Chapter 8.

AGRICULTURAL INSURANCE IN RESPONSE TO CLIMATE CHALLENGE

One major worldwide issue that presents tangible hazards to both the society and economy is climate change. Particularly with regard to physical risk exposures, such as the escalating frequency and intensity of natural catastrophes like floods, droughts, or wildfires, their effects are becoming more and more obvious. According to EIOPA's dashboard on the insurance protection gap for natural disasters, only about 25% of the total economic losses brought on by extreme weather and climate-related events are currently covered by insurance, creating a substantial insurance protection gap for Europe.[273] For insurers and legislators, the insurability and cost of climate-related risks are becoming more and more pressing issues, and the protection gap is predicted to grow if no action is made to close it.

Climate change is predicted to increase physical risk exposures, insurance claims, and risk-based premium levels over time. By increasing the resilience of the economy and society to climate change, the insurance sector may play a special role in combating climate change. Insurance coverage is crucial for buffering governments, corporations, and private citizens from the financial effects of climate-related calamities. The only long-term way to prevent future increases in climate-related damages and losses, as well as any potential disruptions to the insurance markets will be through risk reduction through climate change adaptation and radical change in economic mindset. Mitigating anthropogenic climate change through a rapid and comprehensive transition to a net-zero economy will be critical for avoiding the most severe impacts of climate change.[274]

In recent years, the insurance market has been confronted with new risks and has endeavoured to establish adequate models. Some of the most significant

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[273] European Insurance and Occupational Pensions Authority (2023). *The Role of Insurers in Tackling Climate Change: Challenges and Opportunities.* Frankfurt am Main: EIOPA (retrieved April 28, 2024 from https://www.eiopa.europa.eu/publications/role-insurers-tackling-climate-change-challenges-and-opportunities_en)

[274] OECD (2023). *Enhancing the insurance sector's contribution to climate adaptation*. Paris: OECD Business and Finance Policy Papers, OECD Publishing, https://doi.org/10.1787/0951dfcd-en.

among these risks include: the risk of climate change and natural disasters, nuclear and atomic risk, terrorism and kidnapping risk, and of course, the risk of epidemics and pandemics, which today, in the light of the Covid-19 pandemic, gains particular significance. These risks share common characteristics such as unpredictability, sporadic occurrence, and potential catastrophic impact. It is precisely these characteristics that make them extremely challenging to insure; however, the development of new technologies may change this. In recent years, losses due to natural disasters have been on the rise. Sectors such as trade, agriculture, and tourism are particularly susceptible to the adverse effects of climate change.

Although catastrophe models do not cover all hazards or all geographical areas, one of the biggest modelling firms calculated that between 2000 and 2020, its current suite of models captured about 92% of global insured losses.[275] The insurance industry[276] has developed catastrophe models that apply catalogues of hazard events to inventories of exposure (built environment), measures of vulnerability, and coverage terms and conditions to estimate the potential financial losses for a given property or portfolio of properties in order to assess risk, price coverage, and manage exposures to climate and other natural hazards.

Therefore, many developed countries have introduced insurance against multiple types of risks 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.[277] Natural disasters devastate spontaneously accumulated assets concentrated in specific areas, thus emphasizing the pivotal role of reinsurance, which facilitates global risk dispersion. Global risk dispersion entails the fragmentation and exportation of risk from a given region, thereby safeguarding not only the insurer but also the national economy in the event of natural catastrophes. Fragmentation of risk affords insurers enhanced competitiveness, enabling them to underwrite large and complex risks that would otherwise be untenable without reinsurance.

[275] OECD (2023), op. cit.

[276] Insurance and reinsurance companies, intermediaries, as well as specialized modelling firms

[277] 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.

Moreover, premiums for such risks remain competitive in the market, despite assuming substantial risk. If insurers were to bear such risks independently, either they would be unable to do so, or their premiums would be prohibitively high. Reinsurance has been demonstrated to fulfil a crucial strategic function in insurance markets by fostering insurer growth and increasing their market share.[278] [279] Natural disasters result from poor developmental practices. Natural hazards themselves do not cause disasters. Disasters diminish a country's economic potential by increasing poverty, jeopardizing small businesses and industrial activity, disrupting the functioning of vital systems crucial for diverse economic activities. Moreover, they deplete human capital through fatalities, injuries, and long-term traumas affecting residents in vulnerable areas.

The disruption in the energy balance results in climate change. Global temperature rise leads to sea level increase and alters precipitation patterns. Glacier and sea ice melting contribute to the augmentation of water volume. As a result, extreme weather events occur, and certain plant and animal species face extinction. However, despite significant advancements in tourism and climate change research, substantial gaps persist in earlier publications concerning knowledge on climate change adaptation, particularly regarding the financing aspect of climate change mitigation efforts of information, resources, capacities, and social safety nets to protect themselves and their property.[280] [281] The consequences of the industrial era, fuel combustion, and mass deforestation manifest in the concentration of gases in the atmosphere, leading to the greenhouse effect.

The global temperature rise, induced by both natural factors and irresponsible human behaviour, increasingly triggers extreme heat waves, leading to compromised public health, droughts, floods, and climate change. Without addressing the issues associated with climate change risks and environmental

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[278] Marović, B., Kuzmanović, B., & Njegomir, V. (2007). *Osnovi osiguranja i reosiguranja.* Belgrade: Princip Press, p. 392.

[279] 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.

[280] 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, pp. 6-7.

[281] Simpson, M. C., Gössling, S., Scott, D., Hall, C. M., & Gladin, E. (2008). *Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices.* UNEP, University of Oxford, UNWTO, WMO, Paris

impacts, there can be no prosperity in the development of the agricultural and tourism sectors.[282]

The natural disasters that have occurred in recent decades as a result of climate change make it necessary to rethink the principles of sustainability. There is a considerable gap between the actual damage caused and the proportion of this damage that is covered by insurance. Estimates show that around USD 280 billion of the total losses caused by natural disasters in 2017 and 2018 remained uninsured.[283] During the catastrophic floods in Serbia in 2014, the losses and damage were immense. In this event, 56 people lost their lives, 32,000 people were evacuated from their homes and 119 municipalities were affected.[284]

The factors that influence the use of insurance in agriculture can be divided into the following groups: Risk perception, size of the farm, education level of the owner, previous experience with insurance, income level, type of crop and use of inputs.[285] [286]

The result of this risk is that farmers suffer such high losses that they have no capital for the next economic cycles, or that even farmers who take out loans are unable to repay them, leading to bad loans.[287] Experience shows that today's private agricultural insurance markets are overshadowed by subsidized crop insurance and other agricultural support programs. The question arises: Can a sustainable market for agricultural insurance exist today without government

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[282] 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.

