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Computer Mapping of the Soils Contamination with Heavy Metals Applied for Yerevan city

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Abstract

In the paper a problem of computer mapping of the territory pollution with heavy metals is considered. The main goal is determination of relations between contents of heavy metals in soils and its distribution over the challenging territory.

A simple algorithm is presented and applied for data on Yerevan city.

Introduction

Due to the strict impoverishment of environmental and human health quality parameters, analysis and mapping of man-made pollution has become an urgent issue. The most heavy impact on human organism is recorded in heavy metals (HM) basic sources of which are industrial emissions and production waste.

Very important tasks are determination of spatial distribution patterns in the pollution sources and complex mapping of HM-polluted territories and spatial imaging of the pollution centers, which enable forecasting of the trends in pollution dynamics.

Negative impact of pollution on development of some diseases is obvious, especially on infants. Effect of HMs on children's health is known to begin before the birth and evaluation of such indicators as prenatal mortality would contribute to successful solving the problem.

The complex mapping of soil pollution with HMs is developed and applied for Yerevan city. Sampling in the equal-meshed network of 2000 points have been cared out by the Center for Ecological-Noosphier Studies. For information digital presentation a computer data bases have been created. Each sample contains information about the HMs concentrations in soil. The problem is to find out useful information in form giving possibility to determine the main sources of pollution.

Many methodologies are known for computer mapping which allow to get out maps of territory contamination only for a single HM [1-4]. In [1] we find a method for complex mapping, but for its applying we must put KLARK information about using elements and threshold value, too. Our method don't require any other information than elements concentration values in contaminated environment.

Figures 1 and 2 are displayed according to Cu and Pb concentrations in soils of Yerevan. Their contents are graded by special ranks according to the Cu and Pb elements gradation. The value of element content in soil is replaced with gradation numbers in which the number located. There are three gradation ranges for each element according which the content may be qualified. For example we have 0.015-0.039, 0.04-0.99 and >1 for Pb, 0.01-0.029, 0.03-0.09 and >0.09 for Cu. These gradations allow us to avoid disparity between measurement points of different metals.

