

## RISK MANAGEMENT OF AGRICULTURAL FLOODS

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### Summary

*Agricultural production in Serbia accounts for the largest part of the gross domestic product and can be an economic backbone and the main driver of the domestic food industry and exports, primarily because of its potential such as arable land and a long tradition of agricultural production in these regions. However, numerous risks threaten its stability. The focus of our research is agricultural flooding. The set-up aim of the research is an examination of the causes and consequences of agricultural fields in order to holistically research the current problem. In order to achieve the target, in the paper we will analyze the realization of floods in Serbia, followed by subjective and objective factors of the realization of floods, or the realization of floods caused by human or natural forces and then we will point out the economic consequences of the execution of agricultural floods as well as the application of preventive measures and measures of financing the resulting economic consequences.*

**Keywords:** *agriculture, floods, causes, prevention, insurance.*

**JEL:** *Q01, Q54, G22.*

### Introduction

Throughout the history of civilization, from prehistoric times to the present day, floods endangered human life and property (Njegomir, 2014). Natural forces and phenomena, people attributed to the effect of the higher power that ruled the universe. Disastrous consequences associated with floods were attributed to the anger of the gods and often

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were the cause of the people on Earth. For example, in ancient Greek mythology, Zeus punished all people with great flood except Deucalion and Piru. Faced with the disastrous consequences of the floods, people have adapted to their impact. A specific example is the Sumerian civilization. Despite nurturing the cult of water and the existence of a deity of water in the form of god Ea, the god of water, wisdom and crafts, the myth of the ancestral divine element in water where the roots of life were hidden, Sumerians built the first irrigation systems. Inhibited between the rivers Tigris and Euphrates, the Sumerians, whose survival was threatened by great droughts in the period between 3500 and 2000 BC, built irrigation and drainage systems that controlled influence of water and reduced the potential negative consequences of flooding.

Today, the world is faced with the risk of floods due to climate changes and increased concentration of population and material resources in the affected areas. Climate changes impact on paradigm change in terms of occurrence frequency and the concentration of population and material values impact on paradigm change in terms of intensity of the harmful effects of floods (Njegomir, 2011).

The focus of our research is agricultural flooding. The goal of the research is examining the causes and consequences of agricultural floods in order to have holistic overview of the current problem. In order to achieve the goal in this paper, we will analyze the realization of floods in Serbia and subjective and objective impact on the realization of the floods or the realization of the floods caused by man and by impact of natural forces and then we will point on economic consequences of the realization of agricultural floods and the implementation of preventive measures and measures of financing existing economic consequences.

### **Methodology and data sources**

The focus of our research is on agricultural floods in Serbia and possible implications of climate changes on them in terms of severity and frequency. We use statistical analysis for data processing, analysing, presenting and comparing trends of floods realization and measures taken to prevent them in agriculture production in Serbia.

We firstly analyse the realization of agricultural floods in Serbia using data of Republic Hydrometeorological Service of Serbia. The analysis of objective factors of agricultural floods is followed by special emphasis of the two most risky years when agricultural floods are in question. Additionally, we explain man made factors that cause agricultural floods.

In analysing economic consequences of agricultural floods we compare foreign theoretical knowledge and empirical evidence with the same in Serbia in order to determine similarities and differences. We use data for whole Europe but especially for Thailand, the U.K. and Northern Europe. Data sources encompass European Environment Agency and Food and Agricultural Organization.

We analyse the application of preventive measures and in order to determine what is done and what is ought to be done, on the basis of foreign experiences, to improve the prevention measures. As prevention is one of the key measure that is applied on field, this analysis is

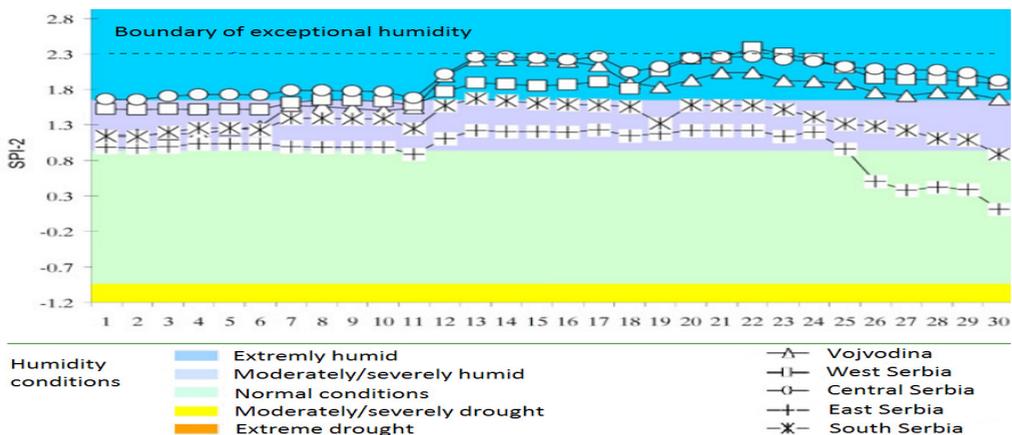
particularly important and is basis for the analysis of the financial indemnification measures. Finally, on the basis of foreign positive experiences we explore the possibilities of financing economic consequences of agricultural floods. Particularly we analyse financing possibilities from three sources: the state budget, insurance and micro-insurance. For the analysis of available sources for financing economic consequences of agricultural floods we use data from National bank of Serbia, World Bank, OECD, Lloyd’s and Microinsurance Centre.

