



Can we pull resilience from the rubble? experiencing earthquakes in Mexico City

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Abstract

This paper serves as an introduction to focus on the meaning of resilience as a notion that hypothetically enables cities and their citizens to remain unaffected by shocks and stresses of diverse nature, but in practice, is a parsimonious representation of a highly complex human endogenous condition that is often not adequately understood and addressed due to weak or weathered disaster risk governance. Through an empirical analysis, the relevance of the occurrence of disasters such as the one produced by the Mexico City earthquake of September 19, 2017, and its relationship to the meaning of urban resilience is addressed. Since the 100 Resilient Cities program launch in 2013, several cities, including Mexico City, have adopted diverse strategies to build and become more resilient to physical, social, and economic shocks and stresses. Nonetheless, the degree of success of such strategies expressed in everyday life within the cities, regardless of what the official documents report, reveals highly heterogeneous results. In the case of Mexico City, it is evident that the appropriate strategy for attaining the desired outcome of becoming a Resilient City has not been successful. Despite setting the goal of advancing disaster risk reduction through urban and regional planning, the impact of the earthquake of September 19, 2017, proved otherwise.

Keywords Earthquake-related disasters · Mexico City · Earthquake early warning systems · Resilience · Integrated disaster risk management · Civil society · Multi-hazards

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1 Introduction

The role of resilience in reducing disaster risk has received increased attention across several initiatives in recent years. The past decade has seen the rapidly increasing goal of developing resilient cities in many countries, particularly those frequently affected by disasters. However, such cities' performance is limited by how disaster risk is managed, mainly due to disarticulated approaches and the nature of disaster risk governance.

Aiming at helping more cities build resilience to the physical, social, and economic challenges that are a growing part of the twenty-first century, in 2013, the Rockefeller Foundation (n.d.) launched the 100 Resilient Cities (100RC) program, which included Mexico City. This framework defined urban resilience as "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what chronic stresses and acute shocks they experience." Similarly, the qualities of a resilient system were characterized as reflective, resourceful, inclusive, integrated, robust, redundant, and flexible (The Rockefeller Foundation 2019).

Thirty-two years after the devastating earthquake in Mexico City in 1985, the city trembled from the impact of a 7.1 Mw earthquake that affected central Mexico on September 19, 2017 (EQKS19-2017). The consequences of the earthquake were catastrophic for the country and its capital city. In Mexico City alone, at least 228 deaths resulted from the disaster triggered by the earthquake, which also caused 73,000 damaged properties, including 5765 homes (40% total loss) and 973 schools, and an estimated impact on the economy between 0.1 and 0.3% of GDP for 2018, in addition to more than US\$3.4 billion, the funds required for reconstruction (Matus et al. 2018).

Fostering disaster risk reduction (DRR) requires integrated disaster risk management (IDRM). This complex approach involves understanding the interrelationships and interdependencies between the processes, decisions, and practices that intervene in the social construction of disaster risk and disasters, including root causes (Oliver-Smith et al. 2016; 2017). IDRM should involve the three levels of government and all sectors of society. Its main target is identifying and applying policies and strategies for DRR to prevent new disaster risks, reduce existing disaster risks, manage residual risks, and permanently control disaster risk factors in society. As a transversal and integrated character process, the relationship with development and its management are indispensable. It also needs integration and coordination across territorial levels and the creation and consolidation of permanent and sustainable institutional and organizational structures on which the participation of vulnerable communities at risk is essential for its success. Therefore, ownership of social actors must also be promoted (Narvaez et al. 2009).

Best practices in IDRM recognize that stakeholders must engage in diverse processes and strategies to work toward integrated targets. In this case, resilience city benchmarks are useful in practice but should consider that DRR strategies cannot succeed without a collective effort. This is a critical aspect of an effective advocacy strategy that seems not to have been considered in the Mexico City Metropolitan Area. This was hand in hand with the fact that although diverse DRR strategies may be pursued, the significant point is that information and knowledge should be made accessible to ordinary citizens in a systematized manner.

Owing to the historical events associated with the establishment of the Aztec Empire on the bed of a system of lakes and its subsequent transformation into the current architecture of Mexico City characterized by the construction of heavy churches after the desiccation of the lakes led by the Spanish conquerors, a large area of the ground in Mexico City is highly

susceptible to earthquakes due to the amplification of seismic waves. Moreover, people's high levels of exposure are frequently attached to the uncertainty of how houses, buildings, schools, hospitals, and other infrastructures have been designed and built.

Even though Mexico City has a long history of building codes and legal frameworks directed to the practical advancement of the construction of earthquake-resistant buildings, the lack of credibility of its inhabitants regarding safe housing and other infrastructure demonstrates that forging strategies should not only focus on policy and outline recommendations for the way forward but should also include robust formulation, implementation, and evaluation.

Despite the long history of the term resilience, dating back to the writings of Seneca the Elder, Pliny the Elder, Ovid, Cicero, and Titus Livy (Alexander 2013), the precise meaning of this term remains a hotly debated topic. Alexander (2013, Tomes 1857, p. 379) provided one of the earliest examples of using resilience during disasters. This referred to the ability of the resourceful and industrious Japanese to withstand the effects of two significant earthquakes during the recovery of the city of Shimoda, southwest of Tokyo, in December 1854.

Widely varying definitions of the resilience concept have emerged. These have been provided and used by diverse disciplines such as art, literature, law, science, and engineering (Alexander 2013). From the perspective of the international arena on disaster risk reduction, resilience is "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management" (UNISDR, 2017:22).

A further definition is given by Béné et al. (2012:48), who use the term good resilience to refer to "the ability of a system to accommodate positively adverse changes and shocks, simultaneously at different scales and with consideration of all the different components and agents of the system, through the complementarities of its absorptive, adaptive and transformative capacities."

