No. 05
NATURAL DISASTERS

CLIMATE CHANGE AND EARTHQUAKES: INCREASING COSTS FOR MEXICAN FAMILIES

MEXICO HAS SHOWN GREAT PROGRESS, BUT COULD BENEFIT FROM IMPROVING FINANCING AND PREVENTION

INSURANCE IS A KEY PLAYER TO PROVIDE SOLUTIONS TO MITIGATE THE RISKS OF CLIMATE CHANGE AND EARTHQUAKES

AXA **Reflections**

PREVENTION, MITIGATION, AND INSURANCE: CLIMATE CHANGE AND NATURAL DISASTERS

INDEX

AXA REFLECTIONS

This “Axa Reflections” booklet is the fifth in a series of publications about relevant topics for Mexicans, their families and the country; such as road safety, health, long term savings, and natural catastrophes, among others.

These publications seek to promote serious reflection and analysis about the challenges that Mexico is facing. Each booklet presents a diagnosis and a series of proposals as solutions.

The purpose of the Reflections is to build consensus for helping the country advance in the design and implementation of better public policies, working together with the insurance sector.

A healthy insurance industry generates important benefits for the national economy: reducing the costs implied by the risks that threaten individuals and societies, the rise of internal savings, the promotion of national and international trade, and the financing of the economy in the long term through the investment in stocks of national companies, or in infrastructure projects, among others.

A strong insurance industry contributes to the country’s economy and to the well-being of its inhabitants. However, the insurance coverage rate remains low in Mexico. Public institutions and individuals do not have the awareness and the incentives to embrace the sector.

Recent studies in experimental economics have demonstrated that people tend to underestimate the possibility of suffering from the effects of certain life changing events. People also tend to prefer smaller payoffs in the present as compared to larger payoffs in the future.

In light of these tendencies, the government and the insurance companies should promote incentives that allow individuals and institutions to protect themselves today, assuring their health and their economic well-being as well as protecting their assets.

INTRODUCTION

Mexico is exposed to several natural phenomena, but three of these are particularly destructive. Hurricanes, floods and earthquakes cause 89% of the fatalities and 93% of the economic losses related to natural disasters every year. Moreover, two thirds of the country and more than 37 million people are in constant risk of experiencing a high magnitude earthquake in the next decade, which represents a great challenge.

At the same time, Mexico is one of the most vulnerable countries in the world to the adverse effects of climate change: 15% of the territory, 68% of the population and 71% of the national economy are highly exposed to the associated risks of climate change. One of the main effects is the higher intensity and frequency of hurricanes, floods and droughts. For example, in December 2014, the hurricane “Odile” caused losses up to $16,700 million Mexican pesos.

If this trend continues, the climate change will cause higher economic and social impacts: by the end of the XXI century, the country will be warmer and drier, the sea level will be higher, hurricanes will be more intense and floods more frequent.

Hurricane “Odile” showed us one more time the magnitude of economic and human losses that meteorological phenomena, related to climate change can cause. Several factors, most of them preventable, influence the magnitude of these losses. The extent of damage depends on rapid information dissemination, awareness of the risk amongst people, their preparation, the status of housing and infrastructure, as well as policies and mechanisms to reconstruct after the catastrophe.

In this AXA Reflections edition we present in seven chapters, the present effects of climate change and earthquakes in our country, as well as the capacities needed to face them. The booklet focuses on preventing measures, and on the adaptation needed to successfully face these events in the future, taking advantage of the structural reforms that Mexico has promoted, such as the recently passed energy reform. In this regard, an efficient insurance market, that covers most of the population in risk, is one of the key solutions.

CLIMATE CHANGE IS ALREADY HAVING SIGNIFICANT AND HARMFUL EFFECTS IN MEXICO AND THE WORLD

Now, there are more hurricanes, torrential rains and droughts. The economic cost associated with these events in Mexico has multiplied. Mexico could lose up to 6% of its national gross product in 2100 due to climate change. However, preventive measures would be less costly.

» **Climate change is real and has effects all over the planet.** This is evident as 99% of scientists agree that climate change is real and some facts have been recently confirmed.[1]

The rise in the planet's temperature between 1880 and 2012 by 0.85° Celsius[2], is the main evidence of climate change and is the cause of a series of cascade effects, like the reduction of ice in the Antarctic ocean from 3.5% to 4.1% of its volume per decade[3], and the reduction of glaciers. Similarly, this contributed to the rise in mean sea level by 19 cm, between 1901 and 2010.[4]

» **In Mexico, the changes in climate are very similar to those of the rest of the world:** between 1960 and 2010, the average temperature of the country increased by 0.85°[5] Celsius and the sea level rose up to 3.8 cm per decade.

» **One of the main effects of global warming is an increase in the frequency and intensity of hurricanes, torrential rains and droughts.** For example, in 2011, Mexico registered three times as many hurricanes, rains, droughts and unusual temperatures than in 1970[6]. Today, flooding affects seven out of ten Mexicans.[7]

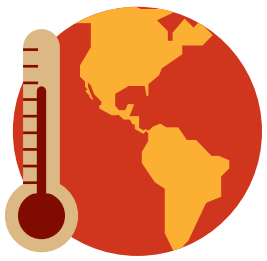
» **The cost and damages to companies, governments and citizens has multiplied**.[8] Between 1980 and 1990, these phenomena caused annual damages up to $730 million Mexican pesos (MMX). In contrast, between 2001 and 2010, the average annual cost rose by $21,950 MMX, almost 30 times more than the past.

Table 1

The planet experiences evident climatic change.

The warmest decade registered in global temperature:

2001/2010[9]



MEXICO AND THE WORLD: CLEAR EVIDENCE OF CLIMATE CHANGE.

Table 2

The evidence of the effects of climate change in Mexico are similar to those in the rest of the world.

Rise of the average temperature in the country between 1960 and 2010.

+0.85°Celcius[10]

Mexico's region most affected by the rising temperature between 1960 and 2010.

North[11]

Average rise of the mean sea level per decade between 1950 and 2010:

Between 1.6 - 3.8cm[12]

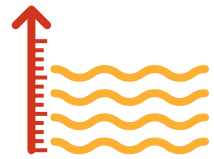


Table 3

In Mexico, meteorological phenomena have intensified during the last four decades.[13]

	1970	2011
Number of hurricanes, torrential rains, floods, heat waves and droughts.	452	**1,459**
Number of droughts.	323	**540**
Number of floods.	80	**460**
Number of torrential rains.	25	**310**
Number of heat waves	18	**141**
Number of hurricanes	6	**8**

Table 4

Estimated effect of climate change in Mexico

	2030[14]	2080[15]	2100
Rise in temperature	+0.6° C	+ 1.5° C	+ 2.5° C[16]
Rise in sea level	+2 cm.	+10 cm.	+ 13 cm.[17]

In addition, by the year 2100 it is possible the rains levels will drop between 10 and 28%. [18]

Table 5

Mexico: Social costs and increasing economic losses

	MAIN EFFECTS	
2030	52 million people will face water shortage .[19]	Almost 3 million people will be left in poverty.[20]
2080	The states most affected by climate change will be Zacatecas, Guanajuato, Chihuahua, Yucatán and Chiapas.[21]	Tourism, ports; energy, communications, and transportation infrastructure will suffer the negative effects.
2100	Between $16,000 and $22,000 MMX will be lost in rural areas.[22]	Corn crops yields will diminish between 29 and 45%; bean crops will diminish up to 30%. [23]

