



Air pollution in Lithuanian cities

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Abstract

The increasing air pollution in the Lithuanian cities during the last years impacts health of people and mortality. One of the main air pollution sources becomes the city transport. The results of total pollution show the tendency of increasing pollution in the cities, after the short decreasing (it was affected by economical recession).

The ways to decrease air pollution are analyzed taking into consideration specific economic situation, infrastructure of cities and streets, optimization of whole transport system. Applications of the Weber-Fechner's dependence law show that an urgent necessity exists to take the measures to reduce air pollution as the influence of pollutants on human health is rapidly approaching toward the critical point. Statistical data of main crossings, transport congestion allow to determine the optimization ways how to direct the city and, especially, transit transport on the other lines rounding these crossings and to build the new ones.

1 Introduction

Quality of people's working and living environment is one of the main factors determining human health and longevity. In Lithuanian cities transport is a basic source of pollution. Research shows that transport directly influence human health and quality of life¹. Analysis of air pollution and qualitative indexes of means of transportation is an urgent problem for the modern development of Lithuanian cities. Reorganization of traffic flows is necessary.

2 Transport – main source of pollution

Present problems of Lithuanian cities differ from many others European cities due to the specific social-economical changes, peculiar geographical position (Lithuania is a country of rapidly increasing transit, one of main reselling center of second-hand automobiles). Industrial pollution of environment decreased recently, but transportation pollution increases. It is considered that transport is a basic source polluting air in Lithuanian cities¹.

The stock of transport is changing very quickly – old soviet cars are changed western European ones. The number of the vehicles in 1988 was 85 per 1 000 inhabitants, in 1997 – 277 vehicles, i.e. increase 3.3 times. The time of exploited cars in Lithuania is about 12 years. The exploited cars are older than the design limit of time is. 50% of cars in our roads are dangerous from the ecological point of view. Results of technical reviews of vehicles show that 24% of all automobiles have the technical defects harmful to environment². According to the information of technical reviews the conditional quality indexes K_i were determined.

$$K_i = \left(1 - \frac{N_{tr} / M_{aut}}{\sum N_{tr} / \sum M_{aut}} \right) \times 100 \quad (1)$$

where, N_{tr} – number of technical defects of the automobile of certain model and time, M_{aut} – number of the automobiles of certain model and time.

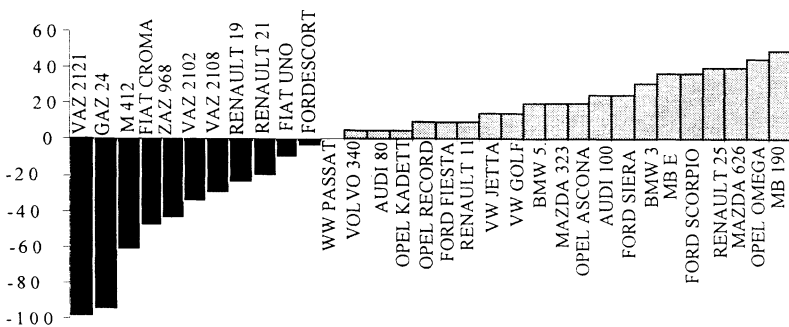


Figure 1: Indexes of technical quality of automobiles

Technical quality indexes of 11-15 years old automobiles, which are exploited in Lithuanian conditions, are given in figure 1. The quality

index of automobile VAZ2121 model is 100%, but the total number of these cars is not dangerous, as it is seldomly used automobile. According to statistics the most popular cars are Opel Kadett, Ford Escort, WW Passsat, etc. models². The quality index of those automobiles is close to zero.

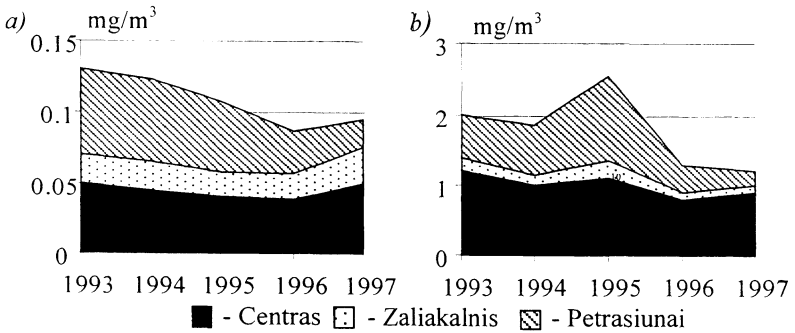


Figure 2: Tendencies of pollution (a – CO_x, b -NO_x) in three districts of Kaunas in 1993-1997

In figure 2 the pollution rate of three districts of Kaunas city is given. Their characteristics are different. Large pollution is assessed in the industrial district Petراسiunai. The presented total pollution estimates both – industrial and transportation – pollution. Industrial pollution decreased due to the less volumes of industry, implementation of new technologies and installation of the new environment friendly equipment. That's why is possible to conclude that transport is the main source of pollution in Lithuanian cities.

