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ECO-GEOGRAPHICAL PROBLEMS CAUSED BY ROAD TRANSPORT IN LANKARAN PHYSICO-GEOGRAPHICAL REGION OF THE REPUBLIC OF AZERBAIJAN AND WAYS OF THEIR SOLUTION

Purpose. In modern times, environmental security remains a global problem. One of the main negative effects of people on the environment is related to road transport. Anthropogenic pollution of the environment is undoubtedly due to the increase in the number of vehicles. As it is known, due to the activities of various types of transport, large amounts of toxic gases are released into the atmosphere every day, which is a high man-made impact on the environment, posing a serious threat to human health. It is very important to carry out eco-geographical studies to assess the damage caused by road transport to the environment and its individual components. The article investigates the existing and possible damages caused by road transport to the environment and human health in the Lankaran physico-geographical region of the Republic of Azerbaijan.

Methods. Comparative approach, statistical analysis, field research, systematic analysis, and cartographic (GIS) method have been used during the study.

Results. The article describes the current state of the International North-South Transport Corridor, the technical characteristics of the highways, the number of vehicles, the amount of harmful substances emitted by them, noise intensity, etc. based on the statistical and fieldwork materials. Based upon the information obtained, the Lankaran physico-geographical region's road map has been developed, the length of the international, local, and land roads and their area size are provided in percentage, and the areas with a denser road transport network are grouped according to their sensitivity.

Scientific novelty. A map of the territorial organisation and density of road transport in Lankaran physical-geographical region has been compiled, the amount of pollutants emitted into the environment by road transport has been determined, and ways to prevent them have been provided.

The practical significance. The obtained results can be used to increase the quality of work done for improving the environmental situation in Lankaran physical-geographical region.

Keywords: Azerbaijan, Lankaran, road transport, eco-geographical problems, environment, noise, destibel (dB).

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ЭКО-ГЕОГРАФИЧЕСКИЕ ПРОБЛЕМЫ, ВЫЗВАННЫЕ АВТОМОБИЛЬНЫМ ТРАНСПОРТОМ В ЛЯНКЯРАНСКОМ ФИЗИКО-ГЕОГРАФИЧЕСКОМ РЕГИОНЕ АЗЕРБАЙДЖАНСКОЙ РЕСПУБЛИКИ И ПУТИ ИХ РЕШЕНИЯ

Цель. В наше время экологическая безопасность остается глобальной проблемой. Одним из основных негативных воздействий людей на окружающую среду является автомобильный транспорт. Антропогенное загрязнение окружающей среды несомненно связано с увеличением количества транспортных средств. Как известно, из-за деятельности различных видов транспорта каждый день в атмосферу выбрасывается большое количество токсичных газов, что оказывает сильное антропогенное воздействие на окружающую среду создавая серьезную угрозу для здоровья человека. С этой точки зрения очень важно проводить эко-географические исследования для оценки ущерба, наносимого автомобильным транспортом окружающей среде и ее отдельным компонентам.

Целью статьи является исследовать эко-географические проблемы, вызванные автомобильным транспортом окружающей среде и здоровью человека в Лянкяранском физико-географическом регионе Азербайджанской Республики.

Методика. В исследовании использовался сравнительный подход, статистический анализ, полевые исследования, систематический и картографический (ГИС) метод.

Результаты. В статье на основе статистических и полевых материалов описывается текущее состояние Международного транспортного коридора Север-Юг, техническая характеристика автомобильных дорог, количество транспортных средств, количество выделяемых автомобильным транспортом вредных веществ, интенсивность шума и т. д. На основе полученной информации была разработана дорожная карта физико-географического региона Лянкяран, протяженность международных, местных и грунтовых дорог, территория их площадей представлена в процентах, а районы с более плотной дорожно-транспортной сетью сгруппированы по их чувствительности.

Научная новизна. Составлена карта территориальной организации и плотности автомобильного транспорта в Лянкяранском физико-географическом регионе, определено количество загрязняющих веществ, выбрасываемых в окружающую среду автомобильным транспортом и предусмотрены способы их предотвращения.

Практическая значимость. Полученные результаты могут быть использованы для повышения качества по улучшению экологической обстановки в Лянкяранском физико-географическом регионе.

Ключевые слова: Лянкярань, автомобильный транспорт, эко-географические проблемы, окружающая среда, шум, дестибель (дБ).

