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TEMPORAL ANALYSIS OF THE TRAFFIC ACCIDENTS OCCURENCE IN PROVINCE OF VOJVODINA

Summary. In the analysis of a different process or events it is necessary to position them in the coordinate system space-time. Space analysis is an easily understandable and less abstract method, so this is one of the reasons why it is more often subject of research. Genesis of traffic accidents can be viewed as a continuous random process and as such, regardless of the accidents happening in the real world, it must be viewed with a temporal aspect. This kind of analysis is important especially if we know that we are making decision and do in time.

The main idea of this paper is to cross the number of traffic accidents with killed and injured in Province of Vojvodina (period 2001-2009) from different time aspect and try to identify for example critical day and hour, or month and day. After this analysis this results are inputs for visualization and time maps. Basic aim of this paper is to emphasize and show temporal analysis as a method for visualization and searching specified patterns in time for decision making process.

CZASOWE ANALIZY WYPADKÓW W RUCHU WYSTĘPUJĄCYCH W PROWINCJI VOJVODINA

Streszczenie. W analizach różnych procesów lub wydarzeń konieczne jest umieszczenie ich w skoordynowanym systemie przestrzeń – czas. Analizy przestrzeni są łatwe do zrozumienia i są metodą mniej abstrakcyjną, więc jest to jednym z powodów tego, że częściej są obiektem badań. Geneza wypadków w ruchu może być widziana jako ciągły, przypadkowy proces i bez względu na rodzaj wypadku, musi być tu rozpatrywany jako aspekt czasowy. Ten rodzaj analizy jest ważny, zwłaszcza jeśli wiemy, iż podejmujemy decyzję i realizujemy ją w czasie.

Główną ideą tej pracy jest przekroczenie liczby wypadków w ruchu z zabitymi i rannymi w prowincji Vojvodina (okres czasu: 2001-2009) z różnego rodzaju aspektów czasowych by zidentyfikować na przykład krytyczny dzień i godzinę lub miesiąc i dzień. Po tej analizie rezultaty są wizualizowane i umieszczane w mapach czasowych. Podstawowym celem tego artykułu jest położenie nacisku oraz pokazanie czasowych analiz jako metody zobrazowania i poszukiwania określonych wzorców dla decyzji tworzących proces.

1. INTRODUCTION

The main tasks of experts in the field of traffic safety are studying and analysing cause and effect of traffic accidents, because their main aim is to give measure how to reduce the number of traffic accidents and its casualties. In area of traffic safety research there are different types of analysis

between dependent and independent variables. Some studies have concentrated on finding where crashes occur most frequently, such as spatial hot-spots using spatial autocorrelation methods such as Getis-Ord Gi [1-3]. Much research effort has been spent on different researches, but only limited research has been carried out to investigate the spatial and temporal patterns of traffic accidents at different scale levels [4]. Experts applied some kind of temporal analysis on the data of traffic accident or injured in traffic accident over time period. The unit of observation is a point or period in time (hour, day, month, and year). Peltzman (1975) gave one of the first examples of a traffic safety analysis on the basis of accident risk, taking development over time into account [7]. This is because temporal analysis is abstract and it is not in first plan during analysis. In analysis of traffic accidents and its consequences, the Kernel density estimation will calculate the density of vehicle crashes around each individual vehicle crash [6-7]. The Kernel density method is one of the most common and well-established methods used to identify spatial patterns. The density of traffic accidents for each pixel in the output raster is calculated by counting the number of crashes in a defined region, or kernel, surrounding the particular pixel [8]. The main difference between spatial and temporal analysis is that spatial is statics and it is based on positioning and counting number of traffic accident on define space, but temporal analyse is dynamic process because it required tracking and positioning occurrences in abstract dynamic dimension The problem in previous research is that methods for identification and visualization temporal black spot is not adequately examined. Also temporal aspect is based on time series and its tools for easily conducting. Numbers of daily accidents fluctuate according to an interaction between traffic volumes, weekday travel patterns, holidays, weather and another factor. There have also been numerous studies examining specific factors affecting changes in motor vehicle accidents and fatalities over time. Many of these have analyzed year-to-year changes, often for entire countries or states (Zlatoper 1984, 1989; Whitfield and Fife 1987; Partyka 1984, 1991; Broughton 1991; Oppe 1991; Chang and Graham 1993). Typically, the effect of policies, economic change, and societal conditions on the risks of accidents and fatalities are examined. There have also been many studies which have looked at changes in accidents and fatality levels from month to-month (e.g. Lassarre 1986; Scott 1986; Golob, Reeker, and Levine 1990; Fridstrom and Ingebrigtsen 1991; Keeler 1994) [9]. The main aim of these studies is to establish general time pattern and defined model. Time series is very useful tool for a first step in the process of identification and selection the shape of distribution. Detailed discussions of the methods about times series can be found in papers of different researchers in this field of mathematics. Between 1950s and 1960s Brown (1959, 1963), Holt (1957, reprinted 2004), and Winters (1960). Pegels (1969) provided classification of the trend and the seasonal patterns depending on whether they are additive (linear) or multiplicative (nonlinear). The most common example of time series used in road safety analysis is the annual or monthly number of accident or fatalities in some country. Time series analysis can be used to quantitatively describe, explain, and predict road safety developments. Researchers may choose one of several techniques for the analysis of time series. If we want to look ahead and find out the future number of accident we need to apply some of the forecasting technique. For prediction a future number of traffic accidents time series is very useful tools, because it could help experts to find out seasonal change, stationary or non-stationary series and applied some accident-forecasting models [10].

