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Research Article

GEOINFORMATIONAL BASIS OF ESTIMATION OF THE MODERN STATUS OF GEOECOLOGICAL FACTOR OF SEISMIC RISK IN THE TERRITORY OF BUKHARA

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ABSTRACT

In the article are considered the current state of researches on assessment of seismic risk in the urbanized territories of Uzbekistan. Modern geoinformation technologies on the basis of ArcGIS allow to make system assessment of a condition of geoecological risk factor and to make the integrated card of seismic risk in the territory of Bukhara.

Keywords: *Natural, Technological, Environmental and Economic Factors Seismic Risk*

INTRODUCTION

A significant part of the Republic of Uzbekistan (the total area of the country with a population of over 32 million people is approximately 448978 square kilometers) is subject to seismic hazard. According to historical data, the maximum intensity of past earthquakes in the region both in the east and in the southwest reached 9-10 points (on the scale of EMS-98). In the future, a reoccurrence of strong earthquakes is possible. For urbanized areas of seismically active regions of the region, the problem of assessing and reducing seismic risk with the purpose of developing measures to reduce damage and manage it is very relevant. Urban areas and densely adjacent to them built-up areas form urbanized areas. Within their concentration are a large number of industrial and civil buildings, hydraulic engineering, road and other types of land and underground structures that create different types of anthropogenic impacts and anthropogenic impact on the geological environment. They involve the development of a number of damage-forming processes and phenomena that require the creation of protective measures. The intensification of urbanization, the formation of large cities and urban agglomerations, industrial production, as well as population growth is associated with the intensive use of limited land, water and mineral resources. The effectiveness of their use and protection from hazardous processes depends largely on the nature of the engineering-geological conditions and the degree of their study. The concept of analysis of seismic risk factors uses the capabilities of ArcGIS, layer wise combining by the data available on the spatial distribution of seismic hazard, on techno genic load and vulnerability of development, as well as on the values subject to the risk of damage and losses. Factors determining the seismic risk of the territories are its main components according to such as natural - geological-tectonic, artificial – techno genic, ecological, socio-economic and administrative, the state of which determines the damage potential, its degree and consequences of earthquakes. Each of these factors is characterized by the peculiarities of the state of the factor under consideration. Modern geo-information technologies based on ArcGIS allow us to make a systematic assessment of the state of each risk factor. This article is devoted to technology of applying modern geoinformation technologies based on ArcGIS for compiling the geoecological basis of seismic risk by the example of geoecological conditions in the territory of the city of Bukhara. Visualization and joint layer analysis of the components of geoecological risk is carried out using geoinformation systems technology based on ArcGIS.

MATERIALS AND METHODS

For the spatial mapping of the complex interaction of geoecological risk components with land uses, a methodology was developed for assessing and managing geoecological risk for urban areas. An assessment of the state of the potential for geoecological risk, and an integrated geoecological risk assessment map for the territory of Bukhara was compiled in ArcGIS format. For assessing and compiling a map of geoecological risk, a computer program "MapGeoEcoRisk" was developed which was created in the C # programming language in the MicrosoftVisual studio environment. As a rule, following five basic procedures were performed- data input, preliminary processing, data management, query creation, analysis and data output in a user-friendly form:

Data input: In the case of entering data from paper cards, these cards must be digitized in accordance with the requirements for digital cards. Technologies INTERGRAF, ArcGIS and a number of other GIS-products allow carrying out this most labor-consuming part of the process of creating a GIS-project in an automated mode, using a scanned cartographic basis. In case of using digitized materials, it may be necessary to bring them to a single format in accordance with the requirements of the software product used.

Preliminary processing of data: Often, in the process of developing a GIS project, it is necessary to use heterogeneous initial information. For example, separate thematic layers can be digitized from maps of different scales; it becomes necessary to bring them to a uniform scale in accordance with the requirements of the project. In cases where digitized materials prepared with the help of other software products and entered into the environment of your project by converting these files, it may be necessary to bring these materials to the level that meets the requirements of the developed GIS project.

