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Road and railway transport in Russia: safety and risks

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Abstract. The Russian Federation (RF) has a very extensive transport network that is one of the largest in the world. The transport safety is among the key priorities of the National Transport Strategy of the RF. Using information of the own database as well as official statistics data, the author analyzed the main causes and triggers of road crashes and railway accidents and traced their temporal variations and spatial distributions within the country. As the leading triggering factor of accidents, ranks the so-called "human factor" including traffic violations by drivers, such as speeding and driving under influence of alcohol and other human errors. A rate of the deterioration of railway tracks and rolling stocks and other technical problems are also increasing during the last decade. In some regions, the poor state of roads and streets remaining among the most severe problems that caused almost 40-50% of road accidents. The transport infrastructure is in urgent need of modernization. Additionally, the paper assessed natural factors contributing to the accident occurrences. The main purpose of the study was to reveal regional differences and to find out areas most at risk of transport accidents.
Key Words: transportation system, human factor, human errors, accident, database.

Introduction. The Russian Federation (RF) has a very extensive transport network that is among the largest in the world. The national transport web stretches from Kaliningrad in the west to the Kamchatka Peninsula in the east and includes 1,283 thousand km of public roads, more than 600,000 km of airways, 228,000 km of pipelines, 121,000 km of railways, and 115,000 km of inland waterways. In June 2014, the Ministry of Transport of the RF has compiled a new version of the Transport Strategy up to 2030 that includes among the key priorities to cope with the modern challenges, such as climate change and a need for increasing the safety of the transportation system. The transportation safety problem is one of the most important and urgent problems of the social and economic development of the country, because the current situation is far from being perfect.

The most dangerous means of modern transportation not only in Russia, but also around the world, is automobile transport. According to the World Health Organization (WHO), "the current road safety situation constitutes a crisis with devastating social and economic impacts that threaten the recent health and development gains that have been achieved" (WHO 2010). Road safety, as a question of high importance, was recognized in global environmental policy deliberations at the recent Rio+20 UN Conference on Sustainable Development. The scale of the problem is as follow: over 1.2 million people die annually on the world's roads (more than 3,000 deaths a day), 27% of them are pedestrians and cyclists, and another 20 to 50 million others are injured due to road crashes (WHO 2013). Road traffic injuries are the eighth leading cause of death globally, killing mostly those between 5 and 44 years of age (WHO 2011), and the leading cause of death for young people aged 15 to 29 (Murray et al 2012). Current trends suggest that by 2030 road traffic deaths will become the fifth leading cause of death in the world, resulting in an estimated 2.4 million fatalities a year, unless urgent action is taken (WHO 2010). The economic consequences of road crashes have been estimated between 1 and 3% of the respective GNP of the world countries, reaching a total over $500 billion. Middle-income countries, such as the RF and Romania, which are motorizing rapidly,

have the highest road traffic fatality rates and the highest deaths proportions among pedestrians.

Road traffic crashes cause the most part of deaths and injuries occurring in all technological accidents in Russia and rank as the second type of technological accidents after fires by the number of accidents (Petrova 2005). Most critical is the fact that 35% of all road traffic deaths occur among pedestrians and cyclists (DRS 2013).

Recognizing the importance of the issue at national, regional, and global levels, in March 2010, the United Nations General Assembly declared 2011–2020 as the Decade of Action for Road Safety with a goal of stabilizing and then reducing the forecasted level of road traffic fatalities (WHO 2010). The RF belongs to the countries having national road safety strategy. It is based around five key pillars including road safety management, safer roads and mobility, safer vehicles, safer road users, and post-crash response. Fatality reduction target of the strategy is from 23.5 to eight deaths per 100,000 populations between 2007 and 2030.

Severe accidents in other means of transportation, such as railway, air traffic, and water transport, occur not so often as road crashes, but the relative risk of these accidents is significantly higher than that of road accidents, because they cause more fatalities and injuries per accident. The risk of railway accidents is particularly increasing during the last years. Thus, we also should consider them speaking about the transportation safety problems.

The majority of investigations into the transportation safety problem in Russia are focused on either the juristic or the medical issues of road accidents (Starodubov & Borovkov 2010; Kudryavtsev et al 2013); some other researches (Ovcharov et al 2012) summarize national statistics and consider only severe road traffic crashes, their causes and consequences. Only few studies concern triggers and effects of transport accidents both at country and regional level (Abbasova & Vashkina 2013) including natural hazard impacts (Petrova 2011a; Govorushko 2012) and their spatial distribution within the country (Petrova 2011b, 2013). We can state lack of research in the field of geographical accident analysis, the same problem that Dicu & Stângă (2013) found for Romania.

The author analyzed the main causes and triggers of road and railway accidents in the RF, their temporal variations and spatial distributions during the last decade using information of the own database as well as official statistics data. The main purpose of the study was to trace regional differences in transport (un-)safety, find out the most critical points and reveal areas most at risk.

Material and Method

Research region. The survey was conducted at the level of the main administrative units of the Russian Federation that are federal regions or the “subjects of the federation”, which represent the highest administrative level. The federal regions of the RF correspond to the states in the USA or federal lands in Germany. The Federal State Statistics Service (FSSS) and other federal institutions of the RF use these administrative units to publish their official statistics data. Therefore, the comparative statistical analysis within the country is only possible at the level of these administrative units.

