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PH. D THESIS

SUMMARY

Catastrophic risk- assessment of the impact of an earthquake in Romania and its insurance

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Contents

Key words: catastrophic risk, earthquake, seismic zones, mandatory home insurance, material damages, financial losses, insurance coverage.

INTRODUCTION

Since ancient times, the natural phenomena that occurred inevitably had an impact on the people and their activities. If at that time the risk was associated with the term "fate", considering that in the face of the manifestation of nature we are powerless, having no possibility to act, over time more and more emphasis was placed on preventive and post-event actions, both being extremely important, first of all to limit exposure and on the other hand to manage appropriately the consequences when a major event occurs.

Catastrophes are events characterized by a low frequency and a high impact, therefore they are often not given the necessary importance, as the consequences are not always "alive" in people's minds. However, nowadays we are witnessing events whose frequency is on an upward trend and whose impact is increasing. It is true that over time there has been a concentration of the population including in the areas exposed to the risk, the technological progress also contributing to the significant increase of the material losses as a result of these severe events.

For most natural catastrophes, the frequency is difficult to be influenced, in consequence an appropriate management of the consequences and also actions that limit the impact must be considered crucial by all the parties involved in catastrophe management worldwide.

Romania is a country exposed to catastrophic risks, one of them being earthquakes, this being one of the main subjects approached in this paper. The seismicity of Romania is extremely complex and well delimited at European level, Vrancea zone being the one that generates earthquakes that affects about 50% of the territory. The capital of Romania is also very exposed, both considering the distance from the epicenter and the characteristics of the soil on which it is located, deposits that amplify the seismic waves propagated.

Although the exposure to earthquake risk is high the level of maturity to manage such an event and to be able to return to the situation before the earthquake requires involvement, collaboration and development at several levels. In order to achieve this objective, it is necessary to look at the impact of a major earthquake from several perspectives: human losses, material losses and of the impact on the state budget.

I consider that saving human lives should be a major priority especially in the current context where in Bucharest there are still a lot of people that live in buildings with red bullets, these being the most exposed in case of an event. Even if there have been defined programs for the rehabilitation of buildings, the progress of the initiatives is quite slow. Moreover, we are unable to introduce an alert system that will inform the population when the earthquake is detected in the epicenter, respectively a few seconds before population to feel it because the specialized authorities consider that we are not prepared to react appropriately and to save our lives but rather it is considered that such a system could generate panic and reactions that would increase the number of victims.

If we consider the material damages, the most important thing for people with homes affected by earthquake is to have the possibility to reconstruct their destroyed houses in a short period after event occurrence. In this scope it has been introduced since 2010 the mandatory home insurance against natural disasters that covers 3 major risks: earthquake, floods and landslides. Although this insurance is mandatory, after 9 years since it was introduced, the insurance coverage is about 20%, which represent a worrying value. Also, the value of the indemnity that a policyholder can receive is only 20,000 Euros, a value that does not cover the cost of reconstructing a home. Of course, the optional insurance represents a solution both for increasing the insured amount of the house, also for considering an extended number of risks covered and for including the goods in insurance. However, currently the insurance coverage for optional home insurance has similar value as the one recorded for mandatory insurance.

For insurance companies that covers catastrophic risks, a major event may even mean bankruptcy, such cases being observed in the United States following severe hurricanes. Therefore, it is very important to assess the exposure and the ability to manage the indemnities to be paid as a result of such an event. Therefore, in most cases insurance companies have reinsurance agreements in place in order to increase their underwriting capacity or to limit their exposure. Considering that currently the insurance coverage in Romania is low, the need for an alternative risk transfer solution developed after accessing the stock market is not considered a viable solution at first glance, but some options may be considered.

Based on the aspects already mentioned, the purpose of our scientific approach is to quantify the material damages generated after an earthquake similar to the one produced in 1977 and to analyze the possible solutions to cover the potential losses. We will analyze the mandatory home insurance policy and its characteristics in order to identify a list of solutions to be applied in order to increase the insurance coverage.

One particular aspect of our approach is represented by the interdisciplinarity of the subject, data and information from engineering, insurance, mathematical-statistical modeling, geology being needed to be correlated in order to obtain and interpret the results. Collaboration with researchers from the National Institute of Research and Development for Earth Physics was a key point for achieving our goal and transposing the results obtained from numerous studies performed by them in insurance. The novelty of the paper is based on the continuation of the existing research, the correlation with other data from different sources in order to obtain a high level of applicability in the insurance field.

The solutions proposed in this paper are applicable for multiple stakeholders: insurance companies, Natural Disasters Insurance Pool - PAID, public authorities.

Summary chapter 1

Catastrophes: conceptual and typological coordinates

In the first chapter catastrophes are presented both from a typological point of view and from the perspective of different approaches that we can have on these complex phenomena who's numerical and impact evolution is on an upward trend.