The problem of creating an algorithm which would allow to map simultaneously

Fig 1 Cu Concentration

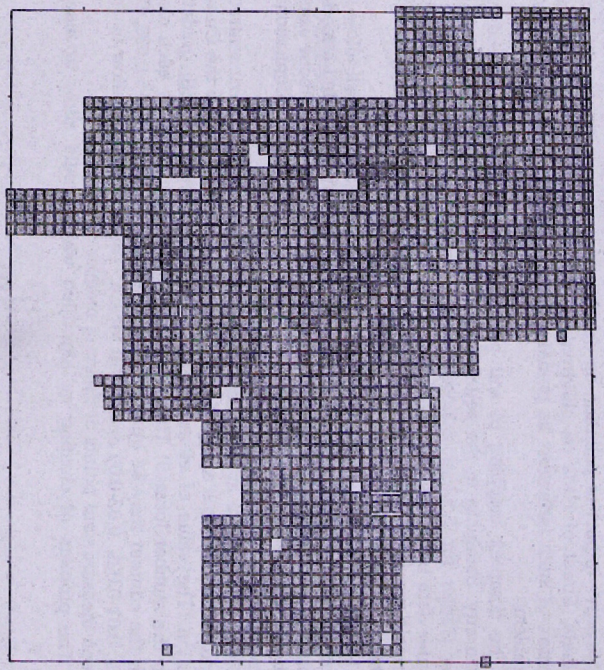


Fig 2 Pb Concentration

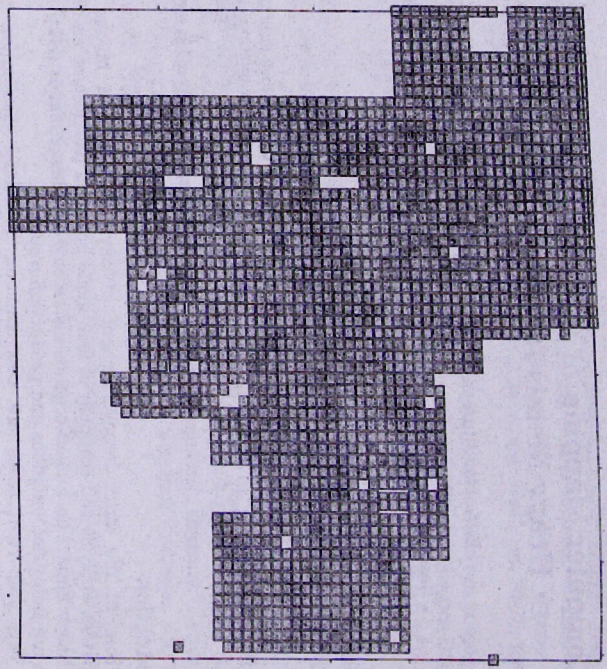
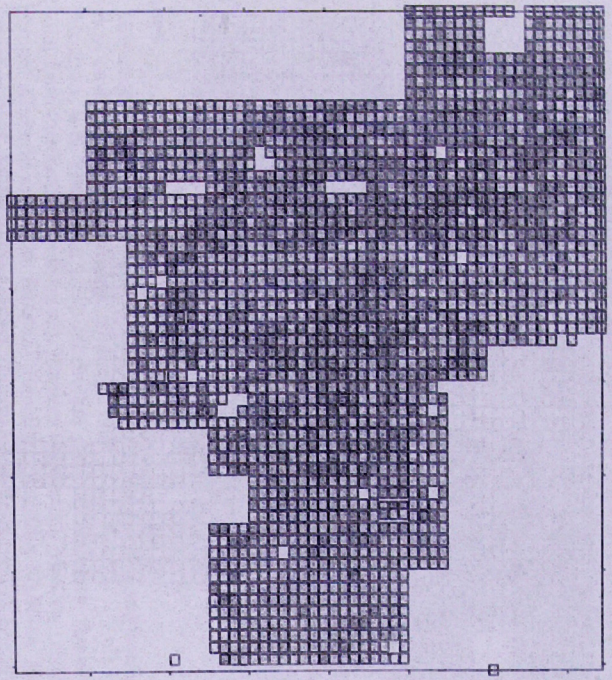


Fig 3 Ag Concentration



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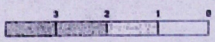
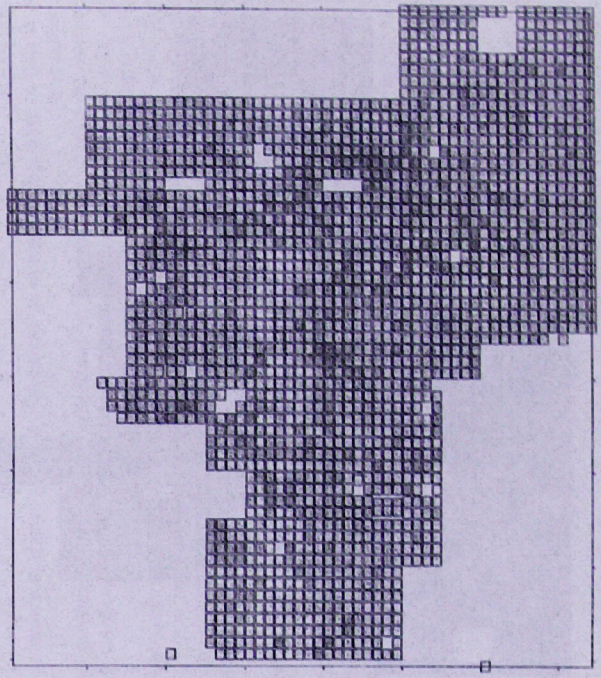


Fig 4 Cu+Pb Concentration



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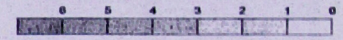