Relevance. The rapid population growth, the development of industrial enterprises, the expansion of transport links in our modern age, etc. have exacerbated the eco-geographical situation in the settlements. This problem is mainly caused by land use, water and air pollution. In order to tackle the problem, a number of researches have been carried out in the environmental protection, and appropriate measures have been taken in this regard. However, until today, the problem has not been fully solved. Thus, each sector has both positive and negative effects of development. One of these effects is related to

road transport. Although road transport has great advantages, its dynamic development leads to a number of negative effects as well. Consequently, they result in eco-geographical problems, such as air pollution, noise generation, change in chemical composition of the soil, etc. From this point of view, it is relevant to study the eco-geographical problems created by road transport and their solutions.

Negative impact of motor vehicles on the environment can pose a serious threat to human health. Currently, road transport remains the main source of air pollution in the country [2]. Thus, despite the appropriate measures taken by the government, most of the vehicles, especially in rural areas, are physically and technically obsolete and are inoperable under environmental standards. Operation of such vehicles increases the amount of greenhouse gas emissions and has a negative impact on the environment. In order to eliminate such cases, regional investigations should be carried out, areas where vehicles move more intensively should be identified, newly designed and projected highways should pass along the edges of settlements.

Analysis. The physico-geographical region of Lankaran, located in the south-eastern part of Azerbaijan, extends 125 km from north to south and 100 km from west to east. The area of the province, with Astara, Lankaran, Lerik, Masalli, Jalilabad, and Yardimli regions, comprises 7,0% of the territory of the republic with overall 6,08 thousand km^2. The territory includes 8 cities, 13 settlements, and 642 rural settlements. They also have a population of 932.7 thousand people, which is 9.3% of the total population of the republic. The population density is 154 per km^2 [7, p. 300].

The natural conditions of Lankaran physical-geographical region are very favourable for the settlement and economic activity of the population, development of settlements, and establishment of relations with the surrounding regions. Components of natural conditions such as relief, climate, inland waters, soil, and vegetation play a great role in the settlement of the population and creation and operation of economic facilities. Although there are few mineral resources, the region has reserves of aggregates, such as sand, clay, river stone, gypsum, and is rich in thermal and mineral waters. The basis of the economy in the region is the agro-industrial complex. There are very favourable natural and economic conditions for the development of agriculture. Humid subtropical climate, fertile soils, water, and sufficient labour resources create great opportunities for intensive agricultural development. The structure of agriculture is dominated by vegetable growing, tea planting, viticulture, and grain growing. About 99% of tea and more than half of vegetables produced in Azerbaijan fall to the share of this region. The use of large amounts of mineral fertilisers, pests, and toxic chemicals in the vegetable sector has led to changes in the aggregate state of the soil, an increase in the amount of toxic chemicals and heavy metal residues in the soil, which in turn has resulted in severe soil degradation.

If to compare the level of urbanisation (24.7%) in the region by country, it could be seen that it is relatively weak. This was due to the specific demographic development of the region. Thus, the region is one of the areas with the highest natural growth in the country, and this figure has always been high in rural areas. High natural growth in rural areas has led to a large share of the rural population and a small share of the urban population within the total population. Currently, radical changes in economic and social development in the Lankaran physical-geographical region lead to population migration. The number of migrants has increased so much in the last decade that some mountain villages (especially in Lerik and Yardimli regions) have already reached the point of depopulation. Therefore, it is important to develop settlements in the highlands, create infrastructure in the region for permanent residence in this area, solve natural gas, electricity, heating, and other socio-cultural and demographic problems of the residents, and take more effective measures in this direction. Such problems also aggravate the eco-geographical situation in the region. Indigenous people destroy ecosystems by cutting down forests to meet their heating and natural gas needs.

40% of the territory of Lankaran physico-geographical region consists of the Lankaran lowland on the coast of the Caspian Sea, while 60% - of the Talysh Mountains. The Lankaran lowland is located between the western coast of the Caspian Sea and the foothills of the Talysh Mountains, extending 100 km from Bolgarchay in north to Astarachay in south. Absolute height varies from -28 m to 100 m. Highways are well developed because of the low relief and low plain with flat surface. The absolute relief of the slopes of the Talysh Mountains ranges from 200 m to 2400 m. The number of highways here is few, and their technical characteristics are quite low as Talysh, Peshtyasar, and Burovar Ranges running in parallel in the submeridional direction near the coast of the Caspian Sea, and the Yardimli, Zuvand, and other lowlands between them complicate the internal structure of relief [6, p. 132].

