

DEVELOPMENT OF LANDSCAPE ZONING SCHEMES FOR SUSTAINABLE MANAGEMENT AND MAINTENANCE OF ECOSYSTEMS

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ABSTRACT: The purpose of the paper is to substantiate the importance of developing landscape plans and landscape zoning schemes for harmonizing the functioning of urbanized territories along with objects of natural territorial complexes using the example of certain districts of the Almaty Region. The authors used the following research methods: generalization; observation; comparison; visual-graphic. The features of landscape planning at different levels of spatial planning are characterized. A comparative analysis of the natural components included in the landscape complexes of five districts of the region was carried out. The features of the structure and spatial characteristics of the landscape organization on the territory of certain districts of the Almaty Region are determined. The percentage ratio of the most common types of soils and landforms in the landscapes of certain areas of the Almaty Region was analysed. The relationship between the effective use of natural and land resources in the implementation of rational landscape planning is substantiated. A variety of factors and indicators that determine approaches to landscape zoning are identified. A cartographic image of landscape planning on the territory of the Balkhash District of the Almaty Region is presented.

Keywords: Natural territorial complexes, Spatial planning, Anthropogenic load, Degradation processes, Environmental protection measures

1. INTRODUCTION

Almaty Region, which occupies an important place in the sector of the national economy of the Republic of Kazakhstan, includes 5 climatic zones, a unique number of landscape and recreational facilities, as well as a priority in the development of both various areas of agriculture and business sectors. In recent years, there has been an increase in the level of degradation processes in the territory of various landscape complexes within the region. There is a significant deterioration in soil fertility, the formation of shifting sand structures due to excessive land use of pastures, the devastation of forest areas, and a decrease in biota species. There is also wind erosion, and overdrying. This situation is exacerbated by a significant number of environmental disasters, including earthquakes and floods [1]. The elimination of conflicts arising from social and natural interactions requires the use of landscape zoning approaches for effective ecosystem management in the context of rational spatial planning. Such innovative methods require confirmation and regulation at the legislative level.

Ryspekov, analyzing the typification of landscapes and the dynamics of the use of

ecosystem services, considers the feature of reducing the indicators of agricultural activities and other sectoral entrepreneurship [2]. In such conditions, although rather slow but gradual, restoration of nature management objects takes place within the region. Berdenov et al. study the landscape structure of territories within urban areas [3]. The norms of urban planning, land and environmental legislation, as well as the peculiarities of the region's nature management, a buffer zone called the "Green Belt" was formed as one of the approaches to support and effectively distribute ecosystem functions.

Ainakul et al. study the concepts of an "innovation ecosystem" and the specifics of the application of nanotechnologies, as well as the means of scientific and technological progress to improve the system for monitoring the integrity of natural components within the surrounding landscapes [4]. Shakenova and Ozeranskaya explore the features of applying methodological approaches to improve the territorial planning of land use using landscape-ecological planning methods [5]. Zones of balanced, environmentally sustainable and economically efficient land management should be formed as a result of the

effective interconnection of the agro-industrial complex and adjacent components of the landscape.

The purpose of the article is to substantiate the principles of landscape planning for the rational distribution of ecosystem services on the example of individual districts of the Almaty Region, as well as to make proposals for the creation of landscape zoning schemes for a more detailed allocation of territory functions.

2. RESEARCH SIGNIFICANCE

The development of landscape zoning schemes for sustainable management and maintenance of ecosystem services is important because it allows for the identification and protection of areas that are critical to the maintenance of specific ecosystem services. The practical significance of the research lies in making proposals for the formation of landscape zoning schemes for effective ecosystem management on the example of a specific area with the justification of the main functions of landscapes and environmental measures necessary to preserve the integrity of all natural components.

3. MATERIALS AND METHODS

The information base of the research was the data from the report "Development of zoning schemes and landscape planning for sustainable management of key biodiversity zones in 7 pilot districts of Almaty Region," formed in 2020 [1]. Decree of the President of the Republic of Kazakhstan No. 887 "On Certain Issues of the Administrative-Territorial Structure of the Republic of Kazakhstan" [6] and Decree of the Government of the Republic of Kazakhstan No. 625 "On the draft Decree of the President of the Republic of Kazakhstan "On approval of the predictive scheme of the territorial and spatial development of the country until 2030" were considered in detail [7].