In this paper it will be shown fluctuation of traffic accident at different temporal scales, such as hourly, daily, and monthly. The main idea is to emphasise that time should be a first step in traffic safety analysis. The main idea is to cross more of this data from different time aspect and try to identify for example critical day and hour, or month and day. After this analysis these results are inputs for visualization and time maps.

2. METHOD OF THE WORK

This paper is based on data obtained from police reports on registered car accidents for Province of Vojvodina and only for accidents which occured in the period from 2001 to 2009. The years from 1998 to 2000 is not taken into consideration because of NATO bombing, these years step away from other years and because of that it is not presented for analysis. We applied statistical, analytical and

cassification method. MS Excel software programme was used for processing and graphical presentation of data.

3. THE OUTLINE OF THE MOST SIGNIFICANT RESEARCH RESULTS

Methods to identify and visualise temporal hot-spots (i.e. times when crash frequency is particularly high) have not been adequately examined in previous research [11]. These temporal studies had tendency to focus on the fluctuation of the number of accidents at different temporal scales, such as hourly, daily, monthly, and yearly [12-13]. In previous paper temporal analysis results were mainly presented in table form or line graphs. Instead this kind of representing data, spider plots can be better solution for illustrating the chronological nature of the temporal data and highlight the temporal hot-spots. In this way it would understand better the change of traffic accident over time. Plug and other in their paper applied visualisation techniques to investigate spatial and temporal structures of single vehicle crashes at different scale levels. Spatial zooming theory was applied to understand the scale issues of single vehicle crashes, and spider plots, Kernel density estimation and Comap were used to identify single vehicle crashes patterns [8].

In this paper temporal analyses were performed using spider plots. In Province of Vojvodina number of traffic accidents with killed and injured is 40,316 for period 2001 to 2009 (Fig. 1). From this plot it is easier to see that the number of accident has growing trend from February to May, after then decreases slightly to September, and after then reach maximum in October. Also, it can be seen that in the second part of the year (from July to January) number of traffic accident fluctuating between 1,500 and 2,000 which is higher than for the first part of year when number of traffic accidents is significantly lower for all year (Fig 1).

