Basics of Atlas Mapping Optimization in the Fergana Valley

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Abstract. Thematic maps reflecting the negative or positive impact of natural and anthropogenic environmental factors on human living conditions are of particular importance in modern world ecological and cartographic research. To optimize the ecological situation in the region, including the river regions and oases of Uzbekistan, such ecological mapping involves the creation of atlases of a systematic collection of analytical and synthetic maps. In the world, environmental mapping gives preference to synchronization methods where specific atlas maps are systematically created by interconnecting environmental characteristics, that is, several maps that interactively interact with their didactic texts in GIS software are deployed on a computer screen at the same time. These research programs ArcGIS, QGIS, and SWAT model software focus on database creation, electronic map visualization, modeling, and analytical mapping.
Keywords. Ecological Mapping, Digitization, Vectorization, Layers, Themes, Synthetic, Electronic Maps, Modelling.

1 Introduction

In the Fergana Valley, pollution of the environment, including air, water, land, by many industrial facilities, vehicles and various chemicals, causes great harm to the health of the population. Cities can be compared to active volcanoes. Urban industrial enterprises, vehicles, and household waste pollute air, water and soil [1].

Therefore, the main goal of creating an environmental atlas of the Fergana Valley is to provide a rich and comprehensive source of information and databases on the environmental situation in the Valley, as well as to develop a state environmental policy, optimize it and apply it in practice [2]. The ecological situation is unstable and constantly changes under the influence of the human factor. Consequently, practical ecological maps, nature conservation of territories and cartographic optimization of the natural environment are used as the basis for the implementation of the project and strategy, which is intended to strengthen environmental education, advocate for the general public and enhance environmental culture [3]. Maps of the ecological atlas allow you to visually determine the place and time of the ecological state of what happened in the past, at the present time and

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which, possibly, will occur in the future, depicting it in color, describing the possibility of counteracting this.

With the help of atlas maps, great opportunities have appeared for showing all the changes that occur in nature. Environmental situations are different, they have different effects on nature and people in the regions of the republic. Water, soil, atmosphere, pollution levels, health impacts and other environmental data cannot be plotted on a single map. Therefore, it is necessary to create a complex of maps, that is, an atlas covering all areas of ecology. Atlas is a system with specific sets of thematic maps that display human-nature interactions, social, natural and man-made elements of society. Therefore, the main purpose of mapping is to register and assess the state of the environment [6].

Environmental atlases include a system of maps dealing with interrelated and complementary environmental issues, and also consist of basic base maps of natural and socio-economic content. Industry and network maps describe and assess the ecological state of certain elements of the environment and represent the environmental problems of various industries (such as agriculture, forestry, water management, industry, etc.). The content of the ecological atlas maps covers various types of mapping, and also works with many objects and events, but among them there are several integrations and syntheses. Maps of different types of scientific and practical directions, their inventory, assessment, forecasting and combination in content, are shown in different directions, which are characterized by their distinctive features.

2 Methods

2.1. Study area

The Fergana Valley is a Valley in Central Asia spread across eastern Uzbekistan, southern Kyrgyzstan and northern Tajikistan. (Fig.1.)

Fig. 1. Map of the study area, Fergana Valley.

The Fergana Valley is an intermountain depression in Central Asia, between the mountain systems of the Tien-Shan in the north and the Gissar-Alai in the south. The Valley is approximately 300 kilometers long and up to 70 kilometers wide, forming an area covering 22,000 square kilometers. Its position makes it a separate geographic zone. The

Valley owes its fertility to two rivers, the Naryn and the Kara Darya, which unite in the Valley, near Namangan, to form the Syr Darya.

The central part of the geological depression that forms the Valley is characterized by block subsidence, originally to depths estimated at 6 to 7 kilometers, largely filled with sediments that range in age as far back as the Permian-Triassic boundary. Some of the sediments are marine carbonates and clays. The faults are up thrusts and over thrusts. Anticlines associated with these faults form traps for petroleum and natural gas, which has been discovered in 52 small fields. [1]

2.2. Methods

Methods of creating an electronic atlas and analysis using modern GIS - programs and methods for their creation with a hybrid type of data storage have the most promising opportunities. Maps of the ecological atlas allow to display the past, present and future, as well as to determine the place and time of the ecological state by depicting them in color, which makes it possible to develop measures to protect the components of nature.

