WEATHER AND SEVERE WEATHER

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Semantics of the word weather (bos. ''Vrijeme'') in official languages used in Bosnia and Herzegovina has etymological synonymic meaning that defines it. Unlike in English language, where two different words are used to describe something we call time and weather, in the languages of the people in Bosnia and Herzegovina word ''vrijeme'' is used to describe both, time and weather. That's why we define temporal and meteorological one. Temporal time refers to the basic time unit– one day, which determines the passage of time between two consecutive lower culminations of middle Sun above meridian of point of standing.

One day is conventionally divided into 24 hours. Temporal time is derived from Earth's rotation and revolution and it belongs to the field of Astronomy. On the other hand, weather determines the state of meteorological elements and phenomena in a given place and time of observation. From all natural phenomena, it changes the most and is unique in elementary, temporal and appearance terms. Weather, as a rule, has settled average rhythms of meteorological elements and phenomena, and in some cases, has their extreme forms defined as severe weather or storms.

Keywords: *weather, natural disaster, extremes, severe weather, climate*.

INTRODUCTION

Term weather is often confused with term climate resulting in interpreting all beyond average weather conditions as a result of climate change in the light of global warming even though it is only one isolated time phase case. If weather is understood as the current state of the atmosphere determined by the quantitative and qualitative indicators of meteorological elements and phenomena, then it is the fact that it is not about climate extremes, as stated in some papers (Andjelokovic, 2010), but rather weather extremes.

Weather extremes can be considered climatic only if those reached conventional climatic period of 30 years, registered as weather at the extremes of the historical distribution – the range that has been seen in the past. That's why, severe weather that occurred during May of 2014., demonstrated as intensive showery precipitation, which caused extremely high water levels is weather disaster but, most likely, will be treated as climatic one for the third climatic period. (1991 – 2020.) Weather generally refers to day-to-day temperature and precipitation activity, whereas climate is the term for the statistics of atmospheric conditions over longer periods of time. Extreme weather describes unusual weather events that are at the extremes of the historical distribution for a given area.

Semantically, bad weather conditions are treated differently in meteorology, but usually terms severe weather and storms are used. Severe weather is clearly the opposite of good weather, and weather, to the same doctrine, is defined as bad and good weather. Every state of meteorological elements and phenomena observed visually or recorded instrumentally over a given place at a given moment of observation and measurement determines the

category of weather which can have an average and approximately repeatable state from the recent or distant past. This defines weather.

Any obvious and drastic deviation of meteorological elements and phenomena from a certain average state, in meteorological practice, is defined as severe weather. In semantic sense, severe weather represents weather as well, because it refers to the current state of meteorological elements and phenomena of some place in the time of observation and measurements with meteorological instruments. Indicators of measurements show more extreme values in relation to the average states. (Spahic, 2002.)

The division of the weather on bad and good is the oldest determination of weather, where good weather defines clarity, regardless of how it affects the living world for its duration. Any other weather is a bad weather. From bad weather, storms are formed, which is then called severe weather.

Frequent or constant storms or severe weather can affect average weather, and average weather in a place over many years is climate. Therefore it is proper to use term severe weather, instead of climatic disasters, especially climate extremes, because the weather is not climate although the weather and climate are related by the phenomena and processes that occur in the atmosphere with the participation of the Earth's surface as time and climatic factor. Extremes are short and sudden weather changes registered by the dates and they refer to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. (Conrad, 1944) Weather disasters don't have averages, and therefore are not climate, but only weather.

Severe weather also includes those phenomena that are direct or indirect consequence of severe weather: floods, erosion, landslides, avalanches, forest fires and others. Everything stated above points to the arbitrariness in defining the severe weather. Most of them are considered natural hazards or stresses. (Oliver, Hidore, 2002.)