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

[284] "Solidarnost na delu", p. 4. http://www.obnova.gov.rs

[285] 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

[286] Tóth, J., & Nemes, A. (2014). Market-type and government supported risk management in theHungarian agriculture. *Presented at EAAE 2014 Congress, Ljubljana, August 26-29,* available at: https://ideas.repec.org/p/ags/eaae14/182854.html (accessed August 12, 2016)

[287] Mustika, M., Fariyanti, A., & Tinaprilla, N. (2019). Analysis of farmers' attitudes and satisfaction against rice farming insurance attributes in Karawang Regency, West Java. *Journal of Agribusiness Forum, 9*(2), pp. 200-214.

programs? In the Republic of Serbia, an insurance culture has yet to develop, resulting in a high level of ignorance among the population, financial illiteracy and a significant aversion to financial services of this type. Consequently, significant efforts in the field of public education are urgently needed.[288]

Creating a sense of security for agricultural producers can only be achieved by reducing risks. Agricultural insurance is a subset of risk management and its development depends on the cost-benefit ratio at the farm or enterprise level and the supply on the insurance market.[289] The entire agricultural system depends on agricultural insurance as it "plays an important role as a measure to protect and improve agricultural production."[290] On the one hand, the transition process has led to the creation of a monopoly on the agricultural market; on the other hand, direct producers have not adapted to the new market order and have remained unorganized and unprotected.[291]

The relevance of the need for insurance as a necessary risk management tool is further underscored by the example of the Hungarian risk management system. A study examining farmers' readiness to engage in insurance policies, with a focus on economic and ecological factors, demonstrates the correlation between crop insurance utilization and production performance.[292] It can be said that insurance serves two fundamental roles: it provides farmers striving to improve their businesses with a safer path to bank loans and facilitates uninterrupted household spending for rural households when they experience seasonal fluctuations due to inclement weather.[293]

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[288] Olević, S. (2016). Perspektive razvoja životnog osiguranja u Srbiji. *Tokovi osiguranja, 4,* p. 68.

[289] Roberts, R. A. J. (2005). Insurance of crops in developing countries. *FAO Agricultural Services Bulletin,* Vol. 159, Rome: Food and Agriculture Organisation of the United Nations

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

[291] Ignjatijević, S., & Cvijanović, D. (2018). *Exploring the global competitiveness of agri-food sectors and Serbia's dominant presence: emerging research and opportunities.* Hershey, PA: IGI Global

[292] Zubor-Nemes, A., Fogarasi, J., Molnár, A., & Kemény, G. (2018). Farmers' responses to the changes in Hungarian agricultural insurance system. *Agricultural Finance Review, 78*(2), pp. 275-288. doi:10.1108/afr-06-2017-0048

[293] Ghosh, P., Mookherjee, D., & Ray, D. (2000). Credit rationing in developing countries: an overviewof the theory, *A Reader in Development Economics,* Mookherjee, D., Ray, D. (eds.), pp. 383-401.

Absolutely, risks to agriculture extend beyond individual farmers and permeate the entire agribusiness value chain. These risks can disrupt supply chains, impact input suppliers, processors, distributors, and retailers, leading to economic losses and instability throughout the agricultural sector. Therefore, managing agricultural risks is crucial not only for the resilience of farmers but also for the stability and sustainability of the entire agribusiness ecosystem.[294]

1. THE EFFECTS OF CLIMATE CHALLENGES

Today we are experiencing climate change due to decades of pollution and mankind's disregard for the environment. There is still great uncertainty about the extent to which these changes are exacerbating the severity of natural disasters. It is undeniable that tsunamis, floods, forest fires and numerous similar events pose a constant threat to property, human and non-human life in many parts of the world, with the frequency and intensity of these events increasing over time. According to the United Nations Global Report for 2021, global malnutrition remains unacceptably high and affects all countries worldwide. Currently, more than three billion people suffer from malnutrition, while seven billion inhabitants of our planet have a poor diet. At the same time, the world's population is growing rapidly. It is estimated that almost 10 billion people will be living on our planet by 2050. The goal of a sustainable food supply is to ensure access to sufficient quantities of high-quality and nutritious food.[295] Trends such as the growth of the world population, urbanization, high population density in urban areas and the easier movement of people and goods also bring with them a drastic increase in the risk of epidemics and pandemics. In addition, there are opinions that climate change and global warming are contributing to the occurrence of certain diseases.[296] Food security is directly linked to climate change and the biophysical impacts on farms, uncultivated plants and vegetation, and wildlife. Even without the threats of climate change, achieving food security goals will require significantly more investment to increase productivity. Investments should also be directed towards improving the overall resilience of food systems and, in particular, ensuring resilience to

[294] Ghalavand, K., Karim, M. H., & Hashemi, A. (2012). Agriculture insurance as a risk management strategy in climate change scenario: a study in the Islamic Republic of Ian. *International Journal of Agriculture and Crop Sciences, 8*(2), pp. 13-17.

[295] Micha, R. (ed.) (2021). *Global Nutrition Report, 2021 - The state of global nutrition,* https://globalnutritionreport.org/documents/851/2021_Global_Nutrition_Report_aUfTRv0.pdf

[296] Burns, A., Mensbrugghe, D., & Timmer, H., (2006). Evaluating the Economic Consequences of Avian Influenza. *Working Paper,* 47417, Washington, DC: World Bank, p. 6.

the risks of natural disasters in agriculture. Eradicating hunger is a goal that must be achieved by 2030. To achieve this goal, farmers must be incentivized through insurance against the risks of natural disasters and through various subsidies.[297]

The negative effects of climate change are expected to continue, leading to production losses in this sector and jeopardizing the achievement of the Sustainable Development Goals, in particular Goal 1, 'Eradicate extreme poverty and hunger', and Goal 7, 'Ensure environmental stability'[298]. Damages to the environment and natural resources occur primarily through the transformation of ecosystems for the extraction of food, water, timber, fuel, etc. While each individual strives to satisfy their needs as much as possible, from a global perspective this leads to a reduction or even loss of biodiversity. The trend towards increasing productivity thus has an impact on the environment and natural resources, further endangering them. The green economy is an appropriate response to the numerous environmental, energy and economic challenges facing Serbia and can contribute to the sustainable and continuous development of the country.

2. AWARENESS AND ADOPTION OF AGRICULTURAL INSURANCE - CHALLENGES FOR THE INSURANCE SECTOR

The products of agricultural insurance are difficult to understand, especially for residents of rural areas with low literacy rates. This suggests that information about insurance products should be simplified to support decision-making by agricultural producers with low levels of education. Expert services can also play a crucial role in disseminating information through various channels such as training, farm visits and media. Informal education of advisors can help farmers to read and understand the terms and conditions of agricultural insurance policies. A major problem related to insurance is that farmers fear that insurance companies will not honor the contracts. They fear that they will have difficulty receiving compensation and that payments will be insufficient or delayed. Some farmers have experienced such defaults directly. The

[297] Radosavljević, K., Tešić, N., & Mihailović, B. (2023). Insurance against the risk of natural disasters in agriculture. *Challenges and Insurance Market's Response to the Economic Crisis,* Kočović, J., Mladenović, Z., Boričić, B., Jovanović Gavrilović, B., (eds.), Belgrade: Faculty of Economics, University of Belgrade, p. 238.

