



Under the rubble: disaster risk management and accountability after the Mexico City earthquake of September 19, 2017

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Abstract

After thirty-two years of the devastating earthquake in Mexico City in 1985, the city was again shaken by the consequences of the 7.1 M_w earthquake that struck central Mexico on September 19, 2017. The impact of the disaster nationwide was 369 deaths, 6000 injured, 256,000 total affected people, and damages in the order of US\$ 6 billion. Although the earthquake's impact figures are not consistent yet, some sources indicate that in Mexico City alone, the earthquake caused 228 deaths, 44 collapsed buildings, and 73,000 damaged properties, including 5765 homes and 973 schools. The effect on the economy was estimated at between 0.1 and 0.3% of GDP for 2018, and the funds needed for reconstruction were calculated at more than US\$3.4 billion. Local government responses to the earthquake were dosed and limited to immediate actions based on a traditional and militarized perspective. Once again, after the quake hit, city authorities and urban planners introduced several actions and initiatives to rethink how disasters can be managed in the city. Regular assessment of impacts on the security of the facilities at risk, liability, damages and losses initiatives, changes to the law, and purges in the local civil protection offices were carried on. As we argue in this article, all these actions are increasingly seen as a cause of serious concerns about the accountability of the authorities responsible for civil protection and risk management at the different levels of government. This article briefly introduces the renewed interest that has emerged in recent years around the globe, including Mexico City, regarding the increasing demands for accountability related to disasters. In the second section, the methodology of the article is described. It will then examine the results and discussion of the analysis of the disaster triggered by the earthquake of September 19, 2017. This included three major topics: (1) background from a hazard perspective and a general characterization of earthquake exposure, (2) damages and losses, and (3) insights into disaster management. The final section concerning closing remarks aims to reflect on future challenges for disaster accountability and community involvement in disaster risk management.

Keywords Earthquake-related disasters · Mexico City · Liability · Accountability · Disaster risk management · Civil society · Multi-hazards

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1 Introduction

The international community has learned essential lessons from the occurrence of disasters. Lessons learned can often offer arguments to provide resources to improve disaster risk management, and lessons learned in one place can often be of great use and help in another. However, lessons learned from the past often cannot be implemented in other sites or are quickly forgotten. This is the case in Mexico City.

Derived from the occurrence of the disaster triggered by the 8.1 Richter scale Mexico City earthquake of September 19, 1985 (EQKS19-1985), the National Civil Protection System (SINAPROC) was created on May 6, 1986. Its mission is to provide attention and articulation of the three government orders to prevent disasters and emergency response. Nonetheless, since its inception, a broad spectrum of discussions and debates conducted by academia, civil society, and other disaster risk-related stakeholders have questioned its functionality in the absence of evidence of adequate formulation and implementation of policies and practices, which reflects the lack of understanding of disaster risk, the continuing civil protection approaches and the absence of capability to mainstream processes of integrated disaster risk management (Alcántara-Ayala et al. 2019, 2020). Likewise, SINAPROC has a bureaucratic character, with little connection with society and communities, serving more as a government coordination body supported by the work of the armed forces.

Despite a current integrated disaster risk management framework that remains on paper but is far from being implemented, Mexico City was struck by another significant earthquake of a considerable magnitude (7.1 M_w) on September 19, 2017 (EQKS19-2017). The consequences of the disaster triggered by this earthquake revealed the lack of multi-sectoral disaster risk reduction practices, the existing gaps in addressing the root causes and drivers of disaster risk as essential insights for policy formulation, and a reluctance to work with the scientific community from an integrated perspective and beyond the mere interest of only assessing hazard dynamics.

The consequences were severe; more than two hundred people died, lost in the rubble of the buildings that collapsed almost instantly. Particularly grave were the economic and social dimensions stemming from destroyed and collapsed buildings, which are increasingly seen as a cause for serious accountability concerns. This is a dilemma from which there is no escape. The EQKS19-2017 appears to constitute a watershed mark moving into an era of public authorities' liability and accountability in Mexico's disasters and disaster risk management.

While various definitions of the term 'accountability' have been suggested, this paper will use the definition proposed by Olson et al. (2011), who considered that accountability is a connection between an actor and a forum. While the actor has a responsibility to explain and justify their plans of action and conduct, the forum is likely to give rise to questions, request additional information, ask for other perspectives, and provide assessments or findings. As a result, the actor can regard consequences as favorable or adverse, proper or colloquial (Olson et al. 2011, p. 61). Likewise, we concur with the perspective of Amaratunga and colleagues, who visualize accountability as an integral part of good governance as it implies a legal obligation on the part of those holding political, bureaucratic, or technical positions to act upon specific distinctly defined duties or functions (Amaratunga et al. 2019, p. 11).

In the same vein, we will use "liability," as it is generally understood in law to mean a term in which almost every type of duty, obligation, debt, responsibility, or hazard arising

by way of contract, tort, or statute is involved (Encyclopaedia Britannica n.d.). Notably, state liability is considered the obligation of the state to compensate and pay damages to any persons or other legal entities for harm to their personal or property rights produced by or imputable to the state. State liability is a fault-based liability. For state liability, a violation of public duties by state institutions, their officials, or private actors authorized to provide public services must have led to harm/infringement (Kirch 2008, p. 1314).

Building on various lessons learned, gaps identified, and future challenges stemming from its preceding international agendas, the Sendai framework for disaster risk reduction (SF) aims to be instrumental in adopting a concise, focused, forward-looking, and action-oriented post-2015 framework for disaster risk reduction. One of the avenues of opportunity acknowledged after the implementation of the Hyogo Framework for Action recognized that strengthened work to reduce exposure and vulnerability, therefore preventing the construction of new disaster risks and accountability for disaster risk construction are needed at all levels (UNISDR 2015:10).

However, while the demand for accountability can be inferred from the different SF priorities, only one of the thirteen SF Guiding Principles directly considers accountability:

Management and disaster risk reduction rely on coordination mechanisms within and across sectors and with relevant stakeholders at all levels. It involves the active contribution of all State institutions of an executive and legislative nature at local and national levels, along with an adequate articulation of responsibilities across public and private stakeholders, together with business and academia, to guarantee shared outreach, partnership, complementary in roles and accountability and follow-up (UNISDR 2015:13).

