

## Assessment of Spatial Unevenness of Road Accidents Severity as Instrument of Preventive Protection from Emergency Situations in Road Complex

A Petrov<sup>1</sup>, D Petrova<sup>2</sup>

<sup>1</sup>Associate professor, *Tyumen State Oil and Gas University*,  
Melnikaite street, 72-221, Tyumen, Russian Federation

<sup>2</sup>Undergraduate, *Tyumen State Oil and Gas University*,  
Melnikaite street, 72-221, Tyumen, Russian Federation

E-mail: <sup>1</sup>ArtIgPetrov@yandex.ru, <sup>2</sup>DaArtPetrova@mail.ru

**Abstract.** Emergency situations in road complex are road traffic accidents (RA) with severe consequences. These are incidents connected with the death and injury of large number of people. The most common reasons for this are the collision of three or more cars, the collision of buses with trains at railroad crossings, the fall of the buses in the mountain gorge, and other similar cases. Is it possible to predict such events? How to build a preventive protection against such emergencies? We have to understand that emergencies in a road complex are qualitative expression of the quantitative processes that characterize the general state of road safety in the region. In this regard, at the level of state monitoring of emergency situations it is important to understand in general - in which region the situation is more complicated and in which is more favorable. This knowledge helps to more efficiently reallocate resources intended to solve the problems of road safety provision. The consequence of this is improvement of the quality of preventive protection from the emergencies in the road complex. The article presents quantitative values of severity of accidents in the Russian Federation regions and the Pareto chart distribution of cumulates of the accident severity for the Russian Federation. On the basis of the complex assessment of the spatial non-uniformity of the accident severity results it offers two important recommendations, implementation of which will alleviate the issue of formation of emergency situations in the road of the Russian Federation on the basis of the complex assessment of the spatial non-uniformity of the accident severity results.

### 1. Introduction.

According to the State Report «On the state of protection of population and territories of Russian Federation from natural and technogenic emergency situations in 2014» [12] 262 emergency situations of diverse nature happened on the territory of Russia in 2014. 567 people killed our country as a result of disaster in 2014 [12, 13]. Structure of quantitative indicators by type of disaster in the Russian Federation (2014) is shown in Fig. 1.

A large proportion of emergency situations - 186 cases (72 % of total) - were the incidents of technogenic nature. These include road traffic accidents (RA) with serious consequences [12]. The



term «accident with serious consequences» is used in relation to the accident, which killed 5 or more people, or 10 or more people were injured.

Table 1 shows the main characteristics of such accidents that occurs in the territory of Russia in 2014.

Data of Table 1 shows that technogenic accidents with severe consequences occupy a priority position among other emergencies on all indicators except material damage. At the same time, the number of traffic accidents with severe consequences is only a small fraction of the total number of accidents with victims.

In 2014 in Russia, there were 199720 accidents with victims, which killed 26963 people and 251785 people were injured [14].

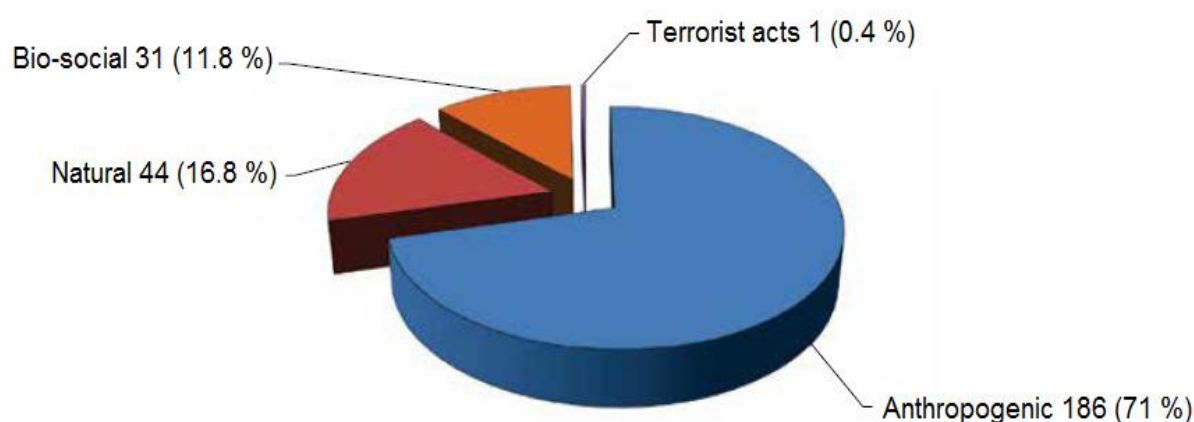


Figure 1. The structure of the quantitative indicators by type of emergency situations, units (%) [12]

