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Research paper

Analysis of Air Basin State of Industrial-Urban Agglomerations in the North-Western Black Sea

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Abstract

The paper considers the influence of the main sources of technogenic pollution on the state of the atmospheric air of the North-Western Black Sea regions. For the first time, a comprehensive assessment of a level of technogenic load on the air basin from the stationary and mobile sources was made and the impact of the stationary and mobile sources on the overall level of air pollution was determined

Keywords: *air basin, sources of pollution, technogenic load, module of technogenic load.*

1. Introduction

The problem of anthropogenic pollution of the air basin of Ukraine's regions is particularly acute. The state of the air basin in the southern regions of the country depends on the quantity and technical and technological features of the industrial facilities and heat power. In addition, the predominant source of technogenic pollution of the air-basin the North-Western Black Sea region is an automobile transport, which accounts for up to 80% of the total amount of pollutants.

The Odesa, Mykolayiv and Kherson regions are confined to the territory of the North-Western Black Sea region. This territory is characterized by a significant degree of a man-caused load on the atmospheric air. The pollution level of the air basin of the Odessa, Mykolayiv and Kherson industrial-urban agglomerations (IUA) in recent years, according to the values of an integrated index of atmospheric pollution, have been characterized by the categories "polluted" - "highly polluted". There for, it is important to identify the main sources of pollution and to assess a technogenic load on the air basin of the North-Western Black Sea regions.

As imprint the data of the regional reports, environmental passports and statistical reporting on the North-Western Black Sea regions about the pollutant emissions into the atmospheric air during the period of 2012 - 2016 were used in the paper.

One of the indicators of a total technogenic load on the territory of the North-Western Black Sea region is a module of a technogenic load (M_T), which is defined as a sum of the weight units of all kinds of wastes (solid, liquid, gaseous) of industrial, agricultural and communal objects for a time interval of 1 year, attributed to the area of the administrative region or the region within which these objects are located, measured in thousand t/km^2 per year [1].

A technogenic load in the vast majority of cases is represented by a significant list of indicators characterizing an impact on the individual components of the environment, including the airs basin – are the emissions of air pollutants into the atmosphere by the stationary and mobile sources of pollution (ths. t/year). Taking into account the principle of M_T determination, we suggested estimating the level of a technogenic load on the air basin on the basis of the calculation of a module of a technogenic load on the air basin (M_{AB}), which is defined as the amount of pollutant emissions into the atmospheric air in thousand t/km^2 per year.

2. Main body

Estimation of a technogenic load on the air basin of the Odessa region. The total number of enterprises that affect the state of the airs basin of the Odesa region in the process of their activity is more than 3000 entities [2].

The general assessment of the load from the stationary sources was made for 2012 – 2016, according to the data of the Main Department of Statistics in the Odesa region, as well as the regional reports on the state of the environment of the Odesa region [2 – 4]. Figure 1 shows the dynamics of pollutant emissions into the air basin from the stationary and mobile sources of pollution. The analysis shows that since 2009, there has been a decrease in pollutant emissions, first of all, due to a reduction of the emissions from the mobile sources.

The largest contribution to air pollution from the stationary sources comes from industrial enterprises, as well as production and distribution of electricity, gas and water.

Figure 2 shows the dynamics of pollutant emissions into the atmosphere from the stationary sources of pollution in the selected towns of the Odesa region. Without taking into account a total amount of pollutant emissions into the air in the region, the maximum values are observed for the cities of Odesa and Yuzhne.

Figure 3 shows a chart of the distribution of M_{AB} in the cities of a region significance in terms of pollutant emissions into the air basin. The analysis of this diagram shows that the maximum level of a load among the towns of the Odesa region is Yuzhne (in different years 2-5 times higher than in Odesa). This is due to a significant amount of pollutant emissions from the town enterprises within its fairly small area. The second and third places are occupied by Odesa and Podolsk. The minimum technogenic load on the airs basin is observed in the cities of Bilhorod-Dnistrovsky and Teplodar.

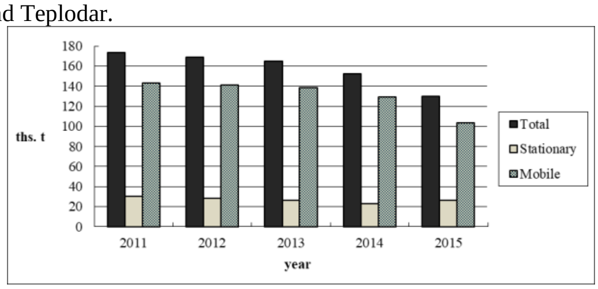

Fig. 1. Dynamics of pollutant emissions from the stationary and mobile sources into the air basin of the Odesa region [3, 5].