Control: GIS-systems can structurally have divided into two main blocks. The processing and presentation unit of graphic information provides wide opportunities for manipulating digital cards. This brings the possibility of joint analysis of several thematic maps, the possibility of three-dimensional representation of maps, the ability to translate into various cartographic projections and many other possibilities. Further improvement of GIS-systems allows expanding these possibilities. The block of manipulation of attributive information is built based on modern DBMS. The advantage of modern GIS-systems lies in the ability to manipulate attributive information in conjunction with cartographic elements.

Request and analysis: Relational DBMSs used to enter, store, process, analyze, and issue attributive information at the user's request in modern GIS systems. In the process of implementation of these studies, were used DBMS ORACLE and ACCES. Modern GIS have a developed system of queries. Therefore, we can compose a query that lists the properties of objects of interest to us, and the system selects objects on the map that satisfy the given query.

Conclusion: The cartographic form of information representation is one of the most informative and efficient forms of representation of spatially distributed data. Using this form of information presentation, GIS provides unique opportunities for compiling, editing, updating and outputting maps, supplementing it with a variety of information presented in tabular form, in the form of graphs, supplementing them with drawings, photographs, and other means that make the material presented more informative, concise and available for analysis.

Implementation of GIS will allow:

- Possibility of improving and automating the maintenance of a database on the potential seismic hazard of the territory, taking into account geoecological conditions;
- Possibility of developing digital maps of seismic risk factors;
- Possibility of prompt provision of the requested information to the consumer in a form convenient for him, etc.

The program "MapGeoEcoRisk" created in the C # programming language in Microsoft Visual studio is intended for working with maps in the *.mxd format. The ArcGIS program is a family of geoinformation software products of the American company ESRI with a wide range of applications. The family of products under the brand ArcGIS divided into desktop and server. The main products of the desktop line are ArcView, ArcEditor, ArcInfo, ArcMap, - each subsequent includes the functionality of the previous one. In addition, the desktop line includes free ArcReader programs (for viewing data published by ArcGIS) and ArcGIS Explorer (lightweight desktop client for ArcGIS Server).

The main server product is ArcGIS for Server, designed for multi-user geoinformation projects with centralized storage and an unlimited number of workplaces, the publication of interactive maps on the Internet. To publish large amounts of raster data, the Image Server product released. To store spatial data in DBMS and to integrate with other information systems, designed the ArcSDE product. In addition, separate products are tools for developers (ArcGIS Engine and ArcGIS Runtime).

Microsoft Visual Studio is a line of Microsoft products that includes an integrated software development environment and a number of other tools. These products allow you to develop both console applications and GUI applications, including those that support Windows Forms technology, as well as Web sites, web applications, web services in both native and managed codes for all platforms, supported Windows, Windows Mobile, Windows CE,. NET Framework, Xbox, Windows Phone. NET Compact Framework and Silverlight. Visual Studio allows to create and to connect third-party add-ons (plug-ins) to extend functionality at almost every level, including adding support for source control systems (such as Subversion and Visual SourceSafe), adding new toolkits (for example, for editing and visual design code in case-oriented programming languages) or tools for other aspects of the software development process (for example, the Team Explorer client for working with Team Foundation Server) (Fig.1).