There are a variety of approaches and definitions of the concept of "catastrophe", even some aspects on which there is no common agreement between researchers in different fields, each of them seeking to capture the quintessence from the point of view of his research area, but the vast majority of them capture some common defining elements. In order to consider an event as a catastrophe, it is necessary to assess it, considering a series of thresholds, most of the classifications being based on the value of the losses, the number of dead people, missing, injured or homeless people. Moreover, there are other terms often used as having the same meaning as the notion of catastrophe, such as disaster, crisis, emergency.

In this paper I will use both terms, catastrophe and disaster, with the mention that the approach will be based on the assumption that between these two terms there is perfect synonymy. The reason why I think that this approach is the most appropriate is because in insurance field both concepts are used in different situations and their replacement would create lack of clarity and confusion, both being terms known in the specialized literature.

Catastrophes can be natural or technological, this classification being based on the factor that triggers their occurrence. When it comes to earthquakes, one of the main catastrophes analyzed in the case study I have to mention that in the literature there are references also to man-made earthquakes, these being induced or triggered but, in this paper,, we will address only natural earthquakes.

Considering the complexity of catastrophic events and the fact that the consequences affects many areas a detailed approach form different perspectives can be done:

- From a **financial** point of view catastrophes are events that generates bot direct and indirect losses. The impact is felt both by economic agents, state budget, insurance companies and population.

- Catastrophes can be seen also as **economic events** whose occurrence can be assimilated to a function determined mainly by two factors: nature and man. Although developed countries will suffer more losses in case a catastrophe will occur, however, the impact will be felt more strongly in poorly developed and emerging countries, as insurance coverage is rather small, they do not have the resources to restore the situation, and thus, there is an amplification of these shocks on poverty and development.
- From a **social** point of view, catastrophes lead to worsening living conditions, loss of homes and even death for many people. Also, the impact felt by companies can finally be transposed in the increase of prices and the final effect is also felt by the population. Long term, catastrophes have also positive effects: for example, replacing the old technologies destroyed with new technologies with increased productivity, the research carried out in the next period and the results obtained.

When it comes to the evolution of the number of natural catastrophes recorded between 1900-2018 worldwide, an upward trend was observed during the analyzed period.

Romania is a country exposed to natural catastrophes, especially to earthquakes but also to floods, these two categories being the major threats for our country.

The results show that even if 80% of cases are represented by floods form a financial point of view the 1977 earthquake determined the highest value of damages, the total value being 2,5 higher than the value of the losses generated by the most powerful flood.

Summary chapter 2

Catastrophic risk

Once the of Solvency 2 Directive was implemented, a taxonomy of risks has also been introduced. Specifically, these risks are considered when calculating capital requirements. Catastrophic risk is a component of life underwriting risk, non-life underwriting risk and health risks.

In order to have a proper risk management cycle the following phases must be considered:

- ***Risk identification:*** this activity is extremely important for any company, the main purpose being to minimize the number of unknown risks.
- ***Risk assessment*** is the second phase, the decision-making process being based on it. There are two types of assessment: quantitative or qualitative. This assessment is based on a risk matrix that allows the risk to be classified into 4 categories: low, medium, high or critical depending on the choice of a combination of probability and impact.
- For all risks that have an inherent level that is not in the company's risk appetite, controls should be defined, a phase known as risk **control**. One aspect that should be considered when defining controls is to classify them according to their importance in order to monitor them accordingly.
- **Risk monitoring** involves monitoring the effectiveness of the defined controls, both from the point of view of the way they are formalized, their documentation in the working procedures and from the operational efficiency point of view. This activity is mainly in the responsibility of the first line of defense, the role of the second line of defense being to offer an independent opinion on the controls design and effectiveness.

The catastrophic risk is mainly characterized by a low frequency and a high impact. This is why it is so difficult to estimate the losses occurred, especially since the historical data are not sufficient, therefore it was extremely necessary to develop models that would be based primarily on generating scenarios of events similar to those that took place in order to improve the results obtained.

By risk materialization we refer to the situation in which the catastrophe no longer represents an uncertain event, but it occurred, the 3 main areas where losses are recorded being the following:

- **Material damages**: are the result of homes, public buildings, infrastructure destruction. These are determined using catastrophe models whose final goal is to estimate the monetary value of the possible losses produced. All models are based on similar modules: the hazard module, the vulnerability module and the financial loss module. If the final purpose of the hazard module is to identify the *locations* most likely to be affected, to determine the *frequency* of occurrence of events as well as the *severity*, the *intensity* of the catastrophes within the vulnerability module will continue with the construction of the *vulnerability functions.* The last step is about establishing the link between the initial data, characteristic of each catastrophe and the level of financial losses. The opinions expressed by the specialists regarding the damage ratio for different types of constructions is also taken into consideration, especially since frequent updates of the damage functions are difficult to be performed.
- **Losses of human lives**, here we refer to dead, missing persons or who have a certain degree of injury. Similar to the way in which the material losses are calculated, the estimation of the number of people affected is also done using cat models, but in this case most of the models are run immediately after the event has occurred, mobility being a key element that must be taken into account.
- **Business interruption** for some companies for a certain period, this being one of the indirect effects of a catastrophe, the continuity plan being extremely important in order to limit as much as possible the interruption period. It must be updated annually and tested in order to ensure permanent improvement of the identified issues.

