# THE EXPERIENCE ON EARTHQUAKE RISK IN CENTRAL AMERICA

Presented by the Central American Actuarial Association (Asociación Acturial Centroamericana) to the 13th ASTIN Colloquium.

The Asociación Actuarial Centroamericana (AAC) is a grouping of Actuaries from the Central American Republics of El Salvador, Guatemala, Honduras, Nicaragua, Costa Rica and Panama. The AAC is a contributing ASTIN member of the International Actuarial Association.

## 1. Background

Earthquakes have been a constant scourge of mankind. Central America has not escaped this phenomenon, indeed the territory has been most affected by them precisely because of its condition as an isthmus that serves as a fragile union between the continental land masses of North and South America, and in consequence being subject to disturbances by the displacement of the continental plates. Our lands abound with beautiful volcanoes, which have also contributed to local seismic activity. Whatever their origin, the earthquakes that have struck our country have left their share of destruction of lives and property.

In Annex 1 a table is presented, showing a history of seismic activity and volcanic eruptions in the countries on the Caribbean Platform, in which we can appreciate in detail the catastrophes that occurred from the XVI Century until 1976. In five centuries the following number of catastrophes originated by earthquake and volcanic eruptions were recorded in Central America:

| *Century* | |
|---|---|
| XVI | 1 |
| XVII | 3 |
| XVIII | 2 |
| XIX | 9 |
| XX | 14 |
| Total | 29 |

We consider a total of 29 catastrophes of the 41 that have occurred during this period in the Caribbean Platform.

In continuation we will refer to the two most important quakes that occurred in the 70's:

In 1972 Managua, Capital of Nicaragua, was devastated by a great earthquake that left a total of more than 10.000 dead, and damage to property that reached the sum of US $ 845 million.

In 1976 Guatemala was also affected by an earthquake that brought death to 20.000 persons, with damages calculated at US $ 2.000 million.

These quakes, which have been the last two major quakes to affect Central America, with their data on losses give us an idea of the necessity for earthquake coverage through insurance systems; and as a consequence, of the need for an adequate and scientific system of tarification combined with a good insurance system that goes from the moment of selection of risks, contract conditions, and cumulus control, to an adequate reinsurance system that covers the need of spreading the risks.

## 2. Some Data on Earthquakes and Insurance in Central America

As we said before, the last two severe earthquakes that occurred in Central America were in Nicaragua in 1972, and in Guatemala in 1976.

In the case of Nicaragua it is estimated that the US $ 845 million in damages were distributed thus:

| | |
|---|---|
| Buildings | US $ 528.0 million |
| Equipment and Machinery | US $ 128.0 " |
| Inventories | 48.0 " |
| Losses in receivables, Emergency and Other Expenses | 141.0 " |
| Total | US $ 845.0 |

The total of capital assets existing in Managua at the moment of the earthquakes, are estimated at some US $ 1.000 million, divided in the following fashion:

| | |
|---|---|
| Housing | 40% |
| Industry | 20% |
| Infrastructure | 15% |
| Commerce and Services | 25% |
| Total | 100% |

The US $ 528 million lost in buildings represent 53% of the US $ 1.000 million of capital assets referred to in the preceding paragraph.

But what was the role played by the insurance industry in the replacement of damages? This question can be answered with the following figures:

a) The total amount insured against fire in the entire Republic of Nicaragua was, at the time of the earthquake some US $ 462 million. Of these, some 67% according to estimates, were insured against damages and fire caused by earthquake, (that is, US $ 310 million).
b) In the area of Managua, city affected by the phenomenon, the losses in goods that could have been insured against earthquakes were of US $ 704 million, divided between buildings, machinery, and equipment and inventory. Of these, some US $ 251 million were really insured against earthquake—which represents some 36% of the total of goods insurable at that moment.
c) Adding insurance against business interruption, the preceding figure increases to US $ 225 million in insured sums, that originated payment of claims of US $ 73 million. On the average some 30% of the insured sum in Managua was indemnified, and some 24% of the insured sum in Nicaragua on the whole. Of the insurable losses some 10% were recuperated through the insurance system.

In reference to Guatemala, at the moment of the earthquake some US $ 2.400 million were insured against earthquakes in the entire country. The damages caused by the earthquake were US $ 2.000 million.

The insurance companies of Guatemala paid in concept of claims US $ 55 million, a figure that represents little more than 2.75% of the damages and some 2. 30% of the sums insured in the republic with

earthquake coverage. The sums insured that correspond to the policieson which claims were paid reach the figure of US $ 533 million.

