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FACTOR TEMPORARY FORECAST OF SOCIALLY SIGNIFICANT MORBIDITY IN PRIMORSKY KRAI

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At present, the problem of climate change and its impact on human health has become one of the central issues in the field of anthropoecology. The aim of this work was to analyze the influence of climatic factors on the socially significant pathology of the population in regions of Primorsky Krai. The main research method was "time factor forecasting". The "factor" approach proposed by the authors is based on the idea of predicting not specific absolute indicators, but morbidity level that could be higher or equal to some critical value given by the researcher. This problem was solved by the original algorithm for interval pattern recognition. Based on this method, the results of temporary factor forecasting of the critical levels for 7 indicators of socially significant morbidity using four climatic, four socio-economic and one environmental factor, are presented. It is shown climatic factors basically are satisfactory and have a high quality for the forecast, while the socioeconomic and ecological factors are mostly unsatisfactory. At the same time, climatic indicators in combination with environmental and socio-economic have yielded significantly better forecasting results than each single factor. The quality of the forecast significantly increases as a result of the combined impact of factors with different character, and climatic factors enhance the impact of certain environmental and socio-economic factors (the phenomenon of synergism). Thus, the proposed method allows predicting epidemiological situation for the following years based on a combination of various environmental factors.

***Keywords**: morbidity, factor approach, climate, forecasting, Primorsky Krai.*

Introduction

Reducing the negative impact of environmental changes on public health is "a guarantee of sustainable social and economic development of the country, fulfillment of social obligations, improving the quality of life" [3]. The modern period continues to be characterized by a very tense epidemic situation in a vast complex of not only infectious but also somatic diseases both at the Russian Far East and in Russia as a whole [1, 7]. On the one hand, this is due to the current unstable socio-economic and environmental conditions, and on the other hand, to the natural dynamics of natural processes. The level of public health continues to decline, which ultimately will have a negative impact on demographic reproduction.

Recently, the problem of the influence of climate and its fluctuations on human health has become one of the central. The issue of linking the health of the population and the climate as an integral part of the environment is the main one in shaping the projections of the future life of a person. This is determined by the fact that significant climate changes in combination with various factors of the human environment significantly change the social and economic conditions of different territories, directly affecting the quality of life of the population. At the same time, studying the features of climate interaction and human health is extremely difficult, since it is connected with the analysis of relationships and dependencies in complex multi-component open anthropoecological systems.

The natural, ecological, socio-economic components of the habitat of the population of human being in the regions of the Russian Far East, interacting with each other, can give different spectra and levels of regional differences in the structure of morbidity. This implies a systematic approach to studying changes in public health, allowing more accurate forecasting of risks and opportunities for their reduction for public health.

The problems of increasing environmental pollution are mostly universal, but some of them have regional differences, due to geographical peculiarities and specificity of local production. Assessment of the importance of man-made pollution on health indicators is more objective, because integrally takes into account the influence of all of them, including unidentified pol-

lutants, their complex and combined effects with other environmental factors on human body.

The purpose of this work was to study the effect of a complex of climatic and environmental factors on some indicators of socially significant pathologies in the population of model areas of Primorsky Krai, as well as testing the original method of factorial temporal prediction for the purposes of forecasting socially significant morbidity.

Materials and methods

The information base for the analysis was the statistical data [4, 5, 8–10] on the dynamics of 7 indices of socially significant morbidity indices in 2000–2015 (endocrine diseases, nutritional and metabolic disorders, mental and behavioral disorders, diseases of the nervous system, diseases of the circulatory system, neoplasms, musculoskeletal system diseases, active tuberculosis) in 10 administrative-territorial units of Primorsky Krai (Vladivostok, Dalnerechensk, Dalnegorsk, Ussuriysk, Lazovsky, Pogranichny, Terney, Khasansky, Spassky, Pozharsky districts). Five influencing factors were used: long-term data on mean air temperature and air pressure in January and July at 10 weather stations located in 10 municipal districts (MD) of the province and one environmental factor – average annual emission of pollutants into the air by industrial enterprises.

Method of time factor forecasting was used. The proposed "factor" approach is based on the idea of forecasting not specific absolute indicators, but morbidity levels that could be higher or equal to some critical value given by the researcher. This problem was solved by the original algorithm for interval pattern recognition [2]. The quality of prediction by factors was calculated by using the ratio of the number of positive results obtained from the links of all incidence rates with this factor in all the study areas to the total number of results obtained (equal to or greater than 0.7). The universality the algorithm proposed allowed carrying out numerous computational experiments with the accumulated array of reliable data, which determines its significant reserve for use in various fields of knowledge.

