Geo-Ecological Assessment Of Yerevan's Environment

Asmaryan Sh.G., Sahakyan L.V.

The Center for Ecological-Noosphere Studies NAS RA, 0025 Yerevan, Abovian Str.- 68, Armenia, E-mail: ashuk@list.ru

Abstract

The goal of this research was assessing geo-ecological state of Yerevan's environment through collation of long-term eco-geochemical and eco-geomorphological research data obtained in the Center for Ecological-Noosphere Studies NAS RA.The research included 4 stages: ecogeochemical assessment, ecogeomorphological assessment, collating ecogeochemical and ecogeomorphological data, revealing risk groups in the population. Systemizing and analyzing the obtained water environment, soil and snow blanket pollution data underlay selection of soil cover as a depositing medium - an indicator of long-term man-made load. For the city's soil cover geochemical survey was done (following a schematic plan, sc. 1:10000, from soil horizon A_1). As a quantity index of pollution applied was a summary index of concentration of elements. Based on geochemical database and employing the IDW method of ArcView GIS software a schematic map of summary pollution of Yerevan's soils with HM has been produced. As a result of collation of eco-geochemical and eco-geomorphological data, a complex assessment map of Yerevan's geo-ecological state has been produced and the city's territory – zoned by ecological stability and risk levels.

INTRODUCTION

Today, cities are treated as a special habitat for humans, a unique product of civilization, a special nature-based environment which brings together all spheres of social life, interrelations between the nature and human beings and their socio-economic and political activities. Urban sites covering as much as 1% of dry land and homing some 45% of the entire population of the Earth produces up to 80-85% of GDP. Global urbanization and its consequences may be visually demonstrated on the case of Armenia and her capital city of Yerevan in particular. The city occupies as much as 1% of the entire area of the Republic and is a home to over 30% of population and some 50-60% of industries. Such a concentration and load has resulted in origination of a number of geoecological problems including those connected with the disturbance of natural geochemical equilibrium and stability of the relief. The latter is one of major present-day concerns. Mainly, the disturbance of geochemical equilibrium of chemical elements manifests itself in pollution of all environmental compartments with not typical and alien chemical elements, in the case of Yerevan – with heavy metals (HM).The problem of stability of urban relief is seen in the disturbance of natural state and process of development of natural conditions.

The goal of this research is to assess geoecological state of Yerevan's environment through collation of data on long-term ecogeochemical and ecogeomorphological investigations performed at the Center for Ecological-Noosphere Studies NAS RA (CENS NAS RA).

MATERIALS AND METHODS

The study object is the capital of Armenia – ancient Yerevan (782BC) - the administrative, cultural and political center of the Republic. The city with a population 1101.9 covers an area

of 227sq.km and lies in the southwest of Armenia, on the northeastern portion of the Ararat valley.

The studies were performed by 4 stages: ecogeochemical assessment, ecogeomorphological assessment, collation of ecogeochmical and ecogeomorphological data, identification of risk groups in the population.

Ecogeochemical assessment. Systemizing and analyzing data on pollution of water and soil mediums and snow blanket of the city's territory underpinned selection of the major study object – soil cover as a depositing medium which serves as an indicator of long-term man-made load. A geochemical survey was performed of the city's soil cover (by a schematic plan sc. 1:10 000 from soil horizon A_1). The sampling net is maximally approached to the even one. Soil sampling and treatment was implemented by methods developed at IMGRE [1]. The collected sampled were analyzed then in IGS and CENS NAS RA laboratories. Indicated was the major spectrum of pollutants - heavy metals: available are data on 21 elements, however this work focuses on 8 of them: Pb, Ag, Cu, Ni, Mo, Cr, Co, Zn. On the basis of a relevant geochemical database implemented was ecologo-geochemical mapping of the city's territory employing the IDW method in ArcView GIS environment. As a quantitative index of pollution we applied a summary index of concentration (SIC) of elements. To reflect spatial distribution of SIC values on the city's territory applied was a gradation scale according to Yu. E. Saet and E.P. Yanin [1,2].

Ecogeomorphological assessment. The morpho-lithological system of Yerevan as integrity of natural structure and man-made cover represents a complex combination of morphogenetically different natural and man-made components. The assessment of morpho-lithological system of Yerevan was provided on the basis of methodic tools developed by E.A.Likhachiova through separating out necessary natural and man-made components [3]. For the assessment we used a topographic map of Yerevan (sc.: 1:25000), a spectrazonal satellite image of high resolution (62cm "QuickBird"), case-specific maps produced between the 80s and 90s of XX cent., data on drilling bores, etc. All the information was processed in the environment of a program product ESRI ArcView GIS using building norms and regulations (BNR). As a result, employing instrumental tools of ArcView GIS and particularly the Model Builder extension through the weighted overlay a synthetic map of the assessment of stability of morpho-lithological system of Yerevan was produced (fig.1).