The study of the problematic aspects of the research topic required the use of the principles of the ecological paradigm and the characteristics of the ecosystem as an object of research in the science of ecology, the study of areas of physical geography that consider natural territorial complexes, as well as the structure and diversity of landscapes.

To achieve the purpose of scientific paper, the following general scientific research methods were used: method of generalization – systematization of the main scientific provisions; establishment of theoretical aspects of landscape zoning in the context of the functioning of the components of an integral ecosystem; study of spatial planning in a particular region; substantiation of axiomatic provisions on natural territorial complexes and diversity of landscapes of Raiymbek, Kegen, Enbekshikazakh, Uygur and Balkhash districts of

Almaty Region; generalization of the features of the formation of degradation processes of soil and vegetation cover.

Method of comparison allowed to characterize similarities and differences in landforms, soil types, and landscapes that prevail in the territories of five separate districts of the Almaty Region. Factor analysis helped to study of the features of the modern use of natural resources in certain areas of the Almaty Region. Visual-graphic was used for mapping of the natural environment of the Balkhash District of the Almaty Region, taking into account the ecological state of the area. Abstract-logical method clarified the essence of the main concepts, definitions and categories. The algorithmization method determined the conceptual provisions of landscape zoning and the allocation of functions provided by different types of natural components in various areas of economic activities.

4. RESULTS

When addressing the issues of supporting the elements of the structure and functioning of the ecosystem, resource conservation and resource efficiency methods are used (Table 1). Landscape planning includes various levels in accordance with territorial development, goals, objectives, stages. At the national and regional levels, there is a general planning of framework changes and the development of a common state landscape program. At the regional level, the collection and analysis are carried out of the prevalence of various natural objects in a particular region or area, indicators of its socio-economic development [8]. At the local level, special measures are taken to protect the environment within a particular settlement or land plot in conjunction with the specifics of the provision of ecosystem services.

Table 1 Characteristics of industries and economic activities in five districts of the Almaty Region [1]

District name	Spheres of entrepreneurial activities
Enbekshikazakh	Food industry, winemaking, construction materials industry
Balkhash	Agro-industrial complex, mining industry, construction materials industry, exploration expeditions
Raiymbek	Commercial industry, agro-industrial complex, drinking water supply
Kegen	Energy industry, construction materials industry, drinking water supply
Uygur	Processing industry, construction materials industry, drinking water supply

Landscape zoning is used for environmental management, the creation of natural properties of landscapes and the elimination of conflicts between the anthropogenic component and the ecosystem services of the region [9].

