

UDK: 3.076:366.6:368:369.013.5:34(430.1)

*Authors: certified actuaries - Actuarial, Statistics and Solvency Risk Management Function*

**Najdana N. Spasojević, MSc<sup>1</sup>**

**Mirjana V. Marković, MSc**

**Jelena M. Kulaš Kostić, MSc**

## **OVERVIEW OF THE ACTIVITIES OF INSURANCE COMPANIES IN NORTH AMERICA UNDER THE IMPACT OF CATASTROPHE LOSSES CAUSED BY CLIMATE CHANGE**

Climate change has increased the *severity and frequency* of natural hazards, thus leading to catastrophe losses. There is a *growing need to reduce adverse effects on international economies, property and health of people*, which is why different types of insurance protection are created to respond to climate change and its consequences.

The state aid in North America, combined with optional insurance provided by private insurance companies, is but one of the responses to these challenges. This model, however, has displayed certain weaknesses such as moral hazard, adverse selection and the lack of solidarity. Fortunately, this can be overcome by combining compulsory and private insurance, state aid and earmarked reserve funds into the creation of an insurance model - a comprehensive coverage of natural hazards - as the only model that meets the current needs for protection.

**Key words:** *climate change, natural hazards, catastrophe losses, insurance, reinsurance, activities of insurers.*

---

1 e-mail:  
najdana.spasojevic@dunav.com  
mirjana.markovic@dunav.com  
jelena.kulas@dunav.com

## 1. Introduction

The researches have shown that in the last decades, climate changes have had a widespread impact on natural and human systems and activities. The observations of this evident impact of climate change are relatively recent. It is believed that this impact in Serbia is still insufficiently explored, whereas in the rest of the world, methods and models for alleviation of financial consequences produced by climate change have already been developed.

In view of the fact that climate change causes catastrophe losses and, consequently, high claim compensations, in recent decades, the leading world's reinsurers, Munich Re and Swiss Re, have intensified their focus on the study of this phenomenon and its effects on insurers' and reinsurers' operations. Comprehensive studies of this issue have been developed and supported by multi-year statistical data obtained by observing these occurrences and their patterns. In order to determine the trend of these phenomena, the analyses use the models that are developed for all natural hazards individually, according to their number and scope as well as their maximum possible consequences on solvency and business operations of insurers and reinsurers.

## 2. Interdependence between Climate Change, Natural Catastrophes and Losses in Insurance and Reinsurance Industry

Climate change<sup>2</sup> is a permanent and considerable change in the statistical distribution of weather patterns over an extended period of time, ranging from decades to millions of years. Climate change is caused by different factors, such as: biotic processes, variations in solar radiation received by Earth, plate tectonics and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change, often referred to as „global warming“.

Through the observations of climate change<sup>3</sup>, it was concluded that it is caused by unlimited burning of fossil fuels – coal, oil and natural gas. This also leads to an increased concentration of carbon dioxide released into the atmosphere. About 25 billion tonnes of carbon dioxide is released in the atmosphere every day, whereas 800 tonnes of CO<sub>2</sub> are spewed every second causing the greenhouse gas layer around the Earth to get thicker and in turn, make

---

<sup>2</sup> Maslin Mark, (2004), *Global Warming, A Very Short Introduction*, Oxford University Press, page 15, 21-22.

<sup>3</sup> Maslin Mark, (2004), *Global Warming, A Very Short Introduction*, Oxford University Press, page 4-12.

the Earth warmer. By 2100<sup>4</sup>, this trend of CO<sub>2</sub> emission could increase the average temperature on Earth from 1.4 °S to 6.4 °S<sup>5</sup> and sea level rise between 0.18 and 0.38m.

The impact of climate change is a global problem felt in all parts of the world, on all continents. It is beyond doubt that climate change caused by human activities and operations is gathering pace, whereas the level of toxic gases is particularly on the rise. All important indicators such as: air temperature, sea level, melting of glaciers and polar ice caps, snow storms, quantity of precipitations and the rise in the number and intensity of extreme weather indicate climate change which is not the consequence of natural climate fluctuation but global warming.