Collation of ecogeochemical and ecogeomorphological data. As a result, a GIS database was complied which allowed to provide scientifically justified treatment, synthesis and analysis of data on that stage with a help of a Model Builder attachment of a program product ArcView GIS and create a complex assessment map of Yerevan's geoecological state. Finally, the territory of Yerevan was ranged by the level of ecological stability and risk.

Identification of risk groups in the population. The produced complex assessment map enabled us to calculate both the number and spatial distribution of the population residing in the bounds of separate fields characterized by definite level of ecological risk.

DISCUSSION OF RESULTS

Ecogeochemical assessment. The geological structure of Yerevan's territory predetermined natural near-clarke contents of heavy metals on the soil cover: $Zn_{(9,4)} - Cu_{(2,9)} - Co_{(1,8)}$ (in brackets, excesses vs. clarke are given). The natural picture of the city's geochemical landscape is strongly complicated by intense and continuous process of technogenesis, which results in an increase in element concentrations typical of given geochemical landscape and the intense entering of heavy metals alien to the landscape [4,5]. Ecogeochemical studies of

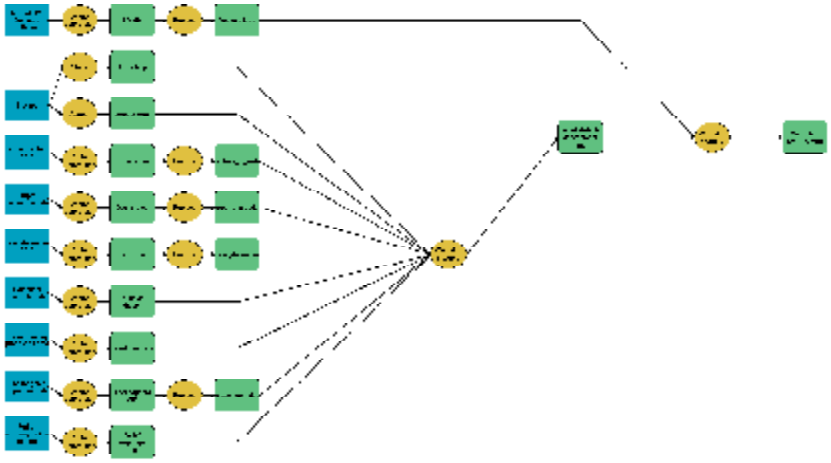

Fig. 1 The creation of the model using Weighted Overlay in Model Builder

levels of heavy metal pollution of soils on the territory of Yerevan indicated that the major part of the city's territory is characterized by high levels of heavy metal pollution. Calculated by background contents of elements in soils a geochemical qualitative series $Ag_{(32.0)} - Pb_{(3.2)} - Ni_{(2.3)} - Cu$, $Mo_{(1.8)} - Cr_{(1.6)} - Co_{(1.5)} - Zn_{(1.2)}$ has indicated that dominating pollutants of Yerevan's soils are Ag, Pb, Ni despite a common inclination to a decrease of heavy metal contents for the recent years.

An integral characteristic of heavy metal pollution of the territory is given by SIC**.** While systemizing geochemical indices of heavy metals and in the complex of ecogeochemical mapping techniques, schematic maps have been produced of distribution of SIC values [2]. A cartographic reflection of SIC values is a territorial generalization of levels and degrees of pollution risk; it disclosed spatial differentiation of the city and finally allows ranging its territory by features of definite level of ecological risk. A result of ranging the territory is a schematic map, which ranges the city's territory by 5-level fields, pollution level ad respective level of ecological risk.

Ecogeomorphological assessment. An outcome of a detailed analysis of natural and man-made constituents is the assessment of stability of the city's morpholithosystem. According to calculation technique relative to a geoecological index, each index was given an expert weight. While distributing the weights, priority was given to morphogenetic indices. This may be explained by the fact that on separate morphogenetic types of relief one distinguishes special morphological and morphometric forms, which – from positions of stability – differently respond to the course of man-made processes. As a result, a map has been

produced of the assessment of stability of urban morpho-lithosystem with reflection of three types of territories: stable, relatively stable and instable.

