Chapter 13.

INSURANCE AGAINST THE RISK OF NATURAL DISASTERS IN AGRICULTURE

We are increasingly faced with natural disasters which lead to great loss of human lives, destruction of economic and social infrastructure, and environmental damage. Natural disasters have been given increasing importance since 1979, through the adoption of numerous international agreements and political frameworks, as the actual and potential consequences of natural disasters have been assessed to be serious and to take on global proportions.[398]

Catastrophic damages are extreme events that occur due to the action of natural forces, when man has no influence on what happens in nature, but also due to the action of man. In contrast to traditional risks, they are characterized by complex spatial and temporal characteristics, resulting in mutually connected destruction that leads to a significant number of insurance claims.[399] Regardless of how a disaster occurs, its end result is damage of high material value. The risks of catastrophic damages include the risks of natural disasters (earthquakes, floods, stormy winds, volcanic eruptions, etc.), environmental disasters, human factor risks (terrorism, nuclear disasters), and infrastructure risks (risks related to transport systems, water supply, systems for electricity, etc.).[400] Catastrophic damages are characterized by high intensity and low frequency, which makes it impossible for insurance companies to establish a homogeneous community of catastrophic risks, and to ensure the balance of their portfolio. The lack of statistical data makes it difficult to estimate the expected intensity and time of occurrence of catastrophic events, so the risk of inadequate assessment of premiums and reserves is high. Due to bad evaluations, losses can arise that threaten the solvency of the reinsurer. Lack of data and pronounced asymmetric

[398] Jovanović Gavrilović, B., & Gligorić, M. (2015). Natural Disasters and Sustainable Development. *Catastrophic risks and sustainable development,* Kočović, J., Jovanović Gavrilović, B., Đukić, V. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 4.

[399] Tešić, N., & Paunović, M. (2018). Possibilities of Measuring Catastrophic Risks. *Insurance in the Post-crisis Era*. Kočović, J., Jovanović Gavrilović, B., Boričić, B., Radović Marković, M. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 253.

[400] Vujović, R. (2009). *Risk management and insurance*. Belgrade: Čugura print, p. 361.

probability distributions of damage objectively hinder the measurement of catastrophic risks. Therefore, timely identification and accurate quantification of these risks require stochastic models, the development and application of which necessitate multidisciplinary knowledge and appropriate software support.[401] Insurance companies, traditionally conservative, show an aversion to taking on catastrophic risks in insurance and offer a reduced scope of catastrophic damages coverage. The lack of disaster insurance services can significantly hinder the development of society and economy.[402]

Natural disasters naturally destroy property concentrated in a certain area, and that is why the role of reinsurance, which carries out global risk dispersion, is very important. Global dispersion of risk is actually "breaking" into smaller parts and "exporting" from a given area, where in this way not only the insurer is protected, but also the national economy in case of natural disasters. Fragmentation of risk gives the insurer better competitiveness, because he can begin to accept large and heavy risks, which he would not be able to do without reinsurance. Also, premium for those risks remains competitive in the market, although a large risk has been taken. If he were to bear such risks himself, the insurer would not be able to, or his premium would be too high. It has been shown that reinsurance performs an important strategic function in insurance markets by supporting the growth of insurers and increasing their market share.[403]

Despite the increase in the price of reinsurance, the profitability of reinsurers will be affected in the coming period by the fact that many companies have already spent their annual budgets for catastrophic risks.[404]

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[401] Paunović, B., Koprivica, M., & Tešić, N. (2019). Contribution of Digitalization to the Improvement of Catastrophic Risks Measurement. *VII International Scientific Conference EkonBiz,* Starčević, V., Katanić, P., Drakul, B. (eds.), Bijeljina: Faculty of Business Economics Bijeljina, University of East Sarajevo, p. 347.

[402] Doganjić, J. (2014). Management of financial and actuarial risks of formation and investment of reserves in non-life insurance. *Doctoral dissertation,* Kragujevac: Faculty of Economics, p. 23.

[403] Marović, B., Kuzmanović, B., & Njegomir, V. (2007). *Basics of insurance and reinsurance.* Belgrade: Princip Press, p. 392; Biener, C., Eling, M., & Jia, R. (2017). The structure of the global reinsurance market: An analysis of efficiency, scale, and scope. *Journal of Banking and Finance, 77*, p. 213.

[404] Delpuech, C. M. (2020). *Global reinsurers face threat if Covid-19 losses are followed by a major catastrophe*. S&P Global Ratings, 2020, https://www.spglobal.com/ ratings/en/research/articles/200908-global-reinsurers-face-threat-if-Covid-19-losses-are-followed-by-a-major-catastrophe-11634227

The instruments used in predicting weather conditions, for the needs of the energy and agriculture sectors, appeared at the end of the nineties and are called weather derivatives.[405]

Therefore, many developed countries have introduced insurance against mulitiple types of risk and new insurance models such as insuring crops and yields based on weather derivates, insuring the total value of crop production or insuring the income derived from crop production. [406]

Climate change is expected to exacerbate secondary hazards, as wetter air and rising temperatures create more extreme weather conditions, making them more likely to spread events such as wildfires, storm surges, and floods.[407] The rise in temperature at the global level, caused by natural factors and irresponsible human behaviour, causes more frequent extreme heat waves that cause impaired public health, drought, floods, and climate change. Without taking into account the problems associated with the risks of climate change and environmental impact, there is no prosperity in the development of the tourism sector.[408]

The growing trend of catastrophic losses at the international level creates a need for better and more comprehensive risk modelling tools. Reinsurance companies are looking more carefully at their portfolios and accumulated risks, and regulators are increasing their capital requirements. Thus, in the recommendation for the implementation of the Quantitative Impact Study 5 - QIS 5 study for the implementation of the Solvency II directive, the scenario model and the standard factor approach were offered as two basic methods of assessing the catastrophic risks of European insurance companies. According to the QIS 5 study, catastrophic risks are divided into the risks of natural disasters

[405] Zeng, L. (2000). Weather derivatives and weather insurance: concept, application, and analysis. *Bulletin of the American Meteorological Society, 81*(9), 2075-2082.

[406] Radosavljević, K. (2021). Agricultural insurance as a means of financial protection of agribusiness in Serbia. *Contemporary Challenges and Sustainability of the Insurance Industry,* Kočović, J., Jovanović Gavrilović, B., Boričić, B., Koprivica, M. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 208.

[407] Swiss Re Institute (2020). Swiss Re Institute estimates USD 83 billion global insured catastrophe losses in 2020, the fifth-costliest on record, Zürich: Swiss Re Institute, https://www.swissre.com/media/news-releases/nr-20201215-sigma-full-year-2020-preliminary-natcat-loss-estimates.html

[408] Radosavljević, K., Mihailović, B., & Popović, V. (2022). The opportunities of insurance against current risks in tourism, *Development of modern insurance market – constraints and possibilities,* Kočović, J., Jovanović Gavrilović, B., Stojanović, Ž., Mladenović, Z., Trifunović, D., Koprivica, M. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 433.