In the specific case of urban contexts, Meerow et al. (2016) suggested that urban resilience alludes to the ability of an urban system and all its component socio-ecological and socio-technical networks to retain or swiftly return to desired functions in the face of a disturbance, to adapt to change and to transform systems that limit current or future adaptive capacity rapidly across temporal and spatial scales.

Mexico's integration into the 100RC responded to various needs. One of the five strategic pillars of the Mexico City Resilience Strategy included planning for urban and regional resilience and establishing disaster risk reduction through urban and regional planning as one of its main objectives (CDMX Resilience Office 2016). However, most actions contemplated focused on disaster response and mitigation measures rather than reducing disaster risk. This signified, in a similar line to the perspective of Béné et al. (2012) on resilience and adaptation to climate change, that misusing the term resilience could dangerously imply a greater focus on disaster resilience than disaster risk resilience, privileging a primary focus on emergency management instead of challenging and addressing the social construction of disaster risk and enhancing integrated disaster risk management.

Some published studies describe the gap between the political discourse and the capacity to govern to build practice resilience (e.g., Wagenaar and Wilkinson 2013; Meerow and Newell 2019). In the same vein, this paper addresses, from an empirical perspective, the relevance of the occurrence of disasters such as the one produced by the EQKS19-2017 and its relationship to the meaning of City resilience from two perspectives. First, it examines the regulatory framework and legislative work based on which the national civil

protection system and the existing disaster risk management initiatives that shape Mexico City policies were created. This can be regarded as an ex-post analysis in that it assesses what happened in recent years regarding the creation and intensification of people's exposure to the potential impact of earthquakes under the umbrella of such normative foundations. Second, a reflection on Real estate development in Mexico City to human rights precepts is presented. Third, lessons learned and lessons forgotten from the 1985 earthquake are explored.

The remainder of the paper is organized into three sections. Section 2 describes the methodology. The results of the analysis are presented in Sect. 3. Finally, Sect. 4 concludes with a discussion and a summary.

2 Methodology

This study was exploratory and interpretive in nature. Contemporary source materials were used to examine the empirical evidence on the role of regulatory frameworks in the Mexico City earthquake disaster of September 19, 2017, within an assumed context of resilience. In the same way, the research comprised an extensive document inquiry that included legal systems, programs, and guidelines related to civil protection, urban development, and the building codes established through time in areas prone to earthquakes. The approach to empirical research adopted for this study was also supported by the authors' large and established national and international experience in the topic of concern.

3 Results and discussion

3.1 Legal frameworks

At the time of the EQKS19-2017, there was a robust regulatory framework in the public administration, the product of 32 years of government and legislative work aimed at creating a national civil protection system and another for the country's capital (Tables 1 and 2). The first is based on the General Law of Civil Protection (GLCP), and the second is on the Law of the Civil Protection System of the Federal District (LCPSFD).

In the Political Constitution of the United Mexican States (PCUMS), an addition was incorporated to article 73 in 1998 to empower the Congress of the Union to legislate on civil protection. In 2000 the first GLCP was approved, and later abrogated in 2012 to give way to the current one, which includes the concept of "integrated risk management" with comprehensive scope to the letter, where prevention is reduced to preparation to act in the face of inevitable impacts, and recovery or reconstruction was considered but with no adequate conceptual and institutional development.

For this reason, when the EQKS19-2017 occurred, there was a lack of structures and procedures for post-impact recovery, leaving this aspect in the logic of the real estate market and the absence of mechanisms for the comprehensive repair of damages and losses. The history of the post-seismic reconstruction of 1985 was repeated when two unrelated reconstruction instances were created after the EQKS19-2017. On the one hand, the National Reconstruction Commission elaborated the bases that gave foundation to the decree of the creation of the National Civil Protection System (known in Spanish as SINAPROC) and

Table 1 Laws related to civil protection and disaster risk in Mexico at the federal level

Law	Content related to civil protection, recovery, and reconstruction	Reference
<i>Federal level</i>		
Political Constitution of the United Mexican States (PCUMS)	It establishes the power of the Congress of the Union to legislate on Civil protection (article 73)	Official Gazette of the Federation (last reform published: May 28, 2021)
General Law of Civil Protection (GLCP)	In the second version of this law, recovery and reconstruction programs and actions were included as part of comprehensive risk management (articles 4, 5, and 57–63) It institutes a centralized system in the national government (articles 7–13) It emphasizes the intervention of the army and the navy as guarantors of aid in emergency or disaster situations (article 21) It defines the victim as someone affected by some threat that requires external assistance, and participation in decisions is not recognized (article 2, section XIV)	Official Gazette of the Federation, June 6, 2012 (last reform published: May 20, 2021)
Organic Law of the Federal Public Administration	Orders the ascription of the civil protection area in the Secretariat of Citizen Security and Protection after several decades of being part of the internal government sphere (article 30 Bis)	Official Gazette of the Federation, the article added with the decree of November 30, 2018
Federal Law for Administrative Responsibilities of Public Employees	It addresses the efficiency in performing duties, occupations, charges, and commissions of public employees and the punishments that may be imposed for failure to do so (articles 7, 8, and 9)	Official Gazette of the Federation, May 28, 2009

