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The Earthquakes Hit Socio-Economically Vulnerable Populations the Hardest

Mexico's population faces different threats and vulnerabilities from man-made phenomena (chemical, sanitary, and socio-organizational disturbances, for example), as well as natural phenomena (geological and meteorological, among others). Among the latter are earthquakes, cyclones, floods, and droughts. They can all have a greater or lesser socio-economic impact, depending on society's organizational, preventive, and response capabilities.

The effects of these phenomena differ according to factors like the geographical location, the existing quality of life, and the response capability of civil society, the

three levels of government, and private business or the market, among the most important.

Mexico has experienced several natural disasters throughout its history. Among those that have produced the greatest loss of life and property are Hurricane Paul; the 1982 eruption of the Chichonal Volcano; the 1985 Mexico City earthquakes, whose economic cost reached 2.1 percent of the national gross domestic product (GDP); Hurricane Gilbert in 1988; Hurricane Paulina in 1997; Hurricanes Stan, Wilma, and Emily that hit the south-southeastern part of the country in 2005; Hurricanes Barbara, Ingrid, and Manuel in 2013; and Hurricane Patricia in 2015.

Mexico is situated in a seismic zone exposed to the movements of five tectonic plates: North America, Pacific, Rivera, Cocos, and Caribbean. Of these, the last two are

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the most active and generate subduction forces toward the North American Plate, causing friction until breaks occur. For this reason, there are temblors every day, some of significant magnitude.

Between 1990 and 2017, 101682 earthquakes took place, 0.04 percent of which could not be calculated; 1.86 percent registered between 0.1 and 2.9 on the Richter scale; 74.35 percent, between 3.0 and 3.9 points; 22.78 percent, between 4.0 and 4.9 points; 0.86 percent, between 5.0 and 5.9 points; 0.10 percent between 6.0 and 6.9 points; 0.01 percent (15 cases), between 7.0 and 7.9 points; and only two quakes larger than 8 points.¹

On September 7, 2017, the town of Pijijiapan, Chiapas was the epicenter of an 8.2-point quake that mainly affected 553 municipalities in the states of Oaxaca, Chiapas, and Veracruz. The Ministry of the Interior declared them in both a state of disaster and of emergency.

Days later, on Tuesday, September 19, another event, this time magnitude 7.1, took place with its epicenter in Axochiapan, Morelos, affecting Chiapas, Oaxaca, Guerrero, Morelos, the State of Mexico, Puebla, Tlaxcala, and Mexico City. The maximum ground acceleration was experienced in places like Tlamacas, State of Mexico (12 gal) and Mexico City's Tlalpan Borough (90), Coyoacán Borough (60), and University City (54).^{* 2}

The second quake, after which 306 municipalities or boroughs were declared disaster areas, and 242 more were declared to be in a state of emergency, had the highest intensity and occurred only 120 kilometers from Mexico City. It caused grave damage in the nation's capital, including the loss of 230 lives, plus direct and indirect economic and psychological damage, and injury to our cultural heritage. It also put the population's resiliency to the test, that is, its ability to recover and achieve better conditions than those that existed before the disaster.

In addition, on Friday, February 16, 2018, another earthquake hit, this time a magnitude 7.2, with an epicenter in Pinotepa Nacional, Oaxaca. This event affected above

all the country's capital and four other states, although it caused less damage than the previous one, mainly because it originated 600 kilometers away from the capital.

It should be pointed out that the greatest impact of the September 7 and 19, 2017 earthquakes was felt in Central and South-southeastern Mexico. The state of Chiapas has registered 58 366 homes with partial or total damage, and Oaxaca, 63 335; that is, a total of 121 701. The data indicate that most of the municipalities with the greatest damage are highly marginalized, lagging behind in indicators like income, educational levels, and housing conditions (see Table 1).

