

Infrastructure road construction environmental risks minimization

Tatyana Sukhadolets^{1,*}, Elena Stupnikova², and Olga Olenina²

¹Analytical Center Social Infrastructure, 115088, Moscow, Russian Federation

²Institute of Economics and Finance, Russian University of Transport (MIIT), 127994, Moscow, Russian Federation,

Abstract. Measures to reduce environmental risks within the infrastructure construction are mainly reduced to recommendations on use of renewable energy sources, and use of vehicles with hybrid and electric motors. The article shows that the predominant factor in reducing environmental risks is investment in fixed assets for environmental protection. The analysis performed using OLS confirmed that the degree of P-value dependence in all three constructed models was obtained for the Investments variable.

1 Introduction

Control over the state of atmospheric air and its pollution is increasing every year, however, almost all the largest agglomerations of the Russian Federation continue to face a number of environmental problems. At the same time, if earlier the sources of air pollution were industrial enterprises, nowadays, the sources of pollution are mobile sources, first of all, the road transport. So, it turns out that the more developed the agglomeration, the greater the need to improve the environmental friendliness of transport, reduce emissions through environmental protection measures and environmental costs.

In addition, Eurasian integration demanded construction of an international transport bridge Europe - Western China that is a transcontinental project similar to the Silk Road, which has already linked Europe and China for several millennia. According to the project, Europe - Western China road will have a length of 8,500 km, and it will be possible to drive along it in just 10 days. In addition, central bypass roads have already been built or are being built around large agglomerations - these are the Central Ring Road around Moscow, the ring road around St. Petersburg, the ChKAD - bypass around Chelyabinsk, the ring roads of Magnitogorsk, Saratov, Rostov-on-Don, Omsk, Voronezh, and etc. As a result, to accelerate movement of population and goods, not only regional, intercountry, but also intercontinental roads are being built.

Currently, an important factor affecting the environment is the fact that in the last decade all Russian regions have increased the volume of goods delivery via e-commerce. All this led to an increase in intercontinental and intracity movement by road. The flows of couriers significantly load highways, which will require additional implementation of road infrastructure projects in the future to improve movement and logistics. And in this case, the

* Corresponding author: sutv@yandex.ru

challenge was the COVID-19 pandemic, which has already changed the way of life of many people in all Russian regions in the area of displacement. This becomes the reason for formation of new requirements for assessment of environmental risks, infrastructure road construction, especially in huge metropolitan areas.

2. Literature Review

The work of Lukashovich [1] shows that a significant proportion of air pollution occurs in the road transport complex. The negative consequences of global pollution are manifested primarily in megalopolises, where there is an active road construction and an increase in the number of vehicles. Transport and environmental risks are becoming even more relevant due to development of transport corridors and the lack of multiple fixation of environmental problems, Zhanbirov [2]. The main pollution of roadside areas is determined by six heavy metals: lead, zinc, nickel, copper, chromium and cadmium, Kosinova & Fonova [3], Dunn [4]. These particles, which are formed from movement of cars, form an aerosol cloud up to two meters high with a maximum concentration depending on the density of the traffic flow, Coffin at all [5]. Therefore, road infrastructure companies must apply the latest environmental technologies to reduce the number of indicators of the impact of environmental risk on the environment, An [6]. Fuel is the source of both nuclear lead particles in the form of soot and battery decomposition products. Zinc oxide, chromium is used in production of automobile tires, paints and varnishes. Metals in the form of nickel, copper, cadmium are found in nickel-plated parts of batteries, cables, and alloys. Unfortunately, emissions are reduced very weakly (Fig. 1). According to Savko [7], these particles have a density from 3,000 kg/m³ of shell particles to 9,000 kg/m³ of nuclear particles.

