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## Territorial fire statistics and assessment of their causes and consequences on the example of the Rostov region

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*Introduction.* A deep and comprehensive analysis of the parameters of the situation with fires in the territories of the Russian Federation and its relationship with socio-economic processes is more relevant than ever for Russia. The article presents, summarizes and analyzes statistical data on the situation with fires and their consequences on the territory of the Rostov region for 2018-2019.

*Problem Statement.* The paper considers the problem of official statistical accounting of fires, the procedure for accounting for people killed and injured in a fire in the context of a changing regulatory framework in this area. The analysis of the situation, official and verified information on fires and their consequences will create a reliable socio-economic characteristic of the Rostov region.

*Theoretical Part.* The paper deals with the peculiarities of accounting of fires and their consequences in Russia. The source materials are the official statistics of the MD of the MES of Russia for the Rostov region on the number of fires on the territory, months, the number of people injured and killed in fires and their distribution by gender, age and time of death, objects and causes of fires.

*Conclusion.* The analysis of fire statistics on the territory of the Rostov region for 2018-2019 is based on official data of the MD of the MES of Russia for the Rostov region, which indicates the reliability of the information provided. Statistical data were evaluated for key factors affecting fire safety: by the number of fires on the territory of the Rostov region, days of the week, months, the number of people injured and killed in the fires and their distribution by gender, age and time of death, objects and causes of fires. Research prospects are outlined.

**Keywords:** fire situation, statistics, consequences and causes of fires, fire objects.

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**Introduction.** A deep and comprehensive analysis of the parameters of the situation with fires in the territories of the Russian Federation and its relationship with socio-economic processes is relevant for Russia. On the example of the Rostov region, the dynamics of fire distribution by causes and objects of occurrence and localities is considered. It also provides statistical information on the age, time of day, days of the week, months, and physiological state of people who died or were injured in a fire. This detailed analysis of statistical data processing will allow for a more correct approach in the future to develop a number of recommendations for improving fire risk management.

**Problem statement.** The authors comprehensively consider the problem of official statistical accounting for fires, the procedure for accounting for people killed and injured in a fire in the context of a changing regulatory framework in this area. The analysis of the situation, official and verified information on fires and their consequences will create a reliable socio-economic characteristic of the Rostov region.

**Specifics of the procedure for registering data on fires and their consequences in the Russian Federation.** In order to comply with the provisions of key legal documents [1-3] regulating the procedure for registering data on fires and their consequences in the Russian Federation, a unified state system for statistical accounting for fires and their

consequences is functioning, the main activity of which is legally performed by the State Fire Safety Service of the EMERCOM of Russia. The official information on fires and subsequent negative events is generated by Rosstat [4].

The Department of Supervision and Preventive Work of the Ministry of Emergency Situations of Russia prevents the occurrence of fires in various regions of the Russian Federation and eliminate their consequences. Its tasks are:

- getting information from the respondents on fires that caused injury or death;
- analysis of the information received and its provision to the state structures that carry out fire supervision;
- receiving, processing and submitting the administrative information on fires that caused injury or death to the Federal state budgetary institution Fire Safety Research Institute EMERCOM of Russia [5].

The coordination of work on the registration of data on fires and their consequences is entrusted to the official statistical office, which performs monitoring, data analysis and statistics on the distribution of the number of fires, dead and injured people. The observation stage is based on statistical and administrative information collected by the respondents [6].

Registration of data on fires and their consequences at the state level is carried out on the basis of:

- reports on fires and their consequences provided by the Department of Supervision and Prevention of the EMERCOM of Russia;
- reports on fires and their consequences, provided by the Federal bodies of Executive power in the subordinate objects.

Since January 1, 2019, statistics have changed, the concept of "catching fire" was excluded. Now it is assumed to account for people who have received injuries that are the reasons for their hospitalization or need outpatient treatment.

The established procedure for registering data on fires and their consequences is mandatory for state authorities, local self-government bodies, organizations and citizens engaged in business activities without forming a legal entity [7].

Official statistical information on fires and their consequences is publicly available, except for information that is restricted by Federal laws.

**Territorial fire statistics.** In 2019, the situation with fires in the Rostov region, compared to the same period of the previous year (hereinafter referred to as the SPPY), had the following main indicators:

- 91 9175 fires were recorded (SPPY — 13964 (–34.3 %);
- 191 people were killed in the fires (SPPY — 210 (–9.04%), of which 3 were children (SPPY — 15 (–80.0 %);
- 224 people were injured in fires (SPPY — 277 (–19.1 %);
- direct material damage was caused in the amount of 294 million 336 thousand rubles. (SPPY — 248 million 15 thousand rubles (+18.7 %).

The Federal Fire-Fighting Service units saved 4,130 people and property worth 2 billion 722 million 652 thousand rubles during the fires.

Figure 1 shows the distribution of the number of fires in the Rostov region by months. As it can be seen from the graph, compared to the same period in 2018, there was an increase in the number of fires in February by 40.2 %, in March by 83.2 %, and in November by 48.3 %. In the remaining months of the year, a decrease in the number of fires was recorded [8, 9].