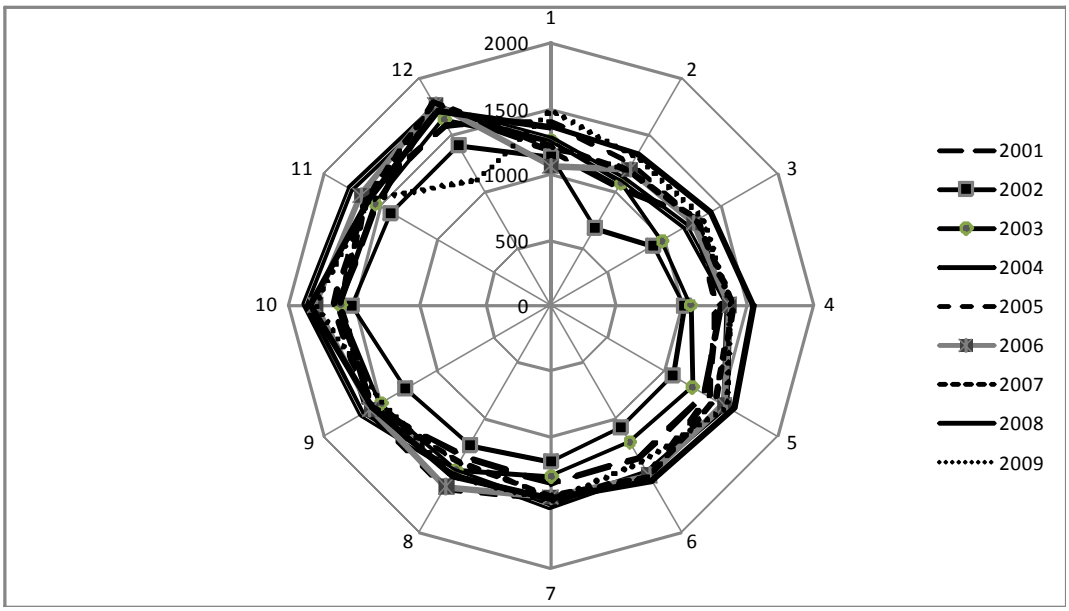

Fig. 1. Number of traffic accidents per month, Province of Vojvodina, period 2001-2009
Rys. 1. Liczba wypadków drogowych w miesiącu, prowincja Vojvodina, okres 2001-2009

In temporal analysis there is a problem with visualisation if we want to show more than two values of parameter. If we analysed number of traffic accident for all period of year per day and hour, we see that number of accident is rising from 6 a.m. to 7 p.m., and after that it significantly decreases. Also, the number of accident is the smallest at working day during night (between 3 and 5 o'clock in the morning). The weekend (day) is also very interesting especially in the night (between midnight and 5 o'clock in the morning) because the number of accident is higher than in every other working day (Fig 2).