Compared to other physico-geographical regions of the Republic of Azerbaijan, Lankaran is characterised by the most favourable environmental indicators from the ecological point of view. The physico-geographical region's specific humid climate and lands not exposed to freezing have made it

possible for forests with many exceptional ancient relict and endemic tree and shrub species to survive here. There are about 150 trees and shrubs in the area, 36 of which are endemic and are listed in the Red Book of Azerbaijan [3, p. 152]. As 24.6% of the territory (150,000 ha) is covered by forests, its reproductive capacity for oxygen lags behind only the Greater Caucasus. However, this opportunity is unevenly distributed across the territory. Thus, due to the high density of highways and the intensity of traffic, the slopes are far behind the mountainous terrain, where the eco-geographical problems caused by the road transport are more prominent.

The North-South Transport Corridor, passing through the Lankaran physico-geographical province, has led to the reconstruction of highways with modern requirements. The newly constructed and commissioned Alat-Astara-state border with the Islamic Republic of Iran highway is a clear example of this. In addition, reconstruction and repair works have been carried out on the inter-village roads in Jalilabad-Yardimli, Ojakaran-Tulaguvan-Gajimarda-Tangerud, Kijaba-Burzubend, Pensar-Toradi, Pensar-Shahaghac, Pensar-Kakalos, Piran-Hamarat-Vijaker, Sarak-Shuvi, Jalilabad-Lekin-Yardimli, Jalilabad-Mashlig-Mughan-Soyudlu, Goytepe-Kazimabad, Aliabad-Vamazghon, Yardimli-Bozayran-Burzunbul-Bilna-Vargaduz-Siriq, Noda-Shingadulan-Khanagah, Samidkhan-Khallyjali-Eminli-Mammadkhanli, Privolnoye-Agdash-Soyugbulag villages, as well as on local roads in Aghdash, Badamaghaj, Siyavar, Lakin, Shikhlar, Fatullagishlag, Vanlik, Oghubulag, Sabirabad, Chinar, Guneshli, Uzuntapa, Mashlig, and other villages. Here, the density of road transport envisages mainly highways of international and local importance, as well as land roads in the villages close to these highways (Figure 1).

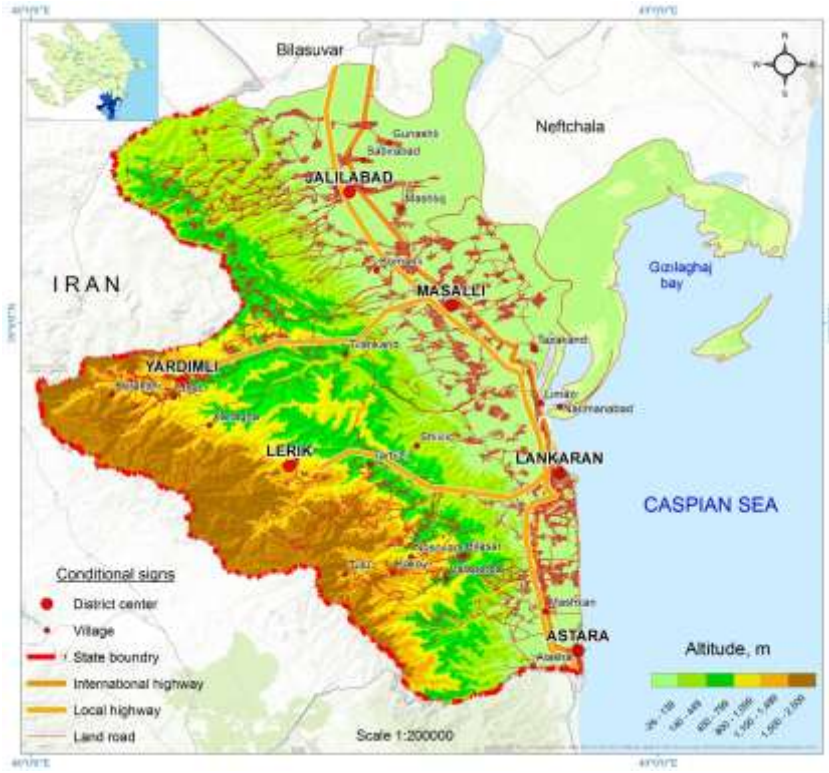


Figure 1. Territorial organisation and density map of road transport in Lankaran physico-geographical region