The Russian Federation consists now of 85 federal regions (Figure 1) including 22 republics, nine kraies or territories, 46 oblasts or regions, one autonomous oblast’/autonomous region (Evreiskaia AO), and four autonomous okrugs/autonomous districts. The two largest Russian cities, Moscow and Saint Petersburg, as well as Sevastopol in Crimea are separate federal regions too (federal cities). The Crimea Republic and Sevastopol as the newly established administrative units (since March 18, 2014) were not included into the analysis and not shown in the Figure 1.

Methodology. Official statistics data of the Federal State Statistics Service (FSSS), as well as statistics data of the Department of Road Safety (DRS), Ministry of Internal Affairs of the RF and annual State reports of the Russian Ministry of Emergency were mainly used for the study. This information is open to the public.

Figure 1. The main administrative units (federal regions) of the Russian Federation.

Additionally, the author created an electronic database of technological accidents including the transport accidents that occurred in the RF since 1992 (Petrova 2008). Official daily reports of the Russian Ministry of Emergency and mass media news reports served as initial sources of the information collected. The database includes occurrence time, location, and a type of each accident, a number of fatalities and injuries, economic and ecological losses, a probable cause of accident, if available, a short description, and a source of information. The information regarding road and railway accidents was used in the analysis. It was impossible to claim complete coverage of all accidents in the database. Only severe accidents that caused five or more fatalities, ten or more injuries or large economic damages, which were reported by the Ministry of Emergency and draw attention of mass media, could be listed. However, the database allowed us to analyze information that is not usually included into the official statistics reports (e.g., the influence of natural hazards, adverse weather conditions, etc.).

Using the statistics summarized over the last 10 years, graphs showing temporal changes in the number of road accidents, fatalities, and injuries, as well as in the proportion of their triggers at the national level of the RF were constructed and analyzed (Figure 2 & 4).

Seasonal variations in the number of road accidents, fatalities, and injuries (Figure 3) were additionally assessed.

Occurrence frequencies of road and railway accidents within federal regions were estimated. For this purpose, annual average numbers of road accidents per 100,000 inhabitants and annual average numbers of railway accidents were calculated for each federal region. All the federal regions were grouped by their risk levels of road and railway accidents, respectively. The resulting maps were created and analyzed (Figure 5 & 6). The contribution of natural factors as triggers of accidents was also assessed.

Results and Discussion

Road safety and risks. Table 1 contains international comparison of some road transport and road (un-)safety indicators.

Table 1

Comparison between Russia and other countries in road transport and road (un-) safety indicators (Aggregated data from Eurostat, FSSS, International Transport Forum/OECD, WHO)

Indicator	*Length of roads (km x1000)*	*Proportion of paved roads (%)*	*Road density (km/km^2 x1000)*	*Total registered vehicles x1,000,000*	*Accidents with injuries x1000*	*Reported road traffic fatalities*	*Estimated GDP lost due to road traffic crashes (%)*
Russia[1]	1283	72.3	54.4	53.3	199.9	27025	1.9[2]
China[2]	4008	53.5[4]	417.5	207.1	-	65225	-
Japan[3]	1208	80.1	3197	89.9[2]	726[2]	7309	1.4[5]
USA[4]	6506	67.4	675.7	258.9[3]	1576[2]	33808[3]	2.3
France[2]	1041,2[3]	100.0[3]	1887.9[3]	34.3	67.3	3992	1.3
Germany[2]	644.5[6]	100.0[6]	1805[6]	50.1	288	3648	1.3[4]
Italy[5]	487.7	-	1619	52.6[3]	211[2]	4237[3]	2[4]
UK[3]	419.6	100.0	1727.4	35.2[2]	160[2]	1905[2]	1.2
Romania[2]	88.6	30.2[5]	351.2[1]	5.0[3]	26.0	2377	-

1 - 2013; 2 - 2010; 3 - 2009; 4 - 2008; 5 - 2007; 6 – 2006.

As by the beginning of 2013, Russia had 1283 thousand km of public roads, 72.3% of them or 928 thousand km had hard surfaces (FSSS 2014). With a large area of the country, the road density was the lowest of all the G8 countries and amounted to 54.4 km/1,000 km^2. However, in the North-Caucasian and Central Federal Districts, it was much higher. The highest densities of the hard-surface roads (including streets) among of all federal regions of the RF had Saint Petersburg (2156 km/1,000 km^2), Moscow (2114 km/1,000 km^2), and Moskovskaia oblast (Moscow region) (695 km/1,000 km^2), as well as the North-Caucasian Republics Alania and Ingushetia with 663 and 606 km/1,000 km^2, respectively (FSSS 2013).

As by the end of 2013, more than 53.3 million vehicles were registered in the RF including 41.2 million cars (77.3%), 2.5 million motorized 2- and 3-wheelers and 4-wheeled light vehicles, more than 6.0 million heavy trucks, and 886.9 thousand buses (DRS 2014). The highest numbers of the registered cars per 1,000 inhabitants had the Far-Eastern regions of Russia, such as Kamchatskii and Primorskii Territory (with 422.6 and 346.7 in 2012, respectively), as well as Ryasanskaia (340.2), Moskovskaia (326.6), and Tverskaia (319.0) regions in Central Federal District (FSSS 2013).