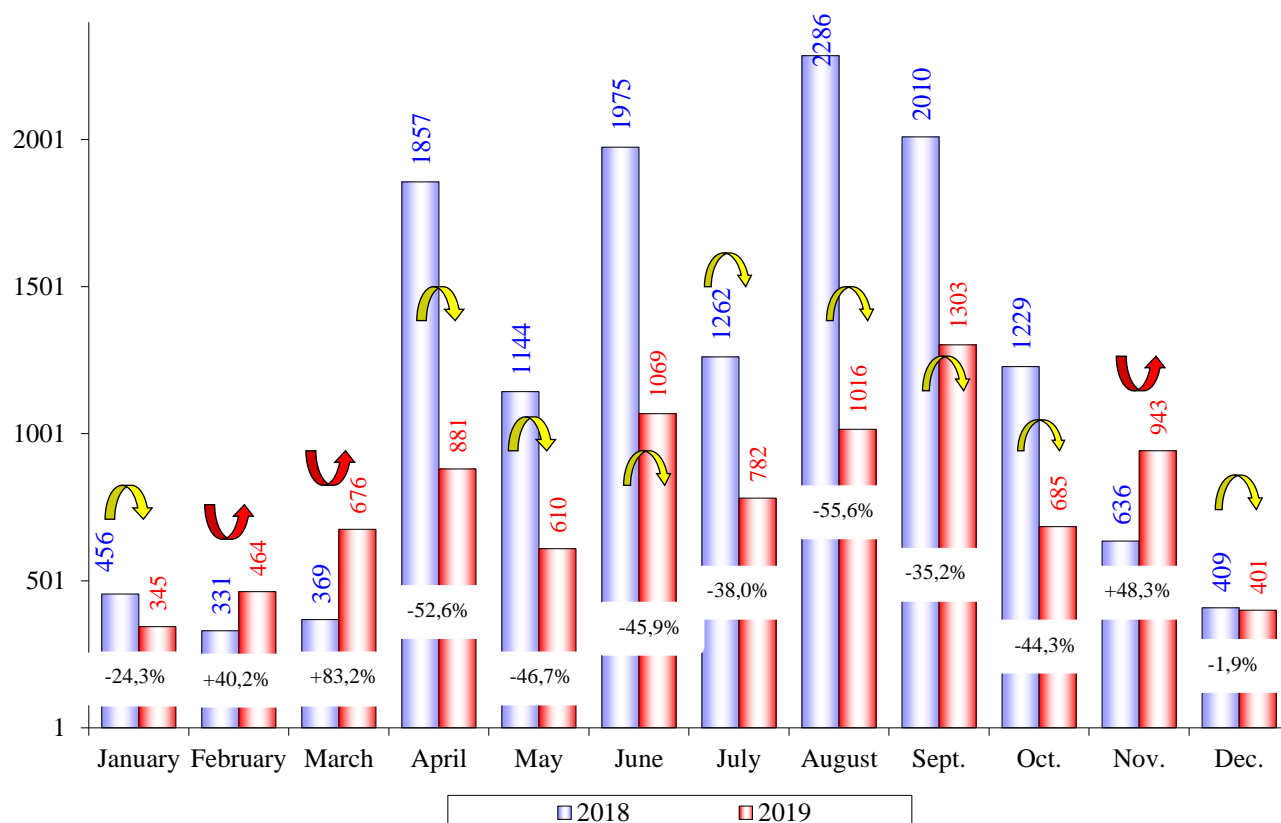


Fig. 1. Distribution of the number of fires in the Rostov region by month

The reduction in the number of people killed was registered in 25 municipalities: Bataysk (–50.0 %), Gukovo (–80.0 %), Zverevo (–100 %), Taganrog (–33.3 %), Shakhty (–30.0 %), Aksay (–22.2 %), Belokalitvinskiy (–42.9 %), Veselovskiy (–100 %), Dubovskiy (–33.3 %), Egorlykskiy (–25.0 %), Zavetinskiy (–100 %), Zernogradskiy (–83.3 %), Kagalnitskiy (–100 %), Kasharskiy (–50.0 %), Konstantinovskiy (–66.7 %), Krasnosulinskiy (–87.5 %), Kuybyshevskiy (–100 %), Millerovskiy (–50.0 %), Oblivskiy (–80.0 %), Rodionovo–Nesvetayskiy (–25.0 %), Semikarakorskiy (–50.0 %), Tarasovskiy (–100 %), Ust–Donetskiiy (–80.0 %), Chertkovskiy (–100 %), Volgodonskiy (s) (–66.7 %) districts (Fig. 2).

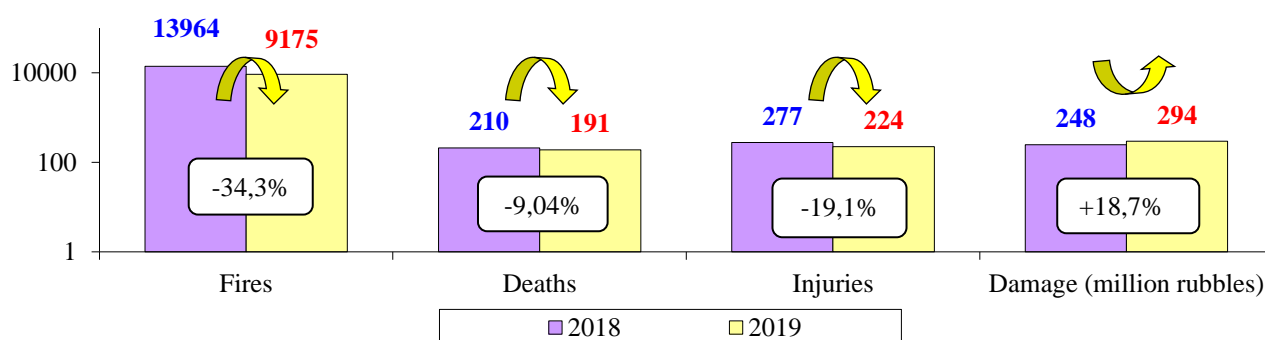


Fig. 2. Number of fires and people killed in the Rostov region

The decrease in the number of people injured in fires occurred on the territory of 23 municipalities: Rostov-on-Don (–15.4 %), Azov (–75.0 %), Bataysk (–100%), Volgodonsk (–75.0 %), Gukovo (–66.7 %), Donetsk (–100 %), Novocherkassk (–53.9%), Novoshakhtinsk (–18.2 %), Shakhty (–70.0 %), Bagaevskiy (–50.0 %), Dubovskiy (–60.0 %), Egorlykskiy (–66.7 %), Zimovnikovskiy (–25.0 %), Kamenskiy (s) (–25.0 %), Matveevo–Kurganskiy (–75.0 %),

Milyutinskiy (–100 %), Oblivskiy (–100 %), Oktyabrskiy (s) (–33.3 %), Salskiy (–57.1 %), Semikarakorskiy (–60.0 %), Tarasovskiy (–67.7 %), Chertkovskiy (–50.0 %), Volgodonskiy (–50.0 %) districts.