[298] BNRCC (2011). National adaptation strategy and plan of action on climate change for Nigeria (NASPA-CCN). *Prepared for the Federal Ministry of Environment Special Climate Change Unit*

government and agricultural insurance companies could take joint action to increase farmers' confidence in insurance by reducing difficulties in meeting contractual obligations to insured farmers, establishing a monitoring body and providing information on insurance companies' claims payments. Minimizing risk for farmers and building a relationship of trust between policyholders and insurers is a way to do safer business.[299] The factors that influence the use of agricultural insurance can be divided into the following groups: Understanding of risk, size of the farm, education level of the farmer, previous experience of using insurance, income level, type of crop and use of inputs. [300] [301] Confidence and education of farmers are related to the use of insurance policies.[302] A suitable model for the organization of agricultural insurance is a public-private partnership accompanied by increased government support and the introduction of elements of compulsory insurance. In such a model, the state would accredit insurance companies that could sell agricultural insurance products at subsidized premium rates.[303] Insurers are exposed to the risks of climate change in three ways:[304]

a) Physical risks, caused by weather conditions, including risks of fires, floods, etc.;
b) Liability risks, arising from the transfer of the cost of lawsuits to insurance;
c) Economic risks, related to costs that companies may incur, for example, due to the need to introduce new, clean technologies into their operations.

The following trends occurring worldwide contribute to the increase in these risks:[305]

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[299] Url, T., Sinabell, F., & Heinschink, K. (2018). Addressing basis risk in agricultural margin insurances. *Agricultural Finance Review, 78*(2), pp. 233-245. doi:10.1108/ afr-06-2017-0055

[300] Wang et al. (2016), op. cit.

[301] Tóth & Nemes (2014), op. cit.

[302] Karlan, D., Osei, R., Osei-Akoto, I., & Udry, C. (2014). Agricultural decisions after relaxing creditand risk constraints. *The Quarterly Journal of Economics, 129*(2), pp. 597-652.

[303] Kočović, J., Rakonjac-Antić, T., & Jovović, M. (2016). Mogućnosti razvoja osiguranja poljoprivede u Srbiji. *Stanje i perspektive agroprivrede i sela u Srbiji,* Stojanović, Ž., Bogdanov, N. (eds.), Belgrade: Faculty of Economics, University of Belgrade, pp. 205-224.

[304] The Geneva Association (2018). *Climate Change and the Insurance Industry: Taking Action as Risk Managers and Investors*. Geneva: Geneva Association, p. 7.

[305] Carroll, C., Evans, R., Patton, L., & Zimplzak, J. (2014). *Climate Change and Insurance.* American Bar Association, p. 13.

1. Increased frequency of natural disasters: earthquakes, floods, fires, tsunamis, and similar natural disasters not only impact life insurance but also property insurance, business interruption insurance, etc.
2. Depletion of natural resources: this primarily poses challenges in business operations, leading to higher input costs and even business shutdowns.
3. Utilization of renewable energy: this entails significant initial costs for establishing infrastructure for such operations.
4. Environmental responsibility: companies are increasingly exposed to reputational risk and environmental responsibility. It is extremely important for insurers to continuously monitor regulations in this field and adapt to all changes.

Despite the already existing sophisticated modelling approaches, the realm of climate change adaptation and risk management, a multitude of uncertainties loom large, posing significant challenges to the development of robust insurance models and products. These uncertainties stem from three key sources: future emissions, hazard dynamics, and societal vulnerability.

First, the trajectory of future greenhouse gas emissions remains shrouded in ambiguity. The extent to which emissions will rise or fall hinges on a complex interplay of technological innovation, political interventions, and societal behaviours. The absence of clarity regarding emission levels complicates efforts to anticipate and prepare for the resulting climate impacts.

Secondly, forecasting changes in hazard frequency and intensity presents formidable challenges. While projections of certain climate variables, such as rising sea levels or temperature increases, may offer some degree of reliability, predicting the occurrence and severity of extreme events proves far more elusive. Natural climate variability further exacerbates this uncertainty, introducing additional layers of complexity to hazard modelling and prediction. Thirdly, the interplay between hazard exposure, societal vulnerability, and economic development adds another dimension of uncertainty. Catastrophic models, upon which insurance products rely, hinge on the intricate interaction between hazards and the assets at risk, as well as the vulnerability of those assets to withstand impacts. Moreover, the dynamics of economic growth in climate-exposed regions play a significant role in shaping future risk profiles, with increased development often leading to heightened damages and losses.

3. AGRICULTURAL INSURANCE SECTOR IN SERBIA

In recent years, losses due to natural disasters have been on the rise. Sectors such as trade, agriculture, and tourism are particularly susceptible to the negative impacts of climate change. Therefore, many developed countries have introduced insurance against multiple types of risks 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.[306]

Table 1. Gross premium of agricultural insurance, gross premium of all insurance, and the share of gross premium of agricultural insurance in the gross premium of all insurance in Serbia for the period 2010-2022

Years	Gross premium of agricultural insurance (000 RSD)	Gross premium of all insurance (000 RSD)	Share of gross premium of agricultural insurance in the total gross premium of all insurance (%)
2010	1,080,053.00	56,520,932.00	1.910890288
2011	1,238,126.00	57,313,998.00	2.160250625
2012	1,564,760.00	61,463,708.00	2.545827531
2013	1,909,174.00	64,041,509.00	2.981150866
2014	2,044,639.00	69,405,005.00	2.945953249
2015	2,194,861.00	79,812,656.00	2.750016238
2016	2,653,992.00	89,137,986.00	2.977397313
2017	2,970,456.00	93,093,994.00	3.190813792
2018	3,371,427.00	99,910,591.00	3.374444057
2019	3,791,729.00	107,449,872.00	3.528835288
2020	4,166,001.00	109,916,743.00	3.790142326
2021	5,042,558.00	119,408,670.00	4.222941265
2022	6,199,314.00	133,925,041.00	4.628943141

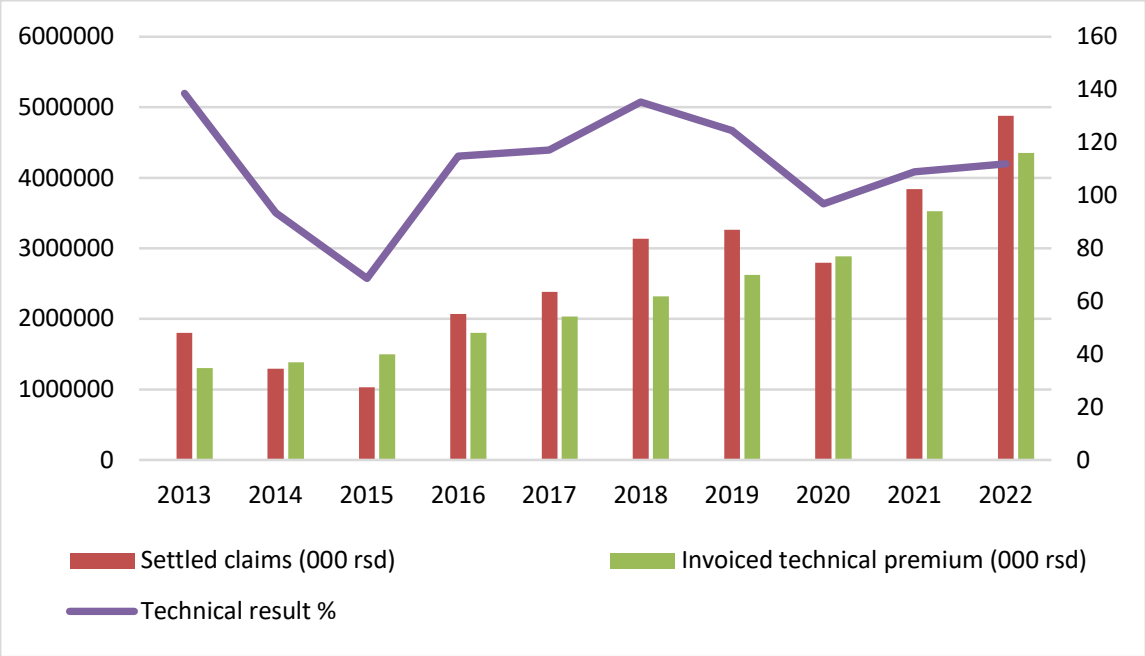
Source: https://nbs.rs

The total premium of agricultural insurance has a low share in the total premium of all insurance in Serbia from 2013 to 2022 (Table 1). The premium of agricultural insurance shows a rising trend during the observed period. On average, the share of agricultural insurance premiums in the total premium of all insurance is only 3.44%. The data on the underdevelopment of agricultural insurance in Serbia are confirmed by the literature cited in the introductory discussion.