Nonetheless, a renewed interest has emerged in recent years: a growth in demands for accountability related to disasters has become increasingly crucial in disaster risk management and governance. On that account, the purpose of the present study was to examine the nexus between liability and accountability and disaster risk management that concerns public authorities. This is further illustrated by the issues stemming from the EQKS19-2017 that stand out for their potentially detrimental effect on Mexico City society as a whole, in the understanding that “accountability in disaster risk governance is a cross-cutting and complex governance issue for which each state has the primary responsibility to ensure that the public are safe and aware of risks, and to prevent and reduce disaster risks” (Amaratunga et al. 2019, p. 4).

2 Methodology

Aiming at capturing historical-social and cultural facts, qualitative and interpretative design documentary research techniques were used. Data were extracted from the analysis, review, and interpretation of multiple sources of published evidence that provided relevant information concerning the disaster triggered by the Mexico City earthquake of September 19, 2017.

In like manner, this paper extended the empirical evidence with the authors’ comprehensive and recognized national and international experience in the analyzed matter. This included fundamental aspects related to the theoretical approaches and conceptualization of integrated disaster risk management.

Additional insights were derived from gathering and reviewing documents concerning legal systems, programs, and guidelines linked to Civil Protection, urban development, and building codes in areas susceptible to seismicity.

3 Results and discussion

3.1 Background

3.1.1 The earthquake of September 19, 2017: a hazard outlook

Since the ancient times of the Aztec empire, earthquakes have caused great concern in the communities that inhabit the central region of Mexico (e.g., García-Acosta and Suárez 1996). Thus, their understanding, including their dynamics and impact, has captivated the attention of diverse disciplines and scientific approaches.

A 7.1 M_w earthquake struck Mexico City on September 19, 2017, precisely thirty-two years after the devastating EQKS19-1985. With an epicenter 12 km southeast of Axochiapan, Morelos, on the border between the states of Morelos and Puebla (18.41° N, -98.71° E), 120 km from Mexico City and a hypocenter of 57 km (Servicio Sismológico Nacional 2017) at the base of the oceanic crust or the top of the oceanic mantle of the subducted Cocos plate (Melgar et al. 2018). The tremor was felt intensively in the country's central area (Fig. 1).

According to Galvis and colleagues (2020), the primary sources of seismicity in the central and southern regions of Mexico are the result of local earthquakes, shallow crustal earthquakes, interplate subduction earthquakes, and intraslab earthquakes, specifically those associated with normal faulting of the Cocos plate. The latter was recognized as the source of the September 19, 2017, Puebla–Morelos earthquake.

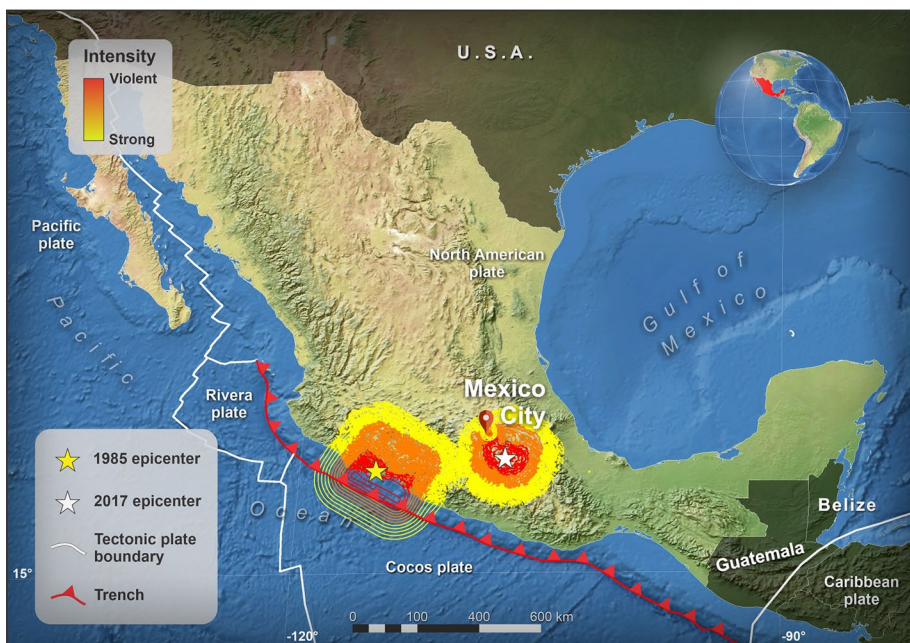


Fig. 1 Location of the epicenters of the earthquakes of September 19, 1985, and 2017 [Source: own map compilation based on the information provided by the USGS (n.d.)]

To explain why the earthquake occurred inland rather than on the Pacific coast like most previously recorded significant events, Melgar et al. (2018) modeled seismic and Global Positioning System data. They found that the tectonic plate under central Mexico is warped and folded. This folding process produces large forces that lead to earthquakes, which are controlled by the roughness or texture of the tectonic plate as it sinks under central Mexico.

Owing to the earthquake's epicenter's proximity to Mexico City, the immediate shock produced by the seism was felt by millions of people, many of whom, a couple of hours earlier, had participated in the annual earthquake drill organized to commemorate the EQKS19-1985.

The EQKS19-2017 induced the collapse of multi-story and vertical housing buildings, along with significant subsidence processes.

Ground subsidence processes were specially expressed in single-family homes through surface cracks in the southeastern area of Mexico City, horizontal urbanization, and the overexploitation of aquifers in territories composed of lacustrine deposits.

It has been argued that any future scenario of land subsidence in Mexico City must consider a possible triggering effect of large earthquakes, and seismic risk assessments must consider the likely impact of land subsidence on shallow faults and fractures (Solano-Rojas et al. 2020).

3.1.2 Earthquake exposure

Without a doubt, considering the long history of seismicity in Mexico, greater exposure to earthquakes in Mexico, particularly in Mexico City, is associated with the location of properties about the ancient lakebed on which the megacity is built that amplifies the earthquake waves, along with the structural conditions of houses and buildings.

Factors found to be influencing structural damage of buildings in Mexico City have been explored in several studies, among them the strong site effects of the lakebed area (Reinoso and Ordaz 1999), which imply that amplifications of the soft soil can be fifty times higher than on the firm soil (Singh et al. 1988). Recent evidence suggests that structural pathologies, including corner asymmetry, pounding, soft story, and plan irregularity modify the structural response by aggravating the demands and causing more damage (Reinoso et al. 2021).