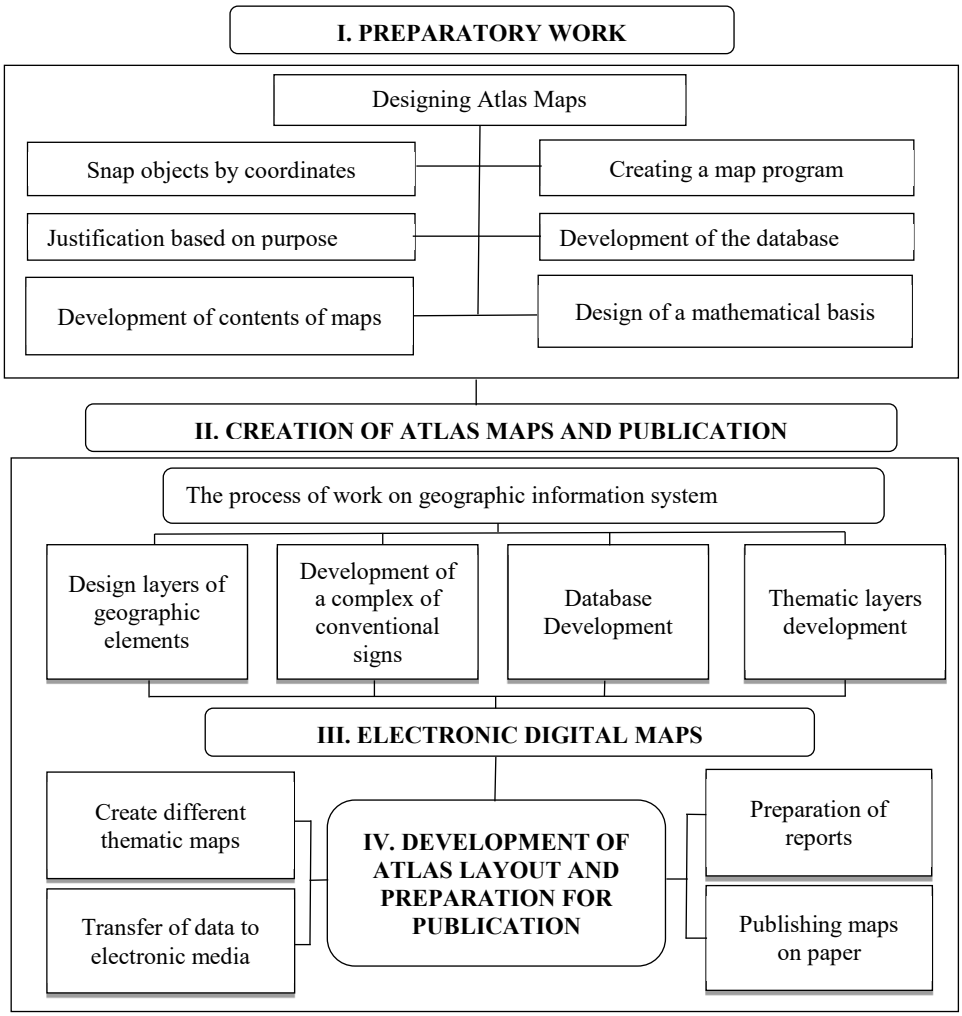

Fig. 2. Designing and mapping environmental atlas in a GIS program

The object of the study is the environmental atlas of the Fergana region. The subject of the study is the structure and content of atlas maps reflecting the environmental state of the Fergana region, developed on the basis of modern GIS technologies. The foundations of environmental atlas optimization are improved on the basis of maps of "degree of anthropogenic load on landscapes," demo ecological state "; Improved digital maps depicting the environmental condition of areas in need of protection in the Fergana region using TIN (Triangulated irregular network), SHAPE vector file and GRID raster files; Improved inventory maps using interactive maps as well as the DEM (Digital Elevation Model).

The cartographic method is most effective in assessing and forecasting environmental situations in the "Population-nature-society" system (Fig.2). At the same time, in the ecological atlas created for the first time, along with traditional indicators, a set of recommendations for the development of ecological culture and a set of measures to preserve the landscape were used.

The creation of an ecological atlas of the Fergana Valley will have a positive effect in the future in determining the state of geosystems changing under the intense influence of human economic activity, in developing a plan of action measures, as well as ensuring sustainability.

3 Results

The scientific significance of the results of the study is determined by the fact that in mapping the ecological condition of the Fergana Valley for the first time GIS-technologies with ArcGIS software, QGIS was used, the structure and content of the ecological atlas of the Territory were developed, as well as methodological approaches to their creation was improved.