Lankaran physico-geographical region has 123.83 km of international roads, 191.9 km of local roads and 61248.8 km of land roads. The roads of international importance pass through 34 settlements, while the roads of local importance - 42 settlements. The most intensive highways pass through mainly Archivan, Allar, Burjali, Garmetuk, Goyachol, Goytepe, Hirkan, Kijaba, Kuvanil, Liman, Musakucha, Penser, Garazanjir, Sapnakanar, Sirinsu, Siyakesh, Tangarud, Khanbulan, Yukhari Nuvadi, and other settlements. To group the roads by their length by regions, most of them fall to the share of Jalilabad (28.5%) and Masalli (22.6%). The region with the most poor-condition roads is Lerik. In total, 567.2 km or 8.8% of highways (Table 1) is concentrated here.

Table 1

Road length in the Lankaran physico-geographical region

Regions	International highways, km	in %	Local highways, km	in %	Inter-village land roads, km	in %
Astara	23,67	19,12	22,6	11,77	687,4	11,2
Lankaran	38,00	30,68	52,1	27,17	999,0	16,3
Masalli	24,99	20,18	41,9	21,84	1390,7	22,7
Yardimli	-	-	19,2	10,02	739,5	12,1
Lerik	-	-	19,0	9,88	548,2	9,0
Jalilabad	37,17	30,02	37,1	19,32	1759,9	28,7
Total:	123,83	100	191,1	100	6124,7	100

Note: Calculations were made with ArcCIS ArcCIS software.

Road transport plays an important role in the implementation of freight and passenger transportation operations in the Lankaran physico-geographical region. However, the share of the physico-geographical region in freight and passenger transportation operations throughout the country is rather low. Thus, 3.7% of freight traffic and 3.8% of passenger transportation in the country fall to the share of the Lankaran physico-geographical region. In 2018, 8,348,000 tonnes of cargo and 75,898,000 passengers were transported through the territory of the physico-geographical region. Comparing these indicators with those in 2010, freight increased by 31.8% and passenger transportation by 34.9%. Within 2010-2018, the number of trucks (12.5%), buses (22.5%) and passenger vehicles (40.7%) also resulted in progress [7, p. 300-371]. Masalli and Lankaran have a large share in the transportation of cargo by highways, Lankaran - in passenger transportation, while Masalli, Lankaran, and Jalilabad regions – in the number of vehicles. This advantage had a positive impact on the formation of their economic spheres (Table 2).

Table 2

Key indicators of road transport in Lankaran physico-geographical region in 2018

Administrative districts	Freight transportation, thousand tons	Passenger transportation, one thousand people	Number of vehicles, unit	Of them			
				Freight	Bus	Passenger	Other vehicles
Astara	1343	8317	7693	962	152	6506	73
Lankaran	2419	33480	19601	2607	420	16413	161
Masalli	2622	14714	20191	2502	219	17324	146
Yardimli	483	2597	2850	387	32	2374	57
Lerik	378	1686	4110	717	66	3250	77
Jalilabad	1103	15104	17871	2019	253	15481	118
Total:	8348	75898	72316	9194	1142	61348	632

Source: Regions of Azerbaijan. Baku, 2019

Increase in the number of vehicles in Lankaran physico-geographical region and their intensive use have led to environmental problems in the region: pollution of the atmosphere and soil, and noise generation. To address such problems, a number of documents have been adopted and measures have been taken in this direction, including The Law of the Republic of Azerbaijan on Environmental protection in 1999, The Law of the Republic of Azerbaijan on protection of Atmospheric Air in 2001, The Decision of the Cabinet of Ministers of the Republic of Azerbaijan on Determination of technical standards for stationary sources of hazardous substances emitted into the atmosphere, as well as for transportation, other types of vehicles and devices, which are sources of air pollution in 2002.