3.2 Damages and losses

The immediate consequences of the disaster across the country were 369 deaths (228 in Mexico City, 74 in Morelos, 45 in Puebla, 15 in Mexico State, 6 in Guerrero, and 1 in Oaxaca), 6000 people injured, 256,000 total affected (EM-DAT database n.d.). Overall losses were estimated at approximately US\$ 6 billion, of which only US\$ 2 billion were insured. The adverse consequences included diverse sectors, such as commerce, industry, schools, roads, and water services. The most affected sector in respect of economic losses was housing. In the states of Morelos and Puebla, dwellings with susceptible or fragile structures with unreinforced masonry, adobe buildings, and many old cultural buildings, including churches or convents, suffered severe structural damage (Re 2018).

In Mexico City alone, the disaster unleashed by the earthquake caused 228 deaths and 73,000 damaged properties, including 5765 homes (40% total loss) and 973 schools. The impact on the economy was estimated at between 0.1 and 0.3% of GDP for 2018, and the

funds needed for reconstruction were calculated at more than US\$3.4 billion (Matus et al. 2018).

Based on information compiled by the National Centre for Disaster Prevention (CENAPRED), Méndez Estrada et al. (2022) provided a comprehensive report on the earthquake's impact at the national level. Accordingly, 1.8 million people were affected, and more than 59,000 were left homeless. The number of damaged health units was 143, and the economic impact was approximately 2190 million US dollars. This corresponded to 71.1% of the total damage registered in the country (Table 1).

Residential real estate was the most affected sector, with 77.39% of the total damage. This was followed by education, urban infrastructure, hydraulic infrastructure, and health, which represented 5.60%, 5.59%, 3.19%, and 2.70%, respectively (Méndez Estrada et al. 2022) (Table 2).

Of the total deceased, 200 people were adults and 28 children; 61 percent ($N=138$) of the fatalities were women, of which the majority were adults ($N=122$) and the rest ($N=16$) girls. The remaining 39 percent of the deceased were men ($N=90$), 72 adults, and 18 infants. The location of the homes of most of the adult victims was concentrated in only two boroughs: Cuauhtémoc and Benito Juárez. At the same time, the children died mainly in the townships of Tlalpan and Coyoacán. Of the total number of children, 19 died (ten girls and nine boys) at the Enrique Rébsamen School in the Tlalpan borough, and four more, two girls and two boys, in building 1C of the ISSSTE multi-family, in the Coyoacán township (Instituto Belisario Domínguez 2017).

Owing to the characteristics of the earthquake and the local soil conditions, widespread damage was caused to the water systems of the metropolitan area. Approximately 3.3 million inhabitants were left without water after the earthquake. Significant damage to buried pipes, primary network, and aqueducts located in Mexico City was more critical in the soft soil areas (i.e., the Lake zone) and significantly less in the more challenging soil areas (i.e., the Transition zone and the Lomas zone) (Ayala Milian and Escamilla García 2022).

The reporting process of the number of properties affected or destroyed has been the subject of debate since the earthquake occurred, not least as a result of several inventories that official governmental bodies have developed but also by several members of the engineering field and civil society due to the lack of intersectoral and interinstitutional coordination.

A month after the earthquake, the Ministry of Agrarian, Territorial, and Urban Development reported 5974 affected properties in Mexico City. The censuses were carried out with the participation of unskilled volunteers who, in just 5 days and with no previous experience, took charge of such an endeavor. Later, the Reconstruction Commission published an assessment of a total of 3340 affected properties on the so-called Plataforma CMDX (Mexico City Platform): 1836 at low risk, 430 at medium risk, 779 at high risk, 235 at high risk of collapse, and 60 collapses. One year after the earthquake, the updated census figures of affected properties were considered official figures by the Government of Mexico City, with a total of 6204 homes with damage (Table 3) (Mexico City Government 2018).

Nonetheless, according to Mexicans against corruption (a non-profit civil association committed to the consolidation of the rule of law in Mexico to prevent, denounce, punish, and eradicate systemic corruption and impunity in public and private systems) during the EQKS19-2017, 12,253 buildings were damaged in Mexico City, 38 collapsed and caused the death of 228 people (Castillo n.d.). These figures correspond to those reported by the Reconstruction Commission, which identified 12,253 affected properties, of which 371 correspond to multi-family buildings (250 renovations and 121 reconstructions) and 11,882 to single-family homes (9049 renovations and 2833 reconstructions). After comparing the

Table 1 Impact of the EQKS19-2017 (Source: adapted from CENAPRED cited by Méndez Estrada et al. 2022)

Federal entity	Total deaths	Affected population	Homeless	Damaged schools	Damaged health units	Damaged economic units	Damages (million USD)	Share of damage (%)
Mexico City	228	1,820,000	59,248	762	143	0	2190	71.1
Morelos	74	1,903,811	63,204	1194	9	5141	365	11.8
Puebla	45	4,050,452	113,380	1152	8	0	224	7.3
Guerrero	6	535,053	15,712	217	19	0	92	3.0
Mexico	15	1,486,691	24,240	555	35	0	196	6.3
Tlaxcala	0	145	136	441	0	0	15	0.5
Total	369	10,036,573	281,560	4321	214	5141	3080	100

Table 2 The economic impact of the EQKS19-2017 in Mexico City (Source: adapted from CENAPRED cited by Méndez Estrada et al. 2022)

Concept	Damage	Losses	Total	%
Residential real estate	1573.4	121.5	1694.9	77.39
Education	92.3	30.3	122.6	5.60
Health	58.4	0.9	59.2	2.70
Hydraulic infrastructure	59.2	10.6	69.8	3.19
Cultural and historical monuments	38.1	3.6	41.7	1.90
Sports	5.6	2.5	8.1	0.37
Communications and transportation	15.8	3.3	19.1	0.87
Urban infrastructure	63.0	59.4	122.4	5.59
Public buildings	1.8	0.1	1.9	0.08
Maritime infrastructure	15.7	1.1	16.8	0.77
Defense infrastructure	1.4	0.0	1.4	0.06
Forestry nurseries	0.6	0.0	0.7	0.03
Emergency response		31.5	31.5	1.44
Total (million USD)	1925.3	264.9	2190.2	100.00

Table 3 Dwellings affected by the EQKS19-2017 registered on the Mexico City platform (Source: Mexico City Government, 2018)

Properties registered on the Mexico City platform	April 2018	September 2018
Low risk	1836	2346
Medium risk	430	2019
High risk	779	1216
High risk of collapse	235	585
Collapses	60	38
Total	3340	6204

database on which this statistical information was based, the Human Rights Commission of Mexico City and the reconstruction noted that the number of single-family homes was 11,884, while the number of multi-family buildings 403. Therefore, the total number of affected properties was 12,287 (Comisión de Derechos Humanos de la Ciudad de México 2019).