The structure and draft of the ecological atlas of maps of the Fergana Valley were developed, on the basis of the geographic information system, moreover, the database "Ecology of Fergana" and its thematic layers also were developed. According to the content, the atlas maps are divided into 3 large sections: the reasons for the destruction of the ecological state; the consequences of environmental degradation; optimization of the ecological state of the Fergana Valley. Texts and legends were prepared on the maps, which facilitate the use of the atlas with modern GIS systems (table 1). Content and configuration changes have been made to reflect the new requirements. The rapidly growing trend in environmental cartography is highlighted based on new methodological approaches, assessment criteria and information sources.

Table 1. The structure of the ecological atlas

#	Name of map	Scale	The main content of the maps
Reasons for the destruction of the ecological state			
1	Map of anthropogenic factors affecting the environment	1:1 000 000	Anthropogenic factors are covered by the scope and measures to improve and protect land resources
2	Pollution map in industrial cities	1:1 000 000	Industrial centers, the amount of toxic gases emitted from industrial sites is given
Consequences of ecological degradation			
3	Air pollution level map	1:1 000 000	Air pollution level. Shown is the amount of toxic substances such as dust, gaseous sulfur, carbon monoxide, nitric oxide, ammonia, hydrogen sulfide compounds
4	Melioration map (irrigation	1:1 000 000	Newly developed regions, irrigation

	networks)		agrotechnical measures against deflation are highlighted. Areas of reclamation shown
5	Demo-ecological state map	1:1 000 000	The map is a database that provides anthropogenic pressure on the natural environment
6	Environmental stress assessment card	1:1 000 000	The degree of tension in the ecological state in the Fergana Valley, the regions of the ecological situation; stabilization
Optimization of the ecological state of the Fergana Valley			
7	Environmental maps	1:1 000 000	The horizontal range limit is indicated in the outlines. The distribution of natural resources that affect human health and the ecosystem is reflected in the distribution of territories
8	The degree of anthropogenic pressure on landscapes	1:1 000 000	The map lists two ecological spaces and economic groups that combine content. The degree of anthropogenic pressure on landscapes, agrodemographic pressure, anthropogenic pressure on agriculture, ecological gene groups in the land fund.
9	Environmental protection map	1:1 000 000	The degree of variability of natural complexes, economic and other human activities, anthropogenic impact on nature and its consequences
10	Ecological maps of the cities of Fergana, Margilan, Kuvasoi, Kokand, Andijan and Asaka	1:25 000	Shown are natural, demographic, technogenic, anthropogenic and other indicators of cities, reflecting the ecological state of tension

1. Data from electronic tachometers and GRS devices, imaging equipment, expedition materials, digital data, copyright originals, existing maps and other source materials were collected. The cartographic and raw materials were scanned and placed at the same scale as the raster images, and then placed in memory.

2. The thematic layers of the ecological atlas maps and their tables were compiled, they were analyzed using the Fergana Valley GIS programs, and a database was created.

3. Classifications of objects, existing tables (attributes) and text data were included in the computer memory.

4. A system of conventional symbols has been developed.

5. The thematic map layers were loaded and cartographic images were created, which were edited separately.

6. The layout of the map has been developed and refined for preparation for publication (Fig.3).

A cartographic base has been prepared for the creation, analysis of thematic layers of the models of the ecological atlas of the Fergana Valley and their drawings, as well as for the creation of a database and a map. Cartographic bases were developed from general geographic elements - the foundations of cartographic and aerospace materials from elements of mathematical foundations (relief, land users, soil cover, settlements, roads, borders) in accordance with the scale and projection of the map.

Creation and use of a multimedia ecological atlas of the Fergana Valley is intended to create a digital model of the valley through a raster image of the valley depression, create a three-dimensional 3D model of electronic ecological atlas maps, visualization and ways of

using it in environmental protection. They were analyzed on the basis of GIS technology, methods of indexing space data and through the preparation of forecast and assessment maps, the monitoring methodology was improved.

ArcGIS geographic information mapping and QGIS-based software use the latest GIS database designs from raw data. The created system allows to solve the following tasks: collection and processing of databases; obtaining statistical information about the parameters of the content structure of any cartographic layer; search for objects by their attributes, plotting them on top of each other for comparative analysis; simultaneous viewing of the state of the territory in several layers using mathematical - cartographic modeling; the use of various imaging techniques, the technique of automatic mapping. (Fig.4.)

