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ROAD ACCIDENTS IN RUSSIA: STATISTICAL AND GEOGRAPHICAL ANALYSIS

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Abstract: Road transport is the most dangerous means of modern transportation. About 1.24 million people die annually on the world's roads. Middle-income countries including the Russian Federation have the highest road traffic fatality rates. The author analyzed the main causes of road accidents in the Russian Federation, their temporal variation and spatial distribution as well as temporal change in the number of road accidents, fatalities and injuries over the last 10 years at national and regional level using official statistics data and information of the database created by the author. The main purpose of the study is to trace regional differences in road (un-)safety, to find out the most critical points and to reveal areas most at risk. The study was done at the level of the main administrative units of the Russian Federation (federal regions). As the leading cause of road accidents in Russia, rank traffic violations by drivers, including drunk driving that accounts for one-fifths of car crashes in some regions. In some regions, as the most severe problem remains the poor state of roads and streets causing 40-50% of accidents there.

Keywords: *road accidents, geographical analysis, regional differences, Russian federal regions*

I. INTRODUCTION

Road transport (especially by automobile) is the most dangerous means of modern transportation. As the World Health Organization (WHO) admitted, “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 evident from the following facts: about 1.24 million people die annually on the world's roads (more than 3,000 deaths a day); and another 20 to 50 million sustain nonfatal injuries due to road traffic crashes (WHO, 2013). Road traffic injuries are the eighth leading cause of death globally (WHO, 2011), and the leading cause of

death for young people aged 15 to 29 (Murray, 2012). Most critical is the fact that 27% of all road traffic deaths occur among pedestrians and cyclists (WHO, 2013). 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 each year, unless urgent action is taken (WHO, 2010). The economic consequences of motor vehicle 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 Russian Federation and Romania, which are motorizing rapidly, have the highest road traffic fatality rates and the highest deaths proportions among pedestrians.

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 Russian Federation also belongs to the countries having national road safety strategy based around five key pillars: road safety management, safer roads and mobility, safer vehicles, safer road users, and post-crash response. Fatality reduction target of the Russian national road safety strategy is from 23.5 to eight deaths per 100,000 population between 2007 and 2030.

Table 1 contains international comparison of some road transport and road safety / unsafety 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 *1000) | Proportion of paved roads (%) | Road density (km /sq.km *1000) | Total registered vehicles *1,000,000 | Accidents with injuries *1000 | Reported road traffic fatalities | Estimated GDP lost due to road crashes (%) |
|----------------------|----------------------------|-------------------------------|--------------------------------|--------------------------------------|-------------------------------|----------------------------------|--|
| Russia ¹ | 930.4 | 78.5 | 54.4 | 43.3 | 199.9 | 26567 ² | 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 | ... |

¹2011; ²2010; ³2009; ⁴2008; ⁵2007; ⁶2006; ⁷2005

As by the end of 2011, Russia had 930,400 km of roads, of which 78.5% were paved (FSSS b, 2012). With a large land area, the road density is the lowest of all the G8 countries and amounts to 54.4 km / 1,000 km². However, in the North-Caucasian and Central Federal Districts, it is much higher. The highest densities of paved public roads in Russia have Moskovskaia region, Ingushetia and Adygeia Republics with 672, 586 and 556 km / 1,000 km², respectively (FSSS a, 2012).

As of 2010, more than 43.3 million vehicles were registered in the Russian Federation including about 34.4 million cars and 4-wheeled light vehicles (79%), 2.7 million motorized 2- and 3-wheelers, more than 5.4 million heavy trucks, and 893.8 thousands buses (RSD, 2010). The highest numbers of the registered cars per 1,000 inhabitants have Kamchatskii Krai (384.9 in 2011), Moskovskaia (304.2) and Tverskaia (297.6) regions (FSSS a, 2012).