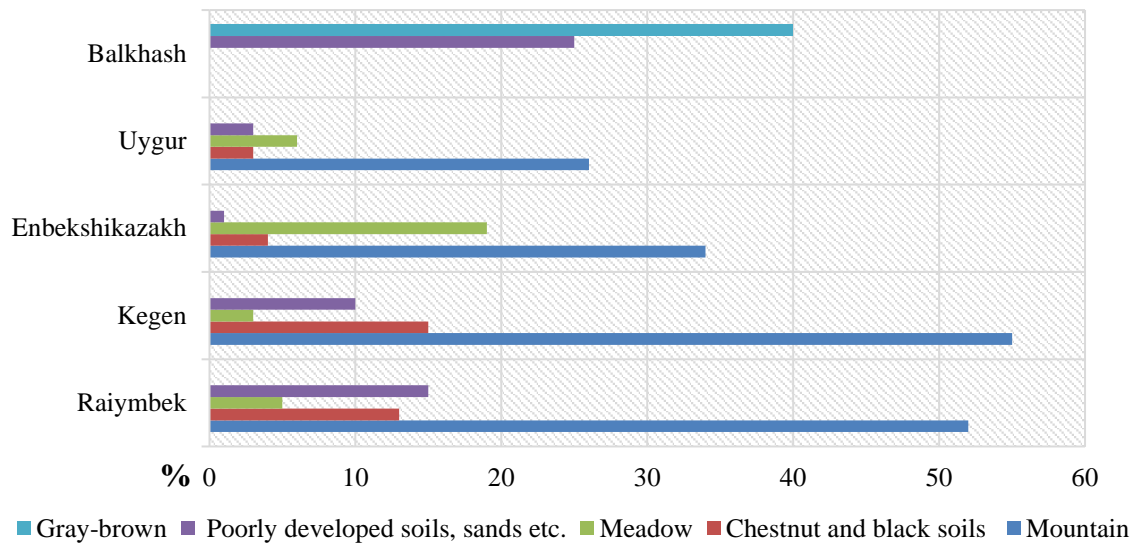


Fig. 1 Most common soil types in the landscapes of individual districts of the Almaty Region [1]

It is the territorial differences of the districts that determine the features of landscape diversity, the quantitative accounting and qualitative analysis of which is necessary to preserve the uniqueness of the biological and natural diversity of the region as a whole. Zoning landscapes for effective management of the ecosystem of the Almaty Region requires the improvement of monitoring methods regarding the rational use of land resources. The percentage of the most common soil types in the landscapes of individual districts of the Almaty Region is shown in Fig. 1. The landscape complexes of the five districts of the Almaty Region, in most cases, include mountain soils, meadow soils and black soils. There are varieties of brown soils and salt marshes (Fig. 2).

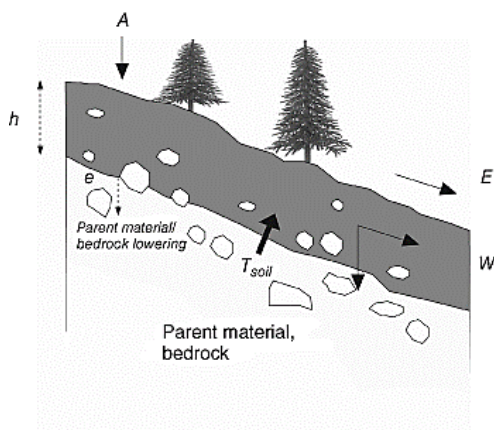


Fig. 2 Soils of Mountainous Landscapes

The study of the features of the soil cover in the territories of mountain landscapes makes it possible to assess these objects as a unique type of natural environment with a high vulnerability of

ecosystems to man-made impact due to a wide range of exogenous processes [10]. The results of landscape studies of the mountainous areas of Rayymbek, Kegen, Enbekshikazakh, Uygur and Balkhash districts of the Almaty Region revealed the main causes of degradation of the soil and vegetation cover, which are the actions of pasture digression [1]. Even despite the fact that there has been a significant decrease in pasture load over the past ten years, specific landscapes have formed with numerous erosional processes. For rational zoning of landscapes and effective management of ecosystem functions, it is necessary to study in detail the spatial structure of landscapes [11].

On the territory of the Enbekshikazakh District, desert landscapes prevail in the temperate zone, which extends within the Ketmen-Zailei mountain-hollow province and is part of the East Trans-Ili physiographic region with a predominance of flat-pre-steppe, high-mountain meadow-steppe landscapes. The Uygur District is also dominated by desert landscapes in the temperate zone, the northern subzone of the North Tian Shan province, and the Shelek-Ketmen mountain-hollow district with flat-foothill, desert-steppe, low-mountain semi-desert landscapes. The territory of the Rayimbek administrative district is characterized by desert landscapes, the northern subzone, the Tien Shan region, the North Tian Shan province with a predominance of mid-mountain steppe, mid-mountain, forest-meadow-steppe, high-mountain, meadow-high-mountain, meadow-high-mountain, meadow-mountain landscapes [1].

