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Assessment of technogenic load on the environment in the regions of the Ukrainian Northwest Black Sea

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Under the influence of industry, energy, transport, agriculture and other sectors of the economy, as well as urbanization, the technogenic load on the territory of the Northwest Black Sea (Ukraine) is increasing. The purpose of the work is to evaluate and analyze the technogenic load on the environment of Odessa, Mykolaiv and Kherson regions, which are included in the designated territory. To evaluate and analyze the level of technogenic load, the principle of calculation of the module of technogenic load was applied. It is also suggested to calculate individual load modules for the environmental components: air pool, water bodies, soil cover and geological environment. It is established that the volume of pollutants into the atmosphere and the discharge of wastewater into surface water objects the maximum level of man-made load is noted for Odessa region, the minimum - for Kherson region. According to the indicators of waste generation and accumulation, the Mykolaiv region is experiencing the greatest load. By the value of the technogenic load module maximum values are characteristic for the territory of Odessa region.

Key words: technogenic load; technogenic load module; environment; Northwest Black Sea

Introduction

Technogenic load on the environment is the ratio of the power of man-made impacts and the degree of renewed ability of natural ecosystems, which can be determined by the reaction of abiogenic and biogenic components. The environment is considered to be safe when its condition meets the criteria, standards, limits and norms set out in the legislation relating to its cleanliness (pollution), resource intensiveness (non-exhaustion), environmental sustainability, sanitary requirements, species diversity, ability to satisfy and others (Mudrak, 2008).

Through the processes of urbanization, the development of industry, energy, transport, agrarian and other sectors of the economy, anthropogenic impact on the regions of the Northwest Black Sea (NBS) is increasing. This area is characterized by a unique natural resource potential. It also has a large number of settlements, industrial, fuel and energy, transport, recreational and other objects, which negatively affects the state and quality of the environment, reduces the value of recreation and worsens the overall ecological situation within certain territories (State and quality…, 2017).

The purpose of the proposed work is to evaluate and analyze the technogenic load on the environment of the NBS (Odesa, Mykolaiv and Kherson regions).

In the Odessa region, mobile sources are the predominant sources of air pollution. Emissions from these sources have been steadily increasing over the last 10 years. However, the influence of stationary sources is quite significant for the formation of the technogenic load on the air pool of this region. Emissions from stationary sources have been declining in recent years with a general trend towards increasing the number of stationary sources of emissions (Ecological passport…, 2006; 2011; 2014; 2017). As of 2018, there were 132 enterprises in the Odessa region, which discharged sewage and other return water into surface water bodies, including: 24 farms discharged into irrigation systems (Regional report…, 2019). Also, according to Regional report (2019), capacities for the utilization and disposal of hazardous industrial wastes have been established and operated in the region, but they are not yet sufficient. According to the Department of Ecology and Natural Resources of the Odessa Regional State Administration, there are 608 landfills of solid municipal waste (SHW) occupying its territory - about 1300 hectares of land. Most of them are in poor condition and are operated in violation of environmental legislation and requirements of sanitary and epidemiological safety.

In the Mykolaiv region, mobile sources are also the predominant sources of pollutant emissions (PE). The list of the main stationary sources in the region varied significantly (from 3 to 17) (National report…, 2001; 2006; 2016; 2019; Ecological passport…, 2010). With the increase in the number of enterprises that emit atmospheric air in the region, the amount of PE is significantly reduced. At present, there are about 160 water licensed enterprises operating in the region. The main polluters of the water resources of the region are water utilities. The main areas where hazardous waste is actually generated in the region include metallurgy, machinery, shipbuilding, food processing, leather processing, water utilities, agricultural enterprises, medical establishments (Regional report…, 2019).

In the Kherson region, mobile sources are the predominant sources of PE emissions, as in other areas of the NBS. Among the stationary sources, Kherson enterprises are the main air pollutants. They mainly consist of enterprises engaged in the production

and distribution of electricity and gas (Ecological passport…, 2019). Unlike in other NBS regions, there is a significant increase in the amount of emissions in the region (by an order of magnitude) that has been generating PE. According to (Regional report…, 2018), in 2017, a total of 1,218 water users were registered. In the territory of Kherson region there are 100 waste generation facilities and 8 waste treatment and disposal facilities (Ecological passport…, 2019). A critical situation has emerged in the area of SNW management. There are also a large number of unsuitable pesticides in the region (Regional report…, 2018).

Material and methods

To estimate and analyze the level of technogenic load, the module of technogenic load (MTL) was calculated, which is defined as the sum of weight units of all types of waste (solid, liquid, gaseous) industrial, agricultural and municipal objects in a time interval of 1 year, related to the area the administrative district or district within which these objects are measured, measured in thousand tons/ km^2 per year (Adamenko & Rudko, 1998).

We propose to calculate the following indicators as separate components of the environmental load module:

- module of technogenic load on the air basin (M_{AP}) according to the indicators of the emissions of PE from stationary and mobile sources of pollution, which involves the sum of two values;
- module of technogenic load on water objects (M_{WO}) according to indicators of wastewater discharges and PE in their composition; this indicator does not imply summation since the amount of PE in wastewater and other return waters is their component;
- module of technogenic load on geological environment (M_{GE}) in terms of waste generated and accumulated in the region; whereas soil formation and, in particular, the accumulation of waste from production and consumption, inevitably cause contamination of the soil cover, it is considered as a component of the geological environment (GE); this metric may also suggest a sum of two values.