The most part of studies investigating road accidents in Russia are focused on either the juristic or the medical issues (Starodubov and Borovkov, 2010; Kudryavtsev et al., 2013), some other researches summarize national statistics and regard mostly severe road traffic crashes, their causes and consequences (Ovcharov et al., 2012). Only few papers concern triggers and effects of road accidents both at country and regional level (Abbasova and Vashkina, 2013) and their spatial distribution (Petrova, 2011). We can state lack of research in the field of geographical accident analysis, the same problem that Dicu and Stângă (2013) found for Romania.

The author analyzed the main causes of road accidents, their temporal variation and spatial distribution as well as temporal change in the number of road accidents, fatalities and injuries in the Russian Federation over the last 10 years at the national and regional level using official statistics data and information of the database created by the author. The main purpose of the study is to trace regional differences in road (un-)safety, to find out the most critical points and to reveal areas most at risk.

II. RESEARCH REGION

The study was done at the level of the main administrative units of the Russian Federation (federal regions or subjects of the federation). These units correspond to states in the USA or federal lands in Germany. The Federal State Statistics Service (FSSS) and other federal institutions of the Russian Federation publish usually their official statistics data for these units, which represent the highest administrative level. Therefore it is only possible to use these administrative units for comparative statistical analysis within the country.

The Russian Federation consists of 83 federal regions (Fig. 1) including 21 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, are separate federal regions too (federal cities).



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

III. DATA AND METHODS

Official statistics data of Road Safety Department of the Ministry of Internal Affairs of the Russian Federation as well as statistics data of the Federal State Statistics Service were mainly used for this study. This information is open to the public.

Additionally, the author has created an electronic database of technological accidents and disasters that occurred in the Russian Federation since 1992 (Petrova, 2008). Official daily reports of the Russian Ministry of Emergency and mass media news reports served as initial source of this information. Occurrence time and location, a type of accident, a number of fatalities and injuries, economic and

ecological losses as well as a probable cause of accident, if available, are registered there; a short description of each event is also recorded. The information collected in the database, regarding road accidents, was also used in the analysis. Of course, the database cannot claim complete coverage of all road accidents. Only severe road traffic crashes causing five or more fatalities and ten or more injuries, which are reported by the Ministry of Emergency and draw attention of mass media, can be listed in the database. However, the database allows us to analyze some information that is not usually included into the official statistics reports, for example, about the influence of adverse weather conditions or some other factors.

Using the statistics data collected and summarized over the last 10 years, graphs showing temporal change in the number of road accidents, fatalities and injuries at the national level of the Russian Federation were constructed and analyzed.

Occurrence frequencies of road accidents at the level of the Russian main administrative units were statistically assessed. For this purpose, average annual numbers of road accidents per 100,000 inhabitants were calculated for each federal region from 2002 to 2011. Five groups of regions having different levels of accident occurrences were revealed. Digital map showing the results was created.

The contribution of different factors triggering road accidents was also calculated for the Russian Federation as a whole and for each federal region. Graphs showing temporal variation of these triggers at the national level from 2003 to 2012 and digital maps of their spatial distribution at the regional level in 2012 were constructed.

IV. RESULTS AND DISCUSSION

IV.1. Temporal variations

As analysis of the statistics revealed, road accidents cause the majority of victims and injuries among of all technological accidents occurring in Russia and rank as the second after fires by the number of accidents (Petrova, 2005). In 2012, the Road Safety Department (RSD) of the Ministry of Internal Affairs of the Russian Federation registered 203,597 road traffic crashes that caused 27,991 fatalities and 258,618 injuries (RSD, 2012). Fig. 2 shows the temporal change in the number of road accidents, fatalities and injuries in Russia over the past 10 years (from 2003 to 2012). The number of accidents and injuries increased between 2003 and 2007, then significantly decreased to 2010 due to stricter road traffic rules and higher penalties and was slightly increasing during the last two years; the number of fatalities had an overall trend to decreasing with its minimum in 2010.

All three indicators are also subject to seasonal variations, having the highest values of road accidents, fatalities and injuries in summer, especially in August, and the lowest ones in February. This fact can probably be explained by increasing car use during the warmer summer months as well as by increasing mobility of the population due to the summer holiday season. Adverse weather conditions such as snowfalls or icing roads during the cold season are responsible for increasing in the number of road accidents in late autumn, in winter and early spring.