Catastrophic risk management is not only of interest for the insurance companies but also for other companies whose activity can be interrupted in case such an event occurs and for the public institutions. Considering the extended impact only through adequate management in each of these areas and collaboration between all institutions involved in risk management, progress can be made towards improving the responsiveness and reducing the impact.

Summary chapter 3

Solutions for managing the impact of an earthquake in Romania

Considering the level of income of the population in Romania, assuming the risk of natural catastrophe which means that the population would rebuild the destroyed or affected buildings with their own money in case of an earthquake or as a result of floods it does not seem to be a viable solution.

Therefore, a first option for the population is the mandatory home insurance. Although it has been introduced as a mandatory insurance since 2009, even after 10 years the insurance coverage is around 20%. The policy covers 3 risks: earthquake, floods and landslides. The decision was made to establish PAID, whose shareholders are the insurance companies but over time there have been many changes, both in terms of the companies that issue these policies and the way in which this form of insurance coexists with the optional insurance. Finally, even insurance companies that were not part of the shareholding of PAID have concluded partnerships with it for issuing mandatory insurance, this fact being determined by the decision on the impossibility of concluding an optional insurance without the existence of a mandatory one for a home.

Given that the mandatory home insurance covers in Romania only the 3 catastrophic risks: earthquake, floods and landslides, but the houses are exposed to many more risks, additional coverage is required, and this is obtained through optional insurance. Moreover, the maximum amount insured through the mandatory insurance is quite small compared to the level of the costs necessary to reconstruct the homes, even after the materialization of one of the catastrophic risks covered by the PAD, therefore also in this situation additional coverage is needed. Another need for optional insurance is determined by the fact that mandatory insurance covers only the building, the goods and equipment within the home not being insured. However, the insurance coverage through optional insurance is also worrying.

The low level of insurance coverage can be explained through several causes (Ioncică M., et al 2009) like: *economic reasons*, *lack of education* of the population regarding the insurance field, *lack of measures and actions to support the application of the legislative regulations*.

Also, the aid received from the state in case of occurrence of events discourages the conclusion of insurance policies. In Romania, 2 funds are made available annually to the

Government: the *intervention fund* and the *budget reserve fund* from which it is decided to release some amounts in order to help people affected by natural disasters.

If the local capacity is exceeded, the Member States of the European Union can call on the European Union Solidarity Fund in order to obtain support for the areas affected by major natural catastrophes. Romania has called for 7 times to release amounts from this fund, benefiting from a total aid of 119.02 million Euros.

Given the major impact of catastrophes on insurance companies, in the vast majority of cases they also conclude a form of insurance, which is called reinsurance. The most appropriate form for catastrophic events is the reinsurance excess of damage per event also known as catastrophic reinsurance.

Catastrophe bonds or cat bonds are a relatively new class of financial instruments, being one of the alternative risk transfer solutions. These appeared due to the limited capacity of the reinsurance market, when the call to the capital market was necessary. In the process to be followed when a cat bond is issued several parties are involved: a **cedent** company, which can be an insurance, reinsurance company, Government, as well as any other company that is exposed to catastrophic risk, a **risk agent**, **an intermediary-structural agent** that in the vast majority of cases is represented by a major reinsurer, a broker, an investment bank that mediates the connection between the cedent and the capital market and a **Special Purpose Vehicle**, this being the company that actually realizes the issue, being mostly an offshore company. The company specialized in risk modeling plays an extremely important role in the issuance of the bond, as, based on the discussions between it and the cedent company, is taken also the decision regarding the type of trigger of the bond: indemnity, parametric, modeled losses, losses in the industry , hybrid. These fixed income financial instruments are attractive to investors, allowing them to diversify their portfolio, being independent of capital market variations.

Summary chapter 4

Case study: impact assessment of an earthquake in Romania

Romania is one of the countries with a significant seismic activity, being considered together with Greece, Turkey and Italy as European countries with important risk exposure.