If the amount of emissions and discharges of PE can be considered as direct indicators of the impact on the air basin and water bodies respectively, the processes of formation and accumulation of various production and consumption wastes pose a threat to the state of all environmental components.

The materials of the Regional reports and Environmental passports of Odessa, Mykolaiv and Kherson regions on the amount of emissions of PE, wastewater and polluting discharges, generation and accumulation of waste for 2003-2018 were used as baseline data.

Results and Discussion

Comparative analysis on the estimation of anthropogenic load on the air basin was made for the period 2003 - 2018. Separate analysis on the emissions of PE from stationary, mobile sources, the total amount of emissions and, accordingly, on the module of anthropogenic load on the air basin (Figures 1, 2 and 3).

If we analyze the data on the emissions of stationary sources (Figure 1), then the maximum amount of PE in the air basin of the NBS regions comes from the enterprises of the Odessa region (40 - 60% in different years). The second place is occupied by the Mykolaiv area, which emissions of the enterprises in some years made more than 40%. According to the value of the indicator of the M_{AP}, it should be noted that in 2009 - 2012 the Mykolaiv region underwent a greater technogenic load on the air pool.

In terms of the amount of mobile emissions from mobile sources (Figure 2), the maximum amount is also observed for the Odessa region (more than 50%). Other areas are characterized by almost the same indicators, however, in recent years, the PE emissions in the Kherson region exceed those in the Mykolaiv region. According to the value of the indicator, the maximum load on the air pool is noted for the Odessa region. The load levels in other regions are almost the same.

The total amount of PE emissions into the atmospheric air (Figure 3) is by far the first place in the Odessa region (50% or more annually), as well as in other emission indicators. The same situation is observed in the level of technogenic load. The minimum level is generally observed in the Kherson region.

Thus, the analysis showed that in almost all the indicators of the PE emission, the maximum level of technogenic load on the air pool among the regions of the NBS is noted for the Odessa region, the minimum - for the Kherson region.

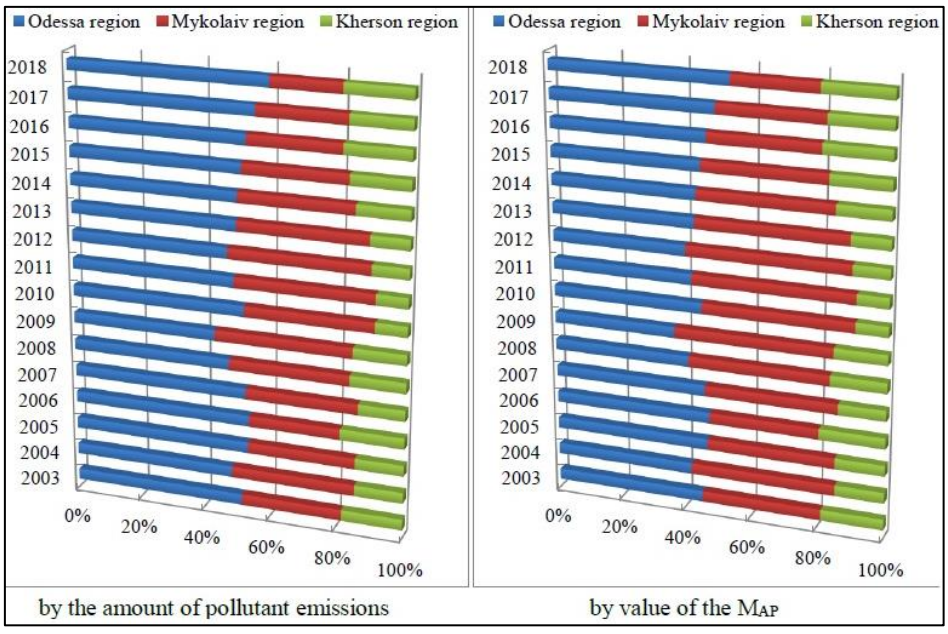


Figure 1. Comparative analysis of anthropogenic load on the Northwest Black Sea region by emissions of pollutants from stationary sources.