(storm, flood, earthquake, drought, and others), and disasters caused by the human factor (motor vehicles, fire, ships, airplanes, liability, credit affairs, and terrorism). The results of the study showed that the largest part of the capital requirements of natural disaster risks is related to the risks of storms and earthquakes, followed by floods and droughts. Reinsurance coverage is currently the most effective method for protecting insurance companies against catastrophic risks.[409]

Several developing country governments have implemented initiatives to provide financing to aid recovery and reconstruction after natural disasters, before crises occur. Rather than tending to react after the events, by selling assets, reallocating budgets, or seeking international aid and loans, the insurance sector and reinsurers could help countries proactively build their resilience to financial shocks associated with natural disasters. Natural disasters, including extreme weather events, tend to occur around the world. Due to the fact that the countries we consider most vulnerable are all in developing markets, where insurance coverage is less than half of the global average, the (re)insurance sector is expected to contribute relatively little to post-disaster recovery and reconstruction.[410]

Developed countries have opted for a different approach in dealing with protection against natural disasters. Some countries have relied on the (re)insurance market to cover natural disasters damages, while others have combined state guarantees for natural disaster coverage and part of the coverage through the (re)insurance market. We will list a few examples of public-private insurance models for natural disasters:[411]

- Flood: This is a joint initiative between the UK Government and insurers who aim to make flood insurance significantly more affordable as part of household insurance.
- Consorcio de Compensacion de Seguros (CCS): a private-public partnership that indemnifies Spanish insurance companies against claims arising from unforeseeable events, including also natural disasters. It is supported by a state guarantee.
- Caisse Centrale de Reassurance (CCR): CCR is the only provider of unlimited coverage against drought, flood, earthquake, and terrorism risks in France and it is backed by a state guarantee. CCR differs from

[409] Doganjić (2014), op. cit., p. 23.

[410] S&P Global Ratings (2020). *Global reinsurance highlights 2020,* https://www.spglobal.com/_assets/documents/ratings/research/global-reinsurance-highlights-2020.pdf, p. 33.

[411] Ibid, p. 35.

> other private reinsurers because its business model relies on a government-mandated program to formalize policy terms. CCR accepts catastrophe insurance in France based on its nature which includes mutual, uniformly set premium rates.[412]

The entire agribusiness system depends on agricultural insurance because it has "an important role as a measure of protection and improvement of agricultural production."[413] Experience shows that today's private agricultural insurance markets are being pushed out by subsidized crop insurance and other programs for agricultural support. This poses a question – can there be a sustainable market for agricultural insurance today, in the absence of government programs.[414]

The factors that influence the use of agricultural insurance can be grouped into the following: risk comprehension, size of the farm, farm owner's level of education, past experiences with using insurance, income level, kind of crop, and use of inputs.[415,416]

1. CLIMATE CHANGE, NATURAL DISASTER RISK MANAGEMENT AND SUSTAINABLE DEVELOPMENT

The Republic of Serbia and the world are facing major challenges in the field of food supply and environmental protection. The answer to these challenges implies the improvement of the current policy of preserving the natural environment and sector policies towards the management of environmental

[412] S&P Global Ratings (2020), op. cit., p. 35.

[413] Sredojević, Z., Jeločnik, M., & Subić, J. (2010). Insurance as Possibility of Business Risk Reducing in Agriculture. *Scientific Papers Series Management Economic Engineering in Agriculture and Rural Development, 10* (2), pp. 207-211.

[414] Glauber, J. W., Collins, K. J., & Barry, P. J. (2002). Crop insurance, disaster assistance, and the role of the federal government in providing catastrophic risk protection. *Agricultural Finance Review, 62*(2), pp. 81-101. doi:10.1108/00214900280001131

[415] Wang, M., Ye, T., & Shi, P. (2016). Factors affecting farmers crop insurance participation in China. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie, 64* (3), pp. 479-492, available at: http://dx.doi.org/10.1111/cjag.12088

[416] Tóth, J., & Nemes, A. (2014). Market-type and government supported risk management in the Hungarian agriculture. Paper presented at *EAAE 2014 Congress*, Ljubljana, August 26-29, 2014 (retrieved August 12, 2016 from https://ideas.repec.org/p/ags/eaae14/182854.html)

protection and natural resources based on the principles of sustainable development. In terms of sustainable food supply in the future, we will be faced with the depletion of natural resources, climate change, rapid urbanization, changing demographic trends, and a growing global population that represents a global challenge. The agricultural sector is gaining more and more importance in the world of the aforementioned changes.

Natural disasters are the result of bad development practices. Natural hazards by themselves do not cause catastrophes. Catastrophes reduce the economic potential of the country by increasing poverty, endangering small business and industrial activity, disrupting the functioning of vital systems essential for the performance of various economic activities. In addition, they reduce human capital due to death, injury, and long-term trauma affecting residents of vulnerable areas. The poor lose the most in disasters, as individuals and as countries, because they lack the information, resources, capacities and social safety nets to protect themselves and their assets.[417]

During 2022, economic losses due to catastrophic events were estimated at 284 billion dollars. Insurance damages totalled $132 billion, of which $125 billion were related to NatCat damages.[418]

Table 1. Total catastrophic damages incurred in 2022 and damages incurred as a result of natural disasters

Total catastrophic damages in 2022	USD 284 billion
Total damages from natural disasters in 2019	USD 275 billion
Total insured catastrophic damages in 2022	USD 132 billion
Insured losses from natural disasters in 2022	USD 125 billion

Source: Swiss Re (2023). Natural catastrophes and inflation in 2022: a perfect storm. Sigma, 1(2023), Zürich: Swiss Re

In Table 1, there is a statistical presentation of data related to catastrophic damages in 2022 and the share of damages in the amount of 96.83% based on natural disasters.

People who live in a difficult economic situation are sometimes forced to live in areas that are vulnerable to floods, frequent earthquakes, landslides, and volcanic eruptions, in other words, to understand catastrophes, it is not enough

[417] Jovanović Gavrilović & Gligorić (2015), op. cit., pp. 6-7.

[418] Swiss Re (2023). Natural catastrophes and inflation in 2022: a perfect storm. *Sigma, 1*(2023), Zürich: Swiss Re

to know the types of risks that can affect people, but also varying degree of vulnerability of different groups of people to natural disasters.

Natural disasters that occur as a result of climate change in recent decades require a review of the principles of sustainability. The impact of crises and disasters on tourism can be complex based on their nature, magnitude and scale.[419] The period of two consecutive years with the highest amounts of damages caused by natural disasters in the world was the period of 2017/2018, when the damages from natural disasters covered by insurance amounted to USD 219 billion, of which more than half of that amount was related to damages caused by realization of secondary risks.