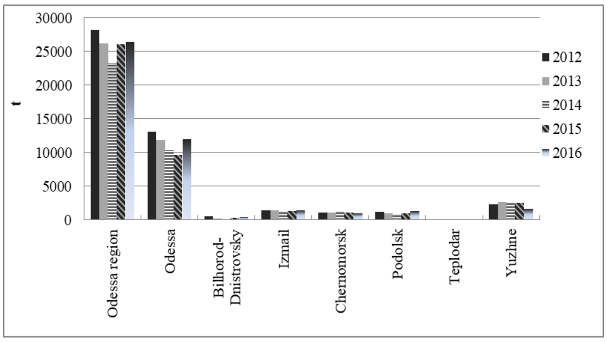

Fig. 2. Dynamics of pollutant emissions from the stationary sources in the towns of the Odesa region in 2012 - 2016 [2, 4, 6].

Among the districts of the Odesa region, the Reni, Ananiv and Rozdilnyansky regions demonstrate the leading sources of pollutant emissions from the stationary sources. The maximum values of M_{AB} are also noted in these districts, as well as in the Kodimsky district of the Odesa region. Figure 4 shows a mapping of M_{AB} in the towns and districts of the region in 2013.

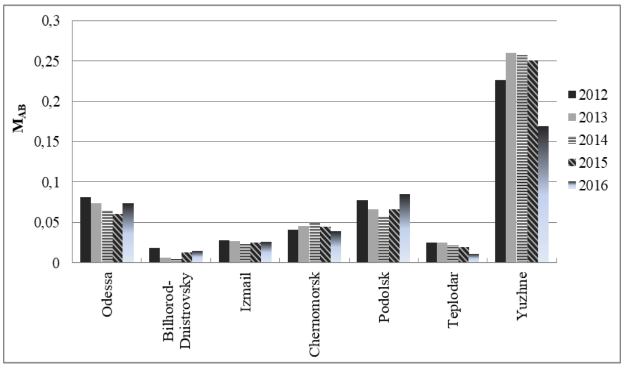

Fig. 3. Diagram of a distribution of the module of a technogenic load on the air basin in the towns of the Odesa region in 2012 - 2016 (stationary sources).

As noted above, the pollutant emission from the mobile sources is an important component of an anthropogenic contamination of the air basin of the North-Western Black Sea regions. The volumes of their emissions by order exceed the volumes of emissions from the stationary sources.

According to the State Statistics Service of Ukraine [6], the M_{AB} calculation for the air basin of the Odessa region by the pollutant emissions from the mobile sources of pollution including an automobile transport has been made. Figure 5 shows the distribution of M_{AB} for 2012 – 2015. As we see, about 90 % of the contribution to the pollutant emissions from the mobile sources belongs to an (aircraft, railways, water transport, etc.). During the research period, the M_{AB} value gradually decreased due to a decrease in a total amount of pollutant emissions from the mobile sources, including motor transport.

According to the results of the calculations, it is expedient to compare a load on the air basin in general from the emissions of the stationary and mobile sources. Figure 6 shows a M_{AB} values chart for 2012 – 2015 from all sources of pollution. As can be seen, the M_{AB} value from the mobile sources is 4 times as high as the same indicator for the stationary sources of pollution of the air basin.