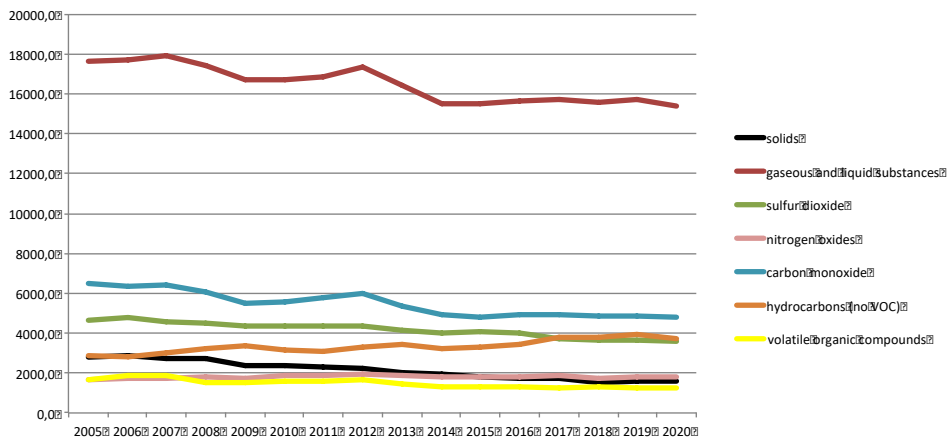


Fig. 1. Emissions of the most common air pollutants from use of road infrastructure (thousand tons).

3 Materials and methods

The study was carried out in two stages. At the first stage, data were collected for 15 years, from 2005 to 2020, for variables (Table 1):

1. Waste from production and consumption in transport.
2. Highways.
3. Investments in fixed assets for atmospheric air protection.
4. Expenses for environmental protection.

5. Emissions of solids and their dynamics are assessed.

Table 1. Variable notation used.

Waste from production and consumption, transport, mln tons	Waste
Automobile roads, ths km	Autoroads
Investments in fixed capital for atmospheric air protection, mln rubles	Investments
Environment protection expenditures, mln. rubles	Expenses
Emissions of solids, ths tons	Emissions

The dynamics of changes in emissions into the atmosphere and the length of roads were assessed (Fig. 2).

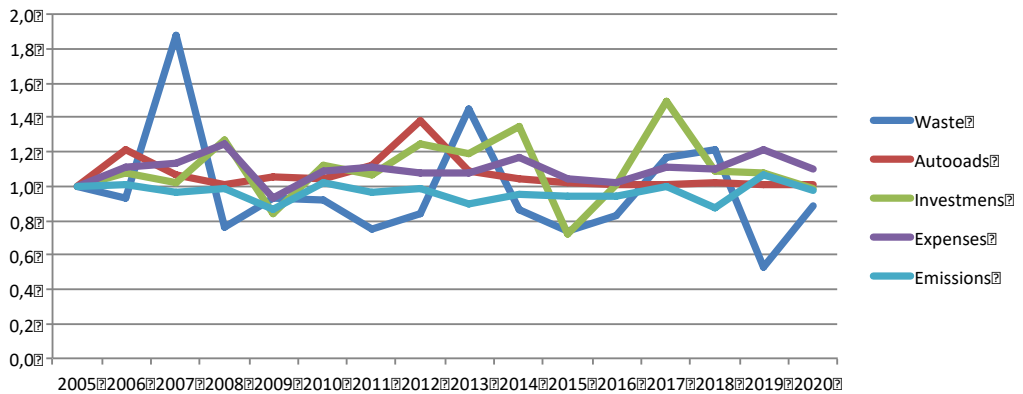


Fig. 2. Dynamics of changes in air emissions, investments and the length of roads.

At the second stage, an assessment of the causal relationship (using regression analysis (OLS)) was carried out for: a) the amount of emissions of solid substances from production and consumption waste, the length of roads, investments in fixed assets for environmental protection and environmental protection costs; b) consumption waste from the length of roads, investments in fixed assets for environmental protection, environmental protection costs, the amount of solid emissions; c) the amount of emissions of solid substances from the length of roads, investments in fixed assets for environmental protection.

The following conditions were met: the mathematical expectation of random errors is zero, factors and random errors were estimated. Factors exogenousness was verified using Schwartz, Akaike and Hennan-Quinn criteria.