The latter method of using atlas maps can be shown with hypsometric color or coloring, which improves the readability of the shadows. Hypsometric staining is a set of colors used to provide additional information about the height of a shaded map. Thus, the ability to visualize the overall elevation height has been increased.

The above basic hill shade capabilities are available in almost all GIS software packages, but more advanced techniques are available in Adobe Photoshop.

Triangulated irregular network (TNT), SHAPE vector files, and GRID raster files are based on the vector data of this area and can often be used to describe concepts that can be referenced to a surface or generally oriented to a surface. There are many adjacent triangles, called TNT surfaces that do not collide with each other and they have created electronic maps of the environmental atlas from numerous points using the Delacney method.

Some 3D visualizations only allow one person to explore. For example, in some vertical real-time systems, the display may be viewed by a device and used by only one person. Other devices allow multiple people to view the display at the same time and directly lead a discussion (for example, CAVE software, which can accommodate multiple people.

The most important aspect of 3D visualization is the use of cartographers to create such visualizations that can be generalized using existing abstracts (for example, geometric shapes of objects) or high-level realities (for example, cities with mountains, trees, and streams filled with movement) (Fig.5)

The use of geoinformation technologies in the field of ecological and geographical research is the basis of the dissertation. The analysis of existing resources and capabilities of automated processing of environmental and geographical data and the results of creating digital electronic maps. The Environmental Atlas is a basic and convenient visual resource for assessing and predicting the state of the environment.