**Table 1.** The main characteristics of the accident with severe consequences in Russia (2014) [12]

Estimated characteristic	Indicator of transport accidents in the Russian Federation (2014)				
	The number of traffic accidents with grave consequences, units / year	The number of deaths in road accidents with grave consequences, pers. / year	The number of victims in road accidents with serious consequences, pers. / year	The number of survivors in an accident with serious consequences, pers. / year	Material damage, mln. rub / year
Absolute value of RA with severe consequences, units.	87	381	968	586	31,64
Absolute value of emergencies of technogenic nature, units.	186	567	1620	1063	16321,53
Relative value, %	47	67	60	53	0,2

Analysis shows that the number of traffic accidents with severe consequences doesn't exceed 0.045 % of the total number of accidents with victims. The death toll of such road accidents is 1.4 % of the total number of people killed on the roads of the country. In this regard, for an understanding of the degree of danger of the situation with traffic accidents in different regions of Russia we need to use other indicators [1, 2, 3, 5].

The best choice [9, 10, 11] is recognized among road safety experts Factor accident severity  $K_{severity\ RA}$  (1):

$$K_{severity\ RA} = \left[ \frac{Killed_{RA}}{Victims_{RA}} \right] \times 100 = \left[ \frac{Killed_{RA}}{(Killed + Injured)_{RA}} \right] \times 100, \quad (1)$$

where  $K_{severity\ RA}$  factor of severity RA in units from 100;  
 $Victims_{RA}$  amount of killed and injured in RA in a year, pers./year;  
 $Killed_{RA}$  amount of killed in RA in a year, pers./year;  
 $Injured_{RA}$  amount of injured in RA in a year, pers./year.

The hypothesis that is proved in this article, is formulated as this: ***The severity of the accident, or the relative proportion of road deaths among the victims (killed + injured) in an accident on the territory of Russia is formed unevenly.*** The thesis, which follows from the proof of this hypothesis, allows to develop the tools of probabilistic forecasting of emergencies [4, 6, 7, 8, 9] connected with accidents in certain regions of Russia.

## 2. Basic data.

The data on the spatial (in the regions of Russia) distribution of accidents with victims and all related information can be found in the archives of the Russian Interior Ministry traffic police [13].

Table 2 shows the Russian regions rating of largest severity of traffic accidents in 2013 [9, 14].

**Table 2.** The Russian regions rating of largest severity of traffic accidents in 2013 [9, 14]

The subject of Russian Federation (2013)	Rating place in the Russian Federation (from the most dangerous to safest)	The numerical values of indicators	
		Severity of RA, killed/victims, $K_{severity\ RA}$	% from the national average of index $K_{severity\ RA}$
Republic of Dagestan	1	20.42	209.0
Chechen Republic	2	18.39	188.2
Tuva Republic	3	17.27	176.8
Kabardino-Balkar Republic	4	17.20	176.0
Republic of Ingushetia	5	16.24	166.2
Republic of Adygea	6	16.18	165.6
Belgorod Oblast	7	14.50	148.4
Krasnodar Krai	8	14.11	144.4
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Moscow	76	6.10	62.4
Komi Republic	77	5.67	58.0

Ivanovo Oblast	78	5.55	56.8
Jewish AO	79	5.15	52.7
Murmansk Oblast	80	4.60	47.1
Saint-Petersburg	81	4.24	43.4
Nenets AO	82	3.41	34.9
Chukotka AO	83	3.13	32.0

Even a simple visual examination of the data in Table 2 makes it clear that the severity of an accident varies in a very wide range of values in different regions. The ratio between the value of the severity of the accident in the most accident-prone region of the Russian Federation - the Republic of Dagestan (20.4) and the value of the severity of the accident in the accident-safe region of the country - Chukotka (3.13) is up to 6.5-fold, which is a very large value.

### 3. Methods of assessing the severity of the spatial unevenness of the accident.

Analysis [9] shows that the spatial distribution of the severity of the accidents in Russian regions is convenient to estimate by constructing a Pareto chart. Features of Pareto diagrams are determined by the bending of the Lorenz curve, which describes the distribution of cumulates accident severity of the Russian Federation space. Fig. 2 shows a Pareto diagram of distribution of severity of the accident characteristics in the space of the Russian Federation regions [9].

