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A HANDBOOK

for Civil Sector Training about Natural Disasters

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HANDBOOK

for Civil Sector Training about Natural Disasters

UNIVERSITY OF BANJA LUKA
FACULTY OF SECURITY SCIENCE
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CONTENT

1. INTRODUCTION

> *Natural disaster is an incidence of hydrological, geological or biological origin, caused by the action of natural forces, such as earthquakes, floods, flash floods, storms, heavy rain, atmospheric discharge, hail, drought, landslide, snowdrifts and avalanches, extreme air temperatures, freezing water flows, epidemics of infectious diseases and the emergence of pests and other natural phenomena on a larger scale, which can threaten the health and life of people or cause severe damage.* [1]

Natural disasters occur as a result of the effect of natural forces with severe consequences for humans, other living beings and material goods. Typically natural disasters are droughts, wildfires, earthquakes, floods, landslides, storm winds, frosts.

Climatic fluctuations during the past decade, amongst others, conditioned all the frequent occurrence of floods and flood waves. In this context, the increasing attention of the scientific and general public is focused on protection and reduction the risk of the flooding.

In the last three decades, the number of natural catastrophes recorded steady growth. Analysis of natural disaster on the example of Serbia showed an increase to 2,000 in the period 1980-1990 and at 2,800 in the period 1990-2000.

Climate change is predicted to result in more droughts, floods, heatwaves, and other extreme weather, as well as more intense storms and rising sea levels. These effects are likely to render agriculture more difficult, if not impossible, across swathes of the globe, including sub-Saharan Africa and parts of Asia which will result in a *huge influx of refugees in Europe over the next 50 years*.

[1] Law on protection and rescue in an emergency, Official Gazette of the Republic of Srpska 121/12

Since 2005 to date, over the globe, more then 700 000 people lost their lives, over 1.4 million people have been hurt, about 23 million have lost their homes or displaced. More than 1.5 billion inhabitants was affected by some form of natural disaster and total economic losses total more than 1.3 trillion dollars.[2]

Between 2002 and 2017, natural disasters have a heavy toll over 80000 people's lives in the European Union, and the material damage is estimated at hundreds of billions of euros.[3]

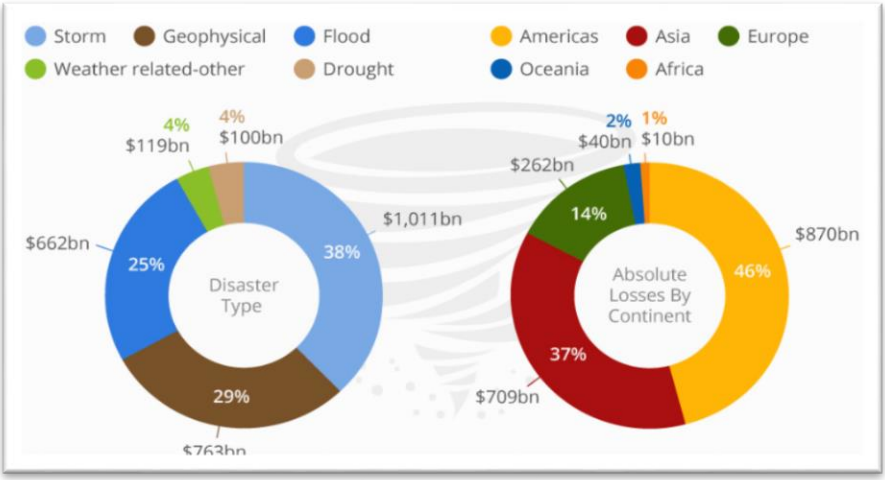


Figure 1: The structure of economic losses by cause of natural disasters since 1995-2015[4]

Management of natural disasters has become the biggest global challenge. Managing this risk is set as a target in the strategy "Europe 2020" and in plan for a sustainable development of the United Nations.[5]

Natural disasters cannot be predicted, but much can be done in terms of reducing and mitigating human and material losses, using the basic

[2] European environmental agency

[3] http://ec.europa.eu/echo/countries/files/aid/factsheets/thematic/disaster_risk_management_en.pdf

[4] Source: UNISDR

[5] Hyōgo Framework for Action and Sendai 2015-2030, Goal 13. "Take urgent action to combat climate change and its impacts

principles, the order of moves and prevention defined in "Strategy for a safer world" in Yokohama ("Hyōgo Framework for Action and Sendai 2015-2030").

A natural hazard is the possibility of occurrence of natural disaster in some area. A natural hazard is a possible loss (human, material, and so on,) caused by natural catastrophe.

Risk = the influence of danger x probability of occurrence[6]

1.1. Natural disasters in the Republic of Srpska

Serbia and Bosnia and Herzegovina are most exposed to the dangers of flooding and droughts. On average every two years, Serbia has been hit by floods. The average annual damage of all the potential danger is 22.94 million dollars in BiH and 82 million dollars in Serbia. Mortality caused by natural disasters is 3.72 in BiH and 10 in Serbia. [7]

Figure 2: The most common forms of natural disasters in the Republic of Srpska

[6] Natural Disasters 9th Edition, Patrick Leon Abbott, McGraw-Hill Education 2013.

[7] Source: „UN ISDR, 2009. South Eastern Europe Disaster Risk Mitigation and Adaptation Initiative: Risk Assessment for South Eastern Europe, Desk Study Review“ p.49

The Republic of Srpska has over 1000 km of river flows, damage from the drought grows year after year, a great number of landslides in urban areas account for the frequent occurrence of emergency situations, like a situation where risks and threats or the consequences of disasters, emergency events and other hazards for the population, the environment and the material goods of such a scale and intensity to their formation or consequences cannot be prevented or rectified regular action of the competent organs and agencies, for their mitigation and removal is necessary to use special precautions, power and resources with enhanced activity mode.

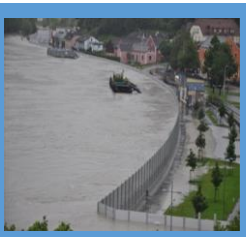
Flooding on several occasions, together with last May from 2014, inflicted such great damage to the economy, infrastructure, the environment, the health of the population, including the loss of human life.

Damage from the floods could not be entirely avoided, but could be less to be taken to build a functional and effective system of protection against floods. Due to flooding, especially during the "May flood", activated the numerous landslides and demolished the housing facilities.

According to available data, on the territory of BiH, in may floods triggered 5,841 ***landslides and rockfalls*** all in vulnerable areas of municipalities.

Although the Republic of Srpska in recent years had longer-lasting problems with ***snow drift***s, however, in some parts of the Republic of Srpska and in certain winter

AN EXAMPLE OF THE MEASURES OF PREVENTION



periods appear certain problems associated with snow drifts on roads designed to prevent the normal progress of transportation and economic activities of the people in the area.

North and Northwest area of the Republic of Srpska oriented on agricultural and food production, almost every year is affected by drought. The damage of the drought during the summer months ranges from 30 to 70% smaller yields than expected by some agricultural cultures, and there are nuerous cases where damage to agricultural crops and 100%.

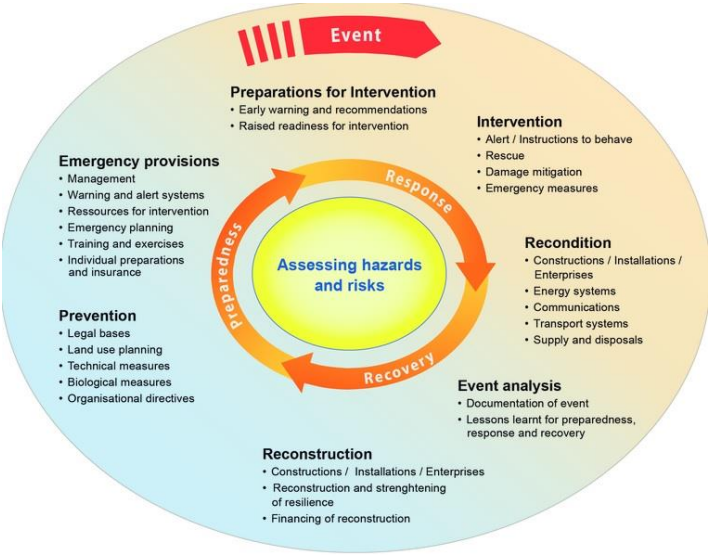


Figure 3: the cycle of natural disaster management, risk and hazard[8]

Large-scale fires in the Republic of Srpska appear during the spring and summer months, and are usually a result of negligent relations of agricultural and forest workers during agricultural works on the way destroying the wattle from the land. In addition, on several occasions, the fires of a larger scale in the area of Eastern Herzegovina which is characterized by rugged

[8] Model integrated risk management Civil protection, Switzerland 2012

land, and wattle which is typical for this region, which resulted in greater fires but without substantial material damage.

Banja Luka seismic area encompasses an area of approximately 10 000 km^2 or territory circling 50 km from Banja Luka and speaking on the basis of different return period falls in area VII, VIII and IX degree maximal expected ***earthquake*** intensity by MCS scale.[9]

1.2. Creation of a system of prevention and education of specialists

Due to the Western Balkan countries aspiring to join the EU, they will have to *increase the quality of the system for early prevention of natural disasters and educate professionals to manage and reduce this risk* in accordance with the EU standards.

The risk management of natural disasters should improve the existing level of education in this area, to raise their technical capacities and develop efective systems of prevention of risks.

In addition, it is necessary to develop and implement a campaign to increase the level of public awareness and training, with the intent to educate citizens about ways how citizents can avoid or reduce the risk of natural disasters in their environment, as part of what we made this Handbook.

Although the risk of natural disasters can be local, national, regional or global, it is of great importance to assess specific local characteristics in order to take appropriate measures to prevent disaster.

[9] "Процјена угрожености од елементарне непогоде и друге несреће", East Sarajevo 2013.

Figure 4: The sky crossed with harp waves.

HARP system is developed by the USA Government. The system is based on the use of ionospheric disturbance for managing communications and transmission of energy. In public there is present many contradictions, in the sense that it is a project with a targeted influence on climate change and human behaviour. How these claims are justified, we leave you to determine.

2. FLOODS

The flooding is inundation of narrower or broader complex of soil with the water from a watercourse, lake or sea. It can occur at any time of the year and are most often caused by heavy rainfall, rapid melting of a thick snow pack, ice jams, or more rarely, the failure of a natural or human-made dam.[10]

Floods are the most frequent natural hazards in the Republic of Srpska, and the costliest in terms of property damage. About 62% of all human and material falls are consequences of floods. Floods can occur in any region, in the countryside or in cities.

All rivers in the Republic of Srpska experienced flooding at one time or another. The potential for flood damage is particularly high where there is development on low-lying, flood-prone lands.

Flash or sudden flooding, where warning time is extremely limited, can be result of other causes such as underground waters, violent rainstorms, or the bursting of dams.

What amount of rain will lead to the emergence of a flood, it is difficult to unambiguously determine. It depends on several factors, and most of them are:

- ✓ soil saturation,
- ✓ occupancy of underground reservoirs and watercourses, reservoirs,
- ✓ and amount of water in the rivers.

[10] Natural Disasters 9th Edition, Patrick Leon Abbott, McGraw-Hill Education 2013

The same amount of rain, and even if it falls a few days, will not always lead to the same consequences. Often it depends on the time of year. The most dangerous are the periods of transition from winter to spring, when there is a snow cover, and worsening of weather with abundant rains brings and warming.

According to current data, annual precipitation amounts have not changed in a larger scale, but their extremes become more pronounced and more frequent. Besides the measures, activities and works, just the speed of reactions during the flooding events of crucial importance for reducing the damage from flooding in the minimum measure.

Defence plans with exact data, computer models of potential events, but also the experiences of the past, must be elaborated in detail and based on real requirements, but also to the realistic opportunities, so that in a given situation were applicable.

2.1. Causes that leed to floods

- On the basis of the main causes of the occurrence of floods there are following types of floods
  - ✓ floods caused by heavy rainfall and snow melt,
  - ✓ floods caused by groundwater,
  - ✓ flooding caused by slipping or earthquakes,
  - ✓ floods caused by collapse of dam or war.

- Given the time of formation of wave of floods can be classified into:

✓ **Lowland (peaceful)** flooding-flooding on major rivers witch takes ten or more hours for a big wave of water. (floods in the Republic of Srpska 2014).

Fig. 5. Example of lowland flooding. The Sava River in the region of Samac 2014

Flash-flooding - flooding in mountain streams, which form a big water wave for less than 10 hours. Because of the density of the wave, these floods are of great destructive power.

Figure 6: Torrential flood-Pavlovac–Banja Luka, year 2014.

✓ ***Acidentne flood*** – floods that currently form a big wave of water breaking or hydropower facilities.

In the picture, the main dam outside of Houston snapped after the fluctuations due to rains that brought tropical storm „Harvey "

Figure 7: Floods in Houston, August 2017

According to the amount of raising water levels, dimensions and size of the flood inflicted damage, floods are divided into four categories.[11]

- ✓ ***Low floods*** are characteristic of lowland rivers and occur every five to 10 years. Since it floods less than 10% of agricultural land, it does not bring significant property damage and does not disrupt life's rhythm in the settlements.
- ✓ ***High floods*** occur every 20 to 25 years and it floods from 10 to 15% of agricultural land. It floods most of the river systems and impair economic activity and communal way of life. In some cases, it requires the evacuation of the population. Those floods make greater property damage.
- ✓ ***The great floods*** are catching the entire river basin, paralyze economic activity and impair the normal functioning of the population. Those type of floods requires evacuation of people and material goods. It occurs every 50 to 100 years old and it floods by

[11] Natural Disasters 9th Edition, Patrick Leon Abbott, McGraw-Hill Education 2013.

50 to 70% of agricultural land. In the flood zone it is completely paralysed economic activity. These floods are characteristic for 100 a year and 200 year of water level and are accompanied by great material damage with casualties.

2.2. Main flood areas in the Republic of Srpska

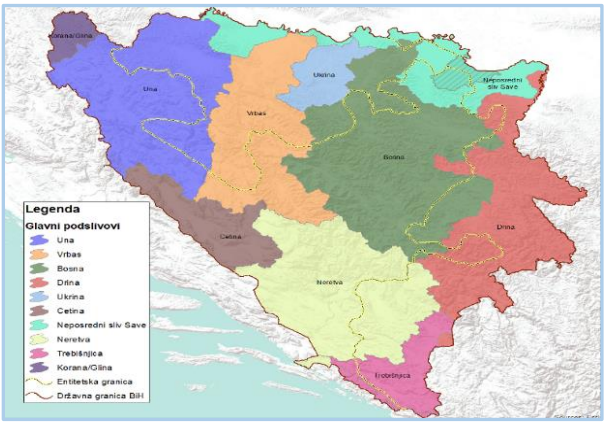


Figure 8: Water resources and largest river areas in Srpska and BiH.

Due to observe the water potential of the Republic of Srpska, here are given the average value of annual flow on major waterflow points, which are relevant for planning in the Republic of Srpska, and the points close to the territory of Srpska.[12]

Figure 9: Drina river

Drina river basin: 164 Bastasi m3/s, Foca 212 m3/s, Visegrad 341 m3/s, Zvornik 387 m3/s, the mouth of 401 m3/s, Sutjeska, Igoce 14.9 m3/s, Cehotina, Foca 16.0 m3/s, Praca, Rakitnica 2.4 m3/s, Lim, Tiller 115 m3/s, Drinjaca 6.5 m3/s.

[12] "Процјена угрожености од елементарне непогоде и друге несреће", East Sarajevo 2013

Figure 10: Bosna River

Bosna river basin: Reljevo 26.8 m3/s, Raspotocje 58.8 m3/s, Maglaj 120 m3/s, Doboj 151 m3/s, Modrica 164 m3/s, the railroad 5.3 m3/s, Miljacka 5.8 m3/s, Krivaja 24.9 m3/s, Spreca 24.3 m3/s.

Figure 11: Vrbas river

Vrbas Basin: Han Scaffold 24 m3/s, Kozluk 60 m3/s, Banja Luka 98.1 m3/s, Delibašic Village-the mouth of 114 m3/s, Swim 35 m3/s, V 15.9 m3/s.

Figure 12: Una and Sana river
Una Basin and Sana Basin: Martin Brod 51.5 m3/s, Bosanska Krupa 108 m3/s, the new city of 221 m3/s, Kostajnica 234 m3/s, Kozarska Dubica 238 m3/s, the mouth of 243 m3/s, Sana, 35.5 Key m3/s, Sana, Sanski Most 50.2 m3/s , Sana, Prijedor 81.3 m3/s, Sana, Delta 84.2 m3/s.

Figure 13: Sava river-

Part of the basin: Jasenovac 799 m3/s, Mackovac 828 m3/s, Ship 1020 m3/s, Zupanja 1180 m3/s.