Figure 2 shows temporal variations in the number of road accidents, fatalities, and injuries in Russia during the last decade (2003-2013).

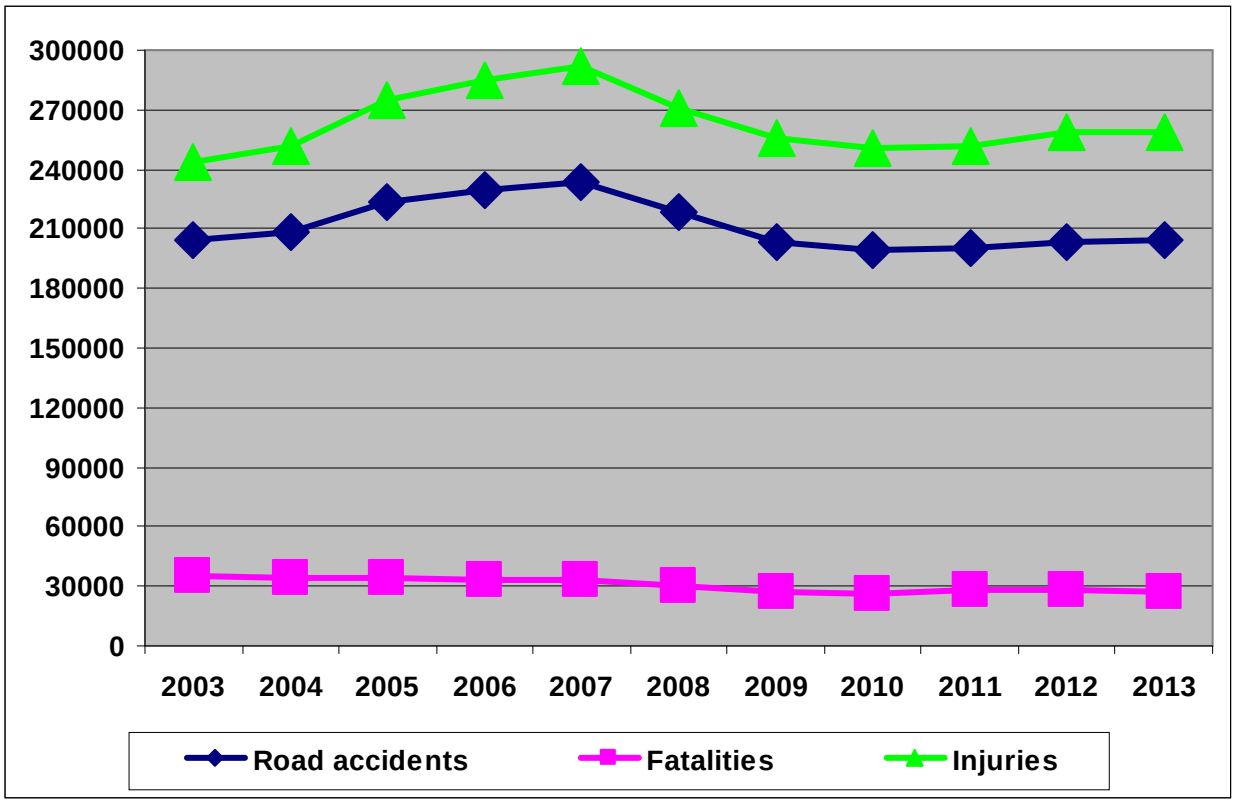

Figure 2. Temporal variations in the number of road accidents, fatalities, and injuries in the Russian Federation in 2003-2013 (Aggregated data from DRS 2004-2014).

The number of accidents and injuries increased rapidly until 2007. This tendency was mainly caused by the rapid motorization of the population, a shift from public to private transport and a growing disparity between the increasing number of cars and the insufficient development of the road network. That situation had led to not only an increase in the number of road accidents, but also to a worsening of traffic conditions and the environment, congestion, and an increase in fuel consumption (General Assembly 2008). Then the number of accidents and injuries fell sharply between 2007 and 2010, after the Russian Government had adopted a special-purpose program "Improved Road Safety 2006-2012" and intensified activities in that area. All the Russian federal regions had adopted appropriate road safety programs and increased their financing. The annual

number of road fatalities in Russia was slightly decreasing too, despite the growth in passenger and freight transport activity. This trend might be attributed to improved road design and construction, improved vehicle safety standards, the introduction of speed limits, higher penalties, and other stricter rules. Indeed, the number of road fatalities fell between 2003 and 2010, from 35,610 deaths to 26,567 deaths (down 25.4% overall). Nevertheless, during the last three years, a number of road accidents, fatalities, and injuries were slightly increasing.

In 2013, the Department of Road Safety (DRS), Ministry of Internal Affairs of the Russian Federation has registered 204,068 road traffic crashes that caused 27,025 fatalities and 258,437 injuries (DRS 2014). All three road (un-)safety indicators are subject to seasonal variations, having the highest numbers of road accidents, fatalities, and injuries in summer, especially in August, and the lowest ones in cold "off-season", especially in February (Figure 3). These variations can be explained by changes in the population mobility that increases in "peak season" throughout summer holidays, which are characterized by increasing in driving, cycling, and walking during warmer summer months. Adverse weather conditions, such as heavy rains, snowfalls and snowdrifts, foggy or icing roads, additionally trigger road traffic crashes, especially during "shoulder season" in late autumn, in winter and early spring.