### Realization of flood risk in Serbian agriculture

In Serbia, annual precipitation increase in average with altitude. In lower regions annual rainfall varies from 540 to 820 mm. Areas with an altitude above 1000 m have an average of 700 to 1,000 mm of rainfall, while some mountain peaks in southwestern Serbia have heavier precipitation up to 1500 mm. Most of Serbia has continental rainfall regime, with larger volumes in the warmer half of the year, except from southwestern areas which have the most rainfall in autumn. The wettest is June, with an average of 12 to 13% of the total annual rainfall. The driest months are February and October. Snow cover is characteristic for the colder part of the year from November to March, and the highest number of days with snow cover is in January (RSZ, 2013).

Standardized Precipitation Index is the amount of rainfall recorded over a period of time represented by the value of the random variable that has a standardized normal distribution probability (RSZ, 2016b). The values of statistical parameters that are necessary for the implementation of this transformation are obtained by processing of long-term data sets of rainfall. Extremely high values of the standardized precipitation index as an indicator of floods, outflowing of groundwater and over-moist land in northern Serbia, especially in the central and western parts were manifested in April 2006 (see Figure 1).

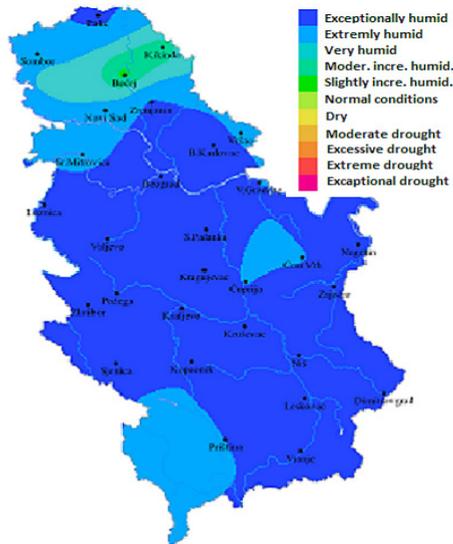
**Figure 1.** Extreme increase of humidity in Serbia in April 2006



Source: RZS (2016a).

Due to the unprecedented floods, especially disastrous years in Serbia was 2014. Serbia is on the first place of all countries that were most exposed to extreme weather conditions in 2014, shown by study of the Global Climate Risk Index, which was launched at World Summit in Paris in December 2015. These floods have affected negatively on about 1.6 million people in Serbia, caused mortality of 51 persons and material damage worth over 2.1 billion dollars. Humidity in the period between April and September 2014 in Serbia is illustrated in Figure 2.

**Figure 2.** Precipitation in growing season (April-September) in 2014



Source: RZS (2016a).

The figure shows that floods, or extreme humidity in the vegetation period, which referred on period from June to September 2014 affected almost all Central and South Serbia, while in Vojvodina expressed strong to extreme humidity, except in southern Banat, western Srem and the wider area of Subotica where, as in the rest of Serbia was expressed extreme humidity.

Vojvodina, the largest area of arable land in Serbia has always been exposed to the risk of flooding. It is considered that 46% of the total territory of Vojvodina is affected by this risk. The total area of Vojvodina amounts to 2.150.600 ha (Vode Vojvodine, 2010). 81% from total area is arable land, 13.3% forests and barren land, while 5.7 of the land is covered by quags, ponds, fishponds and swamps (Vode Vojvodine, 2010).

From 1% of high water is threatened (Vode Vojvodine, 2010):

- 1 million hectares of land, or 45% of the total area,
- 260 estates,
- 1.2 million people,

- 3840 km of roads,
- 150 km railways and
- 800 industrial facilities.

### **Natural causes of agricultural floods in Serbia in 2014 and 2015**

A chronological overview of the catastrophic floods in the Republic of Serbia in 2014, when the floods have caused major risks, threats and consequences. After heavy and long-term rainfall with powerful cyclone that swept through the central part of the Balkan Peninsula, there was a drastic material consequences and drastic effect on human life and health in the Republic of Serbia. In the second half of May of that year, heavy rains included the entire area of the Republic Serbia and in 24 hours there was heavy rainfall, whereby 100 liters spilled per square meter. Maximum precipitation was recorded in May 15, first in Belgrade, where had poured 107.9 liters, in Loznica 110 liters and in Valjevo 108.2 liters per square meters. The result of swollen rivers are landslides that caused death for more than 30 people, and in May 15 was declared emergency situation. Due to the above, there was a large consequences by the advent of floods, landslides, destruction of infrastructure, houses, property and other valuables of enormous proportions.