Kegen District, like all previous areas, includes desert landscape objects, the northern subzone, the Tian Shan region, and the North Tian Shan province with a predominance of plain-foothill, dry steppe,

foothill, grass-steppe, mid-mountain, high-mountain subalpine and alpine meadow-steppe landscape with juniper slate. The territorial organization of the Balkhash District includes elements of the steppe and desert landscape in the zone of the temperate continental belt, the north-western subzone. The physical and geographical features of the region include the Malaisarin ranges, the coast of Lake Balkhash (Fig. 3), the Sariesikatyrau desert and the Taukum sands with a predominance of flat terrain, namely desert-steppe, meadow-steppe and Andrade landscapes. Table 2 indicates that the territories of the studied districts are characterized by mountainous relief with foothill plains, with the plains predominating only in the Balkhash Districts (Fig. 4).



Fig. 3 Lake Balkhash

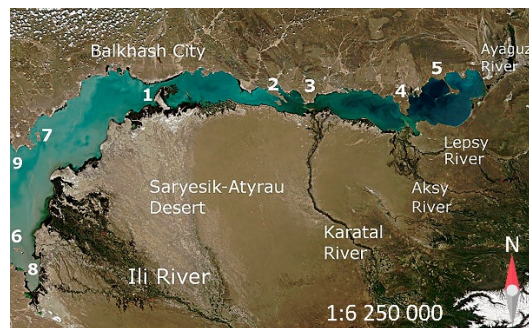


Fig. 4 Mountainous Relief of Balkhash Districts

The efficiency of the functioning of the ecosystem of the region, along with rational

landscape planning, depends on the types of land use within the districts [1]. The basis of landscape zoning includes the following factors: social and economic development; natural components and properties of territorial landscape objects; the purpose of land plots; qualitative and quantitative condition of the district's lands; monetary, economic, and environmental assessment of land; special regime for the use of land of different categories. Depending on the functional purpose of a land plot and its location, various functional zones are distinguished: industrial, engineering and communication, transport infrastructure, recreational, environmental, agricultural, and others [12] (Fig. 5)

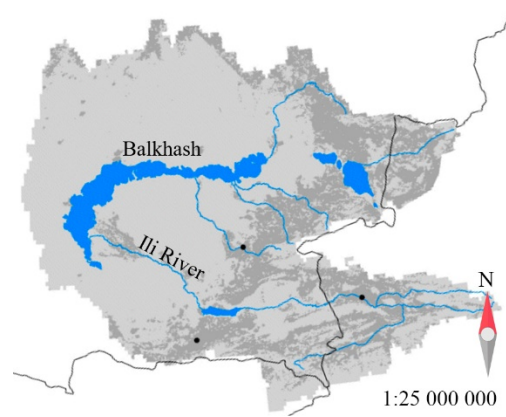


Fig. 5 Map of the Ili River basin and Lake Balkhash

The landscape planning map of the Balkhash District of the Almaty Region is shown in Fig. 6. The landscape planning map of the Balkhash District of the Almaty Region reflects 7 zones, which are characterized by various types of use of natural resources with the receipt of a specific set of ecosystem services. Thus, zoning in the context of environmental management and land use features of the area makes it possible to identify the functions that are provided by different types of landscape for economic activities in various areas, as well as environmental measures necessary to preserve the integrity of the ecosystem and regulate the corresponding anthropogenic load.

Table 2 Landforms prevailing in the territories of five separate districts of the Almaty Region [1]

District	Mountains (%)	Foothill plains (%)	Plains (%)
Enbekshikazakh	34	66	-
Uygur	24	26	-
Raiymbek	inland depressions	mountain highlands	-
Kegen	68	32	-
Balkhash	81.7	19.3	-
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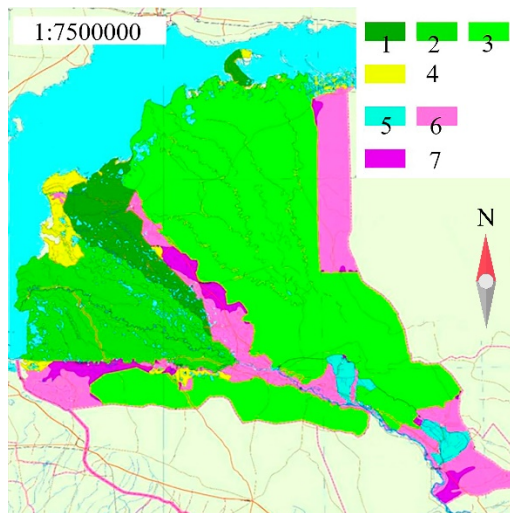