Results and Discussion

Public health is significantly affected by the ecological state of the environment. Nikitin et al. [6] calculate longevity indices, based on the CSO data, which, in turn, are a definite reflection of the environmental situation in the place of residence. The lowest index is 5.20‰ for the Russian Far East, which is about half the mean national value, and 4.66‰ for Primorsky Krai. The ecological state of the territory, which is the result of existing production and natural relations, can be considered as one of the limitations for the functioning the most influential enterprise or the entire territorial-economic structure because it has negative economic and social effects, and also negatively affects the health of the population.

The analysis of ecological and economic indicators of industrial and natural relations in Primorsky Krai showed that the main share in the formation of the ecological state of the region is caused by the pollution of water and atmosphere, which are calculated from the ratio of pollutants and total emissions to the atmosphere and the ratio of contaminated and general wastewater discharges.

According to the assessment of production and natural relations in the region, the municipal district (MD) Pozharsky, Dalnegorsky, Mikhailovsky, Shkotovsky (Figure 1) received a restriction on the further functioning of the existing territorial and economic structure. It should be mentioned that although Pozharsky region is fully classified as "L", with all the parameters under consideration, only the western part of the area where the coal industry and the energy sector are concentrated, should be considered.

Given the low environmental friendliness of industrial and natural relations in Primorsky Krai at the present time, it can be assumed that with the im-

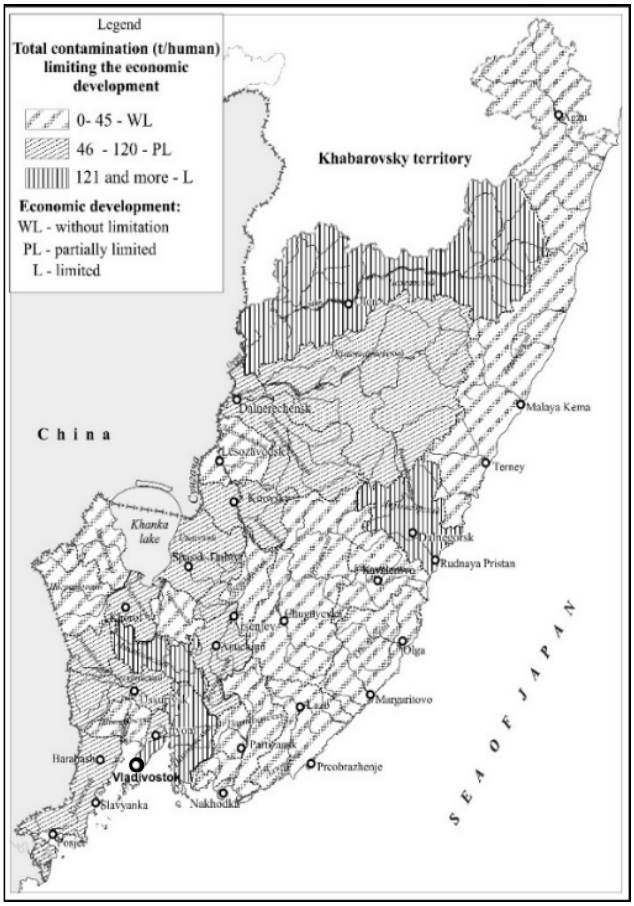

Figure 1. Pollution of Primorsky Krai

plementation of new investment projects, the industrial impact on the environment will increase. This will entail a worsening of social, and then ecological conditions in these territories (Figure 2). When determining the degree of increase in anthropogenic load, we took into account: the type of economic activity of the project, the number of projects of a particular type of activity, the specific impact, the "chain" of man-made impact (i.e., what and how many components of the environment, including humans, will be influenced, directly or indirectly).

