Impact of traffic flows on environmental situation in resort cities

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Abstract. The article discusses the anthropogenic impact of the road network on the formation and functioning of the urban environmental situation. The impact on the territory of preschool educational institutions No. 23 “Svetlyachok”, No. 6 “Yagodka” of Pyatigorsk has been considered in private. Data on the intensity of the movement of vehicles in different time periods, the composition of the auto flow, seasonal distribution of traffic flows are analyzed. General recommendations for ensuring the environmental safety of resort towns and promising questions for further research are presented. When analyzing the areas of promising growth and areas of reconstruction of urban development, allotted for housing construction, it is necessary to pay special attention to the construction of socially significant facilities: schools and kindergartens, the shortage of which exists in the town today.

1. Introduction
One of the consequences of the growth of social welfare is an increase in the transport mobility of the population (the number of trips made during a calendar period), which affects almost all spheres of social activity: working trips, domestic trips, personal trips, leisure trips, vacations, etc. Increasing the purchasing power of the population increases the demand for various types of products, which, in turn, stimulates the development of production. It also finds a reflection in the growth of the volume of cargo and passenger traffic, which are often inefficiently distributed throughout the territory of settlements. The resorts of the North Caucasus faced this problem.

Based on the federal and regional development programs of the region and the city, it is possible to single out one of the priorities, which is to achieve the world level of a comfortable city, based on a balanced socio-ecological system and adherence to the principles of technospheric safety. For this it is necessary to take measures to increase the comfort of living of the population of the town. When analyzing the areas of promising growth and areas of reconstruction of urban development, allotted for housing construction, it is necessary to pay special attention to the construction of socially significant facilities: schools and kindergartens, the shortage of which exists in the town today.

2. The relevance of the study
The main tasks of technospheric safety in the formation of a prosperous environment include: ensuring human security in the modern world, forming the technosphere comfortable for human life and...
activity, minimizing the technogenic impact on the natural environment, preserving human life and health through the use of modern organizational and technical means, timely use of methods for monitoring and predicting the state of the environment. At the same time, special attention should be paid to improving the efficiency of using water and land resources, sustainability and ecological safety of the territory during its urbanization.

In medium and large cities, all kinds of adverse factors of the urban environment are manifested to varying degrees [1-3]. In the context of dynamic urbanization, issues of the negative impact of transport infrastructure on the ecological well-being of the territories of social institutions come to the fore. On the one hand, kindergartens, schools, hospitals should be in transport accessibility for the population, and on the other hand, it leads to congestion during peak hours, an increased concentration of harmful emissions in the atmosphere, and in the future, on the territory of the social facility itself - heavy metal and other toxic compounds are deposited in the soil.

Pollution of the urban environment (air, soil and water) remains a hot topic and continues to threaten the health of residents of many agglomerations. It can be argued that issues of technospheric safety, environmental protection and sustainable socio-economic development of the territory (healthy habitat, material well-being of the population, economic development of the region, etc.) are becoming increasingly interconnected. Motor transport (passenger and freight) is the most important constituent element of the system under consideration, since it is also a “consumer” of natural resources and a “polluter” of the environment [4,5].

Urban transport is a constant source of noise, dust and vibration pollution of the environment due to the operation of automobile engines, the impact of railway wheels on rail junctions, etc. With the development and growth of the city, the inevitable growth of the machine-flow, and therefore, man-made loads. The growth of anthropogenic impact on urban areas created by traffic flows depends on the principles of traffic organization and technical characteristics of vehicles: speed, power and engine design, traffic flow rate of the canvas, carrying capacity, slopes of streets and roads, condition of coverage, number and level of intersections [6-8].

At the same time, special attention should be paid to the residential part of cities, where social facilities are located according to city planning norms.

The dynamic growth of resort towns, is manifested in a point building, which leads to a change in the functional zoning of urban areas. Clear planning boundaries between production and residential areas are lost. In the current situation (the length and density of the road network), the classical principles of the formation and functioning of the main street-road systems are no longer applicable [9]. If you follow the strict principles of the formation of the main streets and roads within the city, then at the stage of master plans it is necessary to solve structured tasks of planning, historical, cultural, transport, economic and environmental nature.

If we look at the maps of the boundaries of the transport infrastructure zones of resort towns in detail, you will notice that the main routes of freight traffic are directed through the centres of towns, there are no transit routes of detours. The districts of resort towns are often connected by 2-3 highways, along which there is a 3-5-fold increase in intensity compared to other streets. Consumer goods, which determine the main flow in the towns of CWS, are directed to residential areas and centres [10,11]. This situation leads to the formation of traffic congestion and, as a result, an increase in the amount of emissions of harmful substances in the central parts and residential neighborhoods of resort towns.

3. Experimental studies

In the period from 2015 to 2016 inclusive, an inspection of exhaust emissions from motor vehicles was carried out in the immediate vicinity of the Municipal State Pre-School Educational Institution kindergarten No. 23 "Svetlyachok" located in Pyatigorsk on Tolyatti street, 40 and Municipal budgetary preschool educational institution kindergarten No. 6 "Yagodka", Pyatigorsk.