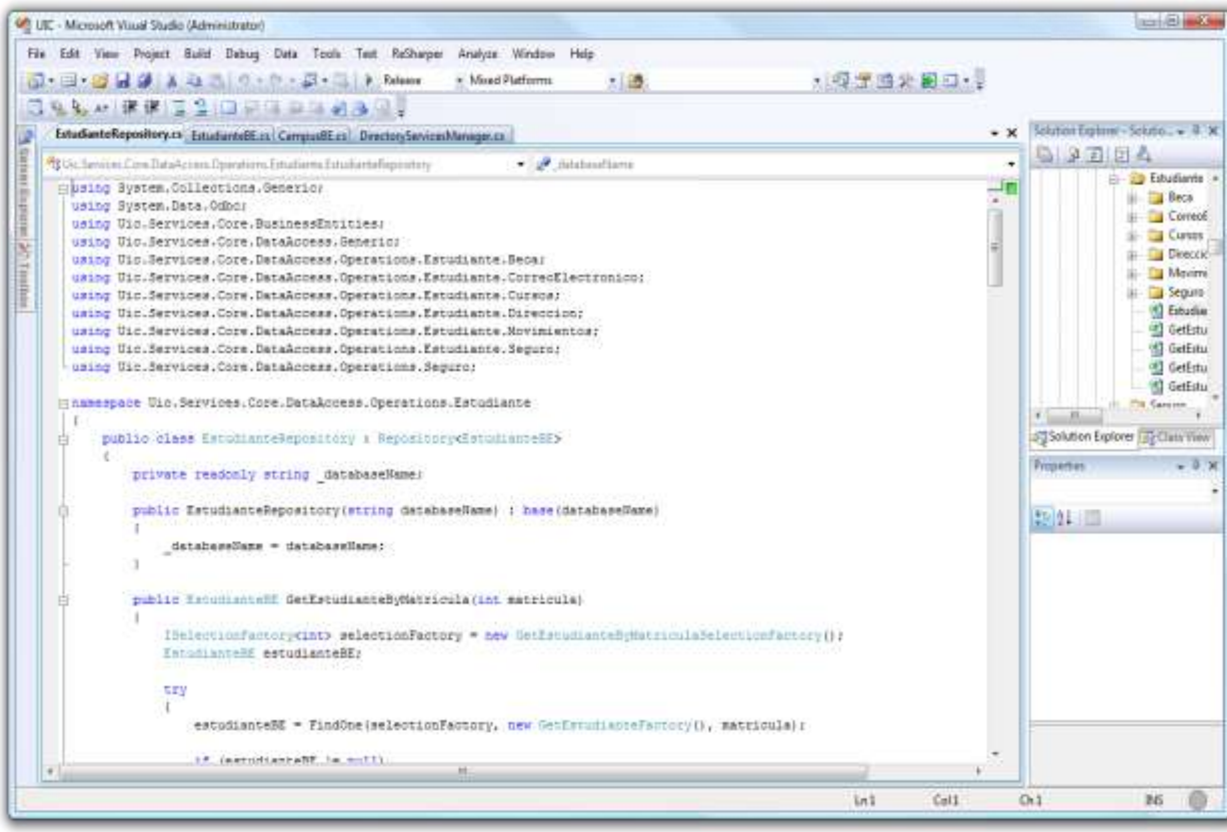


Figure 1: Appearance of Visual Studio with C # program

Visual Studio includes one or more of the following:
• Visual Basic .NET, and before its appearance - Visual Basic
• Visual C ++
• Visual C # (included since Visual Studio .NET)
• Visual F # (included since Visual Studio 2010)
• Before releasing Visual Studio Version 4.0, the Visual Basic 3, Visual C ++, Visual FoxPro and Source Safe development environments were delivered as stand-alone packages.

C # (pronounced as *si sharp*) is an object-oriented programming language. Designed in 1998-2001 by a group of engineers led by Anders Hejlsberg at Microsoft as an application development language for the Microsoft .NET Framework, and subsequently has been standardized as the ECMA-334 and ISO / IEC 23270.

C # refers to a family of languages with a C-like syntax, of which its syntax is the closest to C ++ and Java. The language has static typing, supports polymorphism, operator overloading (including operators of explicit and implicit type), delegates, attributes, events, properties, generalized types and methods, iterators, anonymous functions with support for closures, the LINQ, exceptions, comments in XML format. Learned much from its predecessors - C ++ languages, Pascal, Modula, Smalltalk, and in particular, Java - C #, based on the practice of their use, eliminates some models which have proven to be problematic in the development of software systems, for example, C #, unlike C ++ does not support multiple inheritance of classes (meanwhile multiple inheritance of interfaces is allowed). C # was developed as an application programming language for the CLR and, as such, depends primarily on the capabilities of the CLR itself. This concerns, above all, the C # type system, which reflects BCL. The presence or absence of certain expressive features of the language dictated by whether a particular linguistic feature can be translated into the corresponding CLR constructs. So, with the development of the CLR from version 1.1 to 2.0, C # itself has greatly enriched itself; Such interaction should be expected in the future (however, this pattern was violated with the release of C # 3.0, which is a language extension that does not rely on extensions to the .NET platform). CLR provides C #, like all other .NET-oriented languages, many features that deprived of "classical" programming languages. For example, garbage collection is not implemented in C # itself, and CLR is produced for programs written in C # in the same way as for programs on VB.NET, J #, etc.