An increase in the number of people injured in fires was recorded in Zverevo (+50.0 %), Kamensk-Shakhtinsk (+100 %), Azov (+42.9 %), Aksay (+50.0 %), Veselovskiy (+100 %), Sholokhovskiy (+100 %), Zavetinskiy (+100 %), Zernogradskiy (+50.0 %), Kagalnitskiy (+100 %), Konstantinovskiy (+100 %), Kuybyshevskiy (+100 %), Martynovskiy (+100 %), Morozovskiy (+100 %), Myasnikovskiy (+100 %), Neklinovskiy (+30.0 %), Remontnenskiy (+50.0 %), Tatsinskiy (+100 %), Tsimlyanskiy (+100 %), Sovetskiy (s) (+100 %) districts (Fig. 3).

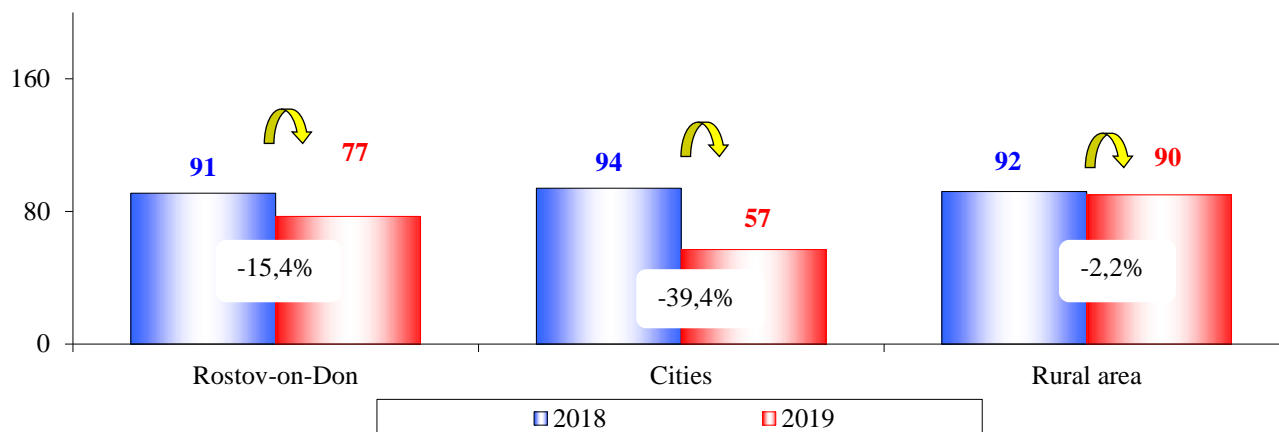


Fig. 3. The number of injured people in fires in the Rostov region

The dynamics of the number of fires decreased in cities, compared to the SPPY by 36.4 %, and in rural areas by 35.2 %. In Rostov-on-Don, the number of fires decreased by 26.1 %.

The increase in the number of people killed in the fire is noted in Rostov-on-Don (+36.0 %), Azov (+50.0 %), Volgodonsk (+500 %), Kamensk-Shakhtinsk (+25.0 %), Novocherkassk (+16.7 %), Novoshakhtinsk (+14.3 %), Azov (+57.2 %), Bagaevskiy (+50.0 %), Sholokhovskiy (+200 %), Kamenskiy (s) (+25.0 %), Martynovskiy (+300 %), M. Kurganskiy (+100 %), Myasnikovskiy (+100 %), Neklinovskiy (+100 %), Orlovskiy (+100 %), Peschanokopskiy (+50.0 %), Remontnenskiy (+100 %), Salskiy (+100 %), Tatsinskiy (+100 %), Tselinskiy (+100 %), Tsimlyanskiy (+100 %) districts of the region (Fig.4).

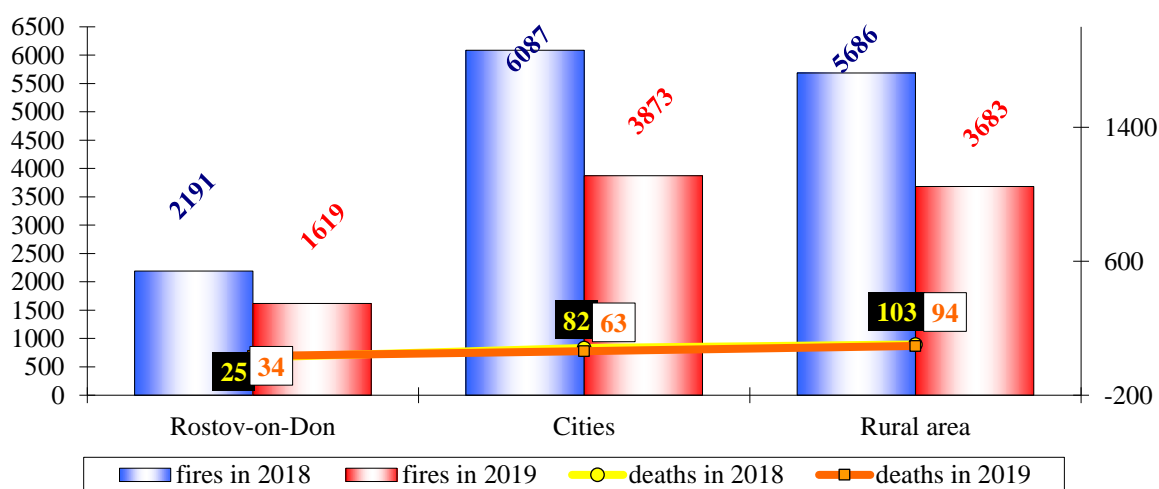


Fig. 4. Number of fires and deaths by region

Among people killed in the fires were men — 74.3 % (SPPY-71.9 %), women — 24.1 % (SPPY — 27.6%) of the total number. Gender was not determined in 1.6 % of the victims (SPPY — 0.5 %) (Table 1). At the same time, 34.6% of people killed in fires were under the influence of alcohol (drugs) (SPPY — 29.5% of the total number of deaths).