Figure 14: Neretva river

Delta Basin: Bet 10.2 m3/s, Glavaticevo 39.8 m3/s, Dragonfly 60 m3/s, Mostar 202 m3/s, Zitomislici 233 m3/s, Buna 41.2 m3/s

Figure 15: Trebisnjica river-

Basin Trebisnjica River: The River Gacko, Srdjevici, Mušnica 8.3 m3/s, Nevesinjsko Field, Zalomka River, Rilje 4.7 m3/s, Zalomka, Poscenje 10.8 m3/s, the trebisnjica River, Grancarevo 74.2 m3/s, Trebisnjica, Gorica 85.6 m3/s. Grancarevo 72.2 m3/ s, Gorica 87.8 m3/s.

In the Black Sea basin is swelling around 722 m3/s (62.5%) while in the Adriatic Sea swells around 433 m3/s (37.5%).[13]

Table 1: River flow length in Srpska and BiH[14]

Name of the River	FLOW LENGHT IN km	
	In the Republic of Srpska	In BiH
DRINA	305	341
SAVA	202	945
VRBAS	117	249.9
VRBANJA	95.4	95.4
SANJA	85	157.7
UNA	82	212.5
UKRINA	80.9	80.9
BOSNA	79	279.4
GOMJENICA	68.5	68.5
DRINJACA	61	91.37
TREBISNJICA	56	96.5
USORA	55	78
LIM	44	234
PRACA	42	62.6
NERETVA	39	225
PLIVA	20	31.45

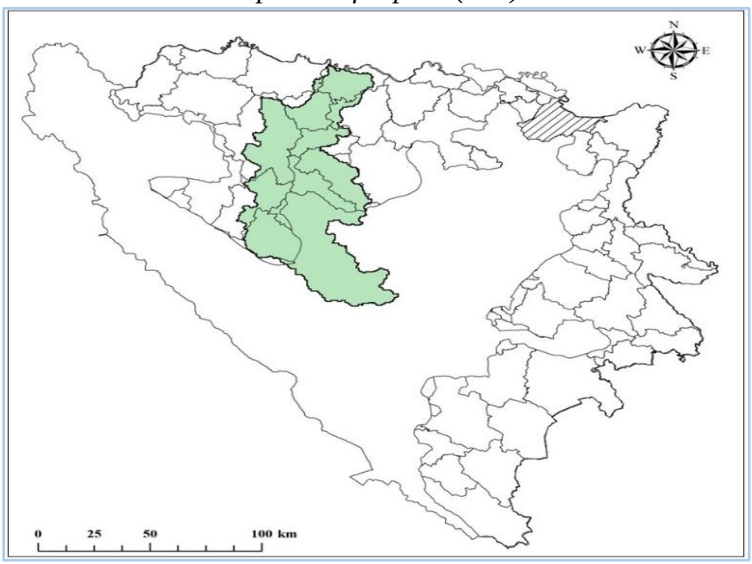
[13] "Процјена угрожености од елементарне непогоде и друге несреће", East Sarajevo 2013.

[14] Republic Hydrometeorological Institute of the Republic of Srpska.

2.3. Analysis of the May flood 2014 in the lower Vrbas area

With a length of 250 km, the Vrbas river is a right tributary of the Sava river, which rises at the foot of a Zec mountain 1,715 MAMSL.[15] ***The total area of the catchment area is 6,273 km2, of which the Republic of Srpska belongs 3,977 sq km or 63% of the territory.*** Given the expressed difference between the source and the mouth of the longitudinal profile, the main stream has a pronounced degree of asymmetry, with big falls in the upper part of the flow. This kind of morphology determine total drop of 6.5 m to 1 km length of the river flow., 117 km, or 47% of the length of the main stream belongs to the Republic of Srpska. The longest tributary of Vrbas river is Vrbanja river (95.4 km)[16], while the larger tributaries are: Pliva, Bistrica, Black river, Krupa, Ugar, Svrakava and Turjanica.

Cartogram 1. *The geographical location of the Vrbas river basin in the Republic of Srpska (GIS).*



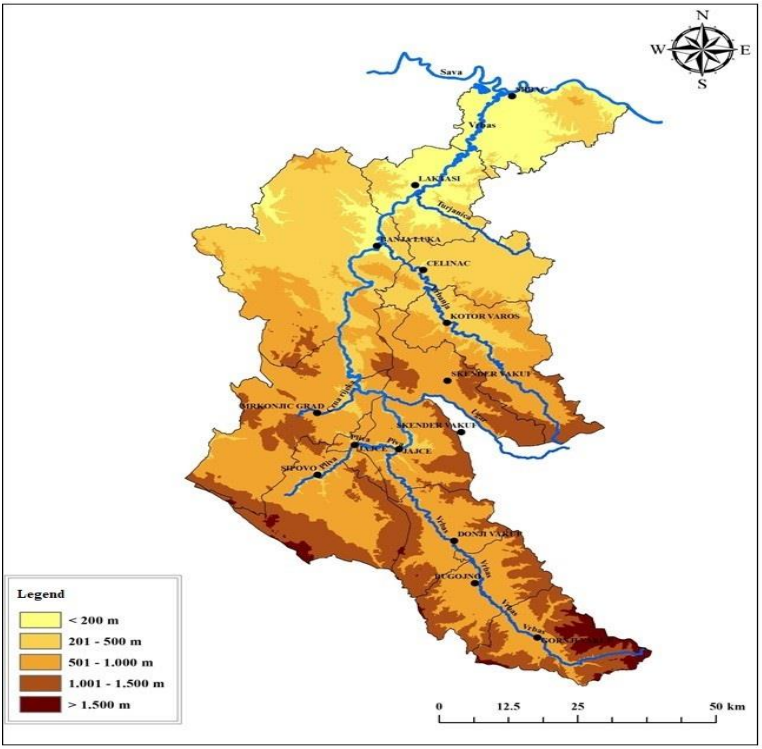
[15] Republic Hydrometeorological Institute of the Republic of Srpska

[16] Republic Statistical Institute of Srpska, Banja Luka.

The Vrbas basin is divided into three sections: ***the upper stream, midstream and lower Vrbas area***.

The upper stream is entirely in the Federation of BiH. The upper stream runs from the spring to the town of Jajce. This move is characterized by a large drop in the River, and a small amount of water, narrow valleys and alluvial extends where extensions are located in larger cities: Gornji Vakuf, Bugojno, Jajce and Donji Vakuf. In the town of Jajce, infuses the Pliva river, which is the most important tributary with larger amounts of water from the main Vrbas stream.

Middle course of the Vrbas move from Jajce to Banja Luka, with a total length of about 72.5 km and the total height difference circa 165 m, with an average fall in relation to the upper part of the river. On this stretch are the hydro lakes and hydroelectric power HPP Jajce and Bocac. These power plants significantly affect water level mode in the lower part of the flow.



Cartogram 2. Hypsometric zones catchment area of the Vrbas river (GIS)

In the lower course of the Vrbas, the River from Banja Luka enters into the Lijevce field. The average fall of River is extremely small. In this area Vrbas often change its flow. *In the past this area was often flooded, so that the River was the limiting factor for population settling of this space.* On the west side of the plain Vrbas borders with the Una river Basin, on the eastern side is the catchment area of the Bosna and Ukrina rivers, while in the south, the Vrbas contributes to Adriatic plain.

The Vrbas basin belongs to the moderate continental climate. The average annual air temperature range of 8.0 to 12.5 ° C in the lower stream. The average height of rainfall varies from about 800 mm/year in the North to around 1500 mm/year in the South. The average amount of precipitation that falls on the watershed each year is 6, 95x109 m^3. Average potential vapor is 700-750 mm, and in the summer months exceeds the height of precipitation.[17] *The highest water level of the river is in the month of April, namely the period between March and may, and August is the month with the lowest flow.*

Of the total area of the basin (6288.4 km^2), the forest areas waste 3880.4 km^2 of agricultural land 2321.8 km^2.

2.3.1. Impact of Cyclone Tamara on flooding in 2014.

Intense rainfall on the territory of the Republic of Srpska started in April 2014, so a continuous period of rainy weather lasted 21 days (from April 14 to May 4). The first was during the rainfall maximum 3th and 4th May, especially in the northern part of BiH, where there has been flooding of some rivers. A period of relatively dry time was 5th up to 11th May, when it is started raining again. All this rainfall led to a rise in the groundwater, while the river itself and the other flows were high before the start of the strongest rainfall 13th May.

Above the North-West of Italy and the Mediterranean, specifically in the area of Genova Bay, 13th May began to strengthen new cyclone named "Tamara" which brought abundant rainfall that triggered the catastrophic floods on 15th May. At the same time, in the northeast of Europe was very

[17] Public institution -Vode Srpske-, Bijeljina

strong and spacious anti-cyclone that disabled the penetration of these masses on the East, so that a cyclone remainded three days in our region. Cyclone "Tamara" regenerated itself and during three days brought huge amounts of rainfall, somewhere even over 200 l of rain (table 2). on May 17, the cyclone gradually weakened, while it is raining all weaker intensity. *Table 2. refers to municipalities and cities with the largest amount of rainfall in Srpska and Bosnia and Herzegovina for the period from 13th up to 17th May 2014.*

Table 2. *Municipalities and cities with the largest amount of rainfall in Srpska and BiH for the period from 13th up to 17th May 2014*[18]

Municipality//City	***rainfall mm***	***Municipality//City***	***rainfall mm***
Tuzla	**247,8**	Petrovac	**156,5**
Han Pijesak	**211,2**	Ribnik	**155,2**
Zvornik	**204,9**	Doboj	**146,6**
Gradacac	**191,4**	Zenica	**136,5**
Istocni Drvar	**195,3**	Mrkonjic Grad	**136,2**
Bijeljina	**178,2**	Sarajevo	**130,6**
Sokolac	**177,4**	Bawa Luka	**107,5**
Srebrenica	**166,9**	Visegrad	**88,3**

In some areas in may 2014 amount of rainfall was three times higher than average, while most of the may rainfall fell in just 4-6 days. An example of this are the city of Bijeljina, where the аверage rainfall for the month of May is 70 mm, while in five days in May 2014 was excreted 178 mm, as well as the city of Doboj in the same period was excreted 147 mm, and May average is 89 mm.

[18] Source: Republic Hydrometeorological Institute of the Republic of Srpska

2.3.2. Consequences of the May flood 2014 on the catchment area of the Vrbas river, Srpska and BiH

According to a report of the European Environment Agency (EEA), since 1998 – 2009 in Europe recorded a 213 floods that killed 1,126 people, while economic losses were greater than 52 billion euros.

In the last fifty years Bosnia and Herzegovina has engulfed several catastrophic floods with huge losses. During 1976 three floods hit 43 of the 109 municipalities in the country, April 2004, flooding has affected more than 300,000 people in 48 municipalities, where 20,000 were destroyed acres of agricultural land, several bridges, and there have been contamination of drinking water in many of the affected municipalities.

The floods that occurred in December 2010, the hardest-hit areas are in the basin of the Drina river, and areas in eastern Herzegovina. During the flooding more than 4,000 people was evacuated[19]

Catastrophic flooding in mid-May 2014. on the territory of Bosnia and Herzegovina the most hit the northern part of the country, specifically the lower and medium flows the river Bosna, Vrbas, Una, Sana, Vrbanja, Drina and Sava stream. ***About a million people directly or indirectly was affected by these floods***.

Damage from the floods were registered in 84 local community, including 37 in the Federation of BiH, ***36 in the Republic of Srpska*** and Brcko District.

In the Republic of Srpska the greatest damage were registered in the municipalities of Doboj, Modrica and Samac, Celinac, and in the cities of Banja Luka, Bijeljina and Prijedor.

In the Federation of Bosnia and Herzegovina, the largest registered damages are in the Sava river in Bosnia, in particular in the municipalities of Maglaj, Zavidovici, Odzak, Orasje, and in the cities of Zenica and Tuzla.

According to official figures and civil protection headquarters staffs for emergency situations in these floods life lost 20 people, 18 in the Republic of Srpska. Two people are missing**.**

[19] Procjene rizika od poplava i klizišta za stambeni sektor u Bosni i Hercegovini, Sarajevo-2015

According to the estimates of total damage in floods 2014 the value reached about 3.98 billion convertible marks (KM). The amount of the approximately 2.49 billion refers to the damage, and 1.49 billion to the losses.[20]

The highest level of damage was observed in the private sector. In the Federation of Bosnia and Herzegovina the total negative effects (damage and losses) are estimated at 2.03 billion, ***while 1.89 billion related to the Republic of Srpska*** and 57.89 million KM in Brcko Distrikt.[21]

Hydrological network of the Vrbas river basin makes up the main stream with numerous tributaries, of which the most significant Vrbanja river as the longest river and Pliva with the largest amount of water. Most smaller watercourses in the middle and the upper part of the basin has a character of a stream. For the catchment area of the river Vrbas regime change is common, water levels and surface runoff during the year. With regard that main stream rises at an altitude of more than 1,700 MASL to the upper Vrbas stream ihas faster watherflow, while most part of the River is in flatland area.

The maximum daily amount of precipitation was measured in the municipality of Bugojno, 14th May (43.7 mm), while in Banja Luka the biggest rainfall intensity wascregistered on the May 17 (36.0 mm).

Table 3. *24-hours precipitation from 14.05. to 17.05.2014. (mm) (meteorological stations in Banja Luka and Bugojno)*[22]

Meteorological station	**14.05.2014**	**15.05.2014**	**16.05.2014**	**17.05.2014**	**Sum**
	06:00h	06:00h	06:00h	06:00h	
Banja Luka	17,4	21,7	32,1	36,0	107,2
Bugojno	43,7	10,7	14,3	1,6	70,3

[20] Procjene rizika od poplava i klizišta za stambeni sektor u Bosni i Hercegovini, Sarajevo-2015

[21] Agić, 2014, 87

[22] Source**:** Analysis of the rising of the event in may 2014. in Bosnia and Herzegovina for the river Bosna in the help of the Republic of Slovenia

During May period 2014 water level on a larger part of the longitudinal profile had the highest value since there are official measurements. On 16.05.2014. at the station Delibasino selo (7 km downstream from Banja Luka) water level was 816 cm. On the same point regular defense limit against flooding is 300 cm, while the emergency is 370 cm. Top rising of the waves that hit the Banjaluku matched up to a maximum daily precipitation, which has prompted the outpouring of the Vrbas, Vrbanja and other tributaries on the territory of the city. According to figures published by the national weather service of the Republic of Croatia, the maximum flow rate of the Vrbas at the confluence of the Sava was 2,000 m3/s

Figure 16. Floods in the Banja Luka suburb of Lazarevo 16.05.2014.

Effects of floods can be seen from several aspects, with the physiognomic, demographic, economic, social, environmental, health, and psychological aspects. Impact of floods can be a negative impact on human health, the environment, economic activity, traffic infrastructure, cultural heritage, etc.

- ✓ Physiological changes are manifested through the transformation of the river basin and the surrounding flooding space.
- ✓ Demographic aspects in evaluating the impact on the population (victims, evacuation).
- ✓ The economic consequences are reflected on the basis of the damage caused by the floods.
- ✓ Environmental aspects in evaluating flood through a violation of quality of water and land.

According to the preliminary flood risk assessment, the catchment area of the river Vrbas river flooded the 8,548 hectare of land. Structures flooded areas indicate heterogeneous character. Percentage, the most represented fields (29%), gardens (13%) and arable land (8%). Meaningful participation have forests, meadows, orchards, and residential and business objects [23].

Table 4. General data on the flood demage on lower Vrvas area (Source: Preliminary flood risk assessment in the area of the Republic of Srpska. Book 6 – Vrbas River Basin. Institute for water management, Bijeljina)

Place and time of appearance of the flood			Damage from flooding								Damage assessment		
Municipality/city	Flooded area (ha)	The date of occurrence of floods	The number of flooded properties				The number of flooded popul.				Direct (KM) in thousands	Indirect (KM) in thousands	Total (KM) in thousands
			Residenti	Shared housi	Individual catte	Support facili	In the field	Evacuated	Evakuisanih	Others said			
Srbac	2 665	16.05.	223		223	456	881	71	165	1	10 312	7 218	17 530
Laktasi	3 081	15.05.	1 085		1 085	2 712	3 797	168	588		27 481	17 862	45 343
Banja Luka	345	15.05.	2 100	11	2 056	3 789	6 530	196	588		35 724	25 007	60 731
	110	15.05.	224		224	196	694	189	567		6 860	41 16	10 976
	2	15.05.	55		55	89	95	20	80		960	480	1 440
	44	15.05.	45		45	75	142	5	15		610	305	915
	68	15.05.	21		21	16	47	-	-		165	80	245
TOTAL	**6 315**		**3 753**	**11**	**3 709**	**7 333**	**12 186**	**649**	**2 003**	**1**	**82 112**	**55 068**	**137 180**

[23] Register of damage in Srpska.