With data compiled from various institutions, the Mexico City Government indicated that a year after the earthquake, the number of buildings affected was 13,452 (Table 4) (CDMX 2018).

The high amount of structural damage during the intraslab EQKS19-2017, especially in small and low-rise buildings, was attributed to the fact that the tremor hypocenter was located at a depth of 57 km and involved higher stress drop than interplate earthquakes and more considerable acceleration along the transition zone, where predominant periods of the soils are shorted (Pinzón et al. 2018; Singh et al. 2018).

Tena-Colunga et al. (2020) evaluated to compile a database that included 2458 buildings and houses damaged to varying degrees in Mexico City: 1059 with medium damage, 938 with high damage, 396 demolished, and 65 that have collapsed or are still classified as high damage with the potential for sudden collapse.

Table 4 Dwellings affected by the EQKS19-2017 (Source: CDMX, 2018)

Census	First data available (April 2018)	Data 1 year from earthquake
Census of affected properties	1248	7021
Census of affected public markets, micro, and small businesses	2603	2603
Infrastructure census	5877	3470
Affected urban historic Cultural heritage census	543	358
Total	10,271	13,452

Based on data collected on-site by the team of Stanford's John A. Blume Earthquake Engineering Centre between September 19 and 24 and supplemented with information from newspapers and social media up to November 1, 2017, Galvis et al. (2020) reported a total of 46 earthquake-induced collapses, including 44 buildings, a pedestrian overpass, and a pedestrian bridge located between two buildings (Fig. 2).

Of the 44 collapsed buildings, 57% were residential structures, which typically had parking lots on their first floor, leading to a weak-story collapse mechanism. Likewise, 14% had a mixed type of occupancy, with the first floor for commercial use and the upper floors for residential use, a characteristic that also results in a weak story collapse mechanism. Commercial structures, which include retail stores and office buildings, accounted for 18% of collapsed buildings. The remaining 11% corresponded to religious facilities and schools. Regarding the number of stories of buildings, 23% of the total collapsed structures had five floors, followed by 7-story buildings, which constituted 16%, and 2-story buildings, which represented 14% (Galvis et al. 2017; 2020).

Galvis et al. (2017) noted that most collapsed buildings occurred in buildings built before 1985 and thus before the establishment of the 1987 building code. Many of them had a soft story and consisted of reinforced concrete with a lateral resisting system composed of flat slabs supported by reinforced concrete columns (see Fig. 2).

3.2.1 The case of the Colegio Enrique Rébsamen

The Enrique Rébsamen school collapse, located in the south of the city, in the borough of Tlalpan, where preschool, primary, and secondary classes were taught, was the most mediatic during the EQKS19-2017. This was not only because of the loss of 19 students and seven teachers but also because of a sensationalist made-up story about a girl who was allegedly trapped in the rubble for days. The girl's story was eventually debunked but was heavily criticized by civil society.

In the same way as other buildings and structures, the collapse of the Rébsamen school was due to a series of irregularities in its construction and the failure of its structures. The school was constructed in 1983; thus, the building was not constructed considering the construction regulations of 1987 and the corresponding technical standards. What is more, the director of the school, and owner of the facilities, 2009 had illegally expanded and built the fourth floor without modifying or reinforcing the structural design, adding an over-weight of 225 tons to the structure (Impunidad Cero 2018).

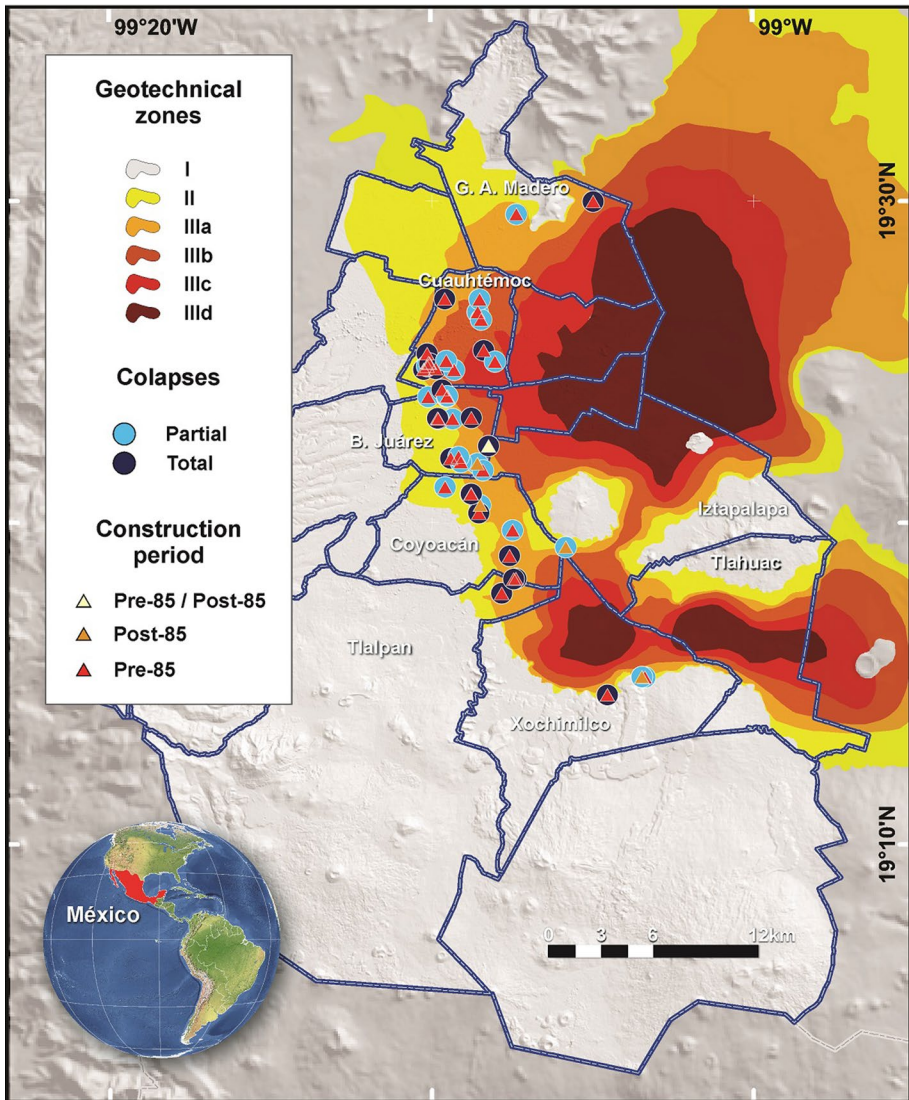


Fig. 2 Location of collapsed buildings (partial and total) according to geotechnical zones and construction period (Source: own map compilation based on the information provided by Galvis et al. 2017)

Fernández Sola et al. (2022) reported that the school consisted of four main buildings or structures, of which the two front structures collapsed (Fig. 3). These buildings that housed the kindergarten were built in 1984 and were made of concrete, presumably formed by a system of columns and a flat slab with a high elevation. The authors suggested that the collapse of the buildings could have been associated with failure at the ends of the columns, and the joint between the column and the flat slab, generating excessive lateral deformations and global instability of the system. Damage was concentrated in the upper and lower parts of the columns.