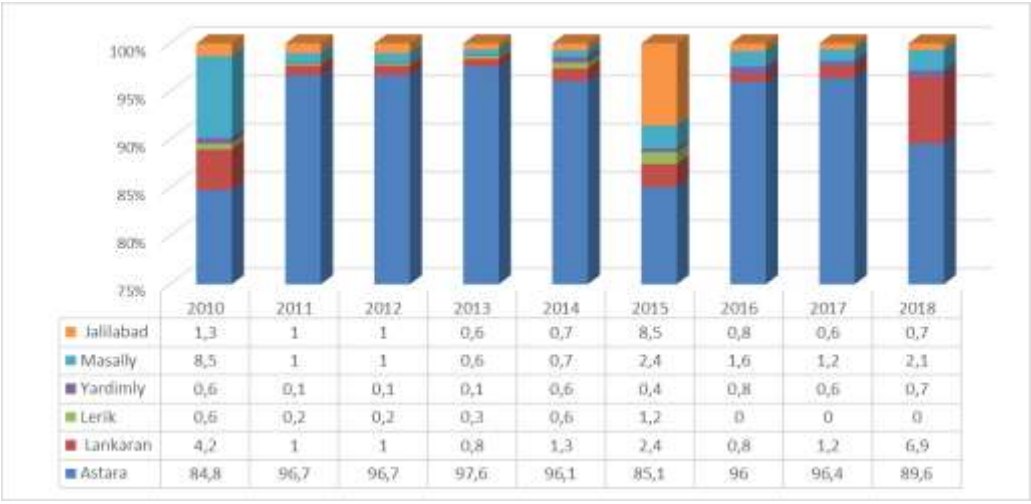
The Law of the Republic of Azerbaijan on Protection of the Atmospheric Air establishes technical standards for each source of atmospheric air pollution and permissible limits for harmful substances, including background contamination [11]. This was also mentioned in the permissible limits for emissions by stationary sources and vehicles in the Decision of the Cabinet of Ministers of the Republic of Azerbaijan on Determination of technical standards for stationary sources of hazardous substances emitted into the atmosphere, as well as for transportation, other types of vehicles and devices, which are sources of air pollution [8]. Ecological posts have been established on the highways to reduce the amount of greenhouse gases emitted into the atmosphere [10]. In this regard, environmental standards

are being applied for the technical parameters of vehicles imported to the country in connection with the implementation of the laws and decisions adopted, including Euro 3 since 2000 and Euro 4 since 2008.

It should be noted that nitrogen oxides emissions in the Euro 3 standard is 256 grams g/km (per kilometre) and 224 g/km – in Euro 4. The difference is 32 grams. This means 3.2 kg of nitrogen oxides for a vehicle driving 100 km per day. Considering the increase in the number of cars in recent years, it could be stated that this figure is higher. However, it should also be mentioned that cars manufactured in accordance with Euro 6 standards since 2012 and Euro 7 since 2017 are not few in our country.

If we analyse the amount of pollutants emitted into the atmosphere by motor vehicles in the Lankaran physico-geographical region for 2010-2018, we can see that the amount of emissions increased due to the increase in the number of vehicles in the region. Currently, the total amount of pollutants in the region is 12,147 thousand tons from both stationary and mobile sources of pollution. About half of it falls to the share of mobile pollution sources, that is, road transport. This is because there are a small number of industrial enterprises, and there are no heavy industrial enterprises. There are only agrarian industrial enterprises equipped with modern technologies in the region.

Looking at the amount of pollutants emitted into the atmosphere from motor vehicles across the regions in the Lankaran physico-geographical province for 2010-2018, Astara outperforms the rest of the regions. The main reason for this is the passing of the highway through Astara, as well as the regular stops of heavy-duty trucks at the customs checkpoint here. For the period analysed, this indicator was at least 84.8% and the highest at 97.6% in Astara, while in other areas, it remained stable. However, there was recorded an increase in air pollution in Masalli (8.5%) and Lankaran (4.2%) in 2010, in Jalilabad (8.5%) in 2015, and in Lankaran (6.9%) in 2018 (Figure 2).