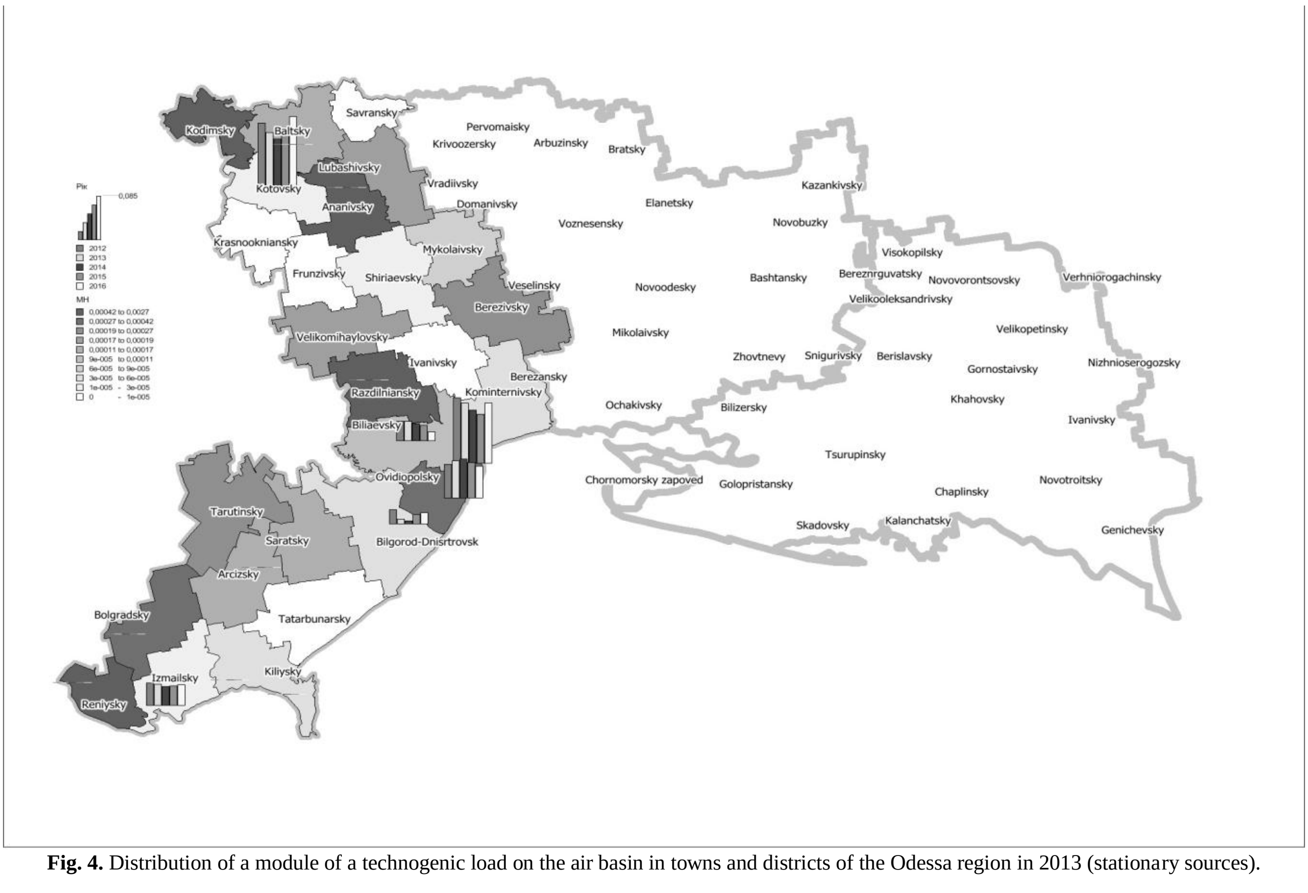

Fig. 4. Distribution of a module of a technogenic load on the air basin in towns and districts of the Odessa region in 2013 (stationary sources).

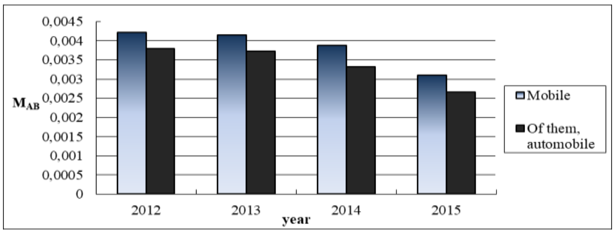

Fig. 5. The value of a module of the technogenic load on the air basin of the Odessa region in 2012 – 2015 (mobile sources).

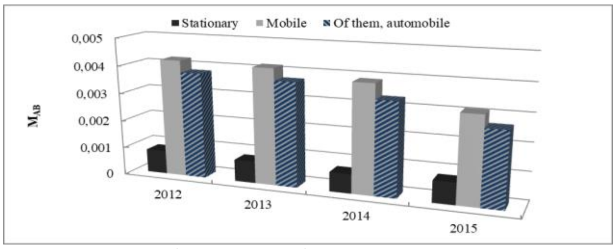

Fig. 6. The value of the module of a technogenic load on the air basin of the Odessa region in 2012 – 2015 (stationary and mobile sources).

Estimation of a technogenic load on the air basin of the Mykolayiv region. The level of a technogenic load on the natural environment, including the air basin of the Mykolayiv region is lower than the average in Ukraine. Figure 7 shows the dynamics of pollutant emissions from the stationary and mobile sources in 2012 - 2016. As we see, in general, there is a slight decrease in pollutant emissions from both the stationary and mobile sources.

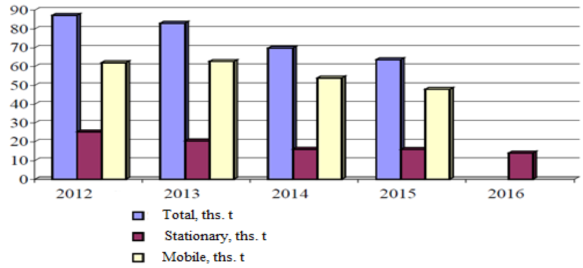

Fig. 7. Dynamics of pollutant emissions into the atmospheric air of the Mykolayiv region in 2012 - 2016 [7].

By the types of an economic activity, the main sources of pollution are the facilities of heat and power industry as well as industrial enterprises.

In order to assess a load on the air basin of the Mykolayiv region, the data from the Main Department of Statistics in the Mykolayiv region, as well as Regional Reports [7 – 9] for 2012 – 2016 were used.

Figure 8 shows the dynamics of pollutant emissions into the atmospheric air from the stationary sources of pollution in the se-lected towns of the Mykolayiv region. The maximum volumes of pollutant emissions from the stationary sources are observed in the city of Mykolayiv. They are an order of magnitude higher than the pollutant emissions in other towns of the region.