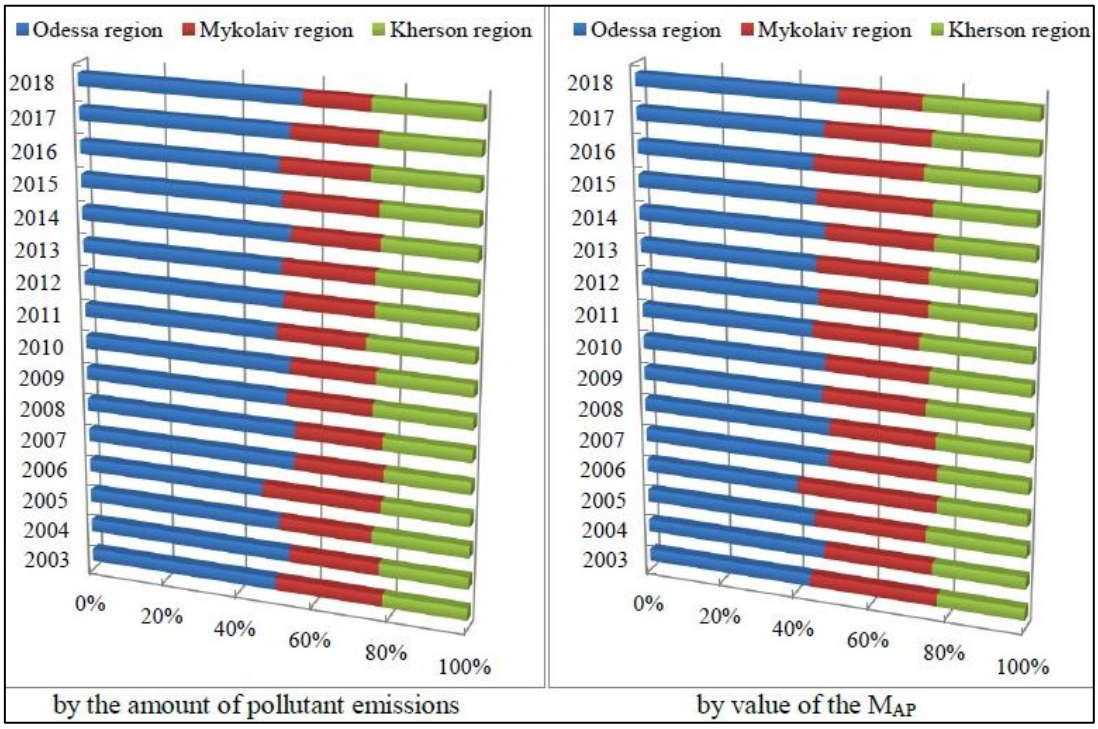


Figure 2. Comparative analysis of anthropogenic load on the Northwest Black Sea region by emissions of contaminants from mobile sources.

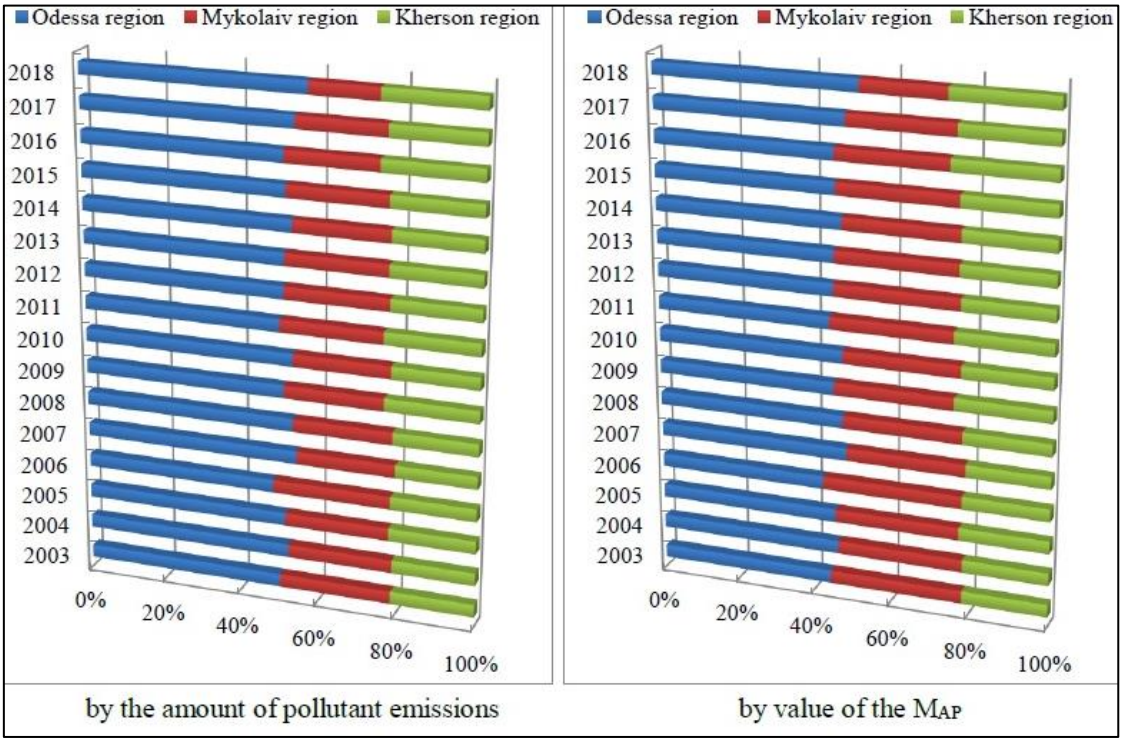


Figure 3 . Comparative analysis of anthropogenic load on the Northwest Black Sea region by the total amount of pollutant emissions into the air.