SEVERE WEATHER

Classification of severe weather

Storms are sudden deterioration of the weather in a certain area and have limited duration. Such weather conditions are associated with the state of the atmosphere, in which, because of the convective air flow, accompanied by heavy rain, sudden change in weather from stable to unstable takes place. Storms may occur at the time of stable clear weather as well, which is characterized by long time without precipitation which results in droughts. Drought is another form of severe weather, which is a prolonged period of persistently dry weather (that is, absence of precipitation). Droughts should not be considered as something that occurs in arid geographic zones only, caused by the arid climate.

Severe weather, with the exception of the polar regions, can occur in all geographic zones, but the most in tropical zones. Basically these are short-term intense meteorological phenomena, except droughts that last longer. Although droughts do not develop or progress as quickly as other forms of severe weather, their effects can be just as deadly. Types of severe weather phenomena vary, depending on the latitude, altitude, topography, and atmospheric conditions. Severe weather, as already mentioned, is sudden atmospheric disturbance, which can be defined with: current daily, seasonal and annual character. Thus, the daily storms include: a downpour, tornadoes, waterspouts, late spring and early autumn frost and seasonal severe weather includes droughts, which can last one season, sometimes

even the whole year. The shorter the severe weather lasts, the harder it is to synoptically predict it.

Genetic classification of severe weather is associated exclusively with the state of meteorological elements and phenomena in the troposphere. Severe weather is divided into: cyclogenetic, thermal, frontal and orographic one. Cyclonic severe weather usually generates above the equatorial latitudes and migrates after the solstice Sun position. In this regard, the most vulnerable areas are Amazon rainforest in South America, the Congo basin, the coast of Guinea gulf and Madagascar in Africa, as well as the wider area of South and Southeast Asia. Generation of severe weather in these latitudes predominantly occurs over the warm seas. Areas with most natural disasters per year are Jakarta, with 136 days in the year and Amazon rainforest, with 200 days in a year.

It is stated in climatological literature, the place with the most common number of storms in the world is the place of Bogor in the mountainous parts of Java – average of 322 days during one year. (Spahic, 2002). The frequency of severe weather is increasing in the geographical zone of westerly winds. In this zone, severe weather mainly occurs over the inland area. Storms occur as the consequence of inflow of maritime ocean air on the heated land where the air is heated further. In these areas, from the north, penetrates cold arctic air that forms the cold front, where severe weather occurs. Above the 60 degrees North and South, severe storms generated from cumulus clouds are very rare. Thermal convection storms are particularly expressive above the North American land. They are conditioned by the trajectory of warm and moist maritime air from the south, with a strong heating of the Earth's surface, especially in the Great American Plains area, and the penetration of the continental polar air from the north. The mutual combination of these processes creates strong turbulence and powerful cumulonimbus clouds that develops into tornadoes. Annual distribution of tornadoes indicates the manner of their formation, and is associated with a front of continental polar and maritime tropical air. These phenomena are rarely formed during the winter period. The same goes for the moderate geographical belt over the area of North America. In the southern parts of the continent, especially in Florida, these phenomena can be formed even during the winter time. The largest number of tornadoes occurs in the Mississippi drainage, which is explained by the monotonous lowland relief being open to the Atlantic Ocean, through which oceanic warm air masses flow freely inside the continent.

Frontal and orographic storms are created by the combination of thermal vertical convection caused by the forced uplift of warm and humid air mass over the mountain ranges. In such circumstances, on the windward sides of the mountain intensive thermal convection is created by cooling the air and water vapor condenses all of which collectively generates severe storms.

Severe weather conditions that last longer are usually considered for seasonal ones and they can be typical for chilly and fresh or for hot summers, as well as for mild or harsh winters. On the other hand, same goes for humid and arid seasons. Severe weather has its consequences, generally called weather disasters. Those are defined by the prevailing phenomena, agents and modifiers such as: water, snow, wind, temperature and so on. All of them pose risks to life, property or require the intervention of authorities. Their consequences, among other things, can be dangerous for the elderly and the people suffering from meteoropathy. The sudden atmospheric disturbances include thermal disturbances as well. Those occur when the temperature is extremely low or extremely high compared to normal values. Same goes for decrease of the air pressure below normal, which is registered

as an extreme interdiurnal decline. Normal values are determined by the climate indicators or averages of the specific element or climate phenomena. This is the limit value. Every weather condition which is above or below the established climate average is considered for extreme.

