Mon-21-059

Cartographic monitoring of atmospheric air quality on the territory of Poltava region (monthly trend)

***E. Bondarenko** *(Taras Shevchenko National University of Kyiv, Ukraine)*, **M. Kyryliuk** *(Institute of Geography, NAS of Ukraine)*, **O. Yatsenko** *(Taras Shevchenko National University of Kyiv, Ukraine)*

SUMMARY

The author's approach to conducting regional cartographic monitoring to identify the territorial distribution of the air quality indicator of the territory of the Poltava region during the month period on the basis of an animated map is developed in the article.

The research is aimed to optimizing the interval of fixation and cartographic representation of the air quality index by isolines; consideration of transboundary air pollutants within the model territory with adjustment of its quality index as an indicator of mapping; identification of natural and anthropogenic factors influencing the mapping index.

The work uses general and special methods of scientific research, in particular: analysis and synthesis, scientific classification, comparative, informational, cybernetic, geoinformation mapping.

As a result of the performance of work, some cyclicity in the spatial development of the phenomenon in time which is consistent with its change for days is revealed. The growth of air pollution is recorded daily from approximately 12 to 24 hours.

It is experimentally proved that the most negative impact on the air quality of the model area is anthropogenic factors, in particular, emissions from stationary and mobile sources.

Introduction
Atmospheric air pollution has long been a major environmental factor in the growth of morbidity and mortality. According to the sources of atmospheric impurities, it is one of the types of natural and/or anthropogenic pressure on the environment, characterized by emissions into the celestial sphere of chemicals, solid particles, and biological materials, which can cause harm to humans, other living organisms and plants.

The degree of danger to humans, which is determined by a certain indicator of air pollution and provides the possibility of safe living and living in a particular area, is determined by fixed and calculated quantitative values of indicators: emissions of certain pollutants and greenhouse gases from stationary and mobile sources; emissions of pollutants by type of economic activity; maximum permissible concentrations of pollutants; complex index of air pollution.

Recently, due to the further development of network technologies and the possibilities of their use, various sources of information on air pollution by its quality index (AQI) on the basis of such indicators recorded at observation points (at monitoring stations) or atmospheric dispersion modeling have become widely available.

The openness of monitoring data will promote citizens' understanding of the state of the environment of living, working, recreation; effective state planning of the environmental management process; better public control; possible change in people's attitudes and behavior to environmental problems at the household level.

The presentation of systematic monitoring information on the territorial distribution of air quality indicators for practical use is quite rational through the use of a cartographic method that will fully, accurately, identify indicators of individual factors on them, and the environment.
The effectiveness of the developed monitoring maps lies in the use of dynamic graphical variables in their creation, which will show the variability of the mapping indicator within a certain area over a period of time.

Method and Theory
The object of the study is the phenomenon of air pollution (according to the index of its quality) in the Poltava region of Ukraine, as a rapidly changing indicator in space and time, studied by creating/using animated monitoring cartographic models. The subject - scientific and applied aspects of mapping the indicator of air pollution in a certain model area on the index of its quality.

This research work within the project "Cartographic monitoring of the environment of Ukraine and its regions" was carried out using general and special methods, among which the main ones are: analysis and synthesis used to implement the main principles of creating dynamic monitoring maps; scientific classification - to determine the place of monitoring maps and their content in the system of thematic cartographic works; comparative - to formulate intermediate and final conclusions in the process of using the created maps; information - to systematize the primary knowledge about the levels of air pollution in the form of a database and its use in the methodological scheme of cartographic monitoring of the study area; cybernetic - in the process of using the functionality required for cartographic monitoring of software products; geoinformation mapping - for the direct creation of a system of cartographic models, which are visual space-time tools and specific scientific cartographic results of cartographic monitoring of air quality at different stages of its implementation.

An integrated scientific approach to the development of monitoring maps is a systematic approach, the possibility of using which in mapping to monitor the air quality of the region is considered through the conceptual basis of creating and applying a single system of resulting documents; the scientific method of application of computer technologies; methodology and methods of developing monitoring maps.

The theoretical basis of cartographic monitoring of air quality is geoinformation ecological-geographical mapping developed on the basis of the geoinformation concept of modern cartography (*Bondarenko, 2007*), within which the map is defined as a problem-oriented geoinformation model of reality.

