
The Influence of the Weather Conditions on Traffic Accidents With the Most Severe Consequences in the Republic of Srpska

Ljubo Glamočić

graduated mechanical engineer, Regulatory Board for Energetics of the Republic of Srpska, Trebinje, ljglamocic@reers.ba

Danislav Drašković

graduated transportation engineer, Paneuropean University Apeiron, Banja Luka, danislavdraskovic@gmail.com

Nikola Torbica

graduated transportation engineer, Agency of the Road Safety of the Republic of Srpska, Banja Luka n.torbica@absrs.org

Received: January 31, 2019

Accepted: April 23, 2019

Abstract: Traffic accidents with the most severe consequences, i.e. killed in traffic accidents and great material damage, are the result of numerous complex impact factors. Among these important factors, there are different time parameters, that is, meteorological parameters. Research on the impact of weather parameters on the occurrence of traffic accidents was the subject of research in the early 70s of the twentieth century. Weather conditions usually have a double impact on the occurrence of traffic accidents such as: the impact on the risk of a traffic accident and the impact on the exposure to the risk of an accident. In other words, it can be said that the time parameters influence directly and indirectly on the safety of traffic, or the occurrence of traffic accidents. Namely, it has been proven that the weather conditions influence the change in the structure of the traffic flow (change of mode of transport), as well as the total number of realized trips. Although the impression is that the impact of weather conditions on the occurrence of traffic accidents is unambiguous and clear, concrete research on the impact of weather conditions is quite rare and the results sometimes differ from the expected ones. Through a review report, a special aspect of the analysis will focus on identifying concrete changes in the characteristics of time, with the aim of recognizing their impact on the number of traffic accidents with the most severe consequences in the Republic of Srpska.

Keywords: traffic accidents, weather conditions, safety on traffic.

INTRODUCTION

Every day more than 3700 die in traffic accidents, which leads an annual 1,35 milion killed in traffic accidents, of this number, almost half are made by vulnerable road users. According to a report from the World Health Organization it is estimated that on the roads in Europe of the total number of dead 27 % dead pedestrians (WHO 2018). Due to this fact traffic accidents have become the main cause of the death and of the bad physical injuries in the countries of the European Union. When it comes to material losses, they amount to 160 milliard of convertible marks even more not counting immaterial losses which include costs of hospital treatment, insurance, sick leave and similarly. For these reasons a certain analysis of traffic accidents with the most severe consequences should contain a detailed analysis of all factors that cause such traffic accidents. The main aim of this analysis is to find out influence factors and to prevent the same in order to reduce the number of traffic accidents and the consequences of these traffic accidents.

LITERARY EXAMINATION

Traffic problems were recognized by scientists from experts of state institutions and many other. *Malenje et al. 2018.* in their work, they investigate unsafe pedestrian crossings and the risks that arise on that occasion. Pedestrian overpasses crossing in unprotected places are very unpredictable with vehicles, in addition to generally hindering the normal flow of vehicles. Drivers must not only anticipate but also react to unpredictable pedestrian procedures to avoid potential pedestrian conflicts. The aim of this paper is to describe the behavior of the driver in the circumstances of an unsafe pedestrian crossing. Results show that pedestrian that cross over to unsafe areas have a negative impact on traffic flows because they are unpredictable congestion and lead to vehicle traffic disruption. Unpredictable crossings can cause traffic accidents when either side misjudges the actions of the other party (whether it is a wrong estimate of the driver or pedestrian). Therefore the work recommends the adoption of additional provisions for pedestrians or

the taking of measures to prevent improper pedestrian behavior of non-compliance with legal provisions.

In their work Uttley et al. 2017. show that ambient light has a significant impact on the risk of injuries to pedestrians at a pedestrian crossing. In the paper itself concluded that the increase in risk is not solely due to the lack of street lighting at the crossings. However, this raises the question of whether the transit lighting is adequate and sufficient to improve the visibility of pedestrians while waiting or crossing the pedestrian crossing. Another factor that can be associated with an increased risk at pedestrian crossings for the dark is trust, which pedestrian can have when deciding to cross and the expected behavior of the driver who is then in the vehicle. The decision to cross the road relies on accurate speed estimation, distance and to the extent of any approaching vehicle. Estimates of pedestrians and drivers will probably be wrong if the low level of illumination at pedestrian crossings. The conclusion of this paper refers to the illumination of pedestrian crossings in particular whether the existing lighting is adequate and whether it could be improved so that the passage would be more visible and the estimates of pedestrians and drivers more precisely.