Comparing the data for Nicaragua and Guatemala we find that while losses in Guatemala are a low percentage of the insured sums (2.3%) in Nigaragua they reach the considerable figure of 24%. This is explained because it is in the capitals that large quantities of insured goods are concentrated, and Managua was almost totally destroyed, whereas the Guatemalan Earthquake, even while it did affect a great part of the country, did little damage to Guatemala City.

### 3. Rates

In Central America, in view of the recent catastrophes, the earthquake rates have been increased, and the territories for which these increased rates are applicable have been redistributed.

For example, in Nicaragua the rates for both before and after the earthquake are shown in the following table:

| | | *Before* | *After* | |
|---|---|---|---|---|
| | *Type of Construction* | *Entire Country* | *Managua* | Rest of the *Country* |
| AA | (Concrete) | 0.20% | 0.80% | 0.50% |
| A | (Concrete with zinc roofing or clay tiles) | 0.50% | 0.80% | 0.50% |
| B or C | (Taquezal or Wood) | 0.80% | 1.20% | 1.20% |

After the earthquake higher deductibles were established and the practice to not insure constructions made of taquezal in Managua and its surroundings was set.

The rates have been increased in the following relative terms:

| *Type of Construction* | *Managua* | *Rest of the Country* |
|---|---|---|
| AA | 300% | 150% |
| A | 60% | -o- |
| B or C | 50% | 50% |

But it is worthwhile asking: Are the increases that have been made in the area, (or the rates in the area at their present levels) —just? deficient? or excessive? Or better stated: What would be the just rates for undertaking earthquake business in the Central America area?

As a first intent towards approximating the construction of a global rate, taking advantage of the data given previously for Nicaragua we can draw a relation between the losses observed in the earthquake of 1972 in respect to the sum insured in the entire country against fire risk, under the supposition that the entire portfolio has earthquake coverage (as has actually almost occurred). This relation would be 16%. Supposing a recurrence period of 35 years, with the same relationship of damages to the sums insured, we would have an average annual rate of 0.46%. If the preceding were multiplied by a safety factor of 1.2, and we add a surcharge of 25% for expenses, the resulting rate would be 0.69%. For the hypothesis mentioned, this should be the average rate that results from the application of diverse rates, higher or lower than the average, in attention to the types of construction, seismic activity in the zone where the construction is located, recurrence for each particular place, maximum probable loss, etc.

The 35 year period corresponds to the superior limit of the interval of recurrences established in Annex 2, that was elaborated by a prominent member of the AAC, based on the information contained in Annex 1. If we had taken the minimum period of 9 years, the average rate that results would be 2.67% instead of 0.69%.

In continuation the average rates for various recurrence periods are given, applying the experience of Managua in 1972:

| *Period of Recurrence in Years* | *Average Resulting Rate* |
|---|---|
| 9 | 2.67% |
| 17 | 1.41% |
| 30 | 0.80% |
| 35 | 0.69% |

If for the sake of simplicity we ignore the rates corresponding to taquezal constructions in the actual Nicaraguan rate, we could say

that these rates would result insufficient for recurrence periods of less than 30 years, and excessive for recurrences of more than 30 years. This comparison gives us a rough answer to the questions asked previously.

Naturally the structuring and analysis of the rate is much more complicated than the simple example given previously, and it is necessary to take into consideration elements such as:

a) Zones of application divided by grade of risk: that is, division of a territory by its seismic antecedents; probability of occurrence of destructive events paying attention to periods of recurrence, intensity, magnitude, acceleration and other relevant data.
b) Engineering Studies, to know the possible response of different types of construction; the characteristics with which the phenomenon can present itself according to the area. The mixture or composition of properties in determined places would give us an idea of the maximum probable losses in determined zones, applying the models mentioned in the preceding subsection (a).
c) Goverment policies regarding regulation of constructions.
d) Classification of insurable constructions.
e) The establishment of deductibles to eliminate small claims, that in some cases obey reasons distinct from the earthquake.
f) The establishment of participations of the insured in coinsurance.

The information basic to structuring a rate, which is the seismological data—even if we applied the science at our reach—cannot be exact because the earthquakes observed cannot be taken as a sufficiently significant sample to use as a base for making inferences on the future of a population that, for the effect of tarification, we do not consider as obeying the law of great numbers.

If is clear then that all rates carry in them subjective elements, but as we actuaries put to better use the information available we will get closer to the rates necessary to meet successfully the losses originated by earthquakes, with a good probability of obtaining the right ones.