With the help of the program "MapGeoEcoRisk" you can open *.mxd file and see it in cartographic mode. *.mxd file includes maps. Maps in ArcGIS consist of a set of layers, drawn in a certain order. The map layer determines which symbols and labels are assigned to the GIS data set as a map (i.e., determines its display). The layer represents geographic data in ArcMap, for example, a specific data topic. Examples of map layers: lakes and rivers, soils, roads, administrative boundaries, land plots, building outlines, power lines, ortho-, photo-images, etc. Each map layer used to display a specific set of GIS data and work with it. The layer refers to data stored in the geodatabase, covers, shape files, rasters, CAD files, etc., but the layer itself does not contain geographic data. Thus, the layer always displays the most update information from the database. The layer will not have displayed on the map if you do not have access to the data source on which it is based. The program "MapGeoEcoRisk" is supported by the operating system Windows 7/8 / 8.1 / 10 in the x32 and x64 (Fig.2.).

RESULTS AND DISCUSSION

In the formation of geo-ecological conditions of the territory of the city of Bukhara, a main role belongs to natural geological-tectonic and techno genic risk factors, which determined the features of both regional geological and local physic-geographical factors.

Natural geological-tectonic factors of risk in include features of the history of geological and tectonic structure, features of the lithological structure, hydrogeological conditions, and also the composition and state of the rocks of the territory. Particular attention in assessing the geological - tectonic structure is given to the identification and location of regional and local waterproofing. Depending on the availability of waterproofing and the depth of its occurrence, it is possible to predict the conditions for the behavior and spread of pollution of the geological environment by harmful components, such as heavy metals and petroleum products, nitrates, phenols and other dangerous substances. Of no small important role in the