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

The average technical result for the period 2013-2022 was 111%, which means that insurance companies in this sector operated below the profitability threshold (the profitability threshold being 100%). For every 1 dinar of insurance premium concluded in 2013, as much as 1.38 dinars of claims were paid out. Incurred losses in agriculture exceeded the collected technical premiums in seven out of the ten years of the observed period. A positive technical result was achieved in 2014, 2015, and 2020. The economic efficiency of agricultural insurance in the observed period is conditioned by the level of incurred losses and the variability of the realized gross premium of agricultural insurance from which the technical premium is deducted.

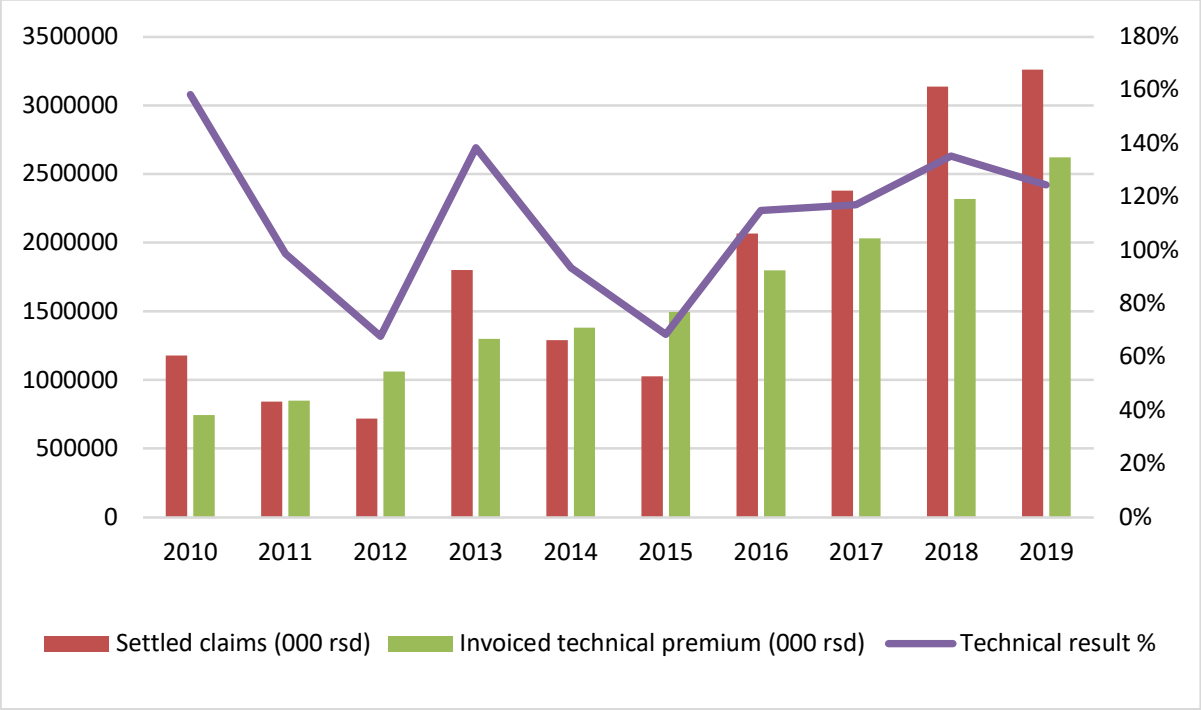
Figure 1. Settled claims, Invoiced technical premium and Technical result in agricultural insurance in Serbia for the period 2013-2022



Source: https://nbs.rs

The average technical result for the period 2010-2019 was 111.7%, indicating that insurance companies in this domain operated below the profitability threshold (profitability threshold being 100%). For every 1 dinar of insurance premium concluded in 2010, as much as 1.58 dinars of damages were paid out. Settled damages in agriculture exceeded the collected technical premiums in six out of the ten years of the observed period. Positive technical results were recorded in 2011, 2012, 2014, and 2015. The economic efficiency of agricultural insurance during the observed period was influenced by the amount of incurred damages and the fluctuation of the realized gross agricultural insurance premium, from which the technical premium is deducted.

Figure 2. Settled claims, Invoiced technical premium and Technical result in agricultural insurance in Serbia for the period 2010-2019



Source: https://nbs.rs

The Serbian insurance market is not highly developed. However, recently, the insurance market has been experiencing stable growth year after year, supported by a positive macroeconomic climate, reduction in unemployment, and improvement in living standards. Special attention should be given to issues such as food supply in Serbia, sustainable land management, and the degree of its vulnerability.

Irresponsible human behaviour in the past has led to significant pollution that has impacted the climate. Polar ice melting, the greenhouse effect, and many others have caused major climate disturbances. In order to prevent future natural disasters caused by climate disruption, the goal advocated by the concept of sustainable development is to invest $100 billion. This investment should prevent the occurrence of tsunamis, earthquakes, floods, and tropical cyclones.

The goal aimed at by the concept of sustainable development is the protection of water surfaces and the reduction of their acidity. The increase in acidity has occurred due to the discharge of large amounts of wastewater and air pollution caused by industrial development.

4. EXTREME CLIMATE EVENTS AS INDICATORS OF CLIMATE CHANGE IN THE REPUBLIC OF SERBIA

Plant and livestock production are exposed to numerous risks due to increasingly frequent weather disasters, climate change, the emergence of new animal diseases, leading to a growing demand for insurance, i.e., for economic protection against various types and forms of risks in the agricultural environment. Insurance at the micro level provides a mechanism for the economic protection of policyholders against harmful effects and contributes to the sustainability, continuity, and competitiveness of farming and future development potentials of agricultural producers.