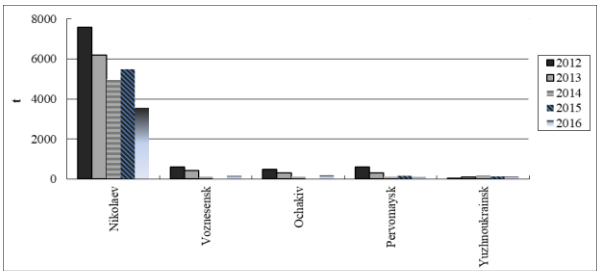

Fig. 8. Dynamics of pollutant emissions from the stationary sources in the towns of the Nikolaev region in 2012 – 2016 [7 – 9].

Figure 9 shows the distribution of M_{AB} values in the towns of the Mykolayiv region in 2012 - 2016. The analysis shows that the maximum values of M_{AB} were noted in almost all towns in 2012. In 2014 - 2015 in the towns of Voznesensk, Ochakiv and Pervomaysk the M_{AB} values declined significantly. In general, the maximum values of M_{AB} are observed in the city of Mykolayiv and, in some years, in the town of Ochakiv, and the minimum values of M_{AB} were traced in the town of Yuzhnoukrainsk.

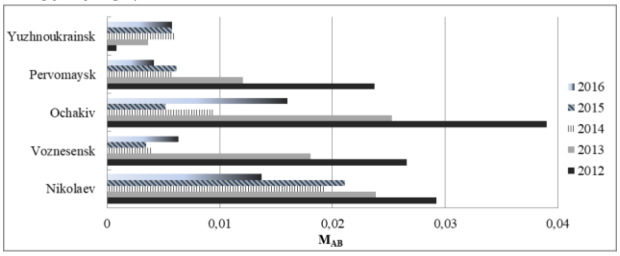

Fig. 9. Diagram of the distribution of the module of a technogenic load on the air basin in the towns of the Nikolaev region in 2012 – 2016 (stationary sources).

Among the districts of the Mykolayiv region, the largest volumes of the emissions from the stationary sources (over 1000 t/year) are observed in 4 districts: Mykolayiv, Voznesensky, Bashtansky and Vitovsky. The dynamics of the emissions in the regions is not unambiguous. Figure 10 shows a mapping of the distribution of the M_{AB} value to the Nikolaev air basin (for example, 2013). The maximum values of M_{AB} are noted in Mykolaiv, Voznesensk, Vytovsky (October), Bashtanka and Arbuzin districts.

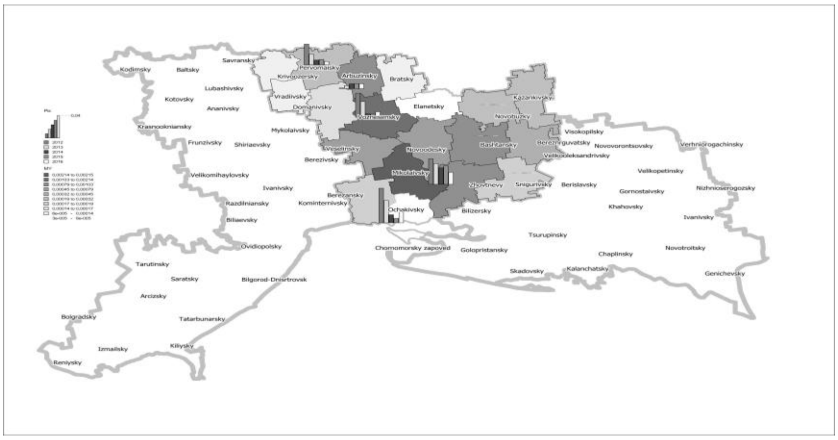

Fig. 10. Distribution of a technogenic load module on the air basin of the Nikolaev region in 2013 (stationary sources).

The calculation of M_{AB} for the Nikolaev air basin by the emissions from the mobile sources of pollution was performed according to the data of the State Statistics Service of Ukraine [10] (Fig. 11).

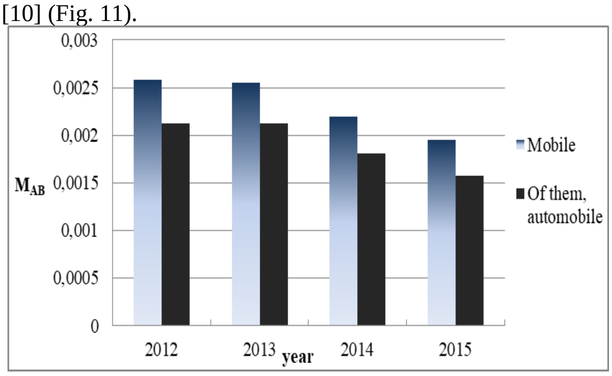

Fig. 11. The value of the module of a technogenic load on the air basin of the Nikolaev region in 2012 – 2015 (mobile sources).