Table 1

Distribution of the dead by gender

Gender	Death toll in 2018	Death toll in 2019	% +,-
Male	151	142	-6,0
Female	58	46	-20,7
Gender is not determined	1	3	+200

1.7 % of the total number of victims were aged from 1 to 6 years (SPPY — 4.1 %), 13.0 % — from 20 to 40 years (SPPY — 17.5%), 44.1 % — from 41 to 60 years (SPPY — 38.7%) and 41.2 % — over 60 years (SPPY — 36.1%)

Table 2

Distribution of the dead by age

Age	Death toll in 2018	Death toll in 2019	% +,-
from 1 to 6 years	8	3	-62,5
from 7 to 13 years	4	0	-100
from 14 to 15 years	1	0	-100
from 16 to 19 years	2	0	-100
from 20 to 40 years	34	23	-32,4
from 41 to 60 years	75	78	+4,0
more than 60 years	70	73	+4,3

If we analyze by day of the week, a large number of fires was observed on Sunday — 1494 fires (16.3 % of the total number) and on Monday — 1360 fires (14.8% of the total number). The maximum number of fires was recorded on Wednesday — 1178 fires (12.8 % of the total number).

The highest number of victims (35 people, 18.3% of the total) — on Saturday, the lowest (19 people, 9.9 % of the total) — on Wednesday.

The main time of day when people were killed is evening and night hours. So, in the period from 8 p.m. to 01.59 a.m., 42 people were killed. In total, 118 people (61.8% of the total number) were killed in the period from 20.00 p.m. to 08.00 a.m. (Fig. 5).

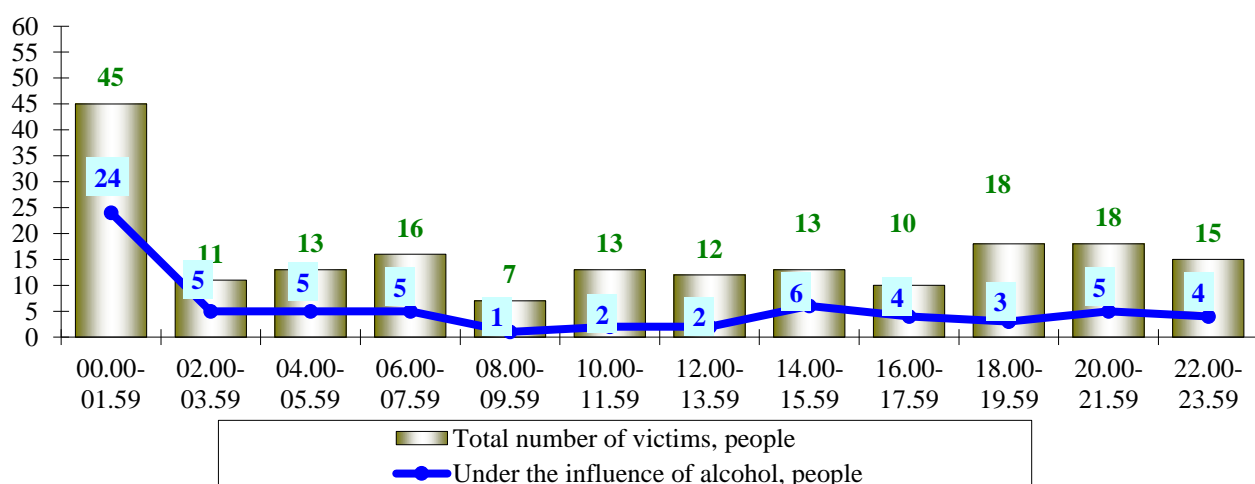


Fig. 5. Number of people killed by time of day

In 2019, there were 3 fires in the Rostov region, as a result of which 3 children died, and in the same period previous year there were 8 fires, the victims of which were 15 children (-80.0% of the SPY).

The main causes of fires that killed children in 2019 include: careless handling of fire — 2 cases, lack of design and manufacture of electrical equipment — 1 case.

Fires that caused the death of children occurred:

— during the period from 12 to 6 p.m. — 2 cases;

— in the period from 6 to 12 p.m. — 1 case.

In 2019 in the cities of the region there were registered:

— 5492 fires (–59.9 % to SPPY);

— 97 deaths (–9.3 % of the SPPY);

— 134 people injured (–27.6% of the SPPY).

Direct material damage was caused in the amount of 124 million 958 thousand rubles (–3.8 %).

The cities of the Rostov region accounted for:

— 59.9 % of the total number of fires;

— 42.5% of the material damage;

— 50.8 % of the number of people killed in fires;

— 59.8 % of injured people (Fig. 6).