To perceive weather deviations, we commonly use the level of the normality of some of the weather elements and weather phenomena. For this purpose it's used something we call the interval of average size (μ) and standard deviation of a certain meteorological element or phenomena (σ) ie. $\mu \pm \sigma$ (Chapman, 1919). Intervals or variations of basic meteorological elements may differ slightly or considerably from the average. If the deviation is significantly above ($\mu+2\sigma$) or below ($\mu+2\sigma$) limit or standard size, then such weather is defined as severe weather and may have a term value.

Deviation interval of meteorological elements or phenomena from the average values is expressed as *percentiles* which divide distribution of results into 100 parts, wherein each part contains 1% of the result of distribution and are in the range from 1 to 100. Given percentile corresponds to the point of distribution, which gives the corresponding percentage of result up to that point, including the result. The percentile is obtained from the relation:

I=P/ (100 • N) in which:

I represent the position of the desired percentile in the distribution,
P – desired percentile,
N - total number of results in the distribution.

According to their intensity, natural (weather) disasters can be dangerous and catastrophic, and their level is determined by the extent of negative impact they have on population and material goods. They include: downpours, heavy rains and rainfall combined with intense snowmelt, high snow levels, late spring and early autumn frosts, sudden melting of snow, high winds, lightning, hail, thick fog, ice, etc. These phenomena can be catastrophic if they last longer than usual and cover larger territorial areas affecting more river systems in some country or region. Thus, catastrophic weather disasters are classified by the intensity, length, territorial scope, destructive and devastating consequences. Severe weather is formed in certain places, which are directly related to the atmospheric action centers, and if these are not within mentioned areas then they are generated from the cyclone activity and have a trajectory over the most labile geographical surfaces. In both cases, the resulting weather conditions can have harmful effects so they are being synoptically predicted.

To reduce the negative effects caused by severe weather conditions, warnings or alarms are issued, which define specific intervals of intensity of a given element or meteorological phenomena. The intensity of dangerous weather conditions, expressed with high deviation of one or more elements or meteorological phenomena compared to the average standard size is expressed with color alarm, going from non-dangerous ie. green one, through yellow and orange to red one.

Meteorological alarms have its full meaning when they are related to geographic areas of cyclone activity with seasonal character, which is characterized by frequent extreme weather conditions and if there is reliable meteorological forecast. Synoptic conditions are more reliable if those are supported by the dense network of weather monitoring accompanied by the space synoptic recordings of genesis and development of storms over a specific geographic area. On the other hand, wrongly predicted severe storms with various color alarms, can result in unnecessary fear, phobias and adaptive actions taken towards predicted weather conditions by the population in the areas covered by mentioned forecast.

SEVERE WEATHER IN BOSNIA AND HERZEGOVINA

The influence of meteorological factors on the weather conditions in Bosnia and Herzegovina

Severe weather in Bosnia and Herzegovina is defined according to the current state of meteorological elements and phenomena conditioned by the frontal and thermal state of the atmosphere modified by the relief. Climatic position of Bosnia and Herzegovina is defined by the Dinaric morphostructure, whose morphological vertex corresponds with the Adriatic direction of expanding, adjusting Mediterranean influences from the south and southwest, as well as continental ones from the north and northeast.

Since Dinaric morphostructure gradually decreases towards the north, with relief dissection of Sava's tributaries from the territory of Bosnia and Herzegovina, the continental influences are deeper, and therefore much broader compared to Mediterranean ones. The Mediterranean influences are limited with high Dinaric range, which is quite steeply sloped towards the Adriatic Sea, so the territory, which is characterized by the Mediterranean and modified Mediterranean influences, is far narrower.