METHODOLOGY

According to needs of research and analysis of traffic accidents with the most severe consequences, it is observed the entire number of such traffic accidents in the Republic of Srpska at different police departments for the years 2015, 2016 and 2017. The Agency of the Road Safety in the Republic of Srpska provided the detailed information about traffic accidents with the most severe consequences (the number of killed and badly injured people). These traffic accidents are related to weather conditions which are divided into two categories:

- „BAD“, bad weather conditions such as rainy, snowy, icy and cloudy weather
- „GOOD“, good weather conditions such as sunny and clear weather

One of the related factors also was visibility which has an important influence on these traffic accidents and which is also divided into two categories:

- „POOR“, poor visibility during the night, dusk and foggy weather
- „GOOD“, good visibility during the day and clear weather

Traffic accidents are divided into several groups according to the type of accident:

Going off the road, side impact, hitting the pedestrian, driving in the opposite direction⁴. The most frequent accidents that happened are presented in the table. Beside these facts, the most frequent months, during which happened the most traffic accidents with severe consequences, are examined in some police departments. In

the charts below we presented some facts which are gathered from the base of traffic accidents of the Ministry of Interior of the Republic of Srpska, by the Agency of the Road Safety in the Republic of Srpska.

Table 1. Traffic Accidents in Dependence of Weather Conditions During 2017.

POLICE DEPARTMENT	WEATHER CONDITIONS		VISIBILITY		TYPE OF ACCIDENT	
	BAD	GOOD	POOR	GOOD	BAD WEATHER CONDITIONS	GOOD WEATHER CONDITIONS
BANJA LUKA	40	94	26	28	Going off the road	Driving in the opposite direction
GRADIŠKA	11	14	9	9	Going off the road	Going off the road
PRIJEDOR	13	55	13	15	Hitting the pedestrian	Going off the road
MRKONJIĆ GRAD	12	6	5	2	Driving in the opposite direction	Hitting the pedestrian
BIJELJINA	37	54	16	17	Going off the road	Side impact
ZVORNİK	40	21	18	17	Driving in the opposite direction	Going off the road
ISTOČNO SARAJEVO	36	16	23	7	Driving in the opposite direction	Side impact
DOBOJ	65	74	30	34	Driving in the opposite direction	Going off the road
FOČA	18	21	7	2	Going off the road	Going off the road
TREBINJE	18	29	6	5	Going off the road	Going off the road

From the previous chart it is visible that the highest number of traffic accidents occurs in police departments of Doboј and Banja Luka but it must be emphasized that in both police departments the number of traffic accidents is lower during the bad weather conditions and it is especially expressed in the police department of Banja Luka. Other police departments of Gradiška, Prijedor, Bijeljina, which are placed at lower elevation (flat areas), also have the lower number of traffic accidents during the bad weather conditions than during the good weather conditions. It is also noticed that the number of traffic accidents in all police departments placed at higher elevation (hilly and mountainous areas of Mrkonjić Grad, Zvornik and Istočno Sarajevo) is higher during the bad weather conditions.

It can be stated that during the year 2016 the number of traffic accidents with the most severe consequences is the highest on the territory of Banja Luka and Doboј police departments and that the number of traffic accidents with the most severe consequences is approximately the same during the bad and good weather conditions on the territory of all police departments. It can also be stated that the number of traffic accidents is approximately the same on the territory of Gradiška, Prijedor and Bijeljina police departments. During the years 2017 and 2016 the number of traffic accidents, in the areas at higher elevation, is higher during the bad weather conditions in comparison to periods of good weather conditions (Zvornik, Istočno Sarajevo and Foča).

Table 2. Traffic Accidents in Dependence of Weather Conditions During 2016.

POLICE DEPARTMENT	WEATHER CONDITONS		VISIBILITY		TYPE OF ACCIDENT	
	BAD	GOOD	POOR	GOOD	BAD WEATHER CONDITONS	GOOD WEATHER CONDITONS
BANJA LUKA	94	95	50	33	Going off the road	Driving in the opposite direction
GRADIŠKA	26	29	19	6	Going off the road	Going off the road
PRIJEDOR	33	40	19	13	Going off the road	Going off the road
MRKONJIĆ GRAD	19	20	5	16	Going off the road	Going off the road
BIJELJINA	29	63	12	21	Side impact	Going off the road
ZVORNIK	43	31	18	9	Driving in the opposite direction	Side impact
ISTOČNO SARAJEVO	46	31	19	12	Driving in the opposite direction	Side impact
DOBOJ	61	77	32	34	Driving in the opposite direction	Going off the road
FOČA	33	11	11	4	Driving in the opposite direction	Hitting the pedestrian
TREBINJE	26	24	6	8	Going off the road	Going off the road

Table 3. Traffic Accidents in Dependence of Weather Conditons During 2015.