The disastrous consequences of the floods in May 2014, Serbia was affected by major floods in most of the parts. This natural disaster is not remembered in Serbia or that it was in similar proportion, it is not remembered and people do not remember that it was recorded in the statistic in the last 130 years. So, what else is the difference between this rainfalls compared to earlier periods, and in the fact that in the short period fell to the ground large quantities of water in the form of cyclone so-called "Tampara" which brought on Balkan this type of catastrophic natural disaster. Due to above, the levels of rivers, small rivers and streams were raised and turned in torrential rivers. Secondly, in addition to above, this disaster was different because it often appeared on different space with the same intensity of rainfall and sometimes with smaller intensity and on different space. „, Due to high intensity of precipitation, the level of rivers and streams increased and jeopardized the vast territory, people and other values of society, which led to the state of emergency, in parts, local communities, as well in whole Serbia. „,Third, man himself contributes to this kind of rainfall and floods, with his power and contribution, destruction or damage to dams, buildings etc. (Pejanović, Mitic, 2016). During the state of emergency, 31.873 people were evacuated and most of them were placed in shelters, it was flooded 2.260 and endangered 1.763 objects. However, for those actions in evacuation and rescue of people in jeopardy and their property and also the property of state, the 3.564 members of fire-rescue units were hired, 847 specialized vehicles, 429 pumping stations and 141 evacuation boat on water. In short, the presented and the other consequences that have occurred in the flooded areas are registered in: the Belgrade region, in cities and towns that have suffered damage, Obrenovac, Umka and Lazarevac. In Branicevo region Kostolac, in Macva Sabac, Mali Zvornik, Krupanj,

Loznica, Ljubovija, Vladimirci, Koceljeva and Bogatić. In the district of Srem, Sremska Mitrovica and Sid. In the Pomoravlje region, Svilajinac, Cuprija, Paracin and Rekovac. In Moravicki district Cacak, Lucani and Gornji Milanovac. In Sumadija district, Raca, Knić and Topola. And at the end in Raska district Kraljevo.

However, complete anti-terrorist unit of RS, Gendarmerie, Special Anti-Terrorist Unit with 2.400 members, traffic police with 60 members, the Administration Liaison and crypto-protection, 1.085 police officers and 998 members of civil protection were hired in evacuation and assistance. Beside teams and institutions from Republic of Serbia, help provided teams from Russia, Macedonia, Slovenia, Bulgaria, Czech Republic, Germany, Austria, France, Hungary, Montenegro and Romania. Help was provided in manpower, equipment for rescue, pumping stations and other assets. A large number of volunteers ie citizens of the Republic of Serbia joined the action. It is observed and recorded data on the consequences caused by flooding in which the most vulnerable municipalities was Obrenovac when 24.000 people was evacuated from this territory. In this area a great threat was a threat of the Thermal Power Plant in Kostolac that was protected and saved from flood by members of Army of Republic Serbia, volunteers from country and abroad and rescuers from listed countries from the region and Europe. This region and the thermal power plant was threatened by swollen river Mlava. The thermal power plant Nikola Tesla in Obrenovac also was in danger of flooding and destruction from the swollen rivers Sava and Kolubara. This power plant was preserved by strengthening embankments on these rivers that were threatened by flood and destruction. Sremska Mitrovica, Sabac, Krupanj, Mali Zvornik, Svilajinac, Kursumlija and others were drastically affected by flood and the population has been evacuated, livestock and other values that were protected from destruction. All this caused deceiving the state of emergency, in the municipality of Kursumlija, Lucani, Pozega, Aleksinac, Prokuplje, Zaječar, Medvedja, Lebane, Doljevac, Gadzin Han, Targoviste, Zitoradja and Dragačevo. According to the estimates in this case the most vulnerable were Prokuplje, Zaječar i Zitoradja. Considering that this paper has limited space, it was not possible to perform detailed and complete analysis of all hazardous areas, people and property.” (Vanredne situacije, 2014). In the end, at a given time and space, the complete infrastructure was threatened in the flooded areas. „Therefore, the risk on infrastructure is occurrence of critical uncertainty and realization of loss, and any loss is consequence of irresponsability of the state and civil subjects in ignorance, negligence and idleness”.The occurrence of natural disasters with devastating power, makes it difficult to protect and rescue, as well as measures of protection after such events (Pejanović, Kolev, Zivanovic, 2014).

It is significant to say that fraudsters are always present with criminal activity even during natural disasters and emergency situations. During the natural disasters, fraudsters stole 400 million euros, and people who were damaged by floods received only 4.3 billion dinars for the reconstruction of houses, while a tenth of that sum was misappropriated by fraudsters. No one in normal situation, especially in emergency situations is not entitled to abuse and criminality, but in Serbia those kind of people do

not hesitate of anything even stealing in state of emergency when people struggle for life and survival.