The Intergovernmental Panel on Climate Change, addressing this issue, estimates and envisages that in the period between 2050 and 2100 climate change will have a strong social and economic impact on the lives of people and their environment. It is considered that this will be manifested in the increased number of floods, tropical cyclones and sea level rise which, for insurance industry, will mean higher property claims and reduced or non-existent insurance cover provided by private insurance companies.<sup>6</sup>

To respond more adequately to the need for coverage of natural catastrophe risks, all leading global insurance and reinsurance companies attentively monitor the statistics and consequences of this phenomenon. Natural catastrophes have always had an important role in insurance industry, reinsurance in particular. For the best possible assessment of natural hazards, reliable and high-quality loss information and database are vital. A comprehensive global disaster database has been widely available since 1980. It provides statistical data and enables trend analysis at the global level, continental level and country level. For some countries, such as Germany and the United States of America, these data have been available since 1970.

### **3. Data on Losses Caused by Natural Hazards for the Period from 1980 – 2014, by Continents**

The data on loss events are registered and recorded after each event and they include the information of: dead, disappeared and injured persons, number of loss events, total losses and losses in insurance industry, with some other details of insured and uninsured damages. Summary data on weather-related losses for the period 1980 – 2014 are provided in the Table 1.

---

4 <http://climatechange.ws/introduction>.

5 [http://wwf.panda.org/sr/klimatske\\_promene](http://wwf.panda.org/sr/klimatske_promene).

6 Source: IPSS SPM 2007, pp.13, Table SPM.3.

**Table 1 Summary data on weather-related losses for the period 1980 – 2014**

<b>Continent</b>	<b>Number of loss events</b>	<b>Total losses in billion US Dollars</b>	<b>Insurance losses in billion US Dollars</b>	<b>Number of fatalities</b>
<b>North and Central America and Caribbean</b>	4,800	1,452	639.20	59,500
<b>South America</b>	1,152	99	6.58	25,500
<b>Europe</b>	4,032	561	178.60	144,500
<b>Africa</b>	1,920	33	2.82	34,000
<b>Asia</b>	5,760	1,056	84.60	578,000
<b>Australia/Oceania</b>	1,536	99	28.20	8,500
<b>Total</b>	19,200	3,300	940.00	850,000

Source: [www.munichre.com](http://www.munichre.com) – Geo Risks Research, NatCatSERVICE – as at January 2015

The data in the Table 1 show that:

- the highest number of losses was in Asia, North America and Europe,
- total economic losses were the highest in North America, Asia, and Europe, where the scope and severity of natural disasters as well as the affected area were the greatest,
- losses in insurance industry were the costliest in North America, Europe and Asia, which are among the most developed continents where natural catastrophe cover has the biggest share,
- the number of fatalities was the highest in Asia due to a wide and densely populated area,
- when generally analysing the world map of natural catastrophes from 2004 to date, it can be observed that this space is divided into three horizontal areas by the frequency of natural hazards. In the first, northernmost area, where Canada, Iceland and Russia are situated, there is a very small number or no natural hazards at all.

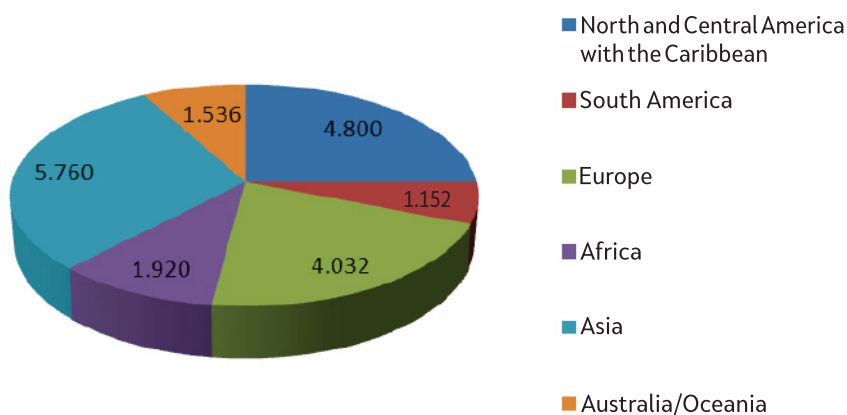
---

## ***Overview of the Activities of Insurance Companies in North America under the Impact of Catastrophe Losses Cused by Climate Change***