Table 2 Laws related to Civil Protection and Disaster Risk in Mexico City

Law	Content related to civil protection, recovery, and reconstruction	References
<i>Mexico City</i>		
Government Statute of the Federal District	At the time of the 2017 earthquake, it mandated the Legislative Assembly to “regulate civil protection” (article 42) It ordered the city government to establish coordination procedures with the boroughs (article 115) It established the boroughs’ powers in their jurisdiction (article 117)	Official Gazette of the Federation, July 1994 (abrogated in February 2017)
Political Constitution of Mexico City (PCMC)	Months before the 2017 earthquake, it instituted the right to citizen security and civil protection against natural or anthropogenic phenomena; the government will adopt protection measures (Article 14-A) Orders the City government to recognize as victims of forced internal displacement persons or groups that escape or flee from their place of residence as “natural or human-caused disasters” (article 20, numeral 6)	Official Gazette of Mexico City, February 5, 2017
Urban Development Law of the Federal District (UDLFD)	It establishes as a policy criterion the transfer of potentialities (article 3, section XXI); to achieve “maximum use of goods and services,” the transfer of “excess rights in construction intensity” is foreseen (article 82) Those who “acquire the authorized development potentialities may increase the intensity of construction” in the properties where investments are channeled; the City government will authorize the respective operations establishing the coefficients of use and occupation of the land, and the “intensity of construction corresponding” in real estate (article 85)	Official Gazette of Mexico City, July 15, 2010
Law of the Civil Protection System of the Federal District (LCPSFD)	Before the 2017 earthquake, it included recovery and reconstruction as aspects of public policy (articles 123–127, 133, and 136–146) It defined the recovery subprogram (articles 71 and 81) and actions to rebuild in affected or at risk sites (articles 143 and 144) The Civil Protection Secretariat was ordered to prepare recovery plans and programs (article 16) It referred to social participation in civil protection and subprograms (articles 7, 15, 16, 33, 46, 47, 113, and 146)	Official Gazette of Mexico City, 27-Nov-2014 (abrogated in 2019)

Table 2 (continued)

Law	Content related to civil protection, recovery, and reconstruction	References
<p>Law for the Reconstruction, Recovery, and Transformation of Mexico City into an increasingly resilient</p>	<p>This law excludes single-family homes from reconstruction programs, projects, and activities. It also failed to recognize the problem of high risk and vulnerability in areas where cracks associated with the earthquake of September 19, 2017, were generated</p> <p>This law establishes overregulation for the displaced population with multiple procedures and requirements applicable under “normal” conditions</p> <p>This law reinforces the “Commission for the Reconstruction, Recovery, and Transformation of Mexico City, in an increasingly Resilient City” as the body responsible for the housing reconstruction program and projects (articles 7–17)</p> <p>As a policy cornerstone for multi-family housing buildings, a model of investment, construction, and sale of additional housing was defined, imposing on neighbors and displaced owners of their destroyed or structurally damaged homes an increase in density of no more than 35% to “finance the replacement of pre-existing dwellings with additional dwellings,” modifying the Urban Development Programs, to guarantee profitability to private investors (articles 38 and 42)</p>	<p>Official Gazette of Mexico City, December 1, 2017</p>
<p>Law for the Integrated Reconstruction of Mexico City</p>	<p>The law did not establish criteria or mechanisms to guarantee the observance of the human rights of displaced persons. It also established overregulation for these people; in contrast, it issued provisions facilitating the intervention of construction companies that, in several cases, failed to comply with the quality and efficiency provisions required from the housing as a human rights approach</p> <p>In this law, the concept of people who suffer from internal forced displacement is unknown, as stipulated in the Political Constitution of Mexico City, by legally defining the “Damaged Person” exclusively as the one who suffered losses (article 2, section XVII)</p> <p>To analyze the problem of risk in areas of subsidence and cracks, the Cracks Committee was created (articles 2, section VII, and 8)</p> <p>It incorporated the single-family housing modality (article 23)</p> <p>An increase of up to 35% of the density was proposed concerning “the Zoning, assigned in the Urban Development Program,” so that “the Affected Persons” have an alternative for reconstructing the property with private ownership. For this reason, these people must accept the construction of additional houses with private investment and not hinder the speculative logic of recovery of private investments (article 26)</p>	<p>Official Gazette of Mexico City, December 7, 2018</p>

Table 2 (continued)

Law	Content related to civil protection, recovery, and reconstruction	References
Law on Integrated Risk Management and Civil Protection of Mexico City (LIRMCPMC)	<p>It incorporates one of the specific programs related to cracking and fractures (Article 81, section II). Creates the Integrated Risk Management and Civil Protection System of Mexico City, with the participation of all institutions and society, which has as one of its responsibilities to work on reconstruction, rehabilitation, and reconstruction (article 6)</p> <p>Recovery and reconstruction are considered stages of comprehensive risk management (article 110)</p> <p>Social participation is reduced to activities in emergencies, without incidence in planning and decisions (articles 169–179)</p>	Official Gazette of Mexico City, June 5, 2019 (last reform published: March 2, 2021)

the cornerstones of the federal civil protection program, on the other hand, the Democratic Concertation Agreement for Reconstruction had housing as a priority.

This implied in the present that civil protection has its foundations in the intervention of the armed forces as it has been instituted in all the national development plans and government until November 2018, when by reforming the Organic Law of the Federal Public Administration (addition of article 30 bis), civil protection was transferred to the internal security area. Reconstruction was not part of the civil protection agenda any longer. Instead, aid, rescue, and preparations for foreseeable impacts were endorsed without any coordination with the areas of reconstruction and recovery.

Even though internal forced displacement due to disasters was consigned in the Political Constitution of Mexico City (PCMC) even before 2017, the lack of knowledge at the state level on this matter influences the discriminatory treatment and the violation of the human rights of disaster victims.

The national plan of development 2013–2018 stated the objective of “safeguarding the population, its assets and its environment in the event of a natural or human-caused disaster,” a line of action related to financial instruments for risk management, with emphasis on the prevention and strengthening of “reconstruction in cases of emergency and disasters.” This falls under the heading of “financial insurance against disasters,” which involves access to risk coverage instruments that contribute to mitigating the impact of disasters on public spending (SHCP 2013, pp. 19).