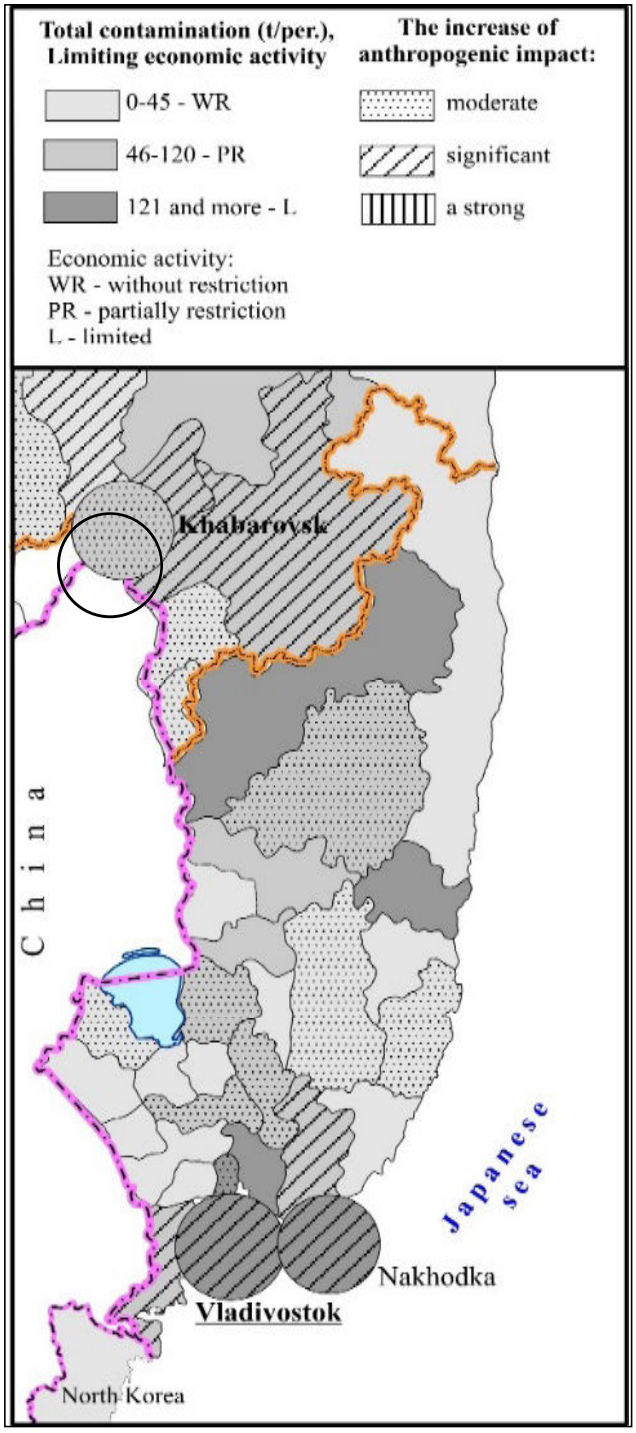

Figure 2. Increase of anthropogenic load on environment in connection with the implementation of investment projects

It should be noted that the functioning of the profile types of production is almost stable. And since natural and resource potential is sufficient and diverse for a long-term perspective of industry production in Pozharsky, Dalnegorsky and Mikhailovsky regions, and there is a production base for the utilization of nuclear submarines in Shkotovsky district, we may assume there will be no structural restructuring of production in the allocated areas. This means that man-made pressure will intensify, which can lead to irreversible consequences of changes in the natural environment, and, most important, to a significant deterioration in the living conditions of the population. Features of the composition and dynamics of anthropogenic air pollution in various areas of Primorsky Krai in combination with the monsoon climate, contributed to the emergence of new effects on human health.

Using method of time factor forecasting, it is possible to forecast critical levels for 7 socially significant indicators of morbidity in 10 districts of Primorye per year (from 2000 to 2016) with the help of climatic and environmental factors of the environment (Table 1–3). In the forecasting results Tables, cells with a prediction quality greater than 0.7, filled with us as an acceptable quality of the forecast for the next year, determined by exceeding the critical levels of morbidity, are painted in gray.

Table 1 presents the quality of forecast from the present for the next year on the pollution of the atmosphere by emissions from industrial enterprises. It is estimated that the quality of the positive prognosis (the probability of exceeding critical incidence rates) for this factor for the next year is low and is only 0.15 (or 15.0%).

Nevertheless, this factor in some areas of the province (Dalnerechensk, Dalnegorsk, Pogranichny, Khasansky, Pozharsky Districts) can act as a forecast and reach critical levels of incidence of active tuberculosis, mental disorders and other diseases (Table 1). In the Dalnerechensky District, for example, a positive prognosis for tuberculosis and mental disorders reaches 100% (1.000). In the Dalnerechensky District, for example, a positive prognosis for tuberculosis and mental disorders reaches 100% (1.000).

With the help of the presented method, it is possible to obtain a higher quality of the forecast by unrestricted search or a combination of forecasting options, if you manipulate the quantity and "nature" of the influencing factors. So, when forecasting for four climatic factors (Table 2), the quality of the positive forecast for the next year will increase sharply to 0.8

Table 1

Temporal factor forecasting of critical levels of socially significant morbidity with the use of an environmental factor (air pollution by emissions from industrial enterprises)

City, municipal district / incidence	Tuberculosis	Neoplasms	Diseases of the endocrine system	Mental disorders	Diseases of the circulatory system	Diseases of the musculoskeletal system	Diseases of the nervous system
Vladivostok	0.625	0.357	0.417	0.455	0.556	0.625	0.500
Dalnerechensk	**1.000**	0.455	0.455	**1.000**	0.714	0.625	0.385
Dalnegorsk	0.833	0.385	0.385	0.417	0.556	0.500	0.556
Ussuriysk	0.500	0.385	0.500	0.417	0.500	0.625	0.500
Lazovsky MD	0.417	0.625	0.625	0.556	0.625	0.556	0.714
Pogranichny MD	0.714	0.417	0.417	0.714	0.500	0.455	0.714
Terneisky MD	0.500	0.385	0.385	0.417	0.556	0.417	0.625
Hasan MD	0.833	0.625	0.417	0.625	0.455	0.417	0.455
Spassky MD	0.417	0.385	0.385	0.500	0.455	0.357	0.417
Pozharsky MD	0.417	0.385	0.385	0.455	0.833	0.714	0.500