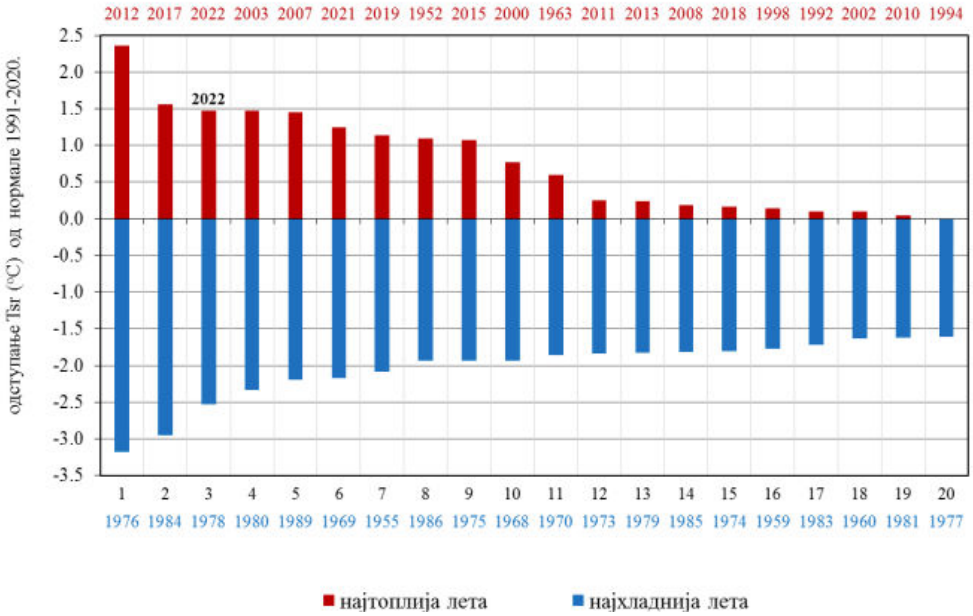
Data on Figure 3 indicate that the years 2019 and 2022 were the two warmest years in Serbia since 1951. Seven out of the ten warmest years in Serbia since 1951 were recorded in the period from 2012 to 2022.

Figure 3. Order of the warmest and coldest years in Serbia for the period 1951 - 2022

Source: https://www.hidmet.gov.rs/

Data on Figure 4 indicate that the years 2012 and 2017 were the two warmest summers in Serbia since 1951.

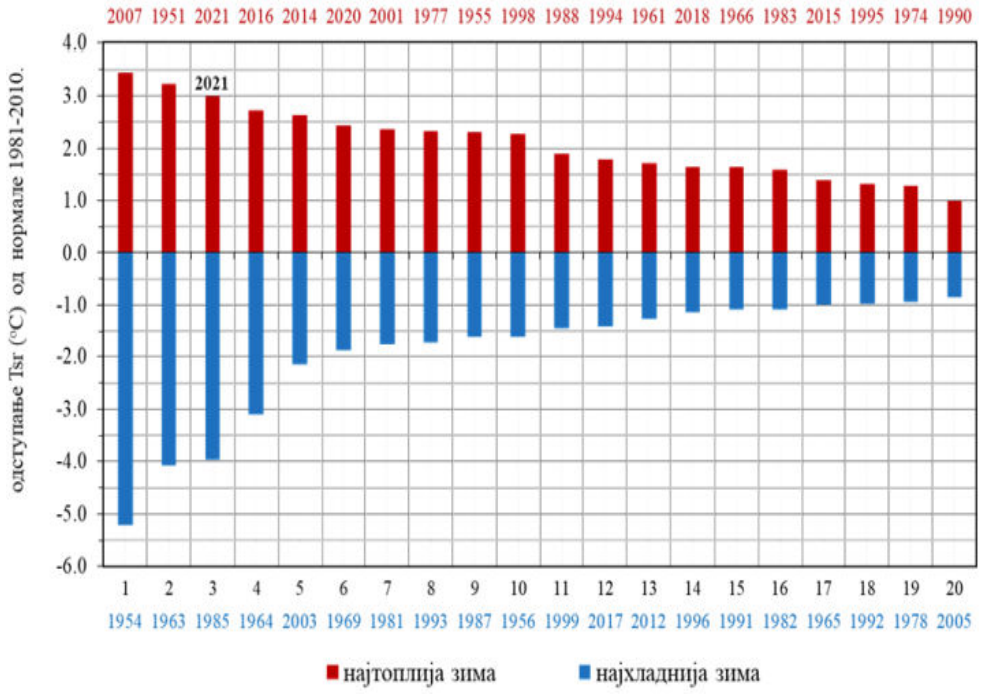
Figure 4. Order of the warmest and coldest summers in Serbia for the period 1951 - 2022



Source: https://www.hidmet.gov.rs/

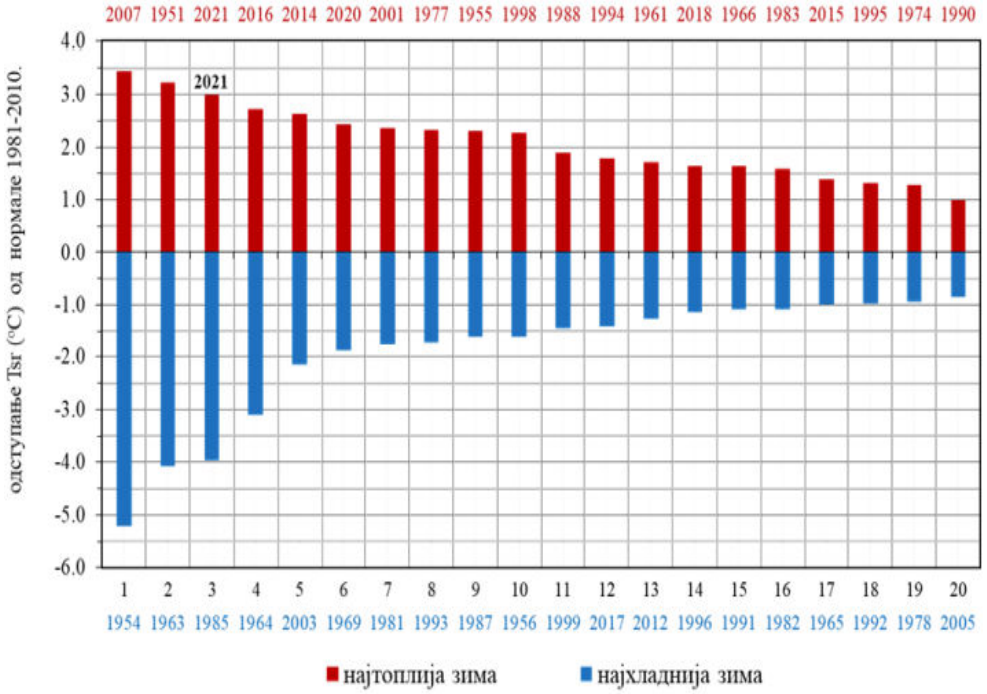
Six out of the ten hottest winters in Serbia since 1951 were recorded in the period from 2012 to 2022. Winters with extreme values in the period from 2012 to 2022 were not recorded.

Figure 5. Order of the twenty warmest and coldest winters in Serbia for the period 1951 - 2021



Source: https://www.hidmet.gov.rs/

Figure 6. Order of the wettest and driest summers in Serbia for the period 1951-2020



Source: https://www.hidmet.gov.rs/

Summer 2020 was the second rainiest summer in the last 70 years in Serbia. From 1951, twenty of the driest summers have been recorded, with five occurring in the period from 2011 to 2020.

Analyzing the given data leads to the conclusion that there is a rise in global temperatures caused by natural factors and human irresponsible behavior. The consequences are increasingly frequent extreme heat waves that disrupt public health, cause droughts, floods, and climate change. Without addressing the issues related to the risks of climate change and their impact on the environment, there can be no prosperity in the development of the agricultural sector.