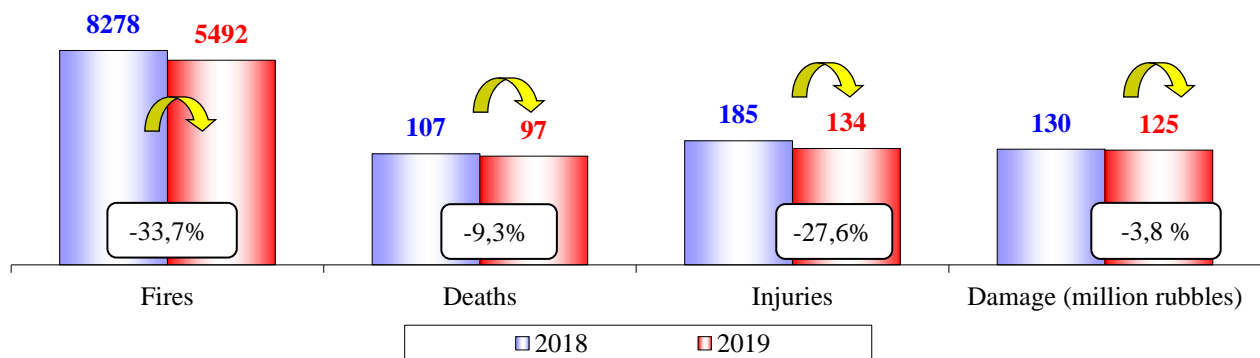


Fig. 6. Number of fires and their consequences in cities

In rural areas of the region there were registered:

— 3683 fires (–35.2 % to APPG);

— 94 deaths (–8.7 %);

— 90 people injured (–2.2 %).

Direct material damage was caused in the amount of 169 million 378 thousand rubles (+44.4 %).

Rural areas accounted for:

— 40.1 % of the total number of fires;

— 57.5 % of the material damage;

— 49.2 % of the number of people killed in fires;

— 40.2 % of injured people (Fig. 7) [10].

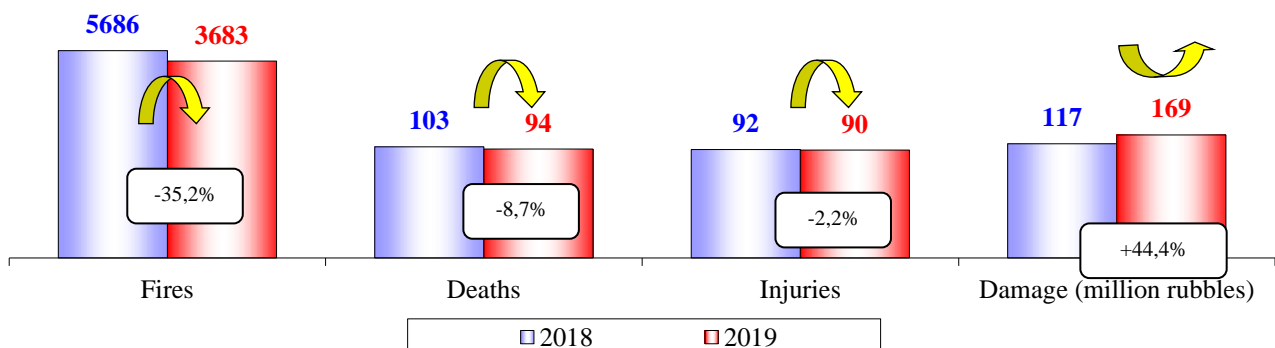


Fig. 7. Number of fires and their consequences in rural areas

In comparison with the SPPY, a decrease in the number of fires was recorded in garden houses (summer houses) (–38.0%), as well as in industrial facilities (–23.9%). There was an increase in the number of fires among motor vehicles (+18.8 %), unused buildings (more than 2 times), warehouse buildings (+40.0%), retail premises (+6.3%) (Fig. 8, table 3).

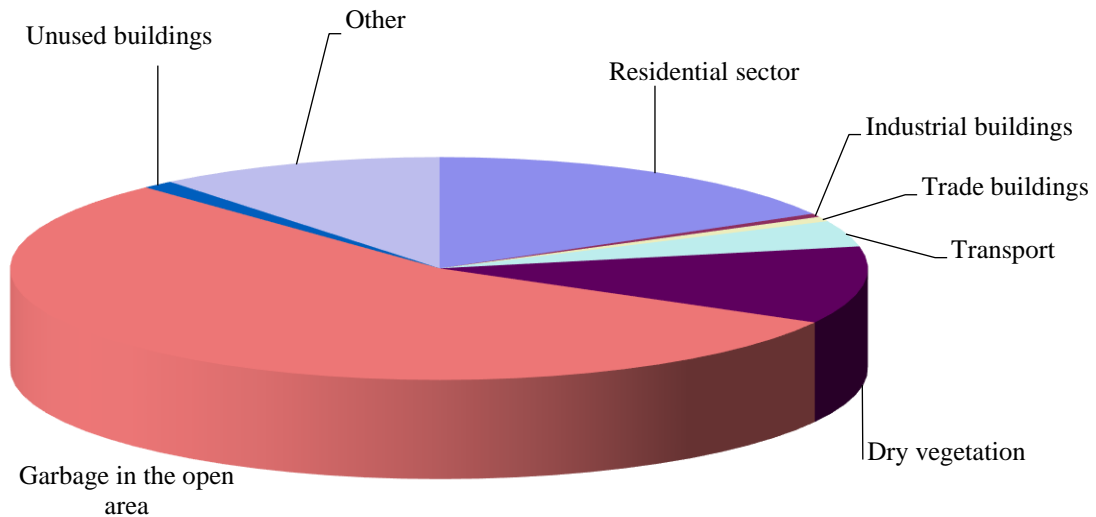


Fig. 8. Distribution of the number of fires by main objects from the total number of fires

Table3

Main objects of fires in comparison with the same period previous year

Fire objects	2018	2019	%	Fire objects	2018	2019	%
Industrial enterprises	55	37	−32,7	Public institutions	15	15	−
Storage facilities	15	21	+40,0	Dwellings	1539	1543	+0,3
Trading enterprises	64	68	+6,25	Agricultural buildings	7	9	28,6
Educational institutions	5	6	+20,0	Open areas	10510	6145	−41,5
Preschool institutions	2	1	−50,0	Buildings under construction	11	7	−36,4
Cultural organizations	6	6	−	Transport	293	348	+18,8
Medical institutions	2	4	+100	Others	1442	966	−33

Fig. 9 and table 4 show the main causes of fires and the dynamics of changes in their number.