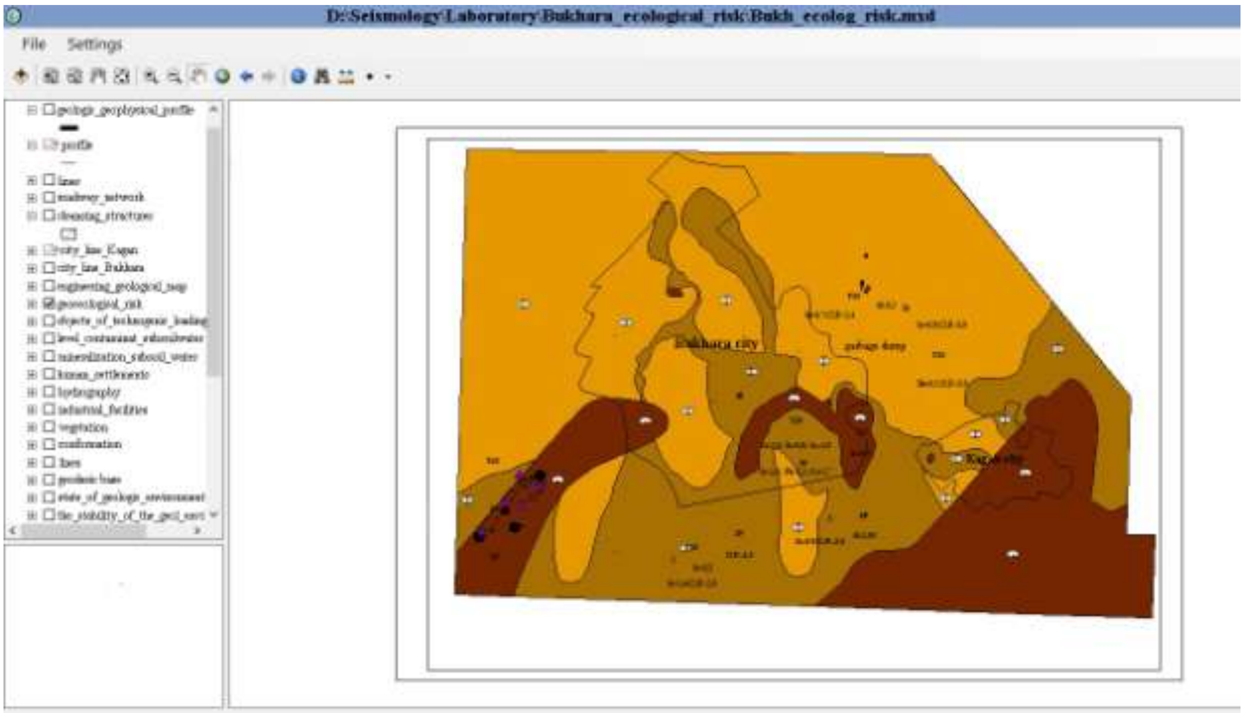


Figure 2: Appearance of ArcMap geoecological risk map for the territory of Bukhara in ArcGIS format

formation of the state of geoecological conditions belongs to the zones of geoecological influence of the engineering structure on the geological environment. The zone of the geoecological influence of the engineering structure on the geological environment is that part of the geological environment within which, under the influence of direct or indirect techno genic impact, significant changes in all or some of its elements occur that are of ecological significance for humans. The boundaries of this zone are the limits, where these changes are absent or insignificant from an ecological point of view. The central and still unresolved issue in the problem under consideration is the question of the criteria for delineating the boundaries of zones of geoecological influence. Therefore, at the initial stage of research, it can be assumed that any changes in some elements of the geological environment can have environmental consequences for humans, and as a result, the boundary of influence should delimit the area where these changes are absent from the region where they have a place. Depending on the scale level of geoecological research, the approaches to distinguishing zones of geoecological influence are different, as different goals and objectives of such studies. At the regional level the geoecological impact zone studies essentially coincide with the zones of techno genic changes of geological environment and the zones of engineering and economic development of the territories, while for this level of research the sources of man-made impacts and the impacts themselves are complex, which often does not allow isolating individual zones from those or other kinds of influences. At the local level of research, it is possible to distinguish more in detail the zones of geoecological influence from one or another specific type of techno genic burden; along with flat topographic models, volume indicators and volumetric models can be used to evaluate and display them. At the detailed level of research, the most detailed characteristics of the zone of geoecological influence, its composition, origin, configuration in terms and section, etc. are given. The sizes and boundaries of the zones of geoecological influence at the detailed level most reliably established experimentally. The most reliable estimate of the zones of geoecological impact of various engineering structures is possible only based on the current system for monitoring the geological environment.