Fig. 6 The landscape planning map of the Balkhash District of the Almaty Region [1]

Conservation measures are necessary to preserve the integrity of the ecosystem (zones 1, 2 and 3): control over compliance with the regulations of environmental and land legislation of the Republic of Kazakhstan; regulated and limited use of natural resources while maintaining the existing extensive use; provision of animals with fodder and pastures; conducting ecological tourism in accordance with national standards, as well as the regulations of the international community.

Conservation measures are necessary to preserve the integrity of the ecosystem (zone 4): restriction of certain types of economic activities of environmental protection objects and their transfer to the category “Refusal to use”; strictly regulated use of natural resources while maintaining the existing extensive use; providing animals with fodder, in particular, hayfields and pastures; conducting ecological tourism in accordance with national standards, as well as the regulations of the international community; regulated extensive use, flooding of floodplain-valley complexes.

Conservation measures are necessary to preserve the integrity of the ecosystem (zones 5 and 6): cultivation of agricultural products with the preservation of soil fertility; protection of surface and underground waters and saxaul groups; regulation of the intensity of degradation processes, in particular, secondary salting, swamping, flooding; regulation of irrigation of irrigated areas, use of innovative water and soil conservation technologies; protection of soil and vegetation cover; increase in the center-forming potential due to regulation of the grazing regime, standardization of anthropogenic loads, local phytomelioration with over-seeding of fodder phytocenoses.

Conservation measures are necessary to preserve the integrity of the ecosystem (zone 7): protection of soil and vegetation cover; complex

agro-amelioration (phytomelioration, mechanical and chemical fixation of moving sands); transfer of special territories to the category of “extensive development of pasture animal husbandry”; change in the intensity and type of specialization with a predominance of camel and horse breeding.

5. DISCUSSION

The practice of effective spatial planning of areas with a variety of types and structures of landscapes requires a clear, regulated compliance with the regulations of land and environmental legislation to minimize environmental risks, as well as the occurrence of degradation processes within the ecosystem. Landscape zoning for effective management and support of ecosystems is carried out by assessing the territory of the region in the context of strategic directions of socio-economic development and greening policy [13]. Improving the directions of spatial planning through the clarification and justification of landscape planning for ecosystem management requires the following tasks: integration of gradually formed zones of landscapes and elements of spatial planning; assessment of the components of nature management and land use necessary for the development of landscape plans; development and digitalization of adapted cartographic material for the development of landscape zoning schemes with the definition of ecosystem functions [14].

Yuan et al. note the importance of landscape zoning for the protection of especially valuable environmental management objects [15]. However, often the generalized division of natural territorial complexes into so-called zones causes the emergence of local conflicts due to large-scale inconsistencies in socio-economic and environmental zoning. The approach used in the local scale of the zoning of the natural complex to resolve local conflicts takes into account the structure of local landscapes and the ecosystem services of the area, starting with a progressive stakeholder analysis for a deeper understanding of the local socio-economic and ecological system, involving the identification and typology of landscape planning objects, as well as the study of relations between stakeholders.

The author of this study supports the opinion of Chinese scientists regarding the importance of studying the features of the formation of the concept of a multifunctional conflict area as a result of the simultaneous use of territories of different functional purposes that are incompatible with each other, but on the contrary, one of them suppresses or completely displaces another ecosystem function. The article did not consider the conflict of interest in the studied areas of the Almaty Region. However, the possible reasons that caused the occurrence of

these conflicts were noted. For example, lands for hayfields and pastures that are allocated within a specific zone and landscape structure in a given area can cause degradation processes in the soil cover, while these territories perform symbiotic functions.