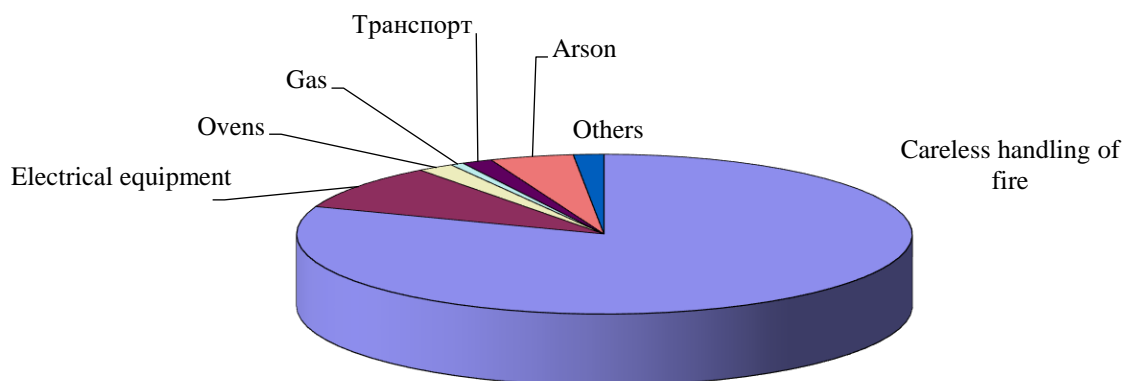


Fig. 9. Distribution of the number of fires according to the main reasons

Table 4

Main reasons of fires in comparison with the same period previous year

Cause of fire	2018	2019	%	Cause of fire	2018	2019	%
Arsons	373	407	+9,1	Careless handling of fire	653	7338	in 11 times
Disregard for the rules of electrical equipment safe operation	790	840	+6,3	Children play with fire	41	51	+24,4
Disregard for the rules of heat generator safe operation	10	22	in 2 times	Disregard for the rules of transport safe operation	113	147	+30,1
Disregard for the rules of ovens safe operation	183	152	-16,9	Disregard for the rules of safe operation when welding or machining metals	18	13	-27,8
Disregard for the rules of gas equipment safe operation	60	63	+5,0	Other reasons	121	142	-17,4

In relative terms, the situation with fires in the Rostov region in 2019 can be described as follows:

- the number of fires per 100 thousand people — 216.4 (34.3 % less than in the SPPY), for 2018 — 329.3 (the average figure for the Southern Federal District was 279.07 and for the Russian Federation — 320.72);
- the number of fire victims per 100 thousand people — 4.5 (10.0 % less than in the SPPY), for 2018 — 5.0 (the average figure for the Southern Federal District was 4.71 and for the Russian Federation — 5.79);
- average damage from a single fire — 32.1 thousand rubles (+80.3 %), for the SPPY 2018 — 17.8 thousand rubles (the average figure for the Southern Federal District was 22.54 and for the Russian Federation — 28.87).
- the number of people injured in fires per 100 thousand people — 5.3 (18.5 % less than in the SPPY), in 2018 — 6.5 (the average figure for the Southern Federal District was 4.76 and for the Russian Federation — 6.45).

Figure 10 shows the excess of 21.7 in the average number of fires (per 10 thousand population) in 28 cities and districts of the region. The values of the indicators are above the "red" line.