Regular air circulation is characteristic for Dinaric area, resulting in generation of different moderate climate types over the territory of Bosnia and Herzegovina. Modification of moderate climate from zonal into different azonal types is conditioned by the Dinaric relief assembly. In addition, climate modification determined by the morphological indentedness, exposures, slopes, relief energy and phytographic coverage of Dinaric morphostructure significantly affected the heat capacity of the surface.

Weather, as well as severe weather is highly affected by the distribution of the action centers in the atmosphere and their trajectory. Cyclonic activity over Bosnia and Herzegovina is transferred from the west to the east, and very rarely on the other way around. During the cyclonic transfer over Bosnia and Herzegovina, disorder of barometric conditions arises, which generates a change in the weather. The more expressive the differences between the barometric systems, the more favorable conditions for the occurrence of severe weather. Above the European continent, during one year, 60 to 65 atmospheric depressions are registered lasting several days and each of them can generate severe weather in some part of the corridor of their trajectory.

Weather in Bosnia and Herzegovina is affected by the action centers that may have a secondary character, of which the most common are those that are generated in Biscay and Genoa Bay. When considering the trajectory of cyclonal and anticyclonal activity over Bosnia and Herzegovina, their constituent elements need to be taken into consideration, among which are the most important air fronts and their sectors, as well as their thermal properties. The transition of depressions over Bosnia and Herzegovina rarely goes over the highest Dinaric range, but rather along the river valleys and low terrains. Depressions, beside from the fact that they bring precipitation, they also affect the change of temperature, humidity and cloudiness. When considering severe weather conditions, the most important is precipitation of vertical thermal convection, which is formed on the cold front of polar air mass which, under the influence of the western air flow from the Atlantic Ocean, spreads across our country far to the east. These weather events occur at the beginning and during warm seasons and are reminiscent of the monsoon tendency. (Cene, 1954; Buljan, Zore-Armanda, 1963, Zlatoje, 1965). They occur during the spring and early summer with the activity of Icelandic and Genoese cyclones that have trajectory marked according to the

International meteorological classification with ''V''. Corridor of the cyclone under the 'V'' symbol is divided into sub-corridors Vd and Ve, which include southern parts of Herzegovina and southern part of the Adriatic sea. Increased pluviometric regime is generated in this area in the colder period of the year, from November to April. Part of the territory, geographically treated as Bosnian, is under the influence of the cyclonal branch Vc, which is presented throughout the whole year, especially during the summer.

Table 1. Differences of the thermal regime (^{0}C) during the spring of 2014. , according to the climate average from 1961. – 1990. in Bosnia and Herzegovina

Meteorological stations	March	April	May	Average Spring	Percentiles Spring
Bjelasnica	1,9	1,1	-0,7	0,8	62
Ivan Sedlo	3,2	1,0	-0,8	1,1	76
Average: mountainous Bosnia and Herzegovina	**2,55**	**1,05**	**-0,75**	**0,95**	**68,5**
Sarajevo	3,0	0,8	-0,6	1,0	77
Zanica	3,4	1,5	0,1	1,6	99
Bugojno	3,3	1,6	0,1	1,7	96
Average: continental Bosnia and Herzegovina	**3,23**	**1,3**	**-0,1**	**1,4**	**90,6**
Livno	2,8	1,4	-0,3	1,3	98
Drvar	2,7	1,8	-0,2	1,4	95
Average: modified maritime Bosnia and Herzegovina	**2,6**	**1,6**	**-0,25**	**1,35**	**96,5**
Tuzla	2,9	1,1	-0,3	1,2	88
Gradacac	4,3	1,6	-0,1	1,9	97
Sanski Most	3,2	1,8	-0,1	1,6	97
Bihac	2,9	1,6	-0,2	1,4	93
Average: lowland continental Bosnia and Herzegovina	**3,3**	**1,53**	**-0,18**	**1,23**	**93,75**
Mostar	2,8	1,3	-0,1	1,3	97
Stolac	2,0	1,0	-0,8	0,7	83
Average: modified mediterranean Bosnia and Herzegovina	**2,4**	**1,2**	**-0,45**	**1,0**	**90**

Source: Federal Hydrometeorological Institute of Bosnia and Herzegovina

Beside the prevailing cyclonic transfer from the west defined by the corridor V and its branches, depressed state of the atmosphere is affected by the cyclonic state from the Mediterranean as well, more specifically Genovese Gulf, which, with the eastern trajectory above our area can produce cyclonic forms that result in severe weather. This refers to the combination with summer rainfall of thermal convection with intermittent burst of cold sea air from the Atlantic Ocean, which reminds, as stated before of monsoon tendency or European monsoon. It occurs mainly in late spring and early summer.