Examples

The cartographic method has long been used to present a variety of environmental characteristics that affect the growth of morbidity and mortality (Atlas of natural conditions and natural resources of the Ukrainian SSR, 1978; Baranovsky, 2000; National Atlas of Ukraine, 2007; Ecological Atlas of Ukraine, 2009). But the vast majority of developed maps, for example, in (*Atlas of natural conditions and natural resources of Ukrainian SSR, 1978; Ecological Atlas of Ukraine, 2009*) can not be attributed to monitoring, as such maps were created at different times without the use of uniform interconnected methods of their development, agreed content and indicators; characterized by a long process of creation; they used generalized integrated indicators linked to administrative-territorial units using statistical (schematic) methods of cartographic representation.

The current stage of development of the theory and practice of cartography allows the introduction of geoinformation and compatible computer mapping technologies, which due to their functionality significantly expand the application of the cartographic method, in particular, options for creating maps of fast-changing phenomena, which are monitoring phenomena.

The created maps (as geoinformation models), fixation, formalization, and systematization of knowledge about mapping objects on which it is carried out with the use of dynamic symbols that form the content of cartographic animations, are logically related to monitoring. Such signs on them (similarly to static variants) by forms of spatial localization can be out-of-scale, linear, and planar (background). On the map, they move, change their original appearance and position, thereby showing the dynamics of the mapping index.

In general, the use of animation on maps has led to the intensive introduction into practice of dynamic graphic variables, due to which all static graphic variables also acquire a temporal dimension. Animations allow you to change the shape and size of an object, the color and saturation, the internal structure, and the position of a symbol on a map that is formed from a combination of graphic variables. The result of regional mapping with the creation of a recommended animated map of air pollution by its quality index, which acts as a dynamic information environment both in terms of indicators and applied graphical variables, is demonstrated in a previous publication (*Bondarenko, Kyryliuk and Yatsenko, 2021)*. This work is interested in scientific and practical aspects. It reveals the possibilities of geoinformation support of data analysis of monitoring studies on the basis of a typical algorithm developed by the authors of cartographic modeling of fast-changing phenomena using isolines (as a method of cartographic imaging for model visualization). The algorithm includes a number of successive steps. These are a selection of the necessary data from the information base; selection of the interpolation method functionally embedded in the software product; setting data interpolation parameters; setting up a data processing environment; direct cartographic modeling of monitoring results; coordination of mapping results; display of monitoring results with the help of an animated map.

The formulated properties of the created map, which distinguish it as a monitoring map and allow it to be used for its intended purpose (the content of the map is based on the use of current indicators of systematic observations of air pollution levels; the map directly provides the modeling stage in the environmental monitoring system; the value of the mapping indicator in the place of its fixation and on the whole territory of the map (as calculated / simulated); makes it possible to detect critical (extreme) values of the indicator in the mapping territory; develop the necessary recommendations (optimize) to improve the environment as a whole and by components).

Presented in the paper *(Bondarenko, Kyryliuk and Yatsenko, 2021*) the author's monitoring map of air quality in the Poltava region on the index of its quality, consisting of nine map frames, dynamically shows its change during the day with a three-hour interval.

Continuation of the study to create a monitoring map of air pollution in the model area is caused, in particular, by the need to:

– expansion of the time interval of the mapping indicator (up to one month) to identify trends in the spatial development of the phenomenon in time compared to its change over the day, week, decade, crescent;

– optimization of the interval of fixation and cartographic representation of the air quality index isoline method;

– taking into account within the model area the study of transboundary air pollutants with the adjustment of its quality index as an indicator of mapping;

– identification of natural and anthropogenic factors influencing the mapping indicator.

Results

The objectives of this work are fully consistent with the approved framework provisions of the State Environmental Monitoring, its structure, territorial levels, as well as the order of operation with possible types of security, defined in (On Environmental Protection, 2021; Provision on the State environmental monitoring system, 2019; etc.).

To present the initial result of mapping and create on the basis of the author's algorithm an animated monitoring map of the estimation type, which presents the monthly trend of air pollution in the Poltava region according to its quality index AQI PM 2.5, we used publicly available information from (Air Quality Index, 2021) for July 2021 year by sampling it from the database. Such information is an integral indicator, which takes into account fine dust particles (Particulate Matter, 2.5 nm) as the most dangerous for the human body. The data is in text format with comma separators (CSV). They are quite easy to convert into mapping indicators, correlated with 00 monitoring stations, unevenly located in the Poltava region, and 00 cross-border stations along its perimeter.