Fig. 3 The Enrique Rébsamen school, where 19 children and seven adults died in the collapse of part of the building during the EQKS19-2017 (Source: Animal Político, 2019)

The field evaluation also indicated that the inelastic deformation was concentrated mainly in the upper zone of the column, a common effect in flat slab systems, especially if the slab is steep. In this case, the slab had a depth of 40 cm for a column cross section of only 30 cm. Additionally, in some columns, it was observed that the transverse reinforcement at the ends of the columns (ties) did not have a small enough spacing to prevent loss of material in the column core and buckling of the longitudinal reinforcement bars (Fernández Sola et al. 2022).

Besides the structural collapse of the building, the Rébsamen case became the first to provide a sound legal trial with severe liabilities for local authorities. Three years after the accident, in 2020, the local Mexican justice system proved that the director of the school, and owner of the facilities, had illegally expanded and built a floor of more than 230 tons above the school that the foundations could not support. Three judges unanimously voted to sentence the director for murder: the Prosecutor's Office has requested a sentence of 57 years in prison for manslaughter. In addition to the school director, there are two other detainees for the Rébsamen case, two construction managers who endorsed the construction, and engineers in charge of signing a certificate before the Government (El País 2020).

In 2021, another historical sentence charged 208 years in prison, the Director Responsible for the Construction of the Enrique Rébsamen school. The engineer was found guilty of the intentional homicide of the 19 children and seven adults who died in the collapse of part of the building. The man was in charge of granting the documents for the security certificates necessary for the private school to continue operating (El País 2020).

3.2.2 The forced-displaced dwellers of Zapata 56

Residencial San José was a building located at 56 Zapata Street, which at the time of the earthquake was less than a year old, in which two women employed in domestic work died, and eighteen people were injured. It was constructed by the company Canada Building

Systems of Mexico. It had an architectural design inscribed with the sustainable idea, with solar panels and water purifiers, in a borough located among the municipalities with the highest Human Development Index in Mexico and Latin America (Domínguez 2021). It was a six-story building with 24 apartments, 18 of which were inhabited by the same number of families at the time of the earthquake. It is considered a paradigmatic case of real estate corruption.

The real estate company failed to comply with the applicable construction regulations within the framework of the housing policy of the government of Mexico City. This building was sold under pretenses. The use of poor construction materials and structural problems were disguised by offering comfort features. Nonetheless, various construction deficiencies were identified by the dwellers before the earthquake. Even though hidden defects were reported, the company did not assume any responsibility since the initial stage.

With the EQKS19-1985, a more complex situation was revealed. The 18 families faced impunity from the company itself and officials who participated in the authorization building process and completion of works. Half of the building collapsed, and the rest was severely damaged. Government surveys confirmed construction deficiencies and shoddy materials, for which the buyers of the apartments filed criminal complaints against the company for homicide and fraud. Nevertheless, to date, a set of procedural irregularities have prevailed, favoring the collusion and impunity of government and judicial officials and the company (Albarrán and Rodríguez 2022).

Both the director responsible for construction and the co-responsible for the installations of the construction project were accused of homicide and omissions in their responsibilities as project managers and, therefore, criminally prosecuted for the collapse of the building. However, they were released in February 2018, and no person was held accountable for the collapse of the property, although it was new.

The victims have suffered neglect and discriminatory treatment in most instances of the capital's government, both the previous administration and the current one (Fig. 4). From the overregulation imposed to meet the requirements to access the reconstruction program, clientelist use of power, and the rejection of the independent organization of victims, to the promotion of construction companies and supervisors of reconstruction or rehabilitation work by the city government. Speculation and abuses in the corresponding reconstruction works are tolerated, in addition to denying those affected the right to decide on project design, among other irregularities. Almost five years after the earthquake, all this has caused an excessive delay for the victims to return to their homes (Domínguez 2021; *Damnificados Unidos de la Ciudad de México* 2021).

Along those lines, there is a situation of forced displacement due to the EQKS19-1985 disaster aggravated by three factors: (1) lack of information; (2) lack of attention to this problem in the reconstruction program; and (3) inadequate provision of services and support was provided while the reconstruction is completed (CDHDF 2018a). However, the Mexico City Human Rights Commission issued a recommendation that only focused its attention on issues related to building demolition. In it, those affected were defined as "structural victims." The resolutions established were unrelated to the deaths and the loss of the recently acquired apartments. In it, the deputy of the borough where the building was located was requested to update the risk atlas and publish it on its official website (CDHDF 2018b).

Currently, the government of Mexico City, which administers the second stage of the reconstruction from 2019 to 2023, has begun criminal prosecutions against the previous government by filing lawsuits against those who held the Reconstruction Commission and the Ministry of Urban Development and Housing. The first is in preventive detention



Fig. 4 Demonstrations from the collapsed buildings' dwellers ask for accountability in the management of the EQKS19-2017. Translation of the message in the picture: "Citizens do not want more corrupt construction companies; punish criminals!" (Source: El Universal 2019)

(Quadratin 2021), and the second is a fugitive with a pending arrest warrant, wanted by Interpol since 2020 (Arellano-García 2022). Both for the alleged crime of illegal use of powers and authorities by authorizing financing for several buildings without complying with the guidelines for various construction works during the first stage of housing reconstruction (2017–2018).

3.3 Disaster management

3.3.1 Government and civil society responses to the disaster

After the EQKS19-2017, more than an institutional paralysis, the state of affairs was marked by a combination of political-institutional behaviors shaped by personal administration and crisis management styles. In the first place, the political calculation, measuring the magnitude and evolution of the events, expressed an inability to react promptly. This responded to the daily and structural inertia in Civil Protection and related areas under conditions of imminent impact due to hazards, based on the culture of waiting and the justification that the occurrence of the disaster was inevitable since authorities have often argued that earthquakes are not predictable. Their destructive force cannot be avoided.