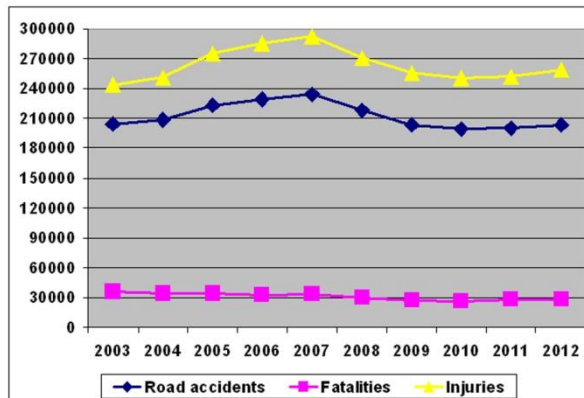


Fig. 2 Temporal change in the number of road accidents, fatalities and injuries in Russia in 2003-2012 (aggregated data from RSD, 2004-2012)

IV.2. Triggering factors

As the leading cause of road accidents in Russia, rank traffic violations by drivers including speeding and driving under the influence of alcohol (drunk driving). Many studies investigate both factors, showing their influence on increasing the relative risk of accidents and fatalities including pedestrian fatality risk (Baum et al., 1991; Shibata and Fukuda, 1994; McLean and Kloeden, 2002; Rosén et al., 2011). Drivers cause 87.2% of all car crashes in Russia; drunk driving accounts for 7.2% of them.

The poor state of roads and streets cause 21.0% of all road traffic crashes. Accidents due to operation of technically defective vehicles are minor and account for only 0.5% of all car crashes. Although illegal road crossing and other violating traffic rules by pedestrians account for 14.0% of all road accidents in Russia, pedestrians represent the most part of road traffic death (about 33%) following by drivers (28%) and passengers of 4-wheeled cars and light vehicles (25%) (Fig. 3).

ROAD ACCIDENTS IN RUSSIA

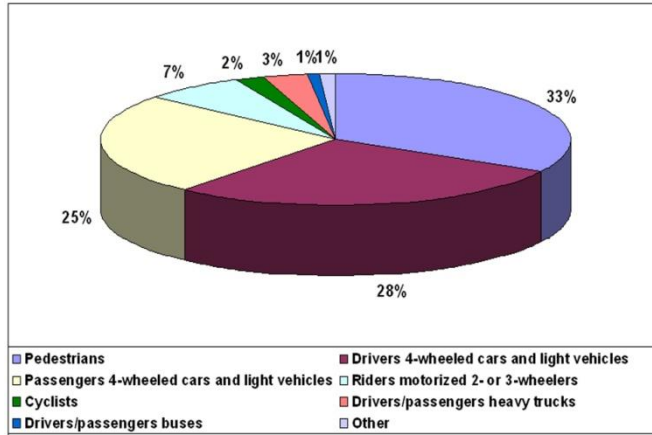


Fig. 3 Deaths by road user category in the Russian Federation (RSD, 2010)

Fig. 4 shows the temporal change in the number of road accidents due to different triggers over the last 10 years. The proportion of accidents caused by drivers' traffic violations was constantly increasing (from 77.7% in 2003 to 87.2% in 2012), while the proportion of accidents due to drunk driving and violating traffic rules by pedestrians was decreasing (from 15 to 7.2% and from 26.8 to 14% between 2003 and 2012, respectively).