Table 2

Temporal factorial prediction of critical levels of socially significant morbidity with the use of climatic factors (mean air temperature and air pressure in January and July)

City, municipal district / incidence	Tuberculosis	Neoplasms	Diseases of the endocrine system	Mental disorders	Diseases of the circulatory system	Diseases of the musculoskeletal system	Diseases of the nervous system
Vladivostok	0.714	0.833	**1.000**	**1.000**	0.714	0.833	0.625
Dalnerechensk	0.833	0.556	0.833	**1.000**	**1.000**	**1.000**	0.833
Dalnegorsk	**1.000**	**1.000**	0.833	0.556	**1.000**	0.833	0.833
Ussuriysk	**1.000**	**1.000**	0.500	0.833	0.714	0.833	**1.000**
Lazovsky MD	0.625	**1.000**	**1.000**	0.833	0.833	**1.000**	0.714
Pogranichny MD	0.833	**1.000**	0.417	0.714	0.833	0.833	0.714
Terneisky MD	**1.000**	0.833	**1.000**	0.714	**1.000**	0.833	0.833
Hasan MD	0.833	0.833	0.833	0.625	0.714	0.714	0.833
Spassky MD	0.833	0.625	**1.000**	0.714	0.714	0.714	**1.000**
Pozharsky MD	0.833	**1.000**	0.833	0.833	0.833	0.833	0.833

(or 80.9%). Moreover, in some regions, the quality of the prognosis will reach even 100% for individual morbidity indicators (1.0).

When predicting the achievement of critical levels of morbidity in the next year by five factors (Table 3), the quality of the positive forecast increased even more and amounted to 0.9 (90.4%).

Thus, forecast with only one environmental factor gives a significantly lower quality of the forecast than with four climatic factors. While climatic factors show mainly satisfactory and high quality forecast, the ecological one is mostly unsatisfactory. Climatic indicators in combination with environmental ones have yielded significantly better forecasting results than a single factor. The quality of the forecast significantly increases as a result of the combined impact of factors of different nature, and climatic factors can enhance the impact of some environmental (synergism phenome-

Table 3

Temporal factor forecasting of critical levels of socially significant morbidity with simultaneous use of environmental factors (mean air temperature and air pressure in January and July plus air pollution from industrial enterprises)

City, municipal district / incidence	Tuberculosis	Neoplasms	Diseases of the endocrine system	Mental disorders	Diseases of the circulatory system	Diseases of the musculoskeletal system	Diseases of the nervous system
Vladivostok	0.833	0.833	**1.000**	**1.000**	0.833	**1.000**	0.714
Dalnerechensk	**1.000**	0.625	0.833	**1.000**	**1.000**	**1.000**	0.833
Dalnegorsk	**1.000**	**1.000**	**1.000**	0.625	**1.000**	0.833	0.833
Ussuriysk	**1.000**	**1.000**	0.556	0.833	0.714	0.833	**1.000**
Lazovsky MD	0.714	**1.000**	**1.000**	0.833	**1.000**	**1.000**	0.833
Pogranichny MD	**1.000**	**1.000**	**1.000**	**1.000**	0.833	0.833	0.833
Terneisky MD	**1.000**	0.833	0.833	0.714	**1.000**	0.833	0.833
Hasan MD	**1.000**	0.833	0.833	0.714	0.714	0.714	0.833
Spassky MD	0.833	0.625	**1.000**	0.714	0.833	0.714	**1.000**
Pozharsky MD	0.833	**1.000**	**1.000**	**1.000**	0.833	**1.000**	0.833

non) and lead to increased levels of morbidity in some areas. At the same time, existing relationships between the elements of these complex anthropoecological systems can be both integrative and competitive, which obviously affects the nature of the epidemic process for specific diseases.

Thus, as a result of the study, a significant amount of predicted data was obtained for 7 indicators of socially significant diseases in 10 districts of Primorsky Krai for the period 2000-2015 (Table 1). The proposed method allows predicting the epidemiological situation for the next year using various environmental factors with sufficient accuracy.

Increasing quantity of factors increases the quality of recognition. The Index of Quality of Recognition (IQR) used in the work can be considered as an analog of the multiple correlation coefficient between the predicted and operating factors, the magnitude of which can be judged by the closeness of the connection between the index of individual diseases and affecting factors. The maximum IQR (1.0) means 100% recognition quality. In order to verify the results of forecasting, it is necessary to compare the critical and true levels of morbidity in the following years.

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