In contrast, the 2014–2018 national civil protection plan did not include a strategy or lines of action concerning recovery and reconstruction from integrated risk management and human rights perspectives. It was noted that most of the resources were channeled to road infrastructure, in addition to affirming that there were “high costs” in reconstruction. A strategic goal was focused on the “efficient allocation of resources for emergency and disaster care to guarantee support to the affected population and infrastructure.” Nonetheless, it lacked the establishment of criteria for designing public policy with communities facing disaster situations.

A noteworthy feature of the EQKS19-2017 is that many victims are part of the middle class. However, the policy attention and response design financed with resources assigned to the so-called Natural Disasters Fund (FONDEN) only included subsidies to people in a situation of patrimonial poverty. This mechanism excluded affected people with higher incomes, who would only be served through market mechanisms, in this case through mortgage loans, as they are not eligible for housing reconstruction programs run by the federal government and the capital government.

The civil protection policy at the local level was reinforced with the promulgation of the PCMC (Jefatura de Gobierno 2017) seven months before the EQKS19-2017. This legal system establishes the “right to urban security and civil protection” if “natural or anthropogenic phenomena occur.” Such right is guaranteed by adopting “the necessary measures to protect people and communities against risks and hazards arising from these phenomena” (article 14-A). Recognition of victims of forced internal displacement due to “natural or human-caused catastrophes” was also incorporated for the first time (article 20, number 6).

The LCPSFD (published in the Official Gazette of the Federal District on November 27, 2014) was abrogated in 2019 with the enactment of the Law on Integrated Risk Management and Civil Protection of Mexico City (LIRMCPMC) and took up provisions in terms of recovery and reconstruction. It should be noted that the 2014 law was not considered in the two reconstruction laws promoted by the Mexico City heads of government in 2017 and 2018, respectively, as both laws were based on precepts of the Urban Development Law of the Federal District, focused on promoting speculative real estate investments.

The law in force in 2017 included explicit references to reconstruction. Accordingly, the recovery subprogram in civil protection (articles 71 and 81) defined that recovery includes actions and resources to rebuild sites affected or at risk by emergencies or disasters (articles 143 and 144). It empowered the Civil Protection Secretariat to develop recovery plans and programs (article 16). It also defined instances and procedures to encourage and support social participation (articles 7, 15, 16, 33, 46, 47, 113, and 146).

The set of legal and programmatic regulations examined shows that, in a fragmented manner, there were bases to design policies and actions for reconstruction and to reduce social vulnerability. However, the evolution of the city governments' laws and programs makes institutional incoherence evident. The current reconstruction plan for Mexico City, published in 2019, subsequently underwent four modifications, in general, to adjust the process to the real estate market dynamics without considering human rights as precepts for designing projects in line with social needs.

Under the current federal administration (2018–2024), a new Sectorial Program for Security and Citizen Protection 2020–2024 was launched. This comprises five priority objectives defined through the provisions of the National Development Plan and in the National Strategy for Public Security of the Government of the Republic to contribute to a new security vision, where civil protection is now fully incorporated into public and national security perspective. The priority objectives, strategies, and specific actions of the sectorial program address the structural origin of organized crime, violence, and all aspects that may put citizens at risk.

The strategy comprises five significant objectives, and the fifth is to “Strengthen Integrated Risk Management to build a sustainable, safe, and resilient country.” The new strategy represents a significant shift toward the implementation of Civil Protections duties as well as disaster risk management under a paradigm that implies the use of military and national security doctrines applied to disaster management. Mexico's armed forces have established a more significant role in the country's affairs in the current President's mandate than ever since the country's military-led administration ended in the 1940s. A record number of troops are patrolling cities, raiding drug labs, guarding critical infrastructure, administering ports, maintaining hospitals building airports, and more decisive disaster risk management actions all over the country (Rodríguez and Lucatello 2021).

A structural deficiency of the official disaster risk management policy is its dependence on military leadership, given its ascription to national security, from which disasters are conceived as factors external to society, thus justifying their institutional management with no prospective and preventive approach. In the legislative field, since the first General Civil Protection Law (2000) and the current one (2012), special recognition has been granted to armed forces in civil protection, a policy focused on immediate assistance, assistance, and territorial control under the ideology of securitization.

Rodríguez (1999) stated that more than two decades ago in Mexico, the functions of the armed forces not contemplated in the Constitution have increased to combat rural guerrillas, patrolling “in dangerous areas” of various cities due to the increase in crime. Support was also given to creating the Federal Preventive Police within the National Public Security System framework, “fight against the narco-economy,” and the activities to help the population in disaster situations.

He further indicated that the army is seen as an organized, disciplined, timely, and efficient response option to disasters. This is a current problem, as institutional weakness exists in other areas of federal public administration. The army's action has been overestimated to the detriment of an insufficiently articulated National Civil Protection System (SINAPROC). The organization and discipline of the army should not be confused with

the strategic basis of SINAPROC, which in the medium term must be consolidated into an IDRM system (Alcántara-Ayala et al. 2019) based on a comprehensive, preventive, participatory, and democratic policy by constitutional precepts.

This problem derives from the vision of the political system that defines disasters as “natural” and a matter of national security. This approach was established in the national development plans from 1980 to date (Rodríguez 1999) and adopted with the creation of the National Civil Protection System in 1986. The latter was based on protecting the civilian population in terms of aid and emergency conditions, with less conceptual and operational development in prevention (disaster risk reduction) and comprehensive recovery. Although the National Urban Development Plan was published in 1978 and included the component of attention and prevention of “Urban Emergencies” incorporating contents oriented to the articulation of public policies, with the occurrence of the earthquakes of September 19 and 20, 1985, the priority the Mexican government focused on promoting and strengthening security and surveillance activities.