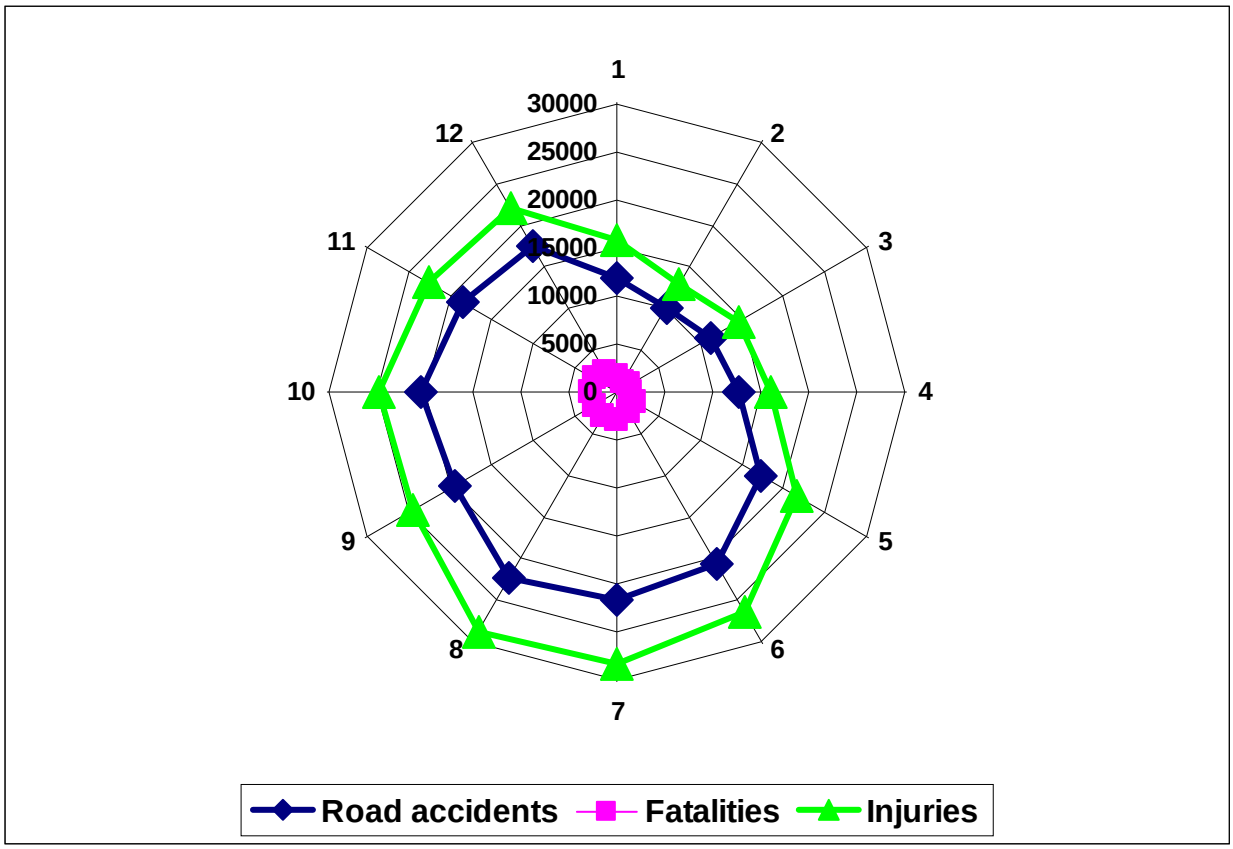

Figure 3. Seasonal variations in the number of road accidents, fatalities, and injuries in the Russian Federation (numerals 1 through 12 denote months) (Aggregated data from DRS 2013).

Figure 4 shows a proportion of road accidents caused by different triggers and their temporal variations during the last decade. Drivers that violated traffic laws caused the most part of road accidents in Russia. The contribution of this factor was constantly increasing from 77.7% in 2003 to 87.7% in 2013. Entering the lane of an oncoming vehicle, speeding, and driving through the crosswalk or intersection on a red light consistently ranked the leading positions in the ranking of the most common traffic violations in Russia. According to statistics, young drivers and owners of high-speed foreign cars most often exceeded the speed limits.

Many studies concluded that both speeding and driving under the influence of alcohol increased the relative risk of accidents and fatalities including pedestrian fatality risk (Baum et al 1991; Shibata & Fukuda 1994; McLean & Kloeden 2002; Rosén et al 2011).