---

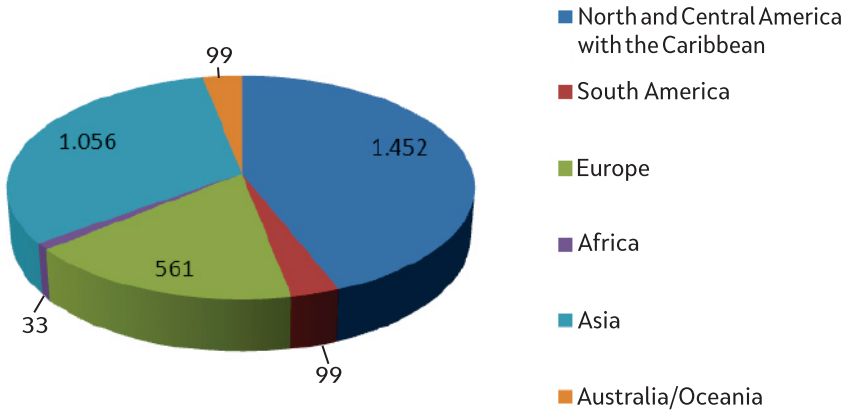
In the second, central area, natural hazards are densely distributed across the territory which includes: North and Central America, West and South Europe, Great Britain, Mediterranean countries, countries of the Balkans, Iran, Japan, China, Indochina, India and Indonesia. In the third and southmost area, natural hazards are concentrated only along the rims of the continents of South America, Africa (except for the northern part of the continent), Australia and New Zealand.

**Figure 1** Number of loss events for the period 1980 - 2014, by continents



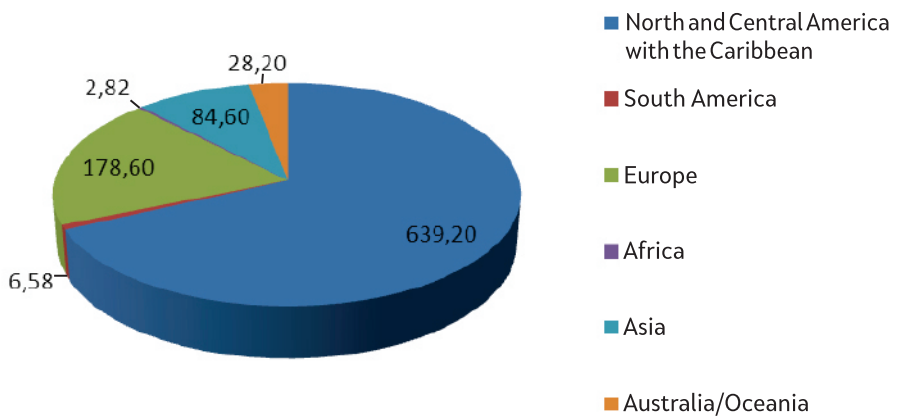
Source: [www.munichre.com](http://www.munichre.com) – Geo Risks Research, NatCatSERVICE – as at January 2015

**Figure 2 Total losses in billion US Dollars for the period 1980 – 2014 by continents**



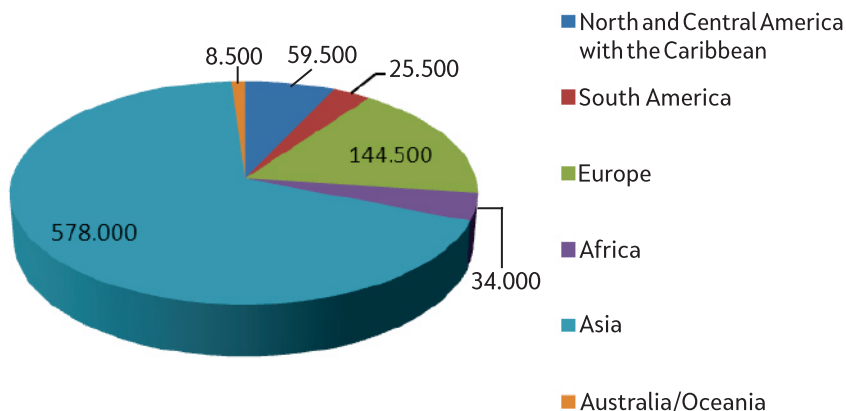
Source: [www.munichre.com](http://www.munichre.com) – Geo Risks Research, NatCatSERVICE – as at January 2015