Table 5. General data on the food demage by peripheral basin of lower Vrbas area (Source: Preliminary flood risk assessment in the Republic of Srpska. Book 6 — the Sava River Vrbas. Institute for water management, Bijeljina.)

The name of peripheral basin	A sub-basin surface (km2)	Place and time of appearance of the flood			Damage from flooding							Damage assessment		
					Број поплављених објеката				Број поплављеног становништва					
		Municipality/city	Flooded area (ha)	The date of occurrence of	Residential buildings	Common	Individual satnovanj	Support facilities	In the field of	Evacuated homes	Evakuisanog	Direct (KM) in thousands	Indirect (KM) in thousands	Total (KM) in thousands
Channel Osorna - Borna	164	Srbac	21	15.5.	-	-	-	10	7	-	-	32	16	48
			19	15.5.	-	-	-	7	-	-	-	22	11	33
Chanel Ina	38	Srbac	1 365	15.5.	98	-	98	113	343	12	36	2 520	1 512	4 032
Chanel Povelic	275	Srbac	214	15.5.	29	-	29	33	87	2	6	608	402	1 010
Vrbanja River	802	Celinac	146	15.5.	860	14	802	80	2 500	1	1	9 554	6 210	15 764
		Celinac	51	15.5.		-	-			-	-	43	21	64
		K. Varos	133	15.5.	30	-	30	46	96	-	-	353	211	564
		K. Varos	148	15.5.	15	-	15	24	61	10	42	583	275	858
		K. Varos	72	15.5.	3	-	3	8	12	-	-	112	45	157
		K. Varos	64	15.5.	42	-	42	78	126	5	21	360	195	555
Total	**1,279**	**-**	**2 233**	**-**	**1 077**	**14**	**1 019**	**399**	**3 232**	**30**	**106**	**14 187**	**8 898**	**23 085**
∑ (Table 4+ Table 5)	**2,706**	**-**	**8 548**	**-**	**4 830**	**25**	**4 728**	**7 732**	**15 418**	**679**	**2 109**	**96 299**	**63 966**	**160 265**

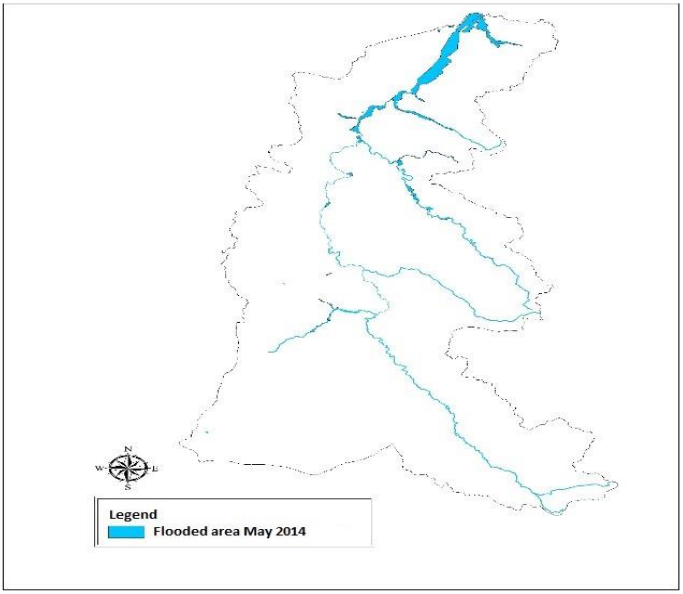
Floods in May 2014 in the lower basin of the river Vrbas River flooded a total population of 15,418 people, while from their homes were evacuated 679 households, namely 2,109 people. The structures of flooded and evacuated population indicates the destructive effects of the rising of the waves in the city of Banjaluku where 7,508 or 49% of the flooded population were evacuated and 59% of the total number of people affected by floods in May 2014 on Vrbas river basin.

Total of 12,562 object were floodes, of which 62% support facilities, while the rest consists of the living individual and shared housing. Most flooded residential is registred in the city of Banja Luka (2,445) and the municipality of Laktaši (1,085).

Commission for assessing the damage to flooded areas in Republic Srpska, on the basis of data collected from local communities, found that the ***total damage*** to the entire lower Basin area is ***160,265,000 KM***. The largest part of that amount refers to the direct damage 96,299,000 or 60%, while the indirect damage about 40% of the estimated amount. The largest economic damage were in the city of Banja Luka, where estimates damage is higher than the 74 million KM.

Although a relatively small number of residents was directly affected by the flood, the economic effects on the municipality of Laktaši are considerably more pronounced. In fact, in the inudacionom area of this municipality there is a multitude of commercial and business entities, so that the direct damages for this municipality is estimated at 45 millions KM. Direct damage in the municipality of Srbac is 23 millions, while in the municipality of Celinac total registered demage is 16 millions KM or damage arising as a result of the May flood 2014.

As one of the measures to mitigate the consequences of the floods the Government of the Republic Srpska has formed a solidarity fund, while for priority rehabilitation of flooded properties granted to one-off subsidies valued at 5,000 KM for each flooded household.



Cartogram 3. Flooded area in the basin of the river Vrbas incurred as a result of the flood May 2014 (GIS).

Throughput of watercourses was not in accordance with the advent of big water, so flooding in May 2014 have left incalculable consequences on the population and material goods. It must be said that in the period that preceded the may floods attention posvecivano system of flood defence and reconstruction of damaged dikes and drain systems. The best example is Banja Luka suburb Cesma where water broke through the solid levee and flooded more than 200 homes.

Additional burden is non-regulated trough the main stream and its tributaries, as well as the presence of a large number of landfills along the watercourse. So was based on the results of UNDP project, which is implemented 2014. year, the overall length of the main stream registered even *115 illegal dumps*. The influence of marshland waves most of these landfills are transported in the downstream part of the flooded area which affected an additional contamination of land and water surfaces.

Anthropogenic influence has further intensified the negative effect of the flood. An example of this are the excessive exploitation of gravel from the river bed, especially in the municipalities of Laktasi and Srbac (in the lower

part of the basin) and the illegal felling of forests in the upper course of which influenced the increase in runoff coefficient and activate individual landslides.

Figure 17. The flood, the suburn Obilicevo in Banja Luka, May 2014.

With the development of urban, economic and infrastructural systems constantly increases the value of material goods in coastal areas, which are reflected in the increase of damage from floods and other adverse impact of water flows. In this context, of facilities for flood protection depends on the normal functioning of almost all economic and other activities in a potentially flooded area.[24]

The war in Bosnia and Herzegovina (1992-1995) caused a great demographic pressure and reviled of displaced population in the Banja Luka area of the city and municipality of Laktaši.

After this period, near by the main stream dozens of illegal objects were built without construction authorization. Wild building the most took place in Banja Luka suburns Prijecani, Kuljani and Cesma, as well as in the suburn Trn in the municipality of Laktaši. In these suburbs was registered the greatest material damage.

When it comes to the agricultural sector the May flooding occurred after spring sowing of arable crops and cultures, so that the damage in flooded ***area is 100 per cent***.

Analysis of the land in the basin of the Vrbas after the flood, showing an increase of content of sand, silt, pH and phosphorus. Flooding in the basin are the most affected crop and vegetable cultures, as well as plant berries.[25]

[24] Miladinovic, Gavrilović, 2012, 155-156

[25] Preliminary flood risk assessment in the Republic of Srpska. Book 6 — the Sava River Vrbas. Institute for water management, Bijeljina

Figure 18. The bridge on the river Vrbas in Banja Luka suburn Cesma, before and after the flood (16.05.2014.)

Floods in May caused a lot of damage and are on an infrastructure, *destroyed or damaged scores of bridges, and the local and regional roads*.

A big part of consumers was hit by disruption to electricity supplies. The worst consequences had a population that was directly exposed to the water , where there is a break in electricity supplies lasted seven days

Bacteriological analysis of water after a flood showed a high degree of contamination and the presence of fecal water in the flooded area, but he prevented the spread of infections, infectious and parasitic diseases.

2.4. Risk maps

Analysis of the potential risks of flooding and its mapping represents the most important professional activity in the framework of the noninvestment measures of protection against floods.

Objective and result of making maps of flood risk, which is the first step in making plans for flood risk management, the determination of significant flood areas as areas in which there is or could show a significant risk of flooding with harmful consequences.

Risk map shows the possible harmful consequences of flooding in relation to:

- ✓ approximate number of potentially endangered population in flooded area,
- ✓ type and number of economic activities in the potentially affected area,
- ✓ position and characteristics of the sensitive buildings (hospitals, schools, homes for the elderly, firefighting units, staffs of civil protection, relevant infrastructure, etc.),
- ✓ plants that could cause sudden pollution in case of flooding,
- ✓ position and characteristics of the cultural property and protected areas that could potentially be affected by floods,

From the above it can be concluded that in determining risk necessarily determines the size of the damage that would cause floods in a particular area for a particular flood script.

Flood risk maps shows the potential adverse consequences for the areas previously designated flood hazard maps for the next flood scenarios:

- ✓ floods large inclusion probability of occurrence,
- ✓ the flood of high probability occurrence (return period of 100 years),
- ✓ flooding small probability occurrences, including flooding due to the possible collapse of dikes on major watercourses – artificial flooding.

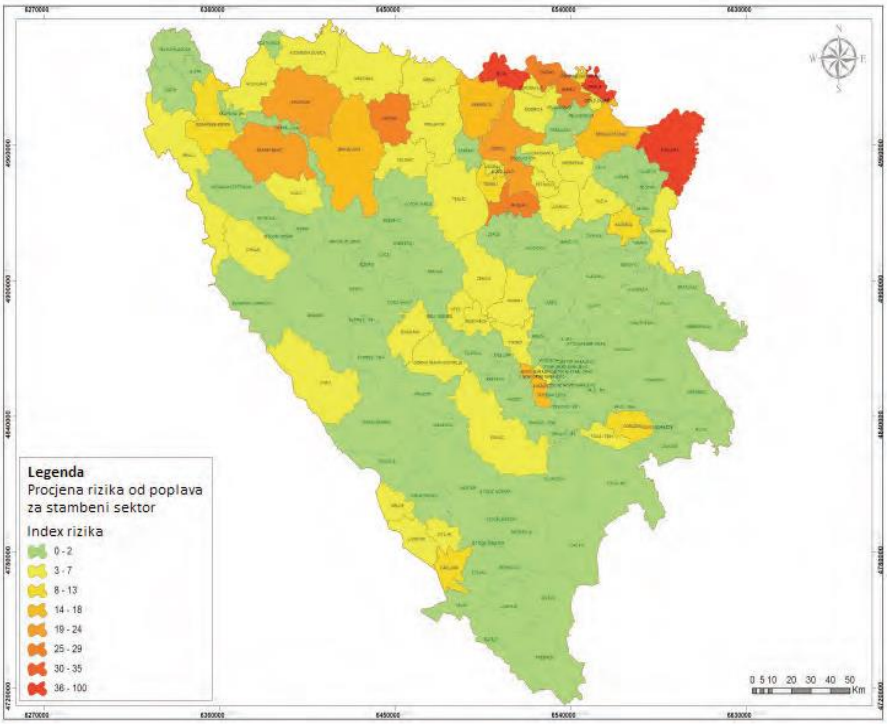
Proceeding from the provisions of Directive 2007/60/EC of the European Parliament and of the Council of 23. in October of 2007. on the assessment and management of risks from floods, the flood risk maps should be shown the following facilities:

- ✓ The number of the endangered population in settlements (up to 100, from 100 to 1,000, more than 1,000),
- ✓ Data on the use of land (inhabited areas, areas of economic purpose, intensive farming, agriculture, forests and low vegetation, swamps and sparse vegetation, bodies of water),
- ✓ Information about the infrastructure taken over from the relevant institutions and/or collected from public data sources.

*The total area that is exposed to an extremely high risk of floods is **97,391** ha, while the total area that is exposed to an extremely high risk of landslides is **7,571 ha**. The total number of residents living in areas exposed to*

*extremely high risk of floods is **283,777**, while the total number of residents living in areas highly significant risk of landslides is 260,731. Populated areas under highly significant risk from flooding covering an area of 810.4 ha, and highly significant risk of landslides of 740.7 ha*.

Figure 19. Significant floodplain areas – Map danger of flooding in for populated areas in Srpska and BiH[26]

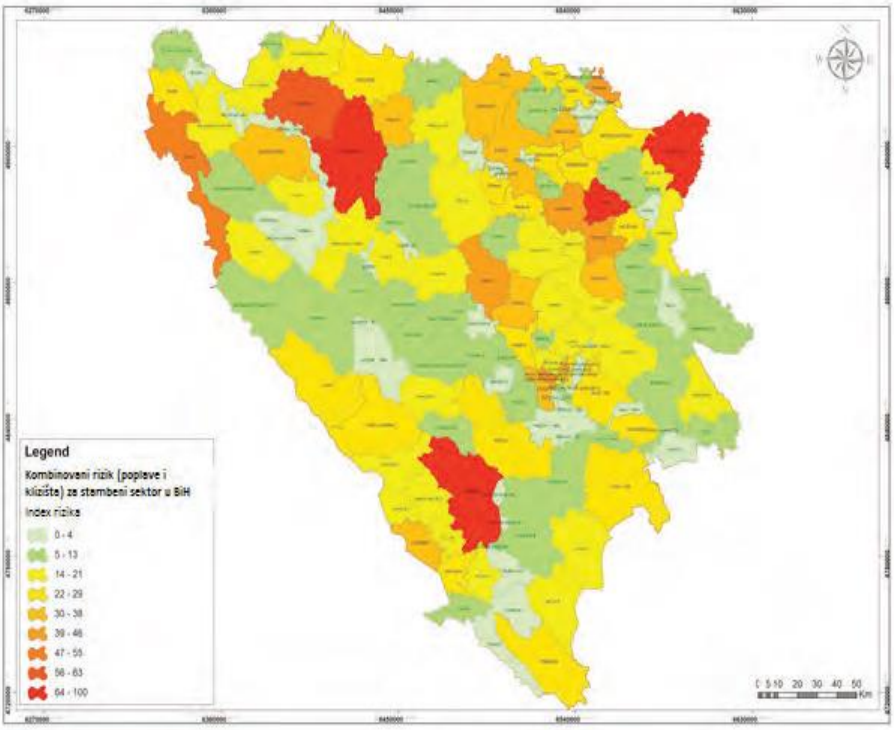


Map of risk for flooding indicates that the highest risk of flooding for the housing sector, subject to the lower part of the Vrbas river, middle and lower part of Sane and Una, and all stream of Sava and Drina river.

[26] Procjene rizika od poplava i klizišta za stambeni sektor u Bosni i Hercegovini, Sarajevo.2015.

Due to the risks of flooding and landslides risks mutually dependent, Figure 20 provides the integrated approach the risk of floods and landslides.

Figure 20. Significant floodplain areas – Map danger of landslides in inhabited areas in Srpska and BiH[27]



Risk assessment combined danger is done by integrating flood risk and the risk of landslides in Srpska and BiH. The result of this integration is the database which results in the combined risk maps. As a result of the integrated map of the risks identified are areas under significant risk as a starting point for determining technical, socioeconomic criteria for defense and preventive action.

[27] Procjene rizika od poplava i klizišta za stambeni sektor u Bosni i Hercegovini, Sarajevo.2015.

2.4.1. Flooding cultural-historical and natural heritage

Flooding and spillage of groundwater in the Memorial area of Donja Gradina, which jeopardises the memorial complex, presents a realistic scenario that in the past took place more than once, and the last time in the spring of 2014. year, when due to flooding rivers Sava and Una, and the underground water. ***Under the water there was about 45% of the Memory area***.

The flat part of the Memorial area of Donja Gradina is located at the mouth of the river Una into Sava river and belongs to the North-West, the flatlands of the territory of the municipality of Kozarska Dubica, in an area limited with the Sava river, the mouth of the Una and subbasin Tisina.

Figure 21: The Sava river, the Jasenovac Memorial complex and Lower Gradina[28]

[28] Google maps

2.5. Flood protection

Flood protection in Srpska can be classified in:

- ✓ Institutional
- ✓ Legal framework.

2.5.1. The institutional framework for water management

In the Republic of Srpska management is arranged in a similar way as in the Federation of Bosnia and Herzegovina.

Basic organ that performs administrative, expert and other surveillance is under the jurisdiction of the Minister of agriculture, forestry and water management.