Table 6

Losses associated with climate change will double between 2050 and 2100.[24]

Sector	Losses for **2050** (in GDP percentage)	Losses for **2100** (in GDP percentage)
Water	**2.2**	**4.5** ↑
Biodiversity	**0.01**	**0.04** ↑
Cattle	**0.5**	**0.83** ↑
Indirect Biodiversity	**0.03**	**0.63** ↑
Total	**2.54**	**6.0**

» **Mexico is one of the most vulnerable countries to the effects of climate change.**[25] **15% of the territory, 68% of the population and 71% of the GDP are highly exposed to the associated impacts of climate change.**[26]

» **If climate change is not reversed, it will produce severe changes in the country for the year 2100.**

By the year 2100, Mexico will be warmer. For example, the temperature will rise 4° Celsius at the US border and between 2.5° and 3.5° Celsius in the rest of the country.[27] The rains will diminish between 10% and 28%[28] and, at the same time, the droughts will increase. The sea level will rise up to 13 cm. in the Pacific ocean.[29]

» **Mexico will suffer more extreme climate events.** For example, the winds and rains will be between 6% and 16% more intense[30] and Mexico will have more hurricanes in the Caribbean, the Gulf and the Pacific. At the same time, the country will be drier. But in some regions, rains will be stronger and more frequent, which will increase the risk of flooding for 2 million people.[31]

» **Climate change will produce increasing economic and social costs, unless this phenomenon is reversed globally.** Mexico could lose between 2.5% of its GDP in 2050 and 6% in 2100 due to the effects of climate change.[32] The agricultural sector (one of the most vulnerable) could lose between $16,000 and $22,000 MMX[33] by the end of the century, partly due to the reduction of the production (between 26 and 78% according to the crop type[34]) of corn, sugar cane wheat, coffee, and beans.

» **Mexico should prevent this rather than remain passive:** implementing preventive measures to reduce the carbon emissions that cause global warming by 50% would be an investment three times smaller (between 0.7% and 2.21% of the GDP) than the expected costs if no action is undertaken.[35]

The decrease in emissions would mitigate the adverse effects of climate change and would allow communities across the country to better face the new climate conditions.

DID YOU KNOW THAT CLIMATE CHANGE WILL MAKE EXTREME WEATHER EVENTS MORE FREQUENT AND MORE INTENSE?

Climate change is the variation in the planet's weather produced directly or indirectly by human activities. This variation is higher than the change that would occur naturally.

1 **Rise of gas levels due to human activity.**
The rise in the number and intensity of certain human activities has increased the production of gases, such as:

- **Methane**
- **Ozone**
- **Water vapor**
- **Carbon dioxide**
- **Nitrogen oxides**

2 **Acceleration in the last decade.**
The gas emissions caused by human activity have increased considerably since 1950.[36]

35%
increased gas emissions to the atmosphere in 2010 compared to 1990.[37]

3 **A greater concentration of gases in the atmosphere.**
As a result of this, the closest layers of the atmosphere to the Earth, have a larger concentration of these gases.

100%
rose the concentration of methane between 1800 and 2013

41% [38]
of carbon dioxide

4 **Greenhouse effect.**
These gases create a capsule which captures the heat that comes into the atmosphere. The heat bounces in the earth or the sea, then it concentrates in the lower layers of the atmosphere. This heat does not have way to escape.

5 **Rise of temperature.**
The result is that global temperature increases.

Main activities responsible for gas emissions related to the greenhouse effect.[39]

(percentages according to the totals in 2010)

Carbon Dioxide

Transport	31%
Generation of electric power	23%
Manufacture and construction	11%

Methane

Fugitive petroleum and gas emissions	46%
Enteric fermentation (digestive process by which carbohydrates are broken down by microorganisms into simple molecules for absorption into the bloodstream of an animal.)	23%
Solid waste disposal	13%

Nitrogen oxides

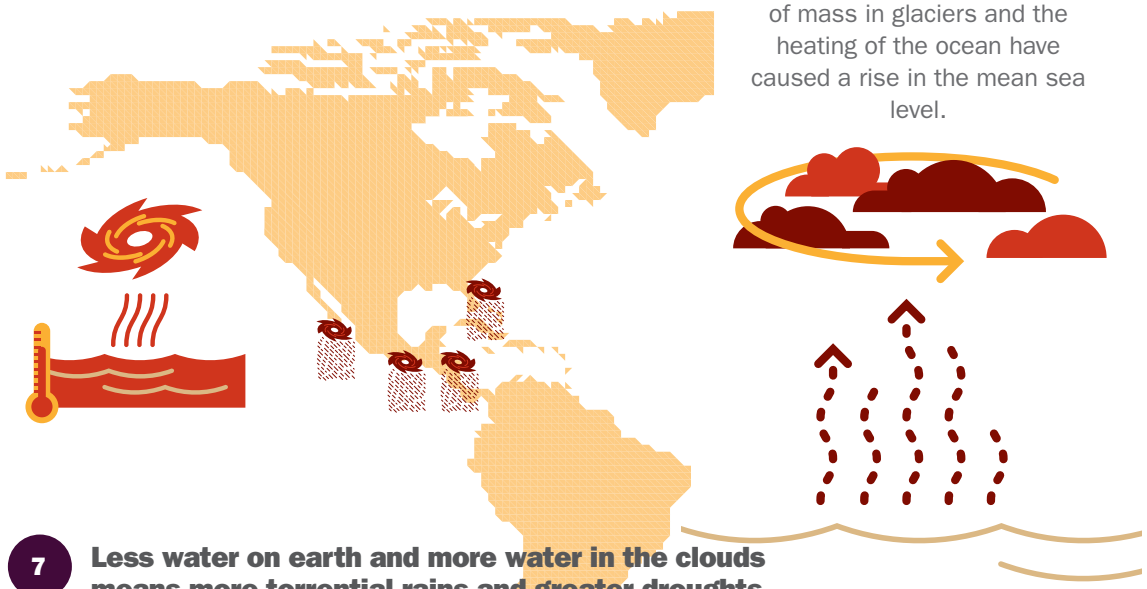
Agriculture	67%
Transport	18%
Manure management	9%

Global warming causes glaciers to melt, sea levels to rise and more hurricanes, torrential rains and droughts.

6 **Glaciers and ice melt.**
The rise in the planet's temperature has caused the mountain glaciers and the ice from the poles, especially in Greenland, to melt continuously. [40]

19cm. [41]

Sea levels rose between 1901 and 2010. The loss of mass in glaciers and the heating of the ocean have caused a rise in the mean sea level.



7 **Less water on earth and more water in the clouds means more torrential rains and greater droughts.**

Higher temperatures produce more evaporation causing two apparently contrary effects: droughts and torrential rains.

The Earth loses more humidity through evaporation, which leads to less water retention in the ground, especially in arid or deforested areas. The result is longer and more extreme droughts.

At the same time, more evaporation produces more clouds, which translates into stronger and more frequent storms.

THE RISE IN THE TEMPERATURE OF THE SEA GENERATES A HIGHER PROBABILITY OF HURRICANES, WHOSE FORMATION DEPENDS ON THE HEAT ACCUMULATED IN THE SEA.