POLICE DEPARTMENT	WEATHER CONDITIONS		VISIBILITY		TYPE OF ACCIDENTS	
	BAD	GOOD	POOR	GOOD	BAD WEATHER CONDITIONS	GOOD WEATHER CONDITIONS
BANJA LUKA	105	122	58	49	Going off the road	Driving in the opposite direction
GRADIŠKA	28	29	22	8	Going off the road	Going off the road
PRIJEDOR	36	56	15	22	Hitting the pedestrian	Going off the road
MRKONJIĆ GRAD	8	15	5	7	Going off the road	Going off the road
BIJELJINA	23	64	13	23	Side impact	Side impact
ZVORNIK	44	31	15	9	Side impact	Side impact
ISTOČNO SARAJEVO	64	45	16	12	Driving in the opposite directin	Going off the road
DOBOJ	78	82	42	23	Going off the road	Going off the road
FOČA	20	4	9	0	Going off the road	Going off the road
TREBINJE	14	39	7	13	Going of the road	Going off the road
BANJA LUKA	105	122	58	49	Going off the road	Driving in the opposite direction

From the previous chart it is visible that in all police departments which are placed at higher elevation (Zvornik, Istočno Sarajevo, Foča), the number of traffic accidents is higher during the bad weather conditions but according to the type of accident facts are not matching with the previous two years. More precisely during

the year 2015 according to the type of accident in Zvornik and Foča police departments, the most dominant traffic accidents are going off the road and side impact whereas in Istočno Sarajevo according to the type of accident, facts are matching with previous two years and the most dominant type is driving in the opposite direction.

In the next chart the most dominant months, during which traffic accidents with the most severe consequences occur, are shown and assigned to police departments for the years 2015, 2016 and 2017.

Table 4. Traffic Accidents in Dependence of Weather Conditions During 2015, 2016 and 2017.

POLICE DEPARTMENT	MONTH
BANJA LUKA	JUNE, DECEMBER
GRADIŠKA	MAY, JULY
PRIJEDOR	AUGUST
MRKONJIĆ GRAD	AUGUST, APRIL, MAY
BIJELJINA	SEPTEMBER, NOVEMBER
ZVORNIK	JULY, MAY
ISTOČNO SARAJEVO	MAY, NOVEMBER, JUNE
DOBOJ	OCTOBER, DECEMBER
FOČA	MAY, JUNE, AUGUST, DECEMBER, JANUARY
TREBINJE	MAY, AUGUST, JULY

In chart 4 it is presented the review of the most dominant months during which traffic accidents with the most severe consequences occurred, divided according to three observed years and according to certain police departments. It is obviously that in the highest number of police departments, during all three observed years, the number of traffic accidents with the most severe consequences occurred during one or two months (Prijeedor, Banja Luka, Gradiška, Bijeljina, Zvornik and Doboj).

The main distractions which can occur during the research are distractions which refer to accidents with light injuries and material damage which are not included by this research. There are also restrictions in database which refer to insufficient possibilities to filter the data and to include other factors which refer to traffic accidents.

RESULTS

Analysis of facts about the most serious traffic accidents for the last three years has shown that in flat areas i.e. areas at lower elevation, there are more traffic accidents with more severe consequences during the good weather conditions i.e. when it is sunny, clear weather etc. Whereas in mountainous areas i.e. areas at higher elevation, there are more traffic accidents with the most severe consequences during the bad weather conditions which is shown on diagrams (diagram 1; diagram2; diagram 3).

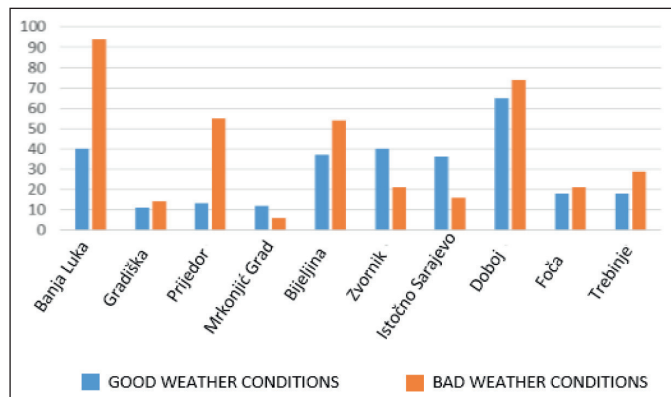


Figure 1. Traffic Accidents With Killed and Badly Injured People During 2017.