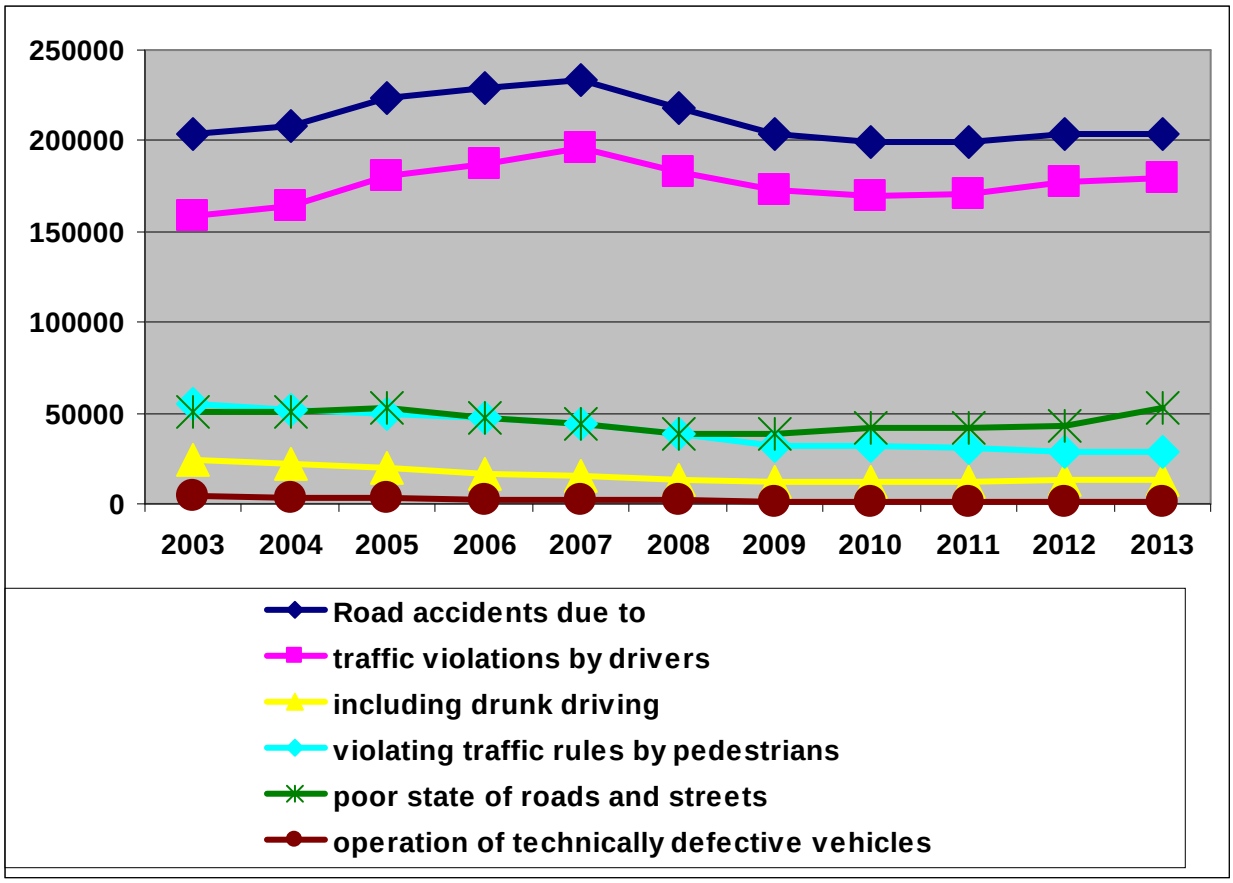

Figure 4. Proportion and temporal variation in the number of road accidents caused by different triggers in the Russian Federation (Aggregated data from DRS 2004-2014).

The proportion of driving under the influence of alcohol among of all accidents caused by drivers was sharply decreasing between 2003 and 2010, from 15% to 7.0% due to the introduction of stricter traffic laws. However it was slightly increasing again during the last three years to 7.6% in 2013. The contribution of this factor was not uniform across the country but varied greatly in different regions of Russia. The most serious problem with driving under the influence of alcohol traditionally had the most northern federal regions, such as Chukotskii and Nenezkii AO (with 23.1% and 22.7%, respectively), Yakutia and Komi Republics, Magadanskaia and Arhangelskaia regions, Krasnoyarskii krai, as well as some regions of Siberia and Central Russia. These regions need extra regulations by local authorities. The most sober drivers live in St. Petersburg (the contribution of driving under the influence of alcohol comprised to 1.4% there), Chechnia Republic (2.1%) and Moscow (2.5%).

The poor state of roads and streets ranked as the second cause of road accidents in the RF. Its proportion remained approximately at the same level during the last decade and accounted for about one-fifth of all road traffic crashes in Russia. In 2013, its proportion increased to 26% (the highest number during the last decade). In some regions, the contribution of this factor was more significant; in Astrakhanskaia region, it accounted for 55.9%, in Samarskaia region and Stavropolskii Territory for almost 50% of all road accidents. Insufficient state of municipal and regional roads especially at the boundaries between federal regions is one of the main problems of the Russian transportation system.

The proportion of road accidents due to pedestrians halved between 2003 and 2013, from 26.8% to 13.8%. However, pedestrians still represent the most part of road traffic death (about 33%) following by drivers (28%) and passengers of 4-wheeled cars and light vehicles (25%). The most undisciplined pedestrians caused 29.8% of road accidents in Tyva Republic unlike to the most disciplined ones in Yamalo-Nenezkii AO that caused only 4.9% of accidents.