Greater militarization has taken place due to the weakening of civilian government institutions, as a result of the transfer of public resources and responsibilities to the armed forces, for example, in matters of food supply (right to food) in the context of disasters and relation to the installation and operation of temporary housing (Rodríguez 1999). This is expressed with the expansion of functions of the Army in the event of disasters, for example, in terms of attention to the population in temporary shelters, food distribution, road rehabilitation, and local infrastructure (Badillo 2022).

The notion of resilience also requires an understanding of how social welfare is secured. This is also linked to how ordinary citizens behaved during and after the EQKS19-2017. Comparing the housing reconstruction process in 1985–1989 (EQKS19-85) with that of 2017–2022, Rodríguez (2022) noted that managing provisional or temporary housing solutions simultaneously with the reconstruction process to offer minimum guarantees of temporary accommodation was essential.

The legal and programmatic framework in Mexico City (see Table 2) has supported a discriminatory government policy toward the displaced population, including the diagnosis of needs, as is the case of provisional or temporary shelters. In this regard, in analyses undertaken in 2022, Rodríguez (2022) pointed out that in the Reconstruction Program (January 2018), 50 shelters were initially installed, with 58,000 “accumulated overnight stays,” 98,000 “accumulated food rations,” and 54,000 “accumulated attentions.” Likewise, the Comprehensive Reconstruction Plan of the current government (February 2019) did not provide data on people affected in camps or with income assistance. As of September 2019, 53,079 “income supports” had been delivered. Similarly, within this regulatory framework, the reality of the survival of hundreds of families who, almost four years after the 2017 earthquake, have remained in camps or survived with relatives, excluded from official policy, is unknown. What is more, restricting temporary accommodation to minimum survival conditions implies denying the recognition of the set of human rights that the nation should have as a guide for humanist and comprehensive interventions (Fig. 1).

3.2 Real estate development in the city to human rights precepts

Earthquakes are one of the natural hazards with the highest average number of deaths per related disaster compared with other hazards, as the EQKS19-2017 showed. In several cases, human losses and damages were associated principally with the collapsing of housing buildings, defined as “multi-familars” (multifamily housing) in the governmental

Fig. 1 Building occupied by the capital's Ministry of Health (in the background) was evicted after the EQKS19-2017 due to the risk of collapse. However, the Ministry of Works and Services of the capital began bidding for the company that will oversee its demolition until 2022. The inhabitants who live in the apartments behind the building in ruins experience daily moments of fear and panic, mainly when earthquakes occur (Source: Ayala and Cisneros 2021)



reconstruction program, built without observing building codes. Indeed, the corruption of real estate investors and government officials is an example of economic activity focused on speculative profit.

It is reiterated that disasters related to seismic hazards make this problem evident, as recently shown by the massive collapse of buildings and human losses in south-eastern Türkiye and parts of the Syrian Arab Republic produced by a 7.8 Mw and 7.5 Mw that occurred on February 6, 2023. In Türkiye alone, as of 3 March 2023, the consequences involved the death of 44,374 people, the evacuation of more than 1.9 million people, 1.9 million people living in tents and temporary shelters, and 11,020 ongoing aftershocks. According to World Bank, direct physical damages in Türkiye have been estimated at \$34.2 billion, the equivalent of 4% of the country's 2021 GDP (OCHA 2023). Of relevance is the well-known fact that in Türkiye, structures are highly likely to be damaged by shaking, with unreinforced brick masonry and low-rise concrete frames (Naddaf 2023), and damage in the affected area was expected even from a 6.5 Mw earthquake given that low-rise brick structures that are constructed very close to each other (Kelam et al. 2022).

Rodríguez et al. (2018) pointed out that, in the case of disasters that occurred in urban areas in Mexico, the National Commission of Human Rights (CNDH) recommendations issued in 1991–2011 did not assess the deficiencies in prospective disaster risk reduction processes, including preventive planning and the problems of real estate businesses, due to a limited understanding and integrated approach to disaster risk. No urban planning and

regulation measures were proposed to guarantee the repair of damage and non-repetition in strict adherence to the human rights of disaster victims (health, right to information, healthy environment, freedom of expression, association, and assembly, right to development, petition, legality, and legal certainty, to life, water and sanitation, property and possession, and adequate housing).

The Government of Mexico City report on the progress of the reconstruction of houses after the EQKS19-2017, updated on March 3, 2023 (CRCM 2023), indicates that the houses without attention are 8084, representing 36.69% of the total universe scheduled (22,036 homes). This means that one-third of the cases have yet to be attended to five years and five months after the disaster, translating into a strategy without a human rights approach.

The Human Rights Commission of Mexico City (CDHCM 2022) reported 414 complaint files, of which only 253 were resolved favorably for disaster victims. However, the CDHCM did not specify the situation of the human rights violated, limiting its report to assessing quantitative indicators. Accordingly, Mexico City lacks a sociodemographic diagnosis of the people affected by the EQKS19-2017 with a comprehensive, differential approach that considers their vulnerabilities. It also lacks a registry of people who were displaced from their homes. In terms of comprehensive disaster risk management and reconstruction, there is still no data that reflects the existence of a transparency strategy to promote the identification, generation, publication, and dissemination of information related to disaster risk reduction, preparedness, and care as the process of reconstruction. Likewise, without providing data from the programmatic universe, this report noted that 61.63% of single-family homes and 21.62% of multi-family buildings were rebuilt. Furthermore, regarding financial support to pay housing rent, it indicated 152,738 in 2020 and 298,922 in 2022, the increase in support delivered is not questioned even though 2022 almost doubled that of 2020 when the progress of works was much less.

Finally, the CDHCM's warnings must be fully considered. The city government should follow-up on various responsibility and accountability procedures in the reconstruction processes, promoting corrective and preventive actions to combat corruption. The task of the CDHCM will remain attentive to the efforts to generate an adequate public policy with a human rights approach to guarantee the fight against corruption in real estate matters.

