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Application of GIS for Optimization of Epidemiological Monitoring

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Introduction

Technology that combines traditional manipulations with databases and complete visualization of geographic (spatial) analysis employing maps has been developed in order to explore the possibilities for Geographical Information Systems (GIS) to be used in sanitary and epidemiological surveillance system based on the analysis of morbidity and identification of influence of hazardous chemical environmental factors on human health.

Methods

Graphical analytic method of information processing allowed visual establishing of mathematically determined cause-and-effect relationships between levels of air chemical pollution and morbidity levels for purulent bacterial meningitis.

Results

Calculated average annual contaminations of atmosphere of 20 administrative rayons and seven cities of Lviv oblast with carbon oxide, lead, sulfur dioxide, and dust during the period 2006-2014 were the objects of the study. During a year, 1,920 air samples were collected per each ingredient for each rayon and city according to laboratory data of facilities of the State Sanitary and Epidemiological Service in Lviv oblast. Average annual levels of the chemical substances were determined within the M.A.C. in all rayons and cities. However, 4-6% of individual samples in the rayons and 8-10% of individual samples in the cities exceeded the allowed concentrations, which imposed a real ecological danger.

Fig. 1. *Levels of carbon oxide air contamination within rayons of Lviv oblast*

Morbidity intensity rates for purulent bacterial meningitis were determined for the same period according to statistical reports on infectious disease morbidity in Lviv oblast. In different years, human morbidity fluctuated from 0.7 to 2.3 per 100 thousand of population in the oblast.

The study found the correlation between the concentrations of carbon monoxide, lead, sulfur dioxide, and dust in the air and levels of incidence of bacterial meningitis in people in the cities of Lviv oblast with 1,092 thousand inhabitants, which compose 42.3% of all oblast population. Correlation coefficients are $r = 0.78$ ($p<0.001$), $r = 0.70$ ($p<0.001$), $r = 0.51$ ($p<0.005$), and $r = 0.68$ ($p<0.02$), respectively.

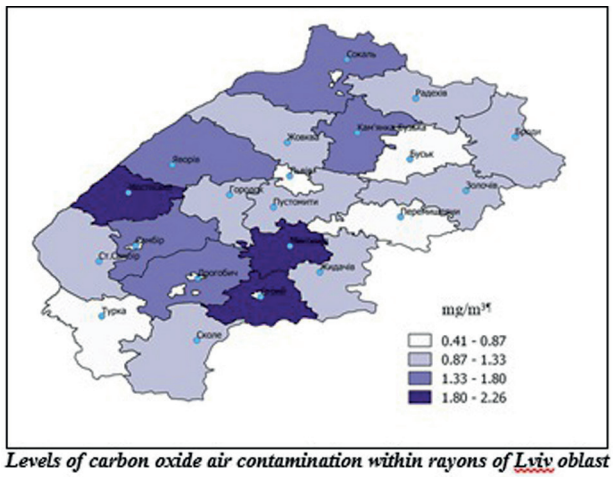
Fig. 2. *Correlation dependencies between air contamination and population morbidity rates for purulent bacterial meningitis within rayons of Lviv oblast*.

The search for a correlation between chemical contamination of atmosphere and the morbidity level the rayon population of the oblast for purulent bacterial meningitis testified the existence of a statistically significant dependence between the level of morbidity for all population layers and atmosphere contamination with sulfur dioxide, lead, carbon monoxide, and dust. The correlation coefficients are $r = 0.62$ ($p<0.002$), $r = 0.52$ ($p<0.005$), $r = 0.63$ ($p<0.005$), $r = 0.56$ ($p<0.05$), correspondingly.

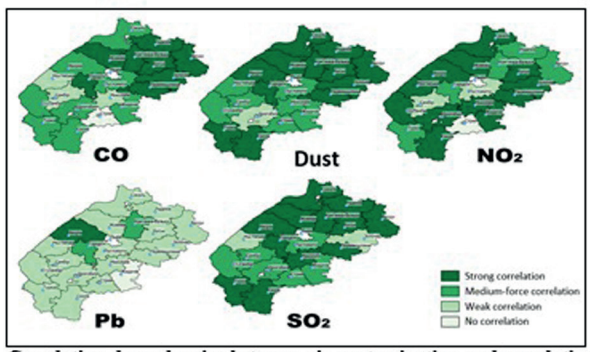
The study found the correlation between the concentrations of sulfur dioxide, and lead in the air of Lviv oblast and levels of incidence of purulent bacterial meningitis in children. Correlation coefficients are $r = 0.55$ ($p<0.05$) and $r = 0.57$ ($p<0.001$), respectively.

Conclusions

Using GIS approach, the study resulted in the development of medical-geographical maps of administrative rayons of Lviv oblast. The maps include peculiarities for each year of surveillance. Cause-and-effect relationships between the levels of the anthropogenic pollution of the air basin of Lviv oblast and morbidity levels for purulent bacterial meningitis for the oblast population have been spatially and temporally visualized as a study result.



Levels of carbon oxide air contamination within rayons of Lviv oblast



Correlation dependencies between air contamination and population morbidity rates for purulent bacterial meningitis within rayons of Lviv oblast.

Keywords

Meningitis; air chemical pollution; Correlation

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