Accidents due to operation of technically defective vehicles were minor and accounted for less than 1% of all car crashes. The highest proportion was recorded in Stavropolskii Territory (6.1%) unlike to Moscow, St. Petersburg, and Mordovia Republic with about 0.1% (DRS 2013).

The official statistics do not include information about influences of natural hazards and adverse weather conditions on occurrences of road accidents. However, the information collected by the author in the database allowed us to fill this gap. As analysis of the data revealed, various natural factors, such as snowfalls and snowstorms, icy conditions of roads, rainfalls, fogs, and mists, trigger about 3% of all severe road accidents.

In terms of absolute values, road accidents occurred most often in Moscow, Moskovskaia region, and St. Petersburg, which had the highest level of the road density and road flow, and the largest number of the registered cars in Russia. These regions also leaded in absolute numbers of injuries in road traffic crashes. In 2013, in above mentioned regions were recorded 11.319 (5.5%), 9.299 (4.6%) and 8.341 (4.1%) road accidents with 841, 1,585 and 444 fatalities, and 12,951, 11,533 and 10,019 injuries, respectively (DRS 2013). Moskovskaia region leaded in absolute numbers of fatalities, followed by Krasnodarskii krai (1,348) and Moscow (841). The main causes were non-compliance with the rules relating to speed of vehicles and right-of-way, as well as driving under the influence of alcohol. In Krasnodarskii krai the situation was additionally complicated by the mountainous terrain and influence of natural hazards and adverse weather conditions (landslides, debris flows, sleets, icing, etc.).

Quite different results were obtained using weighted indicators per 100,000 inhabitants, which allowed us to compare different regions with each other, eliminating their inequalities in populations. Thus, in 2012, the highest numbers of road accidents per 100,000 inhabitants had Pskovskaia and Novgorodskaia regions, as well as Kalmykia Republic with 246.2, 234.2 and 242.5 accidents respectively. In the fatalities per 100,000 inhabitants led Tyva (46.8) and Altai (40.1) Republics, as well as Pskovskaia region (37.2) (FSSS 2013). The highest numbers of injuries per 100,000 inhabitants in 2013 had Kalmykia Republic, Kalushskaia and Tiumenskaia regions, which exceeded by almost two times the national level (DRS 2013). The main causes of accidents were human errors (drivers' traffic violations) and natural factors (icy conditions of roads, snowfalls, etc.).

Annual average numbers of road accidents per 100,000 inhabitants were calculated for each federal region between 2003 and 2013. Five groups of regions having different levels of risk of road accident occurrences were revealed. The results are presented in Figure 5. The highest level (more than 190 accidents a year) had Pskovskaia, Novgorodskaia and Arhangelskskaia regions in the North-Western Russia, Vladimirskaia and Ivanovskaia regions in the Central Russia, Magadanskaia, Sakhalinskaia regions and Primorskii krai in Far East, and Tiumenskaia region, Khakasia and Altai Republics in Siberia.

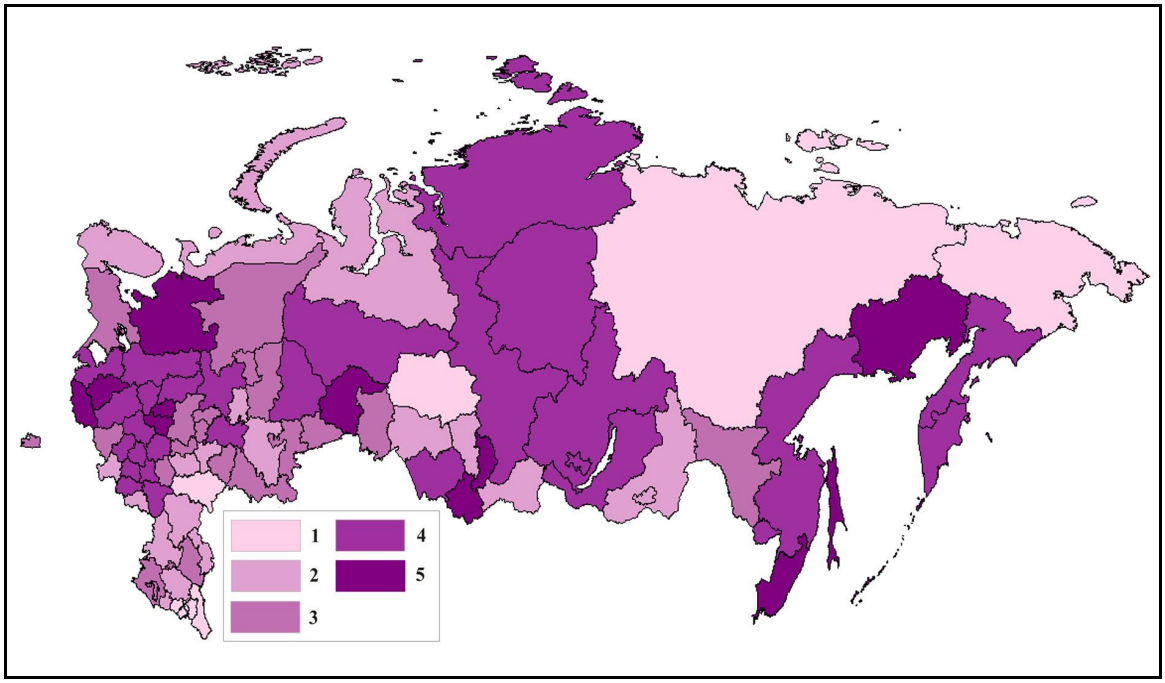

Figure 5. Risk of road accidents (an annual average number of accidents per 100,000 inhabitants, 2003-2013): 1 – very low (less than 100); 2 – low (101-130); 3 – middle (131-160); 4 – high (161-190); 5 – very high (more than 190).