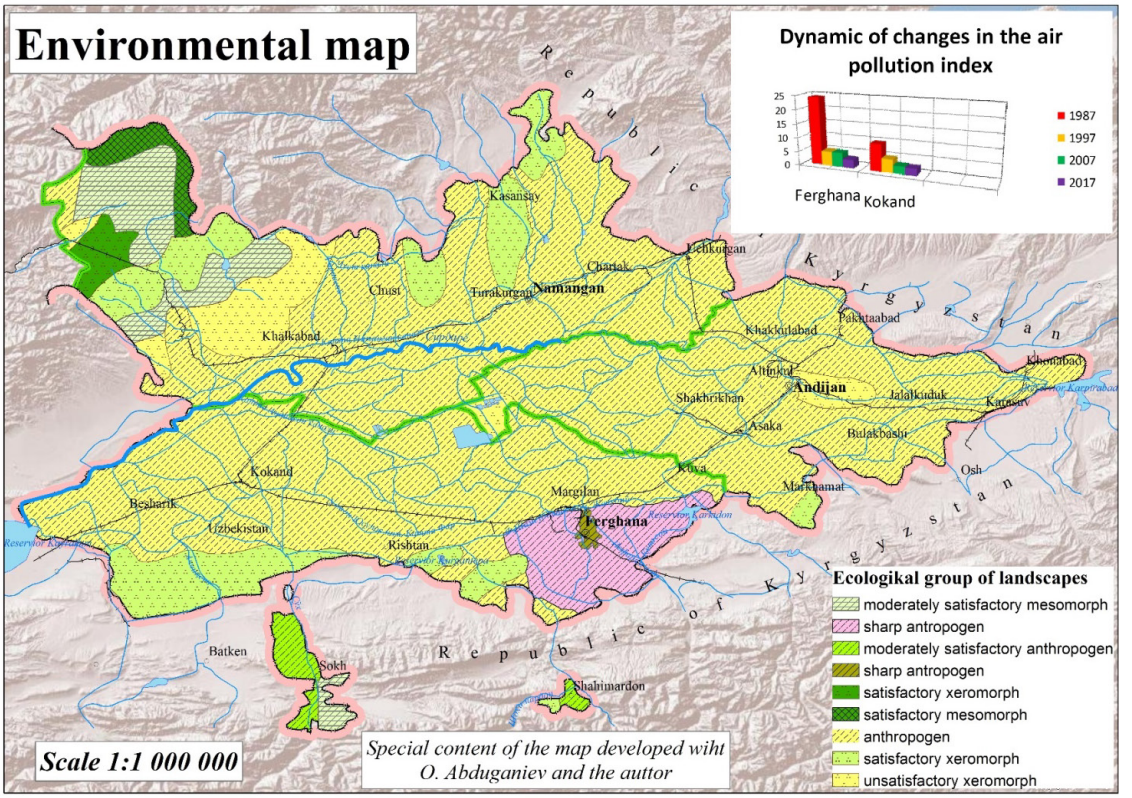

Fig. 3. Environmental map of the Fergana Valley

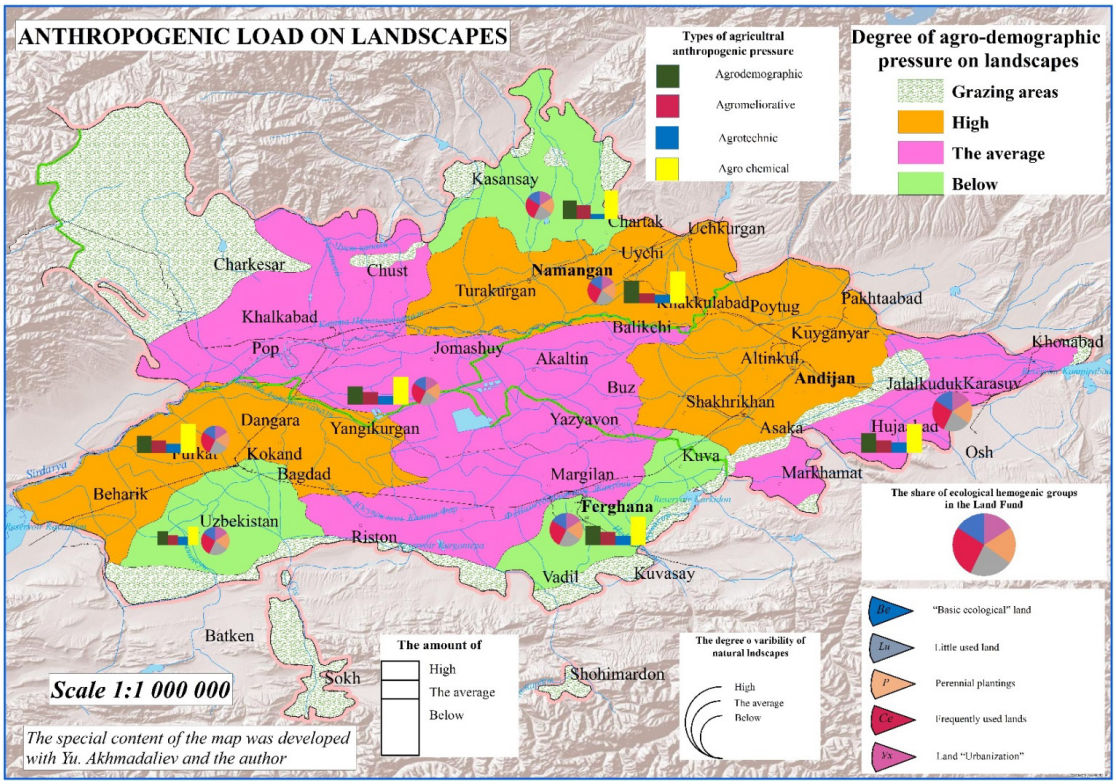

Fig. 4. Map of anthropogenic load on landscapes Fergana Valley

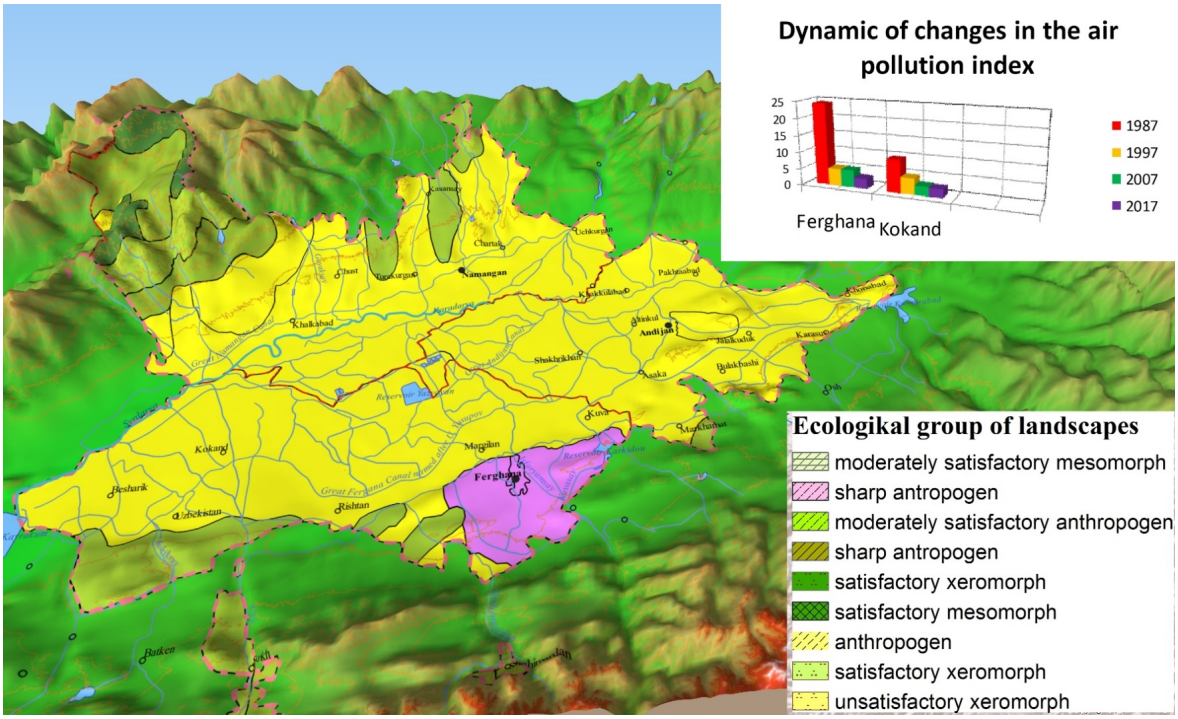

Fig. 5. 3D rendering of ecological map

4 Discussion and conclusion

The scientific significance of the research results is determined by the fact that when mapping the ecological state of the Fergana Valley, for the first time, GIS technologies with the ArcGIS and QGIS software were used, the structure and content of the ecological atlas of the territory were developed, and methodological approaches were improved in their creation.

The practical significance of the research results is determined primarily in the use of the above methods in the development of targeted government programs and practical measures to improve the environmental situation on the basis of conclusions and recommendations, thematic assessments and inventory maps.

Based on the study, the following main conclusions were drawn:

1. The experience of creating environmental atlases is improving every year. The methodological developments associated with the theory and practice of creating atlases are not so great. Modern ecological atlases, created at the present time, are characterized by the fact that they are based on a systemic principle for updating and processing geographic information, as well as on the necessary adaptive functions.
2. Proposals are given on the use of a systematic approach in mapping the nature and ecological state of the Fergana Valley, which made it possible to create a series of analytical and synthetic ecological maps.
3. Development of the composition and content of the ecological atlas using ArcGIS, QGIS and the SWAT model allowed the creation of an ecological database. It is proved that simplified and improved cartographic sources, consisting of several layers and obtained during the creation of maps of the ecological atlas, are the basis for the creation of other maps.