Iglesias et al. explore the issues of integrated management of biodiversity and ecosystem services in heterogeneous landscapes, taking into account the occurrence of risk [16]. The authors consider the peculiarities of the formation of the zoning of the biosphere reserve, which is under the protection of UNESCO and is a typical object for the study of several management zones, which are aimed at minimizing risks and conflicts during landscape planning. The results of research by scientists confirm the fact that landscape planning for the effective management of ecosystem services is the most important task because each natural territorial complex has its own characteristics in the context of the structure and types of landscapes, and therefore approaches to their zoning should take into account all scenarios of risks and conflicts. The authors did not separately consider the risks. However, they noted the already existing degradation processes in the territory of the natural complexes of the Almaty Region, just caused by the risks of excessive anthropogenic load. Thus, the authors of the article presented a map of landscape zoning and identified the main functions and environmental measures in accordance with the features of the spatial organization of the zone.

Lorilla et al. explore the relationship between supply and demand for ecosystem services that meet the needs of the local population [17]. In addition, the level of anthropogenic pressure on ecosystems and the need for the use of natural resources has increased significantly over the past decade, which can lead to a shortage of ecosystem services. Justifying the balance between supply and demand for ecosystem services can contribute to sustainable spatial planning and improve the socio-economic development of the region as a whole. The structure of ecosystem services, which was used in the study of scientists, enabled determining the spatial similarity and discrepancy between the biophysical ability of ecosystems to provide for social needs. Using the landscape zoning method, it was possible to establish where there is a spatial discrepancy, as well as an excess of supply and demand in three components: food supply, climate change control, and recreational properties [18].

At the same time, demand was determined by means of economic evaluation, and supply was determined by means of quantitative determination of biophysical indicators. Due to the difference between the costs of direct and indirect consumption, a combination of two methods of valuation, namely the market price comparison method and the benefit transfer method, have been

used to map the demand for ecosystem services [19]. The relationship between supply and demand was used to identify the spatial relationship between the supply of services and public demand. The results showed that croplands and urban areas generate high demand for all three types of ecosystem services due to high population density coupled with tourism activities. This approach enabled the establishment of priority protected areas. For territories with an unstable ecological regime, it is proposed to both maintain and change the current spatial planning policy in order to improve the decision-making process [20-22]. The result of the research is the formation of a structure of compact landscape zones with various ecosystem services within the Ionian Islands, followed by balancing the needs of local residents.

The research of scientists Xu et al. confirms the current trends in the need for environmental protection, taking into account the increase in urbanization rates and the increase in the needs of the local population in the provision of ecosystem services [23-25]. Indeed, in this case, there is a so-called conflict between the increase in demand and the decrease in supply. That is why effective zoning of landscapes is necessary to regulate spatial planning, taking into account environmental protection measures [26, 27]. The authors in the paper did not consider the problem of the relationship between urbanized territories and existing ecosystem services. However, they studied the level of anthropogenic pressure due to the influence of various economic activities on the integrity of the ecosystem to increase degradation processes.

6. CONCLUSION

The modern concept of an ecosystem is characterized in terms of the relationship between the components of environmental management and industrial, socio-economic facilities created by man within the natural environment. The functioning of an ecosystem is understood as the process of public environmental management, land use and the peculiarities of changes in the territorial organization, which includes a variety of geographical objects, in particular mountain and flat landscapes as a result of anthropogenic load. Rational environmental management itself allows restoring the violation of the relationship between the elements of the ecosystem and involves the solution of the following tasks: elimination and minimization of the negative impact from the excessive load on natural components; maximum preservation of the qualitative and quantitative characteristics of natural and land resources; ensuring resource saving; protection and renewal of

natural resources; development of the recycling direction.

The current level of anthropogenic pressure on the environment requires strict compliance with the existing provisions of environmental and land legislation, in particular, compliance with restrictions and the legal regime for the use of relevant facilities. At the same time, the landscape environment is one of the most important components of environmental management. It is the diverse landscapes within natural territorial complexes that require the formation of a clear landscape management system, in particular, the creation of zoning schemes and landscape plans for managing and supporting ecosystems. The development of effective landscape zoning schemes requires the use of landscape planning programs that ensure not only the protection of biodiversity and the territorial integrity of a particular area of land but also the effective management and support of the ecosystem of the region as a whole by preserving the environment. In this case, an ecosystem approach is used, the main goal of which is to increase the indicators of the socio-economic development of the region by maximizing the conservation and restoration of natural resources.