Similarly, the model of action, limited to immediate responses, lacked a medium- and long-term vision. This has been based on a welfare and militarized perspective, in which the army is deployed to "protect" goods and lives, and reflects a social and territorial control, generally far from the human dignity of the victims.

In this way, in the first hours and days after the earthquake, civil society gathered in the city's diverse social spaces but with a reduced temporality. Immediate solidarity manifests the spontaneous will suffered by an articulated organization of the citizenry with the

emerging communities that flock to the devastated areas (Fritz and Williams 1957; Alfridaus et al. 2015).

Less visible, but with a more far-reaching perspective, was the gestation of grassroots organizations (Pyles 2007; Anderson and Woodrow 2019), which emerged from the rubble, of collapsed buildings, in scenarios of destruction, death, and loss of rights and an increase in urgent needs. This was the forced displacement of the affected population (Zetter and Boano 2009), the diverse groups that repeatedly began rapprochements, negotiations, and meetings with officials overwhelmed by the circumstances of the crisis that questioned political-institutional normality. Given the anti-democratic tradition in decision-making, conflicts arose, and victims in internal forced displacement could not remain in their homes; if anything, they could camp nearby to take care of their belongings located in totally or partially destroyed buildings.

The process evolved toward mobilizations, protests, and public denunciations, stemming from communities in extreme vulnerability. Discussions and reflections occurred collectively in community or neighborhood assemblies and family gatherings. Thus, broad organizations and others of a communal nature appeared: United Victims of Mexico City; Collective of Victims September 19; Cananea victims; United Victims of Benito Juárez, Coyoacán, and Cuauhtémoc; Victims of the Colonia del Mar, among other groups that have faced power to claim their rights, questioned the orientation of the reconstruction policy and denouncing collusion with real estate and construction companies that constructed buildings without structural safety or that did not take care of buildings with decades of existence.

Government responses were dosed, and the strength and mobilization capacity of the victims or forced displaced were measured; political calculation prevailed over the commitment to public service and the solution based on the active consensus of the victims. While the relations of these two main actors continue to be tense, the civil society showed high levels of solidarity and cohesion but mainly in the first hours and days after the disaster, and subsequently retreated into daily life; the flow of aid, and participation, decreased until it disappeared. The government also encouraged this, which recovered control of the scenario and determined when the emergency ended to make way for reconstruction and a return to normality. The reconstruction process has been developed without the perspective of civil society (Aldrich 2012), excepting a few cases of groups that took advantage of the experience and maintained links, such as *Nosotrxs*, *Ruta Cívica*, *Unired*, and some sectors of the journalistic and academic communities that keep ties of work and solidarity (Tierney and Oliver-Smith 2012).

In 2017, the history of misunderstandings continued beyond the immediate earthquake situation to the point that housing reconstruction was far from being a successful model almost five years after the disaster. On the contrary, in Mexico City, there was regression when comparing the process with that observed after the EQKS19-1985. Some achievements of the emerging housing program resulted from moments in which the dialogue between the parties flowed; however, this did not mean a sustained and substantial advance.

3.3.2 Legal responsibilities

The increasing number of disasters worldwide and their consequences are currently acknowledged as a combination of natural hazards and human interference. Individuals, communities, and nations' actions and decisions taken at various levels have considerable impacts on disaster risk reduction (DRR), and the decisions taken at the political level

to reduce the human effects of disasters are strongly contested whenever a large disaster strikes in any country (Mathúna et al. 2018).

Despite considerable progress in shifting emergency management systems to disaster risk management, the legal dimensions of emergency management are often “avoided” by governments due to liability concerns, competing priorities, and lack of clear administrative and civil responsibilities, among other issues. According to recent research conducted by the United Nations Office for Disaster Risk Reduction (UNISDR 2019), poor emergency management governance is a significant contributor to the rise in disasters that could have been avoided. The main point is that the loss of life and damages could be strongly reduced if individuals in charge of disaster emergency management could act according to moral, legal, transparent, and scientifically based actions and practices.

In recent years, the L’Aquila (Italy) earthquake in 2009 was a clear example that set an international wave of determining liabilities and civil responsibilities to public officers in charge of disaster risk reduction but also to the scientists that were blamed for not predicting on time hazards such as earthquakes (Lucatello 2017). According to the Italian public prosecutors in charge of the trial, the L’Aquila earthquake was not a disaster because of the earth trembling but because the effects of the earthquake could have been avoided had someone acted differently or applied the legal frameworks available to reduce the risk (i.e., Alemanno and Lauta 2014; Alexander 2014).

This vision adopted by lawyers and public prosecutors in Italy had dramatic consequences for the role of law after disasters in the world. After L’Aquila, legal cases after disasters to fix responsibilities for public officers accused of misconduct, negligence, and omissions, have proliferated all around the globe, from Chile (Bonney 2013) to Japan (Lewis 2012), the USA (Lauta 2014), the Philippines (Reuters 2015), Mexico and other countries.

The important precedent set by the L’Aquila trials offers an exciting vision of how disaster law and traditional legal domains, such as victims’ compensations for losses and damages, widen the scope of understanding root causes and disaster risk drivers (Oliver-Smith et al. 2016, 2017). Disasters are no longer products of natural hazards that exempt public authorities and citizens from liability. On the contrary, disasters can extend the set of liabilities to enlarge the justice system to a domain that was considered almost “untouchable” given that the power of nature, God’s will, and other traditional visions about “natural disasters,” such as warnings of developments in the political sphere (see Alcántara-Ayala et al. 2023) carried the idea of an impossibility to control nature and its impacts (Lavell and Maskrey 2014). This is also the recent case of several climate change disputes and legal instances in which governments are demanded not to reduce global emissions and where legal responsibilities to entire political elites, decision-makers, and rulers are established for compromising the life of future generations (Setzer and Higham 2021).

The progressive “proceduralization” of disasters may have profound consequences on understanding significant events and their impacts. Designing and implementing management systems based on a broad vision of liability and beyond the sole technical and experts’ opinions—primarily engineers—may change the way we reduce and handle risks. Since the L’Aquila case and after several disasters worldwide, many institutions and people that govern day-to-day risk reduction activities in affected countries, as well as the governing bodies that mandate tasks and priorities, are blamed for passivity, omissions, negligence, and other liability concerns (Lauta 2018).