However, there is a large gap between the actual damages and the portion of those damages covered by insurance. For example, estimates are that of the total amount of damage from natural disasters in 2017 and 2018, as much as USD 280 billion remained uncovered by insurance.[420] Losses and damages were also enormous during the catastrophic floods in Serbia in 2014. Then, 56 people lost their lives, 32,000 people were evacuated from their homes, and 119 municipalities were affected.[421] The material damage was estimated at about 4.5% of the country's GDP, or 1.5 billion euros, while the compensation for damages based on insurance was only 38.3 million euros, or 0.1% of Serbia's GDP. Such data arises from the fact that insurance is underdeveloped, meaning that a very small number of people who suffered damage had concluded an insurance contract.[422]

As a result of the COVID-19 pandemic, the issue of the importance of nutrition has recovered its importance as the central element of life, along with health, after decades in which food safety was taken for granted, at least in most developed countries. The COVID-19 pandemic has provided an opportunity to reflect on the importance of resilience in emergency situations.

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[419] Backer, E., & Ritchie, B. W. (2017). VFR travel: A viable market for tourism crisis and disaster recovery? *International Journal of Tourism Research, 19*(4), pp. 400-411.

[420] Swiss Re (2019). Natural catastrophes and man-made disasters in 2018: secondary perils on the frontline, *Sigma, 2*(2019), Zürich: Swiss Re, p 8.

[421] http://www.obnova.gov.rs

[422] Janković, D., & Tešić, N. (2015). Major Cat Losses in Past Two Decades. *Catastrophic risks and sustainable development,* Kočović, J., Jovanović Gavrilović, B., Đukić, V. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 180.

According to the United Nations Global Report for 2021, global malnutrition is unacceptably high and affects all countries of the world. Today, more than three billion people are malnourished, while seven billion inhabitants of our planet have a nutritionally poor diet. At the same time, the world's population is expanding rapidly, and it is estimated that there will be close to 10 billion people on our planet by 2050. When considering a sustainable food supply, the goal is to ensure access to high quality and nutritionally rich food in sufficient quantities.

Food safety is directly correlated with climate change and the biophysical effect on agricultural land and uncultivated plants and vegetation, as well as animal life. Even without the threat of climate change, achieving food security goals will require much more productivity-enhancing investment. Investments should also be aimed at increasing the overall resilience of the food system, especially to ensure the risk of natural disasters in agriculture. The eradication of hunger is a goal that needs to be realized by 2030. In order to achieve this goal, it is necessary to encourage farmers through various subsidies.

Special importance should be given to the issue of food supply in Serbia, sustainable land management, as well as the degree of its vulnerability. The irresponsible behavior of people in the past led to a large amount of pollution that affected the climate.

The melting of the poles, the greenhouse effect and many others led to major climate disturbances. In order to prevent future natural disasters caused by climate disruption, the goal propagated by the concept of sustainable development is to make an investment of USD 100 billion. This investment should prevent the occurrence of tsunamis, earthquakes, floods, and tropical cyclones.

The goal to be achieved by the concept of sustainable development is the protection of water surfaces and the reduction of their acidity. The increase in acidity occurred due to the release of a large amount of waste water and air pollution caused by industrial development.

The problem we are facing today is deforestation. Forests are of essential importance both for air purification, and for preventing the extinction of many plant and animal species.

In the last three decades, an extremely large number of war conflicts have been recorded. The goal is to prevent them or to reduce them to the smallest possible number. Wars can sometimes last for an extremely long period of time, and the

consequences they have on the economy, during and after them, are extremely large. Because of this, in order to preserve economic stability, it is of great importance to create strong institutions that will resolve conflicts peacefully.

The key cause of the lack of drinking water is global warming which leads to a decrease in the available quantity of clean water. For this reason, people talk more and more about the need for rational use of the most important resource in the world.

With the increase in electricity consumption, there has also been an increase in the pollution quantity emitted into the atmosphere. Harmful gasses and fossil fuels burning have a strong impact on climate conditions, which can be identified on all continents.

Harmful gases and the burning of fossil fuels have a strong impact on climate conditions, which can be identified on all continents. A few decades ago, winters in Serbia were significantly colder, with abundant snowfall, while today this is not the case. In order to reduce the total amount of warming and harmful gases, it is necessary to increase the share of consumption of renewable energy sources in the total sources.

In order to achieve the goals of the concept of sustainable development, it is necessary to achieve economic growth. For this reason, it is essential to conduct frequent research and find innovative solutions, where insurance in agriculture has a special contribution. Researchers and experts have long been debating how risk is managed and how insurance functions in agriculture. Private markets do not provide comprehensive agricultural insurance and, even when strong public interventions are present, the demand for insurance remains low. The reasons for this unsustainability and market failures can often be found in the nature of either the supply or the demand.[423]

Creating a productive system consisting of soil, water, plants, animals, climate and people is the goal of sustainable agriculture. The result of synchronized system of sustainable agriculture is the satisfaction of people's needs for food, better quality of the environment and preservation of natural resources, enabling the smooth flow of natural resource renewal and maintaining efficiency and effectiveness in production.

[423] Smith, V. H., & Glauber, J. W. (2012). Agricultural insurance in developed countries: where have we been and where are we going? *Applied Economic Perspectives and Policy, 34*(3), pp. 363-390.

Some of the measures that contribute to the highest goals, such as improving the quality of life of agricultural producers and society as a whole, are the protection of certain habitats and species.

Certainly, the greatest contribution to the world as we know today was made by the great progress of information and communication technologies. Finding innovative indicators such as the inform index helps in proactive action in ensuring the risk of natural disasters in agriculture.

2. THE INFLUENCE OF THE INFORM INDEX ON THE NATURAL DISASTER RISK INSURANCE MODEL

Insurance products are essential elements of financial planning for individuals, households and businesses. As an important segment of economic activity, insurance is connected to other sectors of the economy.[424]

The insurance of agricultural production is one of the types of insurance that carry the most risk. Crop production is a specific type of economic activity that is characterized by high production risks because it is extremely exposed to various external factors, primarily to natural i.e. climate-related risks such as hail, storms, floods, droughts, etc. throughout its entire annual production cycle. This makes it more complex and more demanding compared to other economic activities.Therefore, many developed countries have introduced insurance against multiple types of risk and new insurance models such as insuring crops and yields based on weather derivatives, insuring the total value of crop production, or insuring the income derived from crop production. Additionally, insurance in agricultural production must be based on a private initiative with a certain measure of participation by the government, it must be marketable, economically sustainable, and profitable.

A higher level of economic growth and development of a country means also a greater demand for insurance. The role of the government can be found in potentially introducing compulsory agricultural insurance and allocating greater funds for subsidies within the government budget.