Apparently, during the period in question there was observed a decrease in M_{AB} due to a decrease in the number of pollutant emissions from the mobile sources was. At the same time, the contribution of the motor vehicles to the total volume of the emissions from the mobile sources is more than 80 %.

The comparison of a load on the air basin in general from the emissions of the stationary and mobile sources (Fig. 12) showed that for the Nikolaev region M_{AB} from the mobile sources is on average 2 to 2.5 times as high as the same indicator for the stationary sources.

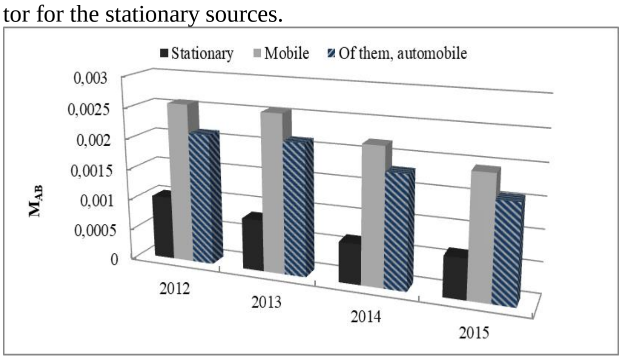

Fig. 12. The value of the module of a technogenic load on the air basin of the Nikolaev region in 2012 – 2015 (stationary and mobile sources).

Estimation of a technogenic load on the air basin of the Kherson region. Harmful emissions to the air basin of the region are carried out by more than 300 enterprises. The greatest number of pollutants gets into the atmosphere from the enterprises of the Kherson region. By the number of emissions, the region ranks 7th among the regions of Ukraine [10]. The largest level of emissions is characteristic for the enterprises engaged in the production and supply of electricity, processing industry and transport. The inflow of pollutant from the mobile sources of pollution and the production equipment in all districts of the region is dominant over the emissions from the stationary sources (Fig. 13). For the period from 2011 to 2015, a total number of pollutant emissions into the air decreased by almost 1.5 times due to a reduction of the emissions from the mobile sources. At the same time, the volume of the emissions from the stationary sources increased by 1.5 times.

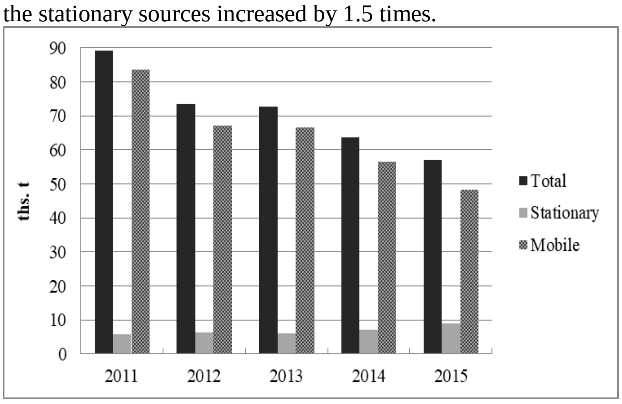

Fig. 13. Dynamics of pollutant emissions into the atmospheric air of the Kherson region in 2011 – 2015 [10 – 13].

For the estimation of a load on the air basin of the Kherson region, the data from the regional reports [10, 12 – 15] for 2012 – 2016 were used.

As of 2013, the maximum number of pollutant emissions from the stationary sources is observed in the city of Kherson, the minimum – in the city of Kakhovka. The maximum load is also noted in Kherson, the minimum – in Nova Kakhovka, at the expense of a larger area of the city (Fig. 14). Amongregions the districts of the region, the maximum emissions were traced in Bilozersk, Golopristansk, Skadovsk and Oleshkivsk districts. The largest value of M_{AB} was noted in the Belozersk, Tsyurupinsk and Skadovsk. In general the emission volumes and M_{AB} values are consistent with each other, except for the Golopristansk district.