Water agencie and Republic public company bring their programs of maintenance of water objects on that need to be approved by the Ministry. These solutions do not surprise, if one takes into account that the same year is adopted *Laws on water* in both entities in compliance with the provisions of international treaties which Bosnia and Herzegovina signed before or took over from an earlier period and signed the Convention and the agreements considering these areas.

2.5.2. Legal framework

In Srpska there was adopted the *Law on water* as well as a number of underlaws necessary for law enforcement.

The law on water in the Republic of Srpska regulates mode of integrated water management in the territory of the Srpska, including protection of water, use of water, protection from harmful water acts, water streams and other water bodies. This law also regulates institutional framework, a way of financing operations, coordination with FBiH in water management and other issues related to integrated water management. The law establishes the obligation of making management plans for county Sava river basin and the Trebisnjica river.

Plan of defense against flooding in the Republic of Srpska conducted by Srpska Government is the main document for the coordination and implementation of activities relevant to the protection and rescue of flood.

The main operational plan for defense against flooding brings the Minister of agriculture, forestry and water management for each year, and the same is determined by way of the implementation of the measures of active defense against the flood on water supply facilities built, at the time of imminent danger of advent large flood water.

Council of Ministers of Bosnia and Herzegovina in November 2014 adopted the ***Action plan for flood protection and river management in BiH 2014-2017***.

The Plan was adopted at the request of the European Union, and after the catastrophic floods that have afflicted the region in 2014. The EU has insisted on the adoption of the Action plan, to ensure a greater degree of coordination and comply in matters of protection against floods and water management at the level of BiH.

The Action plan should contribute to the elimination of shortcomings in systems of *protection against floods and water management*, and more *reliable meteorological data and hydrological monitoring and forecasts of floods, more efficient early by informing and alerting, protection and saving the population and material goods*.

In order to fix the consequences of the floods make the appropriate improvements to the system of protection against floods and water management, the plan is a defined six key measures:

1. Remediation of damage caused by the floods, erosion and torrent streams in 2014 on existing water protection buildings, river beds and canals in affected areas;
2. Harmonisation "*Flood protection system in Bosnia and Herzegovina*" with *EU Directive 2007/60/EC* on the management of flood risks;
3. The adoption of new technical solutions to protect from flooding, erosion and torrent for villages and towns who had constructed the safeguard of water facilities and construction of new facilities;

4. The establishment of a prediction hydrological system in BiH;
5. Strengthening the capacity of institutions responsible for water management in BiH, provide an appropriate level of coordination and cooperation with other institutions in BiH and the provision of an adequate participation in the work of international bodies;
6. Water management.

To coordinate implementation of the measures set out „Action plan for flood protection and river management in BiH 2014 - 2017" responsible to the Ministry of foreign trade and economic relations of Bosnia and Herzegovina.

2.5.3. The existing level of protection from flooding in Srpska

In BiH appropriately are protected areas along the Sava river and to some extent along the Neretva river (where the problem usually represents improper management of hydrocumulation), while on the tributaries of the Sava river protective systems are incomplete or not at all, excluding urban areas. In the area of the Vrbas, except two embankments in the city of Banja Luka, there is no flood protection system.

2.5.3.1. The levees and pumping stations in the Republic of Srpska

Dubica area (Una river embankment length 16,10 km, embankment along Binjacka length 17,00 km, Sava river embankment length 33,10 km, the length of the subchannels 7,10 km),

Lijevce field area (Sava river embankment length 32,20 km, right Jablanicki embankment length 8,50 km, right Vrbas river embankment length 10,80 km, the length of the subchannels 22,50 km),

Area Midle Posavina - Loncari (Sava river embankment length 2,60 km, Tinja embankment length 0,15 km, the length of the channels 25,625 km),

Area Ivanjsko field (Sava river embankment length 28,199 km, channels 8,53 km),

Area Midle Posavina - Samac (Sava river embankment length 88,30 km, Bosna river embankment length 0,50 km, the length of the channels 17,529 km),

Semberia area (Sava river embankment length 20,20 km, Sava river embankment length 10,00 km,

In the Republic of Srpska there are a total of 21 pumping stations with a total capacity of 108.20 m ³/s.[29]

Figure 22: Dam on the Sava River near Bijeljina

Sava river embankment in Bijeljina is awaiting sanation of the World Bank. During the floods in 2014 it was broken in five places.

Figure 23: Dam on the river Vrbanja in suburn Cesma, Banja Luka, 2014.

In Banja Luka suburn Cesma there is 2 km of embankments constructed. Floods in 2014 Vrbanja river is breached the embankment carrying concrete blocks of several tons. Concrete repair of embankment is not made, which means that in the event of stronger rain Vrbanja river will again breach the embankment.

2.5.4. Modern measures to combat floods and their consequences

- ✓ Modern embankment- Embankment on Sava river in Zagreb is an example of modern and functional embankment.

29 Процјена угрожености од елементарне непогоде и друге несреће, East Sarajevo 2013

Figure 24: Sava river embarkment in Zagreb.

Sava river embarkment in Zagreb is an example of an functional and modern river embankment.
The embarkment has modern lighting, race track and station with tap water.

- ✓ Internet portals and applications for mobile phones

Figure 25. Home page of the portal www.poplave.org

On the portal you can find useful information about floods and prevention measures as well as manuals -How to act before flooding-, -How to forecast floods- and -How to act after the flood-.

- ✓ Project and professional education

Figure 26. Logo of the project NatRisk

The project is based on the expansion of capacity in the countries of the Western Balkans for education to fight against natural disasters

- ✓ Solidarity Fund

As one of the measures to mitigate the consequences of the floods, the Government of Republic Srpska has formed a *solidarity fund* for priority of

rehabilitation of flooded properties granted to one-off subsidies valued at ***5,000 KM*** for each flooded household.

2.6. The role of the individual in the event of a flood

Though all levels of government are working to reduce the impact of floods, ***individuals also play an important role***.

What to do in the case of floods.[30]

Everyone has a responsibility to protect their homes and their families. You can greatly lessen the impact of a flood by taking the time to prepare in advance.

This involves three basic steps:

- Find out what to do before, during, and after a flood.
- Make a family emergency plan, so that everyone knows what to do, and where to go in case of an emergency.
- Get an emergency kit, so that you and your family can be self-sufficient for at least 72 hours during a flood.

a. Documentation:

- All valuable papers (passports, driver's license and ID cards, graduation diplomas) put in a safe place and if documents have been damaged put them it the cold and dry place.
- Record details of flood damage by photograph or video, if possible. Register the amount of damage to your home with both your insurance agent and local municipality immediately

In an emergency you will need some basic supplies. You may need to get by without power or tap water. Be prepared to be self-sufficient for *at least 72 hours.* You may have some of the items already, such as a flashlight, battery-operated radio, food and water. The key is to make sure they are organized and easy to find. Would you be able to find your flashlight in the

[30] Learning to live with Floods Natural Hazards and Disasters, Sri Lankan - German Development Cooperation, 2008.

dark? Make sure your kit is easy to carry. Keep it in a backpack, duffel bag or suitcase with wheels, in an easy-to-reach, accessible place, such as your front hall closet. Make sure everyone in the household knows where the emergency kit is.

Figure 27. Basic emergency kit content.

Basic emergency kit consists of:

- ✓ Water — at least two litres of water per person per day. Include small bottles that can be carried easily in case of an evacuation order.
- ✓ Food that won't spoil, such as canned food, energy bars and dried foods (remember to replace the food and water once a year).
- ✓ Manual can opener.
- ✓ Wind-up or battery-powered flashlight (and extra batteries).
- ✓ Wind-up or battery-powered radio (and extra batteries).
- ✓ First aid kit.
- ✓ Special items such as prescription medications, infant formula, boots and etc..

2.7. A positive example of the Republic of Austria in flood protection measures

- ✓ Danube in Vienna is divided into Old and the New Danube.

Figure 28. Vienna - the Old and the New Danube

- ✓ A metal dam in Vienna-Austria

Figure 29. Mobile metal dam

✓ Hauses resistant to flooding

Figure 30: Construction of buildings resistant to flooding.

✓ Insurance

National insurance program is made to cover all areas that are at risk maps and need to be secured from possible flooding.

✓ National company

National company for the prevention of fight against floods in Austria counts 90 employees and has an annual budget of 30 million euros.

The company has vehicles (cars and trucks), a machine for filling bags of sand and electronic detection systems of rising water.

The company covers 250 km of waterways and rivers: Danube, Ty and Morava

2.8. Personal story: "Today in the bedroom instead of flooring we have ceramic tiles"[31]

Ms. Ljilja after 1995 war events, moved in Prijedor. Flood in 2014 hit her, and in her house got nearly seven feet of water.

"*Notification of authorities we didn't get, but we understand what's going on, though no one expected floods of such scale. From this perspective it seems like motion picture to me. How is the water surging, I was trying to save documents and memories. At the time I didn't recognize myself, children saved things, and I cry, I can't stop. I wonder to what do we owe destiny when all we created was taken either by war or water. I walk through the House, water reached my articles, the next time the water was up to my neck, and I'm still taking things out of the locker, completely not aware that in few minutes I could lose my bare life*".

Lilja is a strong woman who tells us today a calm story of passion that has experienced and survived.

"*When it became clear that the water fully soaks the bottom floor of the house, we climbed to the top of the house. I'm looking out the window and see Venice. I can't see the trees, or the fence, only murky water where they're swimming snakes. At that place we spent 24 hours without water, without bread in our rooms. At the end we paid for boat to ship us a water*".

Lilja didn't get a chance to recover from the May floods, and has already been strickemn with the October floods.

"*When there was a flood in October I thought I was going to die. It looked like a war zone to me. And when the water receded, nothing of documents or papers what we own, passports, driver's license and ID card, can't find*

[31] Taken from: www.poplave.org

anything. It's a situation where you're not focused, you're not yourself. All documents are taken over".

Furniture we didn't save, all ended in the jaws of machines which drove it to the dump.

"*Today that means to me a little bit, "says Lilya, ''but at a time when observing how the machine chops up furniture, you have the feeling that everything you do has no meaning*".

On the question of whether it is prepared for any future disasters Ljilja perfectly reasonable answers that did not.

"So what kind of life would be, if you were constantly in fear, constantly under construction. I became stronger from then on, I realized that I just can help myself if I am mentally prepared, and material things we now mean little. "

However, she stopped talking for a moment, then asked,

" When is the next football Cup? "

Ljilja in memory seared that football cup arrives every four years like trouble with water.

"Water finds a way, out of the land, through the foundation of the house, through the parquet floors."

On the question did she make a protection measures on some future floods, Ljilja through humor fits the huse was renewed in Italian style.

"We now have ceramic tiles even in the bedrooms."

Lilja has not lost hope that the city authorities will hear the cries of people who, like her, are afraid of the rain.

"I hope that they will make a dam that will protect us. If the Sana river pours out, no matter in what amount, the water finds even the samll holes and enters in the house ".

3. EARTHQUAKES

> An earthquake is a seismic movement due to sudden disturbances in the interior of the land that causes the release of massive amounts of energy in a short period of time in the form of seismic waves.[32]

Earthquake, any sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks. Seismic waves are produced when some form of energy stored in Earth's crust is suddenly released, usually when masses of rock straining against one another suddenly fracture and "slip." or, sometimes by vulcan activity or by the great waves on the see bank (tsunami). Earthquakes occur most often along geologic faults, narrow zones where rock masses move in relation to one another. The major fault lines of the world are located at the fringes of the huge tectonic plates that make up Earth's crust.[33]

[32] Natural Disasters 9th Edition, Patrick Leon Abbott, McGraw-Hill Education 2013
[33] Britannica encyclopedia

3.1. The types of earthquakes[34]

1. Earthquakes induced by moving tectonic plates:

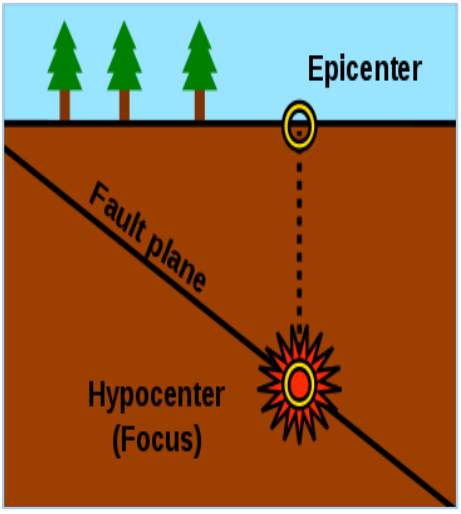
The Earth's crust is divided into tectonic tile, six panel size of continents and 14 subcontinent plates. These plates are moving one over another and during its movement plates is sliding side-by-side or one Panel is below other plates. The friction of these plates causes seismic movements.

Area of the Balkans and the Republic of Srpska is located in the second largest tectonic belt (the Alpide Belt), which extends through the Mediterranean and going on 15 percent of all earthquakes.

The science that deals with earthquakes is called seismology, but despite her advancement and new knowledge, it is difficult to predict the occurrence of the earthquake and its consequences.

2. Earthquakes caused by tsunamis are volcanoes:

Figure 31: Focus, the epicenter and fault plane



The Hypocenter is a place in the interior of the Earth's crust where an earthquake outcomes (hypocentar, focus).

The Epicenter of the earthquake is a vertical projection of earthquakes on the surface of the Earth.

The Magnitude is the quake's strength. It measures the seismic energy released in focus.

The Fault plane is mechanically discontinuity of rock mass, which is path in the movement of clay blocks.

When it comes to the movement of crustal blocks. Surface on which the block move, also known as the slanting grooves surface. If the slanting

[34] Natural Disasters 9th Edition, Patrick Leon Abbott, McGraw-Hill Education 2013

grooves surface under certain angle relative to horizontal, back different wing, above, and flat wing, below the rift area.

Earthquakes on the territory of the Republic of Srpska are the fault of indigenous origin. In addition to the indigenous territory of Srpska seismicity is exposed and seismic action of earthquakes with earthquake territory from neighbouring countries.

Earthquake epicentres concentration is highest in the areas of Herzegovina and the wider region of Banja Luka. Geological setting, there are regional and other structures that are visible signs of destruction are quoted field. Frequently hypocenter depth of earthquakes is ranging from 11-18 km, while the deepest hypocenter earthquakes occur in the wider region of Banja Luka, where the depth is 20-30 km.

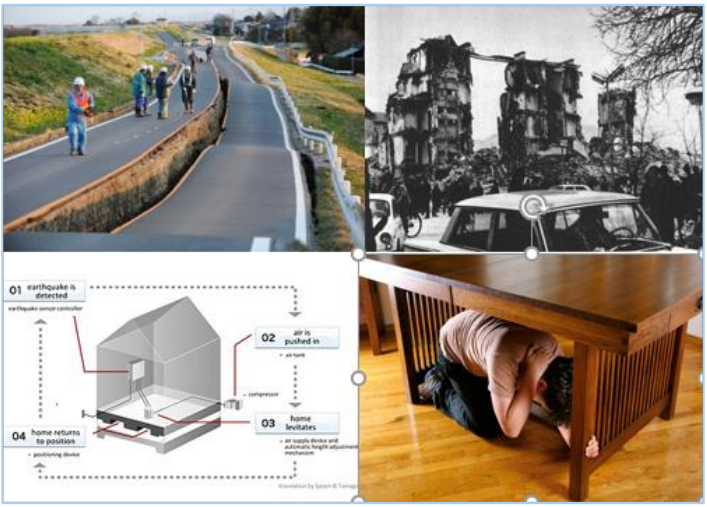


Figure 32: The consequences of earthquakes and some of the measures for prevention and rescue

3.2. Scales for earthquakes measuring

In addition to locating the epicentre of one concussion it is vital to quantify his strength. Strength of earthquakes can be determined via the *magnitude or over intensity of earthquake*.

An earthquake can only have one magnitude, since it is the amount of energy released at hypocenter, and ***can have more intensities*** depending on where the measurement of devastating effects of earthquakes is taken.

1. Scale for assessing earthquake intensity
   - ✓ Medvedev-Sponhauer-Karnik scale, also known as the MSK or MSK-64 scale is macroseismics scale which is used to estimate the intensity of the effects of earthquakes on the basis of perceived effects. This scale to assess the intensity of the earthquake is in use and is a modification of the MCS (Sizing-Kankani-Ziberg). The scale is based on the experiences of the application of the modified Merkali scale, used in Europe from the 1980's. *The scale has 12 degrees* expressed in Roman numerals, and in determining the degree of intensity is taken into account.

2. A scale for assessing the magnitude of earthquakes:
   - ✓ The magnitude of the earthquake is the unit of measure for the quantity of energy released at hypocenter. Richter scale has no upper limit, but has not yet recorded an earthquake measuring 10.