Kindergarten No. 23 "Svetlyachok" is located on the territory between P. Tolyatti, Sportivnaya, Shkolnaya, Shatilo streets (Figure 1).
Since P. Tolyatti Street is a mainline, it is the most dangerous in terms of the amount of harmful emissions from road transport. This is explained by the fact that, according to our observations, the intensity of traffic on Sportivnaya and Shatilo streets is several times less, and it is 15 times less on Shkolnaya Street than that on P. Tolyatti Street. In addition, Sportivnaya and Shatilo streets are located at a considerable distance from the object under study (more than 100 meters). Based on the foregoing, with a sufficient degree of certainty, it is possible to confine ourselves only to identifying the amount of harmful emissions from road transport in a 100 meters long segment of P. Tolyatti Street, which is adjacent to kindergarten No. 23 “Svetlyachok”.

As for kindergarten number 6 “Yagodka” there is only P. Togliatti Street in the immediate vicinity of it, and the intersections are located at a distance of more than 300 meters (Figure 2).

Consequently, the object of study is a segment of P. Tolyatti Street, 100 meters long, adjacent to kindergarten No. 6 “Yagodka”.

On the proposed sections of P. Tolyatti Street, an annual survey of traffic flows was carried out annually in order to determine the intensity of traffic movement by the hour of the day, by the days of the week and by the months of the year. Conversion to a passenger car is carried out by means of reduction coefficients.

In the course of the survey, we found that the reduced traffic intensity at rush hour in both directions of movement is 970 units/hour in 2016, 940 units/hour in 2015, and 960 units/hour in 2014.

For research, the structure of the traffic flow in the surveyed area is important. The main type of transport is motor transport. Internal combustion engines, being the main energy source of modern cars, are at the same time one of the main sources of air pollution: various harmful substances, dust, products of wear, noise, vibration and various types of radiation. The structure and composition of exhaust gases varies depending on the type of vehicle.

According to field surveys in the area, by averaging the segmentation of the traffic flow for 2014, 2015, 2016, the following percentage of traffic flow was identified (Figure 3):

- cars - 82.6%
- trucks - 12%
- buses - 5.2%
- other - 0.2%

Consequently, the object of study is a segment of P. Tolyatti Street, 100 meters long, adjacent to kindergarten No. 23 “Svetlyachok”.

Figure 1. Location of the kindergarten №23 “Svetlyachok”

Figure 2. Location of the kindergarten №6 “Yagodka”

Figure 3. The composition of the traffic flow on P. Togliatti Street.
Due to the needs of the population, the intensity of movement over time is not uniform. The structure, type, composition of the motor traffic flow change cyclically depending on the time of day, day of the week, time of year.

According to the "Instructions for conducting economic surveys for the design of highways", it is possible to determine the traffic intensity by hours of the day (Figure 4,5).

**Figure 4.** Diagram of determining the intensity of movement by the hours of the day for three years in the area of kindergarten No. 23 “Svetlyachok”.

**Figure 5.** The diagram for determining the intensity of movement by the hours of the day for three years in the area of kindergarten No. 6 “Yagodka”.
We construct a diagram of the distribution of traffic flows by days of the week for more detailed information on the objects of the survey. (Figure 6-7)

**Figure 6.** Distribution of traffic flows by days of the week in the area of kindergarten No. 23 "Svetlyachok".

**Figure 7.** Distribution of traffic flows by days of the week in the area of kindergarten number 6 "Yagodka"
It is important to identify seasonal changes in traffic flows in the studied urban area [12]. Quantitative accounting of the movement was carried out in different periods of the year to establish seasonal fluctuations in the movement. (Figure 8-9).

**Figure 8.** Seasonal distribution of traffic flows in the area of kindergarten No. 23 "Svetlyachok"

**Figure 9.** Seasonal distribution of traffic flows in the area of kindergarten number 6 "Yagodka"
Using the detected values of traffic intensity, the numerical values of emissions of nitrogen oxides (CO) and carbon (NOx), hydrocarbons (C\text{\textsubscript{x}}H\text{\textsubscript{y}}), and emissions of solid substances (carbon black) were calculated according to the method presented in GOST R 56162-2014 “Emissions of Polluting Substances to the Atmosphere” [13].

4. Analysis of the data
The municipal state pre-school educational institution kindergarten No. 23 “Svetlyachok” is designed for 15 groups and 280 pupils. There are 11 groups in kindergarten number 23 "Svetlyachok". Groups are formed according to the age of the children.

The list composition of children in the 2015-16 school year amounted to 314 children, which exceeds the design capacity of the preschool institution by 12%.

Pick up groups are as follows:
- Younger groups - 4 (2-3 years), children - 129
- Preschool groups - 9 (children - 187)

Of them:
- Junior groups (3-4 years) - 3, children -100
- The average group (4-5 years) - 2, children - 36
- Senior groups (5-6 years) - 1, children - 27
- Preparatory to school groups (6-7 years) - 1, children – 24

According to SanPiN 2.4.1.3049-13 “The total duration of daily sleep for children of preschool age is 12–12.5 hours, of which 2–2.5 hours is spent on daytime sleep. For children from 1 year to 1.5 years, day sleep is organized twice in the first and second half of the day for a total duration of up to 3.5 hours. The best is the organization of daytime sleep on the air (verandas). For children from 1.5 to 3 years, day sleep is organized once for at least 3 hours” [14].