2.1. Intensity of transport and pollution

Kaunas is one of the most polluted cities in Lithuania. In figure 3 the pollution (b) of different districts of the city and intensity of transport (a) is presented.

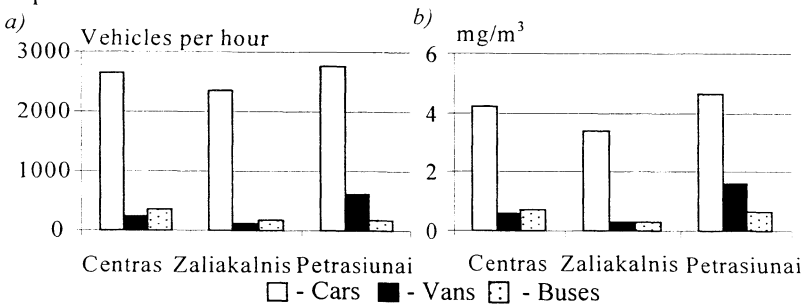


Figure 3: (a) – Intensity of transport, (b) – air pollution in three districts

Total level of pollution is presented in figure 3 and its calculation is based on average pollution of a car and traffic flow in the region³. That is the possible way to define the restriction possibilities of traffic flows. But it is not always possible to put it into the practice due to existing infrastructure of districts, economic situation. This method doesn't allow to make prognoses about the change of situation, if factor decreases and to compare the factors of different nature.

3 'Vector' evaluation of pollution

It is necessary to perform organizational and technical reconstruction and define which pollutant could be reduced more efficiently in the polluted crossings. For this reason the 'vector' methodic is offered⁴. It allows to determine the index f of general pollution in the crossing.

$$f = \sqrt{\left(\frac{R_1}{k_1}\right)^2 + \left(\frac{R_2}{k_2}\right)^2 + \dots + \left(\frac{R_N}{k_N}\right)^2} \quad (2)$$

where, R_i – determined value of the harmful factor i , k_i – permissible value of the harmful factor i .

In engineering computations there are used 2 or 3 components, but usually this vector can evaluate n number of harmful factors.

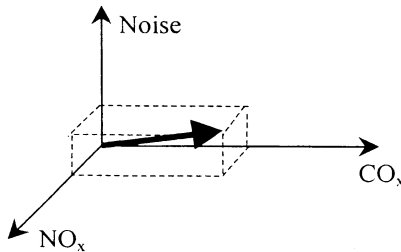


Figure 4: 'Vector' index of pollution

If the economic expenditures of one component reducing are known from the figure 4 it is possible to determine when this general vector will be the smallest one. From the dependence law of Weber-Fechner

$$y = e^{\frac{s R_i}{k_i}} \quad (3)$$

the approaching to the dangerous limit for the human organism can be determined, where s – coefficient of harmfulness for human organism.

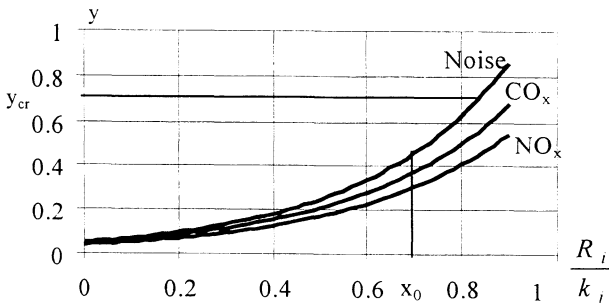


Figure 5: Curves given by application of Weber-Fechner's law

Point $x_0 = R_i/k_i$ (i - noise) shows the present situation, y_{cr} - critical pollution. It is obvious that further increasing of pollution can be harmful. According the 'vector' index of general pollution it is possible to determine which pollutant could be reduced more efficient and effective.

4 Conclusions

1. Present air pollution in Lithuanian cities, using the example of Kaunas, is quite high according to the experimental investigations. From the dependence law of Weber-Fechner it is easy to see that growing of the traffic flows is approaching the rate of pollution to the dangerous limit for human health.
2. Selected methodic for computation of the index of general pollution allows to compare conditional pollution of the crossings and to evaluate few harmful factors taking effect at the same time.
3. Application of the offered methodic allows choosing the priorities how to reduce harmful factors, evaluate financial expenditures for solving these of problems.

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