

## **Weather conditions influence on traffic crashes in the Republic of Serbia**

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**Abstract:** In this paper were analyzed traffic crashes in the Republic of Serbia that occurred as a result of unfavorable weather conditions. A total of 6,875 crashes were analyzed for the period from 2015 to 2023. The aim of this paper is to determine which of the sub-factors has the greatest influence on the number of traffic crashes. The analysis includes three parameters: slippery pavement, the impact of snow, rain, fog, etc., on visibility and the blinding of the driver by sunlight. The research showed that the slippery road has the greatest influence, as a factor that primarily affects the vehicle's controllability. Accordingly, the authors advise regular inspection and cleaning of the pavement, especially after snow and rain.

**Keywords:** traffic crashes, weather, slippery road, visibility, precipitation

### **Introduction**

The occurrence of traffic crashes can be related to various factors: external or internal. Four groups of influential factors are recognized in the literature: human, vehicle, road and

environment (Lipovac, 2016). Each of these elements contains a large number of sub-factors that influence the occurrence of traffic crashes to a greater or lesser extent.

In this paper, the impact of an external factor - the environment, namely weather conditions - on the occurrence of traffic accidents is analyzed. Weather conditions can be different, and for the purposes of this paper they are categorized into two groups: unfavorable weather conditions that have an effect primarily on the vehicle and its handling: rain, snow, ice, etc., and weather conditions that have an effect primarily on the driver: rain, snow, fog (from the aspect of visibility), as well as the blinding of the driver by sunlight.

A large number of authors have investigated the influence of weather conditions on traffic crashes. For example, in Finland, it was shown that the biggest influence has: hail and any weather that affects the appearance of slippery and very slippery pavement (Malin, Norros and Innamaa, 2019). According to the division defined in this paper, the mentioned impacts fall into the first category (impact on the vehicle). On the other hand, in Iran it has been shown that extreme cold, high temperatures and high air humidity have the greatest impact on traffic accidents (Eltemasi and Behtooiey, 2024). These influences can be classified in the second category (influence on human). In Greece (Athens), it was shown that the number of traffic crashes increases linearly with the increase in rain intensity (Theofilatos, 2019). This factor is very interesting because it can equally affect both the vehicle (by reducing friction due to aquaplaning) and the driver (by reducing visibility due to heavy rain). In the USA (Nebraska) it was shown that smaller amounts of snow on the road have the greatest impact on the occurrence of traffic crashes (Walker *et al.*, 2024), which is why the importance of regular cleaning and maintenance of roadways is emphasized.

In this paper was performed an analysis of traffic crashes in the Republic of Serbia that occurred as a result of unfavorable weather conditions. The aim of this paper is to determine which sub-factor within the environment element (weather conditions) has the greatest influence on the number of traffic crashes.

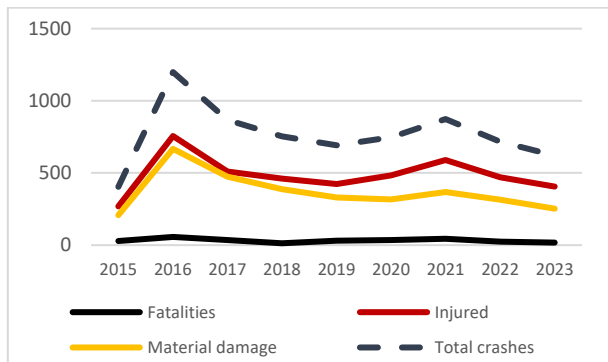
## **Methods and data**

For the purposes of this paper, an analysis of traffic crashes in the territory of the Republic of Serbia was performed, which occurred as a result of unfavorable weather conditions. The data used in this paper were taken from the website of the Road Traffic Safety Agency - Integrated database on traffic safety characteristics (<http://bazabs.abs.gov.rs/absPortal/>). The data covers the period from 2015 to 2023, during which 6,875 traffic crashes were recorded as a result of unfavorable weather conditions. All influential factors from the base, which are related to weather conditions, are included, namely: slippery pavement (result of precipitation), influence of rain, snow, fog, etc., on driver's visibility and influence of driver's blindness from the sun. Data were processed in the Excel software package, using standard statistical methods.

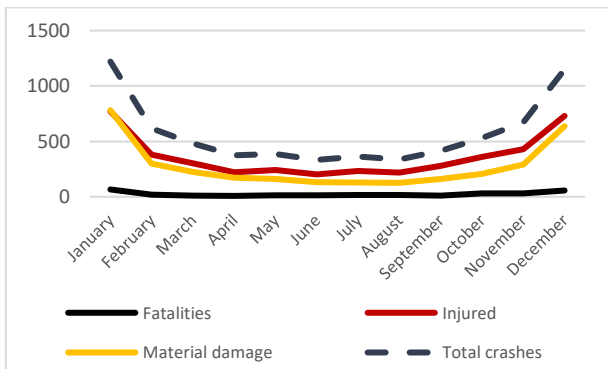
## **Results, discussion and conclusion**