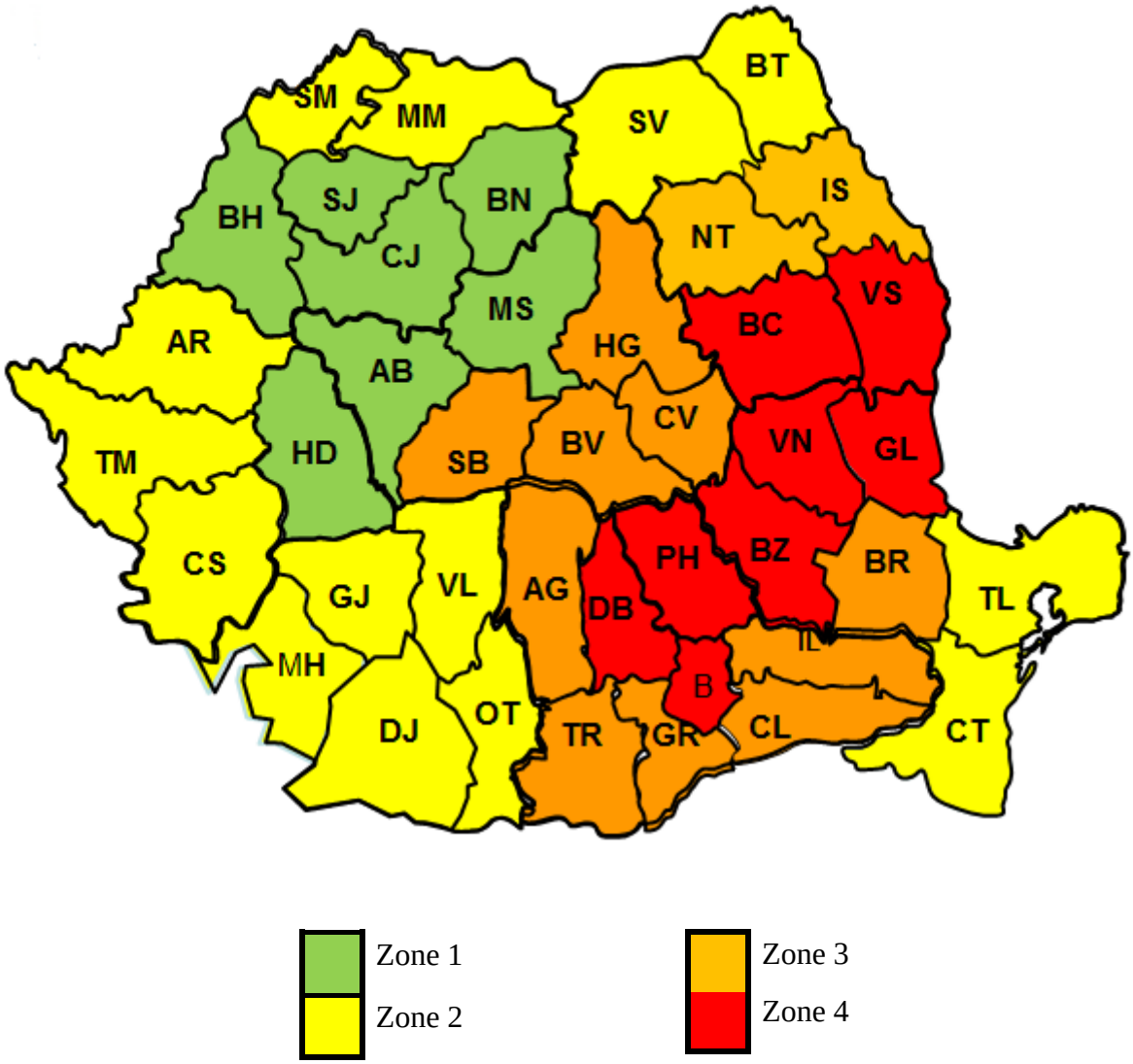
Nowadays in Romania several seismic zones are delimited, these being (Mărmureanu, 2009 and INFP): Vrancea area, East Vrancea area, Crișana - Maramureș area, Banat area, Făgăraș - Câmpulung area, Danube area. If in all other areas, excepting Vrancea, the maximum magnitude recorded was 6 in this case study the focus was on earthquakes generated in Vrancea area.

Vrancea is the main and the most complex seismic area of the country being at the same time one with the best-defined seismic activity in Europe. The earthquakes in this area occur at an intermediate depth of between 60-220 km and affect about 50% of the entire territory of the country. Bucharest is the 10th capital in the world according to the exposure to earthquake risk. The foundations on which it is based are made up exclusively of quaternary deposits, these having the role to accentuate the movements caused by an earthquake.

There are several parameters used when talking about earthquakes: magnitude, intensity and ground acceleration. If the **magnitude** has a unique value not influenced by the distance from the epicenter that gives us information about the seismic energy accumulated inside and released in the hypocenter when the earthquake occurs, the **intensity** reflects the impact at the ground level following an earthquake, taking different values depending on location. In addition to these two notions, often used and somewhat better-known **ground acceleration** is a third parameter on which we will focus, because from the perspective of the impact on buildings it is the most relevant. This tells us how much the earth is moving in a certain area when the earthquake occurs and incorporates information about the ground characteristics in which the seismic waves propagate.