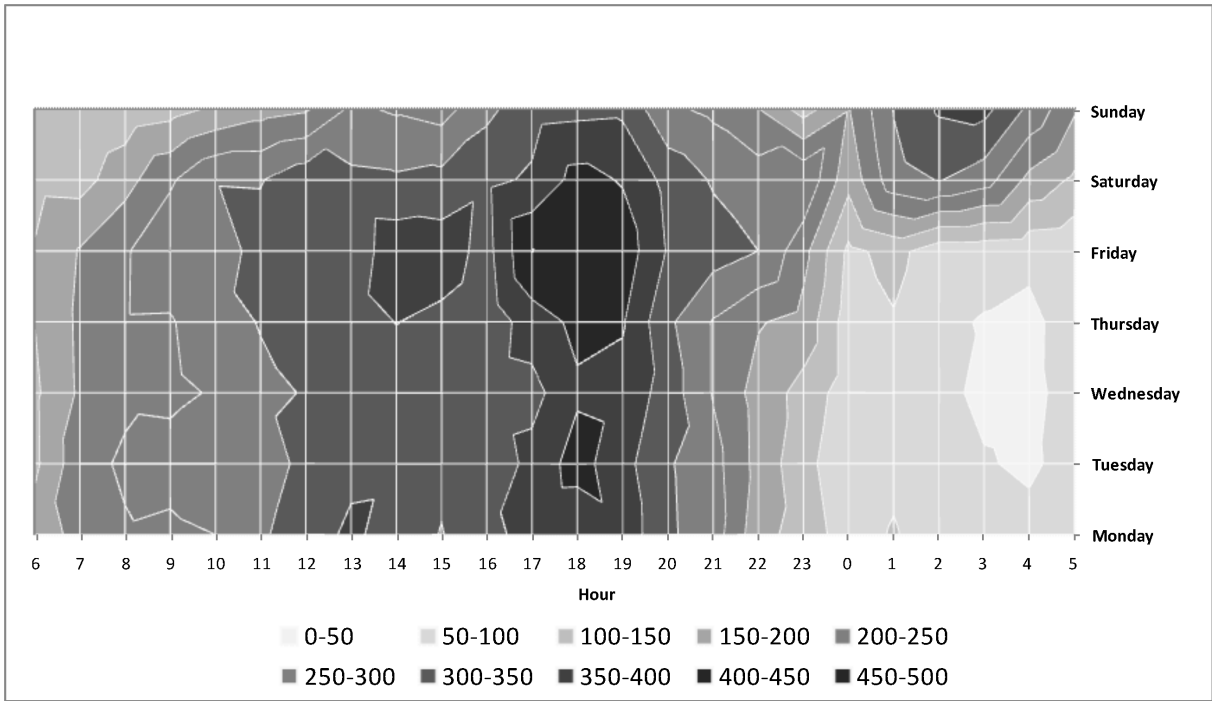

Fig. 2. Number of traffic accidents with killed and injured per day and hour, Province of Vojvodina, period 2001-2009

Rys. 2. Liczba wypadków drogowych z zabitymi i rannymi na dzień i godzinę, prowincja Vojvodina, okres 2001-2009

From Figure 2 it could be noticed that there are a lot of differences between daily and hourly distribution of traffic accidents per month. This analyse can be a first step in decision making process. But there are a lot of spaces for advancement in visualization. It is very important to see this distribution is the same for all the month of year and find out the difference. It is very important to identify critical hour and day in each month. From Figure 3 and 4 it can be seen that distribution of traffic accidents is similar for January and February when the largest number of accident happened between 5 p.m. and 8 p.m. for each day of week, and also it could be noticed for March and April that the contour of darker field spread between 2 p.m. and 8 p.m. Also this is not equal for every day of the week.

Distribution of the number of traffic accidents with killed and injured per months is similar for May and June from the aspect of hour, but if we look at daily distribution it could be noticed that there is a difference for Sunday when the critical period for May is from 12 to 9 p.m., while in June it is from 6 p.m. to 8 p.m. and also in the morning hours between 1 a.m. to 4 a.m. August is a specific month because it is noticeably higher number of accidents between 9 a.m. to 10 p.m. during working days and Saturday, while on Sunday there is also visible the higher number of accidents between 1 and 4 o'clock in the morning. In September and October there is a peak between 6 p.m. and 7 p.m. while this situation is similar for November and December but between 4 p.m. and 6 p.m. (twilight). Increase of number of accidents that occurred during the weekend night is a common characteristic for the entire month (Fig 3 and 4). These critical hours and days could be an important indicator for deeper analyse if we want to find out why the number of accidents in that period of time is the largest.