In these areas, historic exclusion combines with the impacts of natural phenomena, increasing socio-spatial inequality. While different urgent programs have been implemented, they are insufficient due to the structural poverty in which local inhabitants live. Comprehensive, pro-active, territorial development is needed to strengthen these communities beyond the emergency, in addition to rehabilitation, recovery of livelihoods, and reconstruction. A clear strategy is needed to reduce risks, prepare, and create conditions of resilience in these regions, municipalities, cities, and locales.

Three hundred seventy people died in the September 19, 2017 earthquake, and aggregate estimates of direct economic costs due to damage to housing, infrastructure, and equipment are estimated at Mex\$48 billion, which represents 0.23 percent of national GDP. After the 1985 earthquakes, more than 10 000 dead were reported, and losses came to 2.5 percent of GDP.

In the case of Mexico City, the biggest impact was from the September 19, 2017 quake, and its analysis requires seeing it as a complex system. Estimating the main damages involves different physical losses produced in a differentiated way. Two hundred thirty people died in the metropolitan area, but epidemiological risks also arose due to the injured and other affected individuals, although they were controlled. Among the direct damage to 38 collapsed buildings on 36 blocks of the corridor in the transition area between hard and soft soil, including neighborhoods like Lindavista, Roma, Condesa, Hipódromo, Del Valle, or Narvarte, mainly in the Gustavo A. Madero, Benito Juárez, Cuauhtémoc, Miguel Hidalgo, and Coyoacán Boroughs.

According to the Objective Quality of Life Index (icvo),³ 25 blocks enjoy a "very high" quality of life; another 11

TABLE 1. CHIAPAS AND OAXACA. DWELLINGS DAMAGED BY EARTHQUAKES AND MARGINALIZATION INDICATORS (2015)

State	Degree of Marginalization	Number of municipalities with damaged housing	Percent						
			Employed population earning up to twice the minimum wage	Population in a location with fewer than 5 000 inhabitants	Dwellings with some degree of crowding	Population over the age of 15 who have not finished primary school	Occupants of dwellings with dirt floors	Population over the age of 15 who are illiterate	Occupants of dwellings without running water
Chiapas	Very high	19	79,58	88,83	57,55	46,87	20,33	30,20	18,97
	High	56	71,90	78,20	48,72	36,23	10,32	15,56	12,07
	Medium	9	59,30	52,81	40,88	25,82	6,18	10,42	8,26
	Low	2	53,34	29,97	35,44	20,63	5,69	6,67	9,87
	Very Low	1	35,65	1,47	28,11	12,94	2,22	4,32	8,45
	Total	87							
Oaxaca	Very high	4	71,11	72,45	54,85	43,62	35,25	21,17	31,53
	High	16	62,81	79,63	41,19	38,88	8,60	18,50	13,47
	Medium	12	54,73	74,57	34,68	29,04	5,87	10,76	5,09
	Low	7	40,02	42,69	29,08	24,34	2,41	10,36	3,02
	Very Low	2	28,98	6,44	28,72	17,10	1,37	6,05	5,60
	Total	41							
TOTAL		128							

Source: Developed by the author with information from Secretaría de Desarrollo Agrícola, Territorial y Urbano (Sedatu), “Censo de viviendas dañadas por los sismos,” Mexico City, 2017, <http://transparencia.sedatu.gob.mx/#>; and Consejo Nacional de Población (Conapo), “Índice de marginación por entidad federativa y municipio,” Mexico City, 2016, <https://www.gob.mx/conapo/documentos/indice-de-marginacion-por-entidad-federativa-y-municipio-2015>.

Multiple secondary and indirect effects were felt in outlying less-densely-populated areas of the metropolis and in municipalities in the State of Mexico.