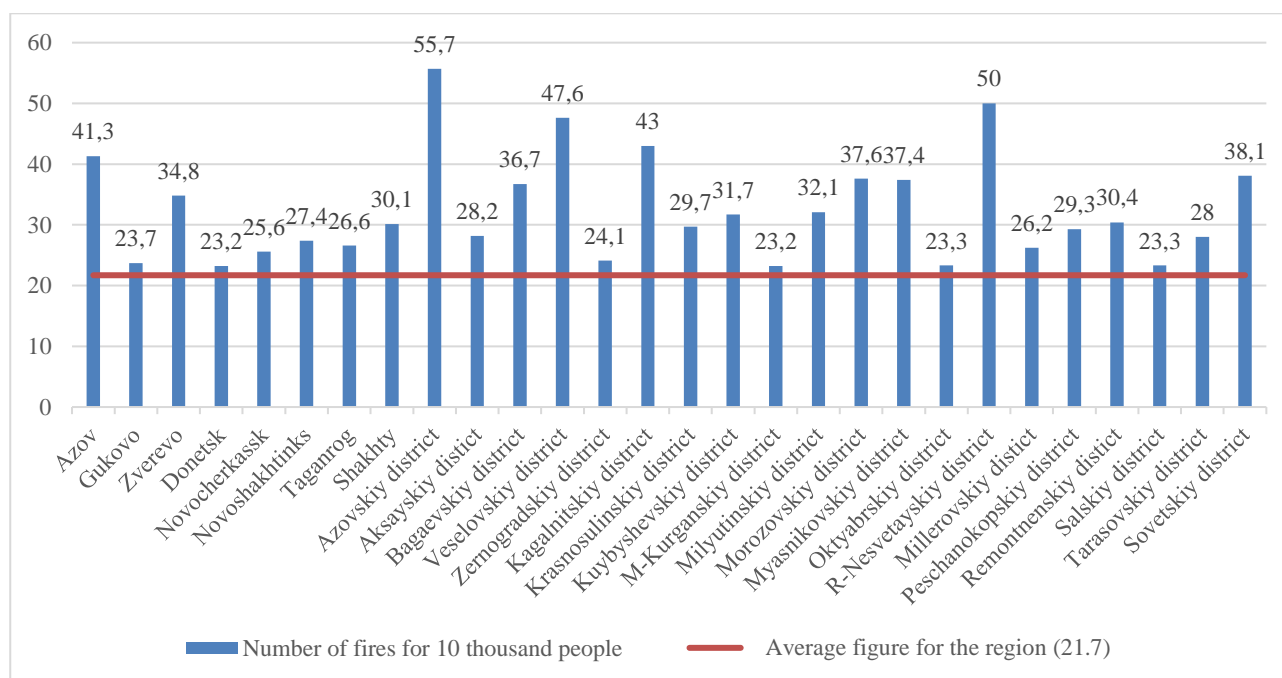


Fig. 10. The number of fires per 10 thousand people



Figure 11 shows an excess of 0.5 in the average number of people killed in fires (per 10 thousand people) in 26 cities and districts of the region. The values of the indicators are above the "red" line.

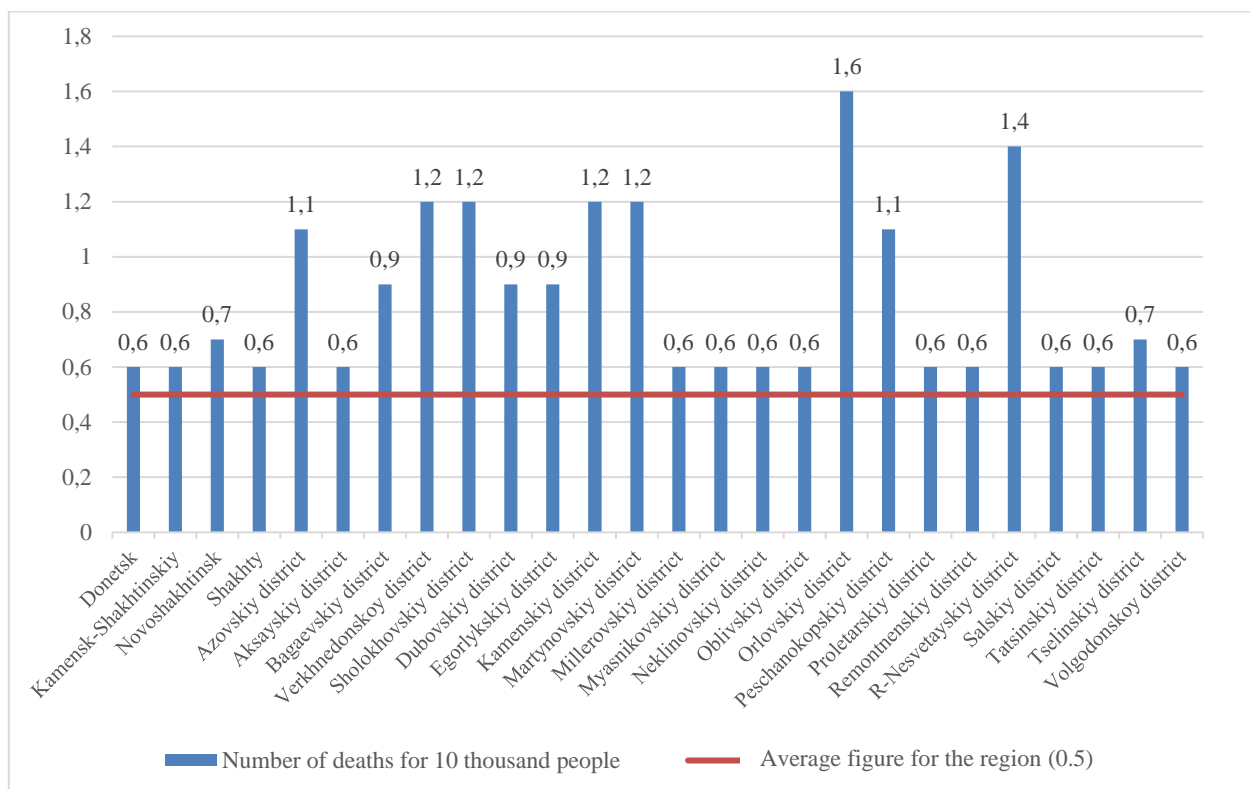


Fig. 11. The number of people killed in fires per 10 thousand people

Figure 12 shows an excess of 0.5 in the average number of injured people in fires (per 10 thousand people) in 21 cities and districts of the region. The values of the indicators are above the "red" line.

