin, Jan English-Lueck, and David Hess.

14. I particularly enjoy thinking with a few recent books, here, including Geoffrey C. Bowker, Stefan Timmermans, Adele E. Clark, and Ellen Balka, eds., *Boundary Objects and Beyond: Working with Leigh Star* (Cambridge, MA: The MIT Press, 2015); Maria Puig de La Bellacasa, *Matters of Care: Speculative Ethics in More than Human Worlds* (Minneapolis: University of Minnesota Press, 2017); and Max Liborion, *Pollution Is Colonialism* (Durham, NC: Duke University, 2021).

#### METHODOLOGICAL APPENDIX

1. Diana Forsythe, "'It's Just a Matter of Common Sense': Ethnography as Invisible Work," *Computer Supported Cooperative Work* 8, no. 1–2 (1999): 127–145.

2. Two excellent texts that detail and analyze responsibility, accountability, and obligation in empirical contexts are Max Liborion, *Pollution Is Colonialism* (Durham, NC: Duke University, 2021); and Jessica M. Smith, *Extracting Accountability: Engineers and Corporate Social Responsibility* (Cambridge, MA: MIT Press, 2021). I recommend both very highly.

3. Key discussions of representation in cultural anthropology include Clifford Geertz, *The Interpretation of Cultures* (New York: Basic Books, 1973); and James Clifford and George Marcus, eds., *Writing Culture: The Poetics and Politics of Ethnography* (Berkeley: University of California Press), 1986. On the politics and limits of representation, see Audra Simpson, *Mohawk interruptus: Political Life across the Borders of Settler States* (Durham, NC: Duke University Press, 2014).



This is a section of [doi:10.7551/mitpress/14328.001.0001](https://doi.org/10.7551/mitpress/14328.001.0001)

# ¡Alerta!

## Engineering on Shaky Ground

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### Citation:

*¡Alerta!: Engineering on Shaky Ground*

By: Elizabeth Reddy

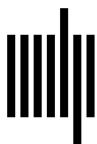
DOI: 10.7551/mitpress/14328.001.0001

ISBN (electronic): 9780262374385

Publisher: The MIT Press

Published: 2023

The open access edition of this book was made possible by generous funding and support from MIT Press Direct to Open



The MIT Press

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The MIT Press would like to thank the anonymous peer reviewers who provided comments on drafts of this book. The generous work of academic experts is essential for establishing the authority and quality of our publications. We acknowledge with gratitude the contributions of these otherwise uncredited readers.

This book was set in Stone Serif and Stone Sans by Westchester Publishing Services.

Library of Congress Cataloging-in-Publication Data

Names: Reddy, Elizabeth, author.

Title: ¡Alerta! : engineering on shaky ground / Elizabeth Reddy.

Description: Cambridge, Massachusetts : The MIT Press, [2023] |

Series: Engineering studies | Includes bibliographical references and index.

Identifiers: LCCN 2022029552 (print) | LCCN 2022029553 (ebook) |

ISBN 9780262545518 (paperback) | ISBN 9780262374378 (epub) |

ISBN 9780262374385 (pdf)

Subjects: LCSH: Earthquake prediction—Mexico—History. | Environmental monitoring—Mexico—History.

Classification: LCC QE538.8 .R43 2023 (print) | LCC QE538.8 (ebook) |

DDC 551.220972—dc23/eng20221028

LC record available at <https://lcn.loc.gov/2022029552>

LC ebook record available at <https://lcn.loc.gov/2022029553>