Railway safety and risks. Railway transport leads in the transportation system in many countries. This is due to its versatility; railways are able to serve all sectors of the economy and to carry passengers regardless of weather conditions (with the exception of particularly unfavorable situations resulting in snow drifts or washout of railway lines), in almost all climatic zones and during all seasons. In the Russian Federation having a vast and extensive territory and natural resources that locate far away from the processing plants, railway transport forms the basis of the transportation system. The proportion of railways in total transport turnover (excluding pipelines) exceeds 80% and in total passenger turnover it amounts to 40%.

As by the end of 2012, the RF had 121,000 km of railways (third rank in the world after the United States and China) including more than 85,600 km of public railways and more than 43,000 km of electrified railways (second rank in the world after China) (FSSS 2012).

Although railway transport belongs to the sectors of the economy with an increased risk of accidents, it is considered the safest form of modern transportation. According to the Russian Ministry of Emergency, traveling by train is about three times safer than by plane and 10 times safer than by car. However, railway catastrophes with a large number of victims and injuries occurred in recent years in different countries of the world. On July 19, 2010 in India, 60 people were killed and another 170 injured as a result of head-on collision of two trains in the station Saintia (200 km from Kolkata) (RBC 2010). On July 24, 2013 in Spain, all the 13 cars of the high-speed train derailed due to excessive speed cornering at the station of Santiago de Compostela (Galicia); 79 people died, over 170 injured (RG 2013).

In the RF, after a slight decrease in the number of railway accidents in 2011, their number increased again: 2010 – 16, 2011 – 11, 2012 – 14, 2013 – 17 accidents (State reports 2011-2014). The main causes of accidents were technical problems, a high degree of deterioration (of tracks, rolling stocks, signaling means, means of centralization and blocking), and a "human factor" (errors of traffic controllers, carelessness and negligence of drivers, the overall decline in skills development, and other human errors). One of the main causes of railway accidents were kinks of the trolley side frames (Asaphova 2014).

Table 2 shows some indicators of risk of railway accidents in the RF calculated by Lukyanovich et al (2013).

Table 2

Indicators of risk of railway accidents (Lukyanovich et al 2013)

Indicators of risk	*2010*	*2011*
Risk of railway accidents	16 years^{-1}	11 years^{-1}
Risk of fatalities in railway accidents	1.3 x 10^{-8}	4.1 x 10^{-8}
Risk of injuries in railway accidents	2.0 x 10^{-8}	2.0 x 10^{-8}

The database created by the author included the information about 766 railway accidents that occurred in Russia in 1992-2013 (Figure 6). As the statistical and geographical analysis of the information revealed, railway accidents occurred most often in Amurskaia and Irkutskaia regions and in Krasnodarskii krai (more than 30 accidents during the study period), in Rostovskaia, Leningradskaia and Moskovskaia regions, Zabaikalskii and Khabarovskii krai's (more than 20 accidents in each region). Figure 6 shows the results of the risk assessment of railway accidents at the level of federal regions of the RF. The resulting risk was assessed by calculating an annual average frequency of their occurrences in every region between 1992 and 2013.

About 17% of accidents registered in the database occurred at railway crossings due to collisions of trains with buses, trucks, cars, or motorcycles. In most cases, such accidents were caused by a "human factor" - attempts of drivers of motor vehicles to "skip" before approaching trains at unguarded railway crossings. The greatest numbers of victims and injuries occurred from collisions between trains and buses.

More than 4.5% of all railway accidents were triggered by different natural hazards or adverse weather conditions. During the study period, railway accidents or violations of rail traffic under the influence of natural factors were recorded in 19 federal regions. Among of their triggers were revealed the following:

- snow drifts (Yamalo-Nenezkii AO, Orenburgskaia region);
- washout of railway lines as a result of heavy rains and flash floods (Dagestan, Karelia, Udmurtia, and Chuvashia Republics, Amurskaia and Sakhalinskaia regions, Krasnodarskii and Khabarovskii krai's);
- snow avalanches (Sakhalinskaia region, Khabarovskii krai);
- rails deformation due to heat wave (Kalmykia Republic, Rostovskaia region);
- landslides (Krasnodarskii krai, Orlovskaia region);
- debris flows (Sakhalinskaia region, Krasnodarskii krai);
- rock falls (Khabarovskii krai, Bashkartostan Republic);
- floods due to spring snowmelt (Vologodskaia and Murmanskaia regions), and other natural hazards.