Sleep is organized according to the daily routine for each age group of children. In preschool № 23 "Svetlyachok", due to the fact that there is no nursery (children aged 1 to 1.5 years), the period of daytime sleep and rest falls at 13.00-15.00 for preschool groups and from 12.00-15.00 for a group of young age.

During this period, the traffic intensity (Figure 4.5) is 650-800 units of vehicles per hour for preschool No. 23 “Svetlyachok”, 600-700 for preschool No. 6 “Yagodka”, which is a polluting factor in the formation of the acoustic environment of the children's territory institutions. Increased noise and toxic emissions from motor vehicles adversely affect the development of the child's body, as a whole, and in particular during daytime sleep. Noise of any origin can lead to sleep disturbances without an obvious awakening due to changes in the sleep microstructure. Behavioral problems were recorded much more often, especially hysteria and uncontrollable behavior, at the age of three in children with persistent sleep disorders [15,16].

The distribution of traffic flows by days of the week (Figure 6-7) in the area of kindergarten No. 23 “Svetlyachok” and No. 6 “Yagodka” shows that the main trend towards an increase in traffic flow is maintained. The most "busy days" are Monday and Friday. Traffic intensity at weekends is lower than on weekdays, on average, by 25–30% in the area of pre-school educational institution No. 6 “Yagodka”, in area No. 23 “Svetlyachok” by 35-40%.

The seasonal distribution of traffic flows (figure 8-9) in the area of kindergarten No. 23 “Svetlyachok” and No. 6 “Yagodka” also shows a tendency towards a constant increase. Kindergarten №23 “Svetlyachok”: If in 2014 within 6 months, the traffic intensity did not exceed 350000 cars, then in 2016 only in January this value is reached, and the rest of the time significantly exceeds this value. If we consider traffic flows near preschool No. 6 “Yagodka”, we can note: the intensity during 2014 was observed unevenly at the beginning of the year - 230,000, spring-summer - 250000-300000, in September there was a jump to 330,000, then by the end of the year there was a trend decline in 2016: data increased by months, September was also the busiest month, with a value of 360,000.

In general, it can be noted that there is a tendency to an increase in the traffic flow, near pre-school educational institutions. What does the increase in traffic and domestic noise in the adjacent territory
entail? The noise impact of vehicles on the territory of cities is inextricably linked with the formation and spread of harmful pollutants. The limiting concentrations of which adversely affect the health of the population [17]. When studying the state of the urban environment, it is necessary to pay attention to the content of fine dust particles [18] within the framework of the provision of motor transport infrastructure of CMW towns from the standpoint of biospheric compatibility and technospheric safety [19].

5. Research recommendations
According to SNiP 23-03-2003 "Protection against noise" [20], the sound level is LA = 55 dBA in the territory immediately adjacent to the buildings of polyclinics, schools and kindergartens, we recommend lowering the value to 40 dBA, limit movement of heavy loads by to roads near kindergartens, limit the intensity of movement during the hours of daytime sleep for children, develop protective measures to reduce noise and dust in the territory of preschool - these activities will help create a comfortable and safe environment for the growth and development of children.

The main tasks should be addressed In the current transport and environmental situation of the towns of the CMV, in order to be able to efficiently manage passenger and cargo traffic: rationalization of traffic routes, taking into account the dynamics of growth and development of the number of vehicles, improving traffic conditions on hauls and intersections, ensuring a rational speed limit on motorways, introducing administrative and economic methods of restricting car entry and parking in the historic center, consider transit vehicles to bypass roads, the establishment of one-way traffic on busy sections of the road network and in the vicinity of day-care centers, restrictions on night traffic in residential and sanatorium-resort areas.

6. Conclusion
The indicator of environmental friendliness of the urban area is one of the most popular in terms of providing comfort and improvement of populated areas nowadays. Currently, even resort towns have environmental problems that require special attention and detailed study.

The study of traffic flows in the town showed that the formation of the urban road network should be based on a set of basic social and environmental data on the territory. There are social data among them: the number of residents, the age composition of the population; town-planning: transport accessibility, composition and structure of the transport flow, the radius of public service; environmental: dustiness, noise load, radiation safety, etc. System analysis and assessment of territories, their zoning according to the main indicators of technospheric safety are an important task and an obligatory component in the development of plans for the development of a city, in particular when analyzing future growth areas and urban reconstruction areas building up.

In the future it is necessary to identify the impact of traffic flows on the environment by acoustic parameters and fine dust pollution, to conduct mathematical modeling of the formation of acoustic resonant waves in a closed social institution, to determine the effect of finishing materials on the formation and propagation of acoustic resonant waves from external noise sources in a closed room, to identify the dependence of the concentration of dust particles of the PM10 and PM2.5 fractions on differences in measurement points and roadway marks and formulate recommendations for ensuring the environmental safety of an urban area near social facilities.

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