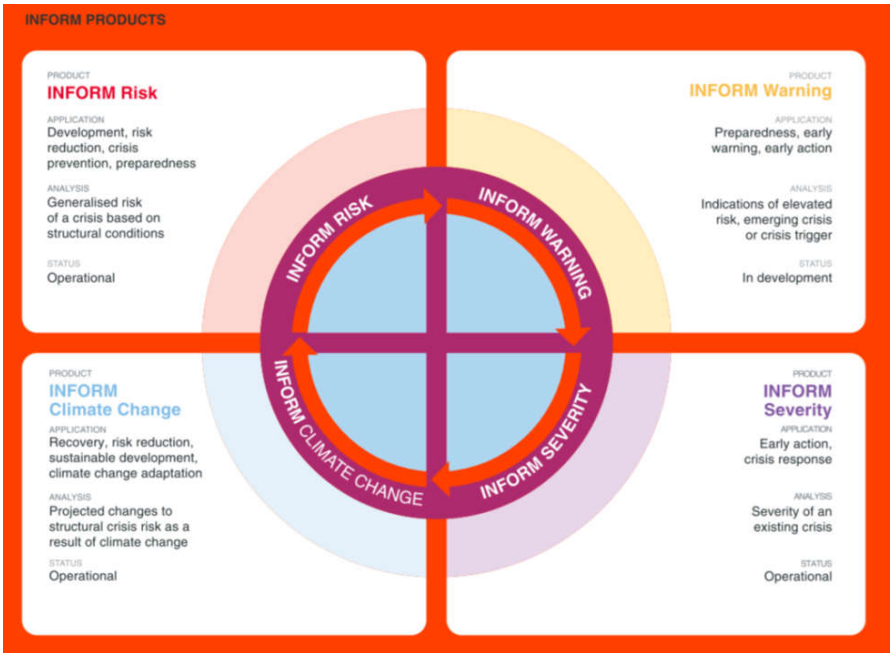
Among the factors that are of importance to insurance are the development of supply and demand and expanding to risks that are have not been covered so far, but also educating agricultural producers as future policyholders of this type of insurance about the significance of financially protecting their production.

[424] Radosavljević et al. (2022), op. cit., p. 415.

Due to the importance that agriculture has in Serbia, concrete measures should be taken to increase the percentage covered by insurance. Even though large crop areas are destroyed every year, agricultural producers are still very hesitant to take out insurance, because it is treated primarily as an expense, rather than an investment in a more secure production.[425]

INFORM develops a suite of quantitative, analytical products to support decision-making on humanitarian crises and disasters, mostly at the country level (Figure 1). These tools assist in decision-making at various stages of the disaster risk management cycle, particularly in prevention, preparedness and response.

Figure 1. INFORM products



Source: Inter-Agency Standing Committee and the European Commission (2022).

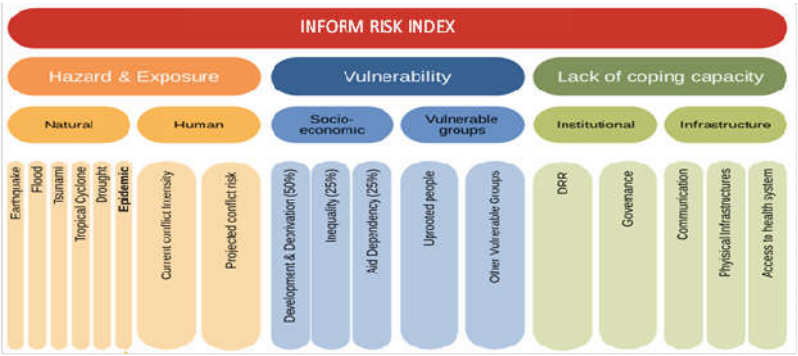
As a result of recent developments on the INFORM Climate Change Risk Index, a new product called INFORM Climate Change has been added to the INFORM report. With this addition, the INFORM report can also inform decision-making processes on adaptation to climate changes.

[425] Radosavljević (2021), op. cit., p. 208.

The purpose of INFORM's products is to make information about crises and disasters more accessible to decision makers. INFORM products aim to aggregate and present existing information in a way that can create a common database and be easily incorporated into decision-making systems. The outputs of the INFORM index element are alerts for each country, which are based on the aggregation of risk information. It presents warnings for scenarios that can be realized due to the impact of natural disasters.

INFORM Risk is an open, composite index that identifies: "countries at risk of humanitarian emergencies that could overwhelm current national response capacities, and therefore lead to the need for international assistance". It was developed in response to recommendations from numerous organizations[426] to improve the common evidence base for risk analysis. Although the index quantifies the risk of a humanitarian crisis, it is equally relevant for developing and disaster risk-reduced actors, as well as for high-income countries.

Figure 2. INFORM Risk Index Model



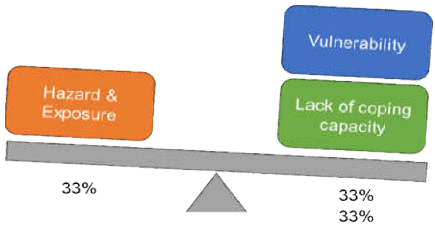
Source: Poljansek, K., Marin Ferrer, M., Vernaccini, L., & Messina, L. (2018). Incorporating epidemics risk in the INFORM Global Risk Index, EUR 29603 EN, Luxembourg: Publications Office of the European Union, doi:10.2760/990429, JRC114652.

INFORM climate change risk is calculated with the same multiplicative equation as INFORM Risk where each of the dimensions is equally weighted (33% each).[427] Vulnerability and lack of coping capacity, internal forces of risk, it was mostly influenced by disaster risk reduction activities (Figure 3, equation 1).

[426] e.g. the World Bank, 2013 and OSNA, 2014

[427] De Groeve, T., Poljansek, K., & Vernaccini, L. (2014). *Index for Risk Management—INFORM—concept and methodology version 2014.* Luxembourg: Publications Office of the European Union, https://doi.org/10.2788/78658

Figure 3. The risk concept behind Inform Risk and Inform Climate change risk indices



$Risk = Hazard\ \&\ Exposure$ NA 1/3 × $Vulnerability$ NA 1/3 × $Lack\ of\ coping\ capacity$ NA 1/3

Source: De Groeve et al. (2014), op. cit.

Serbia's risk profile shows us that it shares 124th place with Greece and Israel within the inform index of 2.8. According to the degree of exposure to hazards, it has the lowest index of 2.5, compared to Greece and Israel. Regarding the vulnerability of the country in case of exposure to hazards, it ranks second compared to the same ranked countries. With an index of 3.7, Serbia faces the problem of a lack of institutional and infrastructural capacity to prevent danger.