The lack of monitoring stations in the model area once again justifies the need to present the result by isolines rather than localized diagrams (as presented, for example, in (The only ecological chatbot in Ukraine, 2021)), which generally provides a continuous area of the indicator. within the territory of mapping and allows further use of the created map. It, in particular, consists in the possibility of conducting geoinformation analysis to identify the impact of relief, climatic characteristics (temperature, precipitation, wind), as well as man-made air pollutants on the value of the distribution of AQI PM 2.5. When using climate maps, both the average monthly indicators (for July) of temperature distribution, precipitation, wind recurrence, and the corresponding monitoring values for July 2021 were used.

The cartographic model of air quality of the territory of the Poltava region according to the averaged data for July 2021 is presented in fig. 1.

Conclusions

Extending the time of mapping in the Poltava region to one month using the optimal three-hour interval revealed a cyclical spatial development of the phenomenon in time, consistent with its change over the day: the growth of air pollution is recorded daily from 12 to 24 hours.

Taking into account the study of transboundary air pollutants in adjacent regions within the model area made it possible to adjust its quality indices as an indicator of mapping in the direction of increase. Anthropogenic factors have the most negative impact on the air quality of the model area: emissions from stationary and mobile sources. Wind speed reduces the distribution of mapping over the area. The relief (with the distribution of heights from 64 to 204 m) does not significantly affect the change of the air quality of the region.

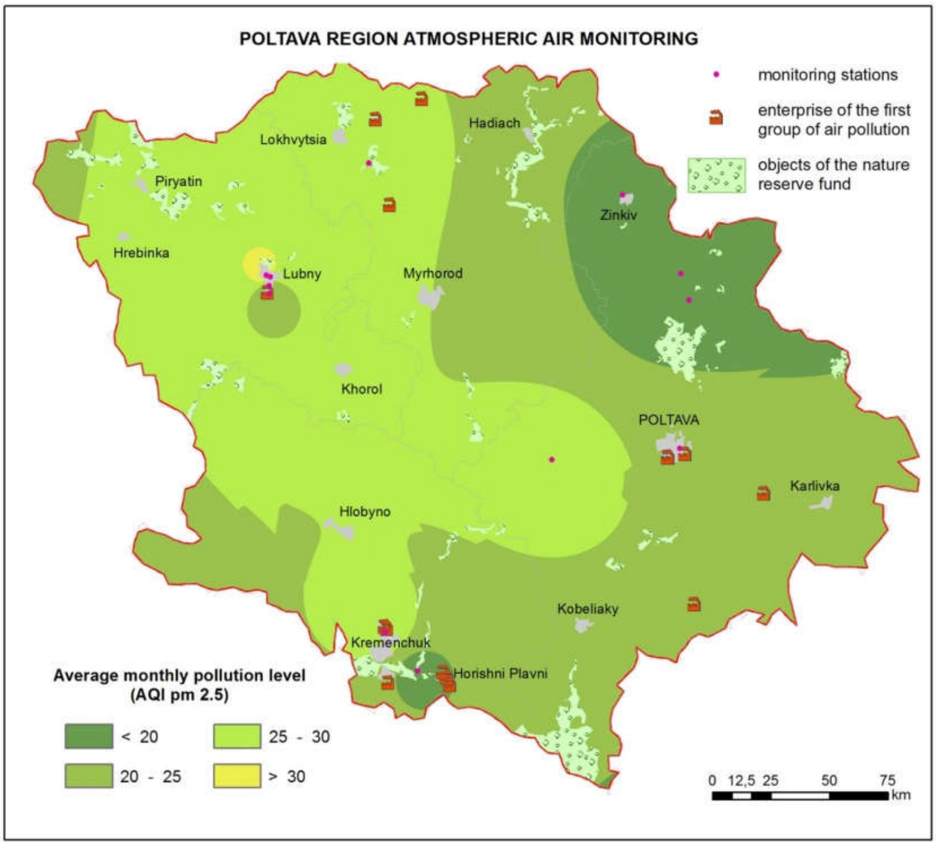

Figure 1 *Atmospheric air quality in the Poltava region (average monthly AQI PM 2.5, July 2021).*

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