Calculation formula:

$$\sum_i e_i^2 = \sum_i (y_i - f_i(x))^2 \rightarrow \min_x \quad (1)$$

e_i^2 - a proximity measure for the sum of squares of the variables under consideration;

x is a set of variables;

$f_i(x)$, where $i=1, \dots, m$, $m > n$.

4 Results and Discussion

With Emissions dependent, the most significant factor was the Expenses variable (0.71), Autoroads (0.24). The highest P-value is obtained for the Investments variable (0.62), Table 2.

Table 2. Model 1. OLS, observations 1-16 are used. Dependent variable: Emissions.

	Coefficient	Std. error	t-statistic	P-value	
Waste	-0,0269948	0,0470547	-0,5737	0,5768	
Autooads	0,248074	0,122319	2,028	0,0653	*
Investmens	-0,0493472	0,0982575	-0,5022	0,6246	
Expenses	0,712652	0,149078	4,780	0,0004	***

In the case of Waste dependent, the Expenses variable (0.94) and Emissions variable (0.98) turned out to be the most significant factor. The highest P-value is obtained for the Investments variable (0.75), Table 3.

Table 3. Model 2: OLS, observations 1-16 are used. Dependent variable: Waste.

	Coefficient	Std. error	t-statistic	P-value	
Autooads	0,665946	0,126605	5,260	0,0001	***
Investmens	0,226994	0,122050	1,860	0,0840	*

In the case of Emissions dependent, the most significant factor was the Autoroads variable (0.66). The highest P-value is obtained for the Investments variable (0.08), Table 4.

Table 4. Model 3: OLS, observations 1-16 are used. Dependent variable: Emissions.

	Coefficient	Std. error	t-statistic	P-value	
Autooads	0,665946	0,126605	5,260	0,0001	***
Investmens	0,226994	0,122050	1,860	0,0840	*

Therefore, the constructed regression models 1-3 show that Emissions and Waste are more dependent on investments in fixed assets for atmospheric air protection.

5 Conclusion

Construction of road infrastructure and further use of highways is associated with emissions of heavy metals and gases into the atmosphere. The negative consequences of such negative environmental risks can be minimized to a greater extent due to investments in fixed assets for atmospheric air protection. With Emissions dependent (Waste, Autoroads, Investments, Expenses variables), the highest P-value was obtained for the Investments variable (0.62). With Waste dependent (Autoroads, Investments, Expenses, Emissions variables), the highest P-value was obtained for the Investments variable (0.75). With Emissions dependent (Autoroads, Investments variables), the highest P-value was obtained for the Investments variable (0.08).

Therefore, our assessment confirms the priority importance of minimizing environmental risks while increasing financing of capital investments in fixed assets for environmental protection. Investments in fixed assets aimed at environmental protection and rational use of natural resources include investments in fixed assets aimed at environmental protection, carried out at the expense of all sources of financing, both within newly constructed enterprises and at existing enterprises [8]. Such investments that will help preserve the environment and reduce risks include: the cost of construction, reconstruction (including expansion and modernization) of facilities, purchase of machinery, equipment, vehicles. It also makes sense to stimulate economically the use of clean fuels, renewable energy sources, vehicles with hybrid and electric motors, materials and technologies that reduce environmental risks and negative impact on the environment.

References

1. O. D. Lukashovich, Chemistry. Ecology. Urban studies. **1**, 142 (2020)
2. Zh. G. Zhanbirov, Science, new technologies and innovations of Kyrgyzstan, **2**, 3 (2021)
3. I. I. Kosinova & Fonova, Engineering-geological and geoecological problems of urban agglomerations, **1**, 418 (2015)
4. F. L. Dunn, The Arboviruses: epidemiology and ecology, **27**, 281 (2020)
5. A. W. Coffin, D. S. Ouren, N.D, et al, Issues In Ecology, **27**, <https://www.esa.org>
6. D. Anh, Innovation and Investment, **4**, 224 (2021)
7. A.D. Savko, Bulletin of Voronezh State University. Geological series **1**, 47 (2003)
8. Rosstat order of July, **383** (2020)