Table 2. Countries by risk

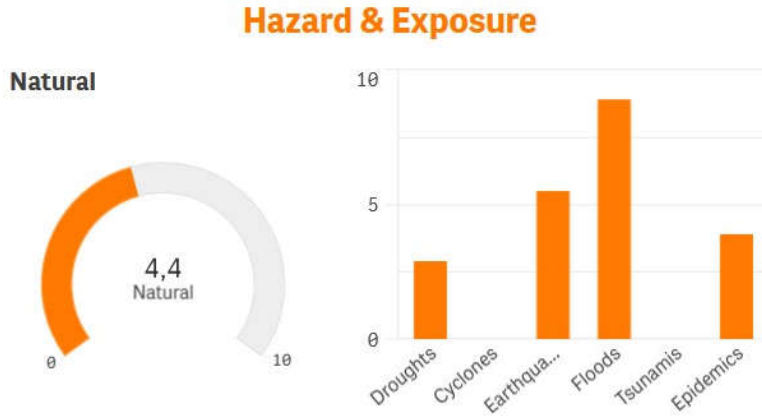
Country	INFORM Risk	Rank	Hazard & Exposure	Vulnera-bility	Lack of Coping Capacity
India	5.3	31	7.4	4.8	4.2
Philippines	5.2	34	7.8	4.4	4.1
Argentina	2.9	121	2.4	2.8	3.6
Botswana	2.9	121	1.5	3.6	4.6
Cyprus	2.9	121	2.4	4.1	2.6
Greece	2.8	124	3.5	2.8	2.3
Israel	2.8	124	5.9	1.7	2.2
Serbia	**2.8**	**124**	**2.5**	**2.4**	**3.7**
Turkmenistan	2.7	127	2.1	1.6	5.9
Romania	2.7	127	2.3	2.5	3.4
Montenegro	2.7	127	2.4	2.6	3.2
Fiji	2.7	127	2.2	3.4	2.7
Bulgaria	2.7	127	2	3.2	3.2
Australia	2.4	142	2.9	2.2	2.1
Japan	2.2	151	5.4	1.3	1.5

Source: Processing by the author based on https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

The data in Figure 4 show us that the indicator of 4.4 exposure to natural hazards is quite high. Threats are drought with the lowest indicator of 2.9, epidemics whose indicator value of 3.9 ranks second in hazard for Serbia.

The highest natural risk for Serbia is floods, whose indicator has a value of 8.9, while indicator value for earthquakes is 5.5.

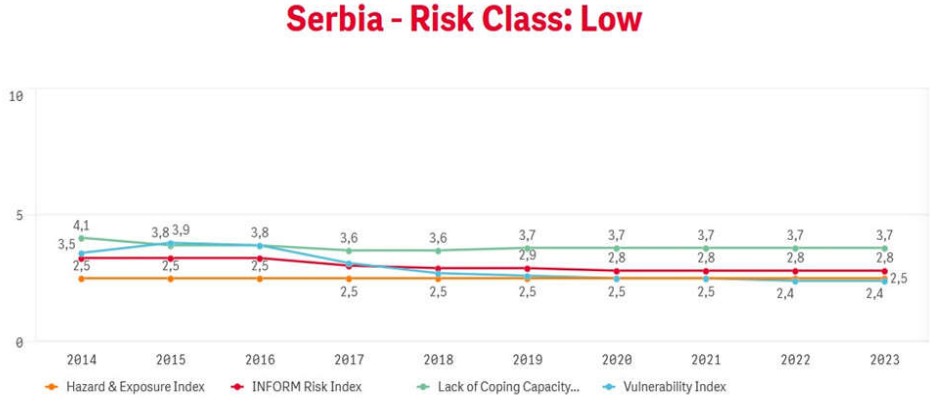
Figure 4. Hazard exposure in Serbia



Source: Author processing based on https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

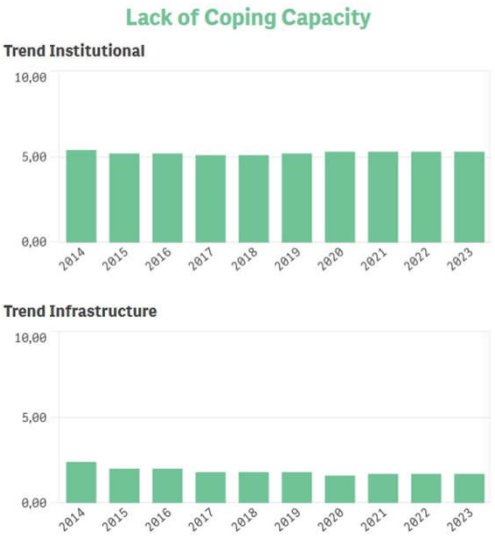
The lack of capacity in Serbia, primarily institutional, can be seen in the data on Figure 5.

Figure 5. Serbia Risk Class



Source: Author processing based on https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

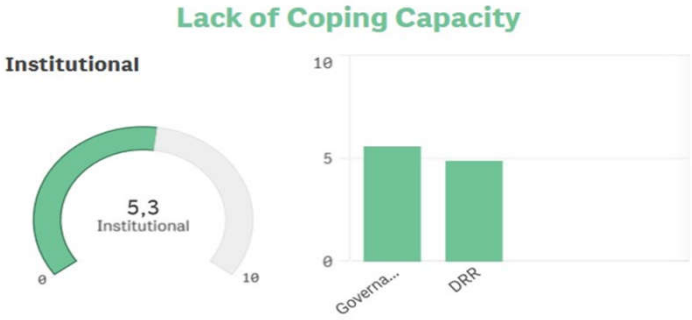
Figure 6. Lack of Coping Capacity in Serbia



Source: Author processing based on https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

Through further analysis we conclude that the indices within the framework of the lack of capacity in Serbia had the highest value in 2014 both for institutions and infrastructure support in case of exposure to hazards. After a value of 5.4 in 2014 for institutional support, the index reaches its minimum of 5.1 in 2017 and 2018. As for the trend within infrastructure support, after the highest value in 2014 of 2.4, it reaches its minimum value in 2020 and is 1.6.

Figure 7. Lack of Coping Capacity in Serbia



Source: Author processing based on https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

Figure 7 presents us with the weakest risk indicator of Serbia, which is institutional support for risk management, mostly from natural disasters, whose index is 5.6 for the observed period. The overall disaster risk reduction indicator has a value of 4.9.

Table 3. Agriculture insurance best practice by country

Country	**Concerning areas**	**Mechanisms**
Australia	Agronomic practices, crop selection, conversation agriculture, crop type and variety, flexibility in crop showing activities	On-farm storage, value-chain development, off-farm investment, enterprise diversity
India	Crop cutting experiments, weather data, crop loan practices, insurance product design	Capacity building, awareness of farmers, crop insurance premium
Japan	Agro production-rice, sugarcane, wheat, barley, fruit; livestock	Multi-peril insurance, designation of the total loss area, practice 'Agriculture National Disaster Compensation Law-1947'
Philippines	Crop production-rice, corn crop; livestock, fisheries, high value commercial crop	Productivity enhancing, partnership with national and local authorities, government intervention to combat the climate change

Source: Malaysia, Presentation at Workshop on 'Evidence for Disaster Risk Reduction and Climate Change Adaptation Effectiveness of Insurance: Challenges and Opportunities', Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia 4-5 July 2014.