3.3. Seismic areas in Srpska and risk maps

Seismity of the Republic of Srpska define seismic zones established on the basis of the historical record of the strongest earthquakes that hit Srpska. In *Table 6*, you can see main seizmic zones on the territory of the Republic of Srpska, with the expected earthquake maximum magnitudes. Seismic zones as well as maximum magnitude are defined based on historical earthquake data.

Seismic hazard is possibility of occurrence of earthquakes within a certain period of time and at a specific location

Seismic activity on the territory of Srpska is uneven. In some areas such as Banja Luka, Ljubinje and Trnovo can be characterized as relatively high, and as a moderate on areas such as Posavina.

Table 6: Threat of earthquakes in Srpska in MCS scale[35]

Max expected intensity	Total surface in Srpska in this zone (km²)	% of surface in the zone	Number of the inhabitans in the zone	% of the population in the zone
VII	9,363.45	38.38%	495,946	34.61%
VIII	13,985.00	57.33%	841,495	58.72%
IX	1,047.53	4.29%	95,596	6.67%
	24,395.98	**100.00%**	**1,433,037**	**100.00%**

Area IX-degree seismic intensity of threat of earthquakes – a devastating earthquake:

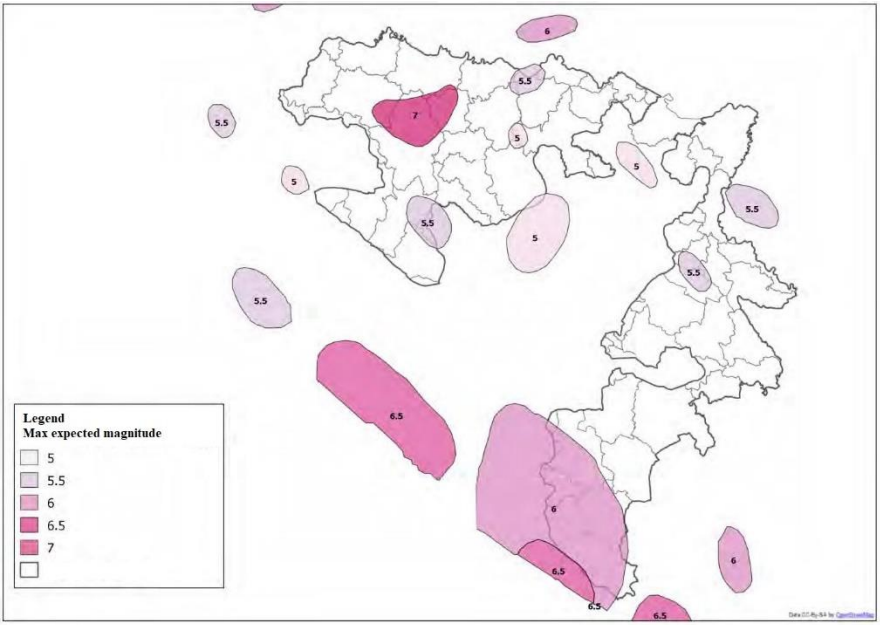
Zone maximum expected intensity of IX degrees per Merkaly scale, according to the seismological map for period of 500 years, is in the Banja Luka area and in southern Herzegovina. This zone includes 4.29% of the territory of the Republic of Srpska, or 1,047.54 km2, out of which on the territory of Krajina:

- ✓ 24% of the territory of the city of Banja Luka and 54.000 inhabitants,
- ✓ 62% of the territory of the municipality of Celinac and 10.500 inhabitants,
- ✓ 43% of the territory of the municipality of Laktasi and 17.000 inhabitants.

The area specified for three local communities, about 81,500 inhabitants live in zone IX.

There are no data from facilities, but it should be known that this degree of seismic intensity means, depending on the type and age of buildings, heavy constructive opšecenja and demolition sites. In Herzegovina in this zone is 41% of the territory of town Trebinje and 12.500 inhabitants.

35 Процјена угрожености од елементарне непогоде и друге несреће, East Sarajevo 2013



Cartogram 4: seismic Zone Map in Srpska[36]

In the picture you can see that the most seizmogene zones on the territory of Srpska is Banjaluka seismic area and Ljubinja area, which is part of the larger seizmogene zone.

3.3.1. Banjaluka seismic area

Banjaluka seismic area encompasses an area of approximately 10,000 km^2, or space 50 km around Banja Luka. According to historical data, this ares is characterized by four series of earthquakes:

- ✓ The first series of earthquakes was 1888, and representative of the series was an earthquake that occurred 20.05.1888. magnitude 5.7 unit on the Richter scale and intensity of VII degree MCS scale.

36Процјена угрожености од елементарне непогоде и друге несреће, East Sarajevo 2013

- ✓ A second series was 1935, and the strongest of all 7 earthquakes that have occurred in this series was the earthquake of 11.10.1935. magnitude 5.1 unit on the Richter and intensity of VII degree MCS scale.
- ✓ The third series was 1969, when from 26.10. to 31.12. happened more earthquakes, of which the strongest was 27.10.1969, 9 hours 10 min in Banja Luka. Magnitude 6.6 units on the Richter scale and intensity of IX degree MCS scale.
- ✓ The fourth series of earthquakes there was 1981. year, and representative of the series was an earthquake that occurred 13.08.198, a magnitude 5.4 on the Richter scale and units of intensity VIII degree MCS scale.

Figure 33: Earthquake in Banja Luka 27.10.1969.

An earthquake that rocked the Banjaluku 1969. razed the city. Fifteen people were killed, more than 1,000 were hurt, damage was enormous.

The earthquake was IX magnitude per Merkal scale, or 6.6 degrees on the Richter scale. It started the previous coup, in the night of 26. in October, in 2.55; seismic continued to 8.53.

Hipocentar was 20 kilometers below the city.

It completely destroyed 86,000 apartments, great damage in the school (266), cultural (146), health (133) and social and public administration facilities (152). The economy suffered significant losses, all the companies are following a period working with significantly reduced capacity, and some are completely stopped producing.

The building of the famous high schools Realka was also destroyed, which is from 1895. until 1898. year built a famous contractor Hyppolite Meek. It was the most beautiful building of the austro-hungarian period, the pride of the city, but was seriously damaged in the quake, so she ordered her demolition on 31. January 1970.

Figure 34: „Krivi sat" at the Krajina square in Banja Luka shows the the time during the devastating crash

As the memory of the earthquake at Banja Luka, in the Krajina Square, is a monument to "krivi sat", whose cursor show the exact time when the earthquake took place-9.11 pm.

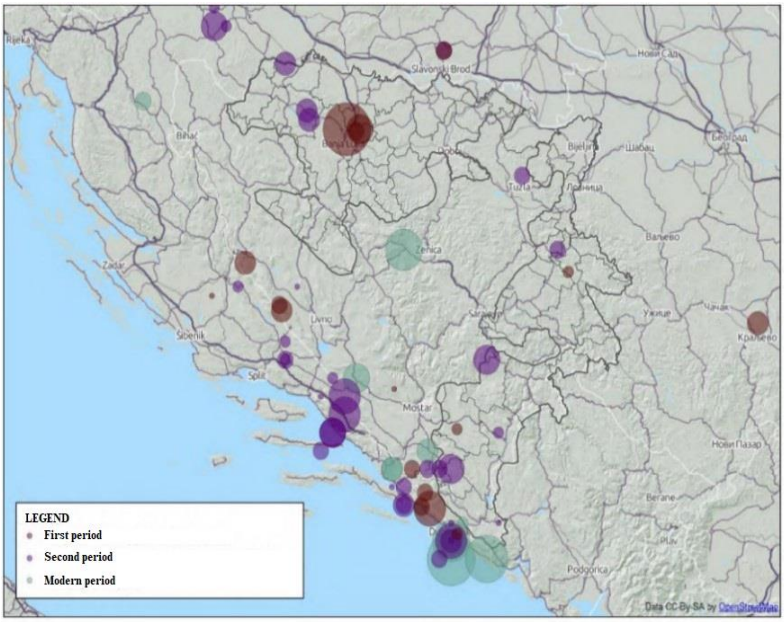
3.3.2. Seismic activity in the territory of the Srpska

Seizic activity at the territory of Srpska may be classified in the three periods:

4. **The historical period until 1823** – Earthquakes in this period, due to the scarce of record books are characterized by little accuracy of geographic coordinates, the intensity of an earthquake is determined on the basis of a small number and lack of precise data, and depth of the hypocenter is not defined.
5. **The early instrumental period 1824.-1964** – Extensive data base for strong earthquakes of this period, provided the basis for spatial and energy defining these earthquakes with sufficient accuracy to create maps of seismic hazards.

6. **The modern period after 1964. year** — Modern period of seismic activity has a different scope and quality seismic data. Registration of earthquakes from that period can be considered valid for the calculation of seismic hazard.

The strongest quake epicenter map on Srpska territory, indicates that seismically most active areas are the Banja Luka Region and Eastern Herzegovina.



Cartogram 5: strongest quake epicenter map (magnitude ≥ 5.0 Richter scale units) on the territory of the Republic of Srpska and region[37]

[37] Процјена угрожености од елементарне непогоде и друге несреће, East Sarajevo 2013

Number	Year	Month	Day	Time	Latitude	Longitude	Depth	Magnitude	TOWN
1.	1969	10	27	8:10:58	44.85	17.22	33.0	6.6	Banja Luka
2.	1927	2	14	3:43:24	43.00	18.10	18.0	6.0	Ljubinje
3.	1962	6	11	7:15:40	43.60	18.40	14.0	6.0	Trnovo
5.	1981	8	13	2:58:13	44.85	17.33	16.0	5.7	Banja Luka
6.	1861	12	18	8:20:00	45.20	16.70	23.0	5.5	Dubica
7.	1888	4	20	10:30:00	44.90	16.90	20.0	5.5	Omarska
8.	1888	5	20	10:30:00	44.95	16.88	16.0	5.5	Kozarac
9.	1907	8	1	10:07:40	43.00	18.00	12.0	5.4	Ljubinje
10.	1969	10	26	15:36:52	44.84	17.30	20.0	5.3	Banja Luka
11.	1908	12	25	21:58:00	44.20	19.00	9.0	5.3	Vlasenic
12.	1902	10	25	21:44:48	43.20	18.50	27.0	5.2	Gacko
13.	2003	12	14	10:09:29	44.08	19.09	20.0	5.1	Han Pijesak
14.	2005	9	27	0:25:34	43.22	18.15	15.0	5.1	Nevesinje
15.	1906	7	4	2:31:10	42.70	18.50	20.0	5.0	Trebinje

Table 7: Strongest earthquake with its epicentre in the territory of Srpska[38]

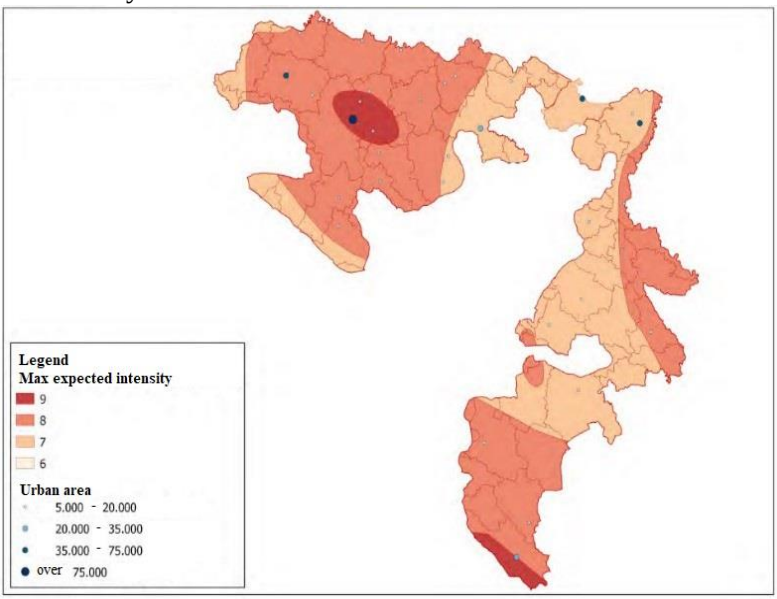
[38] Republic Hydrometeorological Institute of Srpska

3.4. Risk maps

Seismic hazard-is the likely of occurrence of earthquakes relevant characteristics, within a certain period of time and at a specific place, to be in a certain way be manifested at that location. Seismic hazard is expressed with three mutually dependent elements: amplitude movement of the soil, the return period of time and probability of the realisation of such an event.

Seismic risk-represents the degree of possible loss of human life and material goods in the event of an earthquake of a particular intensity in a particular area and is usually expressed in relative numbers (in relation to the maximum possible loss). Mathematically is defined as a convolution of the seismic hazard (quality or seismic resistance of building).

On the attached map are expected earthquake maximum predicteed intensities expressed in degrees MSK-64 scale with probability of 63% and periods for 500 years.



Cartogram 6. Zone of maximum expected earthquake intensity in the period of 500 years in Srpska[39]

[39] Процјена угрожености од елементарне непогоде и друге несреће, East Sarajevo 2013

3.5. Seismic monitoring of the Republic of Srpska

Seismic monitoring of Srpska is carried out according to the Law on seismological activity and involves designing and maintaining the national seismic network; registering, collecting, processing and archiving of data about seismic events; development of seismic maps, and more.

Seismological network of Srpska comprises eight digital automated station of which is seven shortterm station aimed at registering local earthquakes. One is intended for monitoring the global seismic events. The first seismic station in Banja Luka was installed and put into operation after the 1969 earthquake. Since then we can record the development of the national seismological service.

Code	Network	Coordinates	Elevation	Sensor
BLY	MN	44.749° 17.175°	256m	STS-2
BLJ	WS	44.754° 19.193°	97m	SM-2
DOB	WS	44.726° 18.089°	147m	SM-2
HAPS	WS	44.086° 18.951°	1199m	KS2000
MRAK	WS	45.013° 16.900°	850m	KS2000
PRJ	WS	44.972° 16.713°	141m	SS-1
TREB	WS	42.706° 18.344°	275m	SS-1
MGRS	WS	44.411° 17.084°	560m	LE-3D Lite
RUDO	WS	43.618° 19.370°	413m	SM-2

Table 8: The seismological network of the Republic of Srpska[40]

[40] Republic Hydrometeorological Institute of Srpska

Legend: Banja Luka (BLY), Prijedor (PRJ), Mrakovica (DARK), Doboj, Mrkonjic Grad (DUN), Bijeljina (FLASH GAME), Han Pijesak (HAPS), Trebinje (TREB) and a temporary station at the mine Sase Srebrenica**.**

Seismometers: BB-broadband seizmometar, SP-kratkoperiodicni seizmometar, STS-2 — Streckeisen broadband, KS2000-Geotech broadband, SS-1 – Kinemetrics 1s, SM-2- Seismometers by 2s, 5s, S5S Seismometers Le3D Lite- Seismometers 1s

The process of digitizing national seismological network started 2003, with the procurement of the first digital seismic stations, while automatic collecting seismic data in real time was initiated by 2007. The first and so far the only broadband stations on the territory of Srpska which is included in the Mediterranean seismological network is installed in Banja Luka 2009. Thanks to the cooperation with the Institute for geophysics and volcanology in Rome, which controls the Mediterranean network.

3.6. Measures for preventing damages from earthquakes in Srpska

1. ***Expand the existing network of seismological stations***, while enhancing existing locations and equipment. The correct location for the installation of stations it is necessary to build a seismically chute providing constant power and constant data transfer.
2. ***Provide stable data transmission in real time – VSAT***. It is necessary to provide alternative data transmission from Banj brdo, and on another to the backup site, the best in the area of Eastern Herzegovina. Ideally, all stations have provided satellite data transmission. The value of satellite data is variable, depends on the service provider, typically instalise their equipment on the number of sites, and then charge a monthly service.
3. ***Enable mode by the system 24/7/365***. To establish 24-hour mode, as proposed, it is necessary to enable the filling of all vacancies in the Sector for seismology. In order to implement this measure, it is necessary to obtain the consent of the Government of the Republic of Srpska and the expansion of the budget at that position.