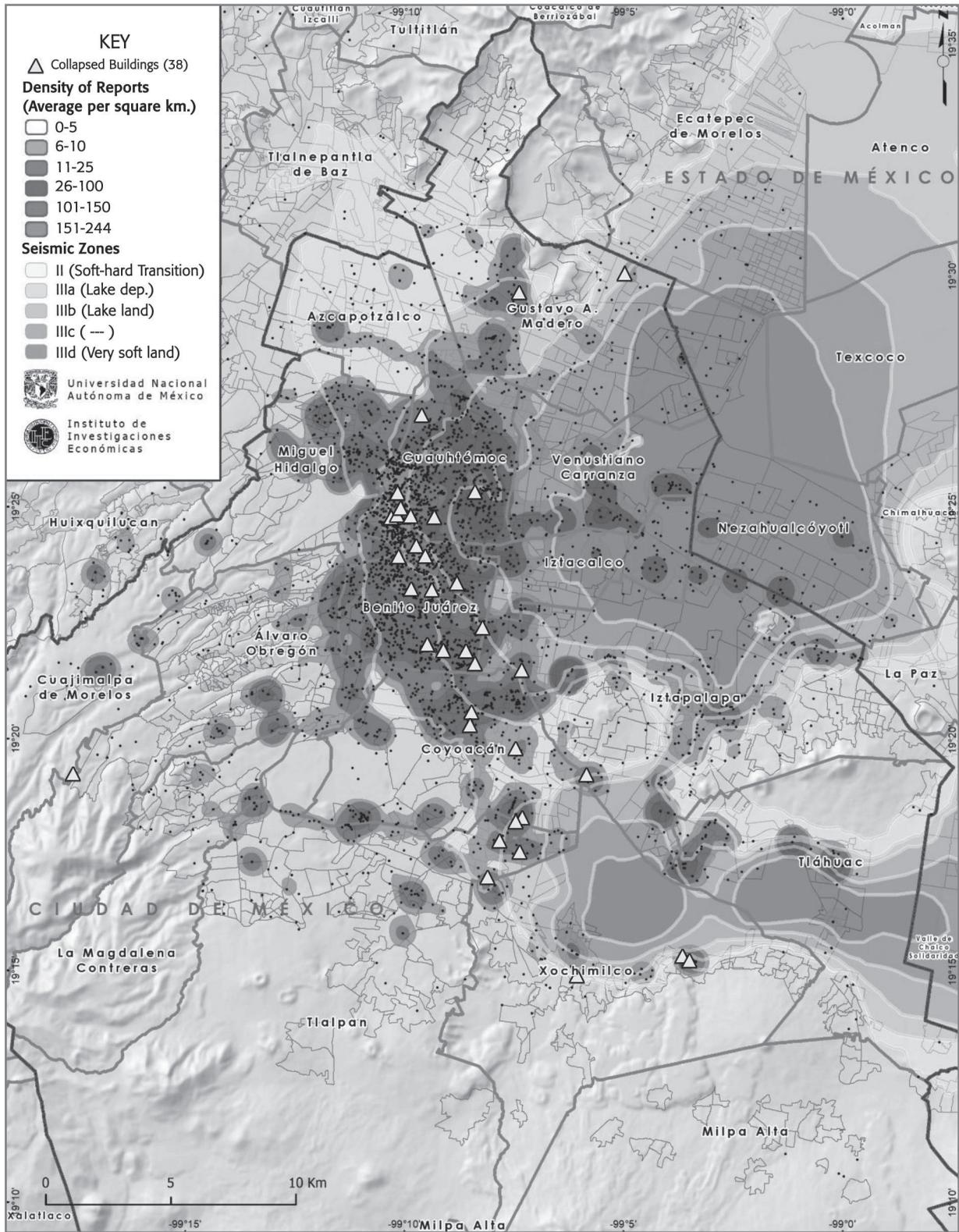
are in the “high” level; and 2 more on the “medium” level. That is, their inhabitants have greater resilience capability compared to those who live in other spaces. Also, homes distributed throughout the entire metropolitan area were damaged, but those classified in the “low” and “very low” level require more attention because before the quakes, they already reported privations and they deteriorated even more, particularly in terms of domestic goods, information and communication technology, road infrastructure, furniture, and public services.