**Figure 3 Losses in insurance industry in billion US Dollars for the period 1980 - 2014 by continents**



Source: [www.munichre.com](http://www.munichre.com) – Geo Risks Research, NatCatSERVICE – as at January 2015

**Figure 4 Number of fatalities for the period 1980 – 2014 by continents**



Source: [www.munichre.com](http://www.munichre.com) – Geo Risks Research, NatCatSERVICE – as at January 2015

## 4. Insurance System in North America

### 4.1. National Flood Insurance Program (NFIP)<sup>7</sup>

Natural hazards such as floods, deluge, storms, hurricanes and earthquakes are highly present on the American territory.<sup>8</sup> System of insurance against natural hazards is an interaction between private insurance market and state aid within the NFIP. This has become unavoidable after the catastrophic floods and hurricanes in the late 1960s had led private insurers to almost completely withdraw from the market. Insurance protection against natural disasters is usually provided through private insurers. In America, the role of a reinsurer is assumed by the Federal Emergency Management Agency (FEMA<sup>9</sup>), which is organized at the state level, as part of the Department of Homeland Security (DHS<sup>10</sup>). The surplus premium, which remains after the payment of

<sup>7</sup> NFIP – National Flood Insurance Program, created in 1968.

<sup>8</sup> Quinto C., (2012.), *Insurance Systems in Times of Climate Change - Insurance of Buildings Against Natural Hazards*, Springer, Berlin, page 69.

<sup>9</sup> FEMA – Federal Emergency Management Agency: Purpose of the Agency is to prepare, protect and recover the insureds from the consequences of all natural hazards.

<sup>10</sup> DHS – Department of Homeland Security.

claims and expenses, private insurers transfer to the FEMA fund which directly assists the National Flood Insurance Fund (NFIF<sup>11</sup>). If the losses arising from natural hazards exceed the premium income, the reimbursement of excess loss is again transferred onto the primary private insurer.

The NFIF operates as follows:

- The insureds have access to the insurance cover only if the community, in whose area the prospective object insured is located, has joined the NFIF. Unfortunately, communities are not obliged to join the fund.
- Similarly, the insureds are not obliged to take out insurance against natural hazards even when their community has joined the NFIF, except for those insureds who take out federally funded mortgage loans. Generally speaking, this type of flood insurance is based on double voluntariness, which leads to a relatively low insurance density. Only 49% of single-family households are insured in this way.
- From an actuarial point of view, the NFIF is characterized as follows:
  - This cover is not a replacement value insurance but the insured is paid only fair value or the repair costs, whichever represents the lower amount. In addition, the insurance sum is limited to USD 250.000 and to USD 500.000 from which it can be concluded that there is an insurance limit.
  - The premium depends on the sum insured, type of insured building and duration of ownership (it is interesting to note that in Serbia, the letter is not included in the risk assessment criteria) and something which is specific for American architecture, height of building.
  - The excess amounts to between USD 500 and USD 1.000.
- The NFIF is affected by the problems of moral hazard and adverse selection, which is caused by the lack of solidarity.

#### **4.2. Florida Hurricane Catastrophe Fund (FHCF)<sup>12</sup>**

The Florida Hurricane Catastrophe Fund<sup>13</sup> was created in 1992, after Hurricane Andrew and following the withdrawal of private insurers due to large losses occurred after multiple hurricane events had hit Florida. The FHCF is structured as a tax-exempt state trust fund administered by the State Board of Administration (SBA<sup>14</sup>). It is interesting to note that in America, windstorm

---

11 NFIF – National Flood Insurance Fund.

12 FHCF – Florida Hurricane Catastrophe Fund.

13 Quinto C., (2012.), *Insurance Systems in Times of Climate Change-Insurance of Buildings Against Natural Hazards*, Springer, Berlin, pp 72-73.