8 In the warmer oceans, with temperatures above 26° Celsius, that correspond to four zones in Mexico (Gulf of Tehuantepec, Sonda of Campeche, Oriental Caribbean and Atlantic Region), the hottest air that circulates above the water elevates as a consequence of evaporation.
Little by little, more and more warm air rises. This causes the formation of clouds. When there are more clouds and warmer air continues to rise, the clouds start twisting like a swirl, due to the motion of the Earth around its own axis. The result is a hurricane or tropical torment.

Table 1

Hurricane force and their capacity of destruction according to their magnitude. [42]

Magnitud	Wind speed (km/hour)	Type of damages
1	119-153 km/hr	Minor damage to docks and buildings. Minor damage caused by floods.
2	154-177 km/hr	Considerable damage to mobile houses, road signs, and docks. Coastal zones may flood 2 to 4 hours before the arrival of the eye of the storm.
3	178-209 km/hr	Probable structural damage to buildings. Coastal zones may be underwater from 3 to 5 hours before the arrival of the eye of the storm. Coastal zones that lie 1.5 meters above sea level may be flooded up to 13 kilometers in-shore.
4	210-249 km/hr	Extensive damage to buildings;, those with weak roofs will be completely damaged. Coastal zones flooded from 3 to 5 hours before de arrival of the eye of the storm. It is necessary to evacuate residential areas 10 kilometers in-shore.
5	Higher than 249 km/hr	Total damage to building roofs. Energy supply failure. Coastal zones flooded from 3 to 5 hours before the arrival of the center of the storm. It is necessary to evacuate residential areas 16 kilometers in-shore.

MEXICO HAS BECOME A GLOBAL LEADER THAT COULD ACHIEVE HIGHER GOALS

The country is facing many challenges: reducing carbon emissions, increasing the available resources for prevention, elaborating risk maps, creating unified protocols to respond in the case of natural disaster, and improving insurance coverage.

» Since 1992, Mexico has performed a leading international role against climate change.

For example, in 1997, Mexico became the first country in Latin America to commit to reduce gas emissions that cause the greenhouse effect by 3.6% by 2012, signing the Kyoto Protocol.

The same year, at a national level, Mexico took a huge step by measuring and publishing the first National Inventory of Greenhouse Effect Gases (INEGEI), which has been published regularly since. Between 2002 and 2012, the country established the first institutions devoted to develop policies to reduce gas emissions (mitigation) and to prepare the regions and the country's sectors for climate change (adaptation). In order to achieve this, Mexican government created the Inter-secretarial Commission for Climate Change.

In addition, the National Development Plan 2007-2012 was the first to establish goals and priorities in climate policy.

At the same time, the Congress approved the General Law for Climate Change in 2012 – the second law of its kind in the world, after the United Kingdom. The Mexican law establishes the goal of reducing gas emissions that cause the greenhouse effect by 30% in 2020 and by 50% in 2050 (in comparison to the 2000 year levels).[43]

» These efforts have been positive but they have not yet shown the expected impact that Mexico committed to.

An international source demonstrated that carbon emissions increased in Mexico, despite the fact that 25% of the established period of time to reach the reduction goal in 2010 has passed.

» Indeed, in 2012, the emissions rose 58% in comparison to 1990.[44]

The last Mexican official publication demonstrates a similar rising trend, since it indicates that emissions rose 33% on average, between 1990 and 2010.[45]

» These results are due to the fact that the implementation of concrete actions destined to reduce gas emissions is only just beginning in Mexico.

Only a fourth of Mexican states have concluded the process of elaboration of their climate change state program; meanwhile the adoption of effective fiscal, financial and economic schemes that foster clean economic growth and development are still in development.

» On the other hand, Mexico is also facing challenges to meet rising costs generated by natural disasters caused by climate change.

Between 2007 and 2014, the Mexican government allocated 27.6 billion MX to the Fund for Natural Disasters (FOPREDEN for its initials in Spanish)[46]. This means that Mexico invested 12 times more in reconstruction activities than on preventing actions through the investment in this fund.

» In 2013, the OCDE recommended that Mexico increased its investment in the prevention of natural disasters.[47]

The cost of the damages caused by volcanic activity, earthquakes and hydro-meteorological phenomena represents another challenge; because it surpasses the budget of the FONDEN, even more when the country registers natural disasters of great magnitude, like in 2010 (see graph 1).

Table 1

Mexico allocated 12 more money to reconstruction activities as compared to prevention activities through the FONDEN and FORPREDEN between 2004 and 2012.[48]

Budget between 2007-2014

FONDEN
$ 27.6 billion MX

FOPREDEN
$ 2.2 billion MX

Graph 1

Costs caused by earthquake damages, volcanic activity and hydro-meteorological phenomena surpass by 600 times the resources allocated to FONDEN (MMX, million Mexican pesos)[49]

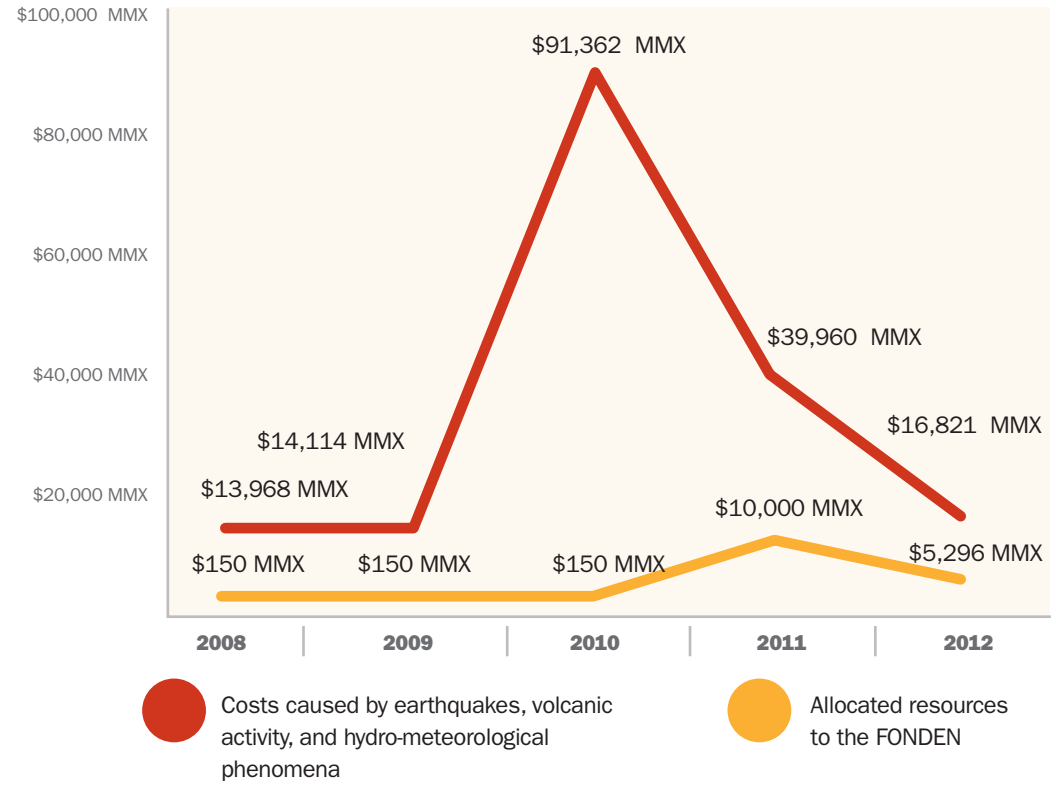


Table 2

Mexico: world leadership in climate change, by the establishment of international agreements and laws.