Surface water load analysis was performed for the years 2004-2018 on the basis of wastewater discharge volumes (Figure 4) and for 2005-2016 on the PE wastewater discharges (Figure 5). As can be seen from both figures, the surface water objects of the Odessa region (55-75% of wastewater discharges and 60-75% of PE discharges from the total volumes) are subjected to the greatest load. Kherson region ranks second in terms of wastewater discharges. According to the value of the M_{WO} indicator, the maximum load level is also noted for the Odessa region. According to the indicators of wastewater discharges, the value of M_{WO} after the Odessa region is the largest in the whole in the Mykolaiv region, and by the volume of discharges of the PE - in Kherson. Comparative analysis of man-made load on GE was conducted by the amount of waste generated in the regions for 2007-2018, by the amount of accumulated waste for 2011-2018 (Figures 6 and 7).

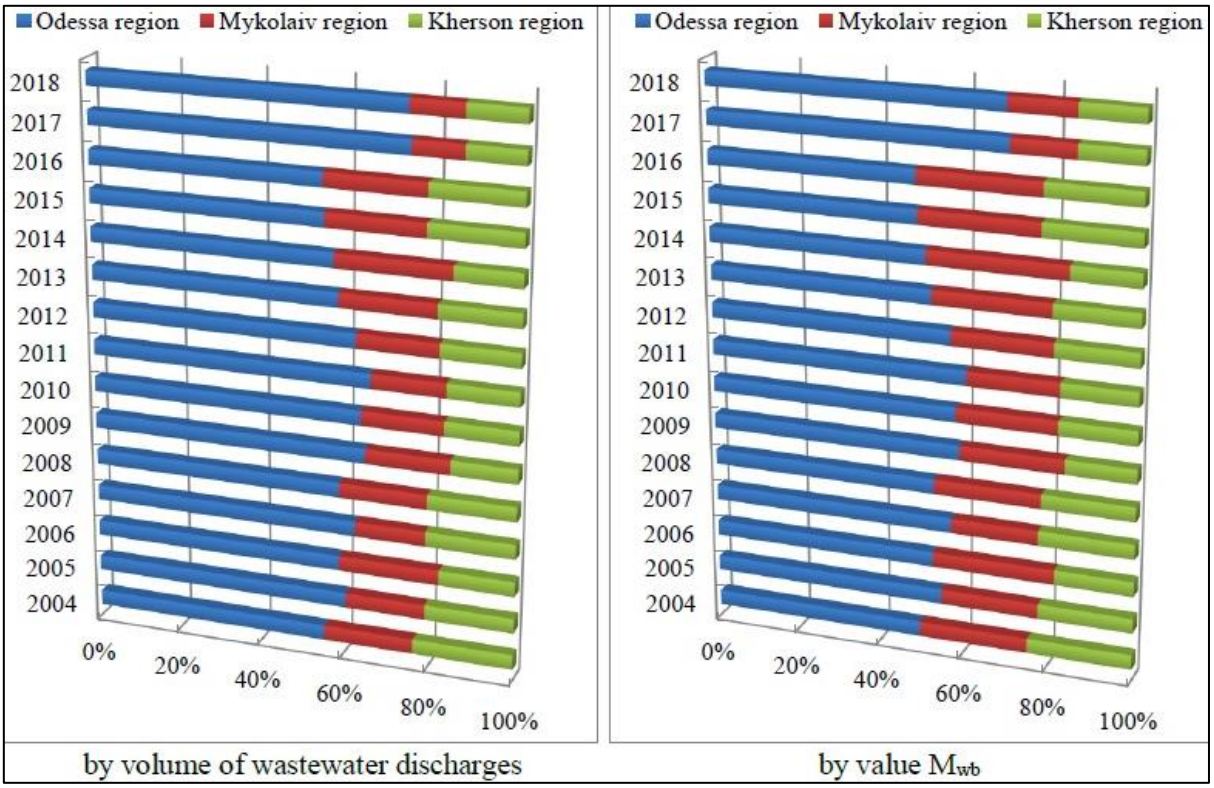


Figure 4. Comparative analysis of anthropogenic load on the Northwest Black Sea region by wastewater discharges into surface water bodies.