14 SBA – State Board of Administration of Florida.



---

## ***Overview of the Activities of Insurance Companies in North America under the Impact of Catastrophe Losses Cused by Climate Change***

---

covers vary state to state, and there is no single fund operating at the level of the United States of America (for example, there is a fund for Florida, for Hawaii....)

The FHCF acts as a reinsurer, whereas direct insurers are still private insurance companies. However, as opposed to catastrophe flood covers, to provide a windstorm cover, all Florida insurers must join the FHCF fund and pay the premium determined according to fixed and precisely defined criteria.

The right to use the funds earmarked for windstorm insurance can be claimed after the disaster is officially declared by the National Hurricane Center (NHC) following the occurrence of a storm.<sup>15</sup> Private insurers must first pay the claims arising from the loss event up to the specified amount of their retention, whereas the remaining portion of the loss is paid by the FHCF. If the FHCF cannot pay the indemnity from its fund, the SBA has the right to top up the fund by collecting its outstanding debts.

Since the windstorm insurance is not compulsory, many people do not insure against it, especially those living in the highest risk areas which entail the highest premiums. On the other hand, insurers have the right to refuse to provide coverage to the insureds living in high-risk areas. In view of that fact, the Citizen Property Insurance Corporation was created<sup>16</sup> as an additional insurance protection against hurricanes, for all insureds, including those to whom other insurance companies had denied coverage. This Corporation is funded from insurance contracts, that is, from effected policies and from additional premium (loading stipulated under all insurance contracts for building structures) of private insurers paid for all covers of building structures they insure, even when the insured building is out of the high-risk area. In this case, the FHCF assumes the role of the reinsurer. Unfortunately, despite such developed system of protection against hurricanes and windstorms, the problems of moral hazard, adverse selection and lack of solidarity are still present in practice.

### **4.3. Major Problems of Solidarity, Moral Hazard and Adverse Selection<sup>17</sup>**

Since the insurance against natural hazards such as flood and windstorm is not compulsory in the United States of America, it can be concluded that the number of covers provided for this risk is quite small. After the occurrence of a catastrophe loss event, everything is in hands of the state, that is, up to its current ability to provide assistance. While relying on a particular state

---

<sup>15</sup> National Hurricane Center – Consorcio, Diversity of Systems, P. 199.

<sup>16</sup> Citizen Property Insurance Corporation (Citizen).

<sup>17</sup> Quinto C., (2012.), *Insurance Systems in Times of Climate Change-Insurance of Buildings Against Natural Hazards*, Springer, Berlin, page 73-74.

aid, policyholders are even less interested in insuring against those risks, which creates the moral hazard problem.

Additionally, these circumstances undermine the motivation of policyholders to take preventive measures and do not even prevent them from building homes at the very same place in, more often than not, a high-risk area, which had been hit by flood or windstorm. Provided that the state has sufficient funds, they will be allocated to the policyholders to build their homes at the same place, regardless of the risk.

Low deductible is one more reason why policyholders are not very motivated to invest in preventive measures. A higher deductible could be a solution to this problem if preventive measures are still not implemented after the occurrence of a loss event.

The NFIF, the FHCF and the Citizen Property Insurance Corporation are also affected by adverse selection problem. The policyholders, who are not exposed to natural hazards, mostly do not purchase insurance against such risks and thus, insurance cover includes only the bad risks for which, consequently, there is no cover, at least not a sufficient one.

Adverse selection has caused serious financial problems. In the past ten years, before Hurricane Katrina, on four occasions, the FEMA had to turn to the Treasury Department for a loan in order to help the NFIF to be solvent. After Katrina, the debts of the NFIF have considerably increased and presently, they amount to 17 billion US dollars.<sup>18</sup>

It has been observed that since 1980, only those policyholders who are evidently exposed to the windstorm risk actually take out insurance against it. During the years, this has led to an adverse selection and accumulation of bad risks, and thus the inability of insurers to cover the losses. These operations also produced a negative impact on reinsurers who accumulated only the bad risks, while the good ones were retained in the insurance portfolio of direct insurers.