1997
Signing of the Kyoto Protocol.
1st Latin American country to adopt the commitment to reduce emissions.

2012
Approval of the Law of Climate Change.
2nd country in the world to approve a law of this type.

2012
Commitment to reduce gas emission by 30% by 2020.
Assuming a larger commitment than the European Union.

» **Amongst other pending activities are the elaboration and updating of the risk maps.** In Mexico, the elaboration of this type of instrument, which is a key preventive element to protect vulnerable populations, has been delayed (see table 3).

» **In addition, during an emergency, communications alerts depend on an uneven capacity of municipal authorities; there is no uniform response protocol at national level.**[50]

» **In the same manner, one of the pending activities is the low rate of insurance coverage.** As a consequence, the assets of families and small businesses (SMEs) are at risk: only 5% of households and between 5% and 10% of SMEs are insured against natural disasters.[51]

Table 3

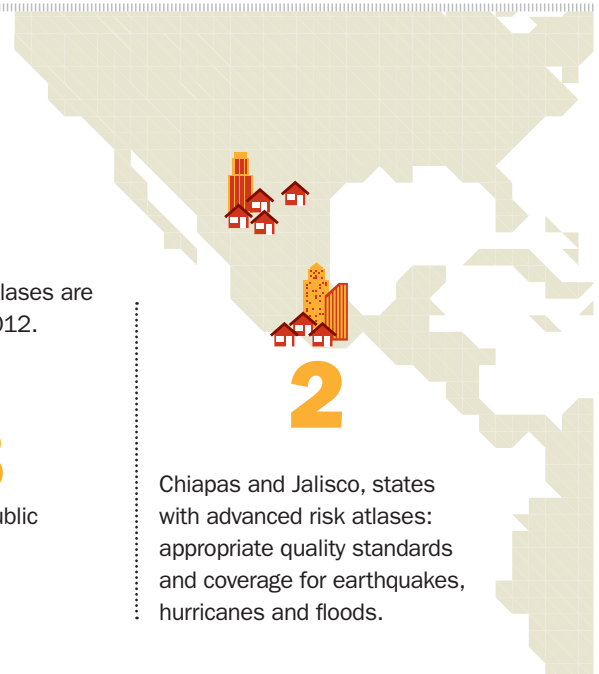
There are still key pending activities for mitigation and adaptation to climate change.[52]

14
States whose risk atlases do not cover earthquakes, hurricanes and floods.

4
States with no risk atlas (Baja California Sur, Durango, Quintana Roo, and Sinaloa)

2
State whose risk atlases are updated to 2012.

13
States with public risk atlas.



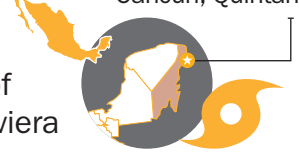
2
Chiapas and Jalisco, states with advanced risk atlases: appropriate quality standards and coverage for earthquakes, hurricanes and floods.

» **The insurance industry is a key ally for businesses recovery in the case of catastrophic events.** Insurance companies help reestablish the assets and the purchasing power of companies and individuals affected by a disaster, and also help them quickly reincorporate to the economic cycle of the country. For example, in 2005, the insurance industry paid for 97% of the damages caused by hurricane Wilma, which devastated the touristic area of Cancun.

Table 4

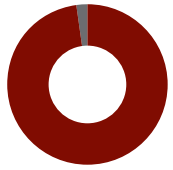
INSURANCES: KEY TO KEEP A BUSINESS RUNNING.[53]

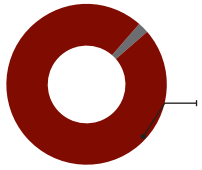
In 2005, hurricane Wilma ans Stan **devastated the touristic infrastructure** of Cancun and the Mayan Riviera



Total amount of damages (hurricanes Wilma and Stan):
$30 billion pesos

Degree of destruction:
98%





97%
of the total damages caused by hurricane Wilma were paid by insurance companies

SOURCE: AMIS 2006

Businesses with an insurance policy **get back on their feet faster** after a disaster occurs.

Out of 5 companies
that experience a disaster, 2 close within the next 5 years.[54]

Two third parts
of the companies that face disasters that last more than 2 weeks, close within the next 2 years.[55]

Table 5

The higher the rate of coverage from the insurance industry, the less the requirement of resources from FONDEN.[56]

Event	Resources paid by the FONDEN (%)	Resources paid by insurance companies (%)	Amount in million dollars
Hurricane Wilma	3.4	96.6	$488.5
Hurricane Emily	37.6	62.4	$929.3
Hurricane Stan	75.5	24.5	$1,813.8
Total in 2005	29.3	70.7	$3,231.5

INTERNATIONAL EXPERIENCE: A POINT OF REFERENCE FOR MEXICO

Incentives for clean transport, funds for green projects, and subsidies have all been effective in reducing carbon emissions. Sustainable agricultural systems, risk maps and early alert systems have demonstrated their efficacy for adaptation. In terms of insurance, the collaboration between the government and the companies has shown good results.

»In terms of mitigation, the US, Germany, the United Kingdom and France reduced their greenhouse gas emissions between 10% and 20% between 1990 and 2010.[57]

The most successful mitigation policies have emerged from the alliances between the public and private sector and have implemented practices such as incentives for clean transport, voluntary agreements between industries to reduce emissions, financing funds for green projects, and subsidies.

»In Japan and the Netherlands, governments have managed to establish voluntary agreements of gas emissions reductions, obtaining positive results. The companies collaborating with these agreements enjoy benefits such as technological transfer and access to alternative credit sources.

»The European Fund for Energetic Efficiency has allocated 146 million Euros to finance public-private alliances dedicated to achieve energy efficiency and sustainable urban transport projects.[58] By 2020, the year in which the European Union seeks to reduce its gas emissions by 20%, it will be possible to evaluate the effectiveness of this fund.

»Mexico can also learn from several international experiences in terms of adaptation.

For example, the World Bank is collaborating with Norway to develop an intelligent climatological agricultural program in Ethiopia, which is reducing deforestation since 2008 and has rehabilitated more than 190,000 hectares to develop higher productivity agricultural projects Initiatives like this are key to improve the adaptation of agriculture, one of the most affected sectors by climate change.

»The United States, France and Korea, have put in practice measures to be prepared when facing risks associated to climate change, like hurricanes, floods, and heat waves (as shown in table 2).[59]

»The United States has a detailed risk map focused on floods, through which the government alerts the population and influences the definition of priorities for construction of new infrastructure and reparation of the existent infrastructure.

The experience of the United States also demonstrates that it is necessary to complement risk maps with stricter construction norms, as well as more severe restrictions for human settlements in zones with a high risk of experiencing natural phenomena, such as floods or tornados,

»In France, the regions and departments must prepare documents where they formalize their territorial regulation plans, preparation and risk communications. This country also has a daily alert system for hydro-meteorological risks.

