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POSSIBILITIES OF REMOTE SENSING FOR MONITORING THE SPREAD OF POLLUTANTS (FOR EXAMPLE, NITROGEN DIOXIDE (NO_2)) IN CITIES OF UKRAINE

МОЖЛИВОСТІ ДИСТАНЦІЙНОГО ЗОНДУВАННЯ ДЛЯ МОНІТОРИНГУ РОЗПОВСЮДЖЕННЯ ЗАБРУДНЮЮЧИХ РЕЧОВИН (НА ПРИКЛАДІ ДІОКСИДУ АЗОТУ (NO_2)) В МІСТАХ УКРАЇНИ

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In modern times, growing anthropogenic pressure has a negative impact on various natural systems of Ukraine, which negatively affects the life of the country's population. One of the most important components in the assessment of living conditions is the quality of the environment in which people live. Today, one of the urgent problems of the modern world is the pollution of the surface layer of the atmosphere by emissions from industrial enterprises. This especially applies to large cities. Environmental problems

of cities, associated with excessive concentration on relatively small territories of population, transport and industrial enterprises, forming anthropogenic territories, are very far from a state of ecological balance. In Ukraine, such cities as Kryvyi Rih, Donetsk, Dnipropetrovsk and others in which their large business structure includes enterprises of ferrous metallurgy, building materials (processing of stone raw materials), they are the main air polluters in Ukraine, and are an example of a modern industrial agglomeration , in which the geographical location of the city's enterprises, features of the landscape, residential development and seasonal climatic changes can form centers of environmental problems in different areas with individual sets of pollutants that affect the quality of atmospheric air.

A powerful tool that will significantly speed up the process of controling the process of atmospheric pollution, which is necessary to overcome the problem of unsatisfactory atmospheric air quality, is the use of remote sensing methods. It is satellite monitoring that will make it possible to detect and identify sources of pollution more efficiently with minimal costs in order to improve planning and make administrative decisions regarding the unsatisfactory state of atmospheric air quality in populated areas, which causes the concentration of gases in the atmosphere, in particular nitrogen dioxide (NO_2), reducing and improving the negative impact emissions on the vital activities of the population in the cities of Ukraine.

Nitrogen dioxide (NO_2) is one of the dangerous gases that is very poisonous when inhaled. The World Health Organization indicates that long-term exposure to air in which the maximum permissible concentration of nitrogen dioxide is exceeded can lead to respiratory diseases and suppress breathing in the lungs.

Nitrogen dioxide (NO_2) is found in the exhaust gases of cars and fumes from thermal power plants. To a lesser extent, the concentration of nitrogen in the air is caused by the burning of gas heaters. It should be noted that the analysis of the ecological state of the territories of cities from atmospheric air pollution by nitrogen dioxide is given in numerous works [1-6].

The purpose of the research is to investigate the content of nitrogen dioxide (NO_2) over the cities of Ukraine according to the data of remote sensing.

Monthly data on NO_2 concentration from the AURA satellite were used in the work. For the years 2005 – 2021, 204 images of monthly NO_2 concentration values with a spatial resolution of 11 km were processed. Space images were processed in the Erdas Imagine program, the contours of the cities of Ukraine were taken from the vector map "Ukraine 500".

For the years 2005–2021, the value of the average concentration of nitrogen dioxide was calculated for all oblast centers of Ukraine and their ranking was carried out by the degree of pollution (Table 1).

Table 1

Results of the ranking of oblast centers of Ukraine for the period 2005–2021 according to the degree of pollution by nitrogen dioxide (NO_2) according to AURA satellite data

№	Oblast centers of Ukraine	Average concentration of NO_2, 10^9molecules/mm^2 за 2005–2021 рр.	№	Oblast centers of Ukraine	Average concentration of NO_2, 10^9molecules/mm^2 за 2005–2021 рр.
1	Donetsk	373,677	14	Kherson	161,637
2	Dnipro	311,244	15	Ivano-Frankivsk	160,078
3	Kyiv	289,655	16	Sumy	146,646
4	Zaporizhzhia	281,198	17	Chernihiv	140,813
5	Luhansk	249,631	18	Lutsk	139,598
6	Kharkiv	225,552	19	Ternopil	136,795
7	Lviv	207,738	20	Chernivtsi	133,956
8	Odesa	199,193	21	Rivne	131,903
9	Poltava	175,805	22	Vinnytsia	131,722
10	Mykolaiv	174,44	23	Zhytomyr	129,498
11	Uzhhorod	169,424	24	Khmelnytskyi	128,147
12	Cherkasy	168,51	25	Simferopol	108,687
13	Kropyvnytskyi	163,594			

In Table 1, 4 groups are clearly distinguished: 1) maximum values of NO_2 air pollution, concentration more than 300 (10^9molecules/mm2) in Donetsk and Dnipro cities, 2) large values, concentration of NO_2 from 250 to 300 (10^9molecules/mm2). It is interesting that this group includes the capital of Ukraine – the city of Kyiv, which can be explained by the largest population compared to other cities and the presence of polluting enterprises (Darnyts′ka CHP), 3) increased values, which corresponds to the presence of 1-2 enterprises with large emissions of nitrogen dioxide and 4) where it is possible to say that the air is relatively clean, compared to the first group, the concentration of NO_2 is 2.2–3.4 times lower.

As a result of the conducted research, the current levels of atmospheric air pollution with nitrogen dioxide (NO_2) in the cities of Ukraine for the period 2005–2021 were estimated. Depending on the level of pollution and

quantitative assessments, the identified trends, the cities were ranked into groups with different degrees of air pollution by this substance.

The feasibility of using Remote Sensing materials to assess the existing level and future trends of atmospheric air pollution in Ukrainian cities, both with nitrogen dioxide and other harmful gases, has been proven.

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