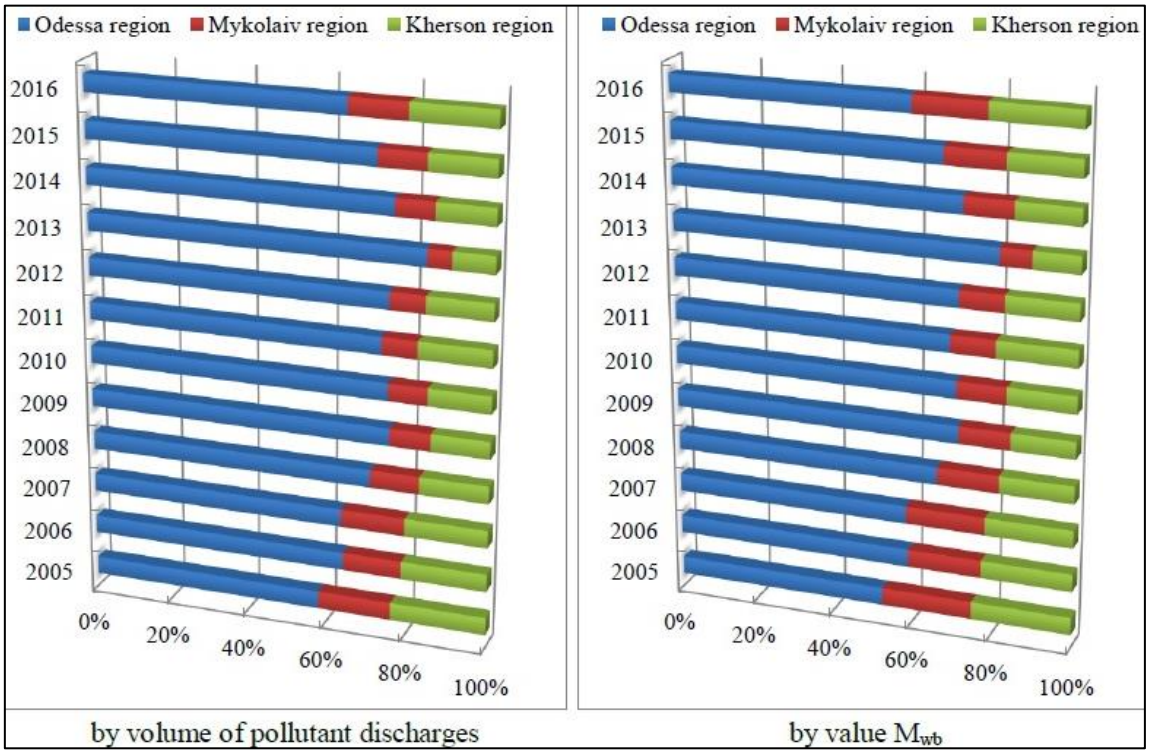


Figure 5. Comparative analysis of anthropogenic load on the Northwest Black Sea region by discharges of pollutants from wastewater into surface water bodies.

As can be seen from Figure 6, the maximum amount of waste among the NBS regions is generated in the Mykolaiv region (in different years 60-75% of the total amount of waste). The volume of waste generation exceeds the order of magnitude in the Odessa and Kherson regions.

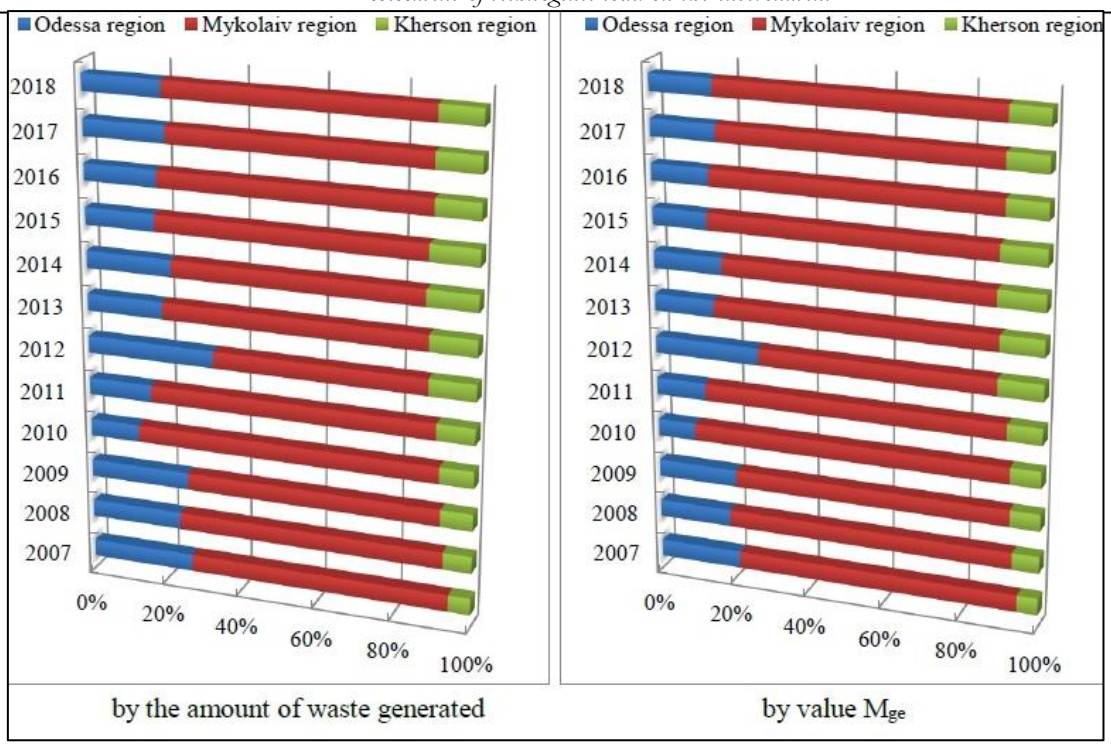


Figure 6. Comparative analysis of technogenic load on the Northwest Black Sea regions by volume of waste generated.