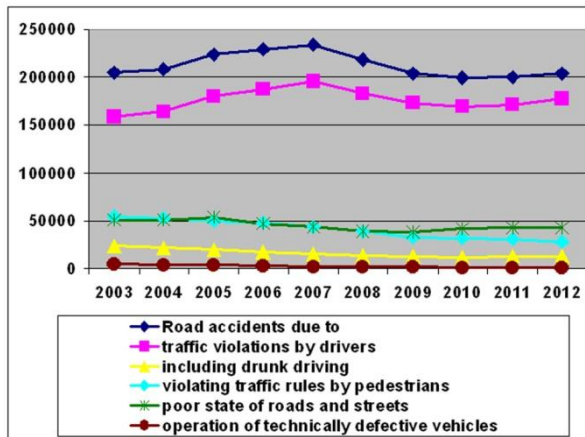


Fig. 4 Temporal change in the number of road accidents caused by different triggers (Aggregated data from RSD, 2004-2012)

The poor state of roads and streets remained approximately at the same level and accounted for about one-fifth of all road traffic crashes. 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 official statistics data not include the information about contribution of natural hazards and adverse weather conditions to occurrences of road accidents. However, the information collected by the author in the database of technological accidents and disasters allow us to fill this gap. As analysis of the database revealed, about 3% of all severe road accidents are caused by various natural factors. The most important among them are snowfalls and snowstorms, icy conditions of roads, rainfalls, fogs, and mist.

IV.3. Regional differences

The proportion of road safety / unsafety indicators and their temporal change reported above have not been uniform across the whole country and can only give an overall picture of the situation at the federal level. The contribution of various triggers and consequences of road accidents vary greatly in different regions of Russia depending on many factors. The results of the statistical and geographical analysis at the level of the Russian federal regions are as follow.

IV.3.1. Road accidents, fatalities and injuries

In terms of absolute values, road accidents occur most often in Moscow, Moskovskaia region and St. Petersburg, which have the highest level of the road density and road flow, and the largest number of the registered cars in Russia. These regions also lead in absolute numbers of injuries in road traffic crashes. In 2012, there were recorded 12,010 (5.9%), 9,241 (4.5%) and 8,288 (4.1%) road accidents that accounted for 810, 1,706 and 445 fatalities, and 14,000, 11,434 and 9,920 injuries, respectively (RSD, 2012). Moskovskaia region leads in absolute number of fatalities, followed by Krasnodarskii krai (1,190) and Sverdlovskaia region (836). The main causes for the high rate of road fatalities in these regions are non-compliance with the rules relating to speed of vehicles and right-of-way as well as drunk driving. In Krasnodarskii krai the situation is additionally complicated by the mountainous terrain and in Sverdlovskaia region by the poor state of roads.

Quite different results are obtained using weighted indicators per 100,000 inhabitants, which allow us to compare different regions with each other, eliminating their inequalities in population. Thus, the highest numbers of road accidents per 100,000 inhabitants had Pskovskaia and Novgorodskaia regions as

well as Evreiskaia AO with 258.6, 247.4 and 242.4 accidents per 100,000 inhabitants in 2011, respectively. In the value of fatalities per 100,000 inhabitants led Tyva Republic (46.6 in 2011), Pskovskaia (38.3) and Leningradskaia (37.2) regions (FSSS a, 2012). The highest numbers of injuries per 100,000 inhabitants in 2012 had Kalmykia Republic, Tiimenskaia and Pskovskaia regions, which exceeded by almost two times the national level (RSD, 2012). The main causes are human (drivers' traffic violations) and natural factors (icy conditions of roads, snowfalls, etc.).

An average annual frequency of road accidents per 100,000 inhabitants was calculated for each federal region from 2002 to 2011. Five groups of regions having different levels of accident occurrences were revealed. Fig. 5 shows the results. The highest level of this indicator (more than 190 accidents) have Pskovskaia, Novgorodskaia and Arhangelskskaia regions in the North-Western Russia, Vladimirirskaia and Ivanovskaia regions in the Central Russia, Magadanskaia, Sakhalinskaia regions and Primorskii krai in Far East, and Tiimenskaia region, Khakasia and Altai Republics in Siberia.