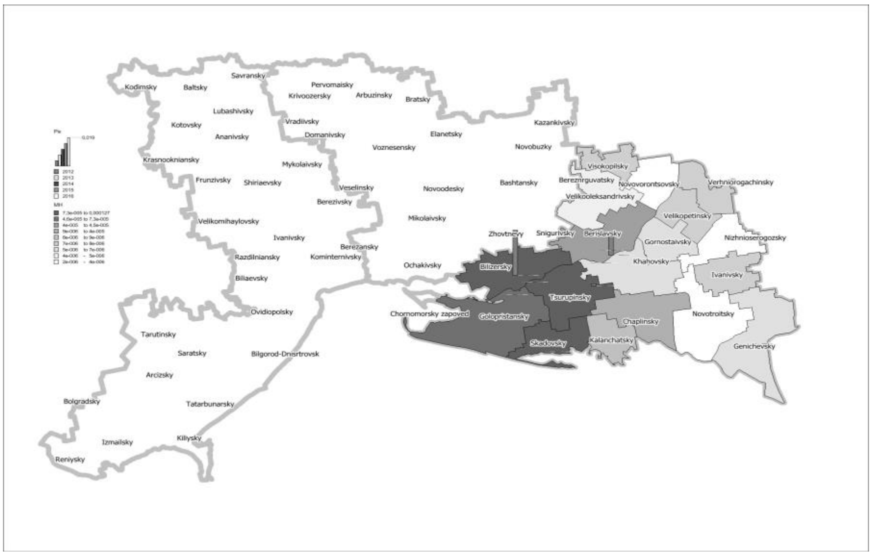

Fig. 14. Distribution of a technogenic load module on the air basin of the Kherson region in 2013 (stationary sources).

Figure 15 shows a chart of the M_{AB} values from the stationary sources of pollution in 2012 – 2016. Compared to other areas of the North-Western Black Sea regions, the Kherson region an increase in a load on the air basin from the stationary sources is saw.

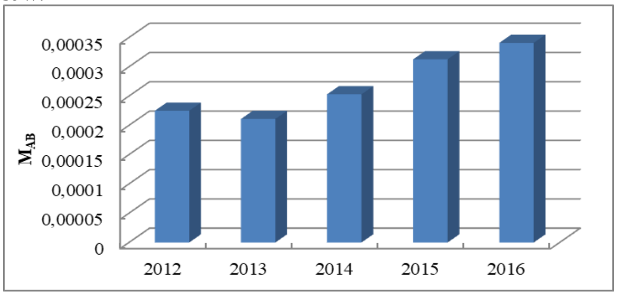

Fig. 15. Dynamics of the module of a technogenic load on the air basin in the Kherson region in 2012 – 2016 (stationary sources).

The calculation of M_{AB} by the emissions from the mobile sources of pollution (including automobile transport) was performed according to the data of the State Statistics Service of Ukraine [10] (Fig. 16). During the study period, there was a decrease in the M_{AB} values due to a decrease in the number of the emissions from the mobile sources, first of all from automobile transport. At the same time, the contribution of automobile transport to a total volume of the emissions from the mobile sources is 90 % or more.

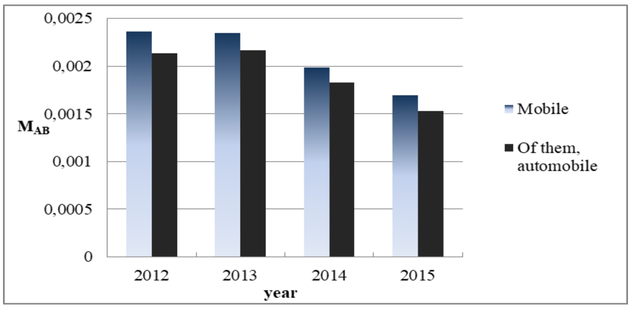

Fig. 16. The value of a module of a technogenic load on the air basin of the Kherson region in 2012 – 2015 (mobile sources).

A comparison between a load on the air basin in general from the emissions from the stationary and mobile sources has been also made (Fig. 17). As can be seen, for the Kherson region, the M_{AB} value from the mobile sources is an order of magnitude higher than the same indicator for the stationary sources.

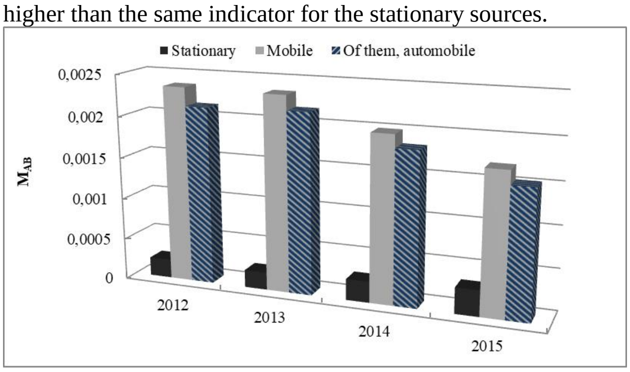

Fig. 17. The value of the module of a technogenic load on the air basin of the Kherson region in 2012 – 2015 (stationary and mobile sources).

Analysis of a technogenic load on the air basin of the North-Western Black Sea regions. Figure 18 shows a comparative graph of pollutant emission from the stationary sources for the North-Western Black Sea regions. The maximum emission volumes for the entire period are recorded in the Odesa region (47 % in 2012 to 53 % in 2016 from the total emissions of the regions). The Mykolayiv region occupies the second place, is contribution being 28 – 42 %. The maximum values of M_{AB} are respectively noted in the Odesa and Mykolayiv regions, and amongthe towns of the North-Western Black Sea regions the largest values of M_{AB} being traced for the towns of the Odesa region (Fig. 19).