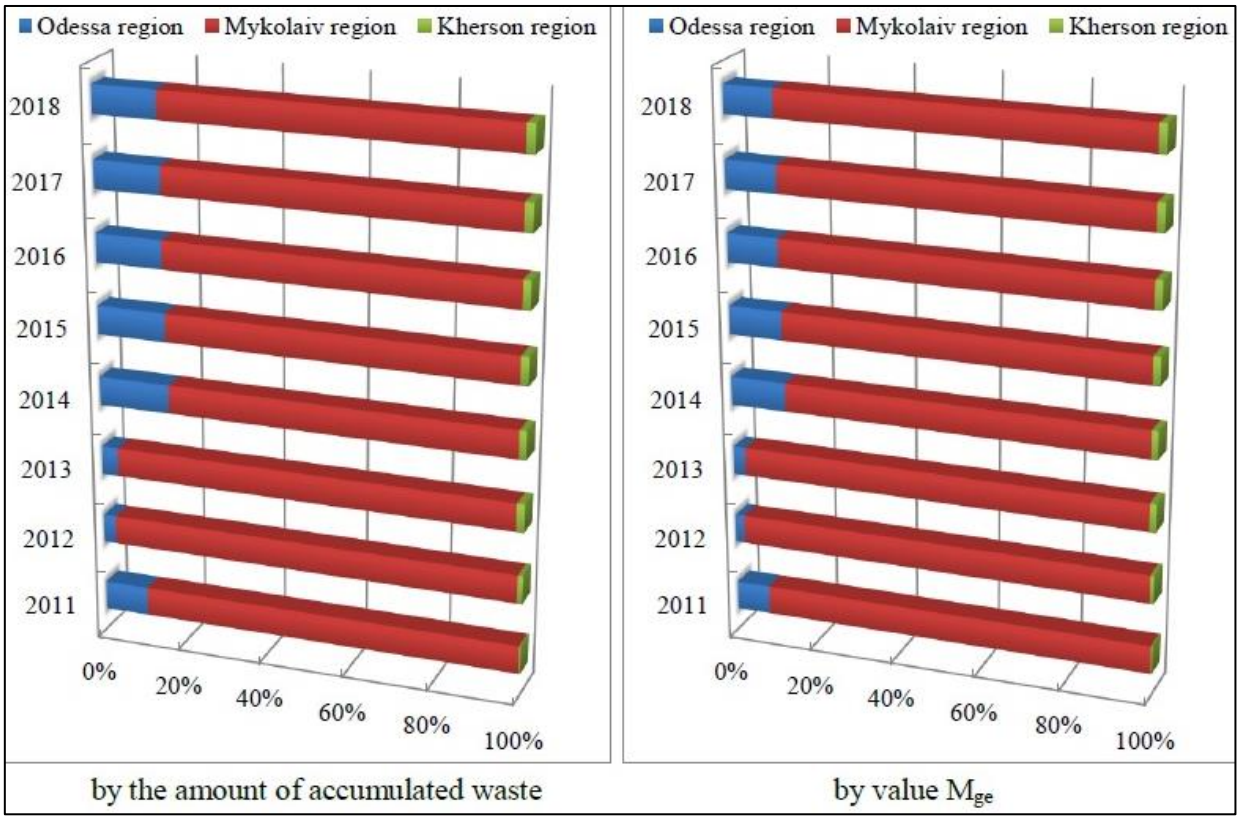


Figure 7. Comparative analysis of anthropogenic load on the Northwest Black Sea region by volume of accumulated waste.

The vast majority of waste in the Mykolaiv region is generated at the enterprise "Mykolaiv Alumina Plant" (in 2018 - nearly 1800 thousand tons, Regional report…, 2019). Accordingly, the level of technogenic load on GE is the highest among the regions of NBS in the Mykolaiv region.

A similar situation is noted in terms of accumulated waste (Figure 7). In this case, the volume of accumulated waste in the Mykolaiv region (80 - 90% in total by the NBS regions) is by one order higher than the corresponding indicators in the Odessa region and by two orders of magnitude - in the Kherson region.

The averaged and generalized results of the study on the level of anthropogenic impact on individual components of the regions of the NBS are shown in Figures 8, 9 and 10.

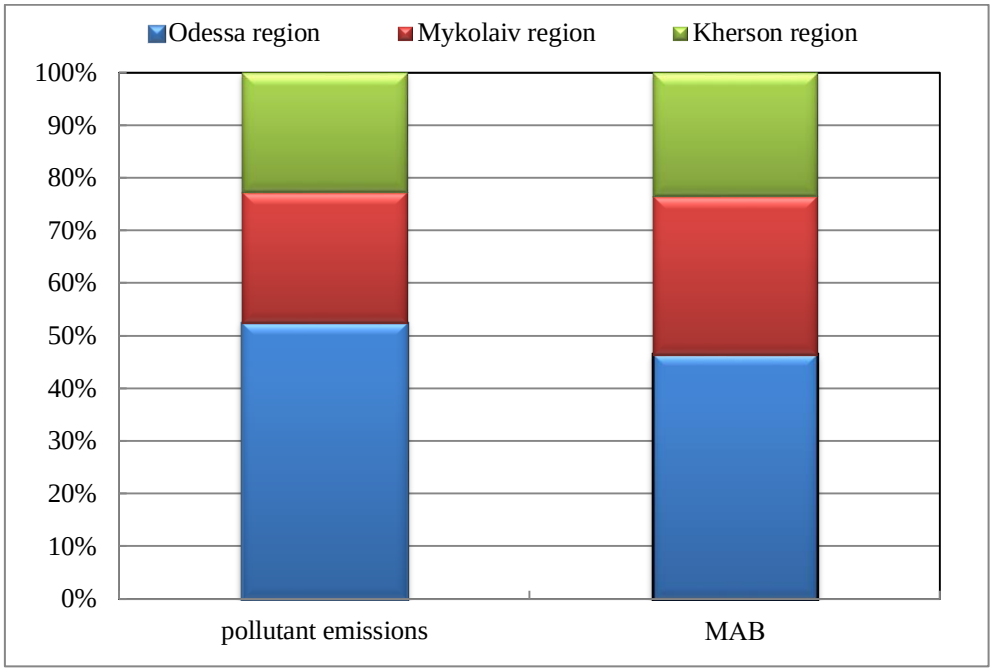


Figure 8. Comparative analysis of the technogenic load on the air pool of the Northwest Black Sea region in 2003-2018.