4. ***Seismic monitoring of facilities***. At objects of particular importance, such as *energy and industrial premises, no artificial reservoirs and dams on them, important bridges and tunnels and other facilities of importance for Srpska*, it is necessary to enforce the seismically monitoring the installation accelerometers to track dynamic response of object. This area is defined in the regulations on Technical standards for seismic monitoring of hifh embarkment, and the Regulations on the execution of maintenance facilities and the issuance of licences for the use and monitoring of soil and buildings during construction and use.
5. ***Development of new seismic hazard maps of Srpska***. It is necessary to draw up a map of the seismic hazard of Srpska, which will reflect the intensity expected maximum horizontal acceleration. This map will allow the use of modern European codes relating to design in seismic areas (Eurocode).
6. ***Regulations on designing and building in seismically active areas.*** As can be seen from the risk analysis (cartogram 6), the whole territory of the Republic of Srpska is in a zone of high seismic risks (VII, VIII and IX), which implies strict respect for regulations about designing and building on the entire territory of Srpska, and especially in urban environments. The frequency of occurrence of destructive earthquakes is small, which results that in the public authorities sometimes ignore the danger of earthquakes and the importance of respect for the regulations that govern this area.
7. ***Seismic micro-maps in urban area***. Engineering-geological and geophysical studies of the site we receive information about possible influences quality of local ground in terms of potential earthquakes. The results of this research allow to define the elements of the seismic risks necessary to create the spatial plan of the Srpska. For larger sites we recommend creating Maps of seismic risk, which contains information used when designing and building residential district, how such industrial and other objects. Map of seismic risk in urban area of Banja Luka was made by the Institute of earthquake engineering and Engineering seismology 1969. Urban area of the city fBanja Luka from that time to this day, increased 6 times.
8. ***Listing, classification and evaluation*** of vulnerability objects.

3.6.1. Normative-legal framework of engagement the subjects of protection system in case of an earthquake in the BiH

The laws which are the basis for the implementation of protection and rescue people and property are:

- ✓ Law on protection and rescue people and property in the event of natural or other disasters, "Official Gazette of Bosnia and Herzegovina", Nr. 39/03, 22/06 and 43/10
- ✓ The framework law on protection and rescue of people and property in the event of natural or other disasters in Bosnia and Herzegovina ("Official Gazette of BiH", number 50/08)
- ✓ Methodology for development of risk assessments in the event of natural or other disasters (Official Gazette of Bosnia and Herzegovina 86/09)

Risk assessment of natural disasters for BiH was made 2012 and is the primary document used to create a plan for protection and rescuing people and property in the event of natural or other disasters in Bosnia and Herzegovina and for the development of the System of protection and rescue of BiH institutions. This document is not exhaustive, and like any other document represents material that need to be updated dynamically. Subject to the modifications, amendments, supplements, upgrades.

3.6.2. Republic Hydrometeorological Institute - measures and activities for emergency protection

The activity of the Republic Hydrometeorological Institute is defined by:

- The law on meteorological and hydrological activities (Official Gazette of the Republic of Srpska Number 20/00 of July 17, 2000),
- The law on seismological activities (Official Gazette of the Republic of Srpska Number 20/97 from July 28, 1997)
- The law on air protection (Official Gazette of the Republic of Srpska Number 124/11 of 14 December 2011).

The activity of the Institute takes place through the existence of the three sectors and one Division:

- ✓ Department of meteorology, with two departments: Department of vigils and Department of climatology and agrometeorology in which there are two departments: Department of climatology and Department of agrometeorology
- ✓ Department of hydrology, with two departments: the Department of hydrology and Ecology Department,
- ✓ Department of seismology, with two departments: the Department for observatory seismology and Department of instrumental and Engineering seismology,

Automatically location the earthquake and sending notifications into operational and communicative Center 121, republican civil protection headquarters a few minutes after the event. Corrective action of the Institute, Sector for seismology implies timely notification of earthquake. In the Sector for seismology is both configured and automatic system for collection and processing of seismic data. The system enables automatic determination of earthquake parameters (geo-coordinates and depth of focus, magnitude), within a few minutes of events and auto-generate notifications in the form of a text message that contains basic information about earthquake.

3.7. The role of citizens in the event of an earthquake

The effects of natural disasters can be significantly mitigated if citizens are informed and familiar with the ways of prevention of natural disasters. When the occurrence of natural disasters first response depends on the citizens as individuals, citizens become main actors. According to this, it is necessary that the citizens have the knowledge about the dangers, how to respond to them, and how co-operation with others are of crucial importance.

What to do during earthquake?[41]

[41] „Manual for behaviour in the event of natural or other disasters " by Sector for protection and rescue Directorate of the Ministry of security of Bosnia and Herzegovina in cooperation

- ✓ Stay remain calm and vigilant and not let you overcome a scare.
- ✓ Be aware that some earthquakes just starting and that thereafter there may be stronger.
- ✓ Don't create panic!
- ✓ Do not attempt to run!
- ✓ Get down on the floor and cover your head.
- ✓ Find shelter in safe areas in the home such as bearing walls, under the table, solid furniture, and remained there until the earthquake/earthquake takes.

If you are on the street, the risk of collapsing high-rise buildings is high, therefore, take the sufficient distance from the danger of crushing chimneys, tiles, glass and protecting your head with your hands or bag.

If you are in a moving vehicle:

- ✓ Stop at the site where it is allowed and safe.
- ✓ Avoid stopping near buildings, trees, overpasses, underpasses, power lines and bridges.
- ✓ Drive carefully after the earthquake has stopped. Avoid routes that involve crossing a bridge or ramp, which may have been damaged by an earthquake.

If you find yourself in ruins:

- ✓ Do not light the match.
- ✓ Do not move.
- ✓ Cover the mouth with a cloth or cloth.
- ✓ Tie the tube or wall to inform the survivors of their presence.

What to do after the earthquake?

- ✓ Be prepared for additional earthquakes. If the object is damaged, the possibility of a stronger earthquake poses a risk, so leave the object calm and without panic. The evacuation is in the order of: mothers with children, the elderly, sick, persons with disabilities, etc.

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with the Republic Srpska administration of civil protection and the Federal civil protection of Bosnia and Herzegovina with the financial support of UNICEF and USAID in BiH.

- ✓ If you are in a damaged facility and feel the smell of gas or you see broken cables, do not light candles or matches because there is a risk of fire and / or explosion in a conscience: mothers with children, the elderly, sick, persons with disabilities, etc.
- ✓ Make sure someone is injured. Do not move seriously injured persons.
- ✓ Follow the instructions of the competent / authorized persons.
- ✓ Use the telephone only in the most urgent conditions as the phone lines do not burden.
- ✓ Do not use cars to leave the streets for rescue services.
- ✓ Do not enter the buildings if electrical or gas installations are damaged.

3.8. A positive example of Japan

Japan has developed the best systems of prevention and protection from earthquakes. This is because Japan has among the highest seismically active areas in the world and over year the country is stricken with more than 2000 earthquakes. Some of these earthquakes have enormous destructive power. Often, the earthquakes in Japan and are accompanied by devastating tsunamis.

What do the Japanese do to prepare themselves?[42]

- **Resistant Houses and buildings** - In order to ensure people's safety, it's a good idea to start at the base. One way to do this is to enhance the earthquake resistance of buildings and houses when they are still under construction, so even when a strong earthquake hits these buildings won't easily collapse, one of the most important causes of injury or death during an earthquake.

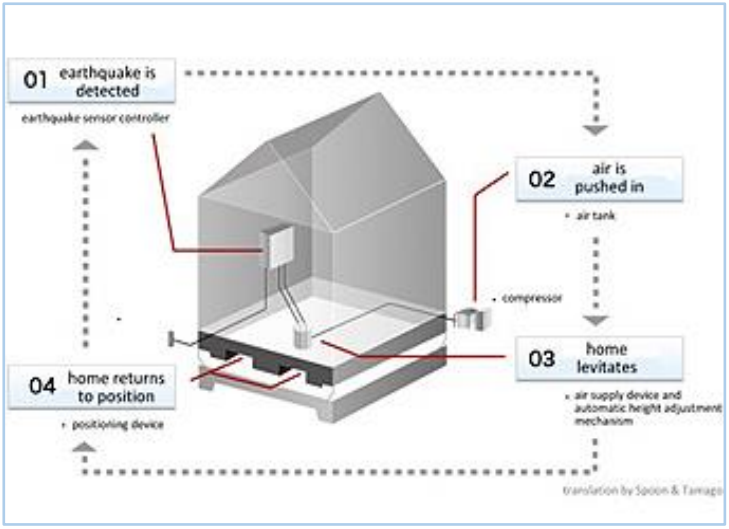


Figure 31: Levitating homes Earthquake-resistant houses in Japan.

[42] Natural Disaster and Nuclear Crisis in Japan: Response and Recovery after Japan's 3/11, Routledge; 1 edition (April 7, 2012)

In Japan, all newly constructed buildings must follow strict rules set by the government. These buildings must meet 2 requirements: they are guaranteed not to collapse due to an earthquake within the next 100 years, and they are guaranteed not to be damaged within 10 years of construction. Moreover, all materials used for construction must follow strict rules of the relevant authorities.

- **Earthquake Alert System**
  All smartphones in Japan have an earthquake/tsunami alert system installed, hence, about 5 to 10 seconds before a disaster strikes the warning system should give people a precious few extra seconds to escape to a safer place or duck under the table. When the alert goes off a buzzing noise is heard, and a voice keeps saying “Jishin desu! Jishin desu” (meaning “There is an earthquake”) until the earthquake stops.

Figure 32: All smartphones in Japan have an earthquake/tsunami alert system installed

Since an earthquake that happens in a coastal area is more likely to generate a tsunami, a warning system improvement contributes to minimizing the loss of lives and property by giving an alert 5-10

minutes before the tsunami comes. Also, the Japan Meteorological Agency has installed more than 200 seismic forecast stations across the country, and on a larger scale the Ministry of Disaster Prevention has set up 800 stations for the creation of the warning system. With all the information gathered from the seismic stations, the government staff can immediately analyze the data, identify the scope of the disaster, as well as predict the time of occurrence time in each location and accordingly launch a warning to the people so citizens can be prepared.

- **Emergency kit**

  To minimize the damage caused by natural disasters, the Japanese government built a system with full emergency faculties in order to serve people when a large disaster happens.

  What you have to do yourself, is to prepare an emergency kit for each member of your household, in which you store essential things like flashlights, medicine, blankets, masks, ropes, a radio, a portable toile and an amount of food that would be enough to survive on for 3 days to 1 week.

Figure 33 The Japanese Government has prescribed the correct content of Emergency kit

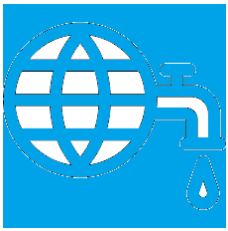
Next, each local self-founded evacuation center (commonly gymnastic rooms in public school buildings) is fully equipped with helmets, blankets, flashlights, food … to serve essential needs of people who come to this center when their homes are not safe anymore.

- **Awareness of Disaster Preve**ntion - The Japanese government focuses on providing their people with sufficient knowledge about earthquakes and tsunamis. Training sessions and/or exhibitions about disaster prevention are regularly held just like conferences for evacuation area construction.

Figure 34: The school system of prevention

This training starts young, from pre-kindergarten children have to regularly participate in the natural disaster drills. All Japanese students know that whenever an earthquake comes they are not allowed to panic, instead, they should protect their head, escape in an orderly way, and absolutely not rush or behave disorderly.

4. DROUGHT



Droughts are periods of time when natural or managed water systems do not provide enough water to meet established human and environmental uses because of natural shortfalls in precipitation or streamflow.[43]

[43] World meteo organization (WMO, 1992)

4.1. Drought definition

One of the natural phenomena that may disrupt the climate and economic system is a drought. As well as floods, disease or starvation, droughts affects the society regardless of their level of economic development. No country is protected from the impacts of droughts on production and supply of food and water. For industrial, wealthier countries drought is mainly an economic problem.

Figure 35: The environmental disaster of the first level – Jablanica Lake dried up, 2015. year.

JABLANICA LAKE

In summer 2015 year Jablanica Lake has dried up. It is ecological disaster of first level.

At one-time flora and fauna richnest in the Lake converted in the Sahara Desert where peek tombstone monuments.

Electric power industry of FBiH, who owns an artificial lake in Jablanica, couse of this unusual desert scene numbered every day big financial losses.

The drought that started in August 2011 cut production at only a quarter of the previous amount.

Electricity is now bought in a foreign market at a high price.

Rama Lake also is dried up in 2014

Figure 36: Rama Lake dried up, 2014.

It is especially endangered biodiversity in regions affected by drought. From an environmental point of view one of the most serious, and the most serious consequences of drought is creating dry areas and desertification of earth. This process is in a global sense accelerated during the 20th century as a result of rapid demographic growth, the negative impact of men (deforestation, conversion of land use, not sustainable agricultural production) and change variability of the climate on Earth, global warming above all. Drought is happening slowly and rarely causes rapid loss of human life. In the event of famine caused by drought, loss of human population, particularly the flora and fauna, in some regions are more drastic than any other natural disaster.

World Meteorological Organization (WMO, 1992) defined drought through several aspects:

- ✓ extended absence or intense rainfall deficit,
- ✓ an unexpected period of dry weather in which lack of rainfall causes serious hydrological imbalance,
- ✓ deficit of rainfall that is causing shortages of water for a certain activity.

4.2. Characteristics of drought

Occurrence of drought is becoming more common throughout the world and affects the developed and undeveloped countries. So far, scientists have not found a reliable method for predicting the drought. It is not quite possible with high accuracy forecast drought in real time. But notwithstanding the foregoing, following and analysing a number of meteorological, hydrological and hydrogeological parameters of drought it is still possible in part to anticipate drought. In contrast to other natural disasters drought appears slow, last long, and covers large areas although its spatial diversity is unable to locate precisely in advance. Drought is happening slowly, rarely causes rapid and dramatic losses in human lives but because of famine caused by drought, as a direct consequence, losses in human and animal populations are sometimes more drastic than any other natural disaster.

The drought is prolonged occurrence when quantity of all kinds of water streams is lower than average. In addition, can be characterized by uneven redistribution of existing precipitation other than the normal distribution in the region over a longer period of time.

Drought is characterized by less than the average amount of:

- ✓ surface water (flow and water levels);
- ✓ the level of groundwater;
- ✓ moisture in the soil, and so on.

4.3. Types of drought

By causes and causal-subsequent chain, drought can be divided into four groups[44]:

- ✓ **Meteorological drought** - Weather drought is drought caused by the reduced amount of rainfall compared to the multi-annual average, or

[44] Bonacci, O. (1993.b): Hydrological identification of drought, Hydrological Processes 7(3), 249-262.

complete lack of rainfall over a period of time. Meteorological drought can develop rapidly and abruptly stop;

✓ **Hydrological drought**– Deficit of precipitation over a longer period of time affects the surface and ground water supplies: the flow of water in rivers and streams, the water level in lakes and on the level of underground water.

Beginning of hydrological drought may lag for a few months comparing the beginning of meteorological drought, however, and also it can take longer duration comparing to meteorological drought.

Figure 37*:* Hydrological drought — the river Trebizat, August 2017.[45]

✓ **Agricultural drought** – Agricultural drought appears in the vegetation period when the humidity of soil and the amount of precipitation is insufficient to provide normal growth and development of plants.

Figure 38: *Agricultural drought,2017*[46]

✓ **Socio-economic drought**- Socio-economic drought occurs when water scarcity begins to affect

[45] Source: https://www.bljesak.info
[46] *Source: https://buka.com*

people, ie the need for water is greater than opportunities to secure waters by technical measures.

If the yield of agricultural crops has been reduced to 20% it is low-drought impact, from 20% to 50% those are high dries, and over 50% those are a hard dries.[47]

4.4. Drought indicators

Drought index is a numerical measure that tracks movement of the drought in two different time periods (observed/base period).

To determine the duration, intensity and frequency of drought, there are a large number of indexes of the drought. Indices of drought are given by using different indicators: quantity and arrangement of rainfall, water level and water level podzemnih, imprint, temperature, evapotranspiration, wind, humidity of air.

The most common drought indices are:

- SPI (Standardized Precipitation Index),
- PDSI (Palmer drought severity index),
- SWSI (The index of the supply of surface water),
- SPEI (Standardized Evapotranspiration Index).

Most commonly used index of drought is a Standardized Precipitation Index SPI. Negative index value SPI indicates the drought, and move into positive values on termination of the drought. SPI provides insight into:[48]

- comparison of amount of rainfalls in different time intervals.
- absolute variance of rainfall (mm),
- relative deviation of amounts of precipitation (%),
- likely of occurrence of different amounts of precipitation (percentiles).

[47] Menaging water for drought, William J. Werick and William Whiple, U.S. Institute for drought, 1998

[48] McKee, Doesken i Kleist 1993. (Redmond, 2002)

4.5. Effects of drought

Effects of drought can be classify on:[49]

1. Economic consequences of drought:
   - The decline of yields of agricultural products.
   - Decline of GDP.
   - Lower production of electricity.
   - Difficulty in water supply.
   - Reduced water quality.