On previous diagram we can see that during the good weather conditions the most dominant police departments are Banja Luka and Doboj police departments and during the bad weather conditions the most dominant is Doboj police department.

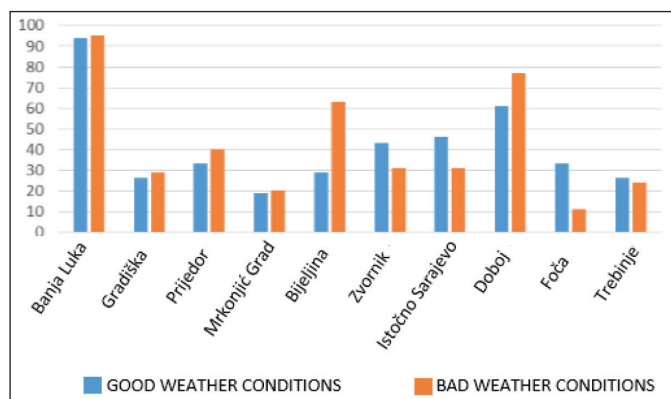


Figure 2. Traffic Accidents With Killed and Badly Injured People During 2016.

On diagram 2 we can see that during the good weather conditions the most dominant are Banja Luka, Doboj and Bijeljina police departments, whereas during the bad weather conditions the most dominant are Banja Luka, Doboj, Zvornik and Istočno Sarajevo police departments.

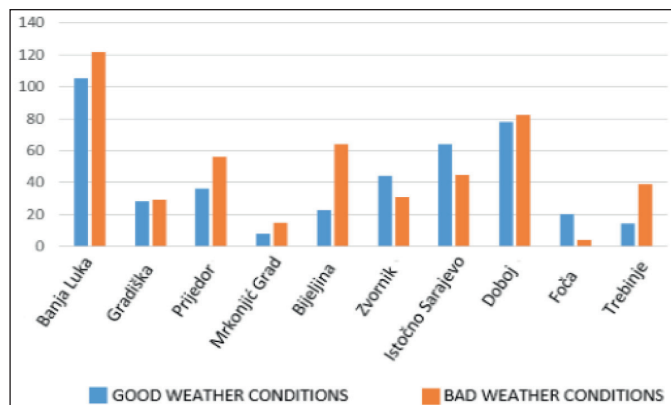


Figure 3. Traffic Accidents With Killed and Badly Injured People During 2015.

On diagram 3 we can see that during the good weather conditions the most dominant are Banja Luka, Doboj and Bijeljina police departments and during the bad weather conditions the most dominant are Banja Luka, Doboj and Istočno Sarajevo police departments.

The highest number of traffic accidents, according to the shown diagrams, occurs in Banja Luka police department. This number can be seen as something which is in accordance with the number of population because Banja Luka police department, in comparison with other police departments, has the considerably higher number of population and therefore the number of traffic accidents can be higher.

From the analysis of the most dominant months during which occurred the highest number of traffic accidents with the most severe accidents, for all three years, it can be seen that the highest number of these accidents occurred during the period of good weather conditions, that is during the period of strong weather changes that is when winter driving conditions change to summer driving conditions (May) and when summer driving conditions change to winter driving conditions (October).

DISCUSSION

Climate conditions are very important factor for a safe traffic. These factors influence the elements of a safe traffic on roads. Climate conditions have two kinds of the influence which are connected to the traffic accidents.

- They influence the human health and mood: Besides many researches into the influence of the climate conditions on humans, it is not still explained completely how the weather conditions influence the human body and mood. Although there is a connection between the climates conditions, human health, human mood and traffic accidents.
- They influence the change of the outside conditions of the traffic: Climate conditions can cause the change of the outside conditions of the traffic which can cause problems for traffic participants. Connection between climate conditions which influence the change of the outside conditions of the traffic and between the traffic accidents is obvious but it is not still completely examined how much the climate conditions influence the number of traffic accidents and the consequences of the traffic accidents. To get a more complete answer it is necessary to do systematic researches on different roads during different climate conditions. When we establish how the climate conditions cause the traffic accidents, we must keep in mind that these conditions are different in certain areas because of the

geographical position.