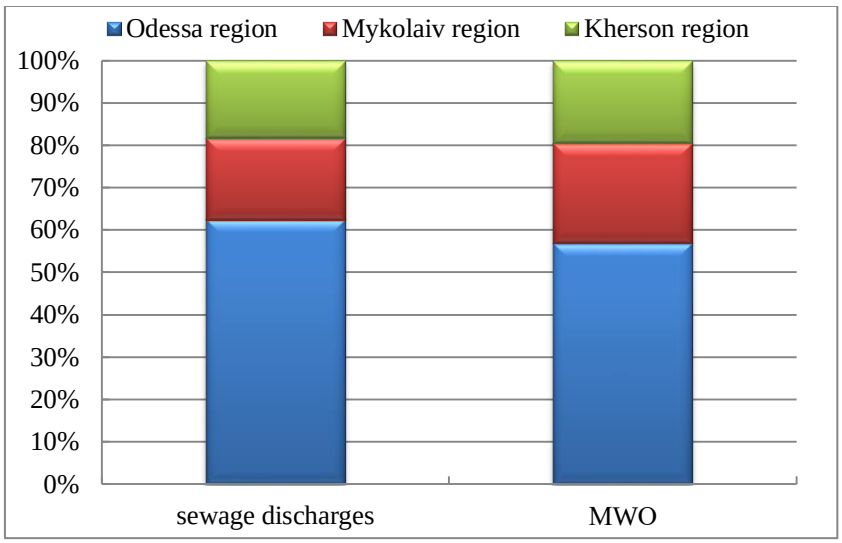


Figure 9. Comparative analysis of the technogenic load level of the water bodies of the Northwest Black Sea region in 2003-2018.

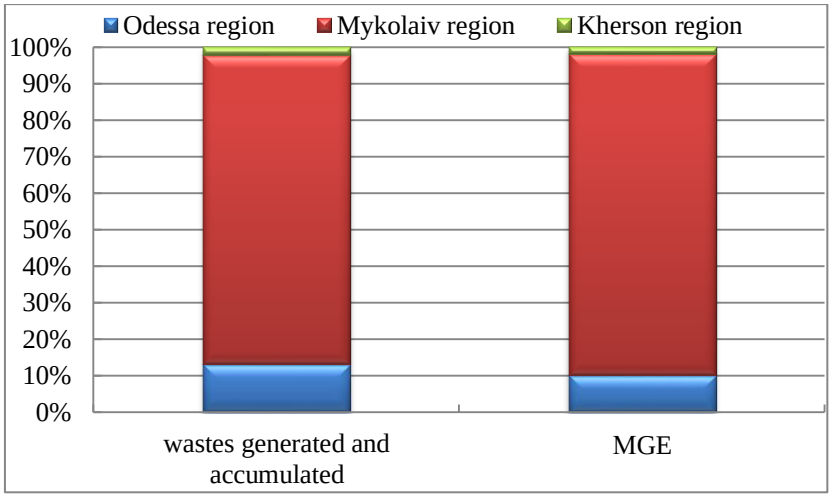
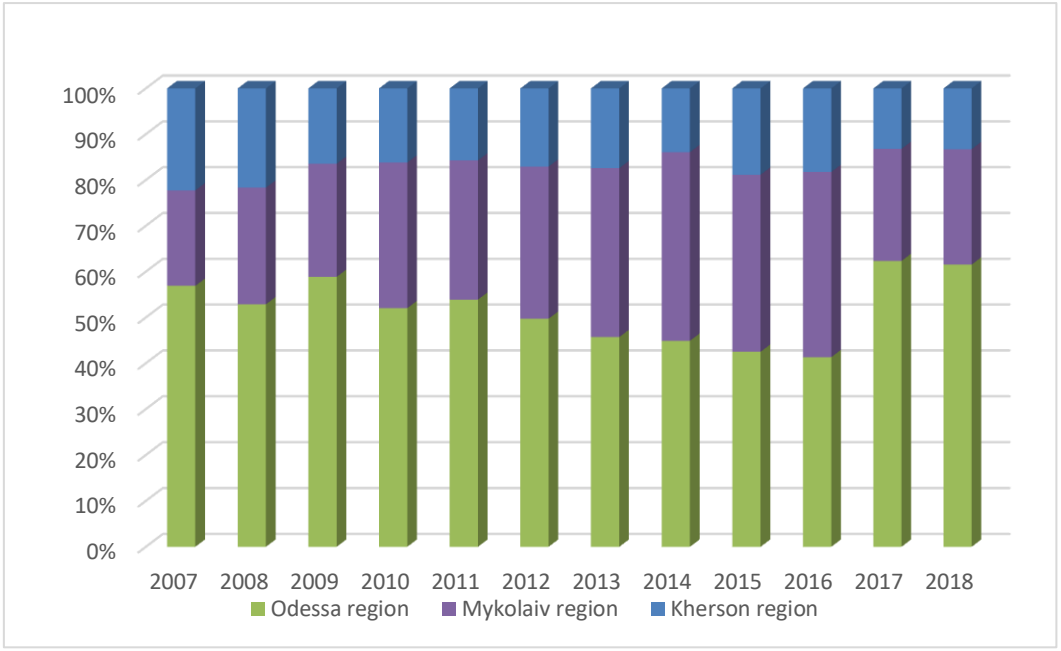