»In Korea, an early alert system works following natural disasters or those caused by human activities. The system sends alerts to the citizens' cell phones to inform them about evacuation plans and connects the efforts of all their institutions.It works like a centralized control tower.

Table 1

Mexico can extract replicable lessons from countries that reduced their own emissions between 1990 and 2010.[60]

Country	CO2 per capita emissions per year (tons of CO2 equivalent per habitant)		Change in percentage 1990-2010 (%)	Change in population 1990-2010 (%)
	1990	2010		
United States	**19.6**	**17.6**	-10%	25%
Germany	**12.7**	**9.9**	-22%	3%
United Kingdom	**10.3**	**8.2**	-20%	10%
Saudi Arabia	**10.2**	**15.6**	53%	75%
European Union	**9.1**	**7.8**	-14%	7%
South Africa	**7.3**	**6.4**	-12%	42%
France	**6.9**	**6.2**	-10%	12%
Mexico	**3.6**	**3.9**	8%	40%
Iran	**3.6**	**5.2**	44%	40%
China	**2.1**	**6.4**	205%	18%
Brazil	**1.5**	**2.2**	47%	33%
India	**0.8**	**1.5**	88%	42%

Table 2

Mexico can take advantage of international experiences for adaptation

Mechanism	Results
Intelligent agriculture from the World Bank. Measures to reconvert soils in order to improve the agricultural production in countries and zones exposed to climate change.	Recovery of more than 190,000 hectares of eroded agricultural lands in Ethiopia.
Detailed risk maps for civil protection in the Unites States, as well as the operation of the National Incident Management System.	The risk map helps generate time wise alerts and influences the infrastructure priority definition.
"Vigilance" alert system, in France.	In 2009, when the storm "Klaus" came, the alert system prevented the high number of casualties that had occurred in a similar storm in 1999.

Table 3

Mexico can take advantage of the experience of developed countries in carbon emission reduction strategies

Mechanism	Results
"Metrobus" in Mexico City. Transportation system registered as a Clean Development Mechanism, which allows trading their gas reduction emissions in the Carbon market.	Reduces 110,000 tons of CO2 emissions per year. Its daily operation replaces one hundred thousand automobile trips.[61]
Voluntary agreement in the Netherlands. Agreements between the government and companies to reduce emissions. They have annual goals and seek to improve energetic efficiency.[62]	30 industrial and government sectors participated. The Netherlands reduced its emission per capita rate by 9% in 2012.[63]
Japanese Plan of Voluntary Action. It started in 1997 with the objective of reducing emissions.[64]	114 associations and industries participated. In 2009, Japan reduced fluorocarbons emissions by 58%.[65]
European Energy Efficiency Fund. Financed by public and private institutions, it grants support for public-private alliances, either at a regional or local level, dedicated to energy efficient, renewable energy or urban transportation sustainable projects, in any of the 27 country members of the EU.	The fund will contribute to the "20/20/20" objectives of the European Union: to reduce the gas emissions by 20%, to increase the use of renewable energy by 20% and to reduce the use of energy by 20% through efficient energy measures by 2020[66].

» **Spain, the United States, France, the United Kingdom, and Turkey have promoted effective financing and protection funds to face natural catastrophes.**
The governments regulate, and, in several cases, mandate compulsory insurance for catastrophic risks.
» **In the United Kingdom**, the government and the private sector signed a historic agreement in July of 2013, to establish a program of private-public insurance for flooding.[67]
» **The United States** finances insurance programs for disasters with resources from individuals (premium payments), that are managed by the public sector (the Federal government and the States).[68]
» **France** operates an insurance program to face disasters through a public based re-insurance that seeks to provide unlimited coverage against disasters to the private insurance sector.[69]
» **In Spain** there is a public organism managed by private insurance companies and public institutions, that regulates and absorbs the risk of insurance companies facing catastrophic risks.[70]
» **Turkey** has a compelling mechanism of insurance against natural catastrophes, which is regulated by the government through private insurance companies.[71]

The international experience demonstrates that these types of programs are effective for protecting families and companies against events or catastrophes of great magnitude.
» **Mexico has not yet adopted many of these solutions but is on the right track in several matters.**
In terms of mitigation, the energy reform will facilitate the participation of new actors in the generation of energy in a competitive and sustainable way, for example, wind and geothermal energy. The country has also vastly improved in civil protection matters, but has not achieved the same in terms of insurance coverage.

EARTHQUAKES ARE THE SECOND CAUSE OF ECONOMIC AND HUMAN LOSS IN MEXICO

High magnitude earthquakes are common in Mexico and are the second most costly cause of natural disasters for the country. Over 37 million Mexicans are exposed to earthquakes.

» Our country lies in one of the zones with the most seismic activity in the planet: The Ring of Fire, where most of the earthquakes in the world are registered.

Every year, there are more than 1,000 quakes in Mexico with a magnitude higher than 4.0 and almost all the country suffers from mild quakes throughout the year. For example, in 2013, the National Seismological Service registered 5,150 quakes, of which 89% registered a magnitude of 4.0 or less.[72]

Relatively strong quakes are common:between 1990 and 2014, 77 earthquakes occurred in Mexico with a magnitude higher than 7.0.[73] Most of them originated in the Pacific Coast.[74]

» Two thirds of the country[75] and more than 37 million Mexicans are in continuous risk of experiencing quakes of great magnitude.[76] The Pacific Coast, from Chiapas to Jalisco, as well as a large part of Baja California, are among the most susceptible regions of experiencing these kinds of earthquakes.

» Earthquakes represent the second most costly cause of natural disasters in Mexico.

Earthquakes, along with hurricanes and floods, are the most dangerous, costly and frequent natural disasters in Mexico. These three phenomena made up 78% of the natural disasters between 1970 and 2012, 89% of the deaths, and 93% of the economic losses.[77]

Between 2008 and 2012, quakes and disasters related to volcanic activity caused damages to the country equivalent to $ 10.9 billion pesos.

Two earthquakes, one on September 19, 1985 and its strongest aftershock on the next day, had an economic cost of 2.4% of the country's GDP, equivalent to $11,400 million dollars of 2011.[78]

The destruction caused by an earthquake is determined by several factors, many of them preventable, such as information about what to do before,during and after the occurrence, generating awareness of the danger and preparatory measures individuals should take, the strength of buildings and infrastructure, as well as the existing capacities to overcome the disaster once it has occurred. In this regard, the collaboration between government authorities, companies, households, and the social sector is key to generate an immediate reaction as well as for reconstruction efforts.

Table 1

Magnitude of a quake

It lies on a scale where each magnitude unit corresponds to 32 times the released energy.

A quake with a magnitude of 8 is...