## 4. Underwriting

In regard to underwriting, which in this case we conceive of as being the application of rates and conditions to specific risks, and

the form in which the community of underwriters must confront the risks, we consider the following:

a) The underwriters must have personnel with training in earthquake matters adequate enough to permit them to act with sound criteria in choosing risks and in applying rates.

b) The actual rates must be revised, as it is considered that they do not have sufficiently ample classification to permit proper selection of the risks to which they apply, complemented by ample instruction manuals. Some of our countries have already taken the necessary steps toward this end, and they are taking advantage of studies on seismic risk that have been made on behalf of underwriting institutions and government authorities.
In the VI Congress of Underwriters of Central America and Panama, that took place in San José, Costa Rica, in November of 1976, aspects related to catastrophic events were discussed, as could well be expected, and among the recommendations was to increase the efforts of the Underwriters Association in each of the countries of the isthmus, before their respective governments, to see that seismological and other studies relevant to risks of a catastrophic nature be made and placed at the disposal of the underwriting companies for their effective use.

c) Study of policy conditions, above all on the subject of deductibles, and of participation of the insured in all loss that arises from earthquake risk. In this aspect we must consider possible pressure by the Governments to see that the burden of loss is not displaced towards the group of insured.
The revision of procedures for insuring catastrophic risks with the purpose of adjusting them to sane and intelligent norms was one of the recommendations of the VI Congress.

d) The establishment (or strengthening, in case they already exist) of reserves for catastrophic risk, as well as the investment of the same to guarantee their immediate liquidity. In the special case of the Isthmus, exposed as a group to frequent earthquakes and with a high concentration of risk in certain zones it is necessary to diversify well the risks of investment, and to analyze, in the light of actual events, the effect of legislation obligating the investment of these reserves in the geographic area of each country. The increase of these reserves permits the companies to

contract excess loss coverages each time in better conditions, which notably betters the solvency position.

e) Pressure government authorities to decentralize, and settling populations, industries, and commerces in zones less exposed to earthquakes.

f) Work towards the establishment of construction codes that give greater safety to the population, and lessen probable expected losses.

g) Administrative control of risks, especially earthquake cumulus.

## 5. Conclusions

The actuarial associations are obligated to actively participate in assessing the respective underwriting organizations in matters of underwriting and tarification related not only to earthquakes risk, but also to other types of events, whether catastrophic or not.

In our special case, the A.A.C. will need the effort of all its members to carry out a task that constitutes a challenge.

Towards this end it would be of great help for us to have the collaboration of Actuaries from developed nations that dispose of greater elements for investigation. The inclusion of this subject in this Colloquium leads us to await valuable contributions that will permit us to get closer to the solution that, for a part of mankind submitted with greater frequency to these catastrophic events, is of vital importance.

## *ANNEX I*

### *SERIOUS EARTHQUAKES AND VOLCANIC ERUPTIONS DURING FIVE CENTURIES IN CENTRAL AMERICA AND THE CARIBBEAN ZONE: CENTRAL AMERICA, NORTHERN COLUMBIA, VENEZUELA*

XVI CENTURY

| | |
|---|---|
| 1530 - Venezuela | Partial destructions of New Cadiz by tidal waves. |
| 1541 - Guatemala | Destruction of the old part of the capital by flooding mud from "Agua" volcano. |
| 1543 - Venezuela | Cumaná destroyed in the greater part by earthquake. |

XVII CENTURY

| | |
|---|---|
| 1609 - Nicaragua | Destruction of the capital, León, after the eruption of Momotombo volcano. |
| 1641 - Venezuela | Earthquake near Caracas, causing great damage. |
| 1648 - Nicaragua | Serious earthquake damage in reconstructed León. |
| 1663 - Nicaragua | Total destruction of León. Earthquake damages also in the surrounding area. Numerous landslides. |

XVIII CENTURY

| | |
|---|---|
| 1766 - Venezuela | The most severe earthquake damages in Caracas and Cumaná. |
| 1772 - Nicaragua | Severe earthquake, and an eruption lasting 10 days, of Masaya volcano. |
| 1773 - Guatemala | Severe earhtquake damage to the capital Antigua, Guatemala. Move to present location. |

XIX CENTURY

| | |
|---|---|
| 1805 - Venezuela | Cumaná is affected again by an earthquake. |
| 1812 - Venezuela | Seismic catastrophe in Caracas and other cities; more than 10,000 dead. |
| 1822 - Costa Rica | Earthquake almost destroys Cartago completely. |
| 1825 - Colombia | Serious earthquakes north of Barranquilla; destructive tidal waves. |
| 1841 - Costa Rica | Cartago and surrounding area affected by quake. Damages also in Nicaragua. |
| 1844 - Nicaragua | Serious earthquake damage in Rivas and San Juan del Norte. |
| 1859 - Guatemala | Probably one of the strongest quakes felt in Central America. Tidal waves in Pacific coast. Eruption of Izalco volcano. |
| 1867 - Costa Rica | Considerable damages caused by eruption of two volcanos. |
| 1875 - Venezuela | Destructive earthquakes causes more than 15,000 deaths in Cucuta and Tachira. |
| 1881 - Nicaragua | Considerable earthquake damage in Nicaragua. |
| 1882 - Panamá | Panmá City seriously affected by earthquake. Eruption of Atrato volcano. |
| 1885 - Nicaragua | Catastrophic earthquake damages in León, Chinandega and Managua. |
| 1898 - Nicaragua | Considerable earthquake damages in León, and also in El Salvador. |