3.3 Lessons learned and lessons forgotten from the 1985 earthquake

3.3.1 Building codes

One of the lessons learned over the past three decades regarding the occurrence of earthquakes is the need to update the Building Code of Mexico City. Following the 1985 earthquake, the 1976 code was revised (DDF 1985, 1987), and subsequent revisions (DDF 2004) have provided state-of-the-art scientific and technical knowledge to meet the most comprehensive and advanced set of engineering requirements, which have been reproduced as a prototype of building codes inside and outside the country (Reinoso et al. 2015).

However, the findings by Galvis and colleagues (2017) were somewhat surprising even to them, given that the cause of many pre-1985 building collapses was the same as 32 years ago. Consequently, they suggested a lack of structural evaluation after the 1985 earthquake and inadequate implementation of effective retrofit strategies. In addition, the potential for cumulative damage, particularly degradation of lateral stiffness in non-ductile reinforced

concrete structures, was considered to play a role in the poor performance of these collapsed buildings.

Similarly, during a field reconnaissance of the EQKS19-2017 by a Japanese team, Alberto et al. (2018) also found that most collapsed buildings were built before 1985 and rehabilitated after minor repairs for residential or commercial use. They also emphasized that after the 1985 earthquake, seismic evaluation of buildings that suffered minor damage was not compulsory, making these structures more susceptible to later earthquakes, including in 2017.

Similarly, before the EQKS19-2017, Reinoso et al. (2015) assessed building code compliance in Mexico City for mid-rise dwellings. Their findings confirmed that several new buildings in Mexico City do not have a reliable record of technical information. In contrast, those buildings with available information showed that many would perform inadequately during a strong earthquake since they do not meet the minimum requirements of the Mexico City Building Code of 2004 (DDF 2004).

In contrast, after the 1985 earthquake, most public schools were seismically evaluated and upgraded where necessary, mainly leading to good performance in the 2017 earthquake. Regrettably, in a school, the small private college Enrique Rebsamen, one of the 4-story buildings completely collapsed and caused 37 deaths. This school did not go through the same evaluation/reinforcement process (see Alcántara-Ayala et al. 2023). Moreover, it had several modifications in recent years, including an additional level in one of the two buildings that collapsed during the earthquake (Galvis et al. 2017).

3.3.2 Mexico's earthquake early warning system (EEWS)

From a technical point of view, another great learning experience was the development of Mexico's earthquake early warning system (EEWS). Faced with the possibility of future earthquakes of great magnitude, one year after the occurrence of the Earthquake of 1985, the scientific experts called for the evaluation of earthquake simulation procedures and a study of the social and technical feasibility of an alert system for Mexico City (Consejo Nacional de Ciencia y Tecnología (CONACYT) and National Research Council 1986). On that account, as indicated by Suárez et al. (2018), in 1991, the Seismic Recording and Instrumentation Centre, A.C. (CIRES) began developing Mexico's EEWS, formerly known as the Seismic Alert System (SAS) to alert the population of Mexico City.

The EEWS of Mexico allows an alert time between 60 and 120 s before the arrival of the S waves of the subduction earthquakes in Mexico City, which allows the possible implementation of public measures to reduce human losses (Suárez et al. 2018).

During its operation, from 1991 to 2017, SASMEX has recorded 6896 earthquakes of magnitude $3.5 < M_w < 8.2$; 158 early seismic alerts have been issued to the different cities included in the system, while 103 have been issued in Mexico City; of these, 32 have been public alerts for earthquakes $M_w > 6$ and 70 for earthquakes of a moderate magnitude of $5.5 < M_w < 6$. Likewise, only one false alert was issued during the first months of the SAS operational stage on November 16, 1993 (Table 3).

Notwithstanding the 30 years of uninterrupted operation of Mexico's EEWS, recent experiences have suggested the urgent need for improvements from transdisciplinary perspectives, from hazard understanding to dissemination and understanding of information within integrated disaster risk management processes (Alcántara-Ayala et al. 2019; 2020). While the EEWS is helpful in schools and low-rise buildings, where people are usually

Table 3 Summary of earthquakes recorded and early warnings issued by SASMEX from 1991 to 2017 (Source: Suárez et al. 2018)

Monitoring				
Earthquakes 3.5 < M < 8.2			6,896	
Discrimination to be			Alerted	Not alerted
Acceleration records			158	6,738
14,750				
Dissemination				
Earthquake Warning Broadcast	Seismic Alerts			
	Public	Preventive	False*	Total
Mexico City-CDMX (since 1991)	32	70	1	103
Oaxaca City (since 2003)	49	31		80
Acapulco (since 2007)	31	14		45
Chilpancingo (since 2007)	31	15		46
Morelia (since 2012)	14	4		18
Puebla (since 2015)	9	1		10

*16 November 1993

trained to evacuate quickly, it is ineffective in high-rise buildings where many people are concentrated (Suárez 2022).

Initially, the EEWS was created to identify earthquakes in the Guerrero Gap’s subduction zone (Espinosa-Aranda et al. 2009), providing at least 60 s for the population to take protective actions. However, on September 19, 2017, the EEWS alert caused much consternation as it was heard in Mexico City at the same time or a few seconds after the arrival of the strong seismic shaking because the earthquake occurred inland (Suárez 2022). Therefore, people should have been given and still need access to a nonhighly technical but clear explanation of the various earthquake dynamics in Mexico and how the EEWS works accordingly as a top priority to reduce risk. Similarly, the strengths and weaknesses of the EEWS must also be communicated to those at risk.