32 times larger than one of magnitude **7**

1,000 times larger than one of magnitude **6**

32,000 times larger than one of magnitude **5**[79]

Graph 1

Earthquakes, among other geological phenomena, are increasingly costly.[80]

Annual cost of geological phenomena in Mexico

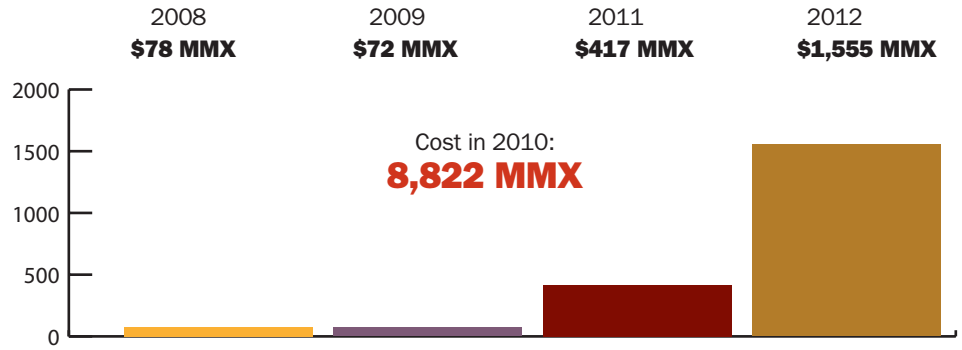


Table 2

The earthquake on September 19, 1985, with a magnitude of 8.1, and its strongest aftershock on the following day, have been the most costly for the country

Economic cost	2.4% of Mexico's GDP, equivalent to $11,400 million dollars in 2011.[81]
Main damages	258 buildings collapsed, 143 partially collapsed and 181 suffered great damage.
Most affected sectors	Public building infrastructure, households, health services, industries and commerce, small and medium businesses, as well as educational services.[82]
Human losses	It has been the earthquake with the largest number of human losses in Mexico.

MEXICO HAS SHOWN GREAT PROGRESS, BUT COULD BENEFIT FOR IMPROVING FINANCING AND PREVENTION

Mexico has created institutions and mechanisms of prevention, but there are still challenges, especially in financing prevention and reconstruction, as well as in improving coverage of insurance against quakes.

» Since 1985, the year in which Mexico City suffered the powerful earthquake of September 19, the country has achieved key advances in prevention and civil protection. For example, one of the most remarkable advances has been the Mexican Seismic Alert System (SASMEX for its initials in Spanish) created in 1991, which monitors the principal seismic regions in the country and alerts citizens and authorities in the cities of Mexico, Oaxaca, Toluca, Chilpancingo and Morelia, about the sudden occurrence of an earthquake. The alert time prior to quake onset varies between 30 and 60 seconds.[83]

Construction regulations, particularly in Mexico City, have improved since 1985.[84] At the same time, between 1986 and 2003, the federal government created key civil protection institutions such as SINAPROC. and CEPAPRED. Additionally, Mexican government created two funds (FONDEN and FOPREDEN) for reconstruction and prevention purposes.

Table 1

Advances: Mexico has created prevention, financing,and earthquake response institutions

Year	Key actions
1985	The Federal government started a structural reinforcement project for schools.[85]
1985-2004	The authorities established stricter construction regulations, as well as rehabilitation programs for damaged buildings.[86]
1991	The seismic alert system started to function.
1996	The Federal government created the Natural Disaster Fund for Mexico (FONDEN).
2002	Mexico City created the Civil Protection Law, which orders three annual drills.[87]
2003	Creation of the Fund for Natural Disaster Prevention (FOPREDEN).[88]
2006	Mexico issued the first sovereign catastrophic bond in the world: "Multi Cat". Its current expiration is in December 2015 and covers 315 million dollars.[89]
2013	The Federal government began to develop the strategy "A Safe Mexico Facing Disasters".[90] Every federal ministry will contribute to improve the infrastructure and public service response.

» Now, citizens and authorities know, like never before, protocols on how to act before, during and after a quake. However, the country is still vulnerable.

It is necessary to reinforce the prevention, mitigation and physical and economic recovery actions, especially those focused on facing large earthquakes.

In this sense, scientific studies, conducted by the National Seismological Service of Mexico, establish there is a high probability that a high magnitude earthquake will occur in the next 10 years. The epicenter of this earthquake would likely be located in the coast of Guerrero and the main damages would likely be in Mexico City. [91]

» The government, institutions, companies and society in general are not sufficiently prepared to face an earthquake of this magnitude or higher.[92]

On one hand, because of the lack of updated risk maps and adequate urban development policies, high risk urban developments continue to grow..

For example, the National Risk Atlas, a key instrument that integrates state, local, and federal information about risks, exposition and vulnerability of cities and regions; lacks sufficient information to manage civil protection services according to an official report in 2012.[93], Indeed, there are only 13 states whose risk atlases cover the three most common threats in the country: earthquakes, hurricanes, and floods.[94]

Moreover, monitoring and early alert systems do not cover all zones in which large magnitude quakes are likely to occur.[95] There is also no unique response and command center for emergencies, that coordinates all efforts. This weakness could delay or diminish the government's response, or create redundant response efforts.

» On the other hand, there is a federal financing mechanism (FONDEN and FOPREDEN) for reconstruction and prevention, but a study performed by the World Bank indicates that there is still the need to create financing and funding mechanisms at a state level to reconstruct the local infrastructure when facing quakes and other disasters.[96]

Disasters, like earthquakes, can impose a strong financial burden for governments, particularly for local ones, which lack financial and rehabilitation mechanisms. For example, between 1999 and 2011, state and local governments covered almost 80% of the resources needed for reconstruction, including low income households (estimated at $1,500 million dollars a year).[97] This measure is relevant due to the lack of private insurance coverage for households and SMEs (see table 2).

» The same study indicates that it is necessary to reinforce the reconstruction strategy, through the transfer of risks from public to the private sector.[98]

This strategy will guarantee immediate resource availability in the case of large scale catastrophes, especially in years of great losses.

Table 2

An important problem is the lack of private insurance coverage for earthquakes.[99]

4% of households have earthquake insurance.

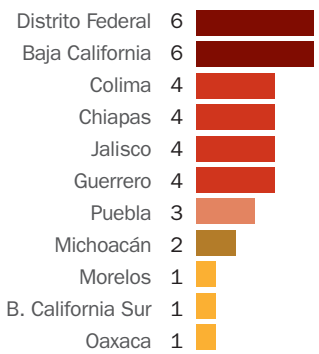
3% of small businesses have earthquake insurance.

5% of small and medium businesses have earthquake insurance.

Graph 1

The most exposed states to earthquakes own 36% of the insurance policies in the country.[100]

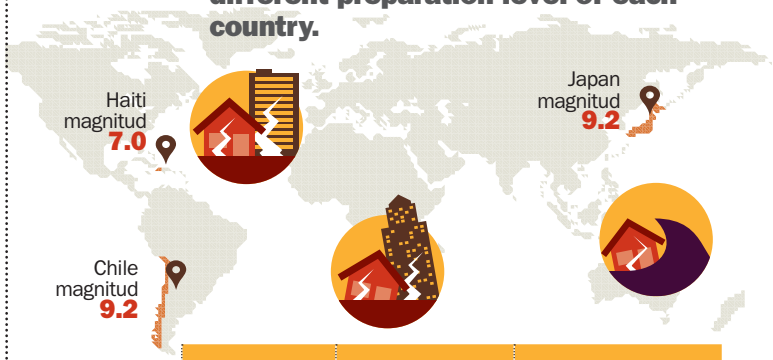
(% insured)



PREPAREDNESS AND INSURANCE: LESSONS FOR MEXICO

Keys to save lives and minimize losses: insurance schemes including the participation of public and private sectors, stricter construction norms, more and better information.