4. The use of geo-innovative technologies in atlas mapping will lead to a decrease in labor costs and time, and an increase in the accuracy of the work performed. At the same time, proposals for software, mathematical basis, layout layout, and projection, generalization of visualized maps of the ecological atlas using ArcGIS, QGIS and SWAT modeling programs based on data characterizing the ecological state of the Fergana Valley were developed and given.
5. The use of imitations of the inventory of space data based on the objectivity and practical orientation of information with the interpretation of images and aerospace images of the atlas, made it possible to create interactive maps.
6. Of particular importance is an operational database of information on geodesy, cartography and cadastres in the shortest possible time with monitoring of the environmental situation and operational information in emergency situations, as well as providing timely access to updated information on the environmental state of the region.
7. When modeling in a GIS suite of commonly used map servers using internal or additional tools, the raster and vector data model made it possible to transform the field in which the spatial distribution of events in the Fergana Valley changes. This database serves as an important source for obtaining relevant scientific conclusions, assessing situation, monitoring, and identification of priority areas for the future.
8. The use of GIS technologies in the field of ecological-geographical research and the use of three-dimensional 3D automated methods for processing existing resources and ecological-geographical data in the development of content on this basis of ecological atlas maps, synchronization of maps is proposed.
9. In order to develop assessment and recommendation maps with cartometric indicators of the ecological state of protected areas in the Fergana Valley, proposals and

recommendations on the trend of planning, assessing and taking into account the environmental impact are given.

10. Ecological atlas of the Fergana Valley and its practical thematic ecological maps will serve as a basis for assessing the ecological situation, nature conservation and rational use of natural resources, as well as optimization of the ecological situation.

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