According to the above, the following conclusions can be drawn:<sup>19</sup>

- The prevention of adverse selection and securing solidarity among the insured parties are a prerequisite for a properly functioning insurance system. Otherwise, it will quickly lose its financial ability to cover all losses due to the lack of sufficient funds earmarked for insurance against natural hazards.
- The larger the set of risks (both good and bad) incorporated into insurance system, the sooner adverse selection is avoided and solidarity among policyholders can be ensured. Good and bad risks must be included in equal measure since this is the only way that equilibrium between risks can be ensured.

---

<sup>18</sup> Consorcio, Diversity of Systems, p. 190 et seq.

<sup>19</sup> CCR, Catastrophes Naturelles, p. 14 19 et seq.; Consorcio, Diversity of Systems, p. 67 et seq.; Von Ungern-Sternberg, p. 105 et seq., 113 et seq.

---

## ***Overview of the Activities of Insurance Companies in North America under the Impact of Catastrophe Losses Cused by Climate Change***

---

- Due to a growing number and amount of claims resulting from natural hazards, preventive measures must be improved.
- Official declaration of a disaster by a regulatory authority should be avoided in order to accelerate the settlement of claims, as this is the case in some European countries.

At the end of 2004, the season of very strong and devastating hurricanes left the FHCF and the Citizen Property Insurance Corporation almost insolvent. The FHCF proved to be inadequate to cover natural hazards as it had used up its funds despite paying only 10% of 22 billion US dollars of the total loss. At the end of 2005, following one more season of strong hurricanes, the fund was even weaker and had to be aided by the SBA which collected its outstanding debts.

The American system of protection against natural hazards such as floods and windstorms is not sufficient to cover the losses with premium, which is why it is said to suffer from the „error in insurance model“. Major problem of this model is the lack of solidarity principle and equilibrium between good and bad risks.

This problem could be overcome, as follows:

- Cover for natural hazards, particularly the risks of windstorm and floods, should be accessible to all policyholders at affordable premiums.
- Insurance against natural hazards should be compulsory for all, regardless of the risk area in which insured buildings are situated.
- The Citizen Property Insurance Corporation should hold a legal monopoly over this type of cover, which should become a statutory cover.
- At the state level, the Flood Management should educate policyholders about the conditions and method of providing insurance cover against natural hazards in terms of: cover exclusions, deductible, premium discounts, preventive measures, risk zones, etc.

In times of climate change, a comprehensive insurance protection with affordable premium will be ensured only provided that the above conditions are fulfilled. This should boost the growth of national economy and help to avoid reliance on the state aid.

#### **4.4. Consequences of “Insurance Model Error” on the Example of Hurricane Katrina<sup>20</sup>**

Hurricane Katrina struck the coastal area of Louisiana on 29 August 2005 and left the gravest consequences in New Orleans. By its strength, it was rated category 5 storm with peak winds of 172 miles per hour. “Eye” of the storm was 23 miles away from the centre of New Orleans and as a consequence of the hurricane, catastrophic floods followed resulting in the loss the compensation of which was paid under the National Flood Insurance Program - NFIP.

After this catastrophe event the situation in the flooded area was the following:<sup>21</sup>

- Many owners did not have an insurance cover against the risk of flood.
- Even in high-risk flood zone, less than 50% of buildings were insured.
- Out of these, some 50-60% had compulsory insurance only because of bank-imposed conditions for construction loans. Out of this number, only 75% had an adequate protection against natural hazards, which amounts to 22% of the total figure.
- Of some 40% remaining, who did not have a compulsory disaster insurance, only 20% had an insurance protection, which is 4% of the total figure.

The above had the following impact on the reconstruction of buildings and population of New Orleans:

- Even 4 years after Katrina, the city still looked as if left to decay, with overgrown grass and shrubs and very few rebuilt buildings.
- Before the Hurricane, the city had a population of about 500.000 people, whereas after 2006, only about 210.000 residents lived in the city. Investigations have shown that 160.000 people changed their address, with only 17.000 having a new address in New Orleans. Two thirds, that is, about 105.000 households reported a new address in a different US state.<sup>22</sup> In 2009, the city had a population of about 300.000 people, which means that some 40% of population had left New Orleans permanently.
- The question of cost effectiveness was raised: should the damaged structures be reconstructed or should new ones be built.