By reducing the risks of climate change through crop insurance, a tool is created to ensure the security of agricultural production and continuous food supply to the market. At the same time, awareness of the necessity of human action to care for the environment will be developed, contributing to sustainable development policy.

The synoptic analysis of the cold wave in Serbia in January and February 2012. The weather situation that occurred during this period in Serbia and its surrounding areas qualifies as an extraordinary and dangerous meteorological

phenomenon. The extremity of this situation is reflected in intense snowfall accompanied by blizzards, resulting in a high snow cover.

In Serbia, the year 2022, with an average air temperature of 12.1°C, is the second warmest year from 1951 to the present, and in Belgrade, with 14.5°C, it is the second warmest since the meteorological station began operating (1888). In Negotin and Sombor, 2022 is the warmest year recorded at those stations.

As a result of global climate change, changes in the intensity and frequency of climate extremes have been observed. Some extreme climate and weather events have become more frequent in recent decades, and the situation in Serbia has proven to be very sensitive to natural disasters, floods, landslides, forest fires, droughts, and heat waves, both throughout its history and in the present day. In Europe, over the past 32 years, there have been 325 floods on major rivers, of which 200 occurred in the last 12 years. Significant floods have been recorded in Serbia in 1980, 1981, 1988, 1999, 2002, 2005, 2006, 2009, and 2014.

Climate indices related to episodes of extreme precipitation show positive trends from 1961-2015 at most stations in Serbia. Projections of maximum annual rainfall from six regional climate models indicate an increase in rainfall intensity. The wettest year to date in Serbia was 2014. The snow cover from April 19 to 21, 2017, is not the latest recorded in Serbia. The occurrence of snow cover in higher areas was recorded latest on June 23, 1999, on Kopaonik, on June 17, 1989, in Sjenica, and in lower areas on May 3, 1970, in Kuršumlija.[307]

To reduce unnecessary costs, agricultural producers are opting out of insurance, not realizing that the greatest expense occurs when their investments fail. For these reasons, it's necessary to educate agricultural producers to perceive this form of protection not as an expense but as a necessary investment. Agricultural producers often don't know what insurance they need to protect themselves best, or how to choose the right insurance and predict which weather disaster will affect crops and when.

Moreover, insurance companies should offer agricultural producers the most adequate and favourable insurance conditions possible. In the development of agricultural insurance, the role of the state and budgetary assistance is crucial. In this regard, the Government of the Republic of Serbia enacted regulations in

[307] https://www.hidmet.gov.rs/

2009 regarding the terms and conditions of using funds to subsidize insurance for animals, crops, and fruits.[308]

Considering the significance of agricultural production in terms of its contribution to gross domestic product and exports, as well as the fact that rural areas occupy a large percentage of the territory, ensuring agricultural production is essential for the further development of primary agricultural production, as well as for agriculture and the state as a whole.

Agricultural production insurance is one of the riskiest types of insurance. Plant production is a highly specific economic activity characterized by high production risks, as it is exposed to various external influences throughout the entire production cycle, primarily natural or climatic risks such as hail, storms, floods, droughts, etc., making it more complex and demanding compared to other activities.

Therefore, many developed countries introduce insurance against multiple risks, new insurance modalities such as weather derivatives-based crop and fruit insurance, insurance for the total value of plant production, or income insurance for plant production.

4. ARGUMENTATIONS AND PROPOSALS FOR AGRICULTURE INSURANCE PACKAGES

Alongside fostering innovation in climate solutions, the insurance sector can alleviate the strains imposed by contemporary capitalism by advocating for sustainable practices and extending insurance coverage to the most vulnerable segments of society. Offering crop insurance to farmers and flood insurance to residents in high-risk zones not only mitigates losses and facilitates economic recovery post-natural disasters but also incentivizes responsible resource management practices essentially important for sustainable rural and agricultural development. Insurance products safeguarding natural resources like forests, fisheries, and biodiversity encourage their sustainable utilization, thereby curbing over-exploitation and safeguarding livelihoods dependent on them. In terms of the economy, insurance strengthens financial resilience by cushioning unforeseen costs. Insurance helps reduce poverty by guaranteeing business continuity and preserving employment opportunities. In essence, the insurance industry is becoming a key player in reducing the risks associated

[308] Regulation on the use of funds to support rural development through investment support in agriculture in 2009, *Official Gazette of the Republic of Serbia,* No. 14/2009.

with climate change and addressing the difficulties of modern capitalism. Such unique perspectives allow for a deeper understanding of climatic processes and lead to the development of new types of goods. In navigating modern capitalism, the insurance industry is championing the interests of the most marginalized by supporting environmentally friendly measures and offering tailored protection plans such as microinsurance and natural resource protection goods [309] [310].

Additionally, insurance in agricultural production must be based on private initiative with a certain level of state participation, be market acceptable, economically sustainable, and profitable.
As such, we argue that:

1) Insurance in agricultural sector shall at first place support and mitigate the risks which threaten the sustainable food production in times of climate risks. Sustainable food production practices are essential for mitigating the impacts of climate change on agriculture. Climate-related hazards such as droughts, floods, and extreme weather events pose significant threats to crop yields, livestock health, and food supply chains. Sustainable agriculture practices, including organic farming, agro forestry, and regenerative agriculture, can enhance soil health, water management, and biodiversity while building resilience to climate shocks.
2) Insurance packages for agricultural resilience shall be developed. Developing insurance packages tailored to the needs of sustainable food producers is crucial for enhancing resilience in the agricultural sector. These insurance products should consider the specific risks faced by smallholder farmers, including crop failures, livestock losses, and market volatility. By incorporating principles of degrowth and sustainability, such insurance packages can incentivize the adoption of climate-smart agricultural practices and support farmers in transitioning to more resilient and diversified production systems.
3) Integrating climate risk assessment into insurance models. Climate risk assessment should be integrated into insurance models to accurately

[309] Tešić, N., Kočović De Santo, M., & Radosavljević, K. (2023). New insurance directions as a response for climate change. *Challenges and Insurance Market's Response to the Economic Crisis,* Kočović, J., Mladenović, Z., Boričić, B., Jovanović Gavrilović, B., (eds.), Belgrade: Faculty of Economics, University of Belgrade, pp. 191-213.

[310] Vujanović, V., & Kočović De Santo, M. (2023). Coupling Culture and Space for the Post-Growth. *Kultura polisa*, *20*(2), pp. 175-197. https://kpolisa.com/index.php/kp/article/view/1483/1409

quantify and price climate-related risks faced by agricultural producers. This requires leveraging climate data, satellite imagery, and advanced modelling techniques to assess the vulnerability of agricultural systems to climate change impacts. By incorporating climate risk assessment into insurance underwriting processes, insurers can better tailor coverage options and premiums to reflect the unique climate risks faced by different regions and agricultural sectors.

4) Promoting resilience and adaptation in agricultural communities. Insurance packages should not only provide financial protection against climate risks but also promote resilience and adaptation in agricultural communities. This can be achieved through targeted investments in climate-smart agriculture extension services, capacity-building initiatives, and farmer cooperatives. By empowering farmers with the knowledge, resources, and tools needed to adapt to climate change, insurance packages can help build more resilient and sustainable food systems.
5) Collaboration and partnership across sectors. Addressing the complex challenges of sustainable food production and climate resilience requires collaboration and partnership across multiple sectors, including government agencies, agricultural organizations, insurance companies, and research institutions. By working together to develop innovative insurance solutions tailored to the needs of sustainable food producers, stakeholders can help build a more resilient and equitable food system that prioritizes ecological integrity, social equity, and long-term sustainability.