Following the analysis performed on the insurance market in Romania, I noticed that there is no unitary approach on how the territory of the country is split in zones depending on the exposure to the seismic risk, therefore, starting from the Romanian seismic map I proposed 4 seismic areas to be used by all the insurance companies: a territorial division on 4 areas:

Figure no. 1 **Counties distribution on seismic zones**



Source: Author processing based on seismic risk map RO-RISK, 2016

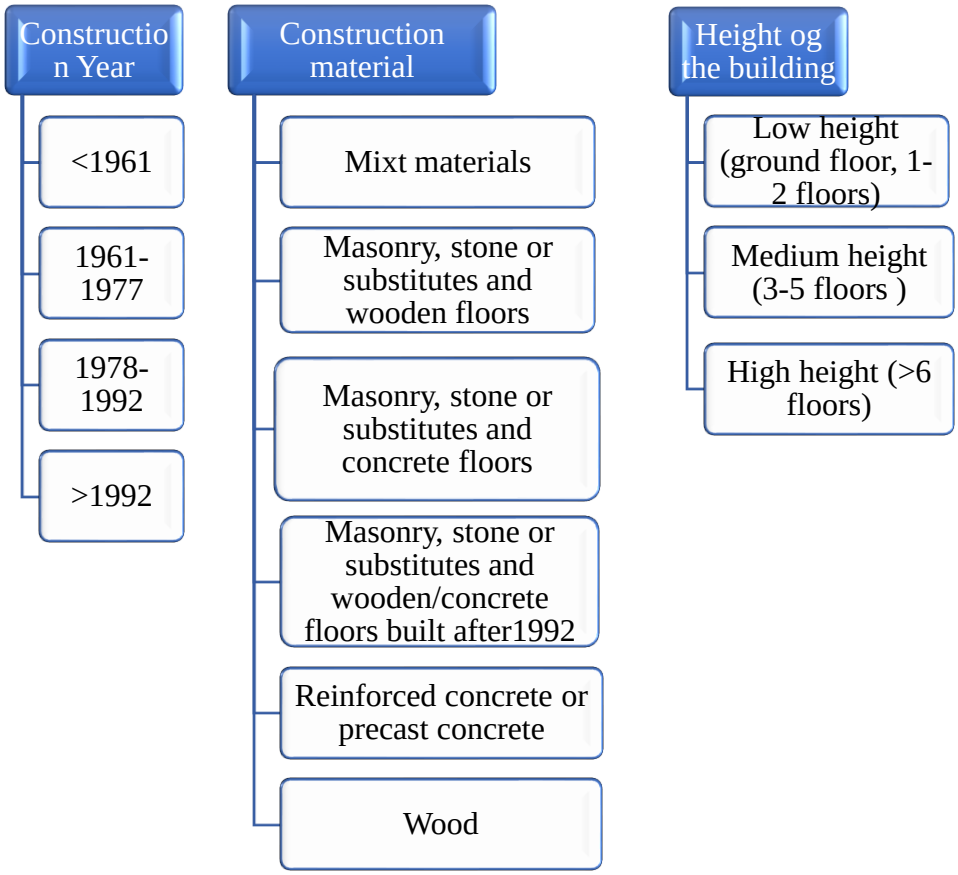
Damage degree of buildings is influenced by 3 main elements:

- **Construction year** is important because it is closely related to the way the buildings were constructed at that moment, the seismic code in force at that time and the stage of the research regarding the anti-seismic construction, as well as the number of important earthquakes to which it was exposed over time.
- **The construction material** is important from the point of view of how it takes over the lateral movement of the building caused by the horizontal displacement of the tectonic plates during the earthquake. The flexibility of the materials used is a first determining factor in diminishing the damage degree of the building.
- When it comes to the **height of the building** it is known that the lateral movement of the building will be felt much stronger as the height of the building increases, the

amplitude on the upper floors being significantly higher compared to the ground floor of the building.

The relevant parameters for the analysis of the housing stock have been presented, but we must establish for each of them what are the values that we will consider when classifying the buildings. In order to achieve this goal, we used the classification considered by SeisDaRo system developed by the INFP research to determine the material damages and the victims caused by an earthquake in Romania, resulting a number of 35 categories.

Figure no. 2 **Parameters considered for classification of the housing stock**



Source: Author processing based on SeisDaRo classification (Toma Dănilă et. al, 2018)

In order to determine the damage degree of the Romanian housing stock, the methodology used is based on the results obtained using the SeisDaRo system developed by the researchers from the INFP. This methodology considers the building as a unit of reference, but from the point of view of the insurance field, it was necessary to transpose them at the level of homes and for this we used the share of homes in categories of buildings according to their height at the level of each county and we first established the average number of homes for each of the categories, subsequently the number of homes with a damage degree

being determined by multiplying the number of buildings, with the average number of homes per building and the weight at the county level of the buildings of that height category.