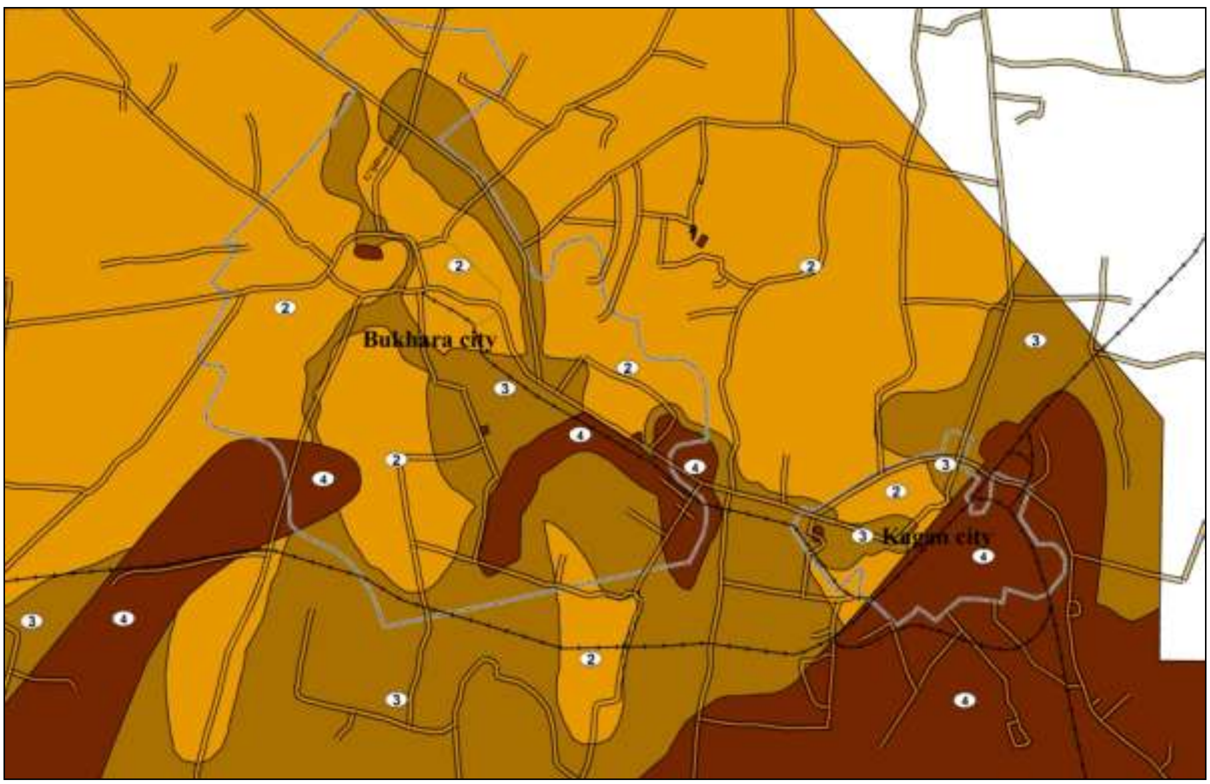
In determination of the current state of geoecological risk in the territory of the city of Bukhara, an expert assessment was made of the compliance of a particular locality with the construction requirements described above, for successfully implement of the tasks for assessing of potential magnitude of the geoecological component of seismic risk, the depth of the groundwater table and its regime, the presence, depth, thickness and nature of the occurrence of the water, the filtration properties of the rocks of the aeration zone, character of the techno genic burden, both residential and agricultural cities, characteristics of the component-wise composition of pollutants, the presence of hazardous industries, the presence and excess of heavy metals in groundwater, condition of sewerage systems, condition of drainage systems (both vertical and horizontal), availability and condition of the treatment facilities, as well as the state of solid waste disposal in the territory of the city of Bukhara. The complexity of assessing geo-ecological risks, including seismic risk, lies in the diversity of engineering and geodynamic conditions in the territory of Uzbekistan. In general, two belts of concentration of urbanized territories are distinguished: - Intermountain and foothill valleys of the Tien-Shan mountain-fold region (East Uzbekistan); - Plain valleys and low mountains of the Turan plate (Southern and Western Uzbekistan). The territory of the city of Bukhara is located in the South-West part of Uzbekistan geologically coincides with the eastern part of the Turan plate, which is part of the young epipaleozoic Ural-Siberian platform. The morphostructure of Western Uzbekistan genetically linked to the South Tien-Shan orogeny, being its west-north-western dive. Neotectonic structures, developed here, represent a chain of mountain structures, stepwise sinking from east to west. In the same direction, the amplitudes of neotectonic motions, powers and sizes, the Cenozoic molasses, the intensity of the relief subdivision, its absolute height decrease.

Features of geological-tectonic and seismological structure of southwestern of Uzbekistan: The territory of southwestern of Uzbekistan, unlike other regions, characterized by a platform-specific situation, where external geological manifestations (indistinct morphological expression, low values of the amplitude of the latest tectonic movements, etc.) are poorly expressed. The western and central parts of Uzbekistan are one of the dangerous seismoactive regions of Uzbekistan, where earthquake occurred in the distant past of Bukhara 942, 1390, 1821, and 1822 years with a magnitude of $M \sim 7.0$, and already in our days, the famous Gazliy 1976, 1984 with $M \geq 7.3$, $I = 9\text{-}10$ point. Assessment of the current state of geoecological risk begins with the determination of the degree of seismic hazard of the territory, that is, with the establishment of the seismic potential of the region, which determined by the possibility of manifestation of the maximum possible earthquakes Mmax. Based on analysis and comparison of seismotectonic, geological, geophysical, seismological methods, the seismic potential of Mmax for the territory of the city of Bukhara is estimated from in $M = 6.9$.