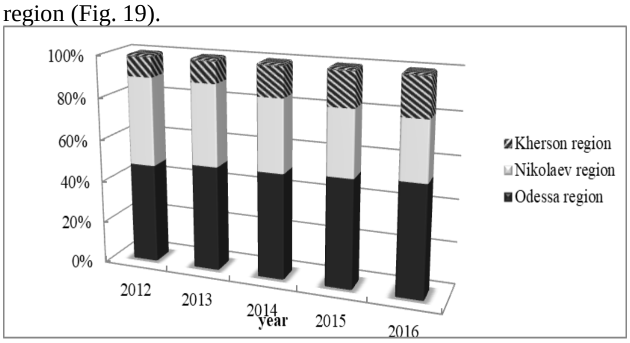

Fig. 18. Volumes of the emissions of pollutants from the stationary sources to the air basin of the North-Western Black Sea regions.

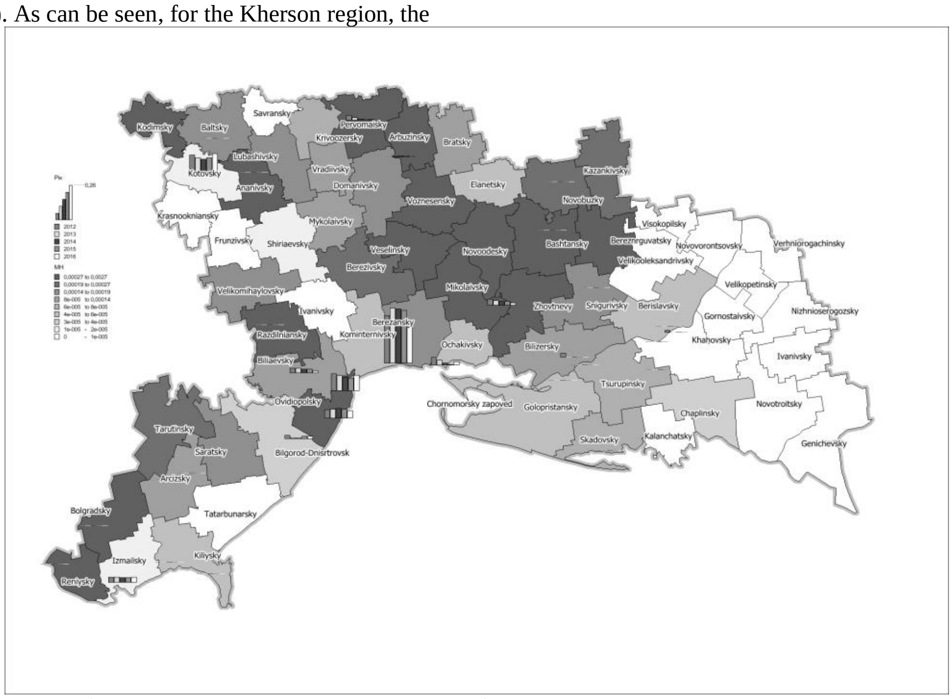

Fig. 19. Distribution of a technogenic load module on the air basin of the North-Western Black Sea regions in 2013 (stationary sources).

Figure 20 shows a comparative graph of pollutant emissions from the mobile sources. Among the North-Western Black Sea regions, the maximum volumes of emissions from the mobile sources are observed in the Odesa region and make up 52 - 54 % of the total volume. In the Mykolayiv and Kherson regions the emissions are almost the same and make 23 - 24 % and 24 - 25 % respectively. The M_{AB} value for the air basin from this category of the pollution sources is also the maximum for the Odessa region (Fig. 21).

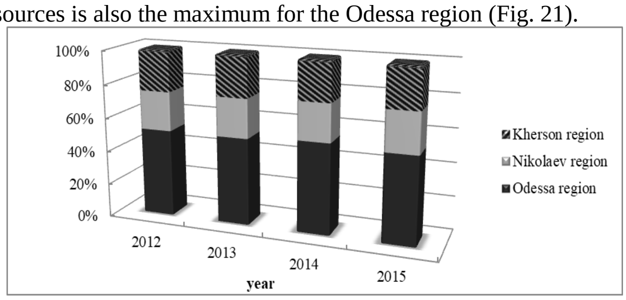

Fig. 20. Volumes of pollutant emissions from the mobile sources to the air basin of the North-Western Black Sea regions.