In Pčinja district due to heavy rains, swollen rivers and torrential streams poured and made a dive, flooding and chaos in their flows. Because of this emergency situation was declared in the cities and municipalities, Vranje and Vladicin Han. In this case drastically were affected Vranjska Banja, resorts Savinci, Bujkovac and Korbevac. Swollen Korbevačka River washed away the two bridges, which interrupted traffic on the road Kobrevac-Kriva Feja and the places around this area. Moravian villages were flooded, Priboj, Stubal, Suva Morava, Lepenica, while in the region of Surdulica, Prekodolce and Zitoradja were flooded. In these disasters Sector for Emergency Situations evacuated 22 persons that were rescued and placed in a reception center ie school in Vladicin Han. Also, the river Vrela poured out in the territory of Surdulica flooding four villages in Vladicin Han. However, it was difficult on the territory of Crna Trava where power lines were broke and villages remained without electricity, as well as other major damage.

The floods that occurred during the weekend on 24 and 25.1.2015, caused damage of more than 5.000.000 euros, destroying bridges on South Morava and to renew one bridge cost more than 30.000.000 million dinars, and to correct only one trawler costs from 200.000 to 2.000.000 dinars. It was destroyed 110 houses and dozens of kilometers of roads. A flood had caused great damage to farms and agriculture. Twenty percent of the population had no electricity and had many other damages and problems.

### **Subjective causes of agricultural floods**

Agricultural production in Serbia should be the support and the main initiator of the economy and exports, primarily because of its potential in arable land, but also because of long tradition of agricultural production in these regions. However, like every branch of industry, agriculture have expressed need for funding, not only because of realization of the current production, but also because of expanding the available capacity (expansion of arable land, pooling, purchasing modern work equipment, expansion of livestock, etc.). (Skakavac, Ivanović, 2014). The arable land may be affected, among other things, by objective and subjective impact factors of the natural flooding.

Many objective and subjective factors have effect on natural flooding. Objective factors are not always predictable, sometimes they manifest suddenly, consequences occur in a short time, and man is not always able to take the necessary protective measures so that the damage is minimal. The objective factors include: heavy and sudden rains that last for a long time; torrential rains in a wide range that occur as a result of heavy rains; rapid warming that causes rapid snow melting and increased height of water flow, rupture of dams and embankments, the absence of alternative solutions for water leakage in the uninhabited areas and similarly.

While on some unforeseen objective factors and conditions cannot be influenced, subjective factors deserve special attention because they only depend on the man and his

behavior. Previous world and national experience showed some subjective factors that directly affect the deterioration of the situation and formation of serious consequences in a much greater extent. Because of that, this requires planned and synchronized disabling a man to take certain actions and activities that can significantly contribute to the deterioration of the situation in the area of occurrence of natural floods. To prevent this, it is necessary to take certain preventive measures that are prohibiting:

- devastation, deforestation and net deforestation and stripping surfaces;
- uncontrolled digging and plowing of meadows, pastures and uncultivated areas, in order to grow annual crops;
- backfill of spring water and uncontrolled collection and disposal of these water;
- construction of buildings without proper planning and project documentation;
- the exploitation of river sediment from the bottom of the slopes, except for the purpose of providing bandwidth capacity of troughs torrents;
- Construction of facilities that could endanger the stability of the land (water mills, dams, canals, ponds, etc.).

Unfortunately, subjective factors are often more dangerous and can produce serious consequences for people and property. The best example are the catastrophic floods in Serbia (Croatia and Bosnia and Herzegovina) in April and May 2014. Disastrous floods in Bosnia and Herzegovina, Croatia and Serbia took away over 50 lives, dislocated hundreds of thousands of people and inflicted enormous material damage whose effects will be felt for years. While the public generally dealt with praises on the efforts of devoted self-organized people to resist the disaster and to deliver humanitarian assistance, the issue of the impact of system policy on the inability of counties to cope with the disaster remained in the shadow.

In considering of these issues, it is important to speak about neighborly relations and cooperation between states to take joint measures and activities to prevent more serious consequences of natural flooding. Neighboring countries in this area must establish maximum cooperation, because nature knows no borders. "Previous experience has shown that the principle of good neighborly relations is very much used by Member States compared to countries which have sought to join EU, primarily for political purpose. Such disputes was in the increased number and each of them, individually speaking, showed all the complexity of the principle of good neighborly relations. In this regard, it is important to mention bilateral dispute between the Serbian and Croatian about border on the Danube, where is disputed 10 000 hectares of the Serbian and around 2500 hectares of the Croatian side. Both parties in the dispute have conflicting goals and perceptions of the possible solutions to the problem." (Domazet, Skakavac, 2016). "The Republic of Serbia is pleading to solve problems on the way so that state border is in the middle of a natural flow of the river Danube, which is in accordance with the rules of international law and that would correspond to the actual situation.