Further directions of research in the system of ecosystem conservation and effective spatial planning include improvement of administrative and economic zoning of the territory through effective territorial organization and rational land use; adaptation of measures for the protection of especially valuable objects of the natural environment to international regulations and standards, as well as in accordance with modern environmental trends and climate change; use of special algorithms and analytical tools, in particular SWOT analysis, to highlight the advantages and disadvantages of environmental management and as a result of the formation of landscape plans and spatial development schemes.

7. REFERENCES

- [1] Report "Development of zoning schemes and landscape planning for sustainable management of key biodiversity zones in 7 pilot districts of Almaty region". 2020. https://procurement-notices.undp.org/view_notice.cfm?notice_id=65410
- [2] Ryspekov T., Spatial and temporal state of ecosystems and their combination in the south-eastern part of Kazakhstan for the current period. *Hydrometeorology and Ecology*, Vol. 4, Issue 95, 2019, pp. 84-85.
- [3] Berdenov Z.G., Kalibekova S., Makhanova N.B., Iliash D.K. and Inkarova Z.I., Landscape structure of the city of Nur-Sultan in the development of the "Green Belt". *Bulletin of Mahambet Utemisov West Kazakhstan University*, Vol. 4, Issue 80, 2020, pp. 322-332.
- [4] Ainakul N., Nurymov S. and Beknazarov A., Formation and development of an innovation ecosystem. *Bulletin of the Turan University*, Vol. 1, Issue 93, 2022, pp. 192-199.
- [5] Shakenova Z. and Ozeranskaya N., Territorial zoning of agricultural land on an ecological-landscape basis. *Problems of the Agricultural Market*, Vol. 2, 2022, pp. 187-194.
- [6] Decree of the President of the Republic of Kazakhstan No. 887 "On Certain Issues of the Administrative-Territorial Structure of the Republic of Kazakhstan". 2022. <https://legalacts.egov.kz/npa/view?id=14133066>
- [7] Decree of the Government of the Republic of Kazakhstan No. 625 "On the draft Decree of the President of the Republic of Kazakhstan "On approval of the predictive scheme of the territorial and spatial development of the country until 2030". 2019. <https://adilet.zan.kz/rus/docs/P1900000625/info>
- [8] Ospanova A., Anuarova L., Spanbayev A., Tulegenova Z., Yechshzhanov T., Shapalov S., Gabdulkhayeva B., Zhumabekova B., Kabieva S. and Baidalinova B., Cytospora cankers on tree plants in urban areas (Karaganda, Astana, Pavlodar) of central and northern Kazakhstan. *Ekoloji*, Vol. 27, Issue 106, 2018, pp. 63-69.
- [9] Allaberdiev R., Rakhimova T., Komilova N., Kamalova M. and Kuchkarov N., Study of Plant Adaptation to the Arid Zone of Uzbekistan based on System Analysis. *Scientific Horizons*, Vol. 24, Issue 10, 2021, pp. 52-57.
- [10] Komilova N., Haydarova S.A., Xalmirzaev A.A., Kurbanov S.B. and Rajabov F.T., Territorial structure of agriculture development in uzbekistan in terms of economical geography. *Journal of Advanced Research in Law and Economics*, Vol. 10, Issue 8, 2019, pp. 2364-2372.
- [11] Sarsembayeva N., Abdigaliyeva T., Kirkimbayeva Z., Valiyeva Z., Urkimbayeva A. and Biltebay A., Study of the degree of heavy and toxic metal pollution of soils and forages of peasant farms in the Almaty region. *International Journal of Mechanical Engineering and Technology*, Vol. 9, Issue 10, 2018, pp. 753-760.
- [12] Paton B.E., Chernets A.V., Marinsky G.S., Korzhik V.N. and Petrov V.S., Prospects of using plasma technologies for disposal and recycling of medical and other hazardous waste. Part 1. *Problemy Spetsial'noj Electrometallugii*, Issue 3, 2005, pp. 49-57.
- [13] Kornichuk N.M., Metelska M.O. and Kyrychuk G.Y., Ecological and geographical characteristics of algal communities on