Of all industries, agriculture is usually the first hit and especially threatened by drought and special crop production. Water shortage especially in the vegetacion period for the plants that can't grow, which can cause their damage and venuce. Many branches of economy are closely associated with farming and harmful impact of drought and transmitted on them. Due to low rainfall forestry damage result from phenomena of various diseases and they are very important and for which the occurrence of forest fires and support development of drought. In a series of economic consequences of drought and water supply are among casualties in villages and in energy.

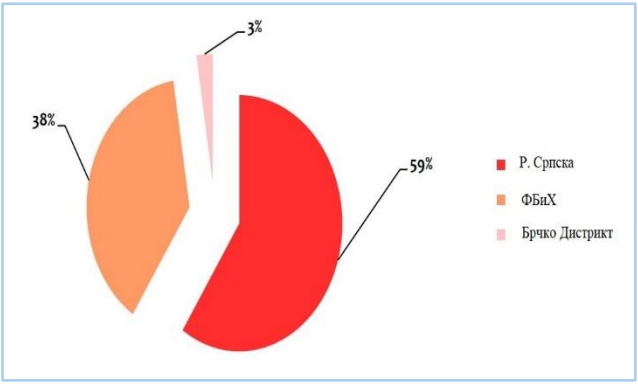


Chart 1: Share of total sown surface of Srpska, FBiH and Brcko District in total sown surface in BiH in 2015.[50]

[49] National Drought Mitigation Center; http://drought.unl.edu

[50] Годишњи извјештај из области пољопривреде, прехране и руралног развоја за Босну и Херцеговину за 2015. годину - Министарство вањске трговине и економских односа Босне и Херцеговине

2. Social consequences:
   - Decline of life standrard.

3. Environmental consequences:
   - The disappearance of plants and animal life.
   - The withering of plants.
   - Fires and destruction of forest areas.

The environmental consequences are related to the violation of the environment, and social on quality of life.

Forest fires represent natural disaster that includes elements of all three mentioned groups drought consequences.

In addition to the economic losses that are reflected in the loss of lumber, firefighting costs and losses in tourism; environmental that include the occurrence of soil erosion, reduction of biocoenoses, disorders in water balance; there are also social consequences caused by population migration (North Africa-Europe), stress and vanishing wildlife.

Figure 39: Fire as an ecological consequences of drought

4.6. Droughts in the Republic of Srpska

The average deficit of water in the North of the Srpska is around 100 mm, in the South up to 300 mm, while the lowest in medium-sized and mountain regions, around 50 mm. In Herzegovina arid period can last up to 5-6 months, and in the North and in the area of crassus 3 months. The probability of occurrence of droughts is most pronounced in the northeast (Semberija and Posavina) and Southwest (Krajina Dinar region).

Based on the analysis of individual sites in the Herzegovina for the period 1961-2010, it turned out that there has been an increase in drought level, the changes were not statistically significant, while the town of Bijeljina have shown a significant positive linear trend.[51]

Drought in Srpska have a periodically character, it clearly shows the decade of the 1981-1990, but in the last 10 years were common, and a 2000, 2003, 2007/2008, 2011 and 2012, although in the period 2001-2010. was the most humid years. All this is closely connected with the general circulation of the atmosphere, and the most affected by the North Atlantic (NAO) and the Arctic Oscillation (AO). Very large and spatially widespread drought there was 2003, and the like was and 1983. It was very widespread and regionally, as can be seen from the image spatial distribution. In the Republic of Srpska, on many stations is recorded absolute minimum value of SPI, and drought is reported as early as the spring, and existed in the summer months.[52]

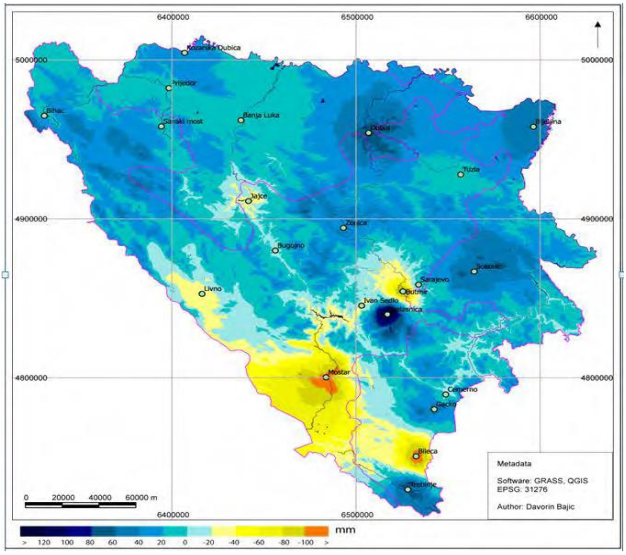
Year 2011. was the driest in the last 100 years in the North, while in the south itwas one of the driest. August and November were extremely arid, especially in the North. In Bijeljina in August was only 1 mm of rain, which is the lowest value in the last 50 years, while in Banja Luka in November 2011. was excreted only 5.1 mm rainfall, which this month makes it driest in the period 1883-2011. Period April-September 2011, with 285 mm total rainfall (average is 576 mm), is a secondary minimum in the last 130 years, until the vegetation period of 1946 represents an absolute minimum of

51 Процјена угрожености од елементарне непогоде и друге несреће, East Sarajevo 2013

52 Like 51.

precipitation (244 mm). In third place is 2000 with 236 mm rainfall during the growing period.

Summer period (June-August) 2012 is among the 10 driest over the past 130 years, together with that during 2000, 2003 and 2011. Less precipitation has been registered only during the summer of 1950, 1946, 1933 and 1952. In June 2012 on the territory of the Srpska had a rainfall deficit of 66%, July 26%, and in August almost no precipitation, and the deficit is even 94%. Given that the average monthly temperature during summer months in Srpska was 3.1 for oC-3.9 c higher than the average in relation to the period 1981-2010. The evaporation was significantly increased and contributed to draining soils, so these weather conditions adversely affected the agriculture and water resources.[53]



Cartogram 9: Changes of annual quantity of precipitation in BiH. Comparing the period 1981-2010, compared to 1961-1990.[54]

The total annual quantity of precipitation is slightly rising (1961-2010), but reduce the number of days with precipitation above 1 mm of rain, and increased the number of days with intense thunderstorms. The largest increase in precipitation is related to mountain areas, the central and the eastern part of the Republic of Srpska (Sokolac), and slightly less in the Southwest. In particular, the significant

53 Процјена угрожености од елементарне непогоде и друге несреће, East Sarajevo 2013

54 Like 53.

increase in precipitation in the North, in the area of Doboj, in the far South-East of Herzegovina.

Expressed changes in annual precipitation layout, with an increase in temperature is one of the main factors which condition more often and more intense occurrence of drought and flood.

Example of the sudden change of the mode in the 2010 and 2011, until 2010 was the year with the highest rainfall in the past 50 years, and 2011 was the driest year in the instrumental period (from 1883) in the North, and one of the driest in the country. In 2010. the year was in almost all months positive deviation of precipitation, with the highest surplus in certain months of 100% in the North to even

The fact that the two years with extremes were occurred one after another shows that there has been a significant change in the rainy periods and that we can expect a shifting of very dry and very rainy periods.

Natural disasters come if there is not 120 to 300 million m3 of water on about 230,000 ha once in 10 years or less, and in more frequent cases of damage from a deficit of water would be manifested in the reduction of yield 5-30% in some cultures and individual support areas. The intensity of the drought are commonly estimated by reducing yields, on condition that it did not influence other harmful factors.

4.7. Monitoring and prevention of drought

Drought monitoring in Bosnia and Herzegovina was established under IPA DMCSEE (Center for drought management for the region of southeastern Europe) co-financed by the European Union through the intergovernmental co-operation in Southeast Europe.

Monitoring is implemented by calculating the SPI index (i.e. standardised precipitation index) for different time intervals (e.g., 30 days, 60 days, month, season, year, etc.) and through the monthly view of FVC and LAI index regarding the condition of vegetation, and are calculated from the data obtained by satellite LANDSAF. SPI index is characterized by simplicity, since they are only required to calculate the rainfall. SPI index analyses the beginning, duration and intensity of droughts. Otherwise, the index is likely

the realization of drought, and it can also be used to keep track of conditions or flooding. They developed a T.B. McKee, Nj Doeken and j. Kleist in 1993 Climate Center in Colorado.

Prevention of danger of drought should enable:[55]

- ✓ Reduction of losses in water supply systems, reconstruction and a faster flow through system.
- ✓ The availability of insurance against drought. Insurance market has developed in environments that institutional support this financial branch and where agricultural sector has the support of the banking sector (in terms of financing of agricultural production) and other participants in the market. Rural areas in transition economies are usually not commercially-oriented and thus they yield protection through insurance unavailable or very limited.
- ✓ The introduction of new technologies in production processes, to reduce the need for additional quantities of water with istosobno improving quality used and dumped water (large industrial consumers, irrigation).
- ✓ Providing additional quantities of water for the irrigation of arable land, which would be created conditions for intensive agricultural production.
- ✓ Improving the supply of the population through already covered by the public water supply systems and extending the same to a larger number of settlements in which there has been a decrease in flow in reservoirs.
- ✓ Protection of existing water sources and find new sources of water, in order to ensure additional amounts of water in vulnerable areas.
- ✓ The construction of artificial reservoirs, which in addition to the production of electric power and created conditions for the development of tourism, protection of flood downstream areas, provides water for irrigation.

[55] National Drought Policy Commission (NDPC) (2000.) Preparing for drought in the 21st century. Washington

- ✓ Insurance spare quantity of water, by building or by placing the water tank, etc. for effective fire protection (especially outdoors).

4.8. A good example of the Republic of Israel in the fight against drought

Isreal is a leading country in the world when it comes to the management of water resources.

De facto, we can say that Israel did not even had water potentials before 40 years old, with the exception of the River Jordan and Lake Galilee.

In the meantime they created it by desalonisation of sea water.

Israel today controls 90% of the water resources in Palestine, which has become a political issue.

What Israel did?

- ***Desalonisation of sea wate***r [56]

Israel draws water from the Mediterranean Sea and through desalonisation process is transforming it into drinking water and water for industrial use. In the last ten years, Israel has built five water factories whose total value is $2 billion. Although it is a expensive technology, Israel is due to this technology turned major desert areas into fertile fields and today controls 90% of water resources in Palestine.

Israel is a country that has 8.5 million people who mostly live in the desert, saline soil and achieves 80 percent self-sufficiency in the production of agricultural products. They import grain, oilseeds, sugar and some meat, from European greenhouse from which in winter Europe supplying many kinds of fruits, vegetables and flowers.

[56] How Israel became a leader in water use in the Middle East - PBS NewsHour You tube chanel

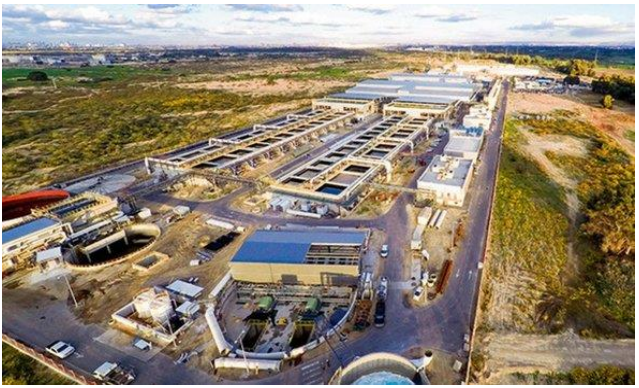


Figure 40: Factory for desalonizaciju sea water in Israel, Ashkelon city [57]

- ***Recycling of water***

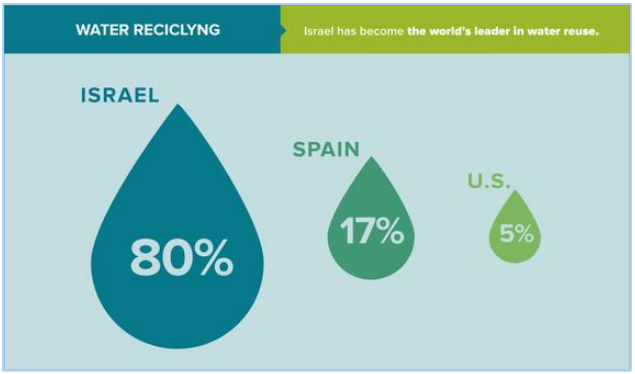


Figure 41: The leading countries in the world by percentage of recycling water

Israel filters waste water, which then can be used, if necessary, even for a drink. Eighty percent of the water in Israel recycles and returns again in use. Thus, for example. in the desert of salt water swimming pools in cultivated fish for commercial production. After the water is used for fish breeding is used to irrigate trees dates and olives.

- ***Politics of water prices and convertion of desert and rocky terrain into the green fields.***

[57] Source: Jewish Virtual Library

Water policy water price encourages saving and can be utilised from any other sources except drinking. In this way considerably reduces water consumption in agriculture. *This best illustrates the fact that in Israel's agricultural production in recent decades increased 12 times, and spending three times.*

Figure 42: Irrigation of deserts and rocky terrain near Tel Aviv [58]

Nowdays, due to the extraordinary climate extremes, there is no more serious agricultural production without systems of irrigation. Using modern technologies farmers very quickly and in a cost-effective way increase food production. Greenhouse production in Israel has also emerged as a response to the natural limitations of the soil, water and climate, which allows the production of an entire year with minimal need for energy and chemicals.

Of 900 hectares in the early 80 's area under greenhouses grew to 13,000 hectares.[59]

Since 1965 it began with all innovation irrigation the Israeli company Natafim has become the largest global company for irrigation. Parts of the desert have been transformed into agricultural fields and forested areas. Additionally, almost all water is recycled again, and evenmore used more than once for different purposes.

[58] Source: Jewish Virtual Library

[59] Let There Be Water: Israel's Solution for a Water-Starved World Seth M. Siegel Thomas Dunne Books, 2015.

5. LANDSLIDES

Landslides are among the group of slides processes whose activity gethers the joint action of gravity, atmosphere (precipitation and temperature), hydrosphere (surface and groundwater), seismic effects, exogenous processes (surface decomposition, planar and liner erosion).

Map of the hazard *- probability of landslide triggering on a specific area at a specific time.*

Map of risk – effects on nature, material goods, people.

5.1. Types of landslides

According to the mechanism of movement of the land, there are next landslides types:

Fall is the separation of the solid rock mass on the steeply inclined slope along the surface.

Slumpis the movement of soil, rock along the sliding surface or along the deformation zone**.**

Spread is slow movement, without clearly defined areas where the movement is performed. The movement of material is relatively slow with advancing that are continuous and relatively small.

Topple is the process of tearing, tilting and rotation severed mass of soil or blocks of solid rock over a point or axis, which is located below the center of running mass.

Flow is the movement of very sodden and very viscous materials, relatively quickly, between the streaming process and skating with more or less water content.

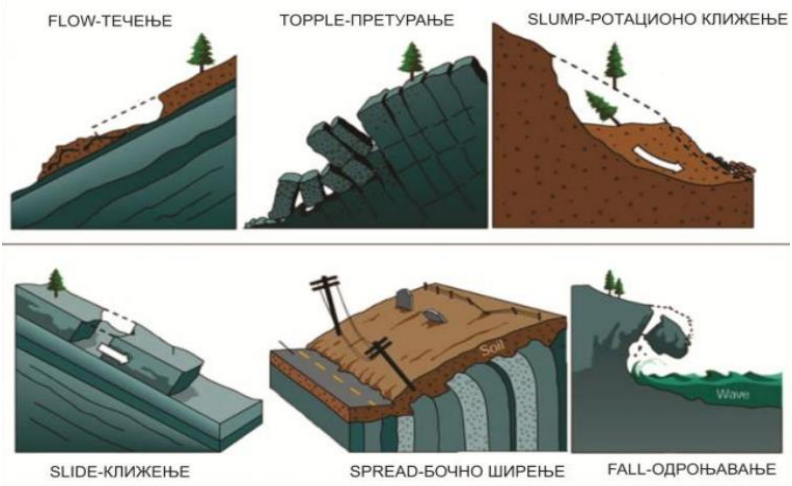


Figure 43: A graphical representation of the sliding processes (Cruden & Varnes, 1996

Landslide is rapidly separating and gravitational movement of rocky mass. Effects can be different depending on the size of the drained fragments and the distance to which they were transported.

Figure 44: Topple on the road[60]

60 Handbook for Beware project, Information about the project and practical guide, The United Nations Development Programme (UNDP)

5.2. Causes of landslides in the Republic of Srpska

Due to topographical features, as well as other natural conditions such as heavy rainfalls, landslides are continuous and very present hazard in Bosnia and Herzegovina and it causes complex and growing problems for communities and authorities at all levels. In the risk assessment for the country, which was adopted by the Council of Ministers in 2012 has already registered a large number of active landslides in the country.