3. Conclusions

As a result of the research, the following conclusions can be drawn:

- In the Odessa region, the enterprises of the industry, as well as the production and distribution of electricity, gas and water, make the largest contribution to the pollution of the air among the stationary sources. Yuzhne has the maximum load level among the towns of the Odesa region by M_{AB}. The second and third places are occupied by Odesa and Podolsk. The comparison of a load on the air basin in general from the emissions of the stationary and mobile sources showed that the value of M_{AB} from the mobile sources is 4 times as high as the same indicator for the stationary sources.
- In the Mykolayiv region, according to the types of an economic activity, the main pollutants are heat power enterprises and industry. The maximum volumes of pollutant emissions from the stationary sources are observed in the city of Mykolayiv. The maximum values of M_{AB} are observed in the city of Mykolayiv, the minimum – in Yuzhnoukrainsk. For the period of 2012 - 2016 there was a decrease in M_{AB} due to a decrease in the number of emissions from the mobile sources. For the Mykolayiv region, the M_{AB} values from the mobile sources are on average 2 to 2.5 times as high as the same indicator for the stationary sources.
- In the Kherson region, by the type of an economic activity, the largest number of emissions is characteristic for the enterprises of the electricity and supply processing industry and transport industry. The maximum load is observed in Kherson, the minimum – in the town of Nova Kakhovka. Compared to other regions of the Northwest Black Sea coast, in the Kherson region there was an increase in a load on the air basin from the stationary sources of pollution in 2012 - 2016. A decrease in M_{AB} from the mobile sources of pollution is due to a decrease in pollutant emissions and, above all, from motor vehicles. For the Kherson region, the M_{AB} value from the mobile sources is an order of magnitude higher than the same indicator for the stationary sources.
- The comparative analysis of the pollutant emissions from the stationary sources and the corresponding values of the M_{AB} indicator for the regions of the Northwest Black Sea coast shows that the maximum emission volumes for the entire period are observed in the Odesa region. The Mykolayiv region occupies the second place. The maximum M_{AB} values are marked in the Odesa and Mykolayiv regions respectively. The maximum volumes of pollutant emissions from the mobile sources and the M_{AB} values are noted in the Odesa region.

The obtained results form the basis for the further development of the environment protection measures and programs to reduce a technogenic impact on the atmospheric air of the regions of the Northwest Black Sea coast. The authorities of the State Environmental Inspection, Ecology and the Natural Resources Departments should focus on the development of the effective measures to reduce an impact of automobile transport.

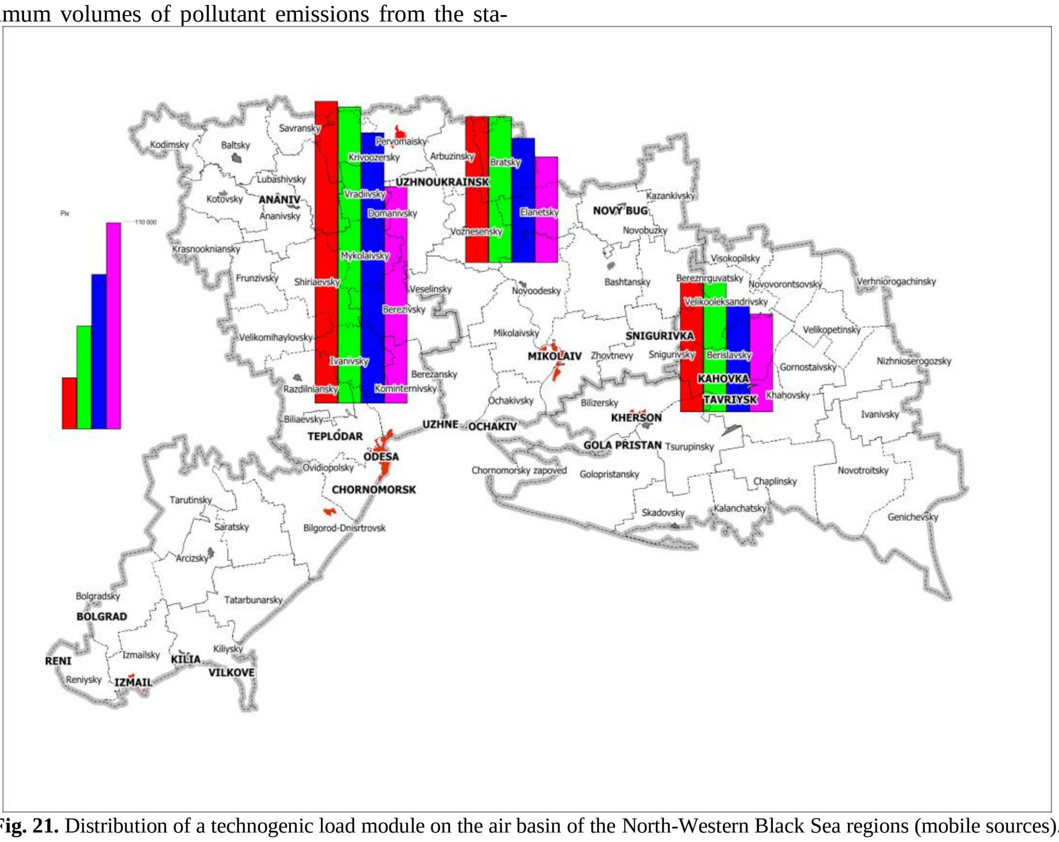

Fig. 21. Distribution of a technogenic load module on the air basin of the North-Western Black Sea regions (mobile sources).

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