In September 2009, eight cars of a freight train ran off the rails because of flooding of railway tracks in Dagestan due to heavy rainfalls. As a consequence of the accident, 150 meters of railway track were destroyed; railway communication was disrupted (RIA "Novosti" 2009). In July 2007, locomotive, 6 platforms for transportation of containers, 4 wagons with metal, and one oil tank-wagon were derailed from the freight train due to rock fall in Khabarovskii krai. In March 2006, locomotive and one car of a passenger train were derailed as a result of snow avalanche in Khabarovskii krai. Thus, despite the fact that railway transport is the most reliable and safest of all types of modern transportation, in recent years, risk of railway accidents was increasing.

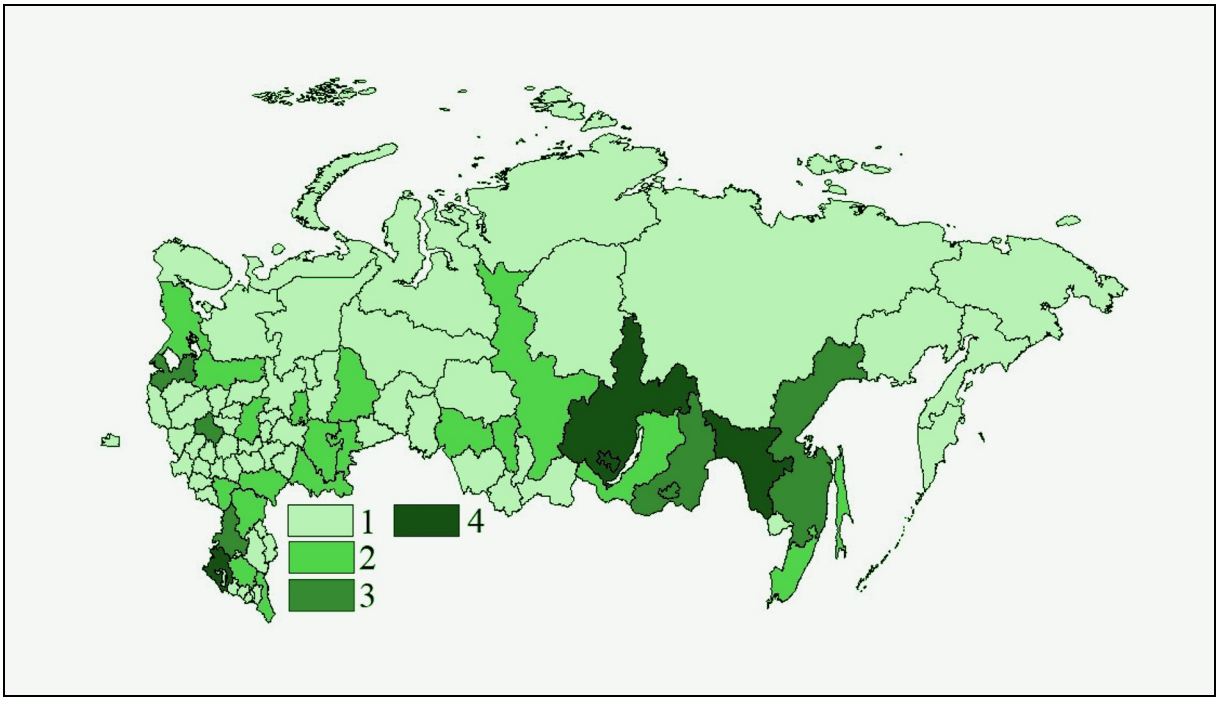

Figure 6. Risk of railway accidents (an annual average number of accidents in 1992-2013): 1 – low (less than 0.3); 2 – middle (0.3-0.6); 3 – high (0.7-0.9); 4 – very high (more than 1).

As the analysis revealed, the main causes of accidents were a “human factor”, a high level of the deterioration of railway infrastructure, failure and wear of rolling stocks, as well as the impact of various adverse and hazardous natural processes and phenomena. This situation calls for the adoption of effective measures to reduce the risk of railway accidents, especially in those regions with the highest level of risk. First of all, it is necessary to modernize the transport infrastructure and rolling stocks, to increase a control over the quality of machinery and to comply with safety regulations and production discipline.

Conclusions. The main causes of road and railway accidents in the RF, their temporal and spatial distributions were analyzed. As the leading triggering factor of accidents, far ahead of the other factors, ranked a “human factor” (traffic violations by drivers, such as speeding and driving under the influence of alcohol, attempts of drivers of motor vehicles to “skip” before approaching trains at unguarded railway crossings, and other human errors). Although driving under the influence of alcohol accounted for 7.7% of all road traffic crashes at the national level, its proportion increased to one-fifth in some federal regions. The local authorities should pay special attention to this problem and take extra regulations to limit this factor.

A high degree of deterioration of tracks, rolling stocks, signaling means, means of railway centralization and blocking, and other technical problems were also increasing. This situation calls for the modernization of the transport infrastructure.

In some regions, as the most severe problem remained the poor state of roads and streets causing almost 40-50% of road accidents there. This factor triggered about one-fifth of all road traffic crashes in Russia during the last ten years. Insufficient states of municipal and regional roads especially at the boundaries between federal regions also need extra measures at regional levels.

The regions most at risk due to manifestation of these factors were revealed.

The future spatial analysis of transport (un-)safety in Russia should be continued at the regional and local levels taking into account all means of transportation.

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