XX CENTURY

| | |
|---|---|
| 1900 - Venezuela | Serious earthquake damages in Caracas and its surrounding area. |
| 1902 - Guatemala | Quezaltenango totally destroyed by earthquake. Serious damages throughout the province. |
| 1904 - Costa Rica | Considerable earthquake damages in ample parts of the country. |
| 1904 - Panamá | Strong quake in the Gulf of Panamá. |
| 1917/18 Guatemala | Capital of Guatemala widely destroyed. Enormous material damages, many deaths. |
| 1926 - Nicaragua | A very serious earthquake causes millions in damages in Managua. |
| 1929 - Venezuela | Seismic catastrophe in Cumaná. |
| 1931 - Nicaragua | Again a great part of Managua is destroyed. Damages valued at 15 million dollars. More than 1,000 dead. |
| 1950 - Venezuela | Earthquake damage in El Tocuyo, Guárico, Anzoategui, Humocaro Alto and Cuaitó. |

| | |
|---|---|
| 1951 - El Salvador | Serious earthquake damages in Jucuapa. More than 400 deaths. |
| 1956 - Nicaragua | Widespread damages in Managua caused by a very strong quake. |
| 1963 - Costa Rica | Eruption of Irazú volcano. Damages of some US $150 million. |
| 1965 - El Salvador | Disastrous aftermath of earthquake: many deaths and more than 30,000 persons left homeless. |
| 1967 - Venezuela | One of the quakes with the most consequences for the country. US $100 million in damages and 250 deaths. |
| 1968 - Costa Rica | Eruption of Arenal volcano, 76 victims. |
| 1972 - Nicaragua | Seismic Catastrophe in Managua: some 7.000 deaths, material damages of approx. US $800 million. |
| 1973 - Costa Rica | Considerable damages by earthquake in Tilarán, Río Chiquito, and Arenal. |
| 1976 - Guatemala | The biggest catastrophe in Central America: more than 25,000 deaths. Material damages of approx. US $ 500 million. |

Source: Pamphlet Guatemala '76—Earthquakes in the Caribbean Plate—edited by Munchener Re.

## *ANNEX II*

### *Occurrence for year of the catastrophes in the area by country*

| *Guatemala* | | *El Salvador* | | *Nicaragua* | | *Costa Rica* | | *Panama* | |
|---|---|---|---|---|---|---|---|---|---|
| *Year* | *Difference* | *Year* | *Difference* | *Year* | *Difference* | *Year* | *Difference* | *Year* | *Difference* |
| 1541 | | 1951 | | 1609 | | 1822 | | 1882 | |
| | 232 | | 14 | | 163 | | 19 | | 22 |
| 1773 | | 1965 | | 1672 | | 1841 | | 1904 | |
| | 86 | | | | 172 | | 26 | | |
| 1859 | | | | 1844 | | 1867 | | | |
| | 43 | | | | 37 | | 37 | *In 22 years:* 1 | |
| 1902 | | | | 1881 | | 1904 | | *Average:* | |
| | 15 | | | | 4 | | 59 | *22 years* | |
| 1917 | | | | 1885 | | 1963 | | | |
| | 59 | | | | 13 | | 5 | | |
| 1976 | | | | 1898 | | 1968 | | | |
| | | | | | 28 | | 5 | | |
| | | | | 1926 | | 1973 | | | |
| | | | | | 5 | | | | |
| *In 435 years:* 6 | | *In 15 years:* 1 | | 1931 | | *In 151 years:* 7 | | | |
| *Average:* | | *Average:* | | | 25 | *Average:* | | | |
| *72.5 years* | | *14 years* | | 1956 | | *21.6 years* | | | |
| | | | | | 16 | | | | |
| | | | | 1972 | | | | | |
| | | | | *In 363 years:* 10 | | | | | |
| | | | | *Average:* | | | | | |
| | | | | *36.3 years* | | | | | |

For the entire area, in 435 years 25 catastrophes have occurred, indicating an average of one catastrophe every 17.4 years. Uncertainty factor 2.0. Recurrence period from 8.75 to 34.8.

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