Variation of traffic accidents volume on different phases of adverse weather conditions

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ABSTRACT

Interactions between adverse weather conditions and road traffic accidents are discussed in this paper. The research is based on traffic accidents data during the period 2001-2002 in Vilnius city, Lithuania. The new approach is used to evaluate meteorological phenomena impact on road collision rates. Traffic Accident Volume (TAV) coefficients are constructed to estimate this impact. Results revealed that adverse weather conditions impact on road accidents vary during different phases of meteorological phenomena. 3 different traffic accident volume phases are marked.

Keywords: traffic safety; road accidents; adverse weather conditions.

1. INTRODUCTION

Traffic volume and safety on roads is a function of a number of the factors. One of the most important is weather conditions [1]. Most dangerous effects show in urbanized territories. Adverse weather conditions influence increasing of road accidents and also could be a reason for traffic jams [2-3].
There are sets of papers describing weather and driving conditions on roads. Mostly, these phenomena are studied in countries with frequent recurrence of adverse, not mild weather [4]. The major part of works are linked to all kind of precipitation [5-12]and much less to winter storm events [13], fog events [10],[14-15] influence magnitude on road traffic accidents.
There are huge variety of methods and data sources used for better understanding of the relationships between adverse weather conditions and traffic accidents fluctuation [12]. The most common method used in the above studies is the “matched-pair approach”[5],[7-8]. Another method used in the studies is a regression approach[12],[16]. Next, Brodsky and Hakkert used 2 different approaches: what they called a “wet pavement index” method and also what they called a “difference in means” method [17]. Finally, one other approach looks at crash severity ratios [5],[18].
The main purpose of this research — to evaluate the variation of traffic accidents volume during different phases of adverse weather conditions. Methodology is based on finding empirical links between traffic accidents and adverse weather conditions. Data on road traffic accidents in Vilnius during the period 2001-2002 is used. 36195 traffic accidents were registered during this period. In 1982 of them people were injured or killed and in 34213 only property damage was done. Information about accidents date and time was given by headquarters of Vilnius police department.

Table. 1. Overall duration (in hours), average duration and standard deviation (in minutes) of adverse weather conditions during the period 2001-2002 in Vilnius city.

	Adverse weather conditions						
	rain	heavy rain	freezing rain	sleet	snow	snowstorm	fog
Overall duration (hrs)	890	599	76	315	1149	151	737
Average duration (min)	136	77	193	115	224	417	198
Standard deviation (min)	171	80	179	109	264	212	73

General information about adverse weather conditions are presented in Table. 1. The data about adverse weather conditions in Vilnius during the period 2001-2002 was collected from Lithuanian Hydrometeorological Service database. Beginning, ending times and overall duration of rain, heavy rain, freezing rain, sleet, snow, snowstorm, and fog were obtained.

2. VARIATION OF TRAFFIC ACCIDENTS VOLUME ON DIFFERENT PHASES OF ADVERSE WEATHER CONDITIONS

During the period 2001-2002 more then quarter (26%) road traffic accidents are recorded under the influence of adverse weather conditions. The influence of weather is more intense during cold season (from November to March), 38 percent of all traffic collisions are recorded under influence of severe weather conditions.

Previous research results showed that traffic accident number increases under the influence of adverse weather conditions [19]. The impact can be different in a beginning phase and in an ending phase of adverse weather though. Road accidents are divided into 20 intervals minutes from the beginning phase of meteorological phenomena to get maximum clearance of the process. Road traffic accident which occur 20 minutes before or after adverse weather conditions are analyzed too, because record time is not always synchronized with real traffic accident time and there are possible territorial disparity of meteorological phenomena duration in different parts of Vilnius.