- gastropod shells of the river Uzh. *Biosystems Diversity*, Vol. 25, Issue 3, 2017, pp. 186-190.
- [14] Komilova N.K., Territorial analysis of medical geographical conditions of Uzbekistan. *Current Research in Behavioral Sciences*, Vol. 2, 2021, 100022.
- [15] Yuan J., Yang D., Liu N. and Gao C., A local-scale participatory zoning approach to conflict resolution in protected areas. *Landscape and Urban Planning*, Vol. 232, 2023, 104677.
- [16] Iglesias M., Hermoso V., Campos J., Carvalho-Santos C., Fernandes P., Freitas T., Honrado J., Santos J., Sil A., Regos A. and Azevedo J., Climate- and fire-smart landscape scenarios call for redesigning protection regimes to achieve multiple management goals. *Journal of Environmental Management*, Vol. 322, 2022, 116045.
- [17] Lorilla R., Kalogirou S., Poirazidis K. and Kefalas G., Identifying spatial mismatches between the supply and demand of ecosystem services to achieve a sustainable management regime in the Ionian Islands (Western Greece). *Land Use Policy*, Vol. 88, 2019, 104171.
- [18] Ryskaliyeva A.K., Baltabayev M.E. and Abaeva K.T., Empirical method for predicting the enthalpy changes of combustion of amides. *Journal of the Serbian Chemical Society*, Vol. 84, Issue 5, 2019, pp. 477-481.
- [19] Paton B.E., Chernets A.V., Marinsky G.S., Korzhik V.N. and Petrov V.S., Prospects of using plasma technologies for disposal and recycling of medical and other hazardous waste. Part 2. *Problemy Spetsial'noj Electrometallugii*, Issue 4, 2005, pp. 46-54.
- [20] Yang Y., Zhe F., Wu K. and Lin Q., How to construct a coordinated ecological network at different levels: A case from Ningbo city, China. *Ecological Informatics*, Vol. 70, 2022, 101742.
- [21] Alekseev A.N., Alekseev S.A., Zabashta Y.F., Hnatiuk K.I., Dinzhos R.V., Lazarenko M.M., Grabovskii Y.E. and Bulavin L.A., Two-dimensional ordered crystal structure formed by chain molecules in the pores of solid matrix. *Springer Proceedings in Physics*, Vol. 221, 2019, pp. 387-395.
- [22] Ryskaliyeva A.K., Baltabayev M.E. and Abaeva, K. T., Regularities of enthalpies of combustion of nitrogen-containing organic compounds. *Journal of the Chemical Society of Pakistan*, Vol. 41, Issue 3, 2019, pp. 531-534.
- [23] Xu Z. Peng J., Dong J., Liu Y., Liu Q., Lyu D., Qiao R. and Zhang Z., Spatial correlation between the changes of ecosystem service supply and demand: An ecological zoning approach. *Landscape and Urban Planning*, Vol. 217, 2022, 104258.
- [24] Uehara M., Holistic landscape planning's value for natural disaster reconstruction: willingness to pay for new residence in different reconstruction planning approaches. *GEOMATE Journal*, Vol. 16 Issue 56, 2019, pp. 92-97.
- [25] Burdzieva O.G., Alborov I.D., Tedeeva F.G., Makiev V.D. and Glazov A.P., Mining Caused Pollution of the Natural Landscape. *GEOMATE Journal*, Vol. 15 Issue 51, 2018, pp. 195-200.
- [26] Tyliczszak B., Drabczyk A. and Kudłacik-Kramarczyk S., Smart, self-repair polymers based on acryloyl-6-aminocaproic acid and modified with magnetic nanoparticles—preparation and characterization. *International Journal of Polymer Analysis and Characterization*, Vol. 23, Issue 3, 2018, pp. 226-235.
- [27] Korneychuk N.N. and Kirichuk G.Y., Structural and functional organization of phytomicroperiphyton of the transboundary stviga river. *Hydrobiological Journal*, Vol. 54, Issue 1, 2018, pp. 3-18.