It can be concluded that despite the state aid and the FEMA and the NFIP funds, New Orleans could not recover from the catastrophic loss, and all

---

<sup>20</sup> Quinto C., (2012.), *Insurance Systems in Times of Climate Change-Insurance of Buildings Against Natural Hazards*, Springer, Berlin, pp 75-79.

<sup>21</sup> Kunreuther/Molaison, in: Richardson/Gordon/Moore II, p. 20 et seq.

<sup>22</sup> Logan, in: Richardson/Gordon/Moore II, p. 279, 282 et seq.

because of the inadequate system of prevention and insurance protection. Hurricane Katrina makes it obvious that a comprehensive insurance against natural hazards, based on statutory insurance, is the only insurance model which meets the needs for protection today, and all the more so in the future, due to climate change.

## **5. Conclusion**

Unlimited burning of fossil fuels – coal, oil and natural gas - is the cause of climate change. When these fuels are burnt, they release carbon dioxide into the atmosphere and create the greenhouse effect. Consequently, by 2100, the average temperature on Earth could increase from 1.4 °S to 6.4 °S, whereas the sea level would rise from 0.18 to 0.38m.

As a response to catastrophic losses caused by climate change, insurance companies have developed different types of activities, one of them being the state aid granted in North America, in tandem with optional insurance of the existing insurance companies.

Requirements to be met by this type of insurance are:

- Comprehensive insurance against natural hazards, regardless of the risk exposure and other adverse circumstances, with the affordable insurance price even for those insureds who are highly exposed to risks.
- Solidarity between insureds and insurers as the only way to ensure financial stability and premium sufficiency, as well as the prevention of adverse selection.
- Encouragement for taking and implementing preventive measures, both by the insureds and insurers, which in turn leads to the prevention of moral hazard and investment of insurers into the alleviation of loss events occurred by the effects of nature.

## **Literature**

- Viscus, and W.K., Born, P., (2006), "The catastrophic effects of natural disasters on insurance markets", NBER Working Paper No. 12348, page 2-20.
- Gollier, C., (1997), "About the Insurability of Catastrophic Risks", Geneva Papers on Risk and Insurance 83, p. 177-186.
- Grace, M.F., Klein, R.W., Kleindorfer, P.R., (2004), "Homeowners' Insurance with Bundled Catastrophe Coverage", Journal of Risk and Insurance 71 (3), p. 351-379.
- Dickson, D.C.M.,(2005), *Insurance Risk and Ruin*, Cambridge University Press, Cambridge.

- Dlugolecki, A.,(2009), *Coping with Climate Change: Risk and opportunities for Insurers*, Chartered Insurance Institute, London/CII\_3112.
- Doherty, N.A. & Richter, A. (2002), "Moral hazard, basis risk, and gap insurance", *The Journal of Risk and Insurance* 69, 9-24.
- Jaffee, D.M. & Russell, T. (1997), "Catastrophe insurance, capital markets, and uninsurable risks", *The Journal of Risk and Insurance* 64, 205-230.
- Kleffner, A.E., Neil, A.D., (1996), "Costly Risk Bearing and the Supply of Catastrophic Insurance", *Journal of Risk and Insurance* 63 (4), p. 657-672.
- Levi, Ch. & Partrat, Ch. (1991), "Statistical analysis of natural events in the United States, *ASTIN Bulletin* 21, 253-276.
- Maul, O., (2011), "Catastrophe Risk Insurance Pools: Opportunities and Challenges for the Mexican States", *World Bank Disaster Risk Financing and Insurance Program*.
- Cummin, J.D., Mahul O.,(2009), *Catastrophe Risk Financing in Developing Countries*, The World Bank.
- Christesen, C.V. & Schmidli, H. (2000), "Pricing catastrophe insurance products on actually reported claims", *Insurance: Mathematics and Economics* 27,189-200.
- Quinto, C., (2012.), *Insurance Systems in Times of Climate Change-Insurance of buildings Against Natural Hazards*, Springer, Berlin.
- [www.munichre.com](http://www.munichre.com)
- [www.swissre.com](http://www.swissre.com)

Translated by: **Zorica Simović**