Average duration of adverse weather conditions is presented on Table. 1. For example, average duration of snowstorms in the period 2001-2002 is almost 7 hours, though average duration of heavy rain and sleet was a little bit more than 1 hour (this number is very different for individual cases, see standard deviation means). First 2 hours (120 min.) from beginning of the adverse weather conditions is selected for the analysis. It is quiet long segment to highlight the variation of traffic accident number. The majority of adverse weather conditions are lasting longer than 2 hours, therefore the further meanings are not taken into account.

At first Background traffic Accident Volume coefficient (BAV) is calculated for every 20 minutes interval. It shows road traffic accident intensity for normal situation without impact of adverse weather conditions. Average proportion between the number of traffic accidents during adverse weather conditions and BAV coefficient allows estimating the impact of specific meteorological phenomena on accident volume during every 20 minutes interval up to 2 hours:

$$TAV = \Sigma TA / \Sigma BAV \tag{1}$$

In Eq. (1): TAV - road Traffic Accident Volume coefficient shows how many times differ the number of accidents during different adverse weather condition types and background values during 20 minutes interval; ΣTA - sum of road Traffic Accidents during different adverse weather condition types during 20 minutes interval; ΣBAV - sum of Background traffic Accident Volume coefficients during 20 minutes interval.

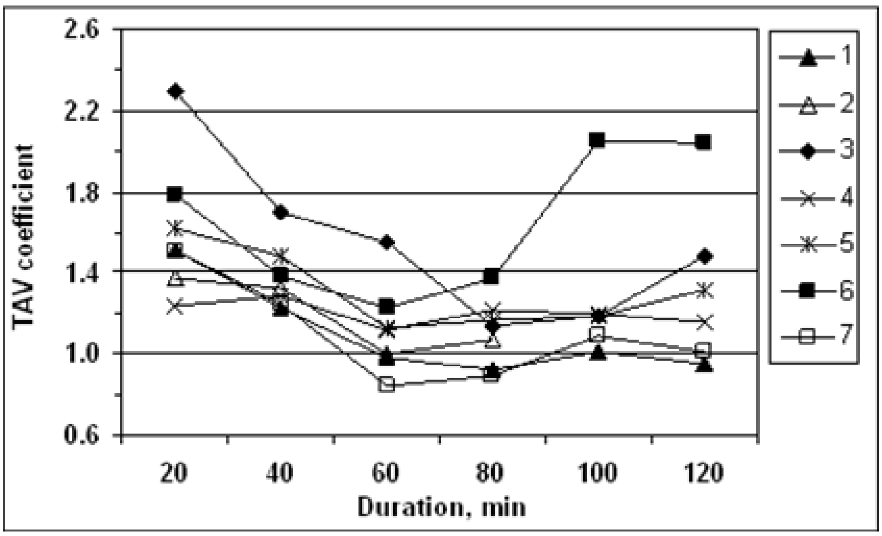

Fig. 1. Fluctuation of TAV coefficient under the influence of different meteorological phenomena according to time passed from the beginning of adverse weather conditions. In figure adverse weather conditions: 1 - rain; 2 - heavy rain; 3 – freezing rain; 4 – sleet; 5 – snow; 6 – snowstorm; 7 – fog.

The curve of Traffic Accident Volume (TAV) coefficient means (Fig. 1) shows that during all phases of adverse weather conditions traffic accident volume does not fall below 1, it means that the number of accidents remain higher than background values all the time. It is possible to mark 3 phases of TAV coefficient. The first phase — very high number of accidents compares to background values during the first 20 minutes interval. The unexpected situation and sudden changes in driving conditions is the main reason for it. The number of road accidents becomes one and a half higher than background values. The second phase — the number of traffic collisions is gradually decreasing and becoming close to background values (40-80 min. from the beginning). The drivers are easily conforming to the changes of road surface and driving conditions. And finally, the third phase — the number of accidents begins to increase again. This situation is not applicable to all adverse weather condition types because the impact of shifted driving conditions becoming stronger than the impact of meteorological phenomena themselves during this phase. For example, under the influence of snowstorm or rain traffic accidents are determined to changes in visibility during the first phase, while during the third phase the increase of accidents are determined to shifted road surface conditions.
The highest value of TAV coefficient (2.3) is recorded during the begging of freezing rain. Meanwhile the most effect on traffic accidents during snowstorm (2.1) is recorded only 100 minutes after the beginning when the drifted snow is rammed down on road surface. It is established that short adverse weather condition events, when meteorological phenomena last less than 30 minutes do not pervert the trends of TAV coefficients. This shows that adverse weather conditions impact on road traffic accident rates stay stable despite the lasting of them.