Furthermore, EEWS use and functioning during the EQKS19-2017 left essential lessons for communities in Mexico City and elsewhere. An interesting reconnaissance exercise was carried on in the aftermath of the EQKS19-2017 to understand the performance and public perception of the early warning system. Public attitudes and responses to earthquake alerts have shaped diverse views about how city people perceive and react to alerts.

The Mexican Seismic Alert System (SASMEX) indicates only that an earthquake likely to be felt has been detected. The alert does not estimate the time until the shaking starts or the intensity, which can vary widely. From the survey carried on in the aftermaths of the earthquake, people seemed to value having an alarm system to take preparedness and immediate response actions, even though they did not feel or notice any shaking when they received the message. The people of Mexico City consider an earthquake alarm “false” only if there is no earthquake, even if they did not experience any shaking (Allen, 2018).

Similarly, to analyze the integration of EEWS into business continuity practices, organizational resilience, and disaster risk reduction, Pescaroli et al. (2022) recognized three significant areas of divergence. Based on Mexico’s EEWS, they identified that the spheres of governance, accountability, and liability; standardization of plans and procedures; and training and education must be considered through practical actions by the social, political, behavioral, and operational context of reference.

In other words, there appears to be widespread acceptance of the information provided by the EEWS, which grants a sense of security, increased public awareness of earthquake hazards, and the promotion of protective behaviors such as evacuation from buildings

that may be prone to collapse. It also seems that all general civil protection simulations of evacuations designed to respond to the seismic hazard carried out routinely during specific times of the year (*simulacros*) contribute to enforcing the idea that early warning systems technicalities provide a temporal security signal through a “simple” call that something is coming along the way. Therefore, the EEWS in Mexico City can help to foster a specific “subculture of prevention.” However, it remains short regarding hazard awareness and certain response behaviors to earthquake signaling. Very few studies address this topic. Among the research to be carried out on this topic, surveys are a valuable source of information.

Applying a public opinion survey on the usefulness of the EEWS regarding the EQKS19-2017, Santos-Reyes (2019) indicated some deficiencies in risk knowledge, monitoring and warning, dissemination and communication, and response capability of the system. Likewise, it was suggested that the city’s inhabitants were unfamiliar with the warning time between the alert call emitted by the siren sounds and the actual ground shaking. Therefore, they concurred with the internationally known goal of building people-centered EEWS. In a similar vein, Santos-Reyes and Gouzeva (2020) analyzed the emotional and behavioral reactions of the residents of Mexico City to the September 19, 2017 earthquake, which should be considered in designing plans for managing disasters derived from earthquakes. These are valuable insights, yet further studies are needed in this field.

3.4 Financial instruments and resilience

In addition to the disaster recovery assistance arrangements, Mexico has recognized the need to reduce the government’s disaster-related contingent liabilities. This has been done by establishing FONDEN, a Natural Disasters Fund that became operational in 1999. According to the World Bank (2012), these funds could be employed to rehabilitate and reconstruct public infrastructure at the three levels of government: federal, state, and municipal; low-income housing; and specific natural environment components. FONDEN comprised two complementary budget accounts, the FONDEN program for reconstruction and FOPREDEN program, aimed initially at disaster risk assessment, risk reduction, and capacity building on disaster prevention.

FONDEN and FOPREDEN were meant to be critical in helping to reduce disaster risk and to mitigate the consequences of disasters in Mexico. This has been the case to some extent. An analysis of the performance of FONDEN and FOPREDEN is beyond the objective of this article. However, the most critical difference between the money each program receives reflects how disaster management through FONDEN has been prioritized over disaster risk management via FOPREDEN. This mirrors the lack of sustained policy-making directed at IDRM. Instead, efforts continue to be mainly oriented toward disaster management.

Along this vein, Alcántara-Ayala et al. (2020) noted that both instruments were created from a civil protection approach, given their focus on applying post-disaster measures and developing infrastructure projects, mainly roads, electrical and hydraulic infrastructure. They also recognized contrasting investments, which during 2013–2017, showed a ratio of disaster response and recovery to prevention expenditures of 46:1 (Rodríguez 2017). Additional concerns regarding the latter suggested that funds are often distributed to states that can present proposals but not according to needs OECD (2013). As a result, processes aimed at reducing social vulnerability and supporting social resilience have not been given high-priority.

With the extinction of the trusts of both funds in 2021, reducing resources began to design disaster care and prevention policies and programs, in addition to channeling resources initially assigned to both funds to federal government megaprojects unrelated to the reduction of disaster risk.

Indeed, as Mansilla (2019) suggested, despite some progress, these financial mechanisms have been widely used to address reconstruction processes, neglecting the recognition and approach to the root causes of risk and disasters. Not to mention that the performance of post-disaster and reconstruction processes could have been more efficient, and lack of articulation and coordination and the misuse of resources still predominate. The complexity of the role of FONDEN and FOPREDEN and the need for more information regarding implementing these funds do not allow a proper assessment to determine their specific contribution to the country's and city's resilience.

3.4.1 Disaster risk governance

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 are more vulnerable to disasters if the local government fails to act or provides 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 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 among government levels during the post-recovery process in 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 in formulating and implementing post-disaster strategies. However, they are not the priority during the reconstruction process. 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 clear. 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. 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 plans (López and Hooper 2020).

Social resilience could be a public policy goal if the State, civil society, the scientific and technological community, and other relevant actors in DRR work together to define strategies and projects supported by a human rights framework (health, food security,

education, housing, employment, and clean water, social participation in the decision-making process), and recognizing the importance of partnerships, participatory, and democratic planning and implementation at the local and community level from a territorial perspective (Rodríguez 2010).

4 Discussion and concluding remarks

This paper has focused on the meaning of resilience as a notion that hypothetically enables cities and their citizens to remain unaffected by shocks and stresses of diverse nature, but in practice, is a parsimonious representation of a highly complex human endogenous condition that is often not adequately understood and addressed due to weak or weathered disaster risk governance.