On the other hand, Croatia's proposal about determination is based on the cadastral diameter, which dates from the time of the Austro-Hungarian Empire, which would enable for Sarengradska and Vukovar Ada to be on the side of Croatia, while Serbia would lose part of municipalities Apatin and Sombor. In addition, Croatia demands that the decision of Badinter Commission is respected and that existing borders between the republics of former Yugoslavia become international or inter-state." (Domazet, Skakavac, 2016). Although the intergovernmental commissions with representatives from both countries were established, in the past decade, no results have been achieved. Recently, arbitration is being mentioned as a potential solution to the problem, and even the International Court of Justice "(Domazet, Skakavac, 2016).

Following the events in this field over the last few years, we can say that the floods in Serbia are no accidents that cannot be predicted. The National Strategy for protection and rescue in emergency situations, from 2011, classify torrential floods in the category of "predictable phenomena that arise quickly and are over soon, and leave the ruins behind." However, although timely prediction demand timely investment in prevention, the Strategy specify the following: "The traditional way to protect from this type of floods is to build a solid system of objects. If this system is inadequate or if it does not exist, after the torrential floods remain the ruins of bridges, roads, buildings and everything in their way. Constructive costs of passive protection system from torrential floods are high and these works are always late to the needs, so the only way to minimize a damage is organizing timely notice of possible torrential floods and evacuating people and moving goods off the road of torrential floods. "

If we look at the situation in other countries, it is clear that this is a general tendency to intensify the fight against floods at the moment when the consequences occur. So, this is a struggle to remedy already caused consequences and to save what still can be saved, because in the previous period, when still was time, nothing or almost nothing was done, especially at the preventive level. In Serbia, as we can see through the media reports in the periods between floods, state funding for regular maintenance of watercourses are smaller. For example, in 2012, funds were not even enough to maintain the existing, let alone for the construction of new dams and dikes. In addition to the lack of investment in infrastructure, the current austerity measures included the reduction in the budget for public services, including the Department for Emergency Situations, whose budget in 2013 was reduced by more than 10 million.

However, the disastrous consequences that hit Serbia, as well as the entire region, have shown incredible good side. What has been done very well to deal with the immediate consequences of the flooding is the incredible solidarity and self-organization of citizens about which should also testify. For all that has been done well only and exclusively is the responsibility of ordinary people who have voluntarily engaged in the defense, as well as professionals and employees of some relevant services. An extraordinary number of people voluntarily started the construction of dams in areas that were at risk of flooding, in Sabac, Sremska Mitrovica, Belgrade, but also in many other places. Through professional services, and in particular members of army

and police, it is evacuated a large number of people from flooded areas and placed in the improvised reception center in Belgrade and elsewhere. Many institutions, civil society organizations and individuals voluntarily raised help for people in reception centers, in the form of food, clothing, shoes, hygiene items, etc. Taxi drivers freely transported people who distributed things in centers, radio amateurs from many cities that were self-organized, gathered information about people who remained trapped in flooded areas and forwarded those information to rescue service. Veterinary students and students from other colleges and animal protection organization were involved in the rescue and care for animals from flooded areas.

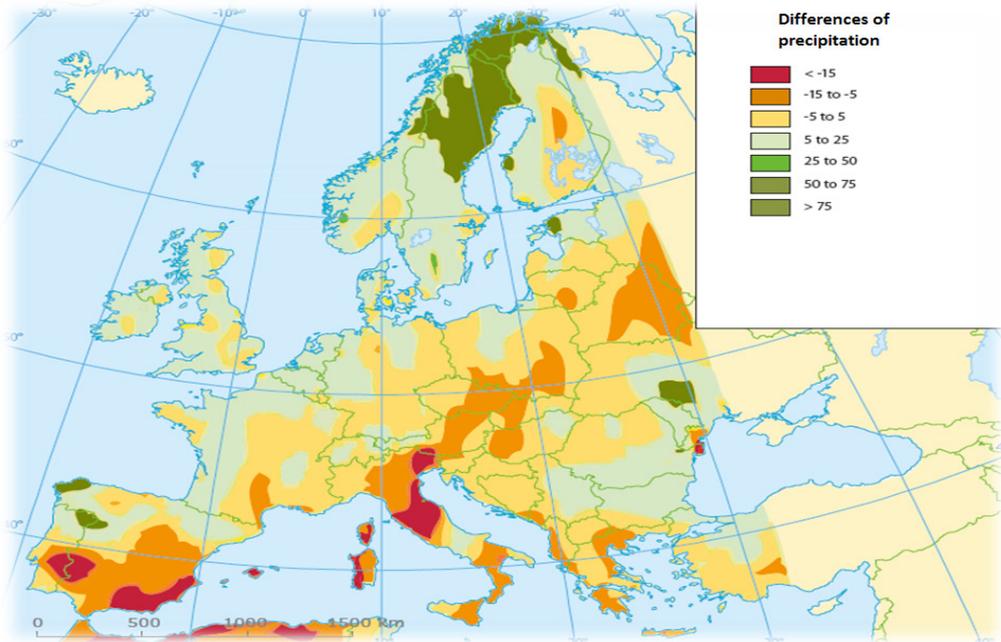
### **Economic consequences of agricultural floods**

Flood is uncontrolled, unexpected flooding of land due torrents, overflowing from the river beds and canals due to break of dykes and dams. Other cases of flooding, caused by excessive rainfall or groundwater, are not considered for flood. Damage caused by floods are due to disorders water-air regime of soil, where there is a displacement of air. The air in the soil, as well as water, is essential or plant life, and that leads to their gradual extinction.