Fig 5 Cu+Ag Concentration

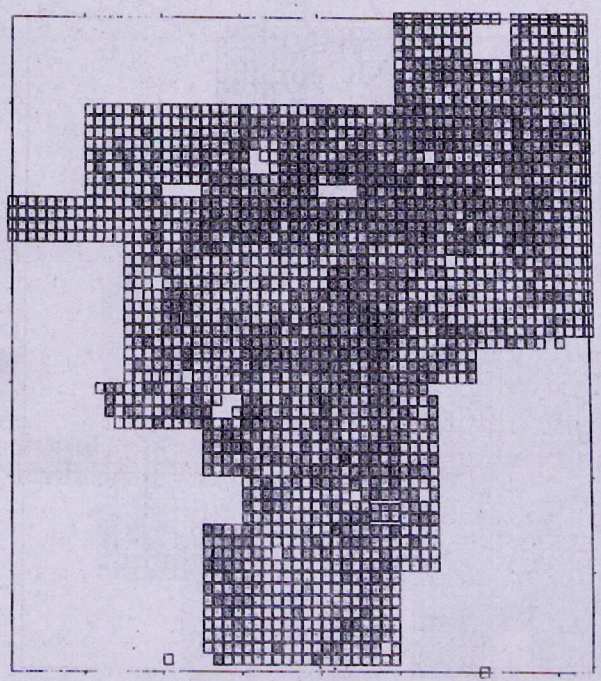

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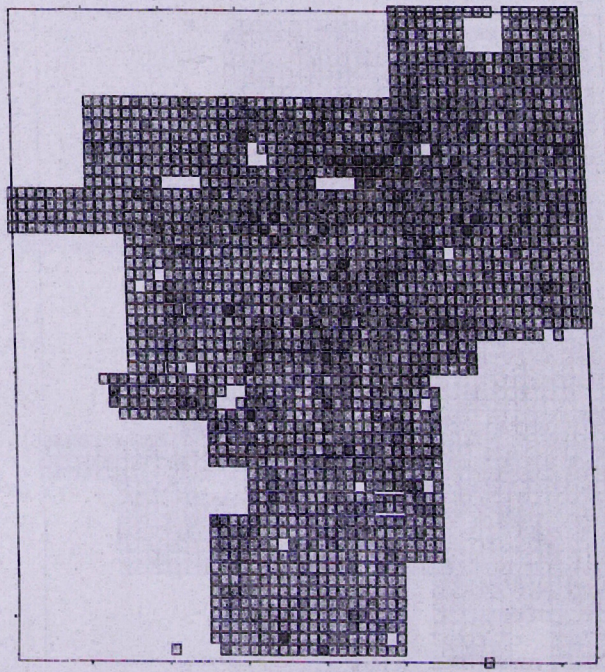
Fig 6 Cu+Pb+Ag Concentration



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several metals and obtain complex maps for HMs has emerged.

On the next point the simple algorithm of realization and calculation is presented. There are 3 maps of some HM concentration, too.

Description of the Algorithm

The algorithm is based on superposition of two and more maps according to which we obtain just one presenting summation of concentrations of metals pairs, triples and etc.

For example, we present on the Figures 1 and 2 the maps of Yerevan city pollution with Cu and Pb and wish to compose the new pattern of combined pollution of the given area with these two metals. The task can be reached by superposition of these maps, i.e. complete overlapping of two images whose computer-based performance has been achieved by the following algorithm.

Here we discuss concentrations of two elements while for the rest ones replication procedures are suggested.

It should be noted that not concentrations, but their gradations were summed up. Let us denote concentrations of two elements as K_1 and K_2 for which basic map should be constructed. For concentrations K_1 and K_2 basic gradations are selected and concentrations $Z_{k,ij}$; k=1,2; i=1,..,M; j=1,..,N are substituted by number of that gradation in which concentration is located.

$Z_{k,mn}$ – HM concentrations with coordinates m and n, where k=1,2; m=1,..,M; =1,..,N; where M and N are number of horizontal and vertical samples points of the territory, respectively.

Task is that to find the multitude of points Z_{3ij}, each of which is a sum of information of two previous ones.

$$Z_{3ij} = Z_{1ij} + Z_{2ij} \qquad i=1..M,\ j=1..N$$

3 maps are provided of which first 2 represent the maps of Cu and Pb concentration gradations in the soils of Yerevan city. Visible 3 ciphers coincide with high concentrations on maps for Cu and Pb. Third map is composed by above-discussed method and the territories of combined pollution may be traced on it. On it we can see the territories with high concentration of Cu and Pb together. As a end grade we had used the sum of maximum gradations of two previsions.

Conclusion

Usage of this method allows us to contour field of territory with high level polyelemental contamination. In particular, the analysis of fig. 6 clearly shows that the most discomfortable from the view point of total pollution appears to be the central and northern parts of the Yerevan city, also the territory adjacent with Yerevan Lamp Plant.

For efficient using above described algorithm we must use a wide number of investigating elements and calculate dominant associations of polyelemental pollution, especially for Yerevan we can get only characteristic combinations of pollutants. This computation allows to compare the getting index of environmental contamination with medical-biological indexes of population.

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