Several authors discuss the omission and negligence within complex and multi-dimensional risk conditions. According to Charbonneau and Bellavance (2012), the blame avoidance theoretical framework is caused by a lack of transparency, incentives,

and performance repercussions. Moynihan's research (2012) of networks in the aftermath of several recent disasters worldwide includes the variable of culture, where *"incentives to use blame avoidance methods when a failure occurs are created by intra-network and extra-network reputations."* Because of blame avoidance strategies, there is a lack of responsibility within these public policy networks, directly impacting how disaster risk and disasters are managed. In other words, complicity, corruption, negligence, and other factors embedded within disaster management and public policy communities, play a significant role in determining liability.

However, a vital contradiction becomes relevant: if laws and regulations tackle corruption and other issues, they do not offer enough protection or even fail to make any difference. This contradiction highlights that the suitability or inadequacy of existing legislative frameworks and rules in the context of disaster risk reduction undermines accountability and liability (Lauta 2019).

Mexico's legal and institutional framework is based on SINAPROC and many laws and regulations. A particular technical-scientific agency (CENAPRED) and the incorporation of the National Defence and Navy Ministry into SINAPROC and other available tools provide a sound system for the country to face disasters. The legal basis for DRR responsibility is established in the Mexican Constitution, which defines, among other things, human rights, and individual guarantees such as the right to adequate and safe housing, a healthy environment, non-discrimination, and protection, though not explicitly for "civil" protection, indemnification, or protection against disaster losses (UNDP 2014).

The Federal Law on State Responsibilities defines the state's and public authorities' responsibilities. While Article 113 of the Constitution establishes obligations to protect legality, honesty, loyalty, justice, and impartiality, the Federal Law for Administrative Responsibilities of Public Employees (Ley Federal de Responsabilidades Administrativas de los Servidores Públicos 2009) addresses the efficiency in the performance of their duties, occupations, charges, and commissions, as well as the punishments that may be imposed for failure to do so. Under the same law, acts or omissions and the lack of proper procedures and misconduct of public authorities can be used to impeach public servants in the line of duty. Individuals' property or rights damaged under erroneous administrative activity have the right to compensation by the rules, limits, and guidelines established by the government. These laws have defined procedures. Administratively, the government can be held accountable and liable, and a public servant can be held criminally accountable.

In the case of Mexico City, a new Civil protection law was passed locally in 2019. The 2021 law on Integrated Risk Management and the Civil Protection of Mexico City (LIRM-CPMC) has many purposes. Several articles in the law—Chapter II about sanctions, art. 221 and followings—establish civil liability for public servants when they may not act in a due manner during their functions. Sanctions may be imposed and demanded, infringing the Penal Code of Mexico City. However, all these articles are not only general. However, they do not specify their responsibilities when a disaster strikes and the outreach of their misconduct. Important questions remain to be addressed in the current city and national legal frameworks and liability concerns: to what extent can civil protection officials or public institutions dedicated to emergencies and risk reduction, or can risk management (and should) be held accountable for the deaths of people, as a result of "uncalculated" risks? How can wrong decisions, negligence, and misconduct, among other issues, be legally prosecuted? Should the legal system prosecute individuals or institutions that fail to address protection in case of disasters and penalize the mistakes committed?

3.3.3 Post-disaster recovery

What constitutes a legitimate post-recovery plan can play a significant role in defining the type, content, and design of comprehensive planning in the context of the Mexican post-earthquake era after 2017. In a highly bureaucratized nation, organizational structures can perpetuate norms and regulations that are considered acceptable by powerful agencies and decision-makers inside the state at all administrative levels. Long-standing corporate practices can become dominated not only by legitimacy concerns but also be surreal and far distant from the limits of on-the-ground implementation and local communities' reality (Miles and Chang 2006).

The development of practical strategies to handle the aftermath of crises in urban or marginalized areas is a significant source of concern after a disaster strikes in much of the Global South (López and Hooper 2020). This is especially important because, while some experts say that communities should consider relocating because of their prolonged socioeconomic and environmental vulnerability, as this article has shown, data reveals that the vast majority of settlements were rebuilt in their original locations following disasters (Mileti and Passerini 1996). Similarly, there is evidence that a lack of communication and collaboration between state institutions and local players might exacerbate vulnerability during the post-recovery phase (Yang et al. 2015). This is particularly true when applied to affected communities or neighborhoods not considered during reconstruction.

In response to the EQKS19-2017, Mexico City authorities and urban planners, among many other national and international stakeholders, developed a strategy to establish a post-recovery framework building on three main pillars: a) reactivating the operations of development finance institutions by creating a recovery and reconstruction fund, b) revisiting and changing the legal framework of the city disaster risk and civil protection law, and c) taking advantage of the opportunities presented by reconstruction and rehabilitation of the affected areas by addressing a new urban plan with more robust monitoring practicing over traditionally at-risk areas such as schools, markets, and informal settlements. As an additional strategy, City authorities strongly increased the capacity building system to improve the knowledge and practices of civil protection operators and officers at all public and private levels, as well as strengthening the use of Atlas and Risk maps based on recent technological advancements to inform about the vast array risks in the city (Novelo-Casanova et al. 2022).

A meaningful change from the old city system was the introduction of a regular assessment of impacts on the security of the facilities at risk, introducing the concept of risk transfer and management of disaster risk to civil society and organized groups such as the Official Responsible for Civil Protection and Director Responsible for Constructions. Given a large number of buildings already present in the city and new buildings constructed as well as the characteristics of the subsoil where they are located, the Government of Mexico City must have enough assistants from the Public Administration that contribute to the surveillance of the application of the Construction Regulations of the Federal District and its Complementary Technical Standards, both in new and existing buildings. The “decentralization” of legal responsibilities and decision-making to organized groups of experts in disaster risk management represents an entirely new turn in the historical risk management policy of the city and for the post-disaster recovery.

At the same time, new articles were added to the LIRMCPMC to enforce the issue of liabilities and legal responsibilities. Under the current law, authorities, public servants,

and assistants of public administration—among others—can be sanctioned under articles 223, 224, 226, and 228 upon infringement of the law and be punished with severe consequences based on the local Penal code and economic sanctions.

However, many challenges lie ahead, including the precise definition of procedures and activities of the different actors involved and the mandate and scope of each agency/service center adscription of these other “federal assistants.” Not to say the mechanisms through which public institutions will continue to operate as efficiently and effectively as possible in the post-disaster environment together with local municipalities of Mexico City after the entry into force of the Mexico City Political Constitution in 2018.