The system generates the number of totally damaged buildings but also the MDR- Mean damage ratio for each locality in Romania.

$$MDR_i^k = \frac{DR0_S^k N_{Si}^k + DR0_M^k N_{Mi}^k + DR0_E^k N_{Ei}^k + DR0_C^k N_{Ci}^k}{N_{Ti}^k} \quad (4.1)$$

where MDR_i^k – mean damage ratio, S, M, E, C represents the damage degree of the buildings: S- slight, M-moderate, E- extensive, C- complete, and N represents the total number of buildings form k category.

We have determined the current impact of an earthquake with exactly the same characteristics as of the one of the 3 major events that occurred in the past in Romania.

Table no. 1 **Scenarios considered in order to analyze the damage degree of buildings**

Occurrence date	Magnitude	Depth (km)
10 of November 1940, hour 03:39	7.7	150
4 of March 1977, hour 21:22	7.4	94
31 of August 1986, hour 00:28	7.1	131

Source: Author processing based on INFP data

The results obtained show that from the point of view of the totally damaged buildings the most exposed counties are Vrancea, Buzău, Prahova, Galați, these also registering a significant number of partially destroyed homes.

In order to determine the financial impact in Romania, starting from the values obtained in terms of the number of homes that would be totally or partially damaged, we used the following reasoning in the calculation:

- Losses are determined by the replacement value the affected homes;
- We determined the value of the partial damages by applying percentages to the losses related to the homes with total damage, as follows: the value of the homes with a low degree of damage represents 2% of the value of totally damaged homes for those with a moderate degree of damage 10%, and for those with a high degree of damage 50%. The methodology is based on the values considered in the Selena software, which is used for determining financial losses as a result of earthquakes.

- We have determined the average surface of homes for each county, the values obtained being between 39,5 sqm and 66,2 sqm, the counties with the highest home surface being Ilfov, Timiș, Satu-Mare, Brașov, Constanța, and at the opposite site being Brăila, Vaslui, Călărași, Mehedinți, Teleorman;
- We have determined the total surface of the homes with a certain damage degree by multiplying their number with the average surface at country level;
- The value of total losses was calculated by considering the replacing value per sqm.

With regards the replacement value, we have used as a starting point the underwriting norms of a non-life insurance company representative for the insurance market in Romania. Therefore, we will consider 2 scenarios:

a) Using an average replacement value of 875 sqm for all the homes in Romania
b) Correlating the information from the underwriting norms on those 6 categories of homes considered in this paper based on their construction material. In this case the replacement value took values between 350 and 900 Euro/sqm.

The results obtained for the two scenarios are comparable, the lower value being obtained as expected, in the case of using scenario 2, respectively considering a differentiated replacement price depending on the construction material of the building. We also note once again that the most significant impact is registered in the case of an earthquake with the same characteristics as the one produced in 1977.

Table no. 2 **The replacement value in Euro for the homes with different damage degree considering the 2 scenarios regarding the replacement value and the 3 earthquakes**

Earthquake scenario	Total
Scenario 1: the replacement value is 875 Euro/sqm	
1940	4.902.960.000
1977	7.255.890.000
1986	1.826.810.000
Scenario 2: the replacement value is differentiated based on the construction material (Euro/sqm)	
1940	3.545.180.000

1977	5.527.660.000
1986	4.146.370.000

Source: Author processing based on INFP, INS data and information from underwriting norms of an insurance company

Once determined the level of financial losses that could be generated by an earthquake in Romania, we continued the analysis by determining the value of the insured losses. The total value of the insured amounts is about 47 billion Euro, in the context of a value of the insurance premiums collected in 2019 of 47 million Euro. Given that PAID started the activity in 2010, we considered relevant to determine the total amount of premiums collected over the entire period, the value obtained being of approximately 230 million Euros.

PAID also has a reinsurance program in amount of 900 million Euros, but by centralizing all these data we identify a significant gap between the level of losses that Romania could record and that of the insured losses, and more than that between the level the premiums received by PAID, including the amounts that could be obtained from the reinsurer versus the amount of the indemnities that the company should pay this gap could create concern in case of a significant event.

The gap between the potential and insured losses is between 2.4 billion Euro and 4.4 billion Euro, the smallest value being recorded in the context of an event similar to the one in 1940 and at the opposite site, the highest value is recorded in the case of an event with the same characteristics as the 1977 earthquake.

The results indicate the need to consider integrated actions in order to cope with a catastrophic event such as an earthquake. In this context, CAT bonds could be a solution to cope with such an event if the insurance coverage will have a higher value. The cedent could be represented by PAID and based on the collaboration with INFP it could be chosen a parameter trigger of the modeled losses, in this case the amount would be released if the losses would reach a level determined by using a software for modeling.

Insurance companies' decisions to be interested in such an instrument is based on the same premises: the growth of the insured portfolio so that reinsurance would no longer be the best solution or it will be necessary to supplement the reinsurance coverage.