In Europe, the biggest economic consequences of natural disasters that are caused by weather changes occur due to floods and winter storms. Winters are wetter and that leads to manifestation of floods, a summers are becoming drier with concentrated extreme precipitation, which represent a new threat, shown by the floods in England 2007 or the floods in Thailand 2011. Floods in the U.K. have produced a total economic damage in the amount of 3,9 billion euros, the floods in Central and Eastern Europe in 2005, 2.8 billion and floods in Central Europe in 2002 over 15 billion euros. Unusually high temperatures during the summer of 1992 in northern Germany caused a deterioration of the crop which caused total economic damage in amount to about 4 billion marks (Brauner, 2002).

The floods from 2013 in Europe caused overall economic consequences in the amount of \$ 16 billion, of which \$ 4 billion in damage was covered by insurance. Floods in Canada have cost \$ 4.7 billion, while the damage for insurance amounted to 1.9 billion dollars. Flooding in the region in 2014, primarily in Bosnia and Herzegovina and Serbia, are a reminder that the area of the region are not exempt from the impact of floods, which particularly threaten agricultural production.

Climate changes affect the flooding of coastal zone and based on the research a significant increase in damage can be expected in longer period of time. Assumptions are that by the end of this century, devastating floods, whose previous probability of realization in the coastal areas in Northern Europe, for example, was one in a million realized every 30 years, which will increase riskiness of insurance and reinsurance sector. Estimates are that with manifestation of these risks of floods in Europe, the anticipated damage will increase in average in the range from 100 to 900 percent annually. For flood-affected countries, this scenario will mean the need to integrate climate change risks in the process of assessment and risk management. Figure 3 shows the trend of average annual precipitation in Europe during the twentieth century.

**Figure 3.** Trend of average annual precipitation in the period from 1900 to 1998 year

Source: EEA (2006). Note: the average annual value from 1901 to 1910 opposite from 1991 to 2000 in percentage (change from -35% to 104%)

Estimates of the International Organization for Food and Agriculture (FAO) are that by the year 2085, 11% of arable land in developing countries will be lost due to climate change, which will reduce the production of cereals in more than 65 countries (McClellan et al., 2005). If we consider particularly Africa, estimates are that 25% to 45% of the habitat will be lost, which will jeopardize agricultural production and crops for food and medical purposes. Agricultural production in under the relatively greatest negative impact of climate change, which is especially highlighted in the least developed countries. Unlike undeveloped countries, developed countries of the northern hemisphere, in certain extend, will be able to take advantage of positive effects of global warming. The problem in developing countries, especially in undeveloped countries is the fact that in these countries there are no adequate institutions and infrastructures for dealing with climate changes, despite the fact that agricultural production has a very important role in their national economies.

### **Preventing economic consequences of agricultural floods**

The assessment of flood risk should be made on the basics for the century-old water and it should refer on long and heavy rains, due to torrential rains and rapid snow melting and erosion processes in the coastal rivers. Particularly it must be indicated whether steams have torrential character, which are accompanying torrential characteristics, if they quickly emerge or if they have devastating effects with parallel appearance of

torrential lava flows, escarpment and landslides. It is important to note the time from detecting rain clouds to the occurrence of the maximum flow, due to the need of informing citizens about the impending danger to people's lives and property.

Based on the assessment from threat of flooding in a particular area, the Operational plan of flood controlling is constituted at the state level and at the levels of each municipal separately. The plan must be made for all entities and resources that will be used when a certain danger occurs.

In order to reduce the harmful effects of water, and that the consequences caused by flooding of agricultural land were less, it is necessary to take certain preventive measures of flood control, as follows:

- a planned, organized and constant work on construction and reconstruction of the defense line against floods,
- constant work on increasing the level of security of defense against floods,
- regular innovation of technical documentation of buildings and areas, dykes and defense lines,
- Improve the systems for monitoring, maintaining contacts and exchange of information on all issues of importance to counter the dangers and performance execution of tasks.

On rivers and smaller streams where the level of organization is weaker, it is necessary to take the following preventive measures:

- Timely build small dams and floodgates in order to adequately perform the reception of flood wave,
- Build a network of lateral courses that will direct flood wave in order to reduce sudden water pressure on some endangered courses and to reduce immediate danger,
- Timely and continuous planned work on afforestation of bare land and grass seeding of certain agricultural areas that would represent the protection of agricultural land.
- Continuous access to cleaning a huge amount of coats, bulky waste and vegetation in the river beds from which threatens pouring water on agricultural land and demolishing on safe places of destruction, storing and recycling.