By coincidence, on the same day that the anniversary of September 19, 1985, the earthquake was commemorated, separated by thirty-two years, another earthquake shook Mexico City. With a population of more than 14 million people, the metropolitan area of Mexico City faced the same problems in 1985 as it does today but with fewer inhabitants. Through the agency of 21.5 million people who live in the so-called “resilient” but fragile megacity, with informal settlements, marginalization, poverty, precariousness, unequal access to essential services, corruption, and lack of science-based policy formulation regarding disaster risk and development, the EQKS19-2017 revealed once again the various dimensions of the vulnerability and lack of resilience of its society.

While the continuous building of resilience has been recognized as key to protecting human life, housing, strategic infrastructure, essential services such as drinking water and sewage networks, food supply, and the city’s transportation network (CDMX Resilience Office 2016), undoubtedly in 2017 the “resilient city” label was not enough to avoid the severe impacts triggered by the EQKS19-2017. The political speech the City Mayor delivered in the early morning hours during the act of remembrance called attention to the lessons learned by the city through training, the permanent work of all its security forces, and the entire population.

Conversely, the 2017 quake revealed deficiencies in transportation, governance, energy, communications, water, sanitation, and health infrastructure, failing to some extent (The Rockefeller Foundation 2019). The lack of intersectoral and interinstitutional coordination and synergies mirrored a hostile advance in integrated disaster risk management.

The organizational changes in the national and Mexico City government’s civil protection systems are characterized by a lack of social participation in decision-making and planning processes. Regardless of the active engagement of the Mexican government in the official meetings of the international agenda directed at DRR, the importance of collaborative work with the DRR’s relevant stakeholders has been regularly neglected, and institutional resilience has been prioritized over social resilience.

In the last four years, the institutional scheme has strengthened the military approach and presidential leadership to disaster management, focusing on designing new search and rescue operations and short-time aid programs, with minimal development in prevention, disaster risk management, and integrated rehabilitation, reconstruction, and recovery.

Regarding the reconstruction in Mexico City recently, the local government announced the future disappearance of the Reconstruction Commission without this organization

fulfilling the objectives and goals for which it was created. For this purpose, functions and resources will be transferred to the housing Institute of Mexico City to attend to a universe of 3333 homes requiring reconstruction or rehabilitation. Of these, 1229 are single-family homes, of which 323 require rehabilitation actions and 906 need to be rebuilt, and 2104 are multi-family homes that need to be reconstructed (Instituto de Vivienda 2023).

Like many other cities worldwide, Mexico City faces significant disaster risks, including those triggered by earthquakes, floods, hurricanes, and wildfires. These events can cause significant damage to infrastructure, disrupt essential services, and result in loss of life and property.

Constructing a resilient city requires a comprehensive and collaborative approach involving multiple stakeholders. Thereupon, these are some steps to start building a resilient city based on the findings of this research:

1. **Develop a resilience plan:** Based on the risk assessment, the city should develop a comprehensive plan outlining the strategies, policies, and measures needed to build resilience. The plan should be developed with the input and participation of all stakeholders and should include clear goals, objectives, and timelines.
2. **Invest in resilient infrastructure:** Authorities must invest in resilient infrastructure to withstand the impacts of disasters. This includes ensuring that buildings, roads, bridges, and other critical infrastructure are designed and constructed to withstand earthquakes, floods, and the impact of other hazards.
3. **Develop comprehensive disaster risk assessments:** Mexico City must conduct a comprehensive risk assessment to identify potential hazards, vulnerabilities, and levels of exposure. This will help city planners understand the nature and scope of the risks and determine the necessary steps to reduce and mitigate them.
4. **Build community resilience:** Community participation and involvement are essential. They should take place from the very beginning of the process. Cities must engage with the local community to understand their risk perception and secure their active participation in disaster risk reduction. This includes providing high-standard education and training on disaster risk understanding and preparedness and promoting community-based initiatives for disaster risk reduction to co-produce knowledge.
5. **Use of science and technology:** Science and technology should be essential vehicles for disaster risk reduction. Recognizing the need to guide the progress, access, and use of scientific evidence and technological developments to support the formulation and implementation of policies oriented to IDRM should be a priority in cities and elsewhere. Therefore, utilizing what is known and identifying what is needed to learn to share and further manage disaster risk would allow the city to use the latest science and technology developments to reduce risk, improve early warning systems, enhance communication, and enable effective response and recovery (UNDRR 2023).
6. **Implement effective land-use planning:** Land-use planning is critical for reducing disaster risks. Mexico City authorities must work on implementing effective zoning laws and regulations to ensure that new developments are in safe areas and that existing infrastructure and environment are protected.

One of the positive aspects of resilience is the ability of the term to foster integrated approaches across sectors (Béné et al. 2012). The effectiveness of such approaches depends on the aptitude to strengthen communities and systems to become resilient through the development and use of absorptive, adaptive, and transformative capacities. However, this

can only be achieved when trust, accountability, and mutual commitment are moving forward (Alcántara-Ayala et al. 2023).

Building a genuinely resilient city requires a comprehensive and collaborative approach that involves multiple stakeholders, including local government, the science and technology community, residents, youth, women, businesses, the disability community, and civil society organizations, among others. Following these steps, cities can reduce disaster risk, protect their residents, infrastructure, and environment, and build a more resilient future.

Within the disaster risk realm, resilience should not be understood simply as a synonym for emergency management. Instead, based on the powerful notion of trusting authorities and reversing top-down approaches, human landscapes should be able to assimilate the potential and actual occurrence of known and emergent hazards into effective and science-informed integrated disaster risk management policies and practices.

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