	2010	2011	2012	2013	2014	2015	2016	2017	2018
Jalilabad	1,3	1	1	0,6	0,7	8,5	0,8	0,6	0,7
Masally	8,5	1	1	0,6	0,7	2,4	1,6	1,2	2,1
Yardimly	0,6	0,1	0,1	0,1	0,6	0,4	0,8	0,6	0,7
Lerik	0,6	0,2	0,2	0,3	0,6	1,2	0	0	0
Lankaran	4,2	1	1	0,8	1,3	2,4	0,8	1,2	6,9
Astara	84,8	96,7	96,7	97,6	96,1	85,1	96	96,4	89,6

Source: The Regions of Azerbaijan. Baku: SSC, 2019, 788 p.

Figure 2. Amount of pollutants emitted into the atmosphere by motor vehicles in Lankaran physico-geographical region, in %

Toxic substances emitted by vehicles cause damage to the environment and human health. Large settlements were formed along the highways, which also created rural agglomerations in turn. These are mainly villages located in the Lankaran and Astara regions and stretching along the highway.

Finding statistical relationships between the maximum air pollution levels and the meteorological situation that conditions them is of great importance in addressing atmospheric air pollution problems. Some experts believe that the main reason for the reduction of emissions is related to decline in production, the failure of the enterprises to operate at full capacity, suspension of work, and implementation of a number of measures aimed at protecting the environment [5, p. 181]. However, experience shows that one of the main sources of air pollution is motor vehicles. Toxic emissions from combustion engines comprise 0.5-10% carbon dioxide, 0.8-25% nitrogen oxides, 3% hydrocarbons, and 0.2% in aldehydes, which have a hazardous effect on the human body and high levels of toxicity [4, p. 61].

Pollutants are poorly distributed in the lower layers of the atmosphere on windless days. The air in the central streets of residential areas is dominated by strong air masses, and toxic waste cannot be spread far away. Most pollutants are observed among the tall buildings and in the lowest areas of the city.

One of the negative impacts of motor vehicles on the environment is noise. In order to tackle the problems, the President of the Republic of Azerbaijan signed a Decree of the vibration and noise

pollution exerting negative environmental impact and health of the person in 2008. The Decree specifies the parameters under which noise and vibrations are normalised and their admissible levels [9]. As it is known, the intensity of the noise is measured by destibel (dB). Experiments have shown that the human hearing range can reach the area up to 20-120 dB. This indicator reaches 75-90 dB on highways and central streets passing through the physico-geographical region of Lankaran, especially in the North-South International Corridor.

Hundreds of hazardous substances emitted from internal combustion engines of various types of vehicles are partially absorbed by soil causing change in its chemical composition and degrading its geochemical environment. As a result, its cleaning in the short run becomes impossible. At the same time, the most frightening fact is that heavy metal compounds are exposed to the surface of plants by joining the biological system through the root system. In the end, they cause many diseases, including neurological and mental disorders, disturbing enzymatic activity of cells and other severe diseases by entering the human body [1]. They fall into the soil in the form of solid or liquid sediments, migrate to different biological chains because they are more resistant to chemical, biochemical or biological breakdown, and eventually have the ability to result in toxic, embryotoxic, carcinogenic, etc. effects. The dynamics of these sediments in the soil profile varies according to the physical and chemical characteristics of the soil. For example, foods contaminated with zinc compounds are transferred to animals and then to humans, causing neurotoxic poisoning. The high content of cadmium causes the fragility of human bones, while its abundance impairs kidney function and leads to their failure.

Result

- Although Lankaran physico-geographical region accounts for 7% of the territory of the Republic of Azerbaijan and 9.3% of its population, only 3.7% of freight traffic and 3.8% of passenger transportation fall to its share. The physico-geographical region has the most favourable environmental indicators from the point of view of eco-geography. Lerik and Yardimli regions have more positive trend in this regard, as they are located in the mountainous area. Astara is the most polluted one by the amount of pollutants thrown into the atmosphere among the regions.
- The territory of the Lankaran physico-geographical region can be divided into the lowland and mountainous parts due to the density and intensity of the highways. The highway is well developed in the hollow areas and relatively poorly developed in the mountainous areas. The quantity of harmful substances thrown into the atmosphere by cars is higher in the hollow territories, while the number of vehicles not meeting environmental standards is higher in the mountains.
- Analysis of 2010-2018 shows that the number of motor vehicles, freight and passenger transportation, including the amount of emissions into the atmosphere have increased. These indicators have also contributed to the increase in noise and contamination of soil. Environmental standards have been applied to overcome the problem. However, the problem has not been fully resolved. That is why this kind of research is very important in the future.

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