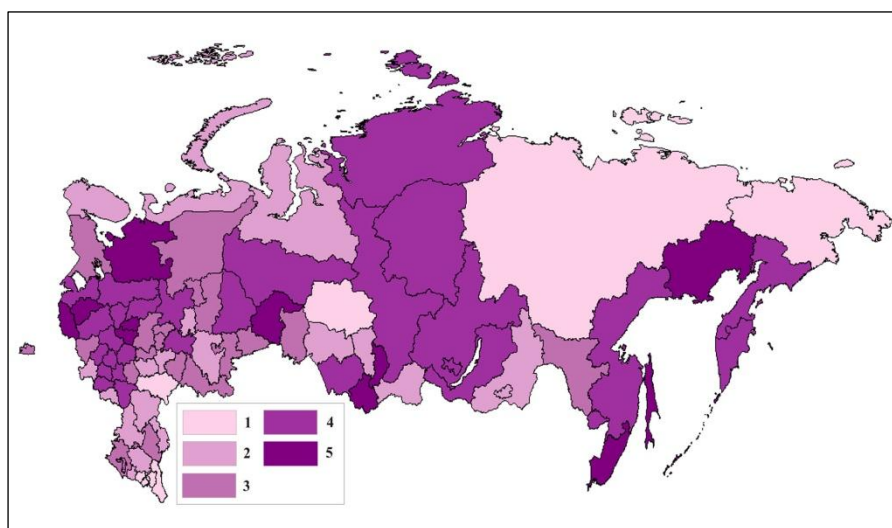


Fig. 5 An average annual frequency of road accidents per 100,000 inhabitants in Russia (2002-2011): 1 – less than 100; 2 – 101-130; 3 – 131-160; 4 – 161-190; 5 – more than 190

IV.3.2. Regional variations of causes

The analysis of regional variations of the main causes of road accidents in 2012 found out that the least law-abiding drivers in Ingushetia Republic triggered

97.4% of car crashes unlike to ones in Novosibirsk region causing 80.5 % (minimum); the average for Russia is 87.2.

The most serious problem with drunk driving had Chukotskii AO: alcohol caused 22.7% of all car crashes in the region that occurred due to traffic violations by drivers. The most disciplined drivers in this regard live in Chechnia Republic (the contribution of drunk driving accounted for only 0.9% of registered car crashes due to drivers), St. Petersburg (1.5) and Moscow (2.3%).

The most undisciplined pedestrians contributed to 27.9% of road accidents in Tyva Republic (maximum) unlike to Khanty-Mansiyskii AO (minimum) where they caused only 5.6% of accidents (the average for Russia is 14.0).

The contribution of poor state of roads and streets varied from 44.6% in Stavropolskii krai to 1.0% in Chechnia. The highest proportion of accidents due to operation of technically defective vehicles was recorded in Tyva Republic (6.8); no accidents due to this trigger were registered in Moscow, St. Petersburg, Leningrad region, and Bashkortostan Republic (RSD, 2012).

Thus, the greatest regional differences among of all factors considered were found in the contribution of poor state of roads and streets and in the problem of drunk driving. Fig. 6 and 7 show geographical distribution of these indicators at the level of the Russian federal regions.