In order to reduce the risk of agricultural flood, at the level of each unit of local government it is necessary to continuously and systematically undertake the following important preventive measures:

- 1) Ensure to determine the general and special conditions for protection against natural disasters and floods in the process of development and adoption of urban plans;
- 2) to predict measures for protection of life and health of people and material

- goods through urban planning of areas and settlements;
- 3) provide planned afforestation and recovery of landslides through the provision of anti-erosion works;
  - 4) to start construction of the missing embankments, coastal defense and maintenance of existing ones;
  - 5) to start construction of hydro accumulations in the series, as well as mini-hydro accumulation;
  - 6) build a system of channels for water drainage and their maintenance;
  - 7) build bridges and culverts with larger capacity;
  - 8) make a marking on the field on the lines of reaching the maximum possible flood wave, which would occur by the demolition or overflow of dam on reservoirs;
  - 9) planned organization of permanent service for observation and information on larger watercourses, to ensure timely notification about the dangers of flooding;
  - 10) execute the training of citizens for protection and rescue from floods, through personal and mutual protection;
  - 11) pursue with the training of companies of interest for protection and rescue from floods and the introduction of their tasks in the defense plans;
  - 12) execute the training of all CZ units, especially those that specialize in water rescue;
  - 13) working on selecting, completing and training of voluntary organizations, civic associations, sports clubs, etc. and defining their missions whose activities are linked to water (kayakers, divers, etc.);
  - 14) provide the realization of coordination and cooperation with the units and headquarters of the Serbian Army, police, gendarmerie and other security structures (particularly with units whose expertise and activities are related to water);
  - 15) provide education and training of CZ headquarters for the management of actions of protection and rescue from floods;
  - 16) Systematically and continuously organize peacetime exercises with the civilians, especially in endangered areas, and practice the system of rescuing people and property from flooding.
  - 17) Develop quality and applicable plans for protection and rescue from agricultural floods on the level of each municipality in the Republic of Serbia.

### **Financing economic consequences of agricultural floods**

Measures intended to finance economic consequences of agricultural floods realization include financing from the state budget, insurance and micro-insurance.

In the most countries in the case of the significant damage caused by the floods that

threaten income of agricultural producers, state ultimately intervene directly by financing from the budget. It should be noted that state intervention in the management of flood risk in agriculture is justified only when the risk management measures based on market principles, such as insurance or futures, are not applicable or do not exist. For example, in order to repair the consequences by Hurricane Xynthia, which in February, 2010 caused significant damage to agricultural producers in France, it was promised support from state from fund for natural disasters. Due to floods in Serbia in 2010 and 2014, state intervened with sources from public funds.

In the case of direct intervention of the state during catastrophic events, which is not always desirable because it stifles the development of private insurance, priority should be given to the public funds in case of realization of catastrophic events rather than ad-hoc type of assistance that leads to a negative impact on the budget. Research shows that the existence of state programs in crop insurance in developed and in developing countries cannot survive without government subsidies, and in most cases social benefits were not clear enough to justify the cost of budgetary funds (Skees, Hazell, Miranda, 1999). In OECD countries, the most common form of state intervention is support to market prices that provides stabilization of prices and reduces price risk on domestic market of agricultural products, whereby the correlation between the degree of support to market prices and the development of a form of risk management is established (OECD, 2009).

The key role of insurance in agricultural production and in society in general is indirect economic protection of life and property from the effects of natural forces and accidents. Insurance improves agricultural production because insurance makes entrepreneurial activities more stable and more certain.

Insurance reduces the uncertainty of agricultural producers and the need to create individual savings accounts or funds, given that the need for cash reserves is reduced (Raulston et al., 2010). By releasing the need for accumulation of surplus funds that, thanks to insurance, can be profitably engaged, insurance provides further support for the development of agriculture (Njegomir, Pejanović, 2011). World Bank indicates that lack of access to insurance of agriculture, which is one of the ten key factors in solving the problem of food security crisis is a serious barrier to productivity, investments and efficiency of marketing systems in agriculture (World Bank, 2008). The importance of agriculture insurance is evidenced by the exclusion of state subsidies for the payment of insurance premiums from the Free Trade Agreement from 1994 by the World Trade Organization, under condition that the insurance provide financial compensation for the climate and natural disasters (Baez, Wong, 2007).

Despite the great importance of insurance, there are various studies that show conflicting results regarding the factors that have a positive impact on agricultural producers to conclude insurance contracts. For example, Velandia et al. (2009) found that level of business risk (Ignjatijević et al., 2016) has a positive impact on conclusion of contract in crop insurance, and land ownership, income outside agriculture (off-farm income)

and education has a negative impact. However, Sherrick et al. (2004) found that agricultural producers will rather conclude insurance contract if their perceived risk of return realization is increased and if they produce on the farms that are larger, older and that are not leased. Also, Enjolras and Sentis (2008), by analyzing the agricultural insurance in France, found that the size and financial strength of holding, diversified production and catastrophic climatic events have a positive impact on farmers' decision on the conclusion of insurance contract.