Both bad weather conditions (snow, ice, rain etc.) and good weather conditions (sunny, clear weather etc.) can have the negative influence on the traffic accidents. If we observe all traffic accidents (material damage, light physical injuries, bad physical injuries and killed people), we can conclude that bad weather conditions considerably contribute to higher number of traffic accidents. However if we observe the most severe consequences of traffic accidents (bad physical injuries and killed people), good weather conditions are more dominant than bad weather conditions i.e. the higher number of traffic accidents with the most severe consequences occurs during the good weather conditions and it is mostly connected to areas at lower elevation i.e. to flat areas. When it is about geographical regions, the bad weather conditions are more dominant than the good weather conditions in the areas at high elevation i. e. more traffic accidents with the most severe consequences occur during the bad weather conditions.

The good weather conditions and higher number of traffic accidents with the most severe consequences can be connected to the vehicle speed and to the carelessness of drivers because the most dominant type of accidents during the good weather conditions is going off the road of the vehicle because of the maladjusted vehicle speed to road conditions. During the good weather conditions, drivers are usually less careful and they are also full of self-confidence and they move faster thus they have a tendency to behave risky and therefore they provoke the traffic accidents with the most severe accidents.

Thus the bad weather conditions connected to elevation also influence the higher number of the traffic accidents with the most severe consequences. According to the type of accident during the bad weather conditions, the most dominant ones are accidents during the driving in the opposite direction and they are followed by poor visibility. These accidents can be connected to the action of passing of a moving vehicle during which drivers start passing another vehicle but because of poor visibility they are not able to estimate whether they have enough space or time to finish the started action. Also these accidents can be connected to bad conditions on roads (ice, snow, rain etc.) which can cause the loss of the vehicle control and passing on the opposite side of the road.

CONCLUSION

This work draws attention to the particularly vulnerable in the category of participants in traffic (pedestrian). Data analysis defines indicators indicating who makes mistakes that are most commonly mistakes in what area under what conditions and for which such types of traffic accidents arise. On the basis of this, certain conclusions and measures have to be taken to mini-

mize the number of such traffic accidents and increase the safety of traffic primarily vulnerable participants in traffic or pedestrians. The inclusion of all institutions of the Republic of Srpska primarily by the institutions dealing with traffic plays a key role in solving this problem. The Traffic safety agency Republic of Srpska as a key factor in coordination with all interested institutions to local government units for governmental and non-governmental organizations and all other entities that are interested in participating and work on improving traffic safety should animate these institutions. Initiation of the Republic of Srpska Ministry of internal affairs for the harmonization of repression measure with a joint preventive action plan is the first step that in the months that are marked as critical for vulnerable road users, they have increased control of pedestrians, especially in segments of light reflective vests and pedestrian movement. Also the institute for Adult education of Republic of Srpska suggest that the problem of vulnerable participants in pedestrian traffic and the way in which they can contribute to solving this problem or what measures can they take in the driver's training so that drivers are ready for situations that they can encounter in traffic and they are tied to pedestrians. When implementing preventive activities, other institutions that can have a significant impact on the population of pedestrians should be animated. To carry out education in the framework of preventive activities how youngest participants in traffic are students from the first to the fifth grade as well as students from the fifth to ninth grade of the elementary school with suggestions on dangerous situations arising from the analysis of the data (suggesting the adapted age of the students).

LITERATURE

- [1] Agency of the Road Safety of the Republic Serbia, (March 2016), *the Impact of the Weather Conditions on Traffic Accidents*.
- [2] Bergel R., Debarh M., Antoniou c., Yanis G., (2003). *Explaining the Road Accidentrisk: WEATHER EFFECTS*, Accident Analysis and Prevention.
- [3] Davidović S., Milošević D., (2015) Banja Luka, *The Influence of the Environmental Factors on Traffic Accidents on the Territory of Banja Luka in 2015*.
- [4] Madžovski M., Divac N., Miletić D., (2015). *Kragujevac The Impact of the Weather Conditions on the Traffic Accidents on the Territory of Belgrade during the longer Time Period*.
- [5] Malenje, J., O., Zhao, J., Li, P., Han, Y. (2018) *An extended car-following model with the consideration of the illegal pedestrian crossing.*, United States.
- [6] Uttley, J., Fotios, S., (2017) *The effect of ambient light condition on road traffic collisions involving pedestrians on pedestrian crossings*, School of Architecture, University of Sheffield, Western Bank, Sheffield S10 2TN, United Kingdom