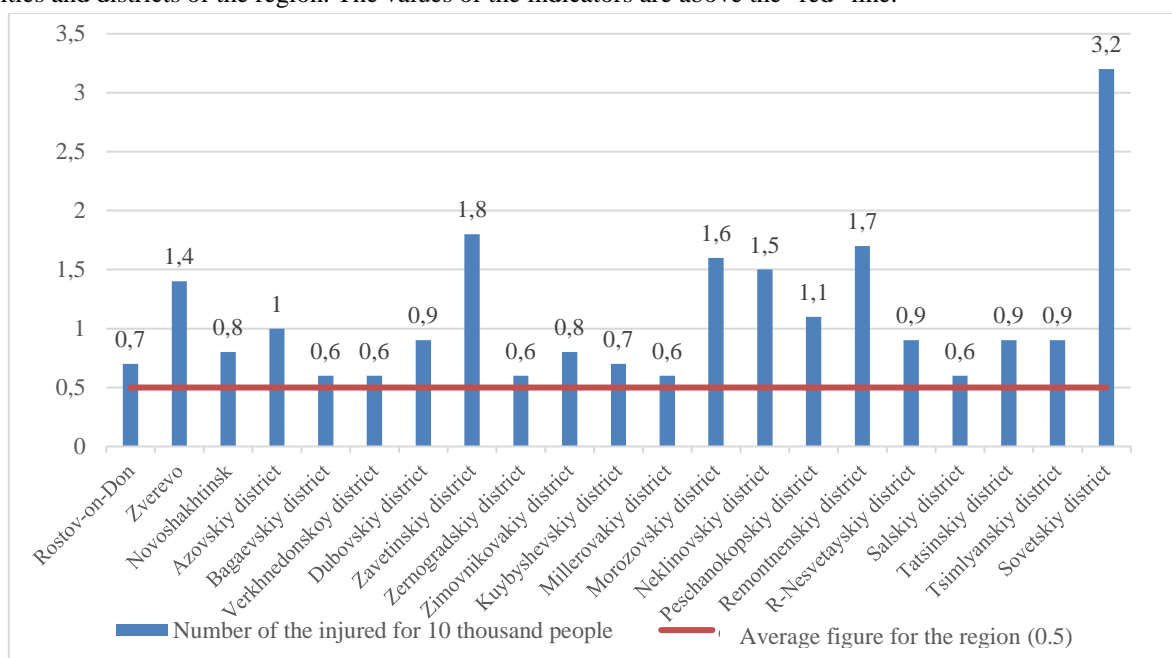


Fig. 12. The number injured in fires per 10 thousand people

**Conclusions.** The analysis of fire statistics in the Rostov region for 2018-2019 is based on the official data of the Ministry of Emergency Situations of Russia for the Rostov region, which indicates the reliability of the information provided.

Statistical data were evaluated based on key factors affecting fire safety: the number of fires in the Rostov region, days of the week, and months; the number of people injured and killed in fires and their distribution by gender, age, and time of death; objects and causes of fires.

As a result, a number of critical factors and conditions have been established, under which the risk of death and injury in fires is maximum:

- the average risk of death in a fire in the Rostov region is  $5 \times 10^{-5}$  people/year, but there are areas where it is 3-6 times higher and does not correspond to the acceptable indicator in Russia (Orlovskiy, Azovskiy and Rodionovo-Nesvetayskiy districts);

- cities in the region take the first place in the number of fires compared to rural settlements and their growth is observed;

- most often, garbage burns in an open area, and fires occur in the residential sector;

- the largest number of fires among objects in the Rostov region occurs at industrial and commercial enterprises;

- August and September are the traditional months of the year with the highest number of fires;

- there are cases of death and injury in a fire on Saturday and Monday, most often during the week, as well as in the evening and at night;

- men die approximately 3 times more often than women in fires;

- the highest number of people killed and injured in a fire is among people aged 41-60 years and 60+.

The main causes of fires in the region are the following:

- disregard for the rules of installation and operation of electrical equipment;

- arsons;

- disregard for the rules of safe operation of furnaces.

Consequences of the negative impact of fires are directly related to the amount of material damage. So in 2019, in the cities of the region, direct material damage was established in the amount of 124 million 958 thousand rubles, and in rural areas, direct material damage amounted to 169 million 378 thousand rubles.

In comparison, in 2019, in Russia as a whole, material damage from fires was 18.2 billion rubles. Compared to the previous year, the amount of material damage increased by 17.1 %. Every day, approximately 1,292 fires occur in the country, in which 23 people are killed, 26 people are injured, and the daily damage amounts to 49.8 million rubles.

Such significant material and human losses make us look for ways to quickly implement new effective fire control measures.

Here is a description of the most promising and popular firefighting measures at the moment.

1. Technologies with artificial intelligence (AI) help us study in detail large amounts of geospatial, meteorological and temporal data to predict the occurrence of fires. AI involves the use of compact sensors that collect information about heat bursts, as well as changes in the illumination of the area. Then the data stored in the cloud is visualized using AI and used to create special temperature maps. These maps are designed to identify critical areas where the temperature is most likely to exceed the permissible limits, as well as areas with the greatest amplitude of temperature fluctuations. All this helps us understand which regions are most at risk, where a fire may occur.

2. Robotic fire extinguishing systems that have the means to register the location of the source of fire by video monitoring. They are effective for eliminating fires of any severity with heavy smoke and high temperatures. In addition to permanently installed robots, the Ministry of Emergency Situations of the Russian Federation uses self-propelled and flying unmanned devices that can perform reconnaissance and rescue people from the fire zone.

3. New fire extinguishing agents for public buildings, such as refrigerants, the main advantage of which is high heat absorption and temperature reduction (up to 70 %). These properties allow not only to quickly eliminate the source of the fire, but also to gain additional time for evacuation.

4. Control and supervision activities — one of the classic effective fire control measures, which also uses new ideas related to the introduction of checklists (lists of control questions) during routine inspections. The idea is that the examiner and the examinee are on an equal footing. The list of control questions is exhaustive. The entrepreneur knows in advance the requirements imposed on him. The inspector is not given the right to check compliance with other security requirements. This makes it possible to simplify supervisory procedures as much as possible, providing an opportunity for self-monitoring and self-assessment of the security status of objects to their owners.

To prevent fires in houses in the region, there are operational groups of representatives of municipalities, senior localities, street and house committees, freelance fire instructors, public associations (volunteers, Cossacks, All-Russian Voluntary Fire Organization, etc.), representatives of the Ministry of Internal Affairs and employees of the Ministry of Emergency Situations of Russia.

As part of preventive measures, more than 3 thousand yard rounds, meetings and briefings with the population are held daily in the region.

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V. G. Ustin — access to official fire statistics; Yu. I. Bulygin — formulation of the main concept, goals and objectives of the study, analysis of the results of the study; P. P. Tretyakov — collection of statistical data on fires, refinement of the text, formulation of the conclusions; V. V. Maslensky — preparation of the text and diagrams.