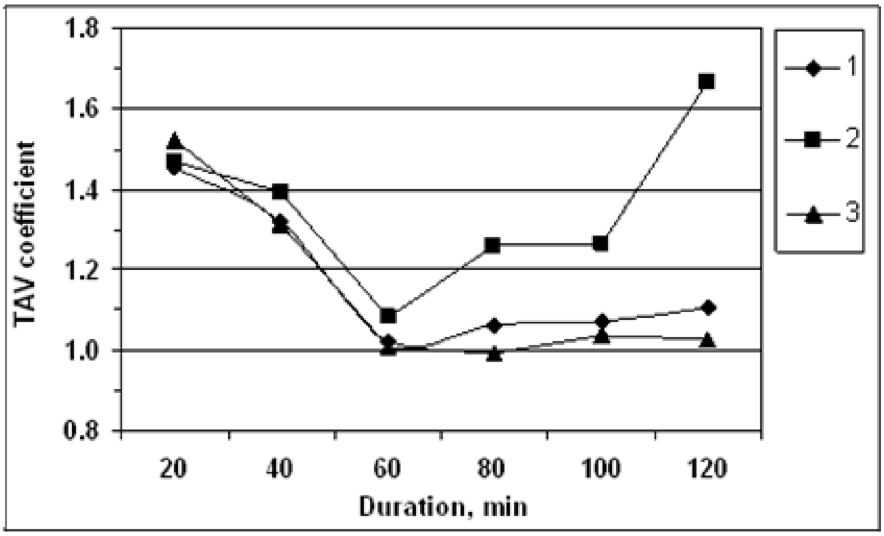

Fig. 2. fluctuation of TAV coefficient under the influence of different precipitation intensity according to time passed from the beginning of adverse weather conditions. In figure different precipitation intensity types: 1 – overall; 2 – heavy; 3 – continuous.

From Fig. 2 it is easy to notice that continuous precipitation is more dangerous to the increase of traffic accident number during the first phase for different intensity rain, sleet and snow. The drivers underestimate the influence of shifted driving conditions and can not use to it offhand. While the heavy precipitation make drivers more intense and demand react to sudden changes faster. However the situation becomes different approximately after an hour from the beginning of adverse weather conditions. The TAV coefficients stay close to background values during continuous precipitation because the drivers are already adapted to the shifted driving conditions and the road surface also stays stable. While the values of coefficients are rapidly increasing during heavy precipitation events, the state of road surface becomes very poor when heavy precipitation lasts for long.

3. CONCLUSIONS

The recent work showed that adverse weather conditions were one of the main factors influencing traffic volume and safety on the roads during our research period (2001-2002) and in general. The impact of different adverse weather is not constant. It depends on how long do adverse weather conditions last, how intense they are, in which complexes they are present and, of course, on their extent and time.
3 different traffic accident volume phases are marked during adverse weather conditions impact. The first phase — very high number of accidents compares to background values during the first 20 minutes interval. The second phase — the number of traffic collisions is gradually decreasing and becoming close to background values (40-80 minutes from the beginning); the third phase — the number of accidents begins to increase again.

During all parts of adverse weather conditions traffic accident volume does not fall below 1, it means that the number of accidents remains higher than background values all the time. Recent research also shows that the impact of continuous precipitation is stronger on the first phase of adverse weather conditions and later (about 60 minutes from beginning) heavy precipitation impact becomes dominant.

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