Conversely, The Commission for the Reconstruction of Mexico City played an important role during the reconstruction process. This is the administrative organization of the Public Administration of Mexico City, in charge of coordinating the reconstruction work for the benefit of the communities damaged by the earthquake under the Comprehensive Plan for the Reconstruction of the city. In coordination with other government bodies, individuals, educational institutions, and civil organizations, the Plan and the commission have faced complex challenges. In March 2022, when 54 months had passed after EQKS19-2017, according to the database of Mexico City’s government, 10,980 out of 22,210 buildings mapped were reconstructed and rehabilitated.

Concerning liabilities, the EQKS19-2017 also showed that the local emergency management legislation lacked regulatory rules for how the city government and local municipalities might lessen community risks. Individuals and communities were and still are more vulnerable to disasters if the local government failed to act or provided inadequate management. Furthermore, financial resources to compensate local governments and private landowners for damages suffered frequently became a substantial liability for the management of the city. When private landowners and ordinary citizens are harmed due to a government’s conduct or inactivity in the event of an emergency, provisions in local legislation and court rulings and demands (*amparos*) have lowered the government’s power to control and manage city planning. Despite significant progress in shifting emergency management systems since 1985, institutions that control day-to-day risk management and the governing bodies that mandate tasks and priorities could be blamed for passivity and slow changes in the overall disaster risk management system.

Another important lesson in risk governance is the fragmentation and lack of collaboration at government levels during the post-recovery process (Jayasinghe et al. 2020) in both the 1985 and 2017 earthquakes. This is problematic because crucial participants from recovery operations can be excluded during the recovery process. Community members and organizations are among the local actors who should be critical players in formulating and implementing post-disaster strategies. However, they are not the priority during the reconstruction process (Fayazi and Lizarralde 2018). The centralization of the process is usually in the hands of the city-level agencies, and the federal government’s increasing involvement in developing and implementing post-disaster plans is apparent. There is often an underestimation of the support that organized civil society, academia, and other sectors can play in helping to shape models that strengthen local response capacity and draw on local risk awareness. Share lessons and practices to better handle potential disasters (Teets 2009). This points to strengthening stakeholder relationships and boosting training and capacity building at all levels. In other words, disaster governance structures should support decentralized capacity building for residents, local governments, and other institutions to develop contextually aware, locally driven prevention and recovery plans and strategies, in addition to seemingly efficient, nationally produced programs (López 2020).

4 Concluding remarks: future challenges for disaster accountability and community involvement

The SF gives the science, technology, and innovation community a clear mandate to collaborate with governments in generating and disseminating the information and solutions needed to strengthen community resilience. Stronger collaborations across disaster risk science, policy, and practice are required. Throughout this article, an interdisciplinary and comprehensive review of accountability and disaster risk management among policymakers and practitioners was analyzed to address systemic difficulties associated with risk reduction in Mexico City after the 1985 and 2017 earthquakes.

Several conclusions emerge from the different sections of the article:

- (1) Unlike the effects associated with the EQKS19-1985, whose most extensive destructive effects were concentrated on multi-family housing, the EQKS19-2017 caused building damage and induced subsidence. The consequences of the disaster triggered by the EQKS19-2017 mirror that structural or intrinsic vulnerability is multi-dimensional and cannot be interpreted exclusively from disaster risk factors, such as poverty and marginalization. Investments that provide corporations with maximum profitability with little security and structural quality, in a context of a real estate boom, had been encouraged by the government and played a crucial role in shaping vulnerability and exposure.
- (2) Households and communities were both considerably affected: to increase community awareness of available knowledge and establish a trust to mitigate future disasters, a combination of science-based actions is needed to develop resilient pathways to balance risk management's short- and long-term goals in Mexico City. Integrated economic, environmental, legal, and science frameworks also need to be escalated at the municipal level, and the collaborative initiatives must connect and work out properly. One of the significant areas for innovation is disaster risk governance (Kirsch-Wood et al. 2022), which requires revisions and improvements concerning liability, transparency, and accountability, along with more solid community communication, clear roles, and sustained involvement of all relevant DRR actors.
- (3) In terms of vulnerability, the EQKS19-1985 and EQKS19-2017 revealed that corruption in private and public works, with little or no presence of the national State as the legal and ethical entity responsible for guaranteeing the right to life, security, housing, and other human rights (Rodríguez et al. 2018) remain a substantial liability. The direct and indirect victims of disasters are subjects of rights, with the ability to propose solutions based on their knowledge of the territory and the experiences acquired in daily life in the face of various dimensions of disaster risk. They require support from the academic community to strengthen the capacities of society in the spheres of community, labor, and citizenship-building.
- (4) Those responsible for the community's well-being are best suited to recognize, plan for, and implement a coordinated response to possible catastrophes. Civil servants, public officials, and other people in charge of disaster risk reduction in Mexico City and the country must follow public safety precautions to avoid more severe damages in the aftermath of a disaster. To ensure that these preventive efforts are carried out appropriately, strict legislative standards, implementation, monitoring, and evaluation are required. The current legislative systems in most parts of Mexico feature permis-

sive provisions with little or no guidance on accountability. As a result, risks arise, and public/civil responsibilities are often left unclear and unpunished.

- (5) Social participation must be based on access to information. The right to the truth is substantive to generate organizational processes that support the involvement of the different sectors in decision-making and is not meant to feed the beneficiaries of federal assistance programs for electoral reasons. The new public policy framework for Mexico City must support the political, legislative, and cultural recognition of human rights to housing, information, and community self-organization.
- (6) It is vitally important to change the current model of civil protection focused on relief and rescue, as well as the partial reconstruction of the material damage that tears apart the community's social fabric. Instead, an integrated approach to managing disaster risk as a sustained and committed process should be implemented. This requires reshaping the institutional organization in the government, parliament, and judiciary to articulate coherent policies that respect human dignity and avoid violating human rights. This reformulation must also elude privileging quick reactions typical of emergency care and tolerance of corruption that leads to the collapse of poorly constructed buildings due to speculative real estate business.

Mexico is front to the opportunity to change the political and economic inertia in disaster risk management and recovery. Currently, legal and institutional public responsibilities are insufficient, and the ethical dimension acquires strategic relevance. Unquestionably, transparency and accountability of the authorities in the three orders of government must be a public policy rationale driving disaster risk reduction actions.

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