Figure 10. Comparative analysis of the level of technogenic load on the geological environment of the area of the Northwest Black Sea in 2003-2018.



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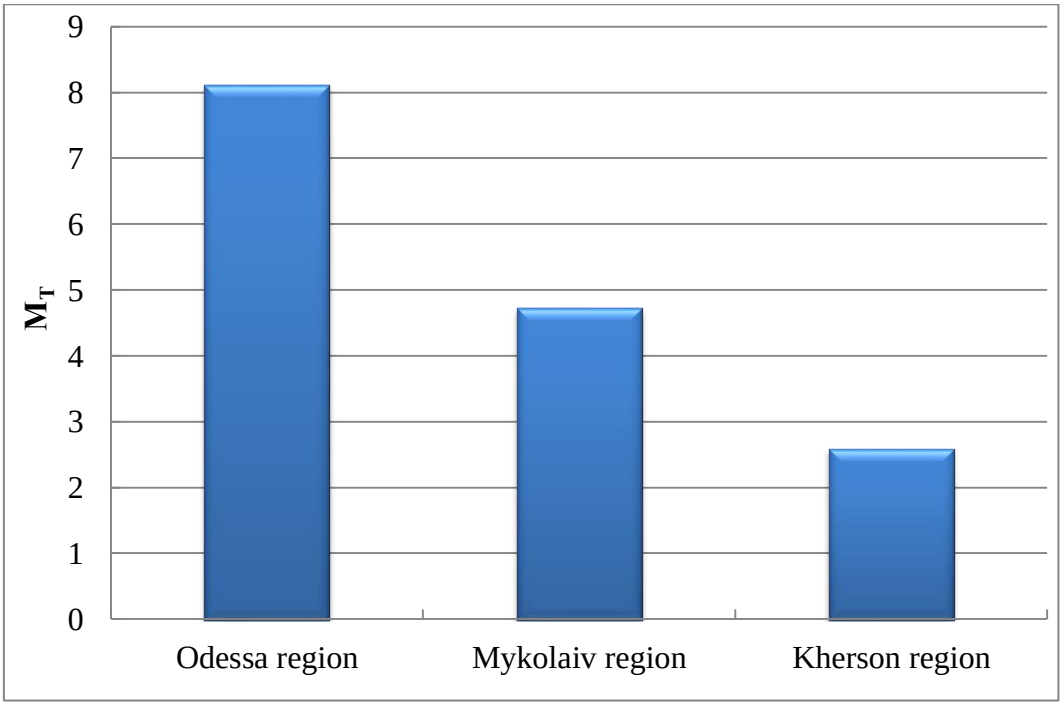

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Figure 11. Comparative analysis of the anthropogenic load on the Northwest Black Sea regions in 2007-2018 (a) and by averaged indicators (b).

Thus, the analysis of materials over a long period of time and the obtained calculations show that the maximum level of man-made load is observed for the Odessa region, and the minimum for the Kherson region, in terms of the emissions of PE into the atmosphere and discharges into the surface water bodies. According to the indicators of waste generation and accumulation, as noted above, the greatest load is undergoing the Mykolaiv region.

At the final stage, a comparative analysis of the change in the M_{TL} of the regions of the NBS was conducted (Figure 11). As can be seen, the value of M_{TL} in the overwhelming majority of years, as well as the averaged indices of maximum technogenic load, is affected by the environment of the Odessa region. Also there is an increase in M_{TL} values in recent years for the Mykolaiv region and a decrease - for the Kherson region.

Separate results of the integrated assessment of the environmental component load of the regions of the NBS are presented in the works of the author with co-authors (Chuga &, Dzhura, 2018; Chugai et al., 2018; Chugai & Bazyka, 2019; Chugai & Dzhura, 2019).

Conclusions

The paper assesses the level of anthropogenic load on the environment of the regions of the NBS. The analysis of materials over many years and the results of the calculations show that the maximum level of technogenic load is observed for the Odessa region, the minimum for the Kherson region, in terms of the emissions of air into the atmosphere and discharges of PE into surface water bodies. According to the indicators of waste generation and accumulation, the Mykolaiv region is experiencing the greatest load.

According to the value of M_{TL} of maximum technogenic load, the environment of the Odessa region (50% contribution and more to the formation of the general level). Also there is an increase in M_{TL} values in recent years for the Mykolaiv region and a decrease - for the Kherson region.

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