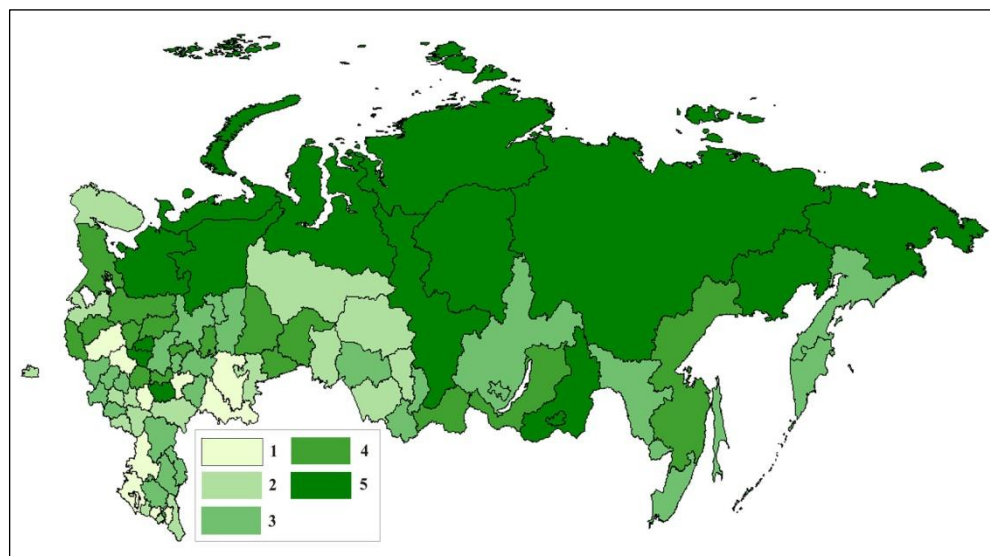


Fig. 6 The proportion of road accidents triggered by drunk driving in the whole number of accidents due to drivers (2012): 1 – less than 4%; 2 – 4-7%; 3 – 7-10%; 4 – 10-13%; 5 – more than 13%

The most serious problem with drunk driving have the most northern federal regions of Russia including Chukotskii and Nenezkii AO, Yakutia and Komi Republics, Magadanskaia and Arhangelskaia regions, Krasnoyarskii krai, as well as some regions of the Central Russia and Siberia (Fig. 6). These regions need extra regulations of this factor by local authorities.

The problem of poor state of roads is more severe in some regions of the South and the Central Russia including Stavropolskii krai, Astrakhanskaia, Moskovskaia, Samarskaia, Yaroslavskaia, and Voronezhskaia regions, as well as Sakhalinskaia region (Fig. 7).

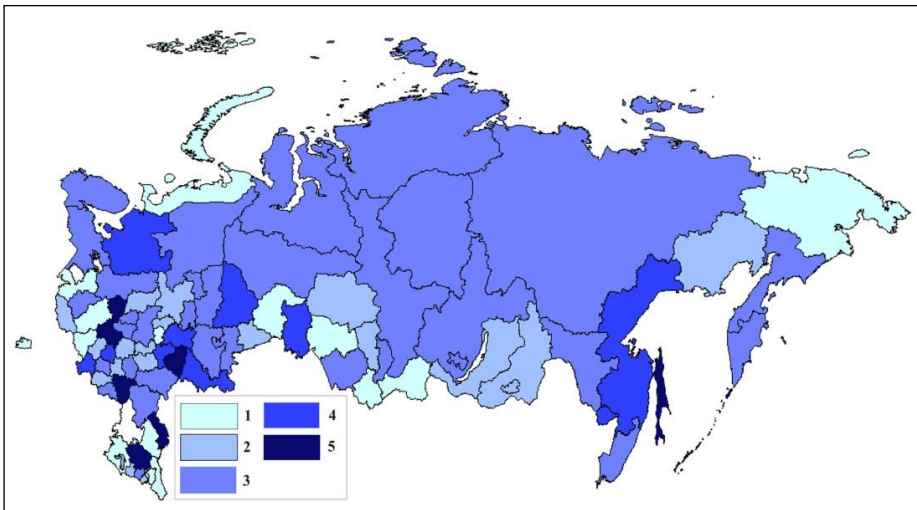


Fig. 7 The proportion of road accidents caused by poor state of roads and streets (2012): 1 – less than 15%; 2 – 15-20%; 3 – 20-25%; 4 – 25-30%; 5 – more than 30%

V. CONCLUSION

The main causes of road accidents in the Russian Federation and their temporal and spatial distribution were analyzed. As the leading triggering factor of road accidents, far ahead of the other factors, rank traffic violations by drivers including speeding and driving under the influence of alcohol. Although drunk driving accounts for 7.2% of all road traffic crashes caused by drivers at the national level, its proportion increases 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.

In some regions, as the most severe problem remains the poor state of roads and streets causing almost 40-50% of road accidents there. It 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 the regional level.

The regions most at risk due to manifestation of these factors were revealed. The future spatial analysis of road unsafety in Russia should be continued at the regional and local levels.

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