The main natural factors in the territory of Bukhara, determining the features of engineering-geological conditions are zonal climatic and regional engineering and geological features of the territory. Among them are: - aridity of the climate; - gently sloping and monoclinically falling tectonic structures forming on the surface low-lying, weakly dissected plains with closed on the edges and with no-drain positions; - low filtration capacity of aquifers; - close occurrence to the surface of the earth of Neogene sandstones and siltstones (5-30 m) serving as a regional water reservoir; - small deviations in the flow of groundwater. These features contribute to difficult water exchange and poor drainage of the territory, therefore, an increase in the water table. Arid climate is associated with intensive evaporation of soil moisture and secondary salinization of soils.

The main techno genic factors affecting the environment of the territory of the city of Bukhara consist of: a) agricultural- associated with the development of irrigation and the chemicalization of agriculture; b) industrial c) domestic.

In developing a methodology for assessing and managing geoecological risk for urbanized areas, we assessed the state of the potential of geoecological risk for the aggregate of natural and man-made factors prevailing in the city of Bukhara, using the ArcGIS system and by the way of the layer wise assessing of the components of geoecological risk arranged map of geoecological risk for the territory of the city of Bukhara, where areas with different levels of geoecological risk potential are allocated: 1-low, 2-moderate, 3-high and 4-very high, and developed recommendations for reducing damage and geoecological risk. 11% of the total area of the city of Bukhara and its environs have a very high potential for geoecological risk; 33% of the area consists of areas with high geoecological risk potential and 56% of the area characterized as areas with a moderate geoecological risk potential; There are no areas with low geoecological risk potential in the territory of Bukhara and its environs (Fig.3.).



Designation:
1. 2 3 4
Risk levels: 1-low, 2-moderate, 3-high, 4-very high
Figure 3: Schematic map of geoecological risk for the territory of Bukhara based on ArcGIS

Characteristics of the potential level of geoecological risk:

Potentially low geoecological risk - the level of groundwater contamination (concerning to the degree of concentration relative to the MPC) is allowed to be less than 1 MPC, and there are component-wise of the chemical composition continuously exceeding 1 MPC such as: Sr, Se, Mn, As, Al, Be and NO_3 and indicators periodically exceeding MPCs such as: NH_4, NP and α-HCH. Mineralization of groundwater up to 1.5 g/l. Techno genic load characterized as undeveloped and under-built. Depth of groundwater table is more than 3 m.

Potentially moderate geoecological risk - the level of groundwater contamination, (concerning to the degree of concentration relative to the MPC), is *moderately dangerous* where elements *constantly exceeding from* 1-5 MPC such elements as Sr, Se, As, Al, Be, and from 1 to 10 MPC NO3, Mn, and indicators *periodically exceeding* 1-10 MPCs such as NH_4, O.P. (oil products content) 1-10 MAC and α-HCH 1-5 MAC. Mineralization of groundwater is from 1.5 g / l to 3.0 g / l. Secondary salinization of soil is developed. Techno genic load characterized as a zone of a single-storey building without a drainage system. The depth of the groundwater table is from 2 to 3 m.

Potentially high geoecological risk - the level of groundwater contamination (concerning to the degree of concentration relative to the MPC) *is dangerous* with an indicator *constantly exceeding from* 5-10 MAC such elements as, 10-15 MPC Mn and indicators *periodically exceeding* 10-15 MAC such as O. P. (oil products content). Mineralization of groundwater is from 3.0 g/l to 5.0 g/l. The flooding of the territory is developed. Techno genic load characterized as a zone of multi-storey building with a sewage system. The depth of the groundwater table is from 1 to 2 m.

Potentially very high geoecological risk - the level of groundwater contamination (concerning to the concentration level relative to the MPC) *is extremely dangerous* with an index *constantly exceeding more than 15 MPC*, elements such as Se and the indicators of periodically exceed more than 15 MPC NH_4. The mineralization of groundwater is more than 5.0 g/l. Soil salinization, subsidence and wetlands are developed. Techno genic load characterized as industrial zones. The depth of groundwater table is less than 1 m.

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