When it comes to insurance of agriculture in Serbia but also in the world, mainly in the insurance companies offer two types occur: crop insurance and livestock insurance. The risk of flooding, with other insured risks, is covered by these two types of agricultural insurance. Crop insurance is the most represented type of insurance which in 2008 accounted about 90% of the total global insurance premiums in agriculture (Iturrioz, 2009). In Serbia, the total insurance premium of agriculture, therefore crop insurance and livestock insurance amounted to 2,194,861,000 dinars (NBS, 2017), which is relatively small. According to the Census of Agriculture (2012) the total number of farms in Serbia was 631,122, which indicates that the total agricultural insurance premiums per farm was about 3478 dinars. This premiums per farm is relatively small especially because state finances 40% of the paid insurance premiums (reimbursement is provided by the Law on Agriculture and Rural Development), and this is the average premium per entrepreneur, whereby a large number of agricultural holdings are not insured.

In developing countries, in poor rural areas, traditional insurance is replaced by micro-insurance. Micro-insurance allows financial compensation in case of damage an avoidance of other inefficient cost mechanisms for protection from damage, which ultimately results in poverty reduction. The concept of micro-insurance is not named because of the size of risk, institution or delivery channels, to which also indicates Churchill (2006), but due the fact that this type of insurance is adjusted to the needs of people with lower incomes. Micro-insurance is effective on markets with little experience in insurance business, or as long as products, procedures and insurance policies are simple, premiums are low, administration efficient and distribution channel innovative. Having in mind these characteristics, based on data from Lloyd's and the Microinsurance Centre, in 2009 micro-insurance included 135 million people, or about 5% of the market potential with the recorded annual growth rate of 10% percent or more in many countries (Lloyd's 3600, 2009). For the application of micro-insurance in financing the results of flood realization and other risks in agricultural production in Serbia, it is necessary that micro-insurance services are less complex, offered to the market at a relatively low premiums and with mandatory participation of all agricultural producers and state support.

### **Conclusion**

Agricultural production in Serbia is exposed to the effects of heavy rainfalls, often accompanied with local floods, usually in June, with average of 12 to 13% of the

total annual rainfall. Exposure to floods is particularly emphasized in recent times and especially in 2014 and 2015. In Vojvodina, for example, 1 million hectares of land, or 45% of the total arable land is threatened by 1% of high water. Cited as well as detailed research presented in the paper undoubtedly point to the importance of agricultural floods and the need for their research. In this paper are explicitly specified objective and subjective influence factors on the realization of agricultural floods as well as the risk management methods of agricultural floods. The most important aspect of risk management of agricultural flood realization is adequate prevention in order to stop the flood realization and to reduce the probability of their realization and financing the harmful consequences when damage from agricultural floods is realized. The application of preventive measures, such as improving the construction of irrigation and drainage systems, should be a planned, systematic, regular and timely. Measures intended to finance the economic effects of agricultural food realization include funding from state budget, from insurance and micro-insurance. We believe that insurance and micro-insurance are the most appropriate form of financing harmful consequences from agricultural floods. Financing damage from the budget should be reduced to a minimum and those sources should be directed to improvement of crop and yield insurance and also animal insurance, not only in terms of subsidizing the payment of insurance premiums, but also through sophisticated support programs, including reinsurance in the final instance, and education of agricultural producers. In the interest of whole society is the continuation of agricultural production and precisely adequate risk management of agricultural floods can enable the continuous development of agriculture in Serbia.

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## UPRAVLJANJE RIZICIMA POLJOPRIVREDNIH POPLAVA

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### Rezime

*Poljoprivredna proizvodnja u Srbiji čini najveći deo bruto domaćeg proizvoda a može biti privredni oslonac i glavni pokretač domaće prehrambene industrije i izvoza, pre svega zbog svog potencijala obradivih površina, ali i dugogodišnje tradicije poljoprivredne proizvodnje na ovim prostorima. Međutim, brojni rizici ugrožavaju njenu stabilnost. U fokusu našeg istraživanja jesu poljoprivredne poplave. Cilj istraživanja koji smo postavili jeste ispitivanje uzroka i posledica poljoprivrednih poplava u cilju holističkog sagledavanja ovog aktuelnog problema. U nameri da cilj ostvarimo, u radu ćemo analizirati ostvarivanje poplava u Srbiji, zatim subjektivne i objektivne uticaja na ostvarenje poplava, odnosno ostvarenje poplava čovekovim i delovanjem prirodnih sila a potom ćemo ukazati na ekonomske posledice ostvarenja poljoprivrednih poplava kao i primenu preventivnih mera i mera finansiranja nastalih ekonomskih posledica.*

**Ključne reči:** *poljoprivreda, poplave, uzroci, prevencija, osiguranje.*

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