The Mexico City (CDMX) government preliminary estimate is that solely in the polygons where the 38 collapsed

buildings were located, 930 businesses existed, employing 7 798 people, and in the first five days after the earthquakes, almost Mex\$35 million were lost.⁴ Also, in the city’s eight hardest hit economic zones, 18 607 economic units exist, employing 357 000 workers, and generating Mex\$462 billion (base year, 2013).⁵

Multiple secondary and indirect effects were also felt in outlying areas of the metropolis even though they were less densely populated, such as the boroughs of Xochimilco, Tláhuac, and Milpa Alta, where the quality of life is lower, and in the State of Mexico municipalities of Ecatepec, Texcoco, Nezahualcóyotl, and Tlalnepantla, where damage was concentrated in individual family homes. Most of the buildings that collapsed were located in neighborhoods with high or very high quality of life. However, the effects also were felt in neighborhoods with a medium-

DENSITY OF REPORTS OF BUILDINGS DAMAGED AND COLLAPSED AND SEISMIC ZONES IN THE MEXICO CITY METROPOLITAN AREA



Source: Instituto de Investigaciones Económicas (IIEc), “La vivienda después de los sismos. Análisis preliminar,” press release, October 4, 2017.

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level quality of life, such as the town of Santa María Nativitas or San Gregorio in Xochimilco Borough, or Santa Rosa Xochiac in the borough of Álvaro Obregón, all in CDMX.

This territorial pattern of effects implies a differentiated response for recovering more rapidly with a focus of socio-spatial equality. The direct effects due to collapses and major damage and the indirect effects of the quakes on the scale of the block combine in a single transition strip, although other damage does exist dispersed throughout the metropolitan area. For that reason, when the diagnostic analysis of earthquake victims was updated, it was broadened out to include 12 of the city's 16 boroughs at Ground Zero for damages to be included in the Mexico City Permanent Plan for Emergencies, for which earthquake security protocols must be established (see map).⁶

Rebuilding these areas will be viable with government support and the participation of society and companies (for quicker results), both for social and political and economic reasons. Several factors should be taken into account to explain the conditions of greater vulnerability and risk to the population of Mexico City:

- a) increased numbers of irregular settlements in reserved areas, ravines, and river beds;
- b) densification of infrastructure, equipping urban and metropolitan areas with roads or highways, electricity lines, or oil or gas pipelines;
- c) economic activities in unsafe areas, such as informal markets that restrict mobility;
- d) insufficient public health, education, supply, or transportation services;
- e) socio-economic inequality among population groups and in the territory;
- f) building codes and norms that are not complied with, in many cases due to real estate corruption; and

- g) lack of planning of metropolitan and regional development, above all, regarding the regulation of land use, housing quality, and transportation.

It should be pointed out that, although people with a higher standard of living are not exempt from experiencing limitations in recovery, the people who suffer the greatest privations face the most adverse effects. The more vulnerable the population, the slower the recovery; that is why it is necessary to put a priority on the distribution of aid and support to people with the most urgent need. Most of the homeless do not have home insurance or any financial backing to deal with risk and cannot pay a loan to rebuild their homes; in addition, they face the risk of unemployment and emotional instability, among other difficulties.

Recovery from the impact of the earthquakes requires the collaboration of civil society, families, governments, and private business throughout the country. In this context, collective, organized action by society is fundamental for prompting a response. After the earthquake, the population responded spontaneously with great solidarity and aid, particularly young people, who voluntarily formed rescue groups to aid victims in the collapsed buildings and houses. The social media contributed to directing aid to people who were trapped and for the removal of debris. After the emergency, messages of solidarity and aid were received; donations came from different national and international governments, companies, social and political actors, artists, and sports celebrities. The public sector contributed support from the Army and the Navy, as well as with brigades from the city government. However, in the following phase of recovery, a series of problems have arisen that require attention.