Some countries that are engaged in agriculture have reduced to the minimum hazards in plant production. The index in Table 4 presents the projection of the risk of natural disasters by country in 2080. The data shows that countries with a very high natural disaster risk index have the best regulated agricultural insurance. Countries focus on several areas of importance such as crop type, agronomic practices, weather data, and design of crop insurance products. Table 3 shows the best practice of agricultural insurance by country and type of crop, as well as mechanisms for agricultural insurance in selected countries. We see that the countries with the best regulated agricultural insurance are pushing for pre-defined crops to be produced, with controlled inputs. Awareness awakening

among agricultural producers is an integral part of agricultural value policy in India. In 1947, Japan enacted an agricultural disaster compensation law.

Table 4. Probabilities of Natural hazard category scores under all tested combinations of weights – scenario in 2080, order from highest to lowest score

INFORM Climate Change Risk Index Natural hazard category – RCP8.5-SSP3 2080																
	Natural	Class	Very Low	Low	Medium	High	Very High		Natural	Class	Very Low	Low	Medium	High	Very High
Philippines	9	Very high	0%	0%	0%	0%	100%	South Sudan	5.1	High	0%	0%	64%	32%	4%
Bangladesh	8.9	Very high	0%	0%	0%	0%	100%	United Arab Emirates	5.1	High	0%	0%	75%	21%	4%
Japan	8.9	Very high	0%	0%	0%	0%	100%	Congo	5	High	0%	0%	47%	49%	4%
India	8.7	Very high	0%	0%	0%	0%	100%	Guinea-Bissau	5	High	0%	0%	10%	88%	3%
Indonesia	8.7	Very high	0%	0%	0%	0%	100%	Lao PDR	5	High	0%	0%	10%	87%	3%
China	8.5	Very high	0%	0%	0%	0%	100%	Mauritius	5	High	0%	0%	55%	41%	4%
Myanmar	8.4	Very high	0%	0%	0%	0%	100%	Uzbekistan	5	High	0%	0%	84%	12%	4%
Viet Nam	8.4	Very high	0%	0%	0%	0%	100%	Burkina Faso	4.9	High	0%	0%	83%	14%	3%
Mexico	8.1	Very high	0%	0%	0%	0%	100%	Chad	4.9	High	0%	0%	79%	18%	3%
Pakistan	8.1	Very high	0%	0%	0%	0%	100%	Mauritania	4.9	High	0%	0%	78%	18%	4%
United States of America	7.9	Very high	0%	0%	0%	0%	100%	Slovenia	4.9	High	0%	0%	56%	40%	3%
Dominican Republic	7.7	Very high	0%	0%	0%	0%	100%	Israel	4.8	High	0%	0%	71%	26%	3%
Ecuador	7.7	Very high	0%	0%	0%	0%	100%	Lebanon	4.8	High	0%	0%	80%	17%	3%
Guatemala	7.6	Very high	0%	0%	0%	0%	100%	Niger	4.8	High	0%	0%	81%	16%	3%
Madagascar	7.6	Very high	0%	0%	0%	0%	100%	Romania	4.8	High	0%	0%	82%	15%	4%
Peru	7.6	Very high	0%	0%	0%	0%	100%	Tajikistan	4.8	High	0%	0%	82%	14%	3%
Thailand	7.6	Very high	0%	0%	0%	0%	100%	Togo	4.8	High	0%	0%	75%	22%	3%
Colombia	7.5	Very high	0%	0%	0%	0%	100%	Vanuatu	4.8	High	0%	0%	10%	88%	1%
Egypt	7.5	Very high	0%	0%	0%	10%	90%	Zimbabwe	4.8	High	0%	0%	82%	15%	3%
El Salvador	7.5	Very high	0%	0%	0%	0%	100%	Brunei Darussalam	4.7	High	0%	0%	78%	19%	3%
Mozambique	7.5	Very high	0%	0%	0%	0%	100%	Eritrea	4.6	Medium	0%	0%	79%	18%	3%
Honduras	7.4	Very high	0%	0%	0%	0%	100%	Kazakhstan	4.6	Medium	0%	0%	87%	10%	3%
Nicaragua	7.4	Very high	0%	0%	0%	0%	100%	Montenegro	4.6	Medium	0%	0%	78%	20%	3%
Venezuela	7.3	Very high	0%	0%	0%	0%	100%	Trinidad & Tobago	4.6	Medium	0%	0%	54%	44%	2%
Haiti	7.2	Very high	0%	0%	0%	0%	100%	United Kingdom	4.6	Medium	0%	0%	71%	26%	2%
Iran	7.2	Very high	0%	0%	0%	48%	52%	Azerbaijan	4.5	Medium	0%	0%	83%	15%	3%
Papua New Guinea	7.1	Very high	0%	0%	0%	10%	90%	Jordan	4.5	Medium	0%	10%	79%	8%	3%
Costa Rica	7	Very high	0%	0%	0%	10%	90%	Rwanda	4.5	Medium	0%	0%	77%	21%	2%
Malaysia	7	Very high	0%	0%	0%	10%	90%	Belgium	4.4	Medium	0%	0%	82%	16%	2%
Somalia	7	Very high	0%	0%	0%	10%	90%	Burundi	4.4	Medium	0%	0%	80%	19%	2%
Tanzania	7	Very high	0%	0%	0%	48%	52%	Georgia	4.4	Medium	0%	0%	83%	15%	3%
Chile	6.9	Very high	0%	0%	0%	82%	18%	Kyrgyzstan	4.4	Medium	0%	0%	87%	10%	3%
Nigeria	6.9	Very high	0%	0%	0%	84%	16%	Moldova Republic of	4.4	Medium	0%	0%	85%	13%	3%
Turkey	6.9	Very high	0%	0%	0%	77%	23%	Poland	4.4	Medium	0%	0%	85%	12%	3%
Panama	6.8	High	0%	0%	0%	10%	90%	Bulgaria	4.3	Medium	0%	0%	87%	10%	3%
Senegal	6.8	High	0%	0%	0%	75%	25%	Palestine	4.3	Medium	0%	0%	88%	9%	3%
Cambodia	6.7	High	0%	0%	0%	80%	20%	Serbia	4.3	Medium	0%	0%	88%	9%	3%
Italy	6.6	High	0%	0%	0%	80%	20%	North Macedonia	4.2	Medium	0%	0%	88%	9%	3%
Korea Republic of	6.6	High	0%	0%	0%	87%	13%	Armenia	4.1	Medium	0%	10%	80%	8%	2%
Brazil	6.5	High	0%	0%	0%	88%	12%	Austria	4.1	Medium	0%	0%	89%	9%	2%
Canada	6.4	High	0%	0%	0%	86%	14%	Bosnia & Herzegovina	4.1	Medium	0%	0%	88%	9%	2%
Tunisia	6.4	High	0%	0%	0%	88%	12%	Namibia	4.1	Medium	0%	10%	80%	8%	2%
Australia	6.3	High	0%	0%	0%	87%	13%	Tonga	4.1	Medium	0%	0%	86%	13%	1%
Cuba	6.3	High	0%	0%	0%	89%	11%	Botswana	4	Medium	0%	11%	80%	7%	2%
Liberia	6.3	High	0%	0%	0%	89%	11%	Kuwait	4	Medium	0%	10%	80%	9%	2%
Albania	6.2	High	0%	0%	0%	89%	11%	Paraguay	4	Medium	0%	10%	81%	8%	1%
Ghana	6.2	High	0%	0%	0%	89%	11%	Ukraine	4	Medium	0%	32%	66%	7%	3%
Greece	6.2	High	0%	0%	0%	90%	10%	Comoros	3.8	Medium	0%	0%	91%	3%	0%