Also, insurance companies that are part of a Group that offers coverage in several countries may choose the option of issuing a multi-risk bond in various areas: for example, earthquake in Romania and Italy, storms in France.

Given the current situation of Romania, in which the Government has an important role in case a major event occurs, in conjunction with the insurance coverage that is relatively small, the analysis of the utility of such a financial instrument should be carried out.

CONCLUSIONS

Romania is a country with a significant exposure to earthquake risk, mainly due to the seismic activity in the Vrancea zone, this being an extremely well-defined area, but at the same time characterized by a great complexity at the European level.

A second type of events that generated significant losses over time and whose frequency is increasing is represented by floods. In many cases, it was necessary to release some amounts from the Government funds especially created to manage the consequences of these events or in other cases to request help from the European Union Solidarity Fund.

In the context where in order to cover the losses caused by higher frequency events, such as **floods**, it was necessary to call for external assistance even if the material damages registered is at a much lower level compared to those that could be caused by a major earthquake it is necessary to pay special attention to these types of events and find solutions for the best management of the consequences.

The coordinates of catastrophic risks: low frequency and significant impact are one of the reasons why it is difficult for population to perceive their impact and the primary feeling is that they will not face such an event. For a lot of people the powerful **storms**, which have been felt more and more frequently in the last period, is considered a real danger than a major earthquake precisely because they have encountered such events more often and the impact is somewhat "alive" in their minds: they have faces such events, either watched on television or read from various sources recent information about the damage caused.

Considering these aspects, we will continue to propose a series of solutions that will lead to the increase of the insurance coverage in Romanian because only in this way I think that the population will be able to be prepared for catastrophic events, the proposed actions being complex and addressing at the same time several aspects: financial, risk awareness and reaction in critical situations.

The mandatory home insurance is the first aspect that will be addressed, its redefinition is the most important factor that would contribute to an increase of the insurance coverage. Further I will present a proposal on how the defining elements should be modified:

- **Risks covered**

To address the needs of the population throughout the country, regardless of the locality in which they are located, we propose to be added some risks to which they are also exposed.

Even if when the mandatory home insurance was introduced, the decision was made to cover only three risks, in order to increase the insurance coverage, the extension of the covered risks is a viable solution that must be considered. The main purpose is to increase the population at risk or in other words each of the homeowners to find on the list of risks covered by mandatory insurance real exposures that may represent a threat to their homes.

Therefore, I consider that the following risks can be covered:

- Storm: this being a violent phenomenon that has increased in intensity and frequency in Romania lately;
- Hail: by the size of the ice particles formed they can affect home exterior;
- **Tornadoes:** even if they do not have the size of those in the USA, unfortunately they have become frequent and with direct consequences, in the form of the material damages registered.

In addition to introducing these new risks, an increase in the transparency of mandatory insurance should also be considered, and from the perspective of the insured risk I consider that on the insurance policy of each home a detailed presentation of the insurance premium should be made for each of the covered risks.

In order to determine the insurance premium for each type of risk included in the insurance policy, it is necessary to consider the location where the home is located, respectively the use of risk maps. In the paper I have presented a proposal on how to split Romania in 4 major areas depending on the ground acceleration, but similar maps must be defined for the other risks covered.

- **Insured amount**

Another element of the mandatory home insurance policy that will be discussed is the insured amount. Currently, there are only two options for a new insurance policy: 20,000 Euro or 10,000 Euro, the value being influenced by the construction material of the home.

Although the current design brings simplicity and clarity among the population on the insurance policy, I think that more flexibility would also lead to an increase of the insurance coverage.

Therefore, I believe that the insured amount should be determined as a product between the unit value (value / sqm) and surface. This method of calculation would diminish the existing gap between the maximum indemnity that an owner receives from PAID and the replacement value of the home. If a significant event occurs and the home is completely destroyed the amount received as indemnity from PAID would provide the possibility of bringing the home to the form prior to the event occurring.

Even though the new formula proposed requires a more complex calculation than the existing one, I consider that it responds better to the owners' needs and can be easily understood. By using this mechanism, the insured amounts would be higher, therefore the insurance premium must be adjusted, but the final purpose of the insurance, to allow the insured object to be brought to the form before the event occurs is fulfilled.

- **Insurance premium**

Once the insured risks are modified and the insured amount, it is obvious the need to define a flexible insurance premium based on home location, construction material and height of the building.

For each of the insured risks, an insurance premium should be determined, and the total amount should be their sum. It is very important to keep the values of the insurance premium differentiated for each of the risks, because only in this way population can understand which are the greatest dangers they can face, how much they pay to be insured for each of the risks.

Obviously, for a proper management of all this information, **it is necessary to develop an application to issue PAD policies that incorporate risk maps, the reconstruction values differentiated depending on the construction material and the module for calculating the insurance premium for each risk covered**. Basically, when an owner conclude a mandatory policy, according to his postal code, the year of construction, the building material, surface and the height of the building the insurance premium will automatically be determined the insurance premium individually on each of the risks and implicitly the total value to be paid.