For the purposes of this paper, traffic crashes were analyzed by type: total number of traffic accidents (6,875), number of fatalities (289), injuries (4,366) and material damage (3,317). Figures 1 and 2 show crashes by year and by month. It is interesting to note that the highest annual number of crashes was recorded in 2016, and then in 2021. The results obtained for 2021 are partly unexpected, considering the emergence of the COVID-19 pandemic, as well as the trend that during that period

the number of crashes in cities decreased, taking into account the closure of cities, restrictions on movement etc. (Escorcia Hernández *et al.*, 2023). On the other hand, it is quite clear why January and December are the months with the highest number of crashes: the winter period, with worse weather conditions, but also a higher vehicles flow due to the holiday season, which is consistent with other similar research (Seeherman and Liu, 2015).



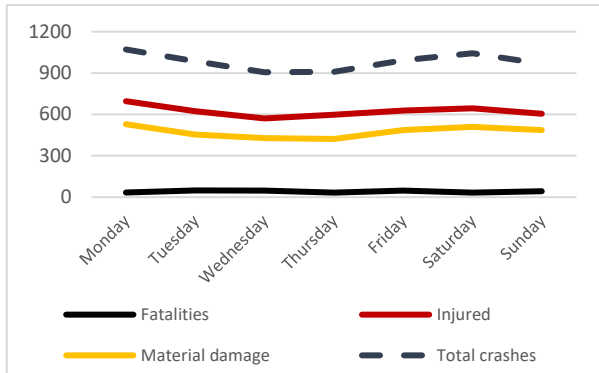
**Figure 1.** Traffic crashed by year



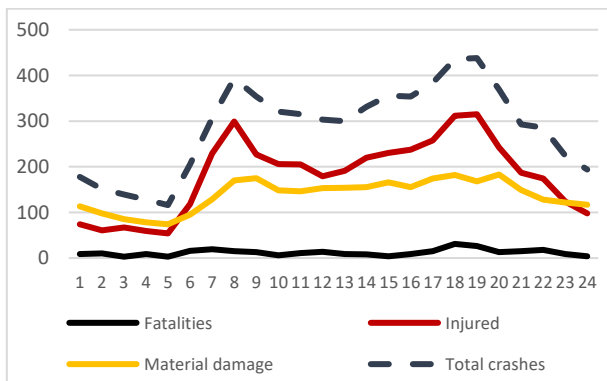
**Figure 2.** Traffic crashed by month

Figures 3 and 4 show the number of crashes by day and hour. The results coincide with the general trends of the occurrence of traffic crashes, which indicate that they most often

occur during Monday (the first working day), Friday and Saturday (the beginning of the first day of the weekend), as well as during peak hours (from 6 a.m. to 9 a.m. morning peak hour and from 5 p.m. to 8 p.m. evening peak hour), when the vehicle flow is the highest.

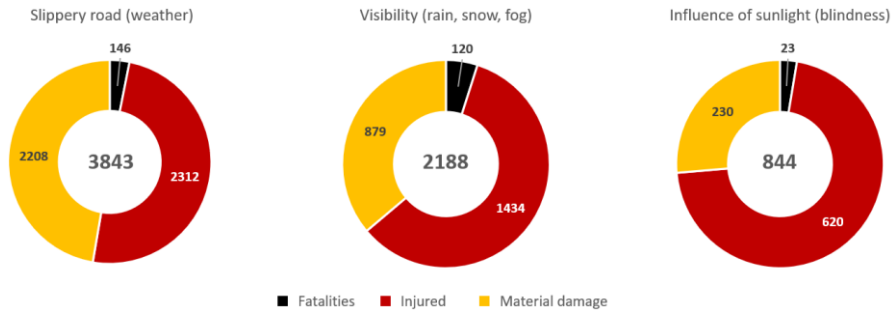


**Figure 3.** Traffic crashed by day



**Figure 4.** Traffic crashed by hour

Figure 5 shows the number and type of crashes in relation to the cause. In the middle of the circle is shown the total number of traffic crashes for each cause. As can be seen from Figure 5, the largest number of crashes (3843) and their consequences were recorded as the cause of slippery pavement (most often the result of rain and ice).



**Figure 5.** Traffic crashes by the cause

Such results coincide the results of other researches, where slippery pavement was also observed as one of the main causes of traffic crashes, especially among young people. (Jonghak *et al.*, 2018; Eboli and Forciniti, 2020). Another cause of traffic crashes is reduced visibility (2188), as a result of unfavorable weather conditions: rain, snow, fog, etc. In the end, the blinding of the driver due to the influence of the sun in the total number of traffic crashes takes 12.3%, that is, 844 traffic crashes occurred as a result of the driver's blinding.

Based on the above, it can be concluded that slippery pavement is one of the most common causes of traffic crashes in Serbia. Accordingly, the author suggests regular maintenance and cleaning of roads, as well as timely and adequate notification of users (with traffic signalization) about the state of the roadway in real time.

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