5. POSITIVE EXAMPLES ON THE ROLE OF THE STATE IN COMBATING CLIMATE CHANGE

Serbia's risk profile shows that it is the country with the highest risk compared to Slovenia and Croatia, which rank 176th and 132nd, respectively. In terms of exposure to hazards, Croatia has the highest index of 92 compared to Slovenia and Serbia. Regarding the vulnerability of the country in the event of exposure to hazards, Serbia is the most vulnerable because despite its lower exposure to hazards compared to Croatia, with an index of 3.7, Serbia faces the problem of capacity shortages (institutional and infrastructural) to prevent hazards. The successful practices of local food systems in the European Union can facilitate learning and information exchange. [311]

[311] Cvijanović, D., Ignjatijević, S., Vapa Tankosić, J., & Cvijanović, V. (2020). Do local food products contribute to sustainable economic development? *Sustainability*, *12*(7), 2847.

Data in Table 2 indicate that the overall risk indicator for Serbia is 2.8, caused by a higher sensitivity to natural disasters due to capacity shortages in Serbia, primarily institutional ones.

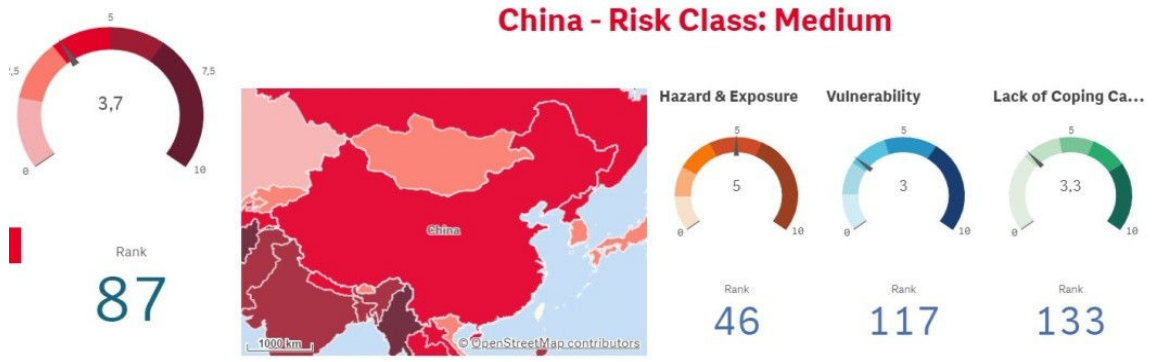
Table 2. Countries by risk

Country	INFORM Risk	Rank	Hazard & Exposure	Natural Hazard & Exposure	Vulne-rability	Lack of Coping Capacity
Serbia	2.8	124	2.5	4.4	2.4	3.7
Croatia	2.6	132	2.8	4.8	2	3.1
Slovenia	1.6	176	1.9	3.4	1.3	1.6

Source: https://drmkc.jrc.ec.europa.eu/inform-index

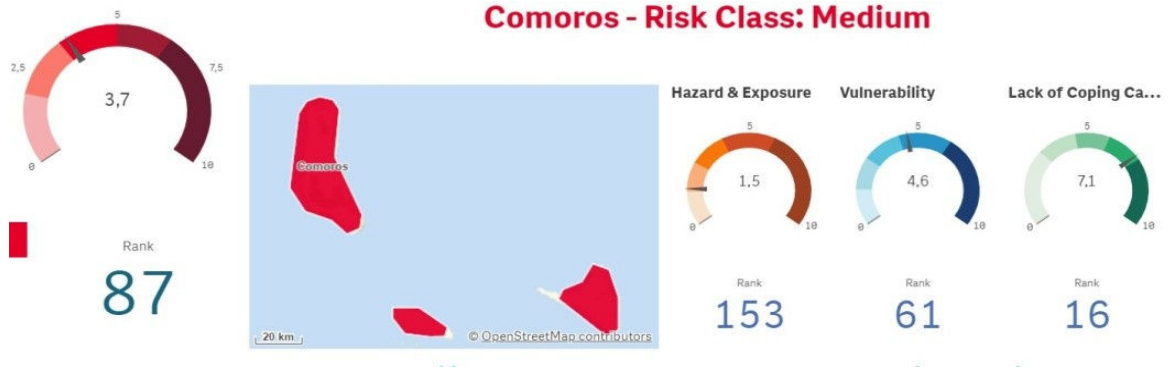
Using the example of China and Comoros, we can observe a successful institutional solution in overcoming the risks of natural disasters. Both countries have the same rank of 87, which determines an inform index of 3.7, placing them in the category of medium risk countries. In terms of exposure to hazards, China has an index of 5, significantly higher than Comoros, whose index is 1.5.

Figure 7. Inform index for China



Source: https://drmkc.jrc.ec.europa.eu/inform-index

Figure 8. Inform index for Comoros



Source: https://drmkc.jrc.ec.europa.eu/inform-index

This difference is mitigated by China's well-developed institutional and infrastructural support system, contributing to a capacity index of 3.3, compared to Comoros' underdeveloped institutional support system, with an index of 7.1. These factors determine China's rank of 117 in terms of system vulnerability, while Comoros ranks high at 61 in terms of system sensitivity to natural disasters.

The opportunities for insurance companies in the Chinese insurance market are immense. This statement stems from the fact that it is a relatively young market that is still developing and is not as constrained by regulatory restrictions and the presence of large traditional systems as is the case with major insurance companies in the West.

The opportunities for insurance companies in the Chinese insurance market are immeasurable. This statement arises from the fact that it is a relatively young market that is still developing and is not as hindered by regulatory restrictions and the presence of large traditional systems as is the case with major insurance companies in the West.[312] Insurance companies in China typically go through three stages of digital evolution:[313] [314]

a) Digitalization of core business: This phase involves creating digital sales channels and automating contract formation processes and claims assessment and payout processes.
b) Offering services not traditionally related to insurance: This may include services such as scheduling medical examinations, purchasing cars or homes, etc.
c) Connecting all policyholder accounts: By linking all policyholder accounts in one place, companies gain a complete picture of their lifestyle and needs.

* * *

Extreme weather events are becoming more frequent due to climate change, which poses a growing threat to world food production. Insurance companies can create novel insurance products that encourage the prevention of climate-

[312] Ernst & Young (2019). *2020 Asia-Pacific Insurance Outlook - Driving innovation and transformation to seize opportunities and sustain growth.* EY, p. 15.

[313] Tang T., Hu, M., & Candreia, A. (2018). *Why Chinese Insurers Lead the Way in Digital Innovation,* Boston Consulting Group, https://www.bcg.com

[314] Radosavljević, K., & Kočović De Santo, M. (2024). Sutainable Development and Demographic Challenges in Rural Areas of the Republic Serbia. Proceeding paper at International conference "*Quantity and quality of growth in the new economic reality",* EKONBIZ 2024, Bijeljina: Eastern Sarajevo University.

related risks. One such product could be a premium reduction for policyholders who adopt adaptation measures connected to climate change. Adaptation strategies can be a crucial instrument to preserve the availability of insurance policies covering climate-related dangers in the future and assist in closing the insurance protection gap connected to climate change[315]. Insurers may guarantee the long-term availability of insurance products, lower the total cost of insurance, and safeguard policyholders against losses by employing a proactive approach to risk management. It is crucial to emphasize, though, that in order to achieve the goal of properly adjusting society and the economy to climate change, additional, non-insurance sector-related actions must be taken, such as creating and enforcing public building codes that accurately reflect the dynamics of climate change.