Table 1 **Differences between the damages in Haiti, Chile, and Japan are due to the different preparation level of each country.**



	Haiti	Chile	Japan
Date	January 12, 2010	February 27, 2010	March 11, 2011
Magnitud	7.0	8.8-9.2	9.0-9.2
Length	1 min aprox.	3 mins 25 secs.	6 mins
Fatal victims	220,000	525	14,617 (tsunami) 1,271 (earthquake)
Injured persons	1.5 million	2 million	340,000
Costs	**14 billion USD**[103]	**24 billion USD**[104]	**235 billion USD**[105]

» Earthquakes in Chile, Japan and Haiti, left relevant lessons for Mexico.

Now the experts know that the magnitude of an earthquake does not determine the amount of fatal victims: the earthquake in Chile, with an 8.8 magnitude, caused 525 fatalities.[101] Haiti's earthquake, with a 7.0 magnitude, left 220,000 fatal victims.[102]

» Preventive actions of these countries were focused on saving lives, which does not necessarily minimize the cost of material damages.

Considering the magnitude of the earthquakes in Japan and Chile, the number of fatal victims was relatively low in both cases, even though the associated costs were considerably high (see table 1).

Taking into account this lesson, in order to face the economic impact of an earthquake, schemes that cover risks are very important, such as insurances or reconstruction funds.

» Other countries have implemented prevention and financing policies for reconstruction, which can be re-applied in Mexico, such as strict construction norms, educational and awareness campaigns, information systems and public-private insurances, as well as early alert and response systems.

Table 2 **The United States, Chile, Turkey, and France have implemented best practices replicable in Mexico**

Country	Mechanism	Description
United States (California)	Public-private insurance funds	The California Earthquake Authority (CEA) seeks to have the largest possible number of insured individuals with a basic coverage instead of a limited number of insured individuals with a large coverage. The CEA has a $10,200 MDD fund since it was founded in 1998.
Chile	Strict construction norms	For moderate earthquakes, the buildings should maintain their original position undamaged; for stronger events small damages and deformations are acceptable. For high magnitude earthquakes, constructions can suffer considerable damages, without collapsing.[106]
Turkey	Education and awareness	The objective is to create awareness in over 5 million people about the risks caused by natural disasters by visiting communities, schools, and public buildings, among others, in a bus where seminars, educational talks and earthquake drills take place.[107]
France	Insurance sector organization	An initiative from the insurance sector in alliance with authorities to share information, and improve visibility of the problems caused by natural disasters in the eye of public opinion, and to improve the cost analysis models and socioeconomic risk scenarios.[108]

» Several prevention schemes have shown benefits. For example, strict construction norms in Chile establish that the priority when constructing housing is saving lives.[109] **On the other hand, Turkey has implemented a citizen preparation plan (that has trained over 5 million people), after the 7.6 magnitude earthquake in August, 1999.**[110]

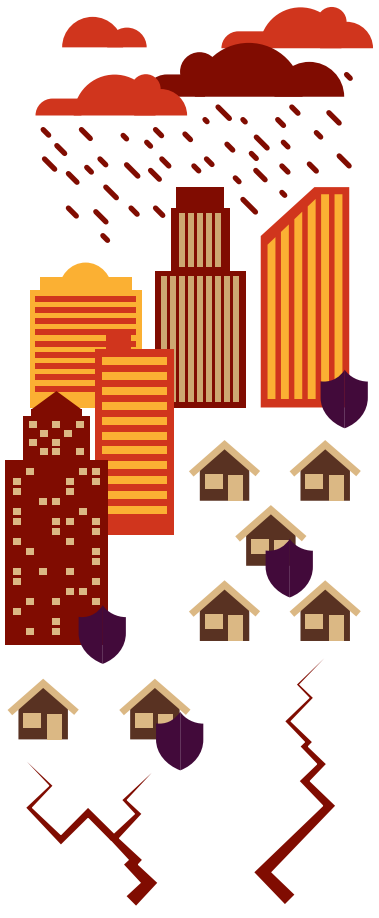
» In France, after the Lothar and Martin storms in 1999, the insurance sector promoted the creation of a public-private alliance to share information, increase visibility of the problems caused by disasters, and to improve the financial cost models and the socioeconomic diverse risk scenarios.[111]

» The experience of other countries in the creation and operation of public-private insurance also represents an opportunity for Mexico.

The earthquake insurance system in California (California Earthquake Authority), for example, has allowed for the strengthening of the capacity of the state's reconstruction in case an earthquake occurs, through the creation of a public-private fund. Since it was created, 16 years ago (in 1998), the system has raised $10,200 million dollars for the payment of "basic" insurance policies that cover the essential infrastructure of the households in case of an earthquake. The fund is independent from the government's budget and grows every year, increasing its solidity.[112]

INSURANCE IS A KEY PLAYER TO ADAPT AND TO PROVIDE SOLUTIONS TO MITIGATE THE RISKS OF CLIMATE CHANGE AND EARTHQUAKES

An efficient insurance market is key to improve prevention and adaptation in order to face the risks associated with climate change and earthquakes.



» **The largest economic losses caused by natural disasters occur in the most developed countries. The reason is that the exposed capital is greater in developed than in developing countries.**
» **But natural disasters in developing countries cause more damages to their economies, because their infrastructure is more fragile, the construction standards are insufficient, and the insurance coverage rate is very low.**[113]

Developed countries recover faster, among other reasons, because their insurance markets are more developed and there is greater coverage among individuals and businesses .

For example, Japan suffered the fourth largest earthquake registered in the history of mankind in 2011. However, Japan reconstructed 300 kilometers of Tokohu highway in only a few days, which connected Tokyo with most of the areas affected by the quake. In addition, the economy of Japan stood strong[114] and the insurance system preserved its financial viability.
» **Insurance systems not only enable a faster recovery, but they also transfer or share the risk from the families or the government to the private insurance sector.**

Turkey, some of the islands of the Caribbean, Colombia and Peru have already listened to this lesson and have implemented innovative insurance schemes (see table 1).
» **The Mexican government has also created innovative insurance instruments.**

For example, in 2012, the Catastrophic Bond “Multi Cat” began to operate, which will cover up to $315 million dollars in damages until 2015 ($140 million for earthquakes and $175 for hurricanes), as long as two parametric conditions previously specified are complied, referring to strength and deepness of the earthquake.[115]
» **AGROASEMEX (A Mexican insurance public sector agency) has implemented parametric insurance (an insurance based on the weather’s variability) to cover the agricultural sector from adverse climatic events.**

This parametric insurance covers 1.1 million hectares out of the 21 million that are annually cultivated in the country, which represents approximately 5%. In 2014, 5 crops were insured: oats, barley, bean, corn and soybeans, seasonal crops; in 481 municipalities in 12 states. The insurance covers the risks of drought and excess humidity, including an insured sum of $1,500 pesos per crop acre annually. The total insured sum in the country is up to 1,664 MMX.[116]

This insurance provides additional benefits for the farmers, who have a higher certainty about their income per period, which enables them to acquire credits as well as other types of loans, which they did not have access before.
» **However, private insurance coverage is still limited:[117] only 4.8% of the households own insurance covering natural disasters.**[118]

In addition, the market decreased 13% in 2014 in comparison to 2013.[119] The largest coverage of the insurance sector is in Mexico City and in the state of Quintana Roo. In contrast, the states with lowest coverage are Chiapas and Oaxaca.[120]

Table 1

Some countries in means of development are insuring better against natural disasters

Country	Practice
Turkey	Department owners must buy an insurance that cover risks caused by earthquakes. These insurances are partly subsided by the World Bank.[121]
Caribe and islands	They created the first multinational fund for catastrophes in order to cover the consequences of hurricanes and earthquakes.[122]
Honduras	The World Bank granted a loan of 12 million USD to this country for designing a risk insurance project for natural disasters that will provide resources in case of emergency situations.[123]
Colombia	The Collective Voluntary Insurance seeks to protect the poorest sectors of the population by insuring their houses. It has been operating since 2007 as a cross-subside to cover losses caused by earthquakes.[124]

HURRICANE ODILE LEFT SEVERAL LESSONS ABOUT IMPROVING THE PENETRATION OF INSURANCE AND RESPONSE MECHANISMS.