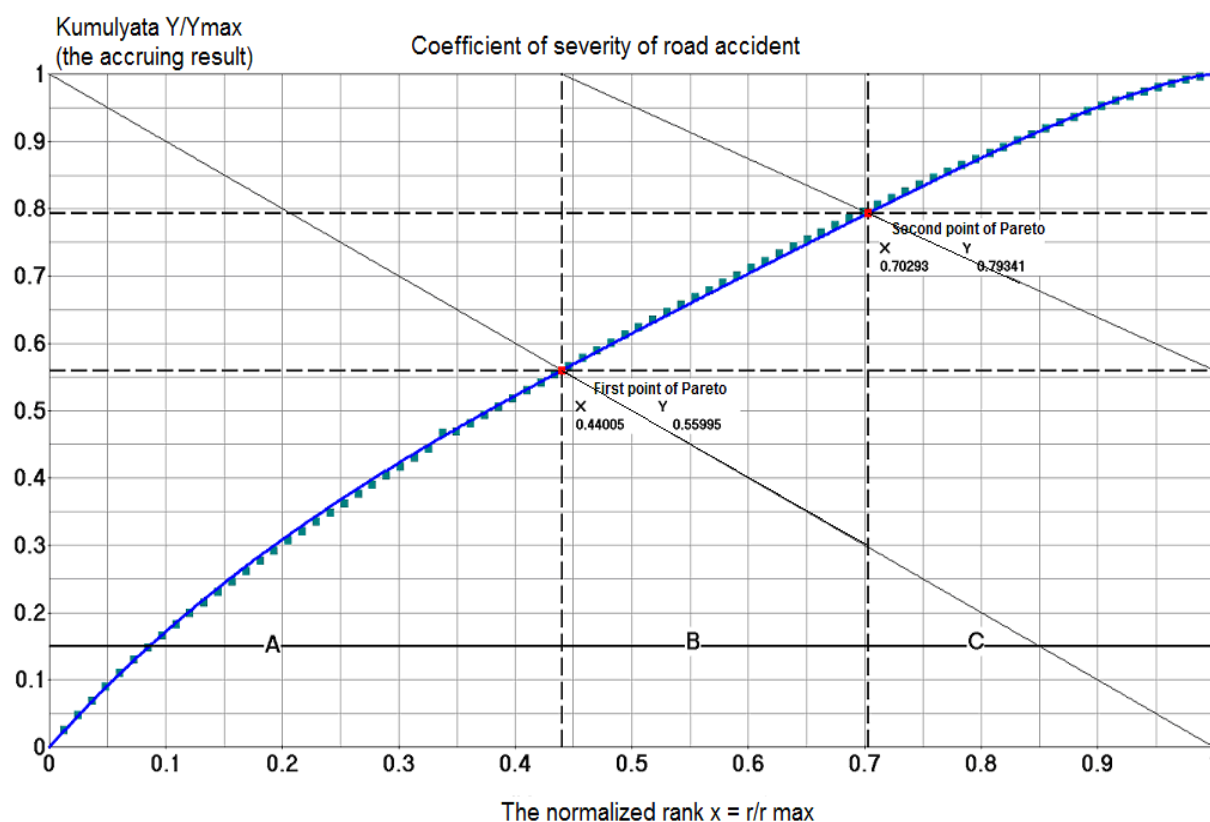


Figure 2. Pareto diagram of distribution of severity of the accident characteristics in the space of the Russian Federation regions [9]

### 4. Results and Discussion

Visual examination of this diagram leads to the conclusion that the bending of the Lorenz curve explicitly is typical only for the end portions of the curve, that is for the first eight (1 ... 8) and the last

eight (76 ... 83) regions of Russia in the ranking index of the accident severity. The list of regions where the accident severity is the highest includes five Caucasus republics, Tuva Republic, the Krasnodar region and Belgorod region (Table 1).

These eight regions (10 % of the composition of the Russian Federation) form about 18 % cumulative result for the severity of the accident in the Russian Federation [9].

The eight regions where the severity of the accident is minimal, are federal cities - Moscow and St. Petersburg, the four northern regions and sparsely populated Jewish autonomous region and Ivanovo region. These eight regions form about 5 % of the cumulates severity of road accidents in Russia [9].

In fact, the severity of the accident, or the relative proportion of road deaths among the victims (killed and injured) in an accident on the territory of Russia is formed unevenly. Thus, we can conclude that the irregularity of the formation of an accident severity in the territory of the Russian space is determined by geographical indication [6, 7, 8, 9]. The geography forms quality of people's life, that reflects on the circumstances related to the features of the trucking accident [6, 7, 8, 9].

## 5. Conclusion

Preventive protection from emergency situations in the road-transport complex can be built only on the basis of forecast assessment based on probability statistics [3, 5, 6, 7, 8, 9]. Presented in this article, Pareto chart of accidents severity in the Russian space [9] allows us to offer two important recommendations, implementation of which will allow to multiple alleviate the issue of formation of emergency situations in the road complex.

- In order to analyze the seriousness of the situation in the sphere of road complex from the point of the possibility of forming an emergency situation it is necessary to adjust some approaches of the Ministry of Emergency Situations of the Russian Federation to the classification of emergency situations. Particularly, the factor of «an accident with serious consequences», that is used by Emergency Department as the most important assessment indicator, should be supplemented with an indicator «The severity of the accident».

- In the space of Russia should be paid special attention to traffic safety in the road complex to the Caucasus republics and the Tuva Republic. There are where the severity of accidents relative to other Russian regions is maximal. There are the most likely emergencies related to the accident.

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