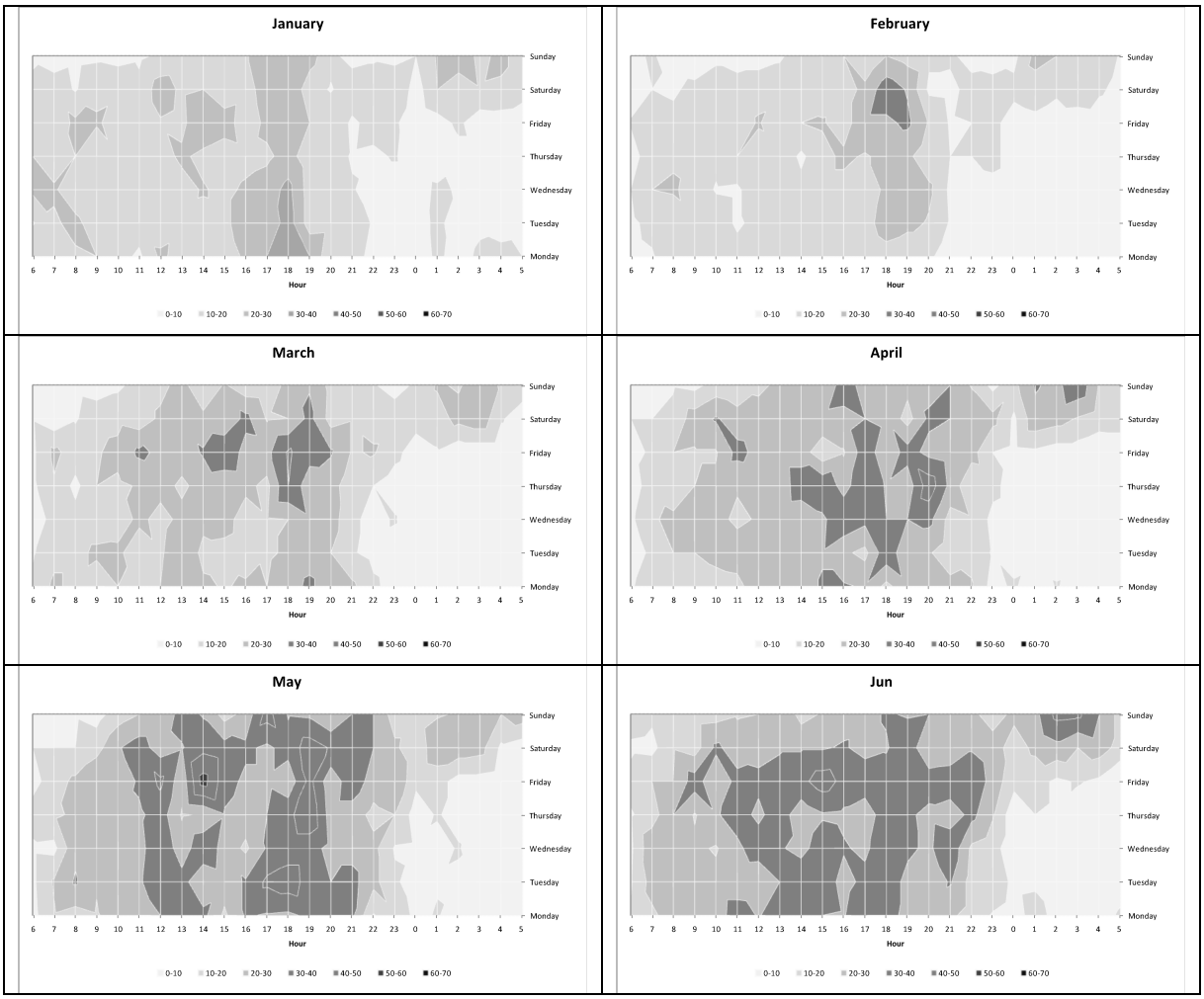

Fig. 3. Number of traffic accidents with killed and injured per months, Province of Vojvodina, period 2001-2009
Rys. 3. Liczba wypadków drogowych z zabitymi i rannymi na miesiąc, prowincja Vojvodina, okres 2001-2009

4. CONCLUSION

The primary goal of this paper was to emphasise the importance of temporal analysis and to show results if we cross three or four time variables. This temporal accident information would be helpful for making decision process which interventions such as improved signs, drink driving control, improvements for school zones, pedestrians and cyclists, and improved infrastructure in highways could be done to improve traffic safety in some regions or roads. From results we can conclude that time mapping is very important. The result for space analysis is always the same because we have two or three dimensions. Temporal analyse is different because if we change the angle of view, in other view, if we cross different time unit we will get different time maps. Analyse shown upper can be improve and we will get more precise results if we do temporal analyse (per year, month, day, hour) for different road users (pedestrians, passengers, drivers, motorcyclists), different age categories (children, youth, oldest), for different type of accident (head on collision, run off, sideswipe rear on collision, collision with parked MV) and other. In this way we can make maps for example critical months, day and hour for pedestrian. This time map is very useful tool and can be often used to visualize phenomena in traffic that change over time. From these maps it is possible to compare values at different point in time and searching specified patterns. Time mapping as the modelling approach in analysis of traffic safety should find an important place for all kind of temporal analysis.