Collation of ecogeochemical and ecogeomorphological data. The ultimate result of geoecological investigations implies getting a generalized, integral picture of ecological state of the studied territory. Integral indices allow demonstration of a complex and multi-component information in a more visual, better generalized and accessible form.
Collating the results of ecogeochemical and ecogeomorphological investigations allowed indicating that the major part of the city – predominantly central, eastern, western and northeastern - is covered by fields of medium and high level of pollution risk – respectively, 49.9 and 46.6% with corresponding level of ecological risk. Relatively favorable ecological conditions are found on the northwestern portion of the city. Territories with extremely hazardous ecological risk are found in a dispersed form and are timed predominantly to the canyons of Rivers Hrazdan and Getar, adding V-shaped valleys in the east and southeast of the city.

Identification of risk groups in the population. Using calculation means, we calculated the quantity of population residing on the territories with definite degree of hazard and level of ecological risk. A resulting outcome was that some 50% of the population is exposed to a hazardous level of ecological risk.

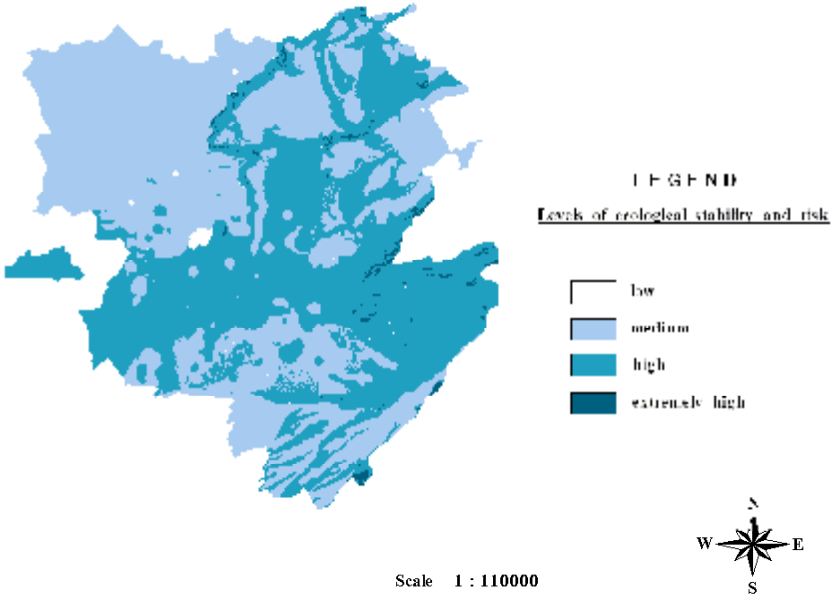

Fig. 2 A map of assessment of ecological state of the territory of the city of Yerevan.

CONCLUSION

1. The obtained research outcomes support a conclusion that the territory of the city of Yerevan clearly manifests both ecogeomorphological and ecogeochemical problems.
2. The research allowed development of approaches to collation of geomorphological and geochemical, ecologically valuable information.
3. Collating the results of ecomorphological and ecogeochemical investigations underpins an integral assessment of ecological state of the city's territory.
4. According to data of a complex assessment map, the major part of the city – 46.6 % homing 47% of citizens - displays high degree of hazard and level of ecological risk
5. The produced assessment map and a relevant database may be used in creation of city development projects, for instance, with a goal to select sites for development of recreational areas as well as in the work of insurance companies.
6. The provided model may serve as a platform for further investigations, may be renewed and complemented by ecologically valuable information and thus is a basis for organization of environmental state monitoring for the city of Yerevan.

REFERENCES

1- Ревич Б.А., Сает Ю.Е., Смирнова Р.С. и др. Методические рекомендации по геохимической оценке загрязнения территории города химическими элементами.-М.: Изд.-во ИМГРЭ, 1982, 112с. (in russian)

2- Перельман А.И., Касимов Н.С. Геохимия ландшафта.-М.: Изд-во "Астеря-2000", 1999, 768с. (in russian)

3-Рельеф среды жизни человека (экологическая геоморфология). 2002, М.: Медия-Пресс, т. 1-2, 640с. (in russian)

4-Сагателян А.К. Особенности распределения тяжелых металлов на территории Армении. Моногр. 2004, Ер.: Изд-во ЦЭНИ НАН РА, 157 с. (in russian)

5-Saghatelyan A.K., Arevshatyan S.H., Sahakyan L.V. 2003, Ecological-geochemical assessment of heavy metal pollution of the territory of Yerevan. / New Electronic Journal dedicated to the 60th anniversary of NAS RA "Natural Sciences". Yerevan, pp. 36-41.