Some of the current challenges for moving ahead in prevention and creating resilience include:

- a) focusing on recovery and reconstruction with an eye to social justice and fulfilling the rights already established in the federal, Mexico City, and state Constitutions;
- b) taking into consideration the social-spatial inequality that existed before the earthquake; to do this, a diagnostic analysis must be done of the quality of life of the population in different locations;

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- c) strengthening the relationship between civil society and government management for organizing plans, programs, and actions to recover housing, businesses—above all small businesses—, employment, infrastructure, and public services;
- d) facilitating reconstruction activities with a trustworthy registry of those affected, the damage to homes, public buildings, infrastructure, and equipment;
- e) guaranteeing a decent home to people who lost theirs, using public funds and focusing on the worst cases;
- f) earmarking sufficient inter-governmental budgets, taking into account extraordinary resources and the subsidies needed to alleviate the earthquakes' effects and arrange for private support to foster resiliency skills;
- g) demanding transparency and accountability regarding public funds and donations;



Multidisciplinary Brigade of Support to the Communities of Mexico

- h) supporting scientific research in this field, updating the Risk Atlas, and analyzing similar international experiences to develop a response;
- i) reordering land use, taking into consideration the risk of disaster;
- j) improving and applying building norms to reduce the population's vulnerability; and
- k) strengthening the early alert systems for risks and natural phenomena, among others.

Mexico faces a variety of risks from natural phenomena, but it also has the capacity to organize society to reduce its vulnerability. **MM**

Notes

1 Sistema Sismológico Nacional, "Estadísticas de los sismos reportados por el ssn," <http://www2.ssn.unam.mx:8080/estadisticas/>.

* Ground acceleration is the measure of earthquakes most used in engineering; it is the value that establishes seismic norms and risk areas. During an earthquake, damage to buildings and infrastructure is intimately linked to seismic velocity and acceleration and not as much to the amount of energy released. For moderate earthquakes, acceleration is a precise indicator of damage, and for very severe earthquakes, it is even more important. The unit of acceleration is the gal, a name that alludes to Galileo Galilei. [Editor's Note, using information from https://en.wikipedia.org/wiki/Peak_ground_acceleration, accessed April 15, 2018.]

2 Sistema Sismológico Nacional, "Reporte especial. Sismo del día 19 de septiembre de 2017, Puebla-Morelos (M7.1)," (Mexico City: UNAM, 2018), http://www.ssn.unam.mx/sismicidad/reportes-especiales/2018/ssnmx_rep_esp_20180216_Oaxaca_M72.pdf.

3 The Objective Quality of Life Index makes estimates based on 33 indicators for people, housing, and urban surroundings taken from

2010 census micro-data for blocks, neighborhoods, and boroughs or municipalities in the Valley of Mexico Metropolitan Area. See Adolfo Sánchez Almanza, comp., *Calidad de vida en la Zona Metropolitana del Valle de México. Hacia la justicia socioespacial* (Mexico City: Instituto de Investigaciones Económicas/DGAPA/PUEC-UNAM, 2018).

4 Gobierno de la CDMX, "Primer informe de la afectación de la actividad económica después del sismo del 19 de septiembre de 2017," <http://www.reconstruccion.cdmx.gob.mx/storage/app/uploads/public/59c/d22/7cd/59cd227cd9cc1206739581.pdf>.

5 Gobierno de la CDMX, "Segundo informe de la afectación de la actividad económica después del sismo del 19 de septiembre de 2017," <http://www.reconstruccion.cdmx.gob.mx/storage/app/uploads/public/59d/f8c/ea3/59df8cea3e63d777033815.pdf>.

6 Salvador Corona, "Mancera anuncia cambios a plan de contingencia para sismos," *El Economista*, February 17, 2018, <https://www.eleconomista.com.mx/politica/Mancera-anuncia-cambios-a-plan-de-contingencia-para-sismos-20180217-0029.html>. [Editor's Note.]