Cyclone activity over the area of Bosnia and Herzegovina, espcially during the spring and eary summer can bring heavy rain, which can be harmful and is treated as weather disasters. They are especially intense at the time of increasing of Icelandic and Genoa depression at the expense of the weakening of the Azores anticyclone. Such severe weather hit the Western Balkans in the spring of 2014 and in meteorological practice those are listed as date peaks of rainfall and water levels. In the mentioned period, thermal regime in Bosnia and Herzegovina in comparison with climate standard from 1961. to 1990. was increased and the maximum value was measured in the continental part of Bosnia and Herzegovina

with average of 1,4 ^{0}C, whereas the minumum average was recorded in the mountainous part of Bosnia and Herzegovina with the average of 0,95^{0}C (Table 1).

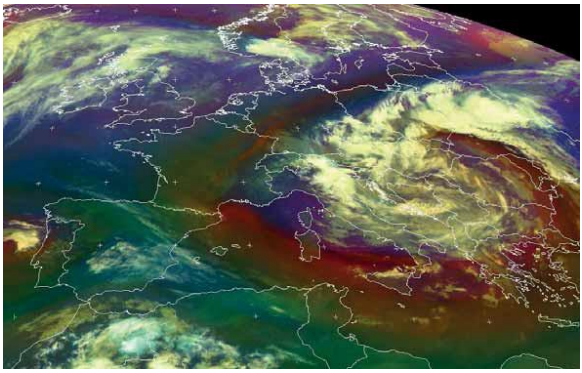

Image nr. 8. Satellite image of the snow storm of the Western Balkans 5/6.03.2015.

The increase in spring temperatures, especially in March and April, caused the pronounced vertical thermal gradient which resulted in creation of low pressure system flooded with Genoa cyclone of moist air from the west-southwest, and limited by the wall of cold polar air mass from the north. (Image 1.) Under such circumstances, new series of downpours were generated, first in the beginning, and then in mid-May. Such weather condition cooled the Earth's surface, so the 2nd decade of May was cooler than the climatological average. Most amplitudes of thermal fluctuations in the negative trend were recorded in the contrasting landscapes of Bosnia and Herzegovina, which affect weather conditions as the modifiers. This synoptic situation resulted in a multiple increase of rainfall in the spring of 2014. compared to the pluviometric climate average in Bosnia and Herzegovina. According to the Table nr. 2, in all areas of Bosnia and Herzegovina, the highest rainfall was recorded, which was exceeding the average registered in the period from 1961. – 1990. several times. Precipitation during April 2014. in Bosnia and Herzegovina, especially in northern parts of the country, was three times higher than the rainiest month of the year.

Table 2. Differences of the pluviometric regime in % of monthly increase and in % of spring average increase in 2014 according to the climate average in the period from 1961. to 1990 in Bosnia and Herzegovina.

Meteorological stations	**March %**	**April %**	**May %**	**average spring %**	**percentiles spring**
Bjelašnica	129,2	264,1	211,1	201,5	99
Ivan Sedlo	105,1	139,4	182,7	130,4	83
Average: mountainous Bosnia and Herzegovina	**117,5**	**201,8**	**196,9**	**166,0**	**91,0**
Sarajevo	95,7	201,6	228,1	178,2	100
Zenica	75,4	329,7	250,9	226,2	100
Bugojno	56,9	238,7	174,8	159,2	100
Average: continental Bosnia and Herzegovina	**76,0**	**256.7**	**217,9**	**187,9**	**100**
Livno	53,9	122,7	135,5	101,2	52
Drvar	71,0	201,6	154,7	144,2	100
Average: modified maritime Bosnia and Herzegovina	**62,5**	**162,2**	**145,1**	**122,7**	**76**
Tuzla	118,5	246,7	369,9	261,8	100
Gradačac	100,0	199,2	322,6	221,7	100
Snaski Most	103,6	257,1	207,5	193,0	100
Bihać	144,6	163,1	171,4	160,5	100