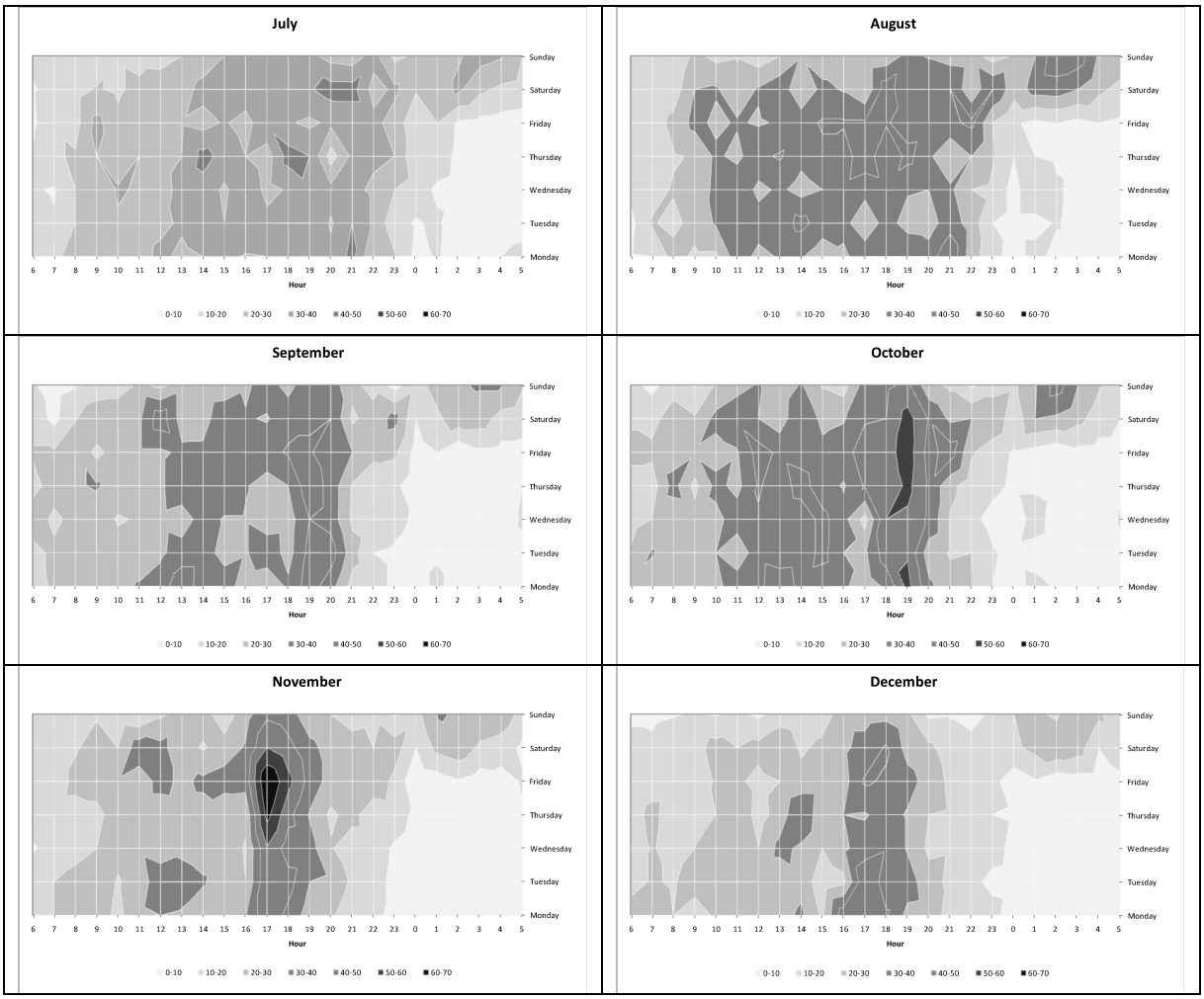

Fig. 4. Number of traffic accidents with killed and injured per months, Province of Vojvodina, period 2001-2009
Rys. 4. Liczba wypadków drogowych z zabitymi i rannymi na miesiąc, Prowincja Vojvodina, okres czasu 2001-2009

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