According to GIZ report large number of developing countries has included objectives to strengthen the resilience of their agriculture sector in their Nationally Determined Contributions (NDCs)[316]. However, most nations lack integrated climate risk management (CRM), which addresses the spectrum of climate risks and includes financial tools to transfer residual risk along with preventive and adaptation actions. CRI is a useful financial tool that aids governments and agricultural producers in dealing with the fallout from extreme weather occurrences. Thus, CRI is seen as an instrument for agricultural risk management, a component of larger customer relationship management (CRM) strategies and national social protection programs, and a long-term, client-focused financial service[317].

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[315] EIOPA (2023), op. cit.

[316] GIZ report (2020) (Retrieved April 30, 2024 from https://www.giz.de/expertise/downloads/En_Advisory%20Service_Climate%20Risk%20Insurance%20Agriculture_2019.pdf)

[317] Using a multilevel approach, GIZ develops capabilities to enhance macro-level framework conditions, meso-level financial and technical service delivery, and micro-level sustainable business models of CRI providers and clients. It consists: 1. Preventive: On-time payments stabilize agricultural earnings, act as a safety net against existential losses, and stop the sale of more assets. CRI promotes overall socio-economic self-empowerment and quicker economic recovery in post-disaster communities when compared to other forms of financial help, such as humanitarian aid. 2. Promotive: By increasing predictability, CRI speeds up economic development by facilitating better planning and higher-value farm-driven investments. 3. Transformative: A well-integrated CRI provides incentives for long-term climate change adaptation and boosts overall resilience by rewarding other climate-smart risk-reducing initiatives with lower premium payments.

In the face of uncertainties times, a paradigm shift in economic thinking becomes imperative. The traditional emphasis on relentless growth and expansion must give way to a more nuanced approach that prioritizes sustainability, resilience, towards post-growth. Such an approach entails reimagining insurance models and products through a lens that acknowledges the finite nature of resources and the imperative of ecological balance.

We find important embracing degrowth principles in the future design of insurance mechanisms necessitates a fundamental re-evaluation of risk assessment methodologies and coverage frameworks. Rather than perpetuating a cycle of perpetual growth and consumption, insurance products should incentivize risk reduction, adaptation, resilience and sustainable practices. This entails integrating considerations of environmental sustainability, social equity, and long-term resilience into insurance pricing, underwriting, and claims management processes.

Integrating principles of degrowth, sustainability, and resilience into insurance models and products for sustainable food production is essential for addressing the multifaceted challenges posed by climate change. By prioritizing investments in climate-smart agriculture, promoting community resilience, and fostering collaboration across sectors, it will be possible to build more resilient and sustainable food systems that ensure food security for future generations while safeguarding the health of the planet. Navigating the uncertainties surrounding climate change demands a concerted effort to embrace degrowth principles and reorient insurance models towards sustainability and resilience. By acknowledging the inherent limitations of conventional growth paradigms and prioritizing ecological integrity and societal well-being, insurance products can play a pivotal role in fostering a more sustainable and resilient future for all.

Furthermore, fostering rural community resilience and enhancing adaptive capacity should form integral components of insurance strategies aimed at addressing climate risks. Investing in risk reduction measures, bolstering infrastructure resilience, and promoting community-based adaptation initiatives can help mitigate future losses and enhance societal well-being in the face of evolving climate challenges.

A recommendation for further directions in the development of agricultural insurance could be an analysis of the extent to which various incentive mechanisms enable improved risk prevention. Mechanisms should address the farm level and the level of the entire chain, taking into account a range of chain

configurations (e.g., short supply chains and export-oriented chains) and farm structures (e.g., family farms and corporate farms with hired labour).[318]

Introducing new programs and types of insurance tailored to the needs of farmers, particularly the introduction of multi-peril insurance, which would cover risks such as hail, drought, floods, storms, frost, excessive rainfall, as well as damages caused by wild boars and snow, which increasingly devastate crops in certain areas (e.g., raspberries). Introducing multi-peril insurance would increase the number of policies, as farmers would pay one premium for protection against several risks, which is certainly more cost-effective than insuring against individual risks.

Based on the experience of developed countries, the development of crop and fruit insurance should be encouraged towards covering multiple risks (a greater number of risks) or all types of risks.

Policyholders must be made aware of the objectives, tasks, and role of insurance, as long as farmers believe that insurance is an additional cost rather than an investment in the future, the development of insurance will not be possible. The state, in cooperation with insurance organizations, must find an adequate way to educate farmers.

In all economies, the food industry constitutes an indispensable segment and contributes to overall economic development, but it also has another, more important role. This industry plays a strategic role in ensuring food security, which is particularly challenging in the face of significant climate change, increasing consumer demands for both quantity and variety of products offered, and mounting pressure on limited natural resources.

Sustainability requires a comprehensive approach to addressing the greatest global challenges, including climate change, poverty reduction, inequality, natural resource protection, and improving quality of life. Green jobs have the potential to be of great importance in overcoming the global economic crisis and responding to climate change. Investments in green sectors create jobs, some initially in construction and installation of infrastructure, but later generate jobs in maintenance and operation of green technologies. Transitioning to green technologies and production methods can contribute to reducing harmful emissions and mitigating climate change.

[318] Meuwissen, M. P. M., Mey, Y., & van Asseldonk, M. (2018). Prospects for agricultural insurance in Europe. *Agricultural Finance Review, 78*(2), pp. 174-182. https://doi.org/10.1108/AFR-04-2018-093

Agricultural insurance in Serbia should take its place in a modern market economy and follow the standards and trends of economically developed countries. This will be facilitated by an increasing number of insurance companies in the market, a more active role of the state, and education of farmers regarding the many advantages of insurance.

The development of renewable energy sources, energy efficiency, and climate change adaptation strategies can help Serbia address these challenges. To prevent environmental degradation and combat climate change, Serbia is working to improve environmental sustainability, including reducing greenhouse gas emissions and improving waste management. The purpose of INFORM products is to make crisis and disaster information more accessible to decision-makers. INFORM products aim to aggregate and present existing information in a way that can create a common database and easily integrate into decision-making systems.

INFORM outputs include alerts for each country, based on risk information aggregation. What is important for the further development of agriculture insurance in the long run is finding ways to encourage farmers to use insurance products, where the state must have a more active role, with the involvement of local self-government. Moreover, cooperation among all three participants - the state, farmers, and insurance companies - is necessary.

Considering the country's economic strength, which is still at the level of developing countries, we can conclude that gross premiums for crop insurance and livestock insurance will be correlated with other branches of insurance activity and follow the upward trend. This conclusion indicates that the absolute values of gross premiums will increase, but the potential for agriculture insurance will remain at an insufficiently developed level. Given all of the above, we have a long way to go to change the current state of crop and fruit insurance in our country.

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