Average: lowland continental Bosnia and Herzegovina	**116,7**	**216,5**	**267.9**	**209,3**	**100**
Mostar	50,8	91,6	95,5	77,1	19
Stolac	62,8	126,9	114,2	99,9	54
Average: modified mediterranean Bosnia and Herzegovina	**56,8**	**109,3**	**104,8**	**88,9**	**36,5**

Source: Federal Hydrometeorological Institute of Bosnia and Herzegovina

April's highest rainfall significantly affected the increase in groundwater levels. This affected increase of the water levels in comparison to the average. Increased rainfall continued in early May of the same year, which resulted in further increase of the water in already wetted grounds, which caused their sliding. The consequences were unprecedented floods and landslides of molasses slopes. These are considered fluvial hazards which generated new relief forms, which have already been discussed in the last issue of this magazine.

DISCUSSION AND CONCLUSION

Severe weather represents only individual events in a series of meteorological data that define the weather. If we accept the definition of climate as a measure of the average pattern of variation in temperature, humidity, air pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time (Han, 1932), then severe weather or weather disasters fall into that category as well. Therefore, weather disasters, produced by the weather extremes, are part of the weather. Meteorological or weather extremes affect the mild climate fluctuations, which are the products of climatic rhythms. Severe weather belongs to weather fluctuations and can't be treated as climatological extremes. Those are characterized by the annual uniqueness. If the extremes of meteorological phenomena and processes are registered in particular climate period, and they have date character, then they can be considered for climatic extremes. Since the severe weather is defined with numerical indicators of meteorological monitoring, then it, in climatic considerations enters the segment of frequencies or incidences of given climatic element. Frequencies in the climate type show how large are the participation of extreme weather values, above or below average, compared to the standard climatic value.

Frequencies of meteorological elements and phenomena, among others, were caused by meteorological factors, especially orographic one in Bosnia and Herzegovina, just like the severe weather. Thus, the air temperatures deviations compared to the average climatological condition are defined with frequencies, and those with frost and summer days which depend on the morphology of the surface. Higher hypsometric morphostructures have an increased frequency of frosty days (days with an average $T < 0^0C$), and thus the possibility of occurrence of extremely low temperatures, which belong to the thermal weather disasters. On the mountain of Bjelasnica, practically there is not even one month, where frosty day was not recorded, and there are average of 192, 8 of frosty days in one year. Lower morphostructures are defined with small number of frosty days, so in Mostar, on average, there are 26.1.

Places with lower altitudes record longer periods where such summer days can occur (days with average daily temperature $T>25^0C$), that can generate severe weather. Usually, high temperatures influence the occurrence of drought, which includes both morphological areas and doesn't have to be conditioned by the relief as a factor of weather. Frequencies of

precipitation are expressed with highest amount of rainfall. They belong to the areas characterized by modified mediterranean or mediterranean pluviometric climate types in Bosnia and Herzegovina, which is 2,4 more compared to the climate average.

Precipitation level from the 2014. was higher than the average highest level of precipitation and in Sarajevo it was 1,6, in Zenica 3,3, and in Tuzla 3,6 time higher etc. Therefore, climatic data, even the highest ones, which are presented by the average, don't have the same importance, as well as they don't belong to the same weather data. This is the reason, why the term climate extremes is not the same as weather extremes, so it is necessary to make a distinction between climate and weather. Climate refers to the weather pattern of a place over a long period, long enough to yield meaningful averages. On the other hand, weather is the condition of the atmosphere at a particular place over a short period of time.

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