Table 2

Odile caused damages for more than $ 16.7 billion pesos when it hit the state of Baja California Sur

Hits land (date):
15/09/2014

Speed of winds:
205 kms/h

Magnitude:
3

Fatalities
5[125]

Most affected areas:
Los Cabos and La Paz

Economic losses:
$16,700 MMX[126]

Damaged households:
10,000[127]

» **In general, insurance penetration is considerably lower in areas with higher vulnerability, where insurance is more expensive. Therefore, public policies are key to reduce human settlements where the risk of natural disasters make prevention and reconstruction more costly.**

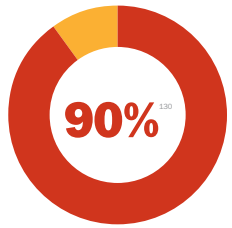
Hurricane Odile, which affected the Mexican state of Baja California Sur, on September, 2014, shows that stronger financing mechanisms are needed at the local level. For example, in Baja California Sur, the hotel industry will recover faster due to the wide penetration of insurance, which is higher than 90%. In contrast, the phenomenon caused a greater financial burden to the state's families, given that only 5% of houses were insured against damages caused by hydro-meteorological phenomena.[128]

Also, the infrastructure suffered considerable damage because of Odile. The Federal Commission of Electricity suffered the biggest collapse in its transmission network in all of its operational history, which motivated the installation of more modern technologies during the reconstruction.[129]

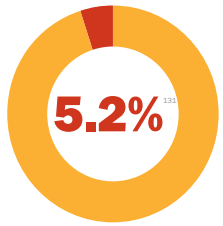
Graph 1

Hurricane Odile: the hotel industry will recuperate faster thanks to the wide penetration and coverage of insurance, in contrast to the households in Baja California Sur.

Percentage of insured hotels in Baja California Sur:



Percentage of insured households against meteorological phenomena in Baja California Sur:



One of the lessons Odile left is that even insured individuals did not know how and with whom to make their policies valid, which delayed the recovery after the damages.

FOUR
PUBLIC POLICY PROPOSALS

1/ Reduce carbon emissions in the country

These actions could help to encourage a cleaner economic development in Mexico, improving its global participation in the effort to reduce greenhouse gas emissions.

PROPOSALS:

Fiscal benefits to industries and businesses that participate in voluntary agreements to reduce carbon emissions

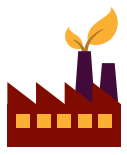
- This action will also stimulate the development of clean energy markets.

Promote the investment in low emissions and non-motorized public transportation

- This action will reduce the indiscriminate use of automobiles in cities, as well as the emissions caused by the automotive transportation.
- The financing can be based on metropolitan schemes of public-private participation, focused on improving the quality and sustainability of transportation systems.

Create a national program that rewards cities or metropolitan zones that leads to the promotion of sustainable mobility, especially electric vehicle transportation

- This program would promote the use of electric vehicles in the country and may use as a basis the experience of France, which is currently the first European market for this kind of automobiles.



Promote efficient energy use in the public and private sector in Mexico:

- The key is to strengthen technical assistance programs for the adequate use of energy from the National Commission for the Efficient Use of Energy and the Trust for Electric Energy Savings (FIDE).

2/ Improve prevention and immediate attention in disasters

These actions could increase Mexico's capacity to react and save lives.

PROPOSALS:

Create National Regulations for Building and Construction

- These regulations will standardize the quality of construction nationally. Even though Mexico City has modern regulations, there are still municipalities and states that do not have them.

Update the National Risk Atlas per locality and create a vigilance system that prohibits human settlements in high risk zones

- This will better allow the identification of risks and facilitate the definition of urban development priorities, as well as the priorities for reinforcing the infrastructure against natural disasters.

Increase the coverage of meteorological and seismic alerts in the country

- This action will improve the information transmitted to citizens and the attention given to them when a natural disaster occurs.

Create unified protocols to manage emergencies caused by natural disasters

- These protocols must include national mechanisms of formal communication across institutions and the population

Design and implement immediate attention protocols by insurance companies to face natural disasters of great magnitude

- These protocols guarantee that the insured people receive timely and adequate attention by insurance companies. For example, quick valuations and key information on how to claim their payments.

3/ Promote new protection and insurance schemes

This action intends to create synergies between government and insurance sector in order to protect the assets of households, businesses and governments, through schemes that strengthen the country's and the families' financial capacity to face natural disasters.

PROPOSALS:

Promote regulation that encourages compulsory insurance of households against natural disasters in the zones with the highest risks

- This scheme can use the resources of the FONDEN along with those raised by the issue of insurance policies, which will transfer the risk to those who decide to settle in riskier zones. The insurance payment may be linked to the payment of public or private services.

Create a basic catastrophic insurance with complementary options, with the participation of the government and insurance companies

- This insurance scheme would offer a simple, basic, economic product according to the risk profile of each individual, who would be compelled to acquire the basic offered insurance.
- Insurance companies would be compelled to offer this basic insurance but could offer a more comprehensive policy.
- The government would act as facilitator and provider of the initial financial reserve. This scheme would reduce the fiscal burden caused after the catastrophe occurs.

Extend the coverage of the FONDEN to cover higher household segments through INFONAVIT and FOVISSSTE (both public institutions provide household credits for low income segments)

- This implies the modification of the actual regulatory frame of FONDEN to broaden its coverage.

Take advantage of the federal programs "Prospera" and "Crezcamos Juntos" to promote the formalization and insurance of their beneficiaries against natural disasters

- This implies creating insurances for the beneficiaries of these social programs according to their risk and income profiles.

Increase the type of insurance coverage that bases its premiums and payments on weather variability

- It is highly recommended that this type of insurance, known as parametric, broaden its coverage in sectors such as energy, transport, tourism, and agriculture.

4/ Encourage innovation and technological transfer in Mexico

This action intends to create incentives for researchers and innovators in the country to focus their activities on projects that address the challenges imposed by the climate change and earthquakes in Mexico.

PROPOSALS:

Using the resources in the National Entrepreneur Fund by the Secretary of Economy, launch a competition for entrepreneurs to design and implement innovative solutions to:

- Reduce greenhouse gas emissions in Mexico, both in industry and households.

- Use new technologies to alert the population when facing earthquakes and meteorological phenomena, as well as better coordinating civil protection and reconstruction actions by businesses, governments and citizens .

- Use the opportunities that the energy reform provides in terms of developing renewable energy sources.

- Generate, 35% of the country's electricity through clean sources by the year 2024, just as the General Law for Climate Change establishes.

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