The war that occurred in the country in the period 1992-1995 also caused extensive migration of the population, which is connected with the illegal construction of housing units in sliding areas or along the river banks. In addition, the lack of documentation on spatial planning based on geological analysis leads to the long-term danger of landslides.

In addition, *people's activities that are related to the spread of settlements to unsafe sites, mining activities that are not based on scientific research, risky construction of roads, embankments and ignoring natural characteristics contribute to the increase in the number of landslides*.

Terain in BiH is complex geological material that includes different stratigraphic units of the paleozoic. The complexity is further increased because of various lithological types of sedimentary, metamorphic and magmatic rocks that mostly characterized by varying degrees of disrepair. Because of its diverse and changing physical and mechanical characteristics, these different ranges of rocks are subject to the process of decomposition and the formation of clay and clay covers.

83% of the total land in BiH is situated in a hilly area (300 to 500 m above sea level), hilly or mountainous Mediterranean area (500 to 700 m above sea level) or mountain area (more than 700 m above sea level). In these areas, the ground is often shallow and level of underland water is high. These topographic and hydrogeological characteristics are considered for one of the main reasons of the high risks of landslides in BiH. [61]

[61] Custovic H. An overview of general land and soil water conditions in Bosnia and Herzegovina, European Soil Bureau – Research Report No. 9

The average annual amount of rainfall in hilly and mountainous areas in Srpska is between 1500 and 2000 mm (south region) and about 1000 mm (central region). Precipitation and a combination of rain and melting snow are one of the most common trigger landslides in Srpska. Continuous heavy rain in mid-May 2014. caused numerous landslides and floods in Srpska, Serbia and Croatia.

In addition, excessive felling and inadequate change uses the grassy land in arable land are the most common cause of landslides associated with human activities. Other human activities that often cause landslides are performing cutting of roads, construction of embankments in the frontal area of landslides and failure of water supply system.

Figure 45: Regional road Lopare-District, Pirkovci, municipality of Lopare 2014.[62]

Figure 46: Zelinje, municipality of Zvornik, 2014. [63]

[62] Како живјети са клизиштима, Cvjetko Sandic, Koviljka Leka, Zvornik, 2015.
[63]The same.

Figure 47*:* Monument in Tjentiste, 2017.

Figure 48: Village of Umka, Belgrade, One of the largest landslides in Europe.

5.2.1. Natural causes of landslides

- Gradient of natural slope;
- Reducing resistance to shear of rocks and soil as a result of processes of physical and chemical decomposition;
- Erosion processes caused by formed and lateral spread of riverbeds;
- Change the level of groundwater and surface water;
- The spatial orientation of Planar circuit elements: stratification, cracks, faults in relation to the disposition of the slopes;
- Tectonic processes;
- Seismic effects.

5.2.2. Technogen causes

Technogen causes arise as a result of human activity, when you consciously or unconsciously, intentionally or elementaly, perform construction, mining, or any other interventions with significant violations of the natural equilibrium and relations on the slopes (Rokic and Vujanic, 2000).

The most significant are:

- Construction of buildings on unstable terrain;
- Poor soil drainage;
- The devastation of a court-stripping land, clearing of vegetation;
- Inadequate cutting of natural slopes;
- Inadequate disposal of materials on slopes (landfill waste, tailings, etc.);

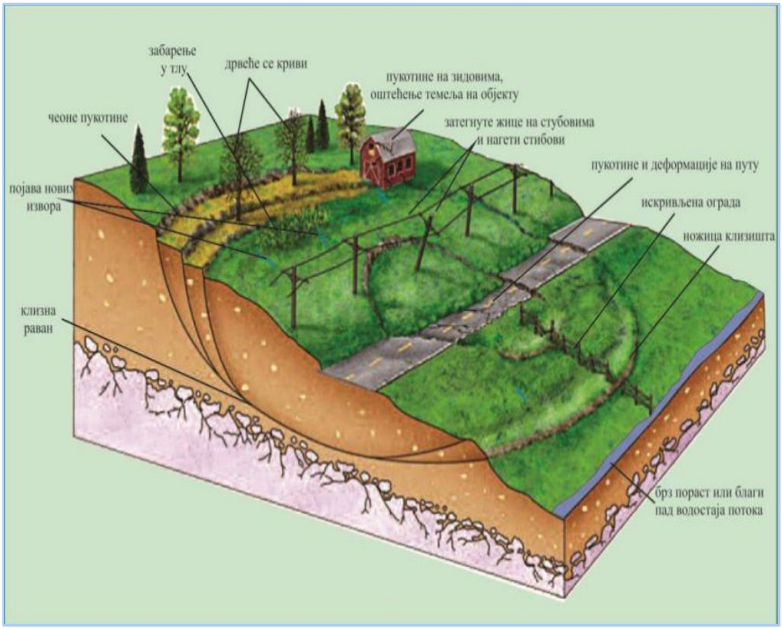


Figure 49: Process indicators slip

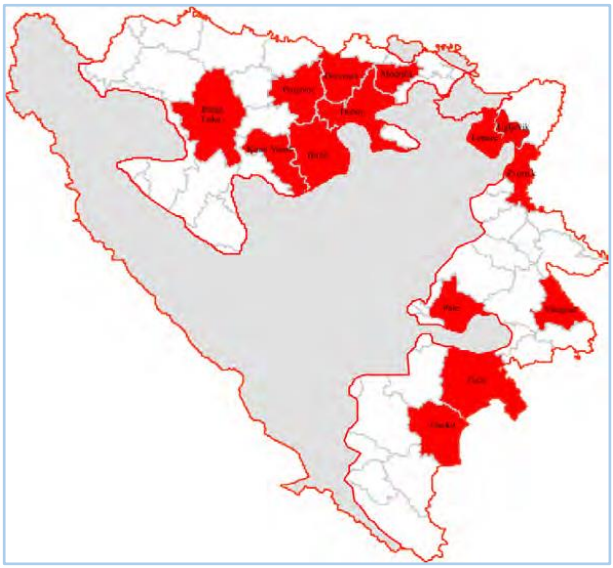
Warning signs:

- Water breaks through the surface of the ground where there wasn't;
- Broken roads and underground plumbing installation;
- A rapid rise in the level of the stream, increased opacity (silt in the water);
- Sharp decline in the level of the stream, and rain still falling, or stop to fall;
- A quiet rumble that amplifies, unusual sounds, such as cracking of trees, etc.;
- Stuck door and Windows, visible cracks on buildings;
- Shooting floors and foundations, separation of soil from the ground up, terrace and stairs, from the main building;
- New cracks or unusual lumps in soil, on streets, roads, etc.;
- Angled pillars, trees, retaining walls or fences etc.;

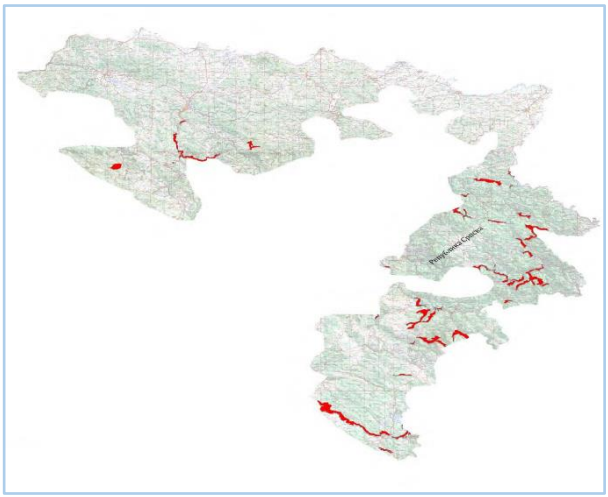
5.3. Risk maps

Map of the hazard *- probability of landslide triggering on a specific area at a specific time.*

Map of risk – effects on nature, material goods, people



Cartogram 10: Cities/municipalities in the Republic of Srpska, most affected by the process of sliding, (*Source*: Republic Institute for geological research, Zvornik, 2011.)



Cartogram 11: Map of threat of landslides (Source: Republic Institute for geological research, Zvornik, 2012.)

5.4. Actions for preventing landslides

Actions for preventing landslides can be divided into three categories:

Measures to combat landslides:

- ✓ emergency measures,
- ✓ permanent (restorations) measures.

For all of these measures it is necessary to conduct professional people, engineers of appropriate professions and emergency services in emergency situations.

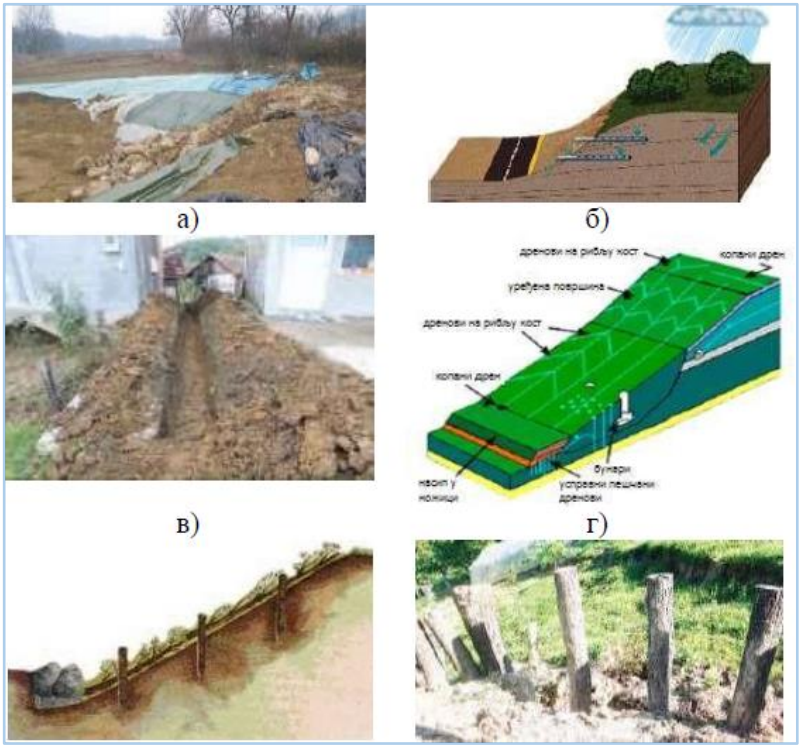


Figure 50. Emergency sanation action: a) nylon overlay, б) setting horizontal drains and channels, (в) and (г), mass redistribution, ђ) and e) scoring stake

5.4.1. Preventive measures

- Inventory of landslides and forecasting maps (a penchant for figure skating, hazard and risk) as a condition for proper planning and design;
- Early warning systems – monitoring in real time;
- Improvement of the legislative power;
- Education of the population and strengthening professional capacity. Emergency (emergency measures) emergency measures for sanation are performed in situations where it is necessary to react urgently work saving human life, property, infrastructure, etc. They immediately implemented after noticing or activating the phenomenon in order to prevent further damage and consequences.
- Draining surface - water drain out of the body by creating landslides channels or trenches;
- Urgent cleaning ducts and ravine if they are buried with earthen materials, construction for easy removal of excess surface water;
- Fill and cover the plastic wrap and waterproof canopies for preventing further passage of surface water.

5.4.2. Permanent measures:

Permanent restorations measures are implemented after detailed geotechnical investigations and making the necessary project documentation. The goal of each research and sanation is stoping the process of sliding under the implementation of one or a combination of methods of sanation.

Most common measures are:

- drainage
- support walls and other structures.

Drainage is most often used as a permanent measures to reduce and limit the influence of surface and groundwater. These measures regulate the flow

of surface waters (surface drainage) and lowers the level of underground water (groundwater drainage).

Figure 51: Poorly constructed drainage as a factor of instability[64]

Retaining structures are one of the most commonly used measure of sanation that is powered mainly by its mass (supporting walls and other constructions).

For more complex sanation often is used combination of stable walls, drainage and foresting of the area, etc.

Figure 52 shows the most commonly used types of supporting structures.

[64] Како живјети са клизиштима, Cvjetko Sandic, Koviljka Leka, Zvornik, 2015.

Figure 52: Construction of retaining wall.

Figure 53: Drainage of landslides as permanent measures of protection.

Figure 54: Action of reforestation landslides in Krupanj, 2014.

5.5. Effects of landslides

Landslides are a serious social problem, because it can have as a result injuries or damage, direct or indirect. Direct damage occurring at the time of activation of landslides, breaking and damage of buildings and human losses (deaths or injuries). Indirect damage is expressed and through a longer period to reduce property values, loss of productivity due to damage to goods or disruption of traffic and finally, the considerable costs of repair damage.[65]

- ✓ Economic consequences, referring to material losses or damage to the equipment and resources that are needed for an evacuation, rehabilitation of landslides and the repair of damaged buildings and the eventual cost of displacement of the population.
- ✓ Social consequences, related to the loss of life, the mental and psychological health of the people, an even greater threat to vulnerable categories (especially children, women, the old, the sick and others), difficult work of schools and health institutions, displacement, existential problems and the additional impact on the budget of each household, and so on.

5.6. A review of legislation in Srpska

Them aim of analysis of the legislation's regulative is to define legal context in which it is possible to define the institutional framevork and implement landslides risk management.

Documents related to the action plans and strategies, laws and laws, procedures, responsibilities implementing in Srpska are:[66]

- ✓ The law on geological studies of the Republic of Srpska ("Official Gazette of the Republic of Srpska" no. 110/13),

65 Handbook for Beware project, Information about the project and practical guide, The United Nations Development Programme (UNDP)

66 Studija upravljanja rizikom od klizišta u BiH, prof. dr Biljana Abolmasov, Sarajevo 2015.

- ✓ The law of spatial arrangement and the building code ("Official Gazette of the Republic of Srpska", no. 55/10),
- ✓ Law on water ("Official Gazette of the Republic of Srpska", no. 50/06 and 92/09),
- ✓ The law on the protection of nature („Official Gazette of the Republic of Srpska “, no. 50/02),
- ✓ The law on forests („Official Gazette of the Republic of Srpska “, no. 75/08).

5.7. Citizenship behavior in the event of landslides

If you notice the danger of landslides you should: [67]

- ✓ inform the competent services at the number 122 or 123;
- ✓ tell your neighbors that may be affected by this risk;
- ✓ help neighbors who need special assistance, children, the elderly and people with special needs;
- ✓ step away from the landslide zone because it is the best protection; during the ban, always look towards the landslides irrespective of the stones or other material that stands out and can hurt you;
- ✓ pay attention to the floods that may occur after landslides and slope failures;
- ✓ move sideways from landslides;
- ✓ don't stand under the big trees or power poles, you may experience a decline;
- ✓ don't go near the edge of the landslide, because it is unstable;
- ✓ if you are in the process of driving encountered on an already activated landslide signal at danger to other participants in traffic who encounter.

[67] Studija upravljanja rizikom od klizišta u BiH, prof. dr Biljana Abolmasov, Sarajevo 2015.

5.8. Personal story – Landslides

A five-member family Maric, living in Banja Luka, Zaluzani village, fears that landslide which triggered ten days ago would destroy the house they live in.[68]

Figure 55: Landslide in Zaluzani, Banja Luka

Since the landslide appeared below their home, worried residents say that every morning as soon as they wake up, they first look through the window to see how the Earth moved. The land has already swept away almost an entire orchard located below, and now threatens the house because it has come just three meters form the house.

Just looking at the cracks indicates how much the situation is dangerous, and pile the fruit in one place makes the situation more dramatic.

Milos Maric says that landslide triggered after melting snow and it constantly keeps moving, and that proves new cracks that keep popping up.

Maric adds that he had informed on the situation city council, but no one came out on the court because of inclement weather.

"They told me that they will send a geologist to examine the land and then take measures. ***Near the house there is deposited the earth from the pool of water that they made and from that point the landslide started to move***, "said Maric.

[68] http://www.atvbl.com/porodica-iz-banjaluke-strahuje-da-im-kliziste-ne-odnese-kucu/

He added that due to the landslide, an auxiliary object underneath the house drowned nearly one meter in the ground, and that the slipper collapsed and a banderu in the orchard and moved five meters.

“We are constantly living in fear because we see that the ground cracked just below the window. Our only hope is if the land stops moving, "said Maric.

He thinks that the only solution is to set up protective walls, but the question is how much it costs, because first we must evaluate the value of the house.

Mirjana Malusic, the owner of the orchard, says that they are only afraid of the daughter and daughter's house, and that the fruit will be planted again.

"The slide was taken by my whole orchard, which was underneath the house, and the land is still moving. Probably water is the cause of the landslide, because there are plenty of wells above the house, "said Malusic.

She adds that the earth has been buried by most of the concrete steps that they built to get down the orchard more easily.

Figure 56: Family house of Maric family

“If the land continues to move like this, the rest will crumble. We live here for 20 years and we never had any problems, and now we live in constant fear" said Malusic.

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