In addition to the options already presented with regards to the characteristic parameters of the mandatory insurance policy, another element that should be considered in order to increase the insurance coverage is organizing risk awareness sessions in each county, the impact of this specific sessions being significantly increased considering that the risks applicable to each area would be addressed specifically. **Campaigns carried out at the level of the whole country are also effective, but I think that the ones applied and specific to the risks in each county are more efficient due to the specific content of the area and thus they are more easily understood by the population.** Using examples of situations, they have encountered or heard about in their area would also add value. Local education institutions should be involved in long-term action plans to raise awareness among children, even beginning with the 5th grade. By introducing specific sessions from an early age, the responsiveness will be improved over time, people being much better prepared and know how to react when faced with a specific catastrophic event. This type of preparation could create the premises for introducing an alert system a few seconds before an earthquake, solution that currently is not considered viable because the population is not prepared and the authorities' fears are that through an inappropriate reaction the number of victims may be higher in this case compared with the situation when they weren't announced before.

Also, it should be taken into consideration to provide more **options** in terms of **distribution channels**. The online sale of policies is an appropriate solution among the young population who wants to access services as easily as possible by simply accessing a web page. For older people, sales though **insurance agents** is the most appropriate channel to meet their needs, they can even move to the homes of potential insured persons but also this time frequent campaigns involving **local authorities** to communicate the benefits of the insurance policy, as well as the fact that it is mandatory, are essential. It is not necessary for the authorities to be the one who communicates all the details, but they can invite, within the various events insurance specialists, to talk about this topic, to point out various important information.

The payment methods of the insurance premium should also be diversified. Being a mandatory insurance, **the collection of the premiums could be associated with the payment of the annual tax**, by this method the degree of collecting the premiums could be increased. Also, **online payment** is a successful option for young people.

All the options presented so far have the purpose of increasing the insurance coverage through preventive actions, but also special attention must be paid in the area of control and

detection mechanisms, , especially when the policy addresses the needs of the owners, they understood its usefulness and the risks to which they are exposed. The **supervisory authority** should first be shifted from the mayors to an **independent authority whose main purpose is not to get the voters' vote.** It should be frequently run reports on non-insured homes, first sending an information to the owners allowing them a reasonable time frame in which they would be able to conclude the insurance policy, and if neither this system works the next step is to send the fine directly to them for non-compliance with the legislation in force. This activity could be taken over by PAID and carried out at centralized level throughout the country. I think that PAID would be the most appropriate to carry out these monitoring because it can use the results of the analysis and correlation with other information, it can initiate additional actions in areas where the insurance coverage has not reached the expected level.

The fact that Romania currently has a mandatory home insurance must be seen as a positive aspect, the bases of such a product being already designed, a part of the population even if it did not concluded the insurance they heard of it and through the actions presented the product and the management of the consequences of a significant event could be improved.

Catastrophes being complex events, with complex and major effects, a joint effort is required from the public authorities, PAID, insurance companies in order to find the necessary levers and to prepare the population in the face of future events.

Therefore, the main beneficiaries of our approach are:

- PAID- the proposals regarding the redefinition of the mandatory home insurance policy being analyzed and implemented as well as the levers for increasing the insurance coverage;
- Insurance companies: can implement the proposed standardization regarding the territorial division of Romania according to the exposure to the seismic risk, delimitation that is based on the ground acceleration. Also, the increase of the insurance coverage and also risk awareness leads an increased number of optional insurances by the insurance companies, therefore higher income. Even if the sum insured by the compulsory insurance is higher, the insurance companies have as main component of insurance coverage the content and extension of the list of risks to those not covered by mandatory insurance.

- Public authorities: first of all, it should feel a smaller financial impact at the state budget when a catastrophe strikes, and it is not necessary to release some amounts from the emergency funds made available to the Government. By diminishing the financial resources allocated in the post-event actions, the state authorities can focus on preventive actions, their implementation leading to diminishing the future impact. An example would be the rehabilitation of a larger number of buildings with a red dot. Moreover, by raising the level of risk awareness, actions can be taken to implement an alarm system in case of an earthquake.
- The population, by being aware of the dangers to which they are exposed and the options they have in order to be able to cope financially with such events, understanding and participating in simulation exercises that can save their life in case of a real event.

The future directions for the development of this work are represented by the coverage of the other risks included in the mandatory home insurance and the same steps for the territorial delimitation of the country and the creation of risk maps, the analysis of the factors that give the buildings vulnerability in the case of the other risks and the evaluation of the financial impact.

Also, from the point of view of the earthquake risk, the impact of the crustal events that have the epicenter in one of the other seismic zones could be analyzed, with the exception of Vrancea.

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