Source: JRS Tehnical Report, EU 2022, Inform Climate Change Risk Index, ISSN 1831-9424

3. CHALLENGES AND RECOMMENDATIONS IN THE AGRICULTURAL INSURANCE OF SERBIA

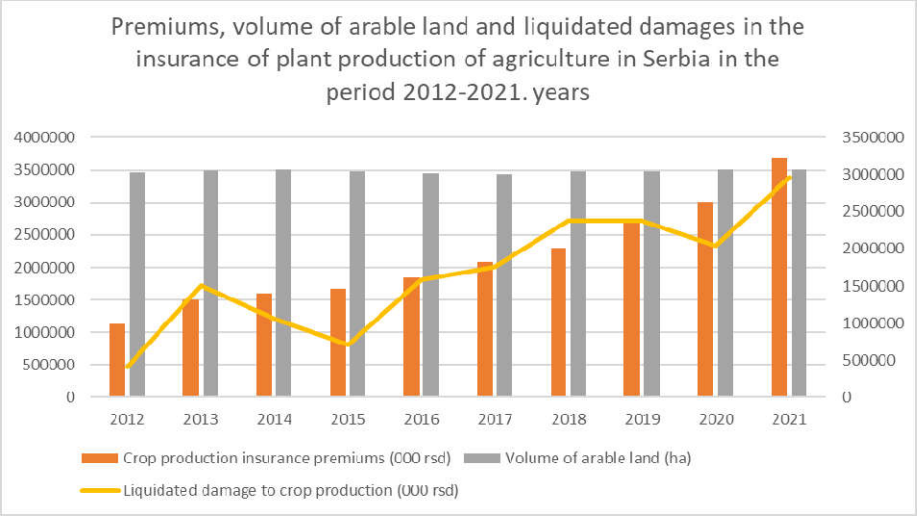
The market for agricultural products in the Republic of Serbia is rather hindered and unorganized, and the main factors determining market trends are: incomplete utilization of the food industry capacity, extensive or semi intensive production, small areas of farms, unfavourable variety structure, high

production costs, product cyclicality, warehouse capacities, free export and import, quality standards and poor organization of farmers.[428]

According to Iturrioz, 2009, today globally crop insurance accounts for 90 percent of the total agricultural insurance premium.[429] Serbia is within the framework of world trends, as shown by the data on the following figures.

According to research by Kočović and Trifunović (2013), the possibilities of the insurance market in Serbia are greater than the current level of its development.[430] The results of the processed data support the mentioned researches.

Figure 8. Comparative presentation of premium trends, volume of arable land and liquidated damages in crop production insurance in Serbia in the period 2012-2021



Source: Author processing based on https://nbs.rs

[428] Radosavljević, K., Vučić, I., & Plavšić, M. (2019). Expansion of marketing channels and their influence on trade in agri-food products: international experiences. *Ekonomika preduzeća, 67*(5-6), p. 379.

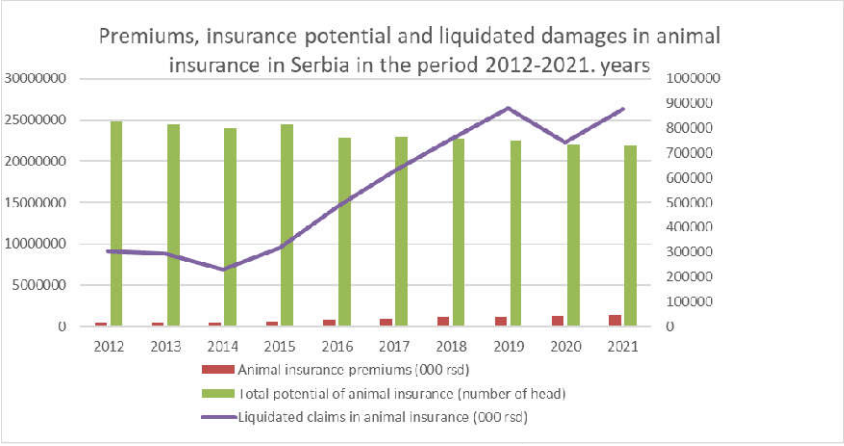
[429] Iturrioz, R. (2009). Agricultural Insurance. *Example Series on Insurance, 12,* Washington, DC: The World Bank, p. 11.

[430] Kočović, J., & Trifunović, D. (2013). Understanding the Essence of Insurance Product as the Condition for the Development of Insurance Market in Serbia. *Product specifics on the markets of insurance and reinsurance,* Kočović, J., Jovanović Gavrilović, B., Radović Marković, M. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 15.

The average value of the volume of arable land is 3,481,302 hectares in the observed period, which represents 69% of used agricultural land in Serbia. Interest in plant insurance is growing, especially after the floods that hit Serbia in 2014. Crop production insurance premiums, in the observed period, recorded a significant growth.

However, besides this growth, agricultural entities, despite the low cost of insurance, insufficiently insure their production, which can be seen in Figure 8.

Figure 9. Comparative presentation of the premium, insurance potential and liquidated damages in animal insurance in Serbia in the period 2012-2021



Source: Author processing based on https://nbs.rs

Promoting plant insurance to the potential of arable land and total agricultural land represents a large area for the protection of agricultural producers from the risk of natural disasters. State aid in plant insurance is inevitable because the average technical result is 109.34% for the research period and in animal insurance it is 99.21%.

Average technical result for the period 2012-2021, for plant insurance it was 109.34%, which means that insurance companies in this domain operated below the profitability limit (100% profitability limit). In 2018, as much as 1.48 dinars of damages were paid for 1 dinar of the concluded insurance premium. The liquidated damages in crop production exceeded the charged technical premium in six of the ten years of the observed period. There was a positive technical result in 2012, 2014, 2015 and 2020. When we analyze animal insurance, we have a positive average technical score of 99.21%. Losses in the animal insurance sector are smaller compared to plant insurance, and the biggest loss

was in 2019, when 1.17 dinars were paid out for 1 dinar of the concluded premium.

Table 5. Liquidated damages, invoiced technical premium and technical result in crop production insurance in Serbia in the period 2012-2021

Years	Liquidated damages of crop production (000 RSD)	Invoiced technical premium in crop insurance (000 RSD)	Technical result %
2012	416273	770942	53.9953719
2013	1506422	1030175	146.2297183
2014	1062003	1094296	97.0489703
2015	710060	1152080	61.63287272
2016	1584411	1269312	124.8243931
2017	1754409	1444467	121.457188
2018	2380199	1602968	148.4869941
2019	2381079	1867922	127.4720786
2020	2048270	2100419	97.51720966
2021	2961248	2580782	114.7422758

Source: Author processing based on https://nbs.rs

Table 6. Liquidated claims, invoiced technical premium and technical result in animal insurance in Serbia in the period 2012-2021

Years	Liquidated damages in animal insurance (000 RSD)	Invoiced technical premium in animal insurance (000 RSD)	Technical result %
2012	302231	290369	104.0851468
2013	294275	270560	108.7651538
2014	228993	288845	79.27885198
2015	315546	343890	91.75782954
2016	482725	529280	91.20408857
2017	625864	586551	106.702401
2018	756677	715356	105.7762848
2019	880215	752544	116.9652539
2020	743099	785885	94.55569199
2021	875803	941798	92.99265872

Source: Author processing based on https://nbs.rs

The economic efficiency of insurance in agriculture in the observed period is conditioned by the amount of damages incurred and the variation of achieved gross premiums of agricultural insurance, from which the technical premium is separated. Extreme temperatures and unfavorable combinations of heat and humidity conditions in sensitive stages of the development of some agricultural crops, as well as insufficient application of appropriate agro technical measures (irrigation, protection against plant diseases and pests...), affected poor yields and losses. The Ministry of Agriculture, as mentioned earlier, is regressing agricultural insurance premium since 2006.

Table 7. Number of agricultural holdings that used the right to regress the agricultural insurance premium

Years	Number of agricultural households
2010.	6.466
2015.	19.799
2020.	28.130

Source: Ministry of Agriculture, Forestry and Water Management, Republic of Serbia

The number of agricultural farms that used the right to these subsidies in the period of 2010, 2015 and 2020 is increasing. In the last observed year, 2020, the right to regress the premium insurance was realized by 28,130 agricultural farms.

The results of the current research by Mahul and Stutley, 2010, show that one of the most important issues in the policy of implementing agricultural insurance is its voluntary or mandatory nature.[431]

The underdevelopment of agricultural insurance is a direct consequence of the underdevelopment of agricultural in Serbia. Basic factors of production, such as water and land, were used irrationally in the last century. Agribusiness, as a balanced natural system, should enable us, based on past experiences, to adopt a new production concept that will achieve high yields and profits while preserving natural resources.

The market of agricultural products in the Republic of Serbia is rather unsettled and unorganized, and the main factors that determine market trends are: extensive or semi-intensive production, small farm areas, unfavorable variety structure, high production costs, cyclical product supply, storage capacities,

[431] Mahul, O., & Stutley, C. J. (2010). *Government Support to Agricultural Insurance Challenges and Options for Developing Countries.* Washington, DC: The World Bank, p. 244.

quality standards and poor farmer organization. Also, there is relatively low utilization of food industry capacities.[432]

On its evolutionary path, agriculture has gone through various developmental transformations and position change in the economic system of countries. The transformation of agricultural activity, from primitive production, through traditional agriculture, all the way to modern (market) agriculture, as we understand it today, took place gradually, over a long period of time. However, in the last two decades, a more dynamic progress has been observed, which is primarily reflected in the market-oriented character of this activity (where profit is the main driving force, as in any other business), but also in the fact that agriculture is now seen as one of the main elements of the development of the entire economy. With adequate strategic planning and risk reduction, agriculture can make a significant contribution to the economic development of the country.[433]

The introduction of new programs and types of insurance that will be adapted to the needs of farmers, and above all the introduction of insurance against several types of risks, which would include, among other things, risks of hail, drought, floods, storms, frost, excessive precipitation, but also damage caused by wild pigs and snow, which increasingly destroy crops in certain areas (raspberries). The introduction of insurance against several types of risks would increase the number of policies, because by paying a single premium, the farmer would receive protection against several risks, which is certainly more profitable than insurance against one type of risk.

According to Kočović et al. (2016), mandatory agricultural insurance should be introduced in Serbia due to the high budget deficit, and as a short-term solution. The proposed model envisages the formation of a pool of insurers, and one of the shareholders would be the state.[434]

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[432] Mihailović, B., Cvijanović, D., Milojević, I., & Filipović, M. (2014). The role of irrigation in development of agriculture in Srem district. *Economics of Agriculture*, *61*(4), pp. 989-1004.

[433] Mihailović, B., & Brzaković, T. (2018). *Knowledge and innovation transfer in agribusiness*. Belgrade: Institute of agricultural economics, p. 82.

[434] Kočović, J., Rakonjac Antić, T., & Jovović, M. (2016). Possibilities for the development of agricultural insurance in Serbia. *State and perspectives of agriculture and rural areas in Serbia*, Stojanović, Ž., Bogdanov, N. (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 205.

A possible model of partially mandatory agricultural insurance would be based on a public-private partnership, and its implementation, in addition to the development of agricultural insurance, would provide the necessary financial resources for current and investment financing and thus the development of the agricultural sector.

Mandatory insurance in agriculture would imply that when applying for state subsidies, for loans with subsidized interest, as well as for the lease of state agricultural land, farmers submit an insurance policy as part of the mandatory tender documentation.

By applying the model, in case of natural disasters, the state would not have to, as before, allocate additional funds from the budget for damage repair, but insurance companies would do it. As a consequence of the implementation of partially mandatory insurance, increased revenues of insurance companies would occur. It would transfer part of the collected premiums to finance agriculture and thereby encourage its development.

The allocation of funds would be controlled by a specialized agricultural institution at the Ministry of Agriculture, Forestry and Water Management. The aforementioned method of financing would reduce the institutional risk in situations where the country is affected by natural disasters because the financing would be directed to proactive action in the segment of institutional frameworks. In that way, the position of Serbia would significantly improve within the report of the natural